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Markku Kotilainen

EXCHANGE RATE UNIONS

A Comparison with Currency Basket and Floating Rate Regimes

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EXCHANGE RATE UNIONS: A COMPARISON WITH CURRENCY BASKET AND FLOATING RATE REGIMES

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ABSTRACT: In the study three exchange rate regimes, the exchange rate union, basket peg regime and floating rates, are analyzed and compared in a recursive three-country framework. We have two big countries and a small open economy, in which the different regimes are compared. The exchange rate between the big countries is floating. The big countries can be called "the USA" and "EMU". The small country (for example, Finland) can have an exchange rate union with " EMU". We use two types of models. The first one is a static extended Mundell-Fleming model, where prices can be fully rigid, fully flexible or something between. The other model is a dynamic rational expectations model along the Dornbusch tradition. We study the effects of various kinds of shocks in each regime. The shocks are goods demand, monetary and supply (productivity) shocks. They can occur in each of the three countries. The total number of shocks is thus nine. In the case of domestic shocks we obtain the result that floating rates insulate the output in the short run more than fixed rates against goods demand shocks. In the cases of monetary and productivity shocks it is the other way round. When having endogenous prices, the outcome is not as dichotomic as when prices are fixed. In the cases of foreign shocks we have to use simulations with sensitivity analysis. According to these the basket peg regime insulates the output well when prices are rigid. When domestic prices respond to the foreign ones, floating performs the best against foreign monetary and productivity shocks. The exchange rate union performs the best when there is a goods demand shock originating in the "EMU" area. The exchange rate union performs the worst when there is a monetary or productivity shock in the "EMU" area. When domestic prices respond fully to changes in foreign prices there is no difference between the regimes with respect to output insulation. We use the framework also in evaluating three potential criteria for optimum currency areas: the degree of price indexation, foreign trade share of the union partner, and the degree of product differentiation. Additionally, we study the effects of indexation of public expenditure and of taxes on the insulation properties of different regimes. We notice among other things that when prices are fully indexed and public expenditure is unindexed, fixed rates lead to a smaller deviation of output than floating, which is the opposite to the traditional Mundell-Fleming analysis, where public expenditure is implicitly fully indexed.

KEY WORDS: Exchange rate regimes, exchange rate union, currency basket exchange rate regime, floating rates, European monetary integration

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TIIVISTELMÄ: Tutkimuksessa analysoidaan ja vertaillaan kolmea valuuttakurssijärjestelmää: valuuttakurssiunionia, korijärjestelmää ja kelluvia kursseja. Tarkastelukehikkona käytetään kahta rekursiivista kolmen maan makroteoreettista mallia. Niissä on kaksi suurta maata ja yksi pieni avoin talous. Vaihtoehtoisia järjestelmiä vertaillaan pienessä maassa, suurten maiden välinen kurssi kelluu. Suuria maita voidaan kutsua nimillä "USA" ja "EMU". Pieni maa (esimerkiksi Suomi) voi muodostaa valuuttakurssiunionin "EMU"n kanssa. Ensimmäinen malli on staattinen laajennettu Mundell-Fleming -malli, jossa hinnat ovat täysin kiinteitä, täysin joustavia tai jotakin niiden väliltä. Toinen kolmen maan malli on dynaaminen rationaalisten odotusten ns. Dornbusch-tyyppinen malli. Tutkimuksessa analysoidaan erilaisten taloudellisten häiriöiden vaikutuksia kussakin järjestelmässä. Tarkasteltavat häiriötyypit ovat: hyödykkeiden kysyntään, rahan tarjontaan (tai kysyntään) ja hyödykkeiden tarjontaan liittyvät häiriöt. Ne voivat tapahtua kussakin tarkasteltavassa kolmessa maassa. Häiriöitä on siten kaikkiaan yhdeksän. Kotimaisten häiriöiden suhteen saadaan tulos, jonka mukaan kelluvat kurssit vakauttavat lyhyellä aikavälillä tuotantoa kysyntähäiriöiden sattuessa enemmän kuin kiinteät kurssit. Rahataloudellisten ja hyödykkeiden tarjontaan liittyvien häiriöiden sattuessa tilanne on päinvastainen. Hintojen ollessa endogeeniset tulos ei ole niin kaksijakoinen kuin kiinteiden hintojen tapauksessa. Ulkomaisten häiriöiden analyysissa käytetään numeerisia simulointeja ja tehdään herkkyysanalyyseja. Näiden mukaan korijärjestelmä insuloi tuotannon hyvin kaikkia häiriöitä vastaan, kun hinnat ovat jäykkiä. Kun kotimaiset hinnat reagoivat ulkomaisiin, kellunta toimii tällä kriteerillä mitattuna parhaiten ulkomaisia rahataloudellisia ja tuottavuushäiriöitä vastaan. Valuuttakurssiunioni toimii parhaiten "EMU"-alueelta peräisin olevien hyödykkeiden kysyntähäiriöiden tapauksessa. Se toimii taas huonoiten "EMU"-alueelta peräisin olevien rahataloudellisten ja tuottavuushäiriöiden sattuessa. Kun kotimaiset hinnat muuttuvat samassa suhteessa ulkomaisten hintojen ja valuuttakurssin kanssa, järjestelmien välillä ei ole eroja tuotannon vakauden suhteen. Tutkimuksessa tarkastellaan mainituilla malleilla myös kolmea potentiaalista optimivaluutta-alueen kriteeriä: hintojen indeksoinnin astetta, unionikumppanimaan ulkomaankauppaosuutta ja tuotteiden differentioinnin astetta. Lisäksi tutkimuksessa analysoidaan julkisten menojen ja verojen indeksoinnin vaikutusta eri järjestelmien vakauttamisominaisuuksiin. Tutkimus osoittaa muun muassa, että kiinteät kurssit vakauttavat tuotantoa paremmin kuin kelluvat kurssit, kun hinnat ovat täysin indeksoidut ja julkiset menot täysin indeksoimattomat. Tämä tulos on päinvastainen kuin perinteisissä Mundell-Fleming-malliin pohjautuvissa analyyseissa, joissa julkiset menot ovat implisiittisesti täysin indeksoidut.

ASIASANAT: Valuuttakurssijärjestelmät, valuuttakurssiunioni, korivaluuttajärjestelmä, kelluvat kurssit, Euroopan rahataloudellinen integraatio

PREFACE

The present study sheds light on some of the numerous aspects which are related to exchange rate regimes. The main focus of the study is on the effects of foreign shocks in different exchange rate regimes. The practical motivation for studying the exchange rate union, floating rates and the currency basket exchange rate regime is that Finland, as well as Norway and Sweden, have had all these regimes during the past few years. The crises of the European Monetary System (EMS) in autumn 1992 and in 1993 have also increased the need to analyze exchange rate unions. The question of the possible formation of the Economic and Monetary Union (EMU) is, however, the most important motivation for the whole study.

This thesis is one in a series of research reports that I have completed concerning exchange rate regimes. My interest in these questions goes back to years 1976-1977 when I participated in the laudatur seminar led by Professor Jouko Paunio. He advised me to prepare my Master's thesis in this area, instead of my originally planned topic in the area of foreign trade. My interest in this topic has remained keen over the years, regardless of other kinds of projects which I have had when working as a researcher in two research institutes and in the Ministry of Finance.

A possibility to continue my research in this field opened when I obtained one year's funding from The Academy of Finland in 1991 for the preparation of my licentiate thesis. After this I received funding for an additional year in 1993 from the Yrjö Jahnsson Foundation for the doctoral thesis, which is a continuation of the licentiate thesis. Without this financial support my thesis would perhaps never have come to an end.

During my thesis project I have discussed with several researchers and got comments and advice for my work. Many comments have influenced my research, while many other good comments have been neglected because they would have shifted the research to areas which I decided to exclude from the scope of the current study. During the preparation of doctoral thesis I have especially profited from the comments of Erkki Koskela (chapter 7) and Olavi Rantala (chapter 5). During the preparation of licentiate thesis, which has been the basis for chapter 4, Kari Alho, Vesa Kanniainen and Clas Wihlborg were the most active persons. Pertti Haaparanta, Jukka Lassila and Pentti Pikkarainen have commented upon my papers during the licentiate as well as the doctoral thesis. Additionally I want to thank some other commentators of *my papers in various seminars; they include, in alphabetical order, Olle Anckar, Torben Andersen, William Brainard, Stephen Golub, Thorvaldur Gylfason, Seppo Honkapohja, James Tobin, Pentti Vartia and Charles Wyplosz.*

I also want to thank my official examiners Pertti Haaparanta and Tapio Palokangas as well as my colleague John Rogers, who has kindly checked my English. Their comments have helped me to find the final form of the thesis.

My employer The Research Institute of the Finnish Economy (ETLA) has provided me with working facilities also during my leave of absence and partial financial assistance during the licentiate thesis. It also publishes the thesis. I wish to express my thanks for this support.

Finally I want to thank my wife Eija-Maija and my son Juhana for their patience during the process of preparing the thesis.

Helsinki, September 1995

Markku Kotilainen

CONTENTS

1 INTRODUCTION

In this study exchange rate unions are systematically compared with currency basket and floating rate regimes. An exchange rate union means a more or less fixed peg of a currency's exchange rate to that of another country or an area inside which the exchange rates are fixed. The Exchange Rate Mechanism (ERM) of the European Monetary System (EMS) and the possibly evolving European Economic and Monetary Union (EMU) are examples of exchange rate unions. The union can be based on joint interventions in defending the exchange rates, as in the case of the ERM, but also a unilateral peg of a currency to another one can be regarded as a form of an exchange rate union, even if the peg in this case is usually less credible.

A currency basket exchange rate regime in this context refers to a system where a currency is pegged to a trade-weighted currency basket. An essential feature of a trade-weighted basket is that it stabilizes the effective exchange rate of a country. This kind of a system was followed for example in Finland and Sweden until 1991, and in Norway until 1990. After that these countries unilaterally pegged their currencies to the European Currency Unit (ECU) until autumn 1992 when they allowed their currencies to float at approximately the same time as the United Kingdom and Italy.[1] There are still many other countries which use their own, often trade-weighted, currency baskets (see appendix 1). In the floating rate regime the exchange rate is

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[1]The ECU is a kind of a currency basket, too, but the weights of the currencies are common to all countries. From 1987 until autumn 1992 there were rarely realignments of the currencies participating in the ERM of the EMS, i.e. the ERM was rather "hard". In the future the ECU is planned to be the common currency of the European Economic and Monetary Union (EMU).

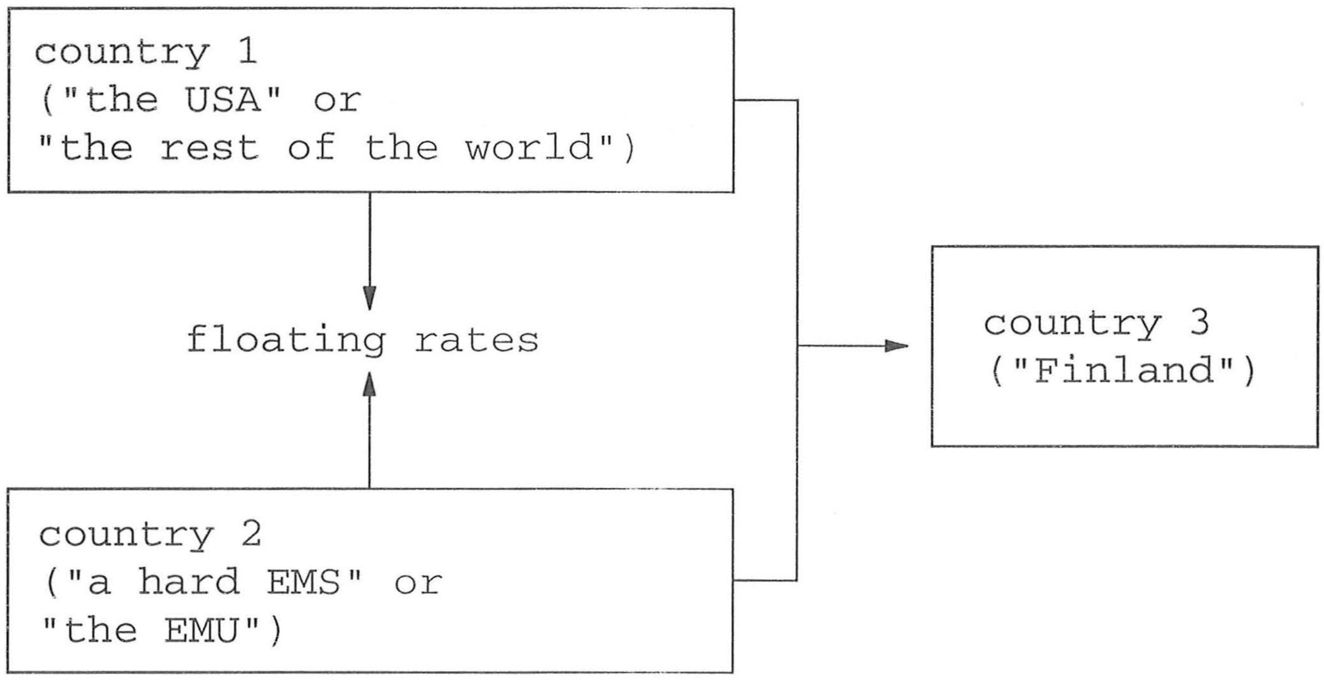
determined freely in the foreign exchange market on the basis of the equilibrium conditions of the economy.

In the analysis of the exchange rate union and the basket regime we confine ourselves to studying credibly fixed rates, i.e. the exchange rates are not expected to change and there is no risk of a change. The study thus puts the emphasis on the systemic properties of the exchange rate regimes rather than on exchange rate policies.

The framework used is a three-country macroeconomic model, in which we have two big countries and a small open economy. The models of the big countries are solved simultaneously, whereas the small country is modelled in a recursive way - i.e. the big countries affect the small economy, but not the other way round.

The bilateral exchange rates of the big countries are determined freely in the foreign exchange market, reflecting the characteristics of the floating rate regime, which is in use between the main currency blocs in the world of today. The big countries can thus be called the "USA" (country 1) and the "EMS" or the "EMU" (country 2). In the third country, which can be called "Finland" or some other small economy, we study three alternative exchange rate regimes: floating rates, exchange rate union with country 2 ("EMU"), and a currency basket exchange rate regime.

Figure 1. Description of the research framework



A common practice in the literature on exchange rate regimes is to study the insulation properties of the regimes in the face of exogenous shocks. We also follow the same procedure. The shocks we study are goods demand, monetary and productivity shocks. These shocks can occur in the home country or in either of the big countries. The total number of the shocks studied is thus nine.

The idea behind the shock approach is that stabilization of certain economic variables, especially of output and prices, against exogenous shocks is desirable. This objective can be legitimized by arguing that stable economic development produces a higher level of welfare than fluctuating development. It can also be motivated by the adjustment costs connected with fluctuating economic development.

The models of each country are basically traditional open economy IS-LM models. In the first part of the study the model used is static with static expectations. The general model includes a supply curve, which makes producer prices endogenous. One special case of this is a fixed price demand determined model according to the Mundell-Fleming tradition. At the other extreme we have a version where domestic producer prices respond fully to changes in foreign prices.

The second model is a dynamic demand-determined rational expectations model. The contribution of the study is here the widening of the so-called Dornbusch-type two-country dynamic analysis of floating and fixed exchange rates into a three-country analysis of floating and the two types of fixed rate regimes.

The main theoretical contribution of this study lies in the field of theories on exchange rate regimes and in the field of the theory of optimum currency areas. The primary modelling contribution entails the widening of the IS-LM framework into a three-country context and in the explicit comparison of the above-mentioned three exchange rate regimes in this framework.

This kind of a three-country study sheds more light on different ways of fixing the exchange rate and on different types of fixity and flexibility than is possible in one- or two-country models. In a floating rate world the exchange rate of the home country is fixed in the exchange rate union with respect to the union partner, but floating with respect to the rest of the world. In the basket peg regime the trade-weighted (effective) rate is fixed. From a macroeconomic point of view the degree of fixity is higher than in the union, even if the bilateral rates can change. Having three countries in the model makes it possible to compare the transmission of foreign shocks in the exchange rate union and in the basket peg regime.

Part of the research can be done analytically. Because of the complexity of the model, there are, however, limitations for obtaining *a priori* results. In these cases the analysis has been extended by means of numerical simulations with sensitivity analysis. Even if numerical techniques are limiting as such, sensitivity analysis with relevant key parameter values gives new insight both into the research of exchange rate regimes and into the properties of the models used.

The study is organized as follows. In chapter 2 a brief survey of theories on exchange rate regimes is presented. In chapter 3 the theoretical approach of the current study is outlined. In chapter 4 the static model is used for analyzing the effects of domestic and foreign goods demand, monetary and productivity shocks. In the case of foreign shocks the two-country world economy model is solved first, and then the effects on the small open economy are recursively analyzed under different exchange rate regimes. It is shown that the results obtained in the fixed price model are modified when supply reactions are taken into account. In the end of chapter 4 an overall evaluation of the results of the static model is presented.

In chapter 5 a dynamic rational expectations model is introduced and used for the analysis of the three exchange rate regimes. Because of the expectation mechanism interest rates can now differ between countries in the floating rate regime. In the basket peg regime the interest rate is a weighted average of the large countries' interest rates. This model is demand determined. Inflation is modelled through a Phillips curve. There is no direct effect of import prices on the domestic price level as in the static model. The nine unexpected exogenous shocks are analyzed in this chapter in a similar way as in the previous model. The main emphasis is on the effects of rational expectations and on the adjustment paths of the most important economic variables in each regime.

In chapter 6 the effects of the shocks are studied with reference to three important criteria for optimum currency areas: the degree of price indexation, the degree of foreign trade integration and the differentiation of foreign trade. A three-country study with a wide variety of shocks sheds new light on the usefulness of the criteria, which usually have been studied in one-country models. In chapter 7 the effects of indexation of public expenditure and taxes are analyzed. As far as I know this is the first study where these forms of indexation are studied consistently in different exchange rate regimes. The summary and evaluation of the results are presented in chapter 8.

2 A SURVEY OF THE THEORIES OF EXCHANGE RATE REGIMES

Modern discussion on the choice of an exchange rate regime goes back to Friedman's (1953) critique of the fixed rate regime. Friedman argued in favour of flexible rates, mainly because he thought that the world economic situation then prevailing was ill-suited to fixed rates. According to Friedman the existing trade barriers and other direct controls could have been abolished by the use of flexible rates. He also argued that the use of flexible rates would release monetary policy from external targets for maintaining internal balance.

Other proponents of flexible exchange rates included Sohmen (1961) and Harry Johnson in his various writings (see Johnson, 1972). Sohmen (1961,

viii) argued that "monetary policy is severely handicapped if exchange ratios against other currencies remain rigidly fixed". According to him monetary policy is the central instrument for smooth and effective countercyclical policy. He questioned the theoretical arguments against floating, maintaining that low elasticities of import and export demand would mitigate real effects of exchange rate changes. The inflationary effects of depreciations are not to his mind a great problem in economic recessions, when depreciations usually occur. Based on a theoretical analysis he also argued that speculation could very well be stabilizing rather than destabilizing.

Johnson's writings are even more policy oriented than those of Friedman and Sohmen. He presents several arguments for and against exchange rate flexibility. His conclusions about the net effects are strongly in favour of flexibility.

These early writings were, although important for the later studies, still rather intuitive and lacked a firm theoretical framework. The theoretical foundation for the analysis of exchange rate regimes was built in the early 1960's with the so-called Mundell-Fleming model, which goes back to Mundell (1960, 1961b, 1961c, 1963, 1964; collected in 1968) and Fleming (1962). (For a survey of the development of the Mundell-Fleming model, see Frenkel and Razin, 1987.) From the insulation point of view the main conclusion of the Mundell-Fleming analysis is that fixed rates are preferable to flexible rates if domestic monetary disturbances are important since they have no impact on output under fixed rates. The only result is a change in foreign exchange reserves. On the other hand, if aggregate demand disturbances are important, flexible rates are preferable, because they eliminate the effects on output.[2]

The results of the original Mundell-Fleming model are strong and dependent on the assumptions used: (1) a small country, (2) assets are perfect substitutes, (3) the exchange rate does not affect asset demand (see Tobin and Macedo, 1980), (4) perfect capital mobility, (5) exchange rate expectations are static, (6) nominal wage and price levels are fixed, (7) there are unemployed resources, (8) an exchange rate depreciation (appreciation) improves (worsens) the balance of trade (the Marshall-Lerner condition), and (9) the whole model is a static one. In spite of these limiting assumptions, the Mundell-Fleming model is still an important starting point for further analysis.

Originally the Mundell-Fleming analysis was developed in a one-country model. It has been widened, however, subsequently to a two-country context (see Mundell, 1964; Swoboda and Dornbusch, 1973; Mussa, 1979; Allen and Kenen, 1980, and Dornbusch, 1980). Argy and Salop (1983) developed the two-country model further by allowing wages and prices to vary and by studying the effects of monetary and fiscal policies with and without real wage indexation in the case of flexible exchange rates. They found that when real wages are fully indexed, fiscal stimulus expands output at home, but this occurs at the expense of output abroad. In the case of monetary policy they obtained the result that world output remains unchanged if wages are fully indexed. The big country model presented in chapter 4 of this study resembles

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[2]From the policy effectiveness point of view the conclusion is that under the regime of fixed rates monetary policy is ineffective in influencing output, whereas fiscal policy is effective. In the floating rate regime it is the other way round.

this kind of a model. In the 1980s some researchers have developed the two-country IS-LM model in a dynamic context (see especially Buiter, 1986; see also Wohltmann, 1991).

Early proponents of flexible exchange rates argued that this regime would insulate the economy from foreign disturbances. To analyze this Marston (1983) developed a model of the foreign economy, and analyzed first the impacts of the disturbance inside that country. After that he considered how the disturbances are transmitted to the small domestic economy. Marston showed that a purely monetary foreign disturbance becomes both a real and monetary disturbance from the domestic country's point of view. Marston argued that flexible exchange rates insulate the domestic economy only in special cases.

Exchange rate unions have traditionally been analyzed with the frameworks suggested by the optimum currency area literature (see for example Ishiyama, 1975; Kotilainen and Peura, 1988; Wihlborg and Willett, 1991; De Grauwe, 1992). The traditional optimum currency area approach tries to single out crucial economic criteria for fixing exchange rates between countries, i.e. for forming a currency union.

According to the traditional approach the following characteristics are thought to increase the attractiveness of exchange rate fixity within an area: (1) high mobility of factors of production (Mundell, 1961a), (2) high share of tradeables in production (openness criterium) (income and price stabilization by fixing) (McKinnon, 1963), (3) a high degree of product diversification (Kenen, 1969), (4) a high degree of financial integration within an area (especially concerning long-term securities) (Ingram, 1969), (5) similarity in rates of inflation (Haberler, 1970; Fleming, 1971), (6) stable real exchange rates (Vaubel, 1978), (7) a high degree of policy integration (for example Tower and Willett, 1970).

Ishiyama (1975) evaluates and criticizes the above-mentioned criteria. For instance, a high mobility of factors of production is shown to be an insufficient condition for fixing an exchange rate. Fleming (1971) has pointed out that internationally mobile capital as a precondition for countries forming an optimum currency area depends on the nature of the disequilibrium, the sensitivity of investment to economic activity and the allowed time period for adjustment. Corden (1973), in turn, criticizes the view that labour movements could be relied upon as a substitute for payments adjustments, both because such a high degree of mobility is not attainable between countries, and because migration creates substantial adjustment costs.

Concerning criteria (2) and (3) Ishiyama (1975, 351-354) points out that they are very sensitive to the type of disturbances facing a country. The product diversification criterion leads easily to a conclusion that is the exact opposite to the conclusion drawn through the openness criterion. The more diversified an economy is, the larger it would be and the smaller the foreign trade sector would be. (For this discussion, see Kenen, 1969b and McKinnon, 1969.)

Criterion (4) means mainly a high degree of asset substitutability. It has been argued that under such circumstances the need for exchange rate changes would be eliminated, because only fractional changes in interest rates would evoke sufficient equilibrating capital flows between countries. Tower and Willett (1970) criticize the mechanism presented by criterion (4) of being primarily financing than correcting, or adjusting payments imbalances. The critique presented against the capital mobility criterion is partly valid in the case of criterion (4), too.

Criterion (4) can, however, be interpreted, according to the latest experience, as an argument in choosing between a fixed but adjustable exchange rate regime as the EMS and a monetary union as the EMU. It has been argued that a high degree of capital mobility makes it difficult to maintain fixed parities if realignments are not permanently ruled out in the form of a common currency. These kinds of arguments have been presented for example by Wihlborg and Willett (1990), De Grauwe (1993) and Eichengreen and Wyplosz (1993). This view has gained more strength with the instability of the EMS since autumn 1992. But it can also be claimed that increasing capital mobility improves the working mechanism of floating rates by adding stabilizing speculation (for example Wihlborg and Willett, 1991).

The "similarity in rates of inflation" criterion can be criticized as being insufficient, because balance of payments problems can arise for microeconomic reasons, too. Changes in demand and supply conditions can lead to changes in equilibrium exchange rates and worsen real competitiveness even if inflation is in line with that of other countries.

Vaubel (1978) criticizes the "traditional" optimum currency area literature for being too eclectic and difficult to operationalize and weight various criteria. He suggests deviations from relative purchasing power parity (real exchange rate changes) as "a comprehensive and operational criterion of the desirability of currency unification".

Vaubel (p. 320) argues that the implications of various previously presented criteria are reflected in the real exchange rate criterion. Real exchange rate changes tend to be the smaller, the larger the factor mobility is. If trade and capital movements between the member countries are highly diversified, the law of large numbers reduces the probability and size of changes in each country's terms of trade (and "terms of finance"). Vaubel (p. 321) argues also that observed real exchange rate changes tend to be the smaller, the more open the potential member economies are vis-à-vis each other.

The policy integration criterion involves diverse elements and it is not very homogeneous. Tower and Willett (1970, 411) mean by policy integration the member countries' general attitude toward inflation and unemployment and their abilities to "trade off between these objectives". In a currency area where each country has its own central bank a similar attitude against inflation is crucial. With respect to fiscal policy the conclusions are not as straightforward. Fiscal policy should be in line with the objectives of the currency area, but on the other hand room for manoeuvre in each country might be needed in responding to country-specific problems. Additionally the current debate on the need for a union-wide fiscal policy through the union budget is related to this criterion (see for example Eichengreen, 1990).

According to the traditional theory of optimum currency areas a common currency or fixed exchange rates are the more attractive the less there are asymmetric (idiosyncratic) shocks in the country in question. This assumption is behind many of the more specific criteria presented earlier. Symmetry of shocks means similar original shocks as well as similarity of the reactions of the economies to common shocks.

It is generally assumed that European economic integration according to the 1992 plan, and reinforced by the common currency, will tend to increase the similarity of economic structures inside the European Union. This assumption is based on increasing role of intra-industry trade and on the converging economic behaviour because of external discipline.

Krugman (1991, 83) argues, however, that increasing integration can lead also to the outcome that European nations become less similar, not more. This argument is based on the reasoning that decreasing obstacles to trade strengthen the importance of economies of scale, which leads to a concentration of production. This kind of a development is exemplified also by the experience of the United States, where production is geographically more concentrated than in Europe (Krugman, 1991, 78). (See also Eichengreen, 1990.) Concentration of production, in turn, makes countries more vulnerable to industry-specific shocks.

Ishiyama (1975) prefers a cost-benefit analysis, where all possible criteria are taken into account in evaluating the pros and cons of a monetary union. Weighting the various criteria in a generally accepted way is, however, a difficult task for an economist.

Heller (1978) studies empirically the exchange rate arrangements of 86 IMF countries to identify the most important characteristics, which help to predict whether a particular country will be a floater or a pegger. Based on a hypothesis given by the theory of optimum currency areas and using the statistical technique of discriminant analysis Heller derives the following characteristics of a floater: (1) a large GNP, (2) a low degree of openness, (3) a high inflation differential, (4) a high degree of international financial integration, and (5) a low trade concentration. The characteristics of a pegger are, correspondingly: (1) a small GNP, (2) a high degree of openness, (3) a small inflation differential, (4) a low degree of international financial integration, and (5) a high trade concentration.

Honkapohja and Pikkarainen (1992) is a similar analysis to that of Heller, but it uses newer data and logit and probit models. Their sample consists of 140 economies, developing and industrialized countries. The authors conclude that small countries with a low diversification of exports are the most likely candidates to peg their exchange rates. Other country characteristics as the level of development, openness of the real or financial sector, geographical diversification of exports, and fluctuations in the terms of trade have hardly any power in explaining the choice of a country's exchange rate regime.

The traditional optimum currency area literature, even if it is rather loose and eclectic, is still an important benchmark in the research of exchange rate unions and provides a lot of working hypotheses for further theoretical and empirical studies. During recent years there has been a rise in the interest in this theory (for example Wihlborg and Willett, 1991; Melitz, 1991 and 1993; Minford, 1995). The criteria presented by the early writers are to be analyzed by means of alternative models and techniques.

New theoretical studies have also added criteria for optimum currency areas. Often these criteria have been presented without mentioning this theory explicitly. Additional macroeconomic criteria which should be emphasized are: (1) the degree of integration with the potential union partner (for example Marston, 1985; Callan, 1989), (2) the degree of wage and price indexation (for example Gray, 1976; Flood and Marion, 1982; Marston, 1982; Turnovsky, 1983; Vilmunen, 1992), (3) the credibility of the domestic monetary policy authorities in their anti-inflationary policies (Giavazzi and Pagano, 1988), (4) importance of the national inflation tax in tax collection (seignorage) (Canzoneri and Rogers, 1990), and (5) the optimal size of a currency area as a function of reducing monetary sales costs in the union and increasing costs due to slower terms of trade adjustment (Melitz, 1991 and 1993).

The first-mentioned criterion does not suggest any clearcut (general) criterion, and the studies done have put emphasis on only some aspects and on some shocks. The literature on this criterion is surveyed later in the context of multi-country models on page 19. (The criterion is analyzed in section 6.2.)

The indexation literature is often more devoted to exchange rate policies than to exchange rate regimes. The main finding of this literature is that exchange rate policy is impotent in changing output if prices are fully flexible. It also implies that there are no differences in terms of output deviation between exchange rate regimes in this case (see Marston, 1982). It is shown in chapter 7 of the current study, however, that this result is not general but requires full indexation of such components of aggregate demand as public expenditure and taxes. (Price indexation as a criterion is analyzed in section 6.1.)

Criterion (3) suggests that countries which lack an anti-inflationary reputation should "tie their hands" by pegging their currencies to the currency of a country whose authorities are "hard nosed", i.e. are credibly anti-inflationary. This argument is based on the models of time consistency and credibility presented by Kydland and Prescott (1977) and Barro and Gordon (1983). They also build on the analysis of Rogoff (1985) about the credibility increasing role of a conservative central banker. (For a discussion on the credibility literature, see De Grauwe, 1992, 45-55.)

An important article in this line of research is Giavazzi and Pagano (1988). The authors of this article clarify the criteria under which a high-inflation country might feel it tempting to belong to an agreement such as the ERM of the EMS. One of the most important characteristics of the ERM is that individual countries are not able to determine their exchange rate or the realignment date. This element creates discipline for the policy makers, because it is an extra penalty for inflation in terms of real appreciation. Membership in the ERM also makes the public aware of this penalty, and thus helps to overcome the inefficiency stemming from the public's mistrust of the authorities.

The gain from tying one's hands is measured by a welfare function, which includes the real exchange rate and an inflation surprise with a positive coefficient, and a quadratic term in inflation with a negative coefficient. The policy maker's control variable is the rate of money creation, and thus inflation. In a rational expectations equilibrium the actual inflation equals the expected inflation. The authorities' incentive to create surprises is thus merely a source of inefficiency, and it is precisely this inefficiency that the ERM is supposed to correct.

Giavazzi and Pagano (p. 1063) show that when the policy maker's incentive to create inflation surprises exceeds the discounted penalty of the appreciating real exchange rate, the ERM regime is unambiguously superior to floating rates. If however the discounted penalty of the appreciating real exchange rate exceeds the incentive to create inflation surprises, the ERM regime is no longer unambiguously superior. The outcome depends in this case on the realignment period, and on how great the difference is between the terms included in the objective function. The longer the realignment period, the more likely it is that the ERM regime is deemed superior.

Canzoneri and Rogers (1990) use a two-country cash-in-advance model in analyzing the importance of national seigniorage when compared to the cost of national currencies in the form of transactions costs. The starting point is in the situation prevailing in some Southern European countries. There the size of the black market is substantially greater than in the Northern EC countries. Taxing the black market succeeds mainly by means of an inflation tax.

The analysis is based on the public finance literature. According to this approach tax rates should be set to spread the distortions that taxes create: the marginal disutility from the last revenues raised should be equalized across all revenue sources. "Optimal tax rates will depend upon characteristics of the activities being taxed, including collection costs; goods and services that are easily taxed in one region may be difficult to tax in another. There is no reason to think that optimal inflation tax for Germany will be the same as that for Italy... Regions that require the same inflation tax may form an optimal currency area. " (Canzoneri and Rogers, 420.)

The advantages of tax spreading in a multi-currency world must be compared to the advantages of a single currency. Canzoneri and Rogers show with the help of a numerical simulation of their model that already rather small valuation and conversion costs can make the EC an optimal currency area. They also show that the importance of the tax spreading argument increases with the share of the public sector in the economy. The benefits of a single currency in turn increase with openness of the economy. The authors show, however, that high substitutability of the goods of the two economies can make national currencies preferable even in the presence of large transaction costs. This is due to the possibility to shift in this case from foreign goods to domestic goods without (substantial) loss of welfare.

Melitz (1991 and 1993) combines arguments based on the theory of foreign trade and those based on open economy macroeconomics in a model where the optimal size of a currency area is determined. In the model of Melitz (1993) the benefits of enlarging a currency area are due to reducing the monetary costs of foreign trade. The costs, which are reduced in a monetary union, derive from having multiple currencies and multiple units of account. The increasing costs in a currency area are in turn due to the slower speed of movement in the real exchange rate to its long-run equilibrium level, when compared to floating rates. The long run is independent of the exchange rate regime, but a monetary union can create short-run costs because of sticky prices.

The costs of a monetary union depend in the model negatively on the ratio of intraindustry trade to total trade in the union, and on the ratio of non-monetary sales costs to trade inside the union. The former relationship is explained by fewer changes in the terms of trade with the other members, and the latter by quicker trade adjustment due to closer geographical, cultural and juridical ties. The costs of a monetary union depend positively on the difference between the equilibrium real exchange rate of the union currency and that of the national currency. If this difference is great, the adjustment of the national real exchange rate to its equilibrium level might be slow, because in the union the common real exchange rate tends to adjust to the equilibrium of the union rather than to that of an individual country.

The size of the currency area is a variable in the model. The model is solved with respect to the optimal value of this size variable. The optimal choice of union partners implies a rising marginal cost of monetary union, since with larger size, the best union partners will progressively worsen in quality.

Of the criteria presented above some have importance in my study, and they are studied more or less explicitly. These are: (1) the degree of wage and price indexation, (2) the degree of integration with the potential union partner, and (3) the degree of product diversification (related to the openness criterion). The conduct of fiscal policy in an exchange rate union is also treated from the indexation point of view in chapter 7.

There are some studies in which exchange rate unions are analyzed in a three-country setting. Marston (1985) studies the effects of a financial disturbance on the union participant countries. He uses a two-model approach where he has a financial market model, inside which the exchange rates are determined, and a real sector model to which the outcomes of the financial sector model are connected.

In the case of a portfolio shift between the union member country and an outside (third) country Marston's main conclusion is that the union disperses the exogenous financial disturbance so that its output effects are shared equally by both union member countries. (This result has importance from the point of view of the current study.) The union is seen in a better light in a case when there is a general disturbance involving shifts between third country securities and those of each of the member countries. If the shifts are less than perfectly correlated, both countries benefit from a diversification effect by joining the union.

Callan (1989) is a numerical dynamic three-country model for analyzing the impacts of an exchange rate union. Callan studies the choice between two potential exchange rate union partners. The study concludes that if deviations from long-run output are to be minimized, the small country should link to the major trading partner when both major countries are equally shock prone, to the shock-free country when trade is balanced, and to the shock free country when the major trading partner is shock prone.

McKibbin and Sachs (1991) use a multi-country approach, too. Their study is, however, more devoted to other aspects (international economic policies) than to an explicit comparison of exchange rate regimes. Their model differs from that of mine also by being a pure numerical simulation model. Argy, McKibbin and Siegloff (1989) is a numerical simulation study carried out with the above-mentioned McKibbin-Sachs global (MSG2) model in accordance with the economic situation of Australia. The other two countries in the model are the United States and Japan. The authors conclude that floating performs the best for every type of shock except for a shock to the Australian demand for money. They also find that, when choosing among fixed rate regimes, Australia is better off pegging to a basket of currencies.

Jones (1982) is a general equilibrium model for n countries. The focus of the study is in evaluation of exchange rate regimes with respect to their impacts on global welfare. The model is used also as a three-country version consisting of two large symmetrical countries ("Germany" and "France") and a superlarge country ("the USA"). The models for each country are very simple. The conditions for optimality become, however, very elaborate and dependent on the parameters of the model.

My approach resembles the three-country frameworks presented above even if the model I use is different. I also analyze a greater amount of shocks and alternative regimes.

In macroeconomic theory currency basket exchange rate regimes have been analyzed in the so-called optimal currency basket literature (for a survey see for example Pikkarainen, 1986; Kotilainen and Peura, 1988). In these studies the aim has been to derive optimal currency baskets with respect to some target variables for a small open economy faced with stochastic shocks. In some cases the covariances of the shocks have to some extent been taken into account, but usually the international transmission of the initial shocks has been neglected.

Bhandari (1985) is an exception; he uses a numerical model where, in addition to the home country, two foreign countries are modelled explicitly. Bhandari uses four optimality criteria: (1) stabilization of domestic output around its expected value, (2) stabilization of domestic output around its full equilibrium value (equivalent to the minimization of the variance of domestic prices), (3) stabilization of domestic reserve (money) stock levels and (4) stabilization of a domestic competitiveness index.

One of Bhandari's key concerns in his article is to compare the optimal currency shares derived under the above criteria with the simple trade weights commonly used in practice.

In his comparison Bhandari gets the following results: (1) except in a single razor edge case involving perfect symmetry worldwide, simple trade-weights are never coincident with optimal weights derived under any optimizing criterion, (2) if foreign monetary disturbances dominate, a low weight should be attached to the currencies of one's close trade partners, and (3) the simple trade weight criterion is insensitive to the relative size of foreign countries and to relative structural variables.

Pikkarainen (1986) and Edison and Vårdal (1987) are examples of macroeconomic studies where the optimal basket approach has been used in empirical research. Sauramo (1989) studies the strategic behaviour of countries using currency basket regimes in a game theoretic setting. Pikkarainen (1991a and b) studies the currency basket regime from a microeconomic point of view.

Floating and fixed exchange rates represent the two extreme alternatives in the choice of exchange rate regimes. There is a wide variety of regimes lying between the extremes, like crawling pegs and target zones. The adjustable peg regime is not a very fixed rate regime, either, if the adjustments occur frequently.

The traditional approach used in the study of these intermediate regimes are the models of optimal intervention. Boyer (1978) uses a simple IS-LM model, where he assumes that intervention can take place in goods and/or asset markets. He shows that if both monetary and aggregate demand disturbances affect the economy, a limited degree of foreign exchange intervention is called for. The optimal degree of intervention depends on the relative importance of the two disturbances. If monetary disturbances alone affect the economy, a fixed rate is optimal, but if aggregate demand disturbances alone affect the economy, a flexible rate is optimal. (About other studies in this line of research see, Edison, 1987 and Marston, 1983).

The problems related to the maintenance of fixed but adjustable exchange rates are in turn analyzed in the studies of speculative attacks. For a survey of this literature, see Willman (1992). The time consistency and credibility literature, referred to above, is relevant also in this context.

In addition to the macroeconomic studies referred, there exist also studies, which concentrate on the microeconomic and business aspects of exchange rate regimes. This line of research is related to the transactions costs of currencies, to the costs of forward cover, and to the effects of these factors on the growth of the economy. These aspects have arisen in the discussion on EMU. (See European Economy, 1990; Baldwin, 1991.)

As has been seen above, the literature on exchange rate regimes is wide but on the other hand rather diffuse. It is not easy to find any clearcut criteria for choosing an exchange rate regime. Because different authors have used different kinds of models in their research, it is also somewhat difficult to make the studies commensurable. Some researchers have studied monetary shocks, some real shocks; some domestic, some foreign shocks etc.

While some conclusions can naturally be drawn, they are not very general. The performance of each exchange rate regime depends on the policy goals of the authorities or society, the nature and origin of the shocks, the country's structural characteristics, and the credibility of the policymakers. These limitations for the generality of the results must be taken as facts of life.

It is, however, necessary to get a more thorough picture of the working mechanisms of each exchange rate regime in the case of each shock and of those structural characteristics of the economy, which are of importance when choosing an exchange rate regime. The current study tries to shed some light on these characteristics by using the same framework for a wide variety of economic disturbances.

3 THE THEORETICAL FRAMEWORK OF THE CURRENT STUDY

My aim in this study is to concentrate on the properties of different exchange rate regimes in the face of different shocks. The criterion in evaluating the performance of the regimes is their ability to insulate important economic variables, especially the output and price levels, from unanticipated exogenous shocks. The study thus concentrates on rather short-term issues. The possible effects of exchange rate regimes on longer-term economic development is outside the scope of this research.

The emphasis is also on the structural characteristics of the regimes rather than on the exchange rate policies. The three regimes analyzed are to a large extent "pure" cases. The two fixed rate regimes, the exchange rate union and the basket peg regime, are assumed to be fully credible.[3] The floating rate regime is also modelled on the basis of the fundamentals, i.e. problems related

[3]It is possible to add a credibility term into the interest rate parity condition of the dynamic model, for example by linking credibility to the change in output or foreign demand (see Rantala, 1993). This is not, however, done in this study.

to, for example, destabilizing speculation are left aside. The main idea is thus to analyze the most important characteristics of the exchange rate regimes in the transmission of shocks. (For a broader collection of approaches in studying the European Economic and Monetary Union, see Kotilainen, Alho and Erkkilä, 1994.)

The model framework has to be chosen according to the research problem. In order for exchange rate regimes to have different impacts on the real variables some kind of a market failure is required. This is shown in the next chapter. One form of market failure is a situation where prices and wages are less than fully flexible. This fact means that the theoretical framework must allow for market imperfections, at least in the short run. This fact stresses the need of some form of "Keynesianism" in the model.[4]

I have chosen the extended Mundell-Fleming model as the framework of the study. This fulfills the requirement of the possibility of market failure in the short run and is manageable in the three-country framework. It is also widely used in the study of exchange rate regimes, making the results obtained comparable with those of many existing studies.

When using IS-LM models instead of, for example, asset market models I want to emphasize the longer than very short-term determinants of the exchange rate, i.e. the flow effects of both monetary and real factors.

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[4]Minford (1995) shows that such a market imperfection can be built into cash-in-advance types of models with microfoundations, too. The analogue of price rigidity of the Keynesian optimum currency area models is in Minford's model the delay between working (receiving cash) and being able to spend the proceeds.

Additionally, IS-LM models are more manageable in a three-country context than asset market models, which make the recursive treatment of the small country impossible by requiring that the big countries hold the assets of the small country, too. Combining short-run asset market effects with longer-run current account effects, as for example in Kouri (1976) and in Dornbusch and Fischer (1980), would further complicate the analysis.

Optimization models along the new classical tradition would make the three-country analysis complex, too. This kind of a modelling attempt is done by Persson (1980). The problem with this study is that the model had to be built very simply, which dimishes the possibilities to obtain relevant results. These models seem to be better suited for the analysis of rather specific issues in a one-country setting. For example Rudiger Dornbusch has preferred IS-LM models to the optimization models. (For the properties of different kinds of models in analyzing exchange rate regimes, see Dornbusch, 1989 and 1986.)

Optimization models are no doubt superior in formal welfare analysis. In the current research the welfare of the aggregate economy is assumed to be determined on the basis of deviations in output and prices.

Modelling the foreign countries with structural equations makes it possible to identify the source of the shock and to take into account the transmission of the foreign shocks in the international economy. This kind of a transmission occurs already within the time horizon relevant for short-run analyses. The shocks the small economy faces are thus composite shocks, combinations of the effects which the exogenous disturbances have had on the big countries. This makes the shocks more realistic from the small country's point of view than just focusing on changes in individual foreign variables.

As opposed to two-country models, in the recursive three-country framework it is possible to distinguish between the exchange rate union and the currency basket regime. Analyzing the exchange rate union in a three-country setting is also fruitful as such, because the impacts of foreign shocks can be analyzed more carefully than in one- or two-country models.

The method of this research project has been to start with a rather simple extension of the Mundell-Fleming model. An important extension is to make producer prices endogenous by adding an aggregate supply curve into the model. Widening this into a three-country context already gives new insights into the traditional theory. This model is static with static expectations.

The model presented in chapter 5 is a dynamic model with rational expectations. The main importance of this model is in the adjustment paths of different variables in the regimes studied. The dynamic model has "Keynesian" properties in the short run and "new classical" properties in the long run, i.e. the capacity output, among others, is not affected by the shocks.

The shocks studied by both models are assumed to be unexpected. Sometimes they are positive, sometimes negative. Limiting the effects of the shocks is therefore desirable. In the static model we are interested only in the short-run effects. Static expectations imply that the shocks are taken as permanent by the economic agents, i.e. agents cannot calculate the duration of the shock or adjustment paths of different variables. In the dynamic model the adjustment paths are calculated and the effect on the output will vanish in the long run, according to the new classical assumption. The agents do not, however, make any forecasts about the duration of the original shock, for example of an exogenous goods demand shock (i.e, whether it is reversed some day or not). The shock is assumed to be permanent in this sense in this model, too.[5]

When comparing the exchange rate regimes I am fully aware of the possibility of a change in the parameter values when moving from one regime to another (the so-called Lucas critique). In the comparisons made I have not, however, built any endogenous determination mechanism for the parameters. One reason for this is that any attempt to do so inevitably obtains only partial results, i.e. can concern only one or a few of the parameters.[6] The reader can, however, evaluate the effects of different parameter values on the basis of the sensitivity analysis done in this study.

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[5]Temporary shocks, i.e. shocks which are assumed to be reversed, are analyzed in Kotilainen (1993). The effects of the shocks and the ranking of the regimes according to the insulation properties are not very different compared to those of the static model presented in chapter 4.

[6]Flood and Marion (1982) have built this kind of a mechanism for the degree of indexation.

4 A STATIC THREE-COUNTRY MODEL

4.1 Structure of the model

The models specified here for the individual economies are based on rather traditional IS-LM models (see for example Dornbusch, 1980, 199; Buiter, 1986). The models used in this chapter include money market (LM) and goods market (IS) equilibrium conditions for each country. The LM curves are presented in equations (1), (5) and (8) below. The goods market equilibriums are presented with two equations: the goods demand equations (2), (6) and (9), and the supply curves (3), (7), and (10). In addition to these equations we have an interest parity condition (equations (4) and (11)). [7]

In spite of the simple structure of the model, it gives the basic results which serve as a reference in more comprehensive models. Making the country models more detailed greatly complicates the three-country analysis. The simple structure is also motivated by the fact that the main focus of the study is on the international transmission of the economic shocks.

The model is presented in natural logarithms (except interest rates) as follows:

<u>Country 1 ("the USA")</u>

$$(1)\ m_1 - p_1 = k_1 y_1 - \Phi_1 i_1$$

$$(2)\ y_1 = - \mu_1 r_1 + \sigma_{12}(e + p_2 - p_1) + \varepsilon_{12} y_2 + f_1$$

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[7]Chapter 4 is based on Kotilainen, 1991a, 1991b and 1992.

(3) $p_1 = \alpha_1(e + p_2) + \beta_1 y_1 - s_1$

(4) $i = i_1 = i_2 = r_1 = r_2$ (ex ante) (common to countries 1 and 2)

Country 2 ("EMU" or "a hard EMS")

(5) $m_2 - p_2 = k_2 y_2 - \Phi_2 i_2$

(6) $y_2 = - \mu_2 r_2 - \sigma_{21}(e + p_2 - p_1) + \varepsilon_{21} y_1 + f_2$

(7) $p_2 = \alpha_2(p_1 - e) + \beta_2 y_2 - s_2$

Country 3 ("Finland")

(8) $m_3 - p_3 = k_3 y_3 - \Phi_3 i_3$

(9) $y_3 = - \mu_3 r_3 + \sigma_3[\theta(e_{31} + p_1 - p_3) + (1 - \theta)(e_{32} + p_2 - p_3)] + \varepsilon_3[\theta y_1 + (1 - \theta) y_2] + f_3$

(10) $p_3 = \alpha_3[\theta(e_{31} + p_1) + (1 - \theta)(e_{32} + p_2)] + \beta_3 y_3 - s_3$

(11) $i = i_1 = i_2 = i_3 = r_1 = r_2 = r_3$ (ex ante).

The symbols are as follows: m = nominal money stock, p = price level (GDP deflator), k = income elasticity of money demand, i = nominal interest rate, Φ = interest rate semielasticity of money demand, y = real output, μ = real interest rate semielasticity of goods demand, r = real interest rate, σ = elasticity of goods demand with respect to relative prices ("competitiveness elasticity"), e = the price of the currency of country 2 in terms of the currency of country 1, ε = elasticity of goods demand with respect to foreign real income, α = the elasticity of domestic prices with respect to foreign prices, β = the elasticity of prices with respect to domestic output, f = exogenous goods demand shock, s = exogenous price shock ("productivity shock"), θ =

foreign trade share of country 1 in the trade of country 3, e_{31} and e_{32} = prices of the currencies of country 1 and country 2 in terms of the currency of country 3, respectively. Additionally, relative prices ("competitiveness") are defined as follows: $c \equiv e + p_2 - p_1$, $c_{31} \equiv e_{31} + p_1 - p_3$, and $c_{32} \equiv e_{32} + p_2 - p_3$. All coefficients of the model as defined above are non-negative. We also assume that $0 < \varepsilon_1, \varepsilon_2, \varepsilon_3 < 1$ and $0 \leq \theta \leq 1$.

The two large countries are assumed to be symmetric. This is due to the tractability of the model. In some cases the effects of asymmetries are also analyzed.

The countries are assumed to produce tradeable goods which can be somewhat different as aggregates. This difference is reflected in the values of σ's. The purchasing power parity condition (PPP) is not required in the model. The absolute PPP holds only if $\alpha_1 = \alpha_2 = \alpha_3 = 1$ and $\beta_1 = \beta_2 = \beta_3 = 0$. For the relative PPP it is enough if $\alpha_1 = \alpha_2 = \alpha_3 = 1$.

In the small country model we assume that foreign trade shares θ and $(1-\theta)$ are the same in the demand as well as supply curve. Making a distinction between these shares could be justified if the country distributions in exports and imports differed essentially. In the demand curve export as well as import shares matter, while in the supply curve only import shares are relevant.

The form in which the interest rate parity condition is written implies that the assets of different countries are assumed to be perfect substitutes. It implies also that the agents are on average risk neutral.

In the big country model y_1, y_2, p_1, p_2, e and $i_1 = i_2$ are endogenous variables. In the small country model y_3 and p_3 are endogenous, and in the floating exchange rate regime also one of the bilateral exchange rates, e_{31} or e_{32}. We can write one of these with the help of e, according to triangular arbitrage, as for example $e_{31} = e_{32} - e$. In the currency basket exchange rate regime the bilateral exchange rates change according to the trade weights so that the effective (trade-weighted) exchange rate remains constant. In the case of an exchange rate union, the exchange rate of the small country is the same as that of country 2.

The monetary equilibrium presented by the traditional LM curve is based on the Keynesian liquidity preference theory. It depicts the equality of the real money stock and the demand for real money balances. By Walras' law the bond market can be omitted from the equilibrium specification, because assets of different countries are assumed to be perfect substitutes.

Under flexible exchange rates the money stock is exogenous, while under fixed rates it is fully endogenous. In the current model version the nominal money stock is deflated by the GDP deflator. This procedure is often used to keep the model simple (for example Buiter, 1986). Using the country's consumption bundle as the deflator results in greater algebraic complexity.

Real money demand depends in the model on real income and on the nominal rate of interest. Transactions demand for money is assumed to be income dependent, whereas the speculative demand is interest rate dependent.

The goods demand equation is depicted by an open economy formulation of the IS curve (see for example Dornbusch, 1980, 194). Without the supply curve output is fully demand determined and the price level is fixed. This assumption is suitable for short-run considerations. The supply side is taken into account in equations (3), (6) and (10).

The output is affected by the interest rate which is determined in the integrated world capital market, by the relative price of domestic goods in terms of foreign goods, by net exports, and by an exogenous factor, which denotes goods demand shocks due to, for example, an increase in exports or debt-financed government spending. An increase in the interest rate affects the output negatively because a higher interest rate reduces investment demand and because it may increase saving. In the other effects the relationship with output is positive.

In the fixed price (demand determined) model we assume that domestic prices are predetermined at a point in time. Inflation is thus excluded. The real interest rate equals in this case the nominal interest rate. Changes in relative prices can occur only through changes in the exchange rate. The relative price is a determinant of demand, output and, accordingly, of employment between countries. The purchasing power parity condition is thus not required, i.e. producer prices in a common currency are not equalized internationally.

The supply curve needs more clarification than the LM curve and the goods demand equation, because this formulation is not standard. When solved in terms of y_1, we can write the supply curve for country 1 as follows:

$$(3)' \quad y_1 = (1/\beta_1)p_1 - (\alpha_1/\beta_1)(p_2 + e) + (1/\beta_1)s_1.$$

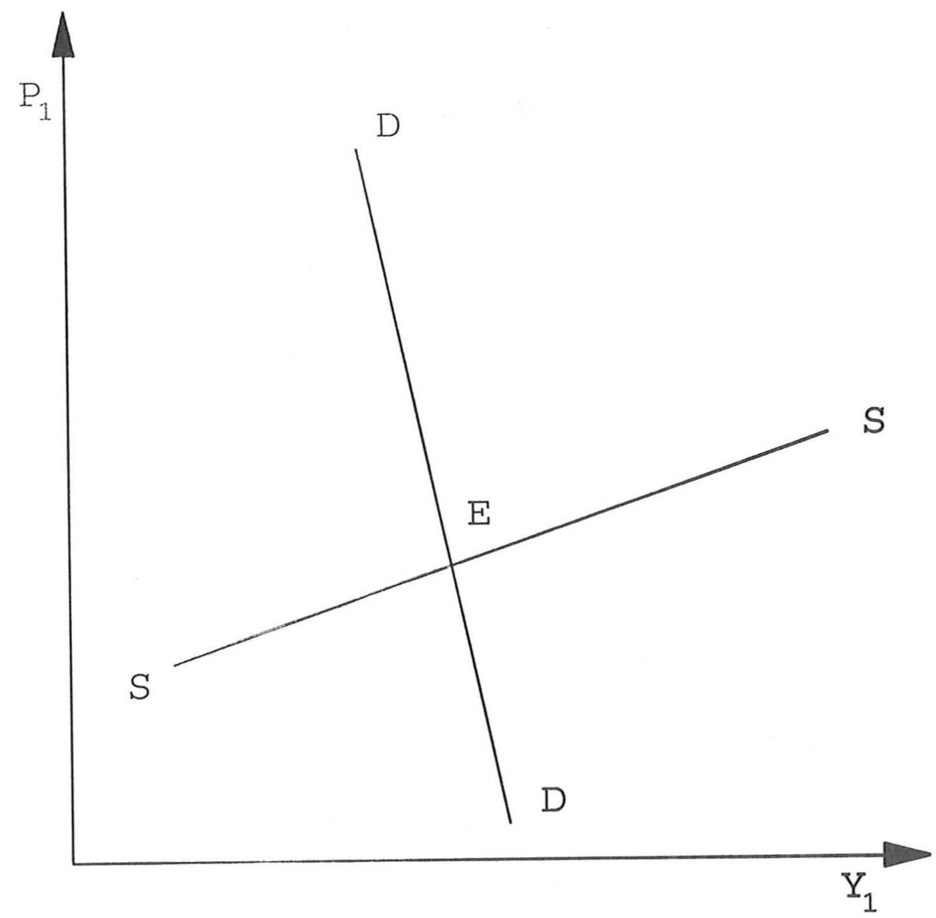
The supply of the domestic good thus responds positively to an increase in its own price, and negatively to an increase in the price of the foreign good, which is assumed to be used in consumption and as an input in the production process. The negative response of output to increases in foreign prices can be interpreted as a reaction to rising prices of foreign inputs and as a reaction to increasing wages due to rising consumer prices. The response of wages and prices, and accordingly of production, is assumed to be symmetric, i.e. they react similarly to an increase and to a decrease in foreign prices. The exogenous shock s_1 is written in the equation as a positive one, which can be interpreted to be, for example, an exogenous increase in productivity.

If α's and β's are equal to zero, we have the special case of fixed prices according to the lines of the traditional Mundell-Fleming model. Output is in this case fully demand determined. This case is relevant for shocks of a rather short duration.

The goods market equilibrium is presented in the following figure 2 for country 1 with respect to output and domestic prices. The supply curve is denoted by SS and the demand curve by DD. The equilibrium is attained at point E. An increase in domestic prices thus increases supply and decreases demand.

The supply curve presented in figure 2 can be derived from the production function (equation (12)), from the labour demand function (equation (13)) and from the consumer price index (equation (14)). When doing this we show that the supply curve used is consistent with the so-called Gray-Fischer model, which is the framework often used in the studies of wage indexation (see Gray, 1976 and Vilmunen, 1992).

Figure 2. Goods market equilibrium in country 1



We present the labour market submodel for country 1 in natural logarithms as follows:

$$(12)\ y_1 = \gamma n_1 + u_1$$

$$(13)\ n_1^d = \chi(p_1 - w_1)$$

$$(14)\ w_1 = \Omega(\tau p_1 + (1 - \tau)(e + p_2)) + \kappa y_1,$$

where n_1 = labour, w_1 = nominal wage level, γ = elasticity of output with respect to labour, χ = responsiveness of labour demand with respect to the relation between producer prices and wages, Ω = responsiveness of nominal wages with respect to consumer prices, τ = the share of domestic goods in the consumer price index, κ = responsiveness of nominal wages to changes in output and u_1 = an exogenous productivity shock. The rest of the variables are as before.

Production is thus an increasing function of labour (the capital stock is assumed to be constant). Labour demand in turn responds positively to an increase in producer prices in relation to wages. The microeconomic rationale behind this is that firms maximize profits, i.e. the value of production over labour costs (p_1y_1 - w_1n_1). They aim at setting real wages equal to the marginal productivity of labour. There is no reason why this level of employment should be equal to the number of workers who want to work. Nominal wages respond positively to changes in consumer prices and in output.

The degree of wage indexation (parameter Ω) is an empirical question. The explicit or implicit indexation differs between countries as well as between periods of time. The length of the wage contract period affects the value of Ω. In the long run it tends to be equal to 1 (assuming that labour unions are rational).

After inserting (14) to (13) and after that (13) to (12) we obtain:

$$(15) p_1 = \frac{\Omega(1-\tau)}{1-\Omega\tau}(e+p_2) + \frac{1+\gamma\chi\kappa}{\gamma\chi(1-\Omega\tau)}y_1 - \frac{1}{\gamma\chi(1-\Omega\tau)}u_1.$$

By denoting $\{\Omega(1 - \tau)\}/(1 - \Omega\tau) = \alpha$, $(1 + \gamma\chi\kappa)/\{\gamma\chi(1 - \Omega\tau)\} = \beta$ and $u_1/\{\gamma\chi(1 - \Omega\tau)\} = s_1$, we obtain equation (3). The same can be shown for the other countries. The formula has the property that when $\Omega = 1$, then $\alpha = 1$, and when $\Omega = 0$, then $\alpha = 0$. Full (zero) indexation of wages with respect to consumer prices corresponds thus to full (zero) indexation of domestic producer prices with respect to foreign prices. When $\alpha = 0$, we have nominal wage rigidity with respect to changes in foreign prices and the exchange rate, and when $\alpha = 1$, we have corresponding real wage rigidity (assuming $\tau < 1$).[8]

In the uncovered interest rate parity condition we assume that exchange rate expectations are static, i.e. the exchange rates are assumed to be the same tomorrow as they are today. Additionally we assume that speculators are risk-neutral. This means that interest rates are equalized internationally through perfect capital mobility (equations (4) and (11)).

In the case of fixed prices rather clearcut results for the big countries are obtained with a model where countries are symmetric. Supply is here assumed to be perfectly elastic. When comparing the effects of foreign shocks on the small economy in different exchange rate regimes, we already have to use numerical calculations to some extent, especially to make a distinction between the exchange rate union and the currency basket regime.

After adding a rising supply curve, we are no longer able to draw *a priori* conclusions from the changes in the endogenous variables in the big country model either - the model is too complicated. Some conclusions can, however, be obtained when we give extreme values (0 or 1) for certain key parameters. As regards the effects of foreign shocks on the small economy, *a priori* conclusions can be drawn concerning the relative post-shock output levels assuming that the pre-shock outputs are the same in different exchange rate regimes. The signs of the changes, and so the deviations from zero, are,

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[8]We have abstracted here, for simplicity, from the direct effect of changes in the prices of foreign inputs. Assuming mark up pricing, changes in the exchange rate will change domestic producer prices through input prices even if there is full nominal wage rigidity, i.e. $\alpha > 0$ even if $\Omega = 0$.

however, dependent on the parameter values. We must therefore rely on numerical calculations of the equilibrium values of the model. When using this kind of a solution method it is also necessary to carry out sensitivity analysis with various alternative numerical values of the parameters. In the case of domestic shocks in the small country, *a priori* results can, however, be obtained.

We assume almost throughout the study that the big countries are symmetric. We thus denote these parameters without a subscript. The smallness of the third country normally implies higher values for the elasticities with respect to foreign demand and relative prices than for the big countries.

When studying the effects of shocks originating in the big countries, we use the following numerical values for the parameters in the baseline scenario:

<u>common parameters:</u>
$k = k_1 = k_2 = k_3 = 0.67$, $\Phi = \Phi_1 = \Phi_2 = \Phi_3 = 0.46$,
$\mu = \mu_1 = \mu_2 = \mu_3 = 0.2$, $\beta = \beta_1 = \beta_3 = \beta_3 = 0.3$
<u>big country parameters:</u>
$\sigma = 0.1$, $\varepsilon = 0.3$, $\alpha = 0.1$
<u>small country parameters:</u>
$\sigma_3 = 0.3$, $\varepsilon_3 = 0.6$, $\alpha_3 = 0.3$, $\theta = 0.3$.

The numerical values presented above are assumed to reflect rather short-term relationships between the variables. Money demand coefficients with respect to income (k) and interest rates (Φ) are adopted from Kremers and Lane (1990). These values are estimated for the EMS countries as an aggregate, but they are used as an approximation for all countries. These estimates are broadly consistent with those obtained by Ripatti (1994) for Finland. In reality money demand coefficients differ between countries, but they differ also over time and according to the money aggregate. Since the main point in the study is to compare the systemic differences between exchange rate regimes, abstracting from the differences seems legitimate. When comparing the exchange rate union and the currency basket regime, the possibly differing money demand elasticities of the small economy are irrelevant. In these regimes the money supply is fully elastic when capital is mobile; the LM curve of the small country can thus be omitted.

The value of μ_3 is an estimate obtained on the basis of econometric models of the Finnish economy and by adjusting the estimate slightly upwards when assuming that the short-run interest rate sensitivity of aggregate demand has increased after the deregulation of the financial markets (see for example Tarkka and Willman (ed.) (1985)). The magnitude, even the sign, of the interest rate sensitivity of especially consumption is, however, a debatable question (see for example Starck, 1990; The BOF4 Quarterly Model of the Finnish Economy, 1990).

The rest of the parameter values are determined on the basis of econometric studies on the Finnish economy, especially on the basis of the econometric model of The Research Institute of the Finnish Economy (ETLA) (for the original version of the model see Vartia, 1974) and the BoF model of the Bank of Finland (Tarkka and Willman (ed.) (1985)). Because most of the parameter estimates needed do not have a direct counterpart in the studies, the values adopted must be considered more or less as "guesstimates". The values of σ, ε and α are between one third and a half of the small country parameters (in the EC countries about one third of foreign trade occurs with non-EC countries).

The model presented above can be criticized on the grounds that it is not derived from microeconomic foundations and that it neglects the intertemporal budget constraints. This is the criticism often presented by the neoclassical school against Keynesian macroeconomic models (see Frenkel and Razin, 1987).

The use of this kind of a model is motivated, however, by the problem setting of the study. We are now interested in the basic international working mechanisms of different exchange rate regimes. Because of the three-country structure, the models of the individual countries must also be kept simple.

The superiority of the optimizing models is not always clear either. The so-called ad hoc models of the Mundell-Fleming tradition are not necessarily less realistic from an empirical point of view than the optimizing models. The ad hoc nature of the models is relative, too. For example, Dornbusch (1987, 9) has argued that in the optimizing models ad hocery is often introduced at a lower level, after which the implications are rigorously derived.[9] The neglect of government budget constraints can also be legitimized in the comparative static models. Some variables, like wages, capital stock and the stock of government bonds held by the public, that are endogenous from a dynamic point of view, are exogenous from the static point of view. (Sargent, 1990, 113.)

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[9]For a critique of the representative consumer assumption used in macromodels with microfoundations, see Kirman (1992).

Optimizing models are more suitable and more manageable in the study of intertemporal issues in a one-country setting. In the study of the transmissions between several countries they can, however, be less tractable and less necessary.

4.2 Domestic shocks in the small country

In the model framework used we cannot make a distinction between the exchange rate union and the currency basket regime in the case of domestic shocks. The regimes are both fixed exchange rate regimes. A distinction can be made, for example, in models where the regimes are assumed to differ in terms of the degree of fixity and accordingly in terms of the credibility of the peg. These aspects are neglected in this study.

In the following we confine ourselves to comparing the effects of domestic shocks in the floating and fixed exchange rate regimes. The analysis is general in the sense that prices can be either fixed or flexible. The traditional fixed price Mundell-Fleming model is thus a special case of this model. The shocks are treated here separately. In practice they can be correlated with each other.

For floating rates we use a model consisting of equations (8)-(11). In the case of fixed rates we can abolish the LM curve (equation (8)) from the model. Because of perfect capital mobility, the credibly fixed exchange rate and risk neutrality of investors, the money supply is now perfectly elastic at the interest rate $i_3 = i_2 = i_1$.

Domestic goods demand shocks are modelled as changes in f_3. They are exogenous changes in, for example, foreign demand or fiscal policy. Monetary shocks spur changes in the money supply or money demand. These shocks are denoted as changes in m_3 (change in money supply). The same effect is obtained through a change in money demand with an opposite sign. Supply shocks are denoted as changes in s_3. They are changes in productivity or other factors affecting the domestic price level directly. From the point of view of their effects they are a combination of goods demand and monetary shocks.

The signs of output effects of the three shocks are presented in the following table.

Table 1. The signs of output effects of domestic shocks

	Δf_3	Δm_3	Δs_3
floating	+[1]	+[2]	+
fixed	+	0	+

[1] Assuming $0 < \alpha_3 < 1$. When $\alpha_3 = 0$, there is no change in output in the case of a f_3 shock.
[2] Assuming $\alpha_3 < 1$. When $\alpha_3 = 1$, there is no change in output.

Positive goods demand and productivity shocks thus increase output in both regimes. A positive monetary shock increases output in the floating rate regime, but in the fixed rate regime output remains unchanged in line with the neutrality of money. The working channels of the shocks are studied in detail in the following.

In the case of **a domestic goods demand shock** occurring in the small country 3 (change in f_3 in equation (9)), output, prices and exchange rates change in the floating rate regime as follows:

$$(16)\ \frac{\delta y_3}{\delta f_3}=\frac{\alpha_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3k_3\sigma_3},$$

$$(17)\ \frac{\delta e_3}{\delta f_3}=\frac{-\beta_3-k_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3k_3\sigma_3},$$

$$(18)\ \frac{\delta p_3}{\delta f_3}=-\frac{\alpha_3k_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3k_3\sigma_3}.$$

It is obvious for relevant values of the parameters that the denominator of the above-mentioned multipliers is positive. The positiveness of the denominator is guaranteed when $0 \leq \alpha_3 \leq 1$, which we can take for granted.

If $\alpha_3 > 0$, a positive domestic demand shock thus increases output, spurs an appreciation of the exchange rate and lowers prices accordingly. (For the effects of wage rigidity, see also Ahtiala, 1981, 14-15.) In addition to the demand curve, the supply curve shifts downwards, too, because of the appreciation, which makes inputs cheaper. Domestic prices decrease as a result of the appreciation and compensate partly for the consequent loss in competitiveness.

Output is insulated fully only when $\alpha_3 = 0$; this case corresponds to the result obtained in the traditional fixed-price Mundell-Fleming model. The change in the trade-weighted exchange rate is now $\delta e_3/\delta f_3 = -1/\sigma_3$. In the case of a positive shock there is thus an appreciation of the exchange rate, the magnitude of which is inversely related to the elasticity of output with respect to relative prices. If the change in f_3 is due to increased public expenditure, it crowds out exports so much that the output effect is neutralized.

<u>In the fixed exchange rate regime</u> we drop the LM curve from the small country model, because the money supply is perfectly elastic when capital is fully mobile and there is no uncertainty about the level of the exchange rate (the LM curve is horizontal). We now have two endogenous variables, output and prices, the changes of which are as follows:

$$(19)\frac{\delta y_3}{\delta f_3} = \frac{1}{1+\beta_3\sigma_3},$$

$$(20)\frac{\delta p_3}{\delta f_3} = \frac{\beta_3}{1+\beta_3\sigma_3}.$$

In the fixed rate regime both output and prices increase after a positive real shock (the IS curve shifts to the right). In the case of fixed prices ($\beta_3 = 0$) output reacts fully to the exogenous change in demand (according to multiplier 1).

For values $0 \leq \alpha_3 < 1$ it can be shown *a priori* that output changes less in the floating rate regime than in the fixed rate regime. If $\alpha_3 = 1$, i.e. domestic prices adjust fully to changes in foreign prices, there is no difference between the exchange rate regimes with respect to the output reaction. (The same result is obtained also by Marston (1982), Turnovsky (1983) and Argy (1990).) The stabilizing effect of the appreciation of the exchange rate on the output in the floating rate regime, when compared to the fixed one, is thus eliminated through price developments.

The above discussion implies the traditional result that floating insulates the output better in the short run against domestic real shocks than fixed rates, and that fiscal policy is less efficient in the floating rate regime than in the fixed rate regime. The short run means here a period during which domestic prices have not adjusted fully to changes in the exchange rate.

The results concerning the stabilization of prices are not as clearcut. Relative changes in prices depend more on the relative magnitudes of parameter values. If k_3 (the income elasticity of money demand) is high relative to β_3 (the responsiveness of prices to changes in output) fixed rates stabilize prices better than floating, and the other way round. A high value of k_3 means that the growing output increases the demand for money more than when k_3 is low (according to the LM curve). This in turn leads to a greater appreciation of the exchange rate and accordingly to a greater decline in prices in the floating rate regime. Additionally, the less open the economy is and the less indexed wages are, i.e. the smaller α_3 is, the smaller the change in prices in the floating rate regime.

In the case of **a domestic monetary shock** (money supply or money demand shock) we obtain the following results in the floating rate regime:

$$(21)\frac{\delta y_3}{\delta m_3}=\frac{\sigma_3-\alpha_3\sigma_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3k_3\sigma_3},$$

$$(22)\frac{\delta e_3}{\delta m_3}=\frac{1+\beta_3\sigma_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3k_3\sigma_3},$$

$$(23)\frac{\delta p_3}{\delta m_3}=\frac{\alpha_3+\beta_3\sigma_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3k_3\sigma_3}.$$

The denominator of the multipliers is the same as in the case of a goods demand shock, and thus positive in the relevant cases. We can now conclude that an increase in the money supply (or, correspondingly, a decrease in the demand for money) leads to an increase in the output if $\alpha_3 < 1$ (i.e. if prices are less than fully indexed). Graphically this is reflected as an outward shift in the LM as well as in the IS curve. The IS curve shifts due to improving competitiveness. The interest rate is internationally given.

In the case of fixed prices ($\alpha_3 = \beta_3 = 0$) the output changes by $\delta y_3/\delta m_3 = 1/k_3$ and the trade-weighted exchange rate by $\delta e_3/\delta m_3 = 1/(k_3\sigma_3)$. These changes are thus inversely related to the income elasticity of money demand (k_3). The magnitude of the exchange rate change depends negatively also on the size of the competitiveness elasticity. The smaller k_3 and σ_3 are, the greater the change in the exchange rate must be to equilibrate the demand for and supply of money and goods (LM and IS curves).

If $\alpha_3 = 1$, the output remains unchanged, i.e. the neutrality-of-money result is obtained. Domestic prices react fully to changes in the exchange rate, and competitiveness does not improve.

We can conclude in the general case for relevant values of the parameters that the exchange rate depreciates as a result of the above-mentioned shock. The price level increases if α_3 or $\beta_3 > 0$ (assuming $\alpha_3 \leq 1$).

In the fixed rate regime the domestic money supply or demand shocks have no effect on the output or prices, either in the cases of fixed or flexible prices. International capital flows mitigate immediately any efforts to influence the domestic output through monetary policy. This is analogous to the result obtained in the traditional fixed-price Mundell-Fleming models (see pages 7-8).

When there is **a domestic productivity shock** the domestic price level changes exogenously. In the floating rate regime a positive productivity shock decreases prices, what increases real money balances. The LM curve shifts accordingly to the right. The shock also improves competitiveness, as a result of which the IS curve shifts to the right, too. We obtain the following changes:

$$(24)\frac{\delta y_3}{\delta s_3} = \frac{\sigma_3}{\alpha_3 + \beta_3\sigma_3 + k_3\sigma_3 - \alpha_3 k_3 \sigma_3},$$

$$(25)\frac{\delta e_3}{\delta s_3} = \frac{1 - k_3\sigma_3}{\alpha_3 + \beta_3\sigma_3 + k_3\sigma_3 - \alpha_3 k_3 \sigma_3},$$

$$(26)\frac{\delta p_3}{\delta s_3} = -\frac{k_3\sigma_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3 k_3\sigma_3}.$$

The denominator is again the same as above so we can assume that it is positive. A positive productivity shock increases output and decreases domestic prices. The exchange rate depreciates in the short run, because we can assume that $k_3\sigma_3 < 1$. The depreciation is due to the excess supply of real balances when the price level decreases. The depreciation is related to the need to increase exports to match the increased output supply. Aggregate domestic demand does not respond directly to a change in productivity in this model, because the model is aimed at short-run analysis of shocks.

The result obtained above is crucially dependent on the assumption of an unchanged money supply. If the money supply adjusts fully to changes in the domestic price level, the output remains unchanged. For the other endogenous variables we get the following results:

$$(27)\frac{\delta p_3}{\delta s_3} = \frac{\delta e_3}{\delta s_3} = \frac{\delta m_3}{\delta s_3} = \frac{1}{-1+\alpha_3}.$$

Prices, exchange rates and the money supply thus change by an equal amount. This kind of a money supply rule can be followed if α_3 (the response of domestic prices to changes in the exchange rate) is rather small. If it approaches the value 1, the rule leads to an exploding path of prices and exchange rates.

In the fixed rate regime a domestic productivity shock leads to the following changes in the output and prices:

$$(28)\ \frac{\delta y_3}{\delta s_3} = \frac{\sigma_3}{1+\beta_3\sigma_3} > 0,$$

$$(29)\ \frac{\delta p_3}{\delta s_3} = -\frac{1}{1+\beta_3\sigma_3} < 0.$$

The LM curve is vertical. In the case of a positive shock the increase in output is due to an outward shift in the IS curve. The decline in prices improves competitiveness, which increases demand.

When compared to a floating rate regime with no changes in the money supply, the fixed rate regime leads to a smaller change in output if $\alpha_3 < 1$ and if $k_3\sigma_3 < 1$, which obviously holds at least in the short run. In the case of a positive shock the depreciation of the exchange rate due to excess supply of real balances leads to a greater improvement of competitiveness in the floating rate regime than the sole decrease of prices in the fixed rate regime. This effect leads to a greater increase in production in the case of floating. If $\alpha_3 =$ 1, there is no difference between the regimes with respect to output insulation. In this case prices react fully to changes in the exchange rate, which means that competitiveness changes by an equal amount in both regimes.[10]

[10] In the hypothetical case, where $k_3\sigma_3 \geq 1$ money demand responds strongly to an increase in output (LM curve), and foreign demand responds strongly to a decline in prices (IS curve). In this situation there is no need for a depreciation of the exchange rate in the floating rate regime (see expression (25)).

When the money supply responds proportionally to changes in the price level, floating rates insulate the domestic output fully, but this kind of a policy is obviously not possible in the longer run when α_3 increases.

4.3 Foreign shocks

4.3.1 Output effects collected

To give an overview we collect in this section the output effects of the different shocks on the big countries as well as on the small country in different exchange rate regimes. We also give some intuition for the signs of the effects. The transmission channels are analyzed in detail in the remaining sections of this chapter.

Big countries

After replacing i_1, r_1 and r_2 by i_2, we get the following model for the big countries (with a floating bilateral exchange rate):

$$(30)\ m_1 - p_1 - k_1 y_1 + \Phi_1 i_2 = 0$$

$$(31)\ y_1 + \mu_1 i_2 - \sigma_{12}(e + p_2 - p_1) - \varepsilon_{12} y_2 - f_1 = 0$$

$$(32)\ p_1 - \alpha_1(e + p_2) - \beta_1 y_1 + s_1 = 0$$

$$(33)\ m_2 - p_2 - k_2 y_2 + \Phi_2 i_2 = 0$$

$$(34)\ y_2 + \mu_2 i_2 + \sigma_{21}(e + p_2 - p_1) - \varepsilon_{21} y_1 - f_2 = 0$$

$$(35)\ p_2 - \alpha_2(p_1 - e) - \beta_2 y_2 + s_2 = 0.$$

In order to analyze the effects of the different shocks on the big countries we solve the model presented above with respect to f_1, f_2, m_1, m_2, s_1 and s_2. We solve the model *a priori* in the case of fixed prices. When prices are endogenous we are no longer able to obtain *a priori* results. In this case we use the baseline scenario presented on pages 38-39 and conduct sensitivity analysis.

In the case of fixed prices and assuming symmetrical structures between the countries, output effects of the goods demand and monetary shocks are as collected in table 2.

Table 2. The signs of output effects in the big countries (fixed prices)

	Δf_1	Δf_2	Δm_1	Δm_2
country 1	+	+	+	-
country 2	+	+	-	+

Positive goods demand shocks thus increase the outputs of both countries. Monetary shocks in turn are of a beggar-thy-neighbour nature, i.e. a positive monetary shock increases the output of the home country, but decreases that of the neighbour country.

When prices are allowed to change, the effects become the more diverse the more domestic prices react to foreign ones. When domestic prices are fully responsive, goods demand shocks have beggar-thy-neighbour effects. In the case of monetary shocks the monetary neutrality result is obtained, i.e. the outputs of both countries are insulated. Positive productivity shocks lead to an increase in the output of the home country and to a decline in the output of the neighbour country when prices react only slightly to changes in the foreign prices. When the price response becomes stronger, outputs of both countries increase.

Small country

The small country effects of a shock that occurs in one of the big countries can differ from the effects on the other big country in all exchange rate regimes (including floating), because the small country is structurally different. It has two trading partners, the economic development of which can differ. Changes in foreign demand thus depend on the foreign trade shares of these countries. Both large countries face changes in foreign demand from only the other big country.

The exchange rate regime of the small country affects also essentially how the shocks are transmitted. We focus here on the output effects of foreign shocks on the small open economy. We study the effects under three alternative exchange rate regimes in the determination of the exchange rate of country 3:

(1) floating exchange rates,
(2) pegging to the currency of country 2 (or membership in the EMU/EMS), and
(3) currency basket exchange rate regime.

In the floating rate regime the market determines the exchange rate. In the exchange rate union the exchange rate is the same as that in the "EMU" area. In the basket peg regime the exchange rate is stable with respect to a trade-weighted basket consisting of the currencies of both large countries.

In considering the small economy we assume throughout the study that the big economies are symmetric. We insert the results of the big country model into the small country model under the above-mentioned exchange rate regime specifications, and solve these models. The assumption that country 2 is the more important trading partner is from the small country's point of view the only structural asymmetry between the big countries. The location of the shock is the essential asymmetry between the big countries when studying the effects of the shocks on the small country.

In the floating rate regime the transmission is the most similar to that occurring in the shock-free big country. This is due to the floating rate regime between the big countries. The differences are due to asymmetries between the countries. In the exchange rate union and in the currency basket regime the transmission channels are more diverse. In the case of shocks occurring in country 1, the exchange rate union with country 2 produces a transmission which is similar, but because of asymmetries and differing foreign trade shares, not identical to that occurring in country 2.

In the fixed price model we can obtain *a priori* results of the output effects only in the floating rate regime. In the exchange rate union and in the currency basket regime the effects through different transmission channels are so controversial that *a priori* results concerning the net effects are not obtained.

In the floating rate regime a positive goods demand shock occurring in either of the big countries leads to an increase in the output of the small country, too. Export demand and exchange rate effects are both positive and compensate for the negative interest rate effect. Positive monetary shocks lead in turn to a decline in the output of the small country. This is due to the appreciating effective exchange rate after monetary shocks occurring in either of the big countries. In the baseline scenario output effects are as presented in table 3.

Table 3. Output effects in the small country in different exchange rate regimes (baseline scenario)

	goods demand shock		monetary shock		productivity shock	
	Δf_1	Δf_2	Δm_1	Δm_2	Δs_1	Δs_2
float	0.185	0.246	-0.009	0.025	-0.010	0.052
union	0.192	-0.003	-0.028	0.509	-0.031	0.351
basket	0.056	0.133	0.168	0.313	0.122	0.198

We see that the three exchange rate regimes lead to different output reactions. This is due to different changes in the exchange rate and prices. The detailed analysis is presented in the following sections.

4.3.2 Goods demand shocks in the big countries

4.3.2.1 Shocks in country 1

Effects on the big countries

Next, the effects of a change in f_1 (a goods demand shock in country 1 due to, for example, debt-financed fiscal policy) are derived on the endogenous variables by using the model consisting of the two big countries (equations (30)-35)).

In the case of fixed prices ($\alpha_1 = \alpha_2 = \beta_1 = \beta_2 = 0$) the endogenous variables are y_1, y_2, e or c, and i_2. We first consider the effects on y_1:

(36)

$$\frac{\delta y_1}{\delta f_1} = \frac{\phi_1 k_2 \sigma_{21}}{-k_1 \epsilon_{12} \phi_2 \sigma_{21} + k_1 \sigma_{21} k_2 \mu_2 - \phi_1 \sigma_{12} \epsilon_{21} k_2 + k_1 \mu_1 k_2 \sigma_{21} + k_1 \sigma_{12} \phi_2 + \phi_1 k_2 \sigma_{21}}.$$

The sign of this expression is not determined on the basis of the signs specified above, although it is very probable that it is positive because the effect of the negative terms in the denominator is small compared to the other terms. We can, however, simplify the multiplier by assuming that countries 1 and 2 are symmetric, i.e. that the parameters in (30) and (33), and in (31) and (34) are the same, respectively. Now we get (the symmetric parameters are denoted without subscripts):

$$(37)\frac{\delta y_1}{\delta f_1}=\frac{\delta y_2}{\delta f_1}=\frac{\phi}{2[k\mu+\phi(1-\epsilon)]}>0.$$

The output effects are thus the same for both countries. An exogenous increase in demand in country 1 leads to an appreciation of the exchange rate by an amount which compensates for the differences in exogenous demand changes (expression (38)).

Expression (37) is positive because we assume that $0 < \varepsilon < 1$, where ε is the elasticity of goods demand with respect to the real income of the foreign country. Intuitively, the explanation for ε being smaller than 1 is that the production (income) of a country is obviously a less important demand factor for the neighbouring country than for the home country. An increase in the demand for goods in country 1 thus increases the output of that country. The impact is the greater the greater ε is and the smaller are the income elasticity of money demand k and interest rate semielasticity of goods demand μ.

If the countries are not symmetric, the difference in output effects of countries 1 and 2 depends on whether the numerator in the country 1 case $\Phi_1 k_2 \sigma_{21}$ is greater, equal or less than the numerator in the country 2 case $\Phi_2 k_1 \sigma_{21}$, i.e. whether $\Phi_1 k_2$ is greater, equal or smaller than $\Phi_2 k_1$ (the denominator is the same in both cases).

The relative magnitudes of the output effects depend thus <u>positively</u> on the domestic interest rate semielasticity of money demand and on the foreign income elasticity of money demand (the LM curves). The intuition behind this dependence is that high values of these parameters lead to a smaller appreciation of the domestic exchange rate, and thus to a higher output than small values of the parameters.

Now we turn to the effects of a change in f_1 on the exchange rate e, and because prices are assumed to be constant, on relative prices (competitiveness) c. We again assume that countries 1 and 2 are symmetric. After taking the derivative we get:

$$(38)\frac{\delta c}{\delta f_1}=-\frac{1}{2\sigma}<0.$$

The sign of the multiplier is negative, i.e. an increase in f_1 leads to the appreciation of the currency of country 1. The appreciation is required to keep the demand for and supply of domestic production in equilibrium in a situation where demand increases exogenously. The magnitude of the appreciation depends inversely on the competitiveness elasticity σ. The higher this elasticity is, the smaller the appreciation needed to equilibrate the market.

Derivation of the above-mentioned equation system for $\delta i_2/\delta f_1$ leads to the following expression:

$$(39)\frac{\delta i_2}{\delta f_1}=\frac{k}{2[k\mu+\phi(1-\epsilon)]}>0.$$

An increase in the demand for goods in country 1 leads to a rise in the world interest rate $i = i_1 = i_2$. This increase is required to equilibrate demand and supply. The uncovered interest rate parity condition guarantees that the increases are the same in both countries.

We summarize the effects of a positive goods demand shock originating in country 1 (an increase in f_1) as follows:

> (1) outputs of both countries increase, and by the same amount if countries are symmetric,
> (2) competitiveness of country 1 deteriorates because its currency appreciates (the currency of country 2 depreciates correspondingly by the same amount),
> (3) interest rates in both countries rise.

The above results differ from the results obtained in a similar model with only one small country. In the latter case an exogenous change in the foreign output, for example because of a fiscal shock, leads to a change in the domestic exchange rate and thus in competitiveness, which in turn compensates for the effects of the changing foreign demand. The domestic output thus remains unchanged in standard fixed-price one-country models (see pp. 43-44). When comparing the results obtained in different kinds of models it has, however, to be remembered that the shocks are different from the home country's point of view. In a two-country model the home country faces, in addition to the changing foreign demand and changing competitiveness, a new interest rate, too. Developments in the home country also affect the developments in the foreign country.

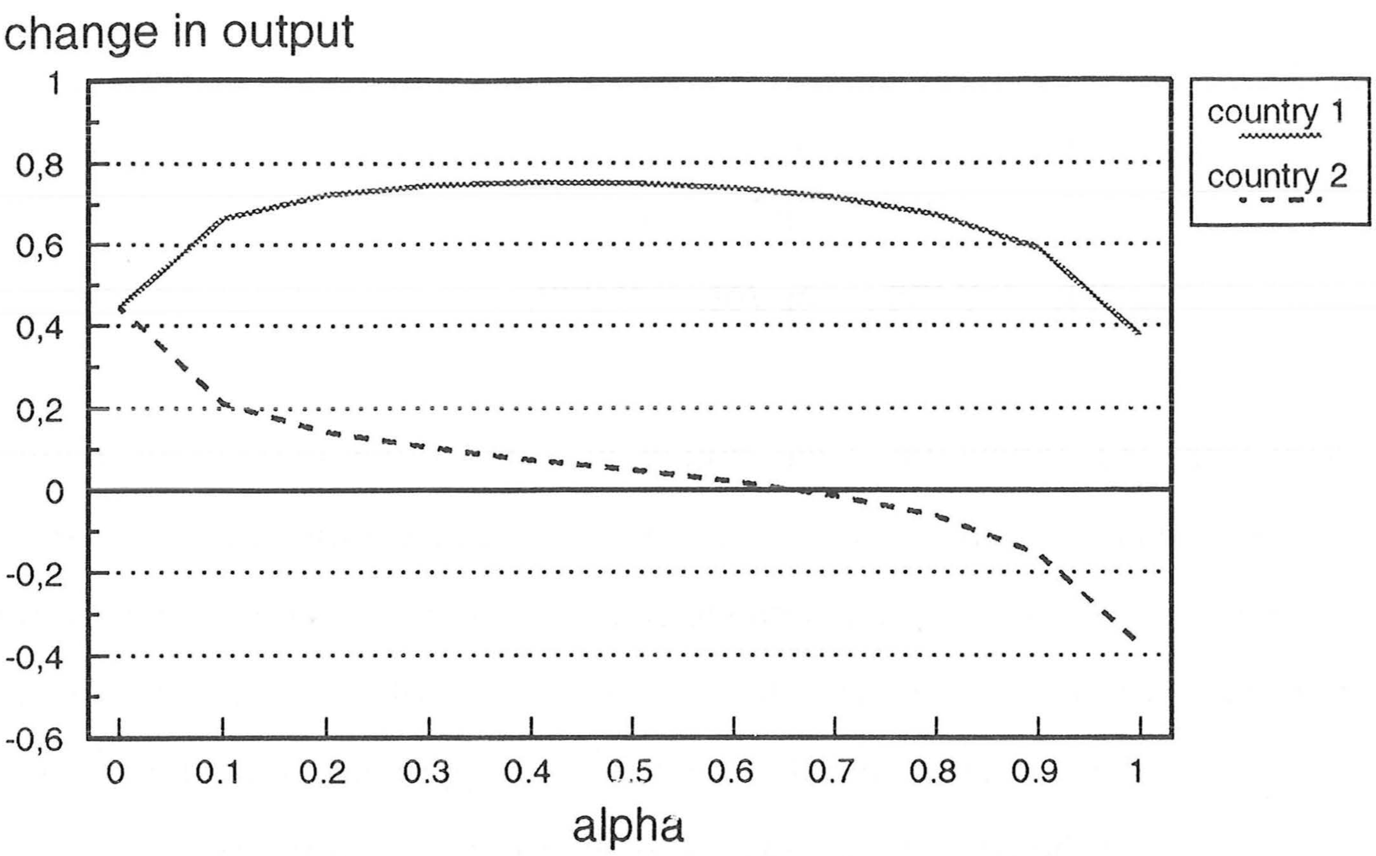
In the case of variable prices we get the following results for the big countries when using the parameter values of the baseline scenario as described on pages 38-39 ($\alpha = 0.1$):

$$\delta y_1/\delta f_1 = 0.667, \quad \delta y_2/\delta f_1 = 0.213$$
$$\delta e/\delta f_1 = -2.354, \quad \delta i/\delta f_1 = 0.960$$
$$\delta p_1/\delta f_1 = -0.005, \quad \delta p_2/\delta f_1 = 0.299.$$

A debt-financed expansive fiscal policy or some other exogenous demand shock thus increases the output of the home country more than that of the other big country, boosts the exchange rate, increases the global interest rate, and raises the price level of country 2. These kinds of price changes are due to changes in the exchange rate. In country 1 the appreciation of the exchange rate slows down the pressure on prices, so that the price level remains almost unchanged. In country 2 the depreciation reinforces the price increases.

The breakdown of the symmetry result in the case of output changes is due to the parameter α, which links domestic prices and output supply to foreign trade prices. This can be seen in the following sensitivity analysis (other parameter values except those of α are the same as in the baseline scenario) (figure 3). In a one-country model an increase in α can be presented as an upward shift of the SS curve in figure 2 (p. 35).

Figure 3. Goods demand shock in country 1: sensitivity of output reactions with respect to α in the big countries



When there is no response to foreign prices ($\alpha = 0$), the symmetrical result is established, even if output supply reacts to domestic prices ($\beta = 0.3$). At the other extreme, when domestic prices are assumed to respond fully to foreign trade prices ($\alpha = 1$), the output of country 2 decreases as much as that of country 1 increases. This result can be shown *a priori*, too:

$$(40)\ \frac{\delta y_1}{\delta f_1} = \frac{1}{2(1+\epsilon+\beta\sigma)}, when\ \alpha = 1,$$

$$(41)\ \frac{\delta y_2}{\delta f_1} = \frac{-1}{2(1+\epsilon+\beta\sigma)}, when\ \alpha = 1.$$

In the baseline scenario the assumption of $\alpha = 0.1$ is motivated by the import content of domestic final demand based on input-output calculations. The idea behind this assumption is that domestic producers are assumed to follow a kind of mark-up pricing. The inflationary process that possibly follows is thus not taken into account.[11]

Effects on the small country

We next study the effects of a demand shock occurring in country 1 on the small open economy under the three alternative exchange rate regimes in the determination of the exchange rate of country 3.

[11]It is assumed above that the two countries are identical, among others, with respect to price flexibility parameters α and β. Asymmetries in these respects change the outcome. For example if the other parameters are the same as in the baseline scenario, but $\alpha_1 = 0.1$ and $\alpha_2 = 1$, $\delta y_1/\delta f_1 = 0.687$ and $\delta y_2/\delta f_1 = - 0.043$. This illustrates a situation where we have rather flexible real wages in the "USA" but full real wage rigidity in "EMU" with respect to foreign prices. This kind of a hypothesis has gained support in some empirical studies in the cases of the USA and some European countries, even if not in this extreme form (OECD, 1989, 44). If real wages are flexible in the "USA", "EMU" is thus better insulated against a US fiscal shock by having rigid real wages, and flexible nominal wages accordingly. The intuition is that in "EMU" changes in the exchange rate are reflected in the domestic price level, what tends to decrease the change in competitiveness (depreciation of the currency in the case of a positive shock).

Floating exchange rates

The small country model is as follows:

$$(42)\ m_3 - p_3 = k_3y_3 - \Phi_3 i_3$$

$$(43)\ y_3 = - \mu_3 r_3 + \sigma_3[\theta(e_{31} + p_1 - p_3) + (1 - \theta)(e_{32} + p_2 - p_3)] + \varepsilon_3[\theta y_1 + (1 - \theta)y_2] + f_3.$$

$$(44)\ p_3 = \alpha_3[\theta(e_{31} + p_1) + (1 - \theta)(e_{32} + p_2)] + \beta_3 y_3 - s_3$$

$$(45)\ i = i_1 = i_2 = i_3 = r_1 = r_2 = r_3 \text{ (ex ante)}.$$

According to the triangular arbitrage we can write: $e_{31} = e_{32} - e$. One of the bilateral exchange rates between the home currency and a foreign currency can thus be calculated through the other bilateral exchange rate and the cross rate between the two foreign currencies.

We assume that the weights of the big countries 1 and 2, θ and $1-\theta$, are the same in both competitiveness and export demand terms. This assumption means in the floating rate case that the relative changes of the two bilateral exchange rates of country 3 are determined according to "real" factors, i.e. the foreign trade shares of countries 1 and 2 (see equation (51)). The overall level of the exchange rate is, however, determined by both the goods and money market equilibrium conditions. (As an example of a model where the role of different degrees of financial market integration are emphasized in the determination of bilateral rates, see Marston, 1985, 278.) We have only one elasticity with respect to competitiveness and foreign demand in the model (σ_3 and ε_3, respectively), the country specific elasticities are obtained by weighting the overall elasticities by the respective trade shares.

Because expectations of exchange rate and price changes are static $i_1 = i_2 = i_3 = r_1 = r_2 = r_3$ ex ante. After inserting these definitions into the model and after replacing $e + p_2 - p_1$ by c, and $e_{32} + p_2 - p_3$ by c_{32}, we can write the model in the case of fixed prices as follows:

$$(46)\ m_3 - p_3 - k_3y_3 + \Phi_3 i_2 = 0$$

$$(47)\ y_3 + \mu_3 i_2 + \sigma_3\theta c - \sigma_3 c_{32} - \varepsilon_3\theta y_1 - \varepsilon_3(1 - \theta)y_2 - f_3 = 0$$

We solve the model in terms of y_3 and c_{32}. The variables c, $i_2 = i$, y_1 and y_2 are determined in the big country model and the small country cannot affect them.

For output we get the following expression:

$$(48)\frac{\delta y_3}{\delta f_1} = \frac{\phi_3 k}{2k_3[k\mu + \phi(1-\epsilon)]} > 0.$$

The positiveness of the above expression is assured because $0 < \varepsilon < 1$ by assumption. A positive demand shock in country 1 thus increases the output of country 3.

In the case of a positive shock export demands from both countries contribute positively to the output. The negative effect of the increasing interest rate is small enough not to mitigate this effect. (For a graphical analysis, see figure 5, p. 73.)

If we assume that $\Phi_3 = \Phi$ and $k_3 = k$, the output effect is the same as in countries 1 and 2. Identical LM curves are enough to produce the same output effects. Export shares θ and $(1-\theta)$ do not matter, because the outputs of both big countries change by the same amount.

For the change in the bilateral exchange rate (=bilateral competitiveness when producer prices are constant) between countries 2 and 3 we obtain:

$$(49)\ \frac{\delta c_{32}}{\delta f_1}=\frac{k_3\mu_3 k\sigma+\theta k_3\sigma_3\phi\epsilon+\phi_3 k\sigma-\theta k_3\sigma_3 k\mu-\theta k_3\sigma_3\phi-k_3\phi\epsilon_3\sigma}{2\sigma\sigma_3 k_3[k\mu+\phi(1-\epsilon)]}.$$

The denominator is always positive, but due to both positive and negative factors in the numerator, we do not know the sign of the above expression *a priori*. The currency of country 2 depreciates with respect to that of country 1 (expression (38)), but we do not know how the rate between countries 2 and 3 changes. The rising international interest rate dampens the demand for money and puts pressure towards depreciation but the increasing foreign demand affects in the opposite direction.

If country 3 is structurally symmetrical to countries 1 and 2, expression (49) reduces to:

$$(50)\ \frac{\delta c_{32}}{\delta f_1}=\frac{1-\theta}{2\sigma}>0,$$

i.e. the currency of country 3 depreciates with respect to the currency of country 2. The pressure towards depreciation thus dominates. If the share of country 2 in the foreign trade of country 3 is zero, i.e. $\theta = 1$, there will be no change in the bilateral exchange rate between these countries.

The effective exchange rate behaves as follows:

$$(51)\frac{\delta c_3}{\delta f_1}=\theta\frac{\delta c_{31}}{\delta f_1}+(1-\theta)\frac{\delta c_{32}}{\delta f_1}=\frac{\delta c_{32}}{\delta f_1}-\theta\frac{\delta c}{\delta f_1}.$$

After replacing $\delta c_{32}/\delta f_1$ and $\delta c/\delta f_1$ by the expressions derived above, we obtain in the general case the following:

$$(52)\frac{\delta c_3}{\delta f_1}=\frac{k_3\mu_3 k-k_3\phi\epsilon_3+\phi_3 k}{2\sigma_3 k_3[k\mu+\phi(1-\epsilon)]}.$$

The change in competitiveness is not clear *a priori*. The appreciation of country 1 currency and the increase in the international interest rate tends to spur a depreciation of the currency of country 3, whereas the increasing foreign demand from both big countries tends cause an appreciation the currency of the small country.

We get the result that (52) is positive if $k_3\mu_3k + \Phi_3k > k_3\Phi\varepsilon_3$, i.e. if

$$(53)\epsilon_3<\frac{k(k_3\mu_3+\phi_3)}{k_3\phi}.$$

If we assume that the LM curve of country 3 is symmetrical to those of countries 1 and 2, so that $k_3 = k$ and $\Phi_3 = \Phi$, we obtain expression (54). (We can maintain asymmetry in terms of σ_3 , ε_3 and μ_3, the competitiveness and foreign demand elasticities and the interest rate sensitivity with respect to aggregate demand, respectively.)

$$(54)\ \frac{\delta c_3}{\delta f_1}=\frac{k\mu_3+\phi(1-\epsilon_3)}{2\sigma_3[k\mu+\phi(1-\epsilon)]}>0$$

Assuming the above-mentioned symmetry of the LM curves we thus get the result that an exogenous increase in the demand for goods in country 1 leads to a depreciation of the currency of country 3. The magnitude of the depreciation depends on the parameters of the IS curve. The greater the response of demand to changes in competitiveness (σ_3) and the greater the response of output to increasing foreign demand (ε_3), the smaller is the depreciation. In a similar fashion, the greater is the response of output to the increasing interest rate (μ_3), the greater the depreciation must be.

With somewhat flexible prices, according to the baseline numerical calculation, the shock leads to an increase in the output of the small country, to a rise in prices, to a depreciation of the effective exchange rate and, accordingly, to an improvement in the competitive position (=relative prices):

$$\delta y_3/\delta f_1 = 0.185,\ \delta p_3/\delta f_1 = 0.318,\ \delta c_3/\delta f_1 = 0.556.$$

The international rise in interest rates tends to lower output, but increasing export demand and improving competitiveness are strong enough to compensate for that effect. The currency of the small country depreciates in relation to the currency of country 1, but appreciates slightly in relation to that of country 2. (For a case of full response of domestic prices to the foreign ones, see figure 6, p. 78.)

Exchange rate union

By an exchange rate union we mean pegging the small country's currency to that of country 2 ("the EMS" or "EMU"). Because the exchange rate of country 3 is fixed with respect to a large country, we can drop the LM equation from the above-presented small country model; the money supply is now perfectly elastic at the interest rate $i_3 = i_2$. We can also drop the bilateral competitiveness c_{32} from the IS equation.

<u>In the case of fixed prices</u> we have just the following IS equation:

$$(55)\quad y_3 = - \mu_3 i_2 - \sigma_3 \theta c + \varepsilon_3 \theta y_1 + \varepsilon_3(1-\theta) y_2 + f_3.$$

After replacing i_2, c, y_2 and y_1 by the expressions derived in the big country model, we obtain:

$$(56)\quad \frac{\delta y_3}{\delta f_1} = \frac{\theta\sigma_3[\phi(1-\epsilon)+k\mu]-\sigma[\mu_3 k-\epsilon_3\phi]}{2\sigma[k\mu+\phi(1-\epsilon)]}.$$

In the case of a positive shock, increasing foreign demand and improving competitiveness contribute positively to output, whereas the rising international interest rate tends to decrease it. The net effect is not clear *a priori*. (For a graphical analysis, see figure 5, p. 74.)

If $\theta = 1$ and countries 1, 2 and 3 are symmetrical, the outcome is the same as for the big countries, i.e. (56) is the same as (37). The output of country 3 in this case increases if the shock is positive.

The change in competitiveness is the fraction θ of the change in competitiveness of country 2 vis-à-vis country 1:

$$(57)\frac{\delta c_3}{\delta f_1}=\theta(-c)=\frac{\theta}{2\sigma}>0.$$

In the face of a positive demand shock in country 1 the effective exchange rate of country 3 thus depreciates, and competitiveness improves, but by less than in country 2 (if $\theta < 1$). The greater θ is, the greater the depreciation and the more likely it is that the output effect is positive (see expression (56)).

With somewhat flexible prices (baseline scenario) the effective exchange rate depreciates slightly more than in the floating rate regime. The positive competitiveness effect on output is thus stronger. The changes in the output, prices and competitiveness are as follows:

$$\delta y_3/\delta f_1 = 0.192,\ \delta p_3/\delta f_1 = 0.332,\ \delta c_3/\delta f_1 = 0.582.$$

Currency basket exchange rate regime

Because the trade-weighted exchange rate ($e_3 = \theta e_{31} + (1 - \theta)e_{32}$) is fixed, we can again drop the LM equation for the same reason as in the previous case. In this case the effective exchange rate remains unchanged, so that competitiveness is stabilized; e_{32} changes so that it compensates for the effects due to a change in e_{31}. The currency of the small country, for example, depreciates with respect to the currency of country 1, and appreciates with respect to the currency of country 2.

In the case of fixed prices we can also drop the whole competitiveness term from the IS equation (because p_1, p_2 and p_3 remain all unchanged). The IS equation is now as follows:

$$(58)\ y_3 = -\ \mu_3 i_2 + \varepsilon_3 \theta y_1 + \varepsilon_3(1-\theta)y_2 + f_3.$$

After derivation and replacing i_2, y_1, and y_2 by the expressions obtained in the big country model, we can write the output as follows:

$$(59)\frac{\delta y_3}{\delta f_1} = \frac{-\mu_3 k + \epsilon_3 \phi}{2[k\mu + \phi(1-\epsilon)]}.$$

In the case of a positive shock foreign demand contributes positively to output, whereas the rising international interest rate tends to reduce it. The outcome is not clear *a priori*. (For a graphical analysis, see figure 5, p. 75.)

The expression $\delta y_3/\delta f_1 > 0$ if $\varepsilon_3 > \mu_3 k/\Phi$. The greater the elasticity with respect to foreign demand, the more likely it is that the net effect is positive. We make the following numerical illustration according to the parameter values of the baseline scenario. In this scenario μ_3=0.2, k=0.67, and Φ=0.46. We now have the following condition for the positivity of $\delta y_3/\delta f_1$: it must hold that $\varepsilon_3 > 0.291$.

In the case of somewhat flexible prices (baseline scenario) the effective (trade-weighted) exchange rate is stabilized, competitiveness changes only due to changes in the price levels. This leads to a rather small increase in competitiveness and domestic prices, and is also reflected in a smaller change in output than in the other exchange rate regimes considered. The multipliers are as follows:

$$\delta y_3/\delta f_1 = 0.056,\ \delta p_3/\delta f_1 = 0.079,\ \delta c_3/\delta f_1 = 0.179.$$

Comparison of effects in different exchange rate regimes

Fixed prices

When comparing output effects in "the EMU-peg regime" to those in the basket peg regime (expressions (56) and (59)), we see that in the former case there is an additional positive factor, the competitiveness effect $\theta\sigma_3 \ / \ 2\sigma$, when compared to the latter one (because of improving competitiveness in the EMU regime).

This means that the output of country 3 is greater in the EMU-peg regime than in the basket regime after a positive demand shock occurring in country 1, assuming that the pre-shock levels are the same initially. The effects are the same in both regimes if the share of country 1 in the exports of country 3 is zero ($\theta = 0$). We can thus tell the relative magnitudes of the effects in these regimes, but **we are not, however, able to tell, on theoretical grounds, which one of the regimes leads to a greater deviation from zero, because we do not know the signs of the changes (one can be positive and the other negative, or both positive or negative).**

If we assume symmetry in parameters between countries 1, 2 and 3, we see that the post-shock output becomes even greater in the floating rate regime than in the EMU-peg regime. The difference $\delta y_3/\delta f_1$ (floating) - $\delta y_3/\delta f_1$ (EMU peg) is equal to $(1 - \theta)/2$ (the expression is positive or zero because $0 \leq \theta \leq 1$).

In the symmetrical case we can write (assuming $\theta < 1$):

$$\frac{\delta y_3}{\delta f_1}(\textit{floating}) > \frac{\delta y_3}{\delta f_1}(\textit{EMU-peg}) > \frac{\delta y_3}{\delta f_1}(\textit{basket}).$$

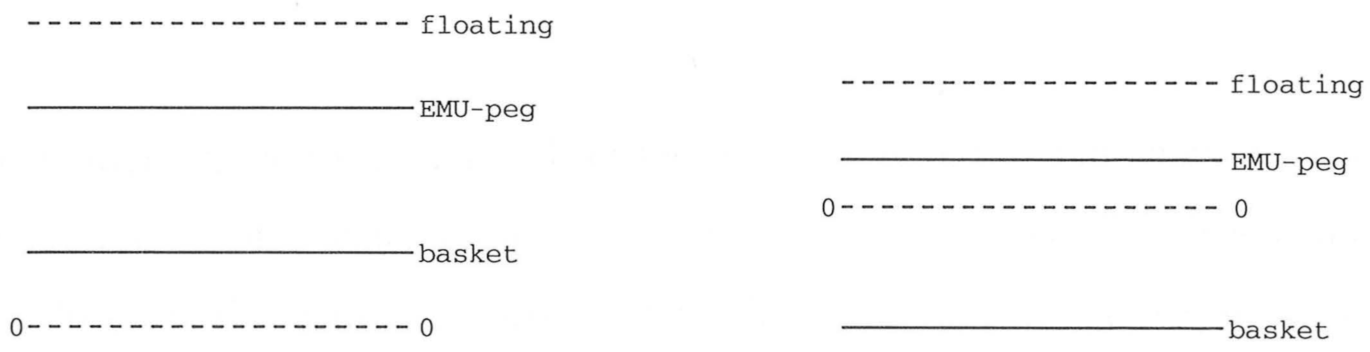
Floating leads thus to the greatest output in the face of a positive real shock occurring in country 1, and the currency basket exchange rate regime to the lowest output. These differences are due to different competitiveness effects in the regimes. In the floating rate regime the competitiveness of country 3 improves as much as that of country 2. In the EMU-peg regime competitiveness improves only with respect to country 1, but is unchanged with respect to country 2. In the currency basket regime competitiveness is stabilized (constant).

With respect to output deviations from the equilibrium level two possible cases are shown in figure 4. The ranking of the regimes depends on the relative magnitudes of the individual effects. Case 1 is obviously more likely for a small open economy, but case 2 is theoretically possible, too.

Figure 4. Change in the output of the small country after a positive goods demand shock occurring in country 1: two possible cases

Case 1. 'Low' interest rate sensitivity of aggregate demand and 'high' elasticity with respect to foreign demand and relative prices

Case 2. 'High' interest rate sensitivity of aggregate demand and 'low' elasticity with respect to foreign demand and relative prices

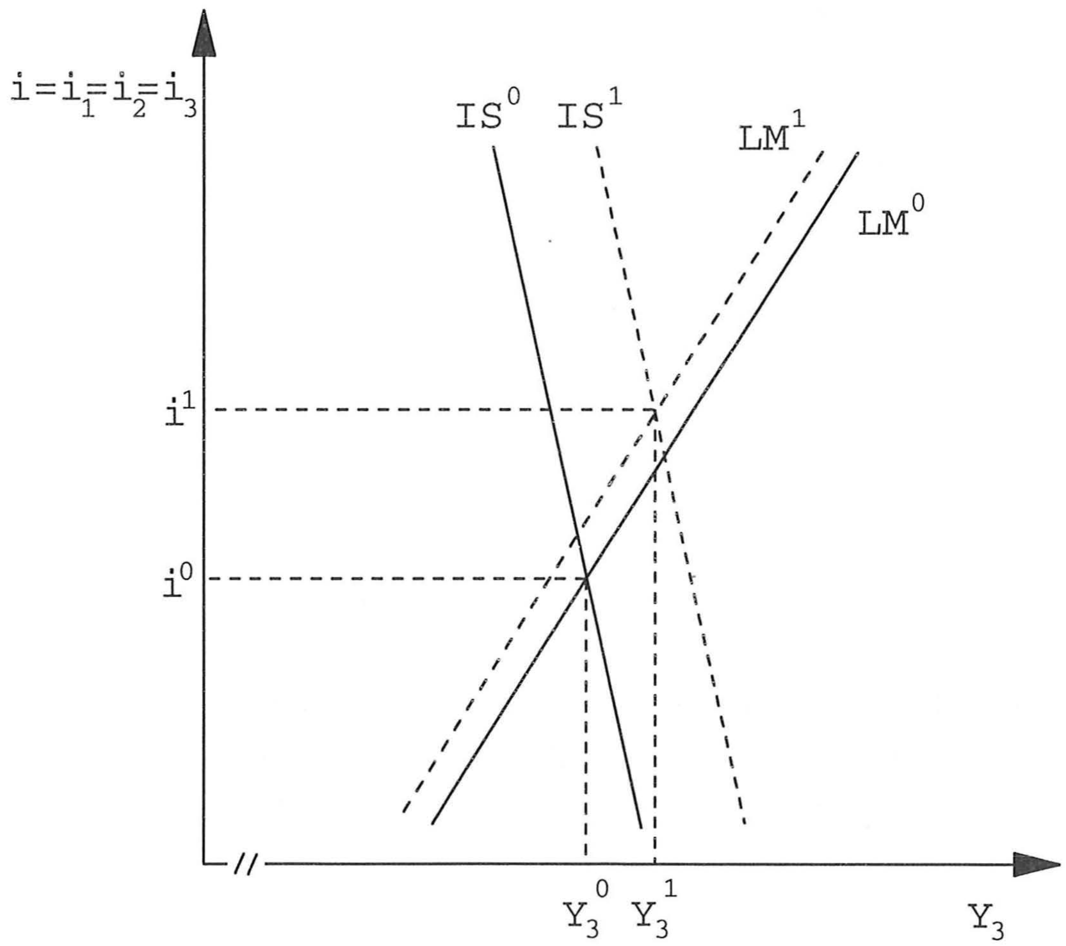


The situation presented in case 1 of figure 4 can be expressed graphically with the help of IS-LM curves (figure 5).

Figure 5. A goods demand shock in country 1, effects on the output of country 3 - a graphical analysis

We assume in all cases that the demand shock is positive and that the large countries are symmetrical, i.e. that y_1 and y_2 increase by an equal amount. The figures are drawn according to the parameter values of the baseline scenario.

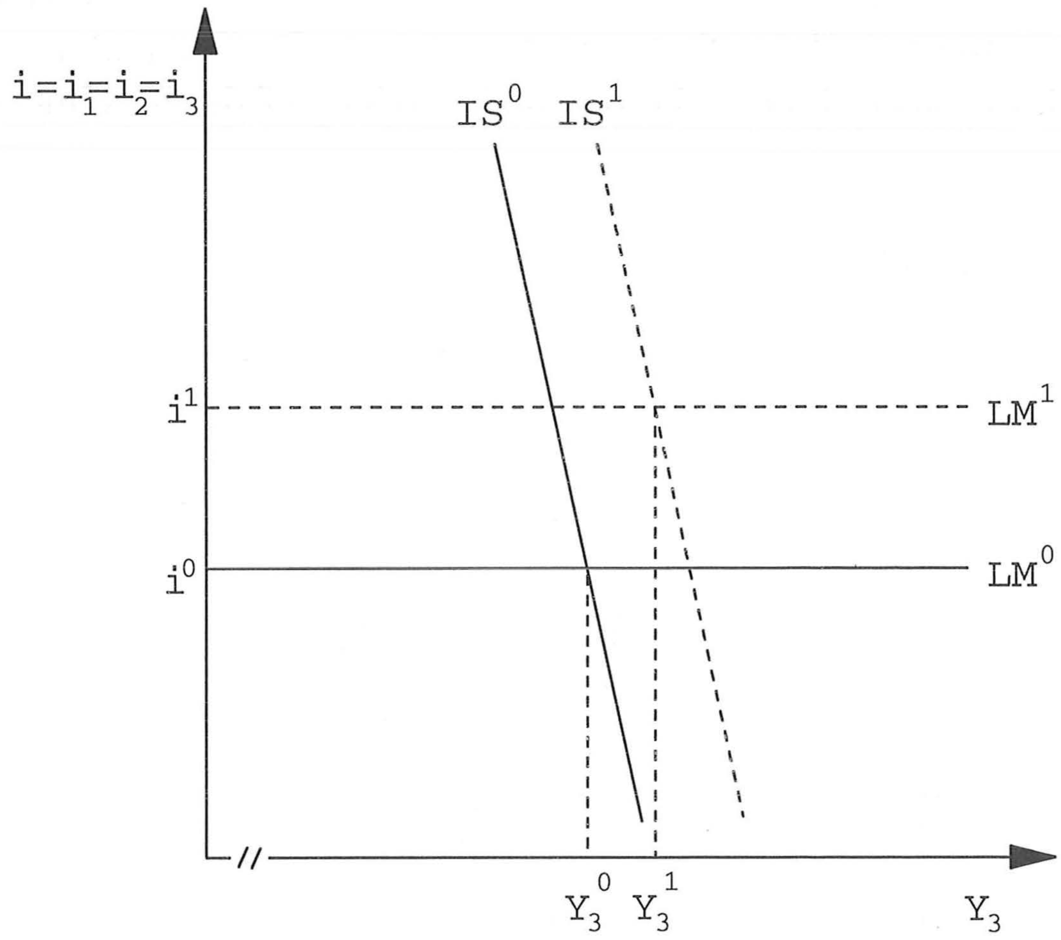
Floating exchange rates:



Export demand of country 3 increases and competitiveness improves at least in the symmetrical case (we do not know this *a priori* in the asymmetrical case). The net effect is nonetheless positive, so that the IS curve shifts to the right. The interest rate increases from i^0 to i^1 (the LM-curve shifts to the left), but this effect is small enough not to mitigate the positive output effect. It can thus be proven *a priori* that the output of country 3 increases from y_3^0 to y_3^1 after a positive demand shock occurring in country 1.

Figure 5 (continued)

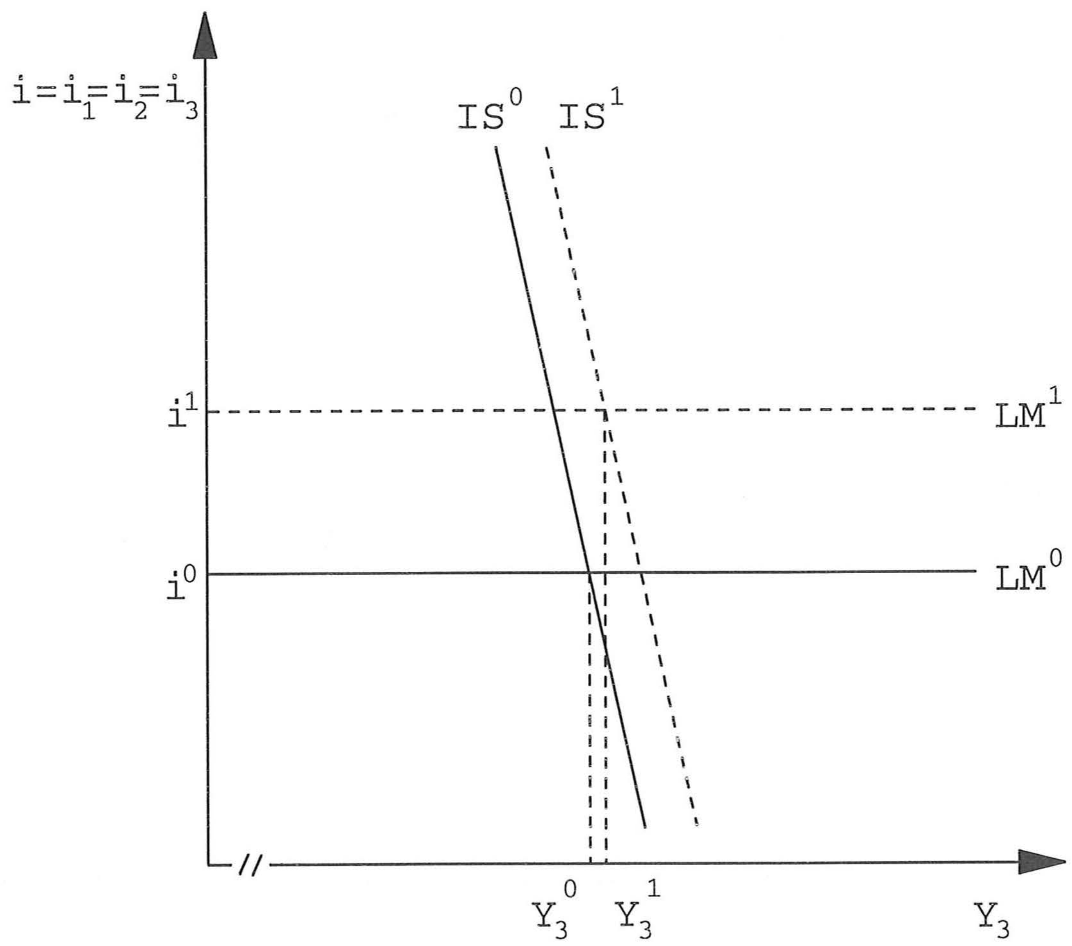
Pegging to the currency of country 2 (membership in an exchange rate union):



In the case of a fixed exchange rate the LM curve is horizontal, i.e. the money supply is perfectly elastic at the internationally given interest rate. After a positive demand shock in country 1 the interest rate increases as above; this effect tends to decrease the output of country 3. Increasing export demand and improving competitiveness, however, tend to increase the output (the IS curve shifts to the right). The net effect on the output of country 3 is likely to be positive. A negative output effect is theoretically possible if domestic output is inelastic with respect to changes in foreign demand and competitiveness (the IS curve shifts only slightly to the right) and if the IS curve is flat. This case is evidently not relevant in the case of a small open economy which trades with non-union countries, too.

Figure 5 (continued)

Currency basket exchange rate regime:



Compared to the previous case the situation differs now with respect to competitiveness, which remains unchanged in this case. The IS curve now shifts less to the right. A negative output effect is again possible theoretically if the domestic output is inelastic with respect to foreign output and if the IS curve is flat (demand for goods is very sensitive to changes in the interest rate). A positive output effect may, however, be more likely. If this is the case, the currency basket exchange rate regime stabilizes the output more than the "EMU-peg regime". The post-shock output of country 3 is smaller by a factor of $\theta\sigma_3/2\sigma$ than in the "EMU-peg regime".

Flexible prices

Even if we are not able to compare *a priori* the deviations of economic variables, because we do not know the signs of the effects, we can compare the post-shock levels, as was the case with fixed prices, too (pp. 70-72). Assuming that the output is in all exchange rate regimes at the same level before the shock, it can be shown that the exchange rate union leads to a higher output after a positive real shock occurring in country 1 than the basket regime. The difference between the output effects is as follows:

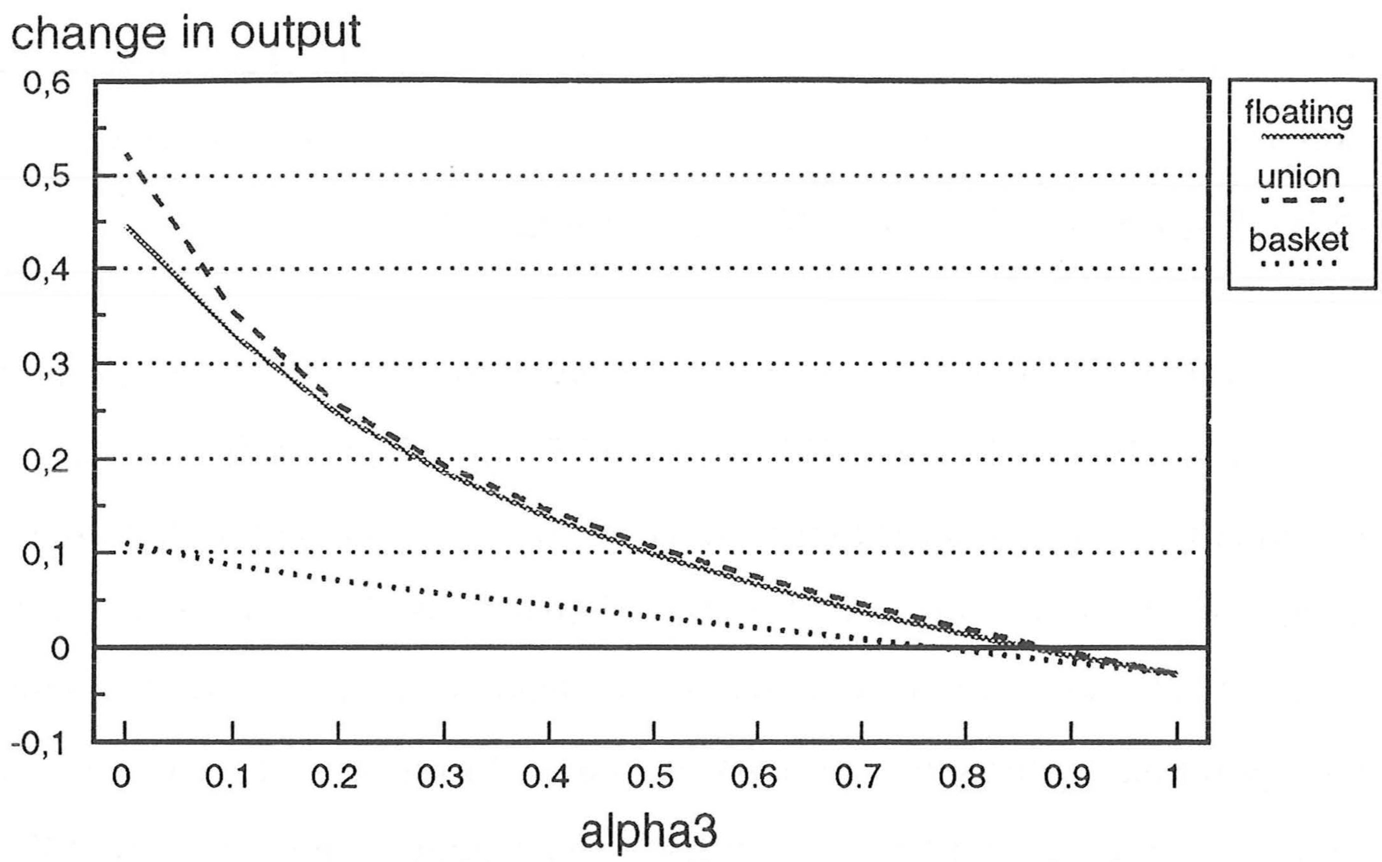
$$\frac{\delta y_3}{\delta f_1}(EMU\text{-}peg) - \frac{\delta y_3}{\delta f_1}(basket) = \frac{(1-\alpha_3)(\beta + k + \alpha k)\sigma_3\theta}{2(\alpha + \alpha\epsilon + \beta\sigma + k\sigma - \alpha k\sigma)(1+\beta_3\sigma_3)}.$$

It can be shown that this formula is positive for values $0 \leq \alpha \& \alpha_3 < 1$ and $\theta > 0$. If $\alpha_3 = 1$, $\sigma_3 = 0$ or $\theta = 0$, the formula is zero and there is no difference between the output effects in the exchange rate union and in the basket peg regime. The difference between the output effects in these regimes consists of the competitiveness effect and of the price effect through the supply side. If α, α_3, β and β_3 are all zero, we are back in the fixed price case, where the above-mentioned formula reduces to the difference in the exchange rate effect. When assuming symmetry between all three economies, it can additionally be shown that floating leads to an even higher post-shock output level than the union in the case of a positive shock. It must be assumed that $0 \leq \alpha < 1$ and $0 \leq \theta < 1$.

In the baseline scenario the conclusion that the currency basket exchange rate regime stabilizes the output more than the other two regimes holds for a wide range of values of α and α_3, too, as is seen in figure 6 on page 78. However, if $\alpha_3 = 1$, i.e. if domestic prices adjust wholly to foreign trade prices, there is no difference between the regimes in this respect. This is the same result which was obtained in the case of domestic shocks, too (pp. 44-45). The basket regime stabilizes also domestic prices better than the other regimes with the respective values of α and α_3. Floating is the second best.

The above-mentioned results apply to an economy where output is rather responsive to changes in competitiveness and foreign demand. In more closed real economies, with small values of σ, σ_3, ε and ε_3, the change in the interest rate can outweigh the effects of export demand so that a positive goods demand shock occurring in country 1 can lead to a decline of the small country's output in the currency basket regime. In this case it is possible in principle that the exchange rate union leads to a smaller change in output than the basket peg regime (see appendix 6). (The situation is similar to that of the fixed-price case, see figures 4 and 5, pp. 72-75.)

Figure 6. Goods demand shock in country 1: sensitivity of output in the small country with respect to α and α_3 ($\alpha_3 = 3 * \alpha$)



In the case when $\alpha = \alpha_3 = 1$ the change in output in all exchange rate regimes is as follows (baseline calculation): $\delta y_3/\delta f_1 = -0.541$. The negative effect thus increases when α approaches 1. This is because the output effect of the shock on country 2 (the more important trading partner) becomes negative (see figure 3, p. 60).

4.3.2.2 Shocks in country 2

Effects on the big countries

If we assume again that countries 1 and 2 are symmetrical, a demand shock occurring in country 2 leads to the same output effects as a corresponding shock occurring in country 1. Interest rate reactions are also the same. But competitiveness changes in the opposite direction, by an equal amount, depending on the origin of the shock. If the demand shock occurring in country 2 is a positive one, the exchange rate of **country 2** appreciates, and competitiveness thus deteriorates.[12]

Effects on the small country

Floating exchange rates

In a floating rate regime there is no difference according to the origin of the shock in the case of fixed prices. All factors affecting the output of country 3, interest rate, competitiveness and export demand, develop as in the case when

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[12]If the big countries are asymmetric with respect to the degree of real wage rigidity so that $\alpha_1 = 0.1$ and $\alpha_2 = 1$, i.e. there is substantial real wage flexibility in "the USA" and full real wage rigidity in "EMU", $\delta y_1/\delta f_2 = 0.195$ and $\delta y_2/\delta f_2 = 0.888$. Real wage rigidity in "EMU" thus leads to a greater deviation of output of that area than in the baseline case ($\alpha_2 = 0.1$), where $\delta y_2/\delta f_2 = 0.667$. This is due to the greater effect of the exchange rate on the price level. In the case of a positive shock the appreciation of the currency leads to a greater decline in prices, which decreases the deterioration in competitiveness and increases the growth of the output accordingly. This result is the opposite to the case when the shock occurs in country 1.

the shock originates in country 1. Output thus increases by the same amount in both cases if the shock is positive (see expression (48) on page 63). (For a graphical analysis, see figure 5, pp. 73-75.)

In the case of somewhat flexible prices (baseline scenario) the effects of this shock are different from those of a shock occurring in country 1, because country 2 is assumed to be a more important trading partner than country 1. This result differs from that obtained with a fixed price model. The reason for this difference is that export demands from the big countries differ in this model version; in the fixed price model the outputs of both big countries change by an equal amount (see pp. 56 and 59).

In the case of a shock occurring in country 2 the export demand of country 3 grows by more than when the shock occurs in country 1. According to the goods and money market equilibrium conditions the effective exchange rate of the small country depreciates also less in this case, and accordingly the domestic price level rises less. Also the improvement in competitiveness is smaller. The results of the baseline calculation are as follows:

$$\delta y_3/\delta f_2 = 0.246,\ \delta p_3/\delta f_2 = 0.277,\ \delta c_3/\delta f_2 = 0.399.$$

Exchange rate union

After solving the model with respect to the output of country 3 we obtain in the case of fixed prices:

$$(60)\ \frac{\delta y_3}{\delta f_2}=\frac{\sigma[\epsilon_3\phi-\mu_3 k]-\theta\sigma_3[k\mu+\phi(1-\epsilon)]}{2\sigma[k\mu+\phi(1-\epsilon)]}.$$

In the case of a positive shock foreign demand contributes positively to the output, whereas the deteriorating competitiveness and the rising international interest rate contribute negatively to it. (For a graphical analysis, see figure 7, p. 84.)

We do not know the sign of the multiplier *a priori*. As a comparison to the effect of a corresponding shock originating in country 1, we get:

$$\frac{\delta y_3}{\delta f_1}-\frac{\delta y_3}{\delta f_2}=\frac{\theta\sigma_3}{\sigma}>0.$$

A positive real shock originating in country 1 thus leads to greater output than a corresponding shock originating in country 2. This is due to the competitiveness factor. If the positive demand shock occurs in country 1, the effective exchange rate of country 3 depreciates by the fraction θ of the depreciation occurring in country 2. If the same shock occurs in country 2, there will be an appreciation of the same magnitude. Interest rate and export demand effects are the same irrespective of the origin of the shock.

In the case of somewhat flexible prices (baseline scenario) the effects of increasing export demand are almost completely compensated for by the increasing interest rate and the deteriorating competitiveness, which results from the appreciating effective exchange rate. The appreciation causes also a decrease in the domestic price level. The result differs from the effects occurring in country 2, in the respect that the real shock there is internal and affects demand directly. In the small country the increase in demand is indirect and smaller:

$$\delta y_3/\delta f_2 = -0.003,\ \delta p_3/\delta f_2 = -0.187,\ \delta c_3/\delta f_2 = -0.867.$$

Currency basket exchange rate regime

In the fixed price case interest rate and export demand affect the output of country 3 in the same way as regards both origins of the demand shock, and competitiveness remains unchanged in both regimes. Because of symmetry between the big countries, output of the small country changes thus also by the same amount as in the case when the shock originates in country 1 (expression (59)). We do not know the sign of the change *a priori*. (For a graphical analysis, see figure 5, p. 75.)

In the case of somewhat flexible prices (baseline scenario) the effective exchange rate remains constant and again stabilizes prices and competitiveness better than the other regimes, but exactly for this reason it is worse in stabilizing output than the exchange rate union. Export demand grows now more than when the shock occurs in country 1. Only the rising interest rate tends to offset the growth effect. The outcome is as follows:

$$\delta y_3/\delta f_2 = 0.133,\ \delta p_3/\delta f_2 = 0.066,\ \delta c_3/\delta f_2 = 0.020.$$

Comparison of effects in different exchange rate regimes

When comparing the output effects in the EMU-peg and the basket peg regimes in the case of fixed prices (expressions (60) and (59), the latter after replacing δf_1 by δf_2 in the denominator), we see that the post-shock output is greater in the basket peg regime by the amount $\theta\sigma_3/2\sigma$ (if the shock is positive), assuming that the pre-shock levels are the same.

After assuming symmetry of parameters between countries 1, 2 and 3, we see that $\delta y_3/\delta f_2$ (floating) - $\delta y_3/\delta f_2$ (basket) = 1/2. We can thus write in the symmetrical case:

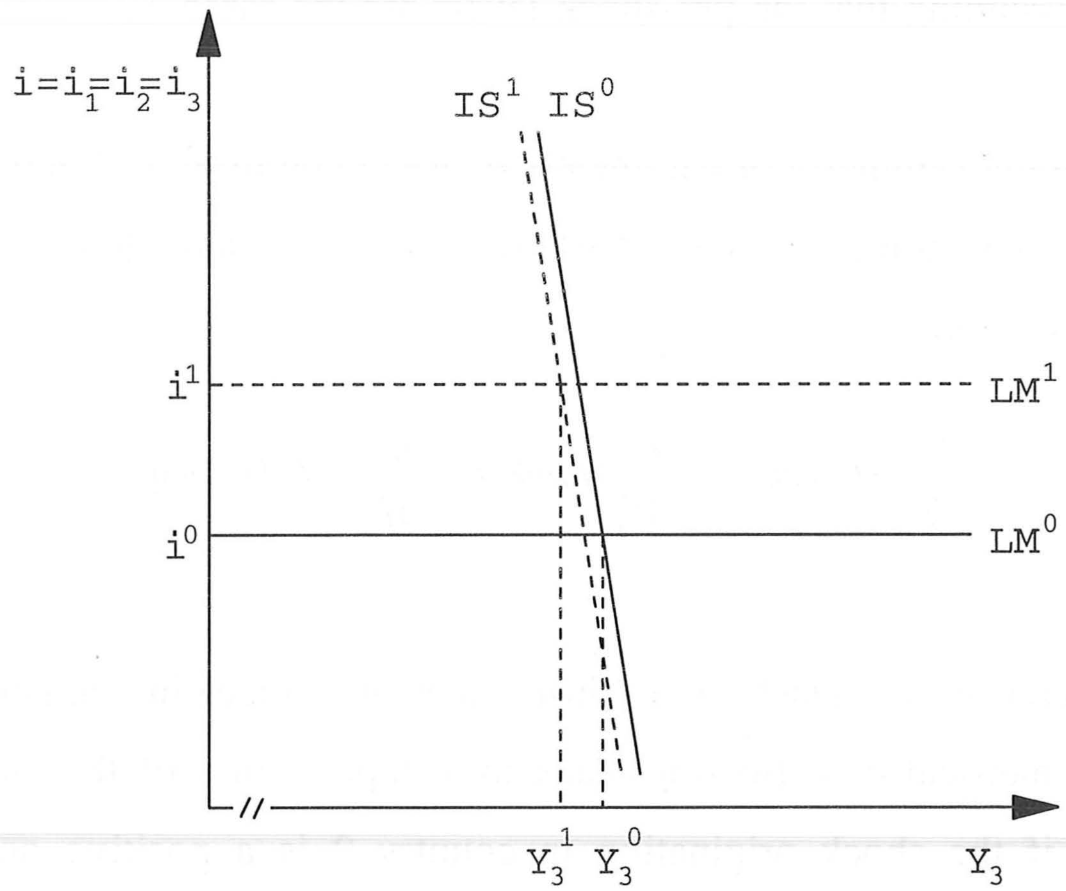
$$\frac{\delta y_3}{\delta f_2}(floating) > \frac{\delta y_3}{\delta f_2}(basket) > \frac{\delta y_3}{\delta f_2}(EMU\text{-}peg).$$

These differences are again due to differences in changes in competitiveness. In the symmetrical case floating leads to a depreciation of the currency of country 3 if the shock originating in country 2 is a positive one. In the currency basket regime there is no change in competitiveness, and in the EMU-peg the competitiveness of country 3 worsens. (A graphical analysis of the output effect in the case of the exchange rate union is presented in figure 7. For floating and basket peg the effects are the same as presented in figure 5 for a f_1 shock.)

Figure 7. A goods demand shock in country 2, effects on the output of country 3 - a graphical analysis

The figure is drawn according to the parameter values of the baseline scenario.

Pegging to the currency of country 2 (membership in an exchange rate union):

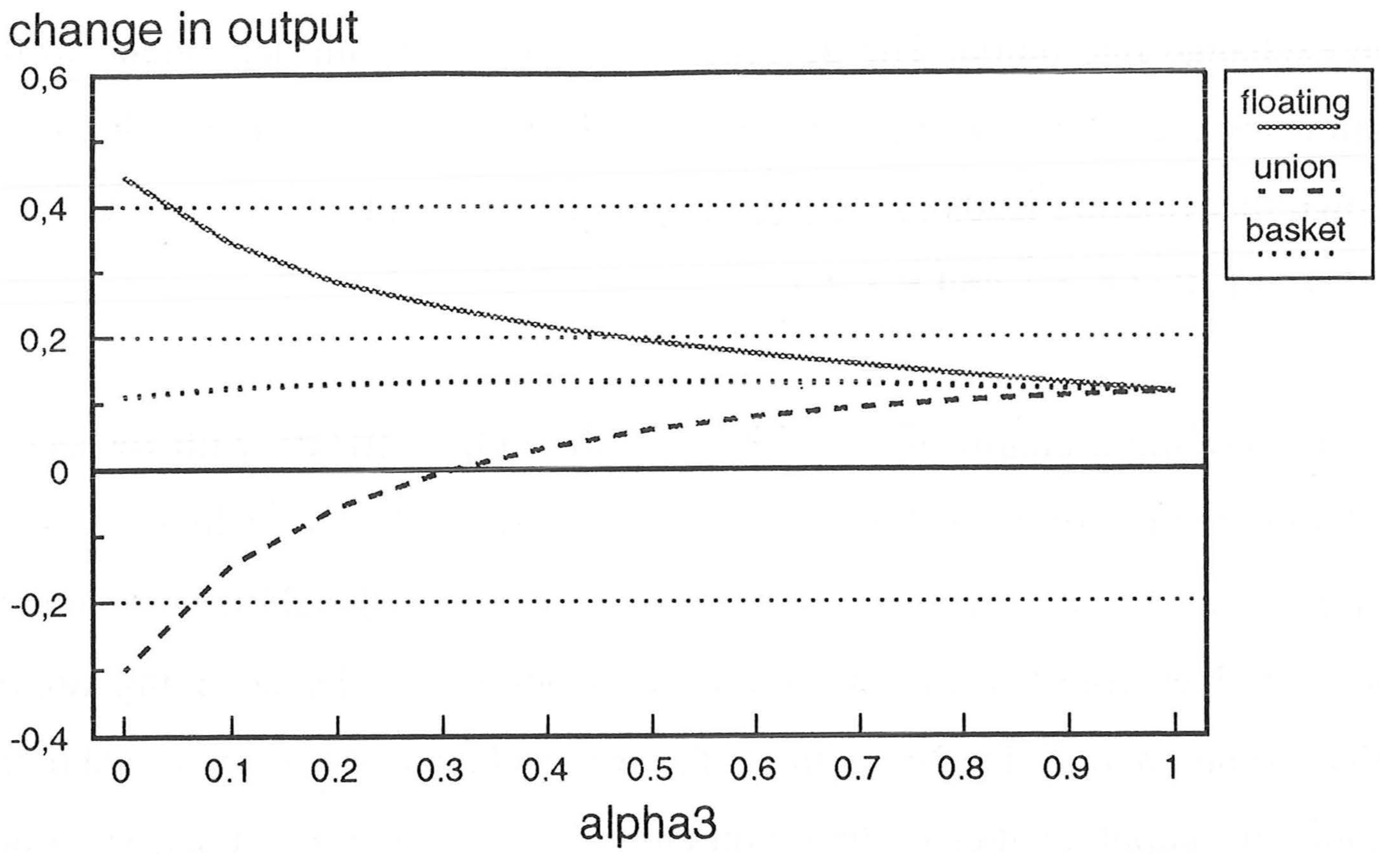


In the case of a credible exchange rate union the money supply is perfectly elastic at the internationally given interest rate, which is reflected in a horizontal LM curve. Because the big countries are assumed to be symmetric, a positive goods demand shock occurring in country 2 increases the international interest rate by the same amount as in the case of a f_1 shock, i.e. from i^0 to i^1. The LM curve accordingly shifts upwards. Export demand increases by the same amount as in the case of a f_1 shock, but the effective exchange rate appreciates together with that of country 2 (by multiplier $\theta/(2\sigma)$). The direction of the change in the IS curve is thus not known *a priori*. According to the baseline scenario the competitiveness effect dominates because of the large change in the big country exchange rate, and the IS curve shifts slightly to the left. The output of the small country decreases from y_3^0 to y_3^1.

In the case of flexible prices the difference between the post-shock output levels is the same as in the case when the shock occurs in country 1 (page 76). Now, however, the basket peg regime leads to a higher output level than the exchange rate union. The deviation from zero is again dependent on the parameter values. In the case of symmetry between the economies it can be shown that floating leads to the highest post-shock output. (We must assume: $0 \leq \alpha < 1$, $0 < \varepsilon < 1$ and $\theta < 1$.)

In the baseline scenario the sensitivity of the output effects with respect to different values of α and α_3 is seen in figure 8. If the values of these parameters are very low, the currency basket regime still stabilizes the output the best. Nevertheless, as the parameter values grow, the changing import prices (due to the change in the effective exchange rate) soon make the change in output smaller in the union case. Thus, if there is a positive goods demand shock in country 2, the appreciating exchange rate in the case of the union reduces import prices and increases the output through the supply channel. The currency basket regime stabilizes the output more than the floating regime for all values of $\alpha_3 < 1$. In the case when $\alpha_3 = 1$, there is no difference between the regimes with respect to output stabilization.

Figure 8. Goods demand shock in country 2: sensitivity of output in the small country with respect to α and α_3 ($\alpha_3 = 3 * \alpha$)



In the case when $\alpha = \alpha_3 = 1$ the change in the output of country 3 is in all exchange rate regimes as follows (baseline calculation): $\delta y_3/\delta f_2 = -0.376$. The output changes thus by less than in the case when the shock occurs in country 1. This is because the dominating negative effects are now partly compensated for by the positive export demand effect due to the larger foreign trade share of country 2. When the shock occurs in country 1, the export demand effect is negative.

As expected, the currency basket regime is again the best in stabilizing domestic prices with all relevant values of α and α_3. The exchange rate union is now the second best alternative, and floating the worst in this respect (see appendix 4.).

In an alternative calculation (presented in appendix 6), where all economies respond less to changes in competitiveness and foreign demand, a real shock occurring in country 2 leads to a greater decline in output in the exchange rate union than in the baseline calculation (the interest rate sensitivity of aggregate demand is the same in both calculations). This result is due to the smaller positive effect of foreign demand and due to the greater negative exchange rate effect - because the exchange rate of country 2 appreciates more than in the baseline calculation. When output reacts less to changes in the exchange rate, a greater change in the exchange rate is needed to restore equilibrium. In this alternative calculation, when the real sectors of the economies are rather closed, the basket regime leads to the smallest change in output.

4.3.3 Monetary shocks in the big countries

4.3.3.1 Shocks in country 1

When analysing the effects of a money supply or demand shock originating in country 1, we again solve the effects occurring in the big countries first, and then insert these results into the small country model. We assume that the small country does not affect the solution of the big country model; we also assume symmetry between the big economies.

Effects on the big countries

After solving the effect of a monetary shock on the output of country 1, we get the following result in the case of fixed prices:

$$(61)\ \frac{\delta y_1}{\delta m_1} = \frac{2k\mu + \phi(1-\epsilon)}{2k[k\mu + \phi(1-\epsilon)]} = \frac{\mu}{2[k\mu + \phi(1-\epsilon)]} + \frac{1}{2k} > 0.$$

An increase in the money supply, or a decrease in money demand, in country 1 thus leads to an increase in that country's output. The output of country 2 in turn decreases (given $1-\varepsilon > 0$):

$$(62)\ \frac{\delta y_2}{\delta m_1} = \frac{-\phi(1-\epsilon)}{2k[k\mu + \phi(1-\epsilon)]} < 0.$$

The above result is the so-called beggar-thy-neighbour result, where an expansive policy in one country leads to a positive impact in the home country but to a negative impact in the neighbouring country. Expansive monetary policy is not, however, a zero-sum game worldwide, because the output of country 2 decreases less than that of country 1 increases. There will be a positive net effect of the magnitude $\mu/[k\mu + \Phi(1-\varepsilon)]$.

The positive impact on country 1's output is due to improving competitiveness and a decreasing interest rate (expressions (63) and (64)). Export demand, as country 2's output decreases, has a negative impact on the output of country 1. The effects on c and i are as follows:

$$(63)\ \frac{\delta c}{\delta m_1} = \frac{\epsilon + 1}{2k\sigma} > 0,$$

$$(64)\frac{\delta(i_2=i_1)}{\delta m_1}=-\frac{1-\epsilon}{2[k\mu+\phi(1-\epsilon)]}<0.$$

The decreasing interest rate has a positive impact on the output of country 2 also, but the worsening competitiveness is enough to compensate for this positive effect like the positive effect due to increasing export demand.

In the case of a money supply shock, or equivalently of a money demand shock with the opposite sign, the endogenous variables change in the following way in the case of somewhat flexible prices (baseline calculation):

$\delta y_1/\delta m_1 = 0.396$, $\delta y_2/\delta m_1 = -0.013$

$\delta e/\delta m_1 = 3.382$, $\delta i/\delta m_1 = -0.670$

$\delta p_1/\delta m_1 = 0.427$, $\delta p_2/\delta m_1 = -0.299$.

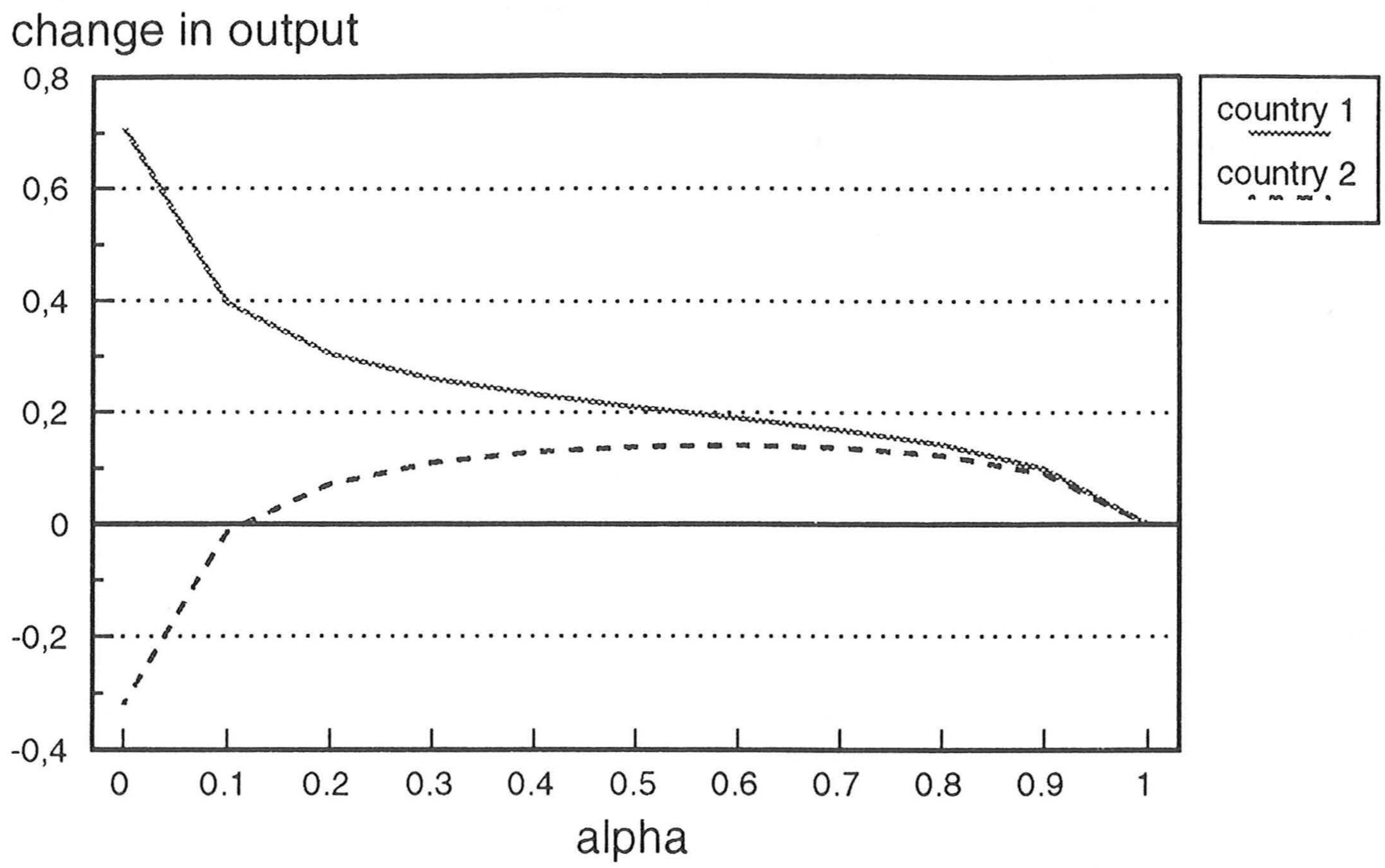
If the monetary shock is an increase in the money supply (or equivalently a decrease in money demand) the output of country 1 increases, whereas that of country 2 remains about unchanged. The exchange rate of country 1 depreciates, and the global interest rate decreases. The depreciation and the increase in output lead to a rise in the price level of country 1. In country 2 the opposite movements of these variables lead to a decrease in prices.

When looking at the following figure 9, we notice that the beggar-thy-neighbour result is obtained when the value of α is low, but when α increases somewhat above 0.1 the output of country 2 increases, too. This is because of the supply effect of decreasing import prices in country 2. Competitiveness deteriorates in the flexible price case less than in the fixed price case. The effects of the shock on the two countries approach each other when α grows. When $\alpha = 1$ the neutrality-of-money result is established for both countries. This is a general result, which holds for all positive values of the other parameters.

Even in the case of $\alpha = 0$ (and $\beta = 0.3$), the increase in output of country 1 is greater than the decrease in the output of country 2. This is the same result that was obtained in the model with fixed prices. Monetary policy is thus not a zero-sum game worldwide in terms of output changes when $0 \leq \alpha < 1$. There is, however, a net increase in the international price level with all values of α from 0 to 1.[13]

[13]When real wages are rather flexible in "the USA" and fully rigid in "EMU" ($\alpha_1 = 0.1$ and $\alpha_2 = 1$) (otherwise symmetric baseline scenario) the output effects of a positive monetary shock occurring in country 1 in the two countries are $\delta y_1/\delta m_1 = 0.364$ and $\delta y_2/\delta m_1 = 0.279$. When comparing to the baseline scenario, we see that the output of country 2 is less insulated in the case of full rigidity of real wages. In this case the appreciation of the exchange rate is fully reflected as a decline in prices, which in turn diminishes the deterioration of competitiveness. (The effects of real wage rigidity on output insulation in "EMU" are in an m_1 shock case the opposite to those in an f_1 shock case, see footnote 11, p. 61.)

Figure 9. Monetary shock in country 1: sensitivity of output reactions with respect to α in the big countries



Effects on the small country

Floating exchange rates

In the case of fixed prices solving the model gives the following expression for the change in the output of country 3:

$$(65)\ \frac{\delta y_3}{\delta m_1} = -\frac{\phi_3(1-\epsilon)}{2k_3[k\mu+\phi(1-\epsilon)]} < 0.$$

The output of the small country thus decreases, as does that of country 2, if there is an increase in the money supply (or a decrease in money demand) in country 1. If $\Phi_3 = \Phi$ and $k_3 = k$, i.e. if the LM curves are symmetric, the effect is the same as in country 2. The negative impact on the output of country 3 is due to the net effect of changes in competitiveness and export demand. The worldwide decrease of interest rates has a positive impact on the output of country 3. The effect of the export demand depends on the relative export shares of countries 1 and 2. If θ is great, export demand has a positive impact. If θ is small, the impact is negative. (For a graphical analysis, see figure 10, p. 100.)

To determine the change in competitiveness we first derive the change in c_{32}, the bilateral competitiveness between countries 3 and 2. After that we calculate the change in the effective exchange rate/competitiveness by using expression (51). The competitiveness c, between countries 1 and 2, is determined in the big country model (expression (63)). The change in competitiveness of country 3 is as follows:

(66)

$$\frac{\delta c_3}{\delta m_1} = \frac{-k_3\mu_3 k(1-\epsilon) - k_3\epsilon_3\theta[2k\mu + \phi(1-\epsilon)] + k_3\epsilon_3(1-\theta)\phi(1-\epsilon) - \phi_3 k(1-\epsilon)}{2kk_3\sigma_3[k\mu + \phi(1-\epsilon)]}.$$

The above expression is likely to be negative, because the numerator is evidently negative (the only positive term is small compared to the other terms), and the denominator is always positive. If there is symmetry between economies 1, 2 and 3 (in parameters), the numerator is always negative, and the whole expression is negative (we assume $\varepsilon<1$). When the money supply in country 1 increases, the currency of country 3 thus appreciates effectively, i.e. competitiveness deteriorates.

In the case of somewhat flexible prices (baseline scenario) the effective exchange rate of country 3 appreciates and leads to a worsening of competitiveness, but also to a fall in the price level. Even if the increasing foreign demand and the declining interest rate tend to increase the domestic output, the competitiveness effect is big enough to reduce the growth of output to about zero:

$\delta y_3/\delta m_1 = -0.009$, $\delta p_3/\delta m_1 = -0.302$, $\delta c_3/\delta m_1 = -0.758$.

Exchange rate union

In the case of fixed prices we use equation (55) (we do not need the LM equation). We now solve the IS equation in terms of a change in the money supply of country 1. Exogenous variables are derived from the big country model presented in equations (30)-(35) (solved in expressions (61)-(64)). The output effect is as follows:

(67)

$$\frac{\delta y_3}{\delta m_1} = \frac{\sigma k \mu_3(1-\epsilon) + \epsilon_3 \sigma \theta[2k\mu + \phi(1-\epsilon)] - \sigma_3 \theta(\epsilon+1)[k\mu + \phi(1-\epsilon)] - \sigma \epsilon_3 (1-\theta)\phi(1-\epsilon)}{2k\sigma[k\mu + \phi(1-\epsilon)]}.$$

We do not know the sign of this change *a priori*.

Change in competitiveness is a fraction θ of that of country 2, i.e.

(68) $\delta c_3/\delta m_1 = -\theta(c) = -\theta(\varepsilon+1)/2k\sigma < 0$.

If m_1 increases, the competitiveness of country 3 worsens.

The output effect is positive if

$$\theta < \frac{\sigma(1-\epsilon)(k\mu_3 - \epsilon_3\phi)}{[\sigma_3(\epsilon+1) - 2\epsilon_3\sigma][k\mu + \phi(1-\epsilon)]}.$$

The negative term in the denominator is small. We can thus assume that the denominator is positive.

If country 3 is symmetrical to countries 1 and 2, the above condition is as follows:

$$\theta < \frac{k\mu - \phi\epsilon}{k\mu + \phi(1-\epsilon)}.$$

A decreasing interest rate and increasing export demand in country 1 contribute positively to the output of country 3. Worsening competitiveness (expression (68)) and decreasing export demand in country 2 (the more important trading partner), in turn, contribute negatively to it. The output effect differs from that in country 2 even in the symmetrical case. This is due to different foreign demand and competitiveness effects. For country 2 the only export market is country 1, where output grows. For country 3 also the declining output of country 2 affects demand. Competitiveness deteriorates in the small country by less than in country 2 when $\theta < 1$ (see expression (68)). (For a graphical analysis, see figure 10.)

As a numerical illustration (in the symmetrical case) we assume: $k=0.67$, $\mu=0.2$, $\Phi=0.46$, and $\varepsilon=0.3$ (according to the baseline scenario presented on pages 38-39). Now the condition for positiveness of $\delta y_3/\delta m_1$ is $\theta<-0.009$, which is not possible (foreign trade shares cannot be negative). In this example the effect of an increase in the money supply in country 1 on the output of country 3 is thus negative.

In the asymmetrical case we assume additionally: $\varepsilon_3=0.6$, $\sigma_3=0.3$, $\sigma=0.1$ and $\mu_3=0.2$. Now the condition for positiveness of $\delta y_3/\delta m_1$ is $\theta < 0.123$, which is the case when trade with country 1 is very small. Now competitiveness deteriorates only slightly and the positive effect of the decreasing interest rate dominates.

In the case of somewhat flexible prices (baseline scenario) the appreciation of the effective exchange rate is slightly greater than in the case of floating rates. This leads to decreasing import prices, but also to deteriorating competitiveness. The net effect is a bit greater decrease in output than in the floating rate regime. The change is, however, close to zero:

$$\delta y_3/\delta m_1 = -0.028,\ \delta p_3/\delta m_1 = -0.337,\ \delta c_3/\delta m_1 = -0.696.$$

Currency basket exchange rate regime

In the case of fixed prices we derive the output effects of a change in m_1 by inserting the export demand and interest rate expressions derived earlier into equation (58) presented on page 69. Competitiveness is stabilized so that c_{32} changes to compensate for changes in c. The output effect is as follows:

$$(69)\ \frac{\delta y_3}{\delta m_1}=\frac{2\theta\epsilon_3[k\mu+\phi(1-\epsilon)]+(k\mu_3-\epsilon_3\phi)(1-\epsilon)}{2k[k\mu+\phi(1-\epsilon)]}.$$

Again, we do not know the sign of the change *a priori*. In the case of a positive shock the increasing foreign demand from country 1 and the declining interest rate contribute positively to output. The declining foreign demand from country 2, however, contributes negatively to it.

If $\theta = 0$, we have:

$$\frac{\delta y_3}{\delta m_1}=\frac{(k\mu_3-\epsilon_3\phi)(1-\epsilon)}{2k[k\mu+\phi(1-\epsilon)]}.$$

If $\theta = 1/2$, we have, in turn:

$$\frac{\delta y_3}{\delta m_1}=\frac{\epsilon_3 k\mu+\mu_3 k(1-\epsilon)}{2k[k\mu+\phi(1-\epsilon)]}>0.$$

Thus, if there is trade with only country 2, output <u>can</u> increase when m_1 increases, which requires that $k\mu_3 > \varepsilon_3\Phi$. The greater the interest rate sensitivity of output demand is, the more likely it is that output increases in this case (the interest rate declines). A high value of ε_3 in turn gives a high weight for the negative foreign demand effect from country 2, which tends to decrease the output.

Because the output of country 2 declines (expression (62)), a high value of k means that money demand in country 2 decreases more than when k is small. A lower demand for money means a smaller decrease in output of country 2, and accordingly a smaller decline in export demand for country 3 products. Because the international interest rate declines, a high value of Φ in turn leads to a greater increase in the demand for money, and accordingly to a lower output of country 2, and to a lower export demand for country 3 products.

When the trade share of country 1 (θ) is greater or equal to 1/2, output doubtlessly increases. The interest rate and export demand effects are both positive.

When we look at the output multiplier (69), we see that a positive impact of an increase in the money supply of country 1 is rather probable (there is only one negative factor in the numerator and it is obviously small compared to the joint effect of the other factors).

In the case of somewhat flexible prices (baseline scenario) the positive effects due to export demand and interest rates are only slightly compensated for by the negative change in competitiveness. Because the effective exchange rate is stabilized, the effect comes through changes in prices. The change in output is greater than in the cases of floating and the exchange rate union:

$$\delta y_3/\delta m_1 = 0.168,\ \delta p_3/\delta m_1 = 0.026,\ \delta c_3/\delta m_1 = -0.108.$$

Comparison of effects in different exchange rate regimes

Fixed prices

In the currency basket exchange rate regime the negative impacts of an expansionary monetary policy of country 1 on the output of country 3 are weaker than in "the EMU-peg case", where competitiveness weakens. The interest rate and export demand effects are the same in both cases (assuming no behavioral differences between regimes). When assuming that the initial output levels are the same, the currency basket exchange rate regime thus leads to a greater post-shock output than participation in EMU:

$$\frac{\delta y_3}{\delta m_1}(basket)-\frac{\delta y_3}{\delta m_1}(EMU\text{-}peg)=\frac{\theta\sigma_3(1+\epsilon)}{2k\sigma}>0.$$

Assuming symmetry of parameters in countries 1, 2 and 3, we get:

$$\frac{\delta y_3}{\delta m_1}(basket)-\frac{\delta y_3}{\delta m_1}(floating)=\frac{\epsilon(2\theta-1)+1}{2k}>0,$$

which is greater than the difference between the output effects in the basket and EMU regimes. In the symmetrical case we can thus write:

$$\frac{\delta y_3}{\delta m_1}(basket)>\frac{\delta y_3}{\delta m_1}(EMU\text{-}peg)>\frac{\delta y_3}{\delta m_1}(floating).$$

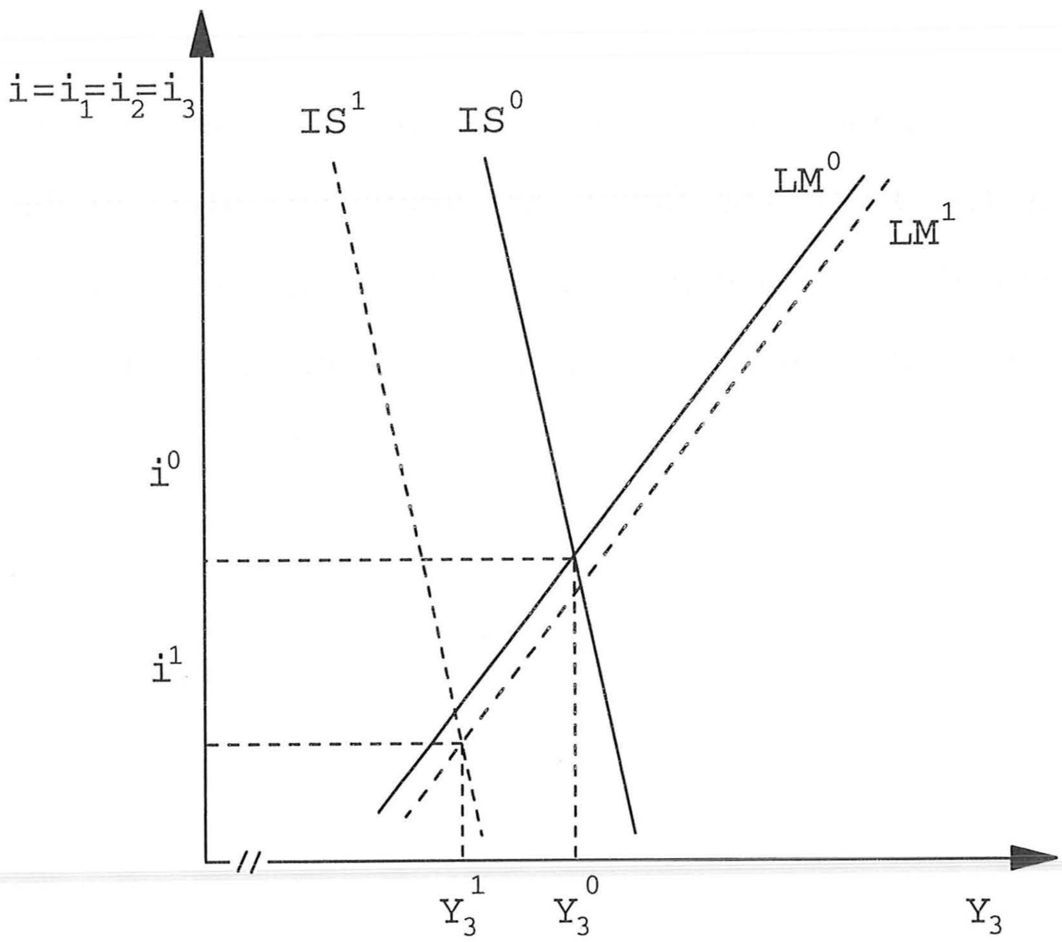
In the floating rate regime output declines in the case of a positive m_1 shock. In the other two regimes the sign of the change cannot, however, be determined *a priori*.

This ranking is again due to differences in exchange rate (competitiveness) effects. If the money supply increases in country 1, floating leads to the greatest appreciation of the exchange rate of country 3, whereas in the currency basket regime the effective exchange rate is kept unchanged, and competitiveness is thereby stabilized. In the EMU-peg regime competitiveness deteriorates in relation to country 1, but is constant in relation to country 2.

Output effects of a monetary shock occurring in country 1 are presented graphically in figure 10. The figures are drawn according to the baseline scenario, where the exchange rate union leads to the greatest deviation of output (contrary to the symmetric case presented on the previous page).

Figure 10. A monetary shock in country 1, effects on the output of country 3 - a graphical analysis

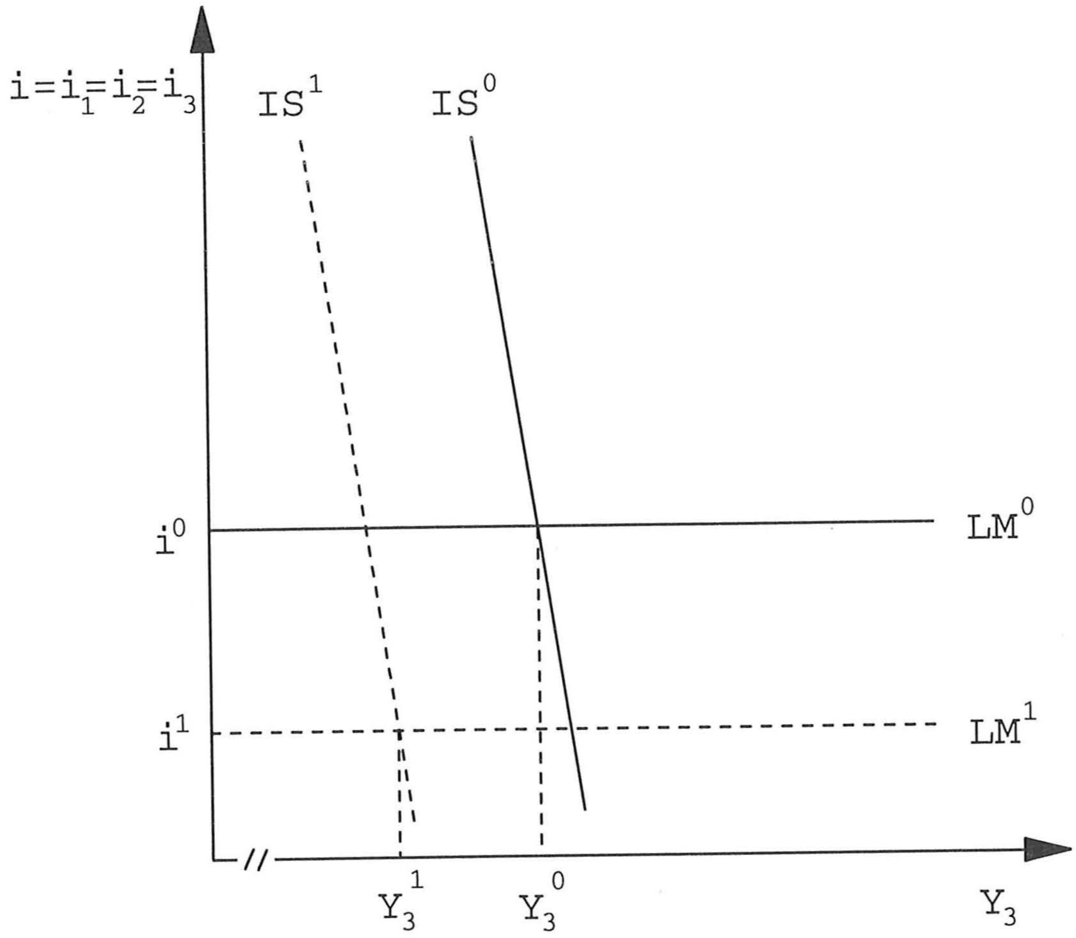
Floating exchange rates:



The international interest rate declines after a positive monetary shock occurring in country 1. In the small country this is reflected in a shift of the LM curve to the right. At the same time, however, the appreciation of the domestic exchange rate worsens competitiveness and shifts the IS curve to the left. The export demand effect is approximately neutral in the baseline scenario, the demand from country 1 increases, but that of the more important trading partner, country 2, declines. (The net effect of competitiveness and export demand is negative *a priori*.) As a result of these effects the output of country 3 decreases from y_3^0 to y_3^1 (shown *a priori* in expression (65)).

Figure 10 (continued)

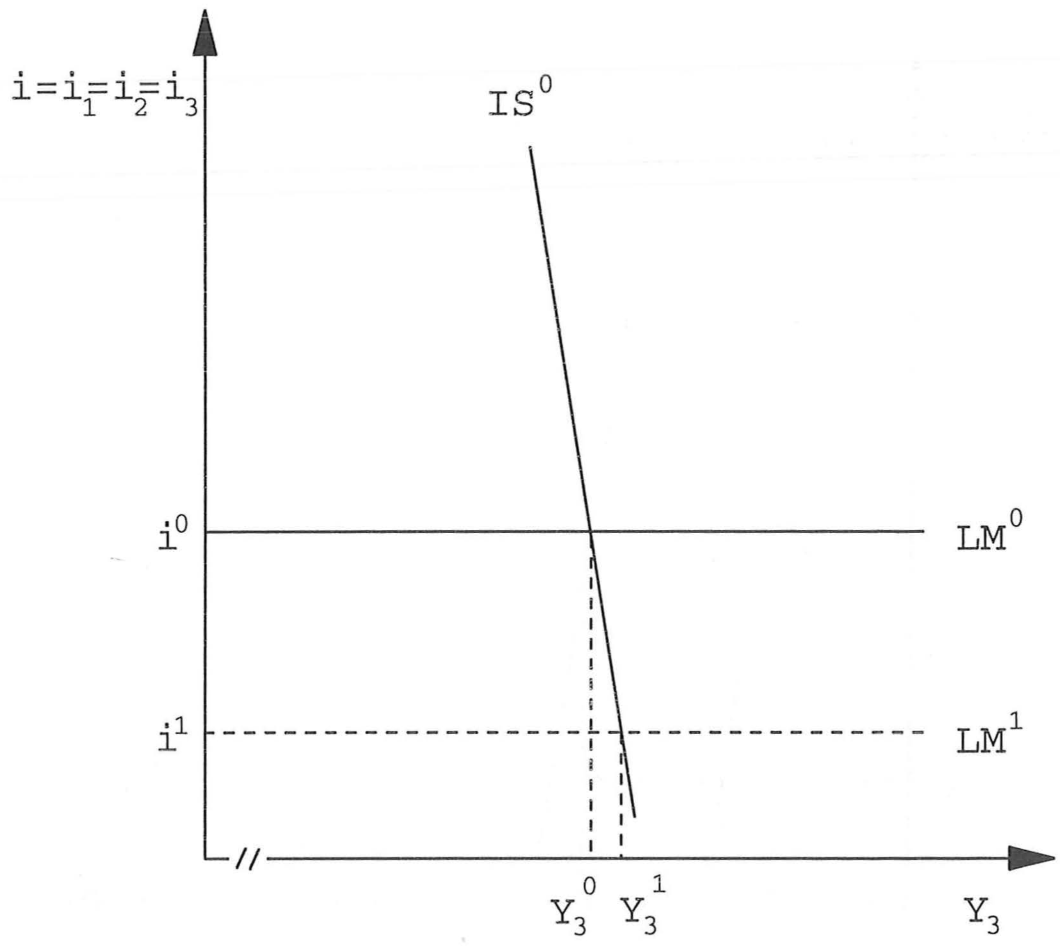
Pegging to the currency of country 2 (membership in an exchange rate union):



The horizontal LM curve shifts downwards after a positive monetary shock occurring in country 1, and the interest rate declines. The IS curve shifts to the left because of deteriorating competitiveness. (The negative competitiveness effect is shown *a priori* in expression (68).) The export demand effect is approximately neutral in the baseline scenario. The magnitude and sign of this effect depends on the foreign trade shares of the big countries, because the output of country 1 increases and that of country 2 declines. According to the baseline scenario the output of country 3 decreases from y_3^0 to y_3^1. The decrease is greater than in the floating rate regime.

Figure 10 (continued)

Currency basket exchange rate regime:



The horizontal LM curve shifts downwards and the interest rate declines after a positive monetary shock occurring in country 1, as in the case of the exchange rate union. The effective exchange rate is stabilized in the basket peg regime so that the only effect on the IS curve comes in the fixed price case from the export demand. In the baseline scenario (where $\theta = 0.3$) the export demand effect is, however, approximately neutral. The demand from country 1 increases, but that of country 2 decreases. The IS curve remains in this case unchanged. The output increases due to the decline in the interest rate from y_3^0 to y_3^1. The sign of the change cannot, however, be determined *a priori*.

Flexible prices

In the case of flexible prices it can also be shown *a priori* that the basket peg regime leads to a higher post-shock output level in the case of a positive shock (if the pre-shock output level is assumed to be the same in different exchange rate regimes). The difference between the output effects is as follows:

$$\frac{\delta y_3}{\delta m_1}(basket) - \frac{\delta y_3}{\delta m_1}(EMU\text{-}peg) = \frac{(1-\alpha_3)(1+\alpha+\epsilon+\alpha\epsilon+2\beta\sigma)\sigma_3\theta}{2(\alpha+\alpha\epsilon+\beta\sigma+k\sigma-\alpha k\sigma)(1+\beta_3\sigma_3)}.$$

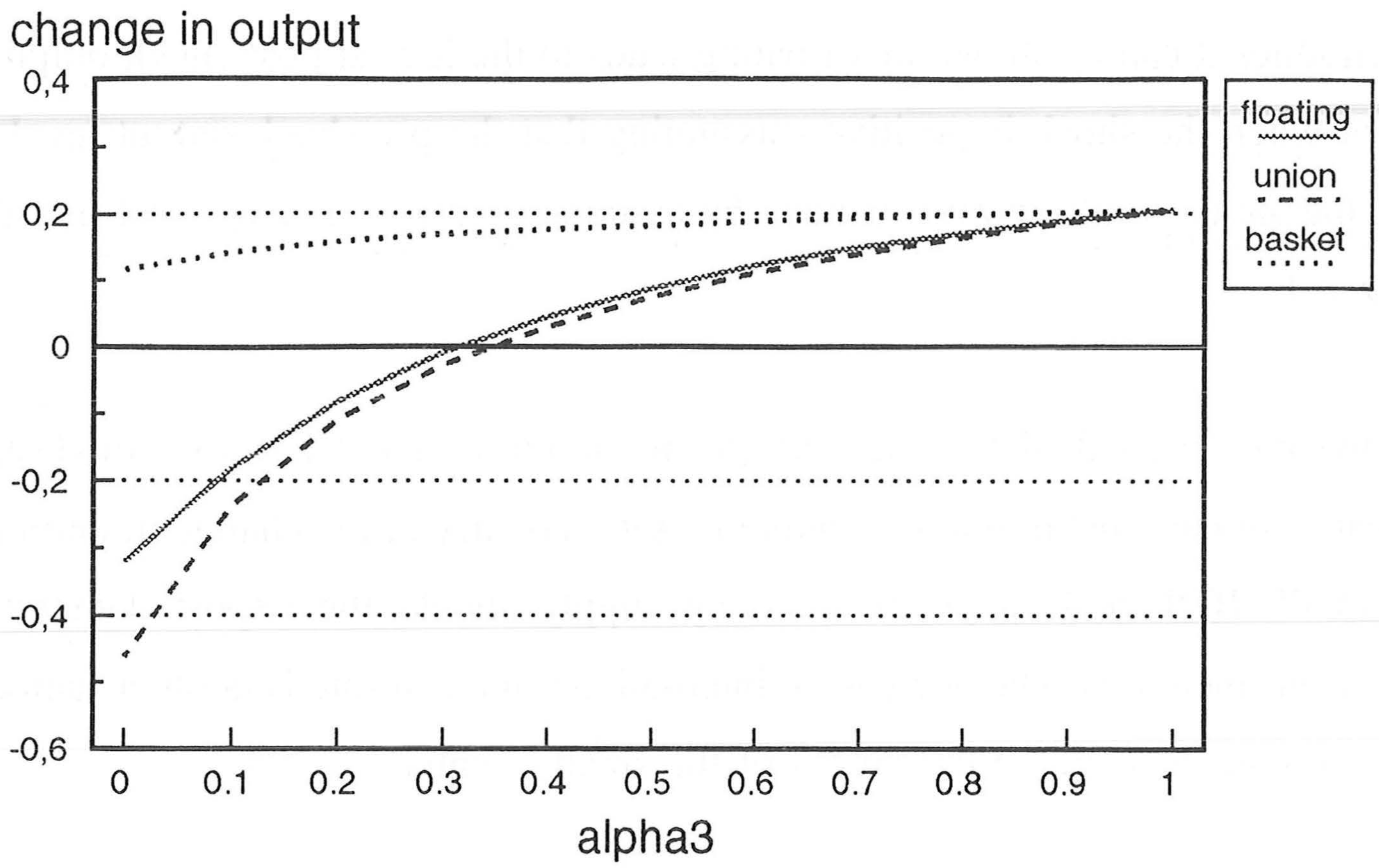
When assuming $0 \leq \alpha \& \alpha_3 < 1$ and $0 < \theta \leq 1$, the formula is positive. This formula, like that in the case of real shocks, consists of differences in the competitiveness and price effects. If $\alpha = \alpha_3 = \beta = \beta_3 = 0$, only the difference in the exchange rate effect is left, and the formula reduces to the same as that obtained in the fixed price model (p. 98). In the case of symmetry between all economies it can be shown that floating leads to the lowest post-shock output level when the shock is positive - assuming that the pre-shock output levels are the same in all regimes. It must be assumed that $0 \leq \theta < 1$, $\varepsilon < 1$ and $0 \leq \alpha < 1$.

In the baseline calculation the change in foreign demand is rather modest, because in the most important trading partner, country 2, the change in output is small. If there is a positive money supply shock, the export demand, however, increases. The decreasing international interest rate is another factor which tends to increase the output of the small country.

The output reactions in the floating rate regime and in the exchange rate union are very similar with different values of α and α_3 (figure 11). Changes in output are greater in these regimes than in the basket peg regime when the values of α and α_3 are very low. Nevertheless already with modest values of these parameters the change becomes smaller. This is due to the strengthening supply effect of import prices. The basket regime again stabilizes domestic prices the best with all values of α and α_3 considered, floating is the second best in this respect and the union the worst (appendix 4).

In the alternative calculation, presented in appendix 6, the ranking of the regimes according to the change in output does not change. The result is thus not very sensitive to competitiveness and foreign demand elasticities.

Figure 11. Monetary shock in country 1: sensitivity of output in the small country with respect to α and α_3 ($\alpha_3 = 3 * \alpha$)



When $\alpha = \alpha_3 = 1$, there is no change in the output of country 3 in any of the regimes. This is due to the neutrality-of-money effect in the big countries.

4.3.3.2 Shocks in country 2

Effects on the big countries

A monetary shock originating in country 2 creates the same effects in country 2 as a similar shock originating in country 1 creates in country 1. The same reasoning applies to the effects on country 1. In the case of fixed prices an expansive monetary policy in country 2 depreciates its exchange rate, reduces the interest rate, and leads thus to an increase in the output of country 2. The output of country 1 declines, but by less than the output of country 2 increases. (About the magnitudes of the effects, see expressions (61)-(64).) In the case of somewhat flexible prices the output of country 2 increases according to the baseline scenario, whereas that of country 1 remains about unchanged. With full flexibility the neutrality-of-money result is obtained (see p. 89 and figure 9).

From the small country's point of view there is a difference between the shocks originating in countries 1 and 2, because country 2 is assumed to be a more important trading partner than country 1. Export demand thus changes more when the shock occurs in country 2 (when $\alpha < 1$). The change in the interest rate is the same, because the big countries are assumed to be symmetric.[14]

<u>Effects on the small country</u>

Floating exchange rates

<u>In the case of fixed prices</u> there is no difference in output effects according to the origin of the shock. The effect of a money supply shock occurring in country 2 is thus negative by the amount presented in equation (65). The differences in export demand changes are compensated for by corresponding differences in changes of competitiveness. The IS curve shifts thus by the same amount as in the case of an m_1 shock. (For a graphical analysis, see figure 10.) Technically this is due to the same country weights in the export demand and competitiveness terms. Differences in output effects arise if the weights are assumed to be different. In the symmetrical case it can be shown that the currency of country 3 effectively appreciates.

In <u>the case of somewhat flexible prices</u> (baseline scenario) the effects of changes in export demand and interest rates are compensated for by opposite effects of changes in the effective exchange rate and competitiveness. If there is a positive monetary shock in country 2, the effective exchange rate of

[14]When real wages are rather flexible "in the USA" and fully rigid in "EMU", i.e. when $\alpha_1 = 0.1$ and $\alpha_2 = 1$ (otherwise the baseline scenario), $\delta y_1/\delta m_2 = 0.019$ and $\delta y_2/\delta m_2 = 0.089$. When also $\alpha_2 = 0.1$, $\delta y_1/\delta m_2 = -0.013$ and $\delta y_2/\delta m_2 = 0.396$. The output of "the EMU" is thus better insulated when real wages there are rigid. This is due to the reflection of the depreciation (in the case of a positive shock) fully in the increase of prices. This deteriorates competitiveness, which decreases the increase in output. The opposite is true, when a monetary shock occurs in country 1 (see footnote 13, p. 90).

country 3 appreciates and competitiveness deteriorates:

$\delta y_3/\delta m_2 = 0.025$, $\delta p_3/\delta m_2 = -0.254$, $\delta c_3/\delta m_2 = -0.348$.

Exchange rate union

In the case of fixed prices we get for the change in the output of country 3 the following:

(70)

$$\frac{\delta y_3}{\delta m_2} = \frac{\sigma k\mu_3(1-\epsilon)+\epsilon_3\sigma(1-\theta)[2k\mu+\phi(1-\epsilon)]+\sigma_3\theta(\epsilon+1)[k\mu+\phi(1-\epsilon)]-\sigma\epsilon_3\theta\phi(1-\epsilon)}{2k\sigma[k\mu+\phi(1-\epsilon)]}.$$

We do not know the sign of the change *a priori*, but it is likely that it is positive because there is only one rather small negative term (the last one) in the numerator. All other factors, except the export demand of country 1, contribute positively to the output. If we assume that $\theta \leq 1/2$, we can show that expression (70) is positive. The total foreign demand in this case is positive. (For a graphical analysis, see figure 12, p. 112.) By assuming symmetry of parameters between countries 1, 2 and 3 we can conclusively show positiveness (independently of the value of θ).

When comparing the effects of a money supply shock originating in country 1 to the corresponding effects of a shock originating in country 2, we get:

$$\frac{\delta y_3}{\delta m_1} - \frac{\delta y_3}{\delta m_2} = \frac{(2\theta - 1)\epsilon_3 \sigma - \theta(\epsilon + 1)\sigma_3}{k\sigma}.$$

We do not know the sign of this difference in the general case, but by assuming, again, $\theta \leq 1/2$ (i.e. country 2 is the more important trading partner), we get:

$$\frac{\delta y_3}{\delta m_2} > \frac{\delta y_3}{\delta m_1}.$$

An increase in the money supply thus leads to a greater output of country 3 when it occurs in country 2 than in country 1. This is due to the greater increase in foreign demand and the depreciating effective exchange rate in the former case and the appreciating effective exchange rate in the latter case. The same result is obtained when assuming symmetry of parameters in countries 1, 2 and 3.

In the case of somewhat flexible prices (baseline scenario) the reactions of the effective exchange rate and, accordingly, of competitiveness reinforce the impacts of the shock. In the case of a positive monetary shock in country 2 increasing export demand, declining interest rate and improving competitiveness all tend to increase the output of country 3:

$$\delta y_3/\delta m_2 = 0.509,\ \delta p_3/\delta m_2 = 0.520,\ \delta c_3/\delta m_2 = 0.704.$$

The depreciation of the effective exchange rate leads to an increase in the price level, but because α is rather small in the baseline scenario, competitiveness improves appreciably.

Currency basket exchange rate regime

For the change in the output of country 3 we get in the case of fixed prices the following expression:

$$(71)\ \frac{\delta y_3}{\delta m_2} = \frac{-2\theta\epsilon_3[k\mu + \phi(1-\epsilon)] + (k\mu_3 + \epsilon_3\phi)(1-\epsilon) + 2\epsilon_3 k\mu}{2k[k\mu + \phi(1-\epsilon)]}.$$

We are not able to tell the sign of the change *a priori*. It is not possible in the symmetrical case, either, but it depends essentially on the magnitude of the export demand weights. Export demand with respect to country 2 increases, but with respect to country 1 decreases. If $\theta \leq 1/2$, the output effect is positive. If $\theta = 1$, positiveness is still possible, due to the positive impact of the decreasing interest rate. Competitiveness remains in this case unchanged. (For a graphical analysis, see figure 12, p. 113.)

We do not know the relative effects of the shocks originating in countries 1 and 2 *a priori*, either:

$$\frac{\delta y_3}{\delta m_1} - \frac{\delta y_3}{\delta m_2} = \frac{(2\theta - 1)\epsilon_3}{k}.$$

If $\theta < 1/2$, an expansive monetary policy of country 2 leads to greater post-shock output in country 3 than a similar policy pursued by country 1, assuming that the pre-shock outputs are the same. The relative magnitudes of the effects depend thus on the export market shares of countries 1 and 2.

In the case of somewhat flexible prices (baseline scenario) trade-weighted relative prices (= competitiveness) remain almost constant and the change in output is due to changes in export demand and interest rates:

$$\delta y_3/\delta m_2 = 0.313,\ \delta p_3/\delta m_2 = 0.157,\ \delta c_3/\delta m_2 = 0.052.$$

Comparison of effects in different exchange rate regimes

Fixed prices

In the general case it can be shown that the post-shock output is greater in the EMS/EMU-peg regime than in the currency basket regime by the amount $\theta\sigma_3(1+\varepsilon)\ /\ 2k\sigma$ if the money supply of country 2 increases - when assuming that the pre-shock outputs are the same. This is due to the improving competitiveness with respect to country 1 in the former regime; in the latter one average competitiveness is unchanged. When we assume that the foreign trade share of country 2 is equal to or greater than that of country 1 ($\theta \leq 1/2$), we can show *a priori* that output changes have the same sign in both regimes, and that the deviation is greater in the exchange rate union than in the basket peg regime.

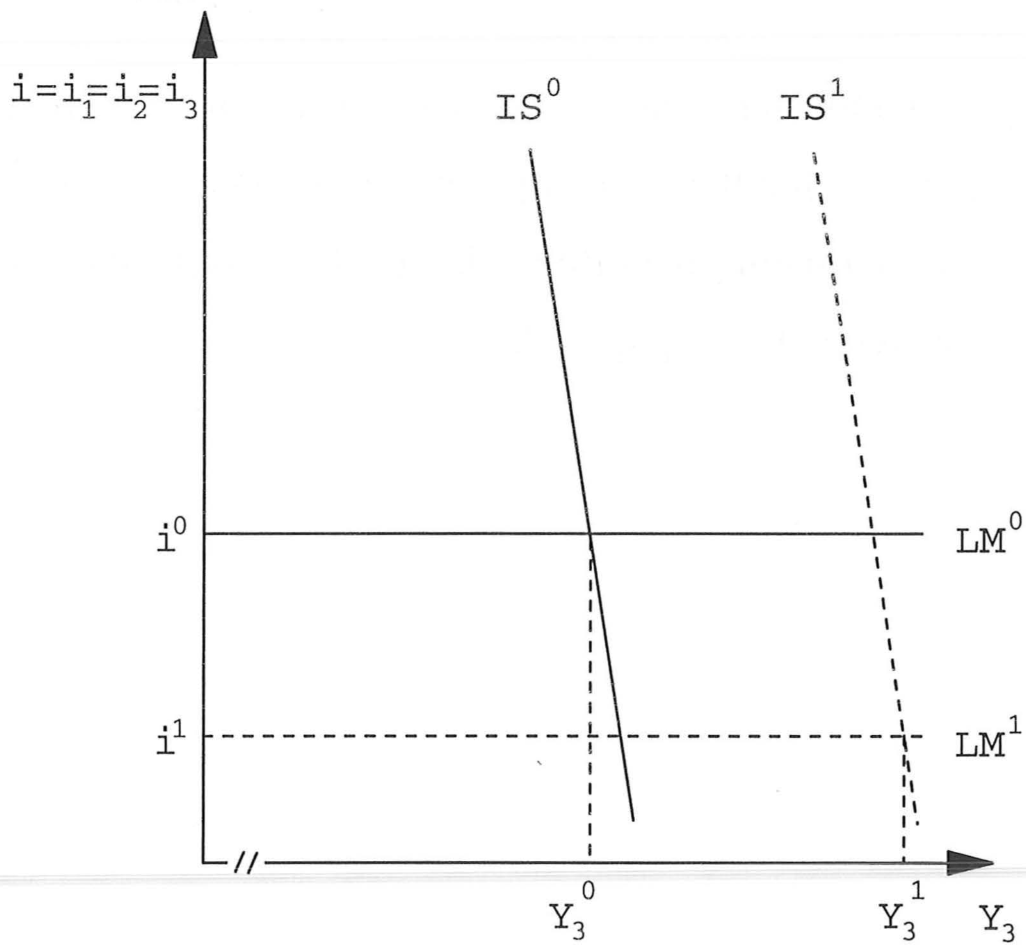
Assuming symmetry of parameters between countries 1, 2 and 3 it can, additionally, be shown that the post-shock output in the basket peg regime is also greater than that in the floating rate regime (if the shock is positive) (independently of the value of θ). We can thus write:

$$\frac{\delta y_3}{\delta m_2}(EMU\text{-}peg) > \frac{\delta y_3}{\delta m_2}(basket) > \frac{\delta y_3}{\delta m_2}(floating).$$

Output effects of a monetary shock occurring in country 2 are presented graphically in figure 12 for the exchange rate union and for the basket peg regime. In the case of floating the effects do not differ from those presented for an m_1 shock in figure 10 on page 100.

Figure 12. A monetary shock in country 2, effects on the output of country 3 - a graphical analysis

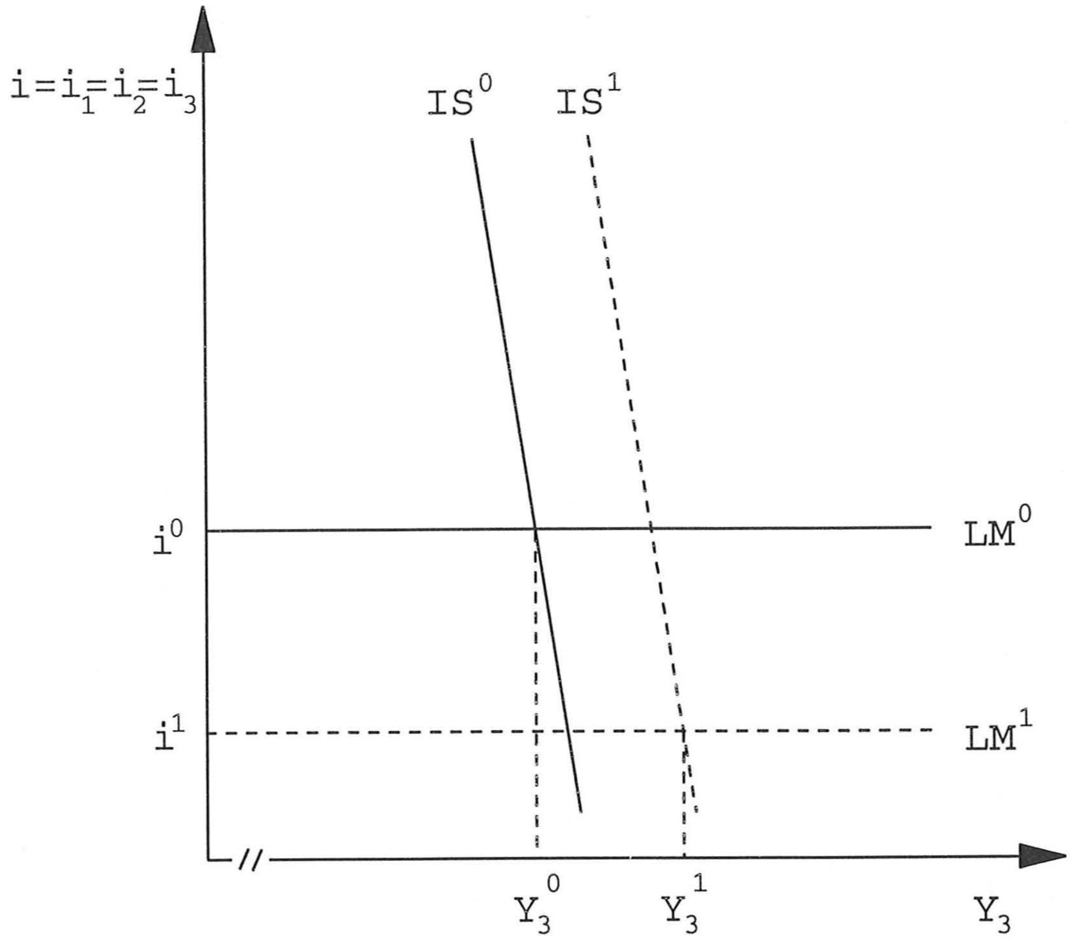
Pegging to the currency of country 2 (membership in an exchange rate union):



After a positive monetary shock occurring in country 2 the horizontal LM curve shifts downwards as in the case of an m_1 shock, and the interest rate declines. It is shown *a priori* that competitiveness improves (the opposite of expression (68)). This effect tends to push the IS curve to the right. The effect of the export demand depends on the foreign trade shares of the big countries. According to the baseline scenario the share of the growing economy (country 2) is large, which leads to a clear increase in export demand. The IS curve shifts due to the competitiveness and export demand effects to the right. The output of country 3 increases from y_3^0 to y_3^1.

Figure 12 (continued)

Currency basket exchange rate regime:



A positive monetary shock occurring in country 2 leads to a decline in the interest rate and to a downward shift of the horizontal LM curve. The effective exchange rate and accordingly competitiveness remains unchanged. The increasing export demand shifts the IS curve to the right in the baseline scenario, where the share of country 2 in the foreign trade is large. The output increases from y_3^0 to y_3^1, which is less than in the exchange rate union.

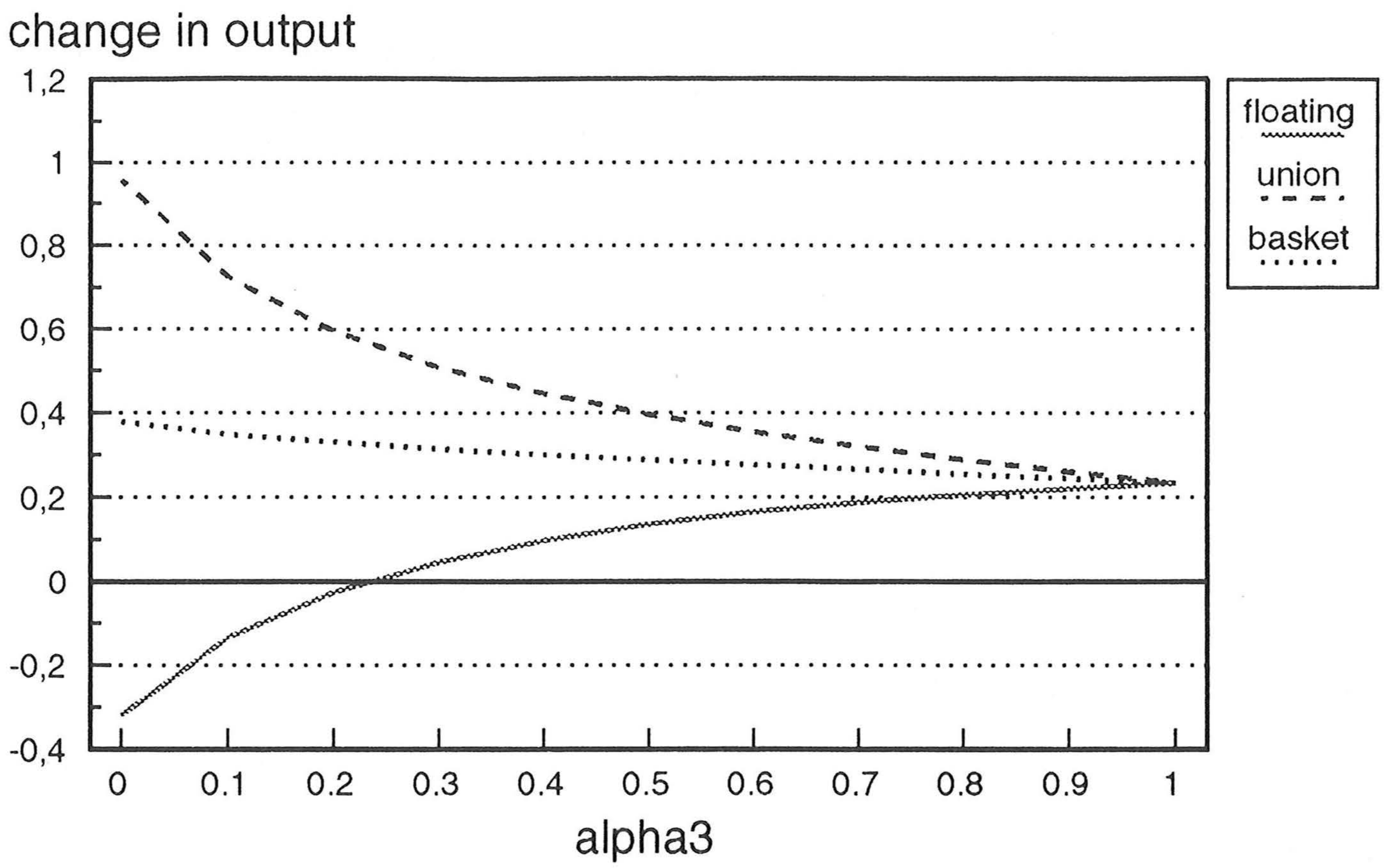
Flexible prices

Also in the case of flexible prices it can be shown *a priori* that the exchange rate union leads to a higher post-shock output than the basket regime after a positive shock, assuming that the pre-shock levels are the same in different exchange rate regimes. The difference is the same as in the case of a monetary shock occurring in country 1, but the ranking between the regimes is the opposite. The position of the floating rate regime cannot be shown *a priori*, not even in the case of symmetry.

The sensitivity analysis with respect to α and α_3 is presented in figure 13. Floating stabilizes the output the most already with zero values of α and α_3. In the fixed price case, when also $\beta = \beta_3 = 0$, the basket regime is somewhat better than floating in the case of this shock, too. (In the baseline scenario $\beta = \beta_3 = 0.3$.) The currency basket regime stabilizes the output more than the exchange rate union with all values of $\alpha_3 = 3 * \alpha$ up to 1, where there is no difference between the regimes. The better performance of the basket peg regime is due to the "shock reinforcing" change of the exchange rate in the exchange rate union. The results are not sensitive to the values of competitiveness and foreign demand elasticities (appendix 6).

The basket regime is again the best in stabilizing domestic prices, except when $\alpha_3 = \alpha = 0$. In this case floating is the best. The exchange union is for all values of $\alpha_3 = 3 * \alpha$ the worst in this respect. This is due to the large changes in the effective exchange rate and output. (For changes in prices, see appendix 4.)

Figure 13. Monetary shock in country 2: sensitivity of output in the small country with respect to α and α_3 ($\alpha_3 = 3 * \alpha$)



When $\alpha = \alpha_3 = 1$, the neutrality-of-money effect (no change in the output of country 3) holds, as in the case when the shock occurs in country 1.

4.3.4 Productivity shocks in the big countries

4.3.4.1 Shocks in country 1

<u>**Effects on the big countries**</u>

We assume that there is a supply shock in country 1 due to, for example, a change in productivity. This shock is presented in the supply curve as variable s_1. An increase in s_1 results from an exogenous decline in domestic costs and is reflected in declining producer prices and increasing supply of goods (equation (3)' on page 33). A decrease in s_1 results in the opposite reaction. Graphically an increase in s_1 can be presented as a downward shift of the SS curve in figure 2 on page 35. Declining prices lead to an outward shift in the LM as well as in the IS curve, the former by creating excess supply of real balances and the latter by improving competitiveness.

In this version of the model a change in s_1 does not lead to any change in monetary policy. This can be rationalized, for example, by the difficulty to notice shocks, by the sluggish reaction of monetary policy, or by the difficulties to form a realistic money supply rule. (See pages 49-50 about the effects of a money supply rule in the case of a domestic supply shock occurring in the small country.) The neglect of any money supply reaction implies that the effects must be interpreted to be short-term.

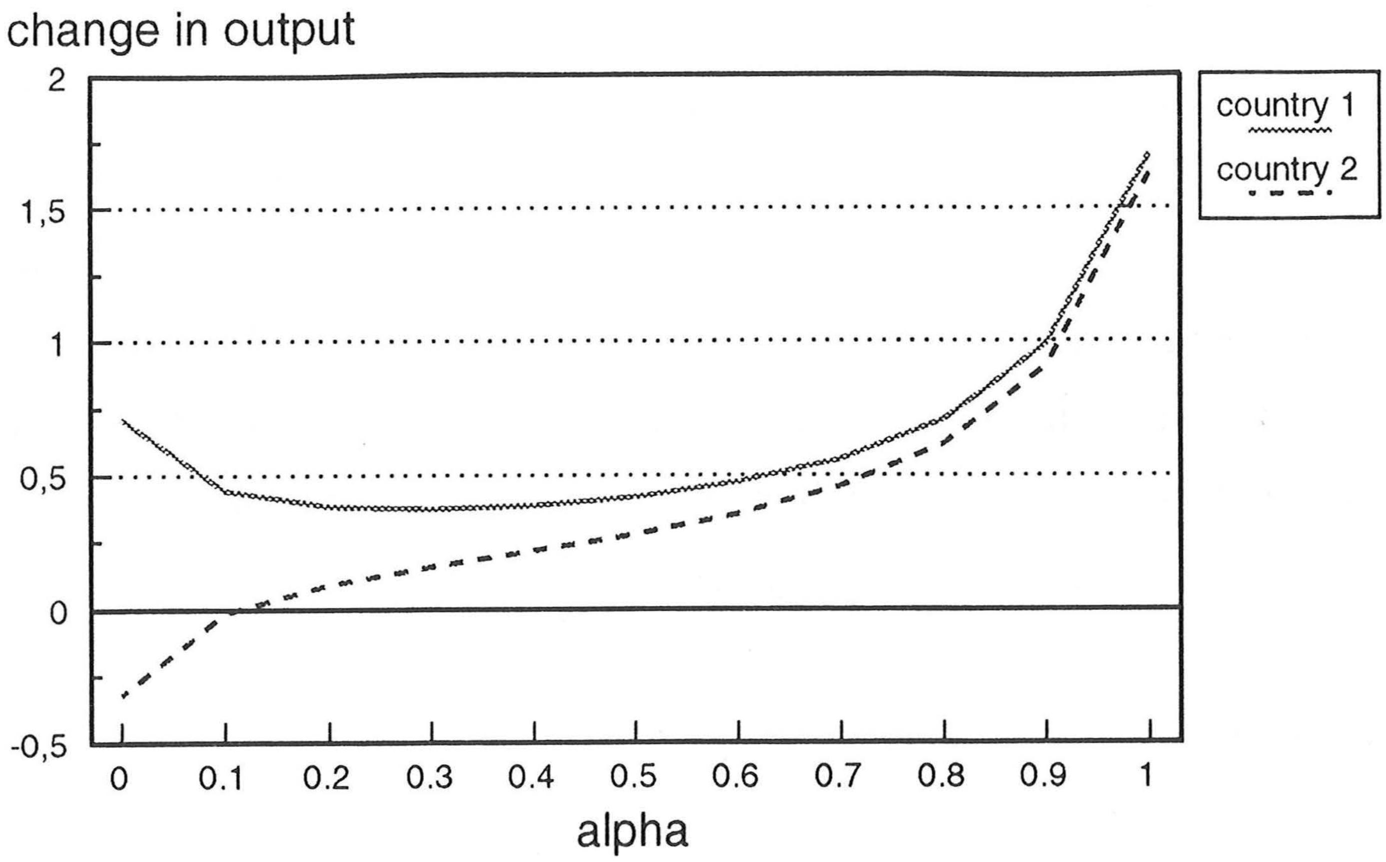
In this kind of a model an exogenous decline in domestic prices (a positive supply shock) leads in the baseline calculation to the following results:

$$\delta y_1/\delta s_1 = 0.440, \qquad \delta y_2/\delta s_1 = -0.014$$
$$\delta e/\delta s_1 = 2.646, \qquad \delta i/\delta s_1 = -0.744$$
$$\delta p_1/\delta s_1 = -0.637, \qquad \delta p_2/\delta s_1 = -0.333.$$

Output of country 1 increases after the shock and that of country 2 decreases slightly. The interest rates also decline globally. Because the money supply does not react to the change in prices, there is an excess supply of real balances, which leads to a depreciation of the currency of country 1. The depreciation is needed to match the increased output supply with a corresponding demand. The price level falls in both countries, but more in country 1, where the shock originates.

In the case where the reaction of domestic prices to import prices (α) is small, the output of country 2 decreases. When this reaction is stronger, the output of country 2 increases, too. The shock thus disperses more abroad and the aggregate output effect is strengthened. (Figure 14.)[15]

Figure 14. Productivity shock in country 1: sensitivity of output reactions with respect to α in the big countries



[15]When $\alpha_1 = 0.1$ and $\alpha_2 = 1$ the output effects are $\delta y_1/\delta s_1 = 0.426$ and $\delta y_2/\delta s_1 = 0.408$. Real wage rigidity with respect to foreign prices thus increases the output deviation in "EMU" from what it is in the baseline scenario. This is due to the greater response of the domestic price level to that of country 1. In the case of a positive shock prices decline clearly also in country 2, which improves competitiveness.

When $\alpha = 1$, it can be shown *a priori* that the outputs of both big countries increase, with the increase in country 1 being higher than that in country 2:

$$(72)\ \frac{\delta y_1}{\delta s_1} = \frac{1+\epsilon+2\beta\sigma}{2\beta(1+\epsilon+\beta\sigma)} > 0,$$

$$(73)\ \frac{\delta y_2}{\delta s_1} = \frac{1+\epsilon}{2\beta(1+\epsilon+\beta\sigma)} > 0.$$

<u>Effects on the small country</u>

When the supply shock occurs in country 1, the export demand of the small country does not change very much when the value of α is low, because the output of the more important trading partner (country 2) remains almost unchanged. In the case of a positive shock declining international interest rates tend to increase the output of the small country. Basically the effects on output are very similar to those of monetary shocks. This is natural, because in both cases there is a change in real money balances and in competitiveness in the country where the shock originates.

It can again be shown *a priori* (under the assumptions presented below) that the post-shock output is lower in the exchange rate union than in the basket regime given that the pre-shock output is at the same level. This can be seen from the following expression:

$$\frac{\delta y_3}{\delta s_1}(EMU\text{-}peg) - \frac{\delta y_3}{\delta s_1}(basket) = \frac{(\alpha_3 - 1)(1 + \epsilon - 2k\sigma)\sigma_3\theta}{2(\alpha + \alpha\epsilon + \beta\sigma + k\sigma - \alpha k\sigma)(1 + \beta_3\sigma_3)},$$

which is negative if $0 \leq \alpha \& \alpha_3 < 1$, $\theta > 0$ and $\varepsilon > 2k\sigma - 1$. The two first-mentioned conditions are obvious. Because σ (the "competitiveness elasticity" in the big countries) is rather small (clearly less than 0.5), the last mentioned condition holds even if $k = 1$. For floating this kind of a ranking cannot be shown - even in the case of symmetry.

In the floating rate regime output remains almost unchanged in the baseline calculation. The effects of export demand and the interest rate are offset by the change in the effective exchange rate and thus in competitiveness. The effects of the shock are as follows:

$\delta y_3/s_1 = -0.010$, $\delta p_3/\delta s_1 = -0.336$, $\delta c_3/\delta s_1 = -0.773$.

In the exchange rate union the effects are similar to those in the floating rate regime. The change in the effective exchange rate and, accordingly, in competitiveness is somewhat greater, and the price level changes somewhat more. This difference is due to the slight opposite change in the bilateral exchange rate between countries 3 and 2 (e_{32}) in the case of floating. In the exchange rate union this exchange rate is fixed. The effects are as follows:

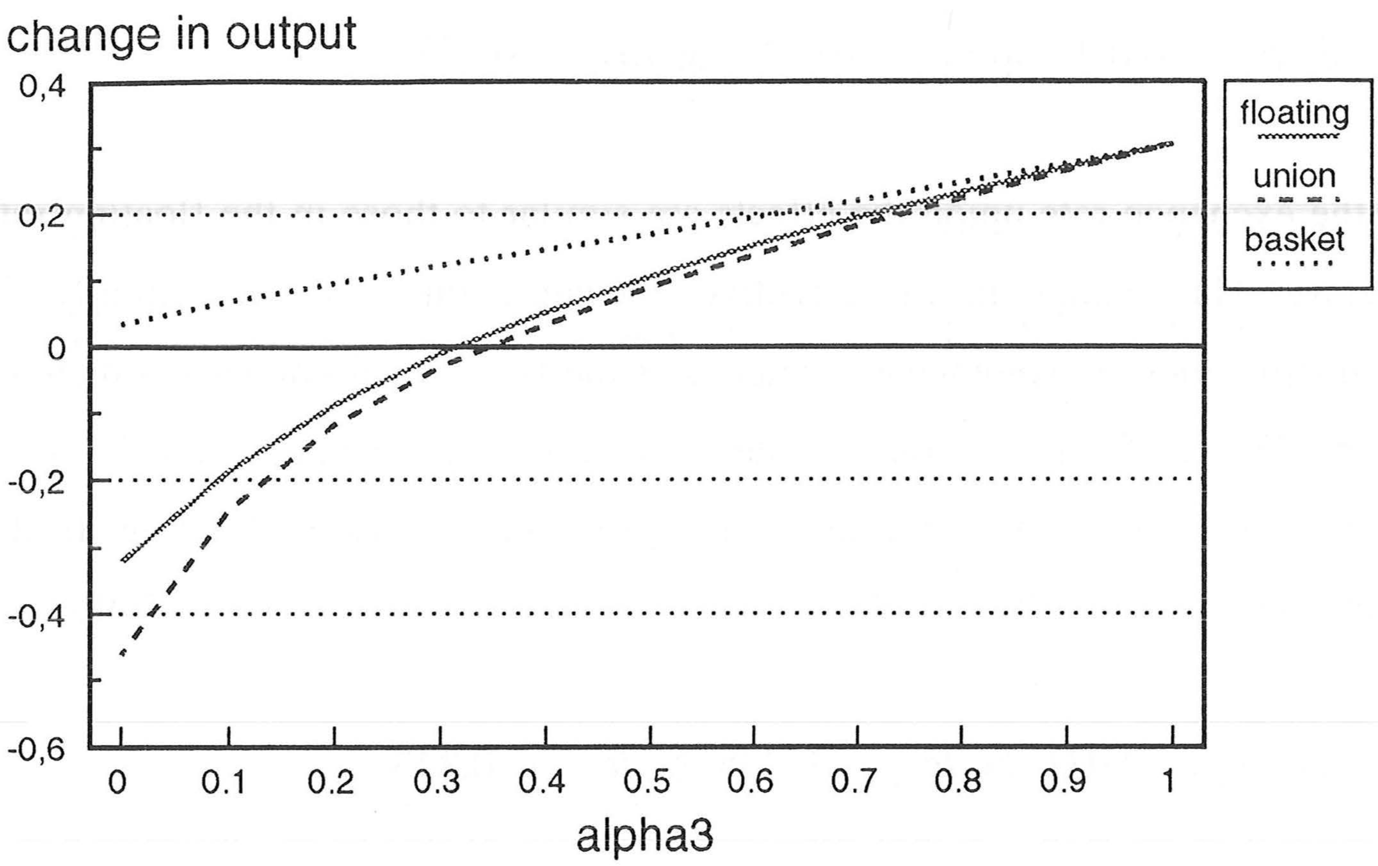
$\delta y_3/\delta s_1 = -0.031$, $\delta p_3/\delta s_1 = -0.375$, $\delta c_3/\delta s_1 = -0.843$.

In the currency basket regime competitiveness deteriorates only through the producer price channel, because the effective exchange rate is stabilized. The positive effects due to export demand and interest rates are thus offset to a smaller degree than in the previous cases. Output changes, accordingly, by a greater margin:

$$\delta y_3/\delta s_1 = 0.122,\ \delta p_3/\delta s_1 = -0.091,\ \delta c_3/\delta s_1 = -0.333.$$

The sensitivity of output effects with respect to α is very similar to the results obtained when we analysed the effects of a monetary shock occurring in country 1 (figure 15). The currency basket regime again stabilizes the prices the most with all relevant values of α_3 (from 0 to 1), floating is the second best and the union the worst in this respect.

Figure 15. Productivity shock in country 1: sensitivity of output in the small country with respect to α and α_3 ($\alpha_3 = 3 * \alpha$)



In the case when $\alpha = \alpha_3 = 1$ the change in the output of country 3, according to the baseline calculation, is as follows for all exchange rate regimes: $\delta y_3/\delta s_1 = 1.979$.

4.3.4.2 Shocks in country 2

Effects on the big countries

Because of the assumption of symmetry between the big countries, the results are again the mirror image of those presented in the previous section.[16]

Effects on the small country

The effects on the export demand of the small country are greater in this case than in the case when the shock originates in country 1 (see figure 14). The results are similar to those of a monetary shock. The most important difference between the regimes is that in the case of an exchange rate union the depreciation of the currency leads to an increase in prices, whereas in the other regimes prices decline.

Under the same assumptions as presented in the case when the shock occurs in country 1 (page 119) it can be shown that the exchange rate union leads to

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[16]When $\alpha_1 = 0.1$ and $\alpha_2 = 1$ the output effects are $\delta y_1/\delta s_2 = -0.007$ and $\delta y_2/\delta s_2 = 0.134$. The output of country 2 is insulated more than in the case when $\alpha_1 = 0.1$. In this case $\delta y_2/\delta s_2 = 0.440$. The better insulation is due to the price effect of the change in the exchange rate. When α_2 is high, prices are higher and competitiveness is worse in the case of a positive shock than when α_2 is low.

a higher post-shock output than the basket regime, assuming that the pre-shock output is at the same level. This result is thus the opposite of that when the shock occurs in country 1. The difference is the same as presented on page 119, but of the opposite sign.

In the floating rate regime the output effects due to changes in export demand and interest rates are compensated for by the opposite effects of the effective exchange rate and competitiveness. Output is rather well stabilized, and the price level falls. The effects are thus very similar to those in country 1:

$$\delta y_3/\delta s_2 = 0.052,\ \delta p_3/\delta s_2 = -0.377,\ \delta c_3/\delta s_2 = -0.931.$$

Immediately after the shock, when α and α_3 are low, country 2 is thus affected the most, whereas countries 1 and 3 are almost insulated when their exchange rates are floating.

In the exchange rate union the effective exchange rate depreciates together with that of country 2, although by less. This effect on relative prices is, however, compensated for by the producer price development. The price level in country 3 increases contrary to the developments in the other two countries (because of the depreciation). Relative prices in a common currency (competitiveness) remains for this reason almost unchanged, so the output effect is neutral. The increase in output is thus mainly due to the increasing export demand and the declining interest rate:

$$\delta y_3/\delta s_2 = 0.351,\ \delta p_3/\delta s_2 = 0.180,\ \delta c_3/\delta s_2 = 0.068.$$

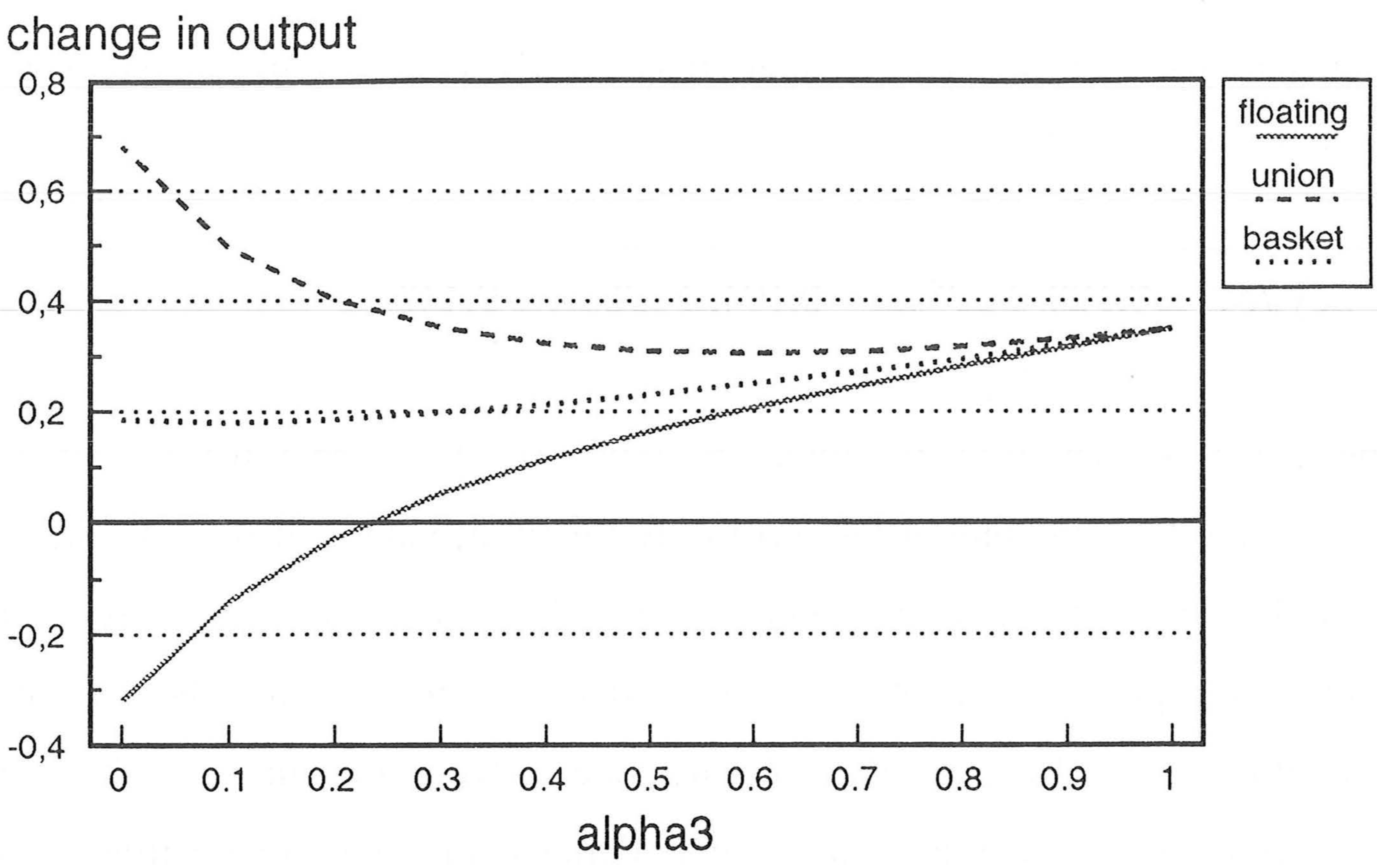
In the currency basket exchange rate regime the effective exchange rate is stabilized, but because the prices of country 3 change less than those of countries 1 and 2, the competitiveness affects in the opposite direction than export demand and interest rates, and makes the change in output smaller than in the case of the union:

$$\delta y_3/\delta s_2 = 0.198,\ \delta p_3/\delta s_2 = -0.104,\ \delta c_3/\delta s_2 = -0.442.$$

The sensitivity analysis presented in figure 16 shows that the basket peg regime stabilizes the output the most only for small values of $\alpha_3 = 3 * \alpha$, and for higher values floating exchange rates are the best in this respect. When α_3 grows, the price level of country 3 declines more, and the negative competitiveness effect in the floating rate regime becomes weaker. An increase in α in turn makes the export demand effect more positive in all regimes (figure 15). The basket regime is better than the exchange rate union in terms of output stabilization for all relevant values of α and α_3. In the exchange rate union an increase in α_3 makes the price effects of the depreciating exchange rate stronger and tends to decrease the increase in output by deteriorating price competitiveness.

The basket regime stabilizes prices the best for the values of α_3 from 0 to 0.3, but after that the exchange rate union alternative gives the smallest change in the domestic price level. Floating leads to the greatest changes in the price level with relevant values of $\alpha_3 = 3 * \alpha$.

Figure 16. Productivity shock in country 2: sensitivity of output in the small country with respect to α and α_3 ($\alpha_3 = 3 * \alpha$)



When $\alpha = \alpha_3 = 1$, the change in the output of country 3 according to the baseline calculation for all exchange rate regimes is as follows: $\delta y_3/\delta s_2 = 1.996$. The change is thus somewhat greater than in the case when the shock originates in country 1. This difference is due to the greater share of country 2 in the foreign trade of country 3.

4.4 An evaluation of the exchange rate regimes using static models with static expectations

4.4.1 Comparison of the effects in the case of different shocks

Fixed prices

In the case of a goods demand shock originating in country 1 (we call this case R.1.) we are able to show for the change of output in country 3 (assuming symmetry between the big countries) (pp. 70-71):

$$(R.1.)\frac{\delta y_3}{\delta f_1}(EMU\text{-}peg) > \frac{\delta y_3}{\delta f_1}(basket).$$

In the case when the corresponding shock originates in country 2 (case R.2.), we can show (p. 83):

$$(R.2.)\frac{\delta y_3}{\delta f_2}(basket) > \frac{\delta y_3}{\delta f_2}(EMU\text{-}peg).$$

In the case of a money supply shock originating in country 1 (denoted by M.1.) we can show (p. 98):

$$(M.1.)\frac{\delta y_3}{\delta m_1}(basket) > \frac{\delta y_3}{\delta m_2}(EMU\text{-}peg).$$

And when a corresponding shock originates in country 2 (case M.2.), we obtain (pp. 110-111):

$$(M.2.)\frac{\delta y_3}{\delta m_2}(EMU\text{-}peg) > \frac{\delta y_3}{\delta m_2}(basket).$$

We can thus give the ranking according to the post-shock output levels (assuming the same pre-shock outputs), but we do not know *a priori* the signs of the shocks, and thus not the ranking of the regimes according to the deviation from zero. This kind of a ranking is needed when evaluating the performance of different exchange rate regimes in stabilizing the economy against exogenous foreign shocks. In this respect the relative performance of the currency basket exchange rate regime and the EMU-peg regime appears to be an empirical question, depending on the relative magnitudes of various effects and thus on the parameters of the model.

In the floating rate case we can determine the signs of the changes *a priori*. When there is a demand shock in the big countries, the output effect on country 3 is positive, and in the case of a money supply shock it is negative. The effect is independent of the origin of the shock. To compare theoretically the output effects with those in the EMU-peg and basket peg regimes, we have, however, to assume symmetry of parameters between all three countries. Now we obtain the following ranking with respect to the post-shock outputs of country 3 - when assuming that the initial outputs are the same. We denote the cases as above. (The signs of the changes are presented in parenthesis.)

$$\begin{matrix} & (+) & (?) & (?) \\ (R.1.) & \frac{\delta y_3}{\delta f_1}(floating) > & \frac{\delta y_3}{\delta f_1}(EMU\text{-}peg) > & \frac{\delta y_3}{\delta f_1}(basket), \end{matrix}$$

$$\begin{matrix} & (+) & (?) & (?) \\ (R.2.) & \frac{\delta y_3}{\delta f_2}(floating) > & \frac{\delta y_3}{\delta f_2}(basket) > & \frac{\delta y_3}{\delta f_2}(EMU\text{-}peg), \end{matrix}$$

$$\begin{matrix} & (?) & (?) & (-) \\ (M.1.) & \frac{\delta y_3}{\delta m_1}(basket) > & \frac{\delta y_3}{\delta m_1}(EMU\text{-}peg) > & \frac{\delta y_3}{\delta m_1}(floating), \end{matrix}$$

$$\begin{matrix} & (?) & (?) & (-) \\ (M.2.) & \frac{\delta y_3}{\delta m_2}(EMU\text{-}peg) > & \frac{\delta y_3}{\delta m_2}(basket) > & \frac{\delta y_3}{\delta m_2}(floating). \end{matrix}$$

Floating thus leads in the symmetrical case to the greatest or to the smallest output depending on the nature of the shock. The relative effects on the output of country 3 in the EMU-peg and in the basket peg regimes depend also on the origin of the shock. The stabilizing effects of the regimes are dependent on the magnitudes of the parameters of the model.

When assuming that the foreign trade share of country 2 is equal to or greater than that of country 1, it is shown in section 4.3.3.2 *a priori* that the sign of output changes in country 3 is the same in the case of an m_2 shock in the

EMU- and basket peg regimes. Output deviation is thus greater in the former than in the latter regime.

To get a feel for the differences between the regimes with respect to absolute changes in output we assume values for the important parameters, according to the baseline scenario presented on pages 38-39. The results are presented in table 3. (For an alternative set of parameter values see appendix 3.)

Using these parameter values we get the result that in the R.1. case the currency basket regime leads to a smaller deviation of output than the EMU-peg regime. The signs of both deviations are positive.[17] The difference between the changes is $\theta\sigma_3/2\sigma = 1.5\theta$ (due to the competitiveness factor). In the R.2. case the basket peg regime again leads to the same rather small positive change as in the R.1. case, and the EMU-peg regime to a greater negative change in absolute terms. The difference between the post-shock outputs is the same as before (competitiveness factor).

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[17]This result is sensitive to the values of θ, ε_3, σ_3 and μ_3. If the values of the first three parameters are low (the IS curve shifts only slightly to the right) and the value of μ_3 is high (the IS curve is rather flat), the result changes. For example if ε_3=0.2, ε=0.1 and σ_3=0.2, the condition that the "EMU-peg regime" stabilizes the output of country 3 better than the basket regime is: $0 < \theta < 0.073$ (ceteris paribus). This case is thus relevant for a country which pursues almost all of its trade with the union country and whose trade is not sensitive to changes in competitiveness and export demand. If however the IS curve is steep (the value of μ_3 is low) and the three other parameters are as above, the "EMU-peg regime" is only slightly better in stabilizing the output than the basket regime. (For a graphical analysis, see figure 5, pp. 73-75.)

Table 3. The effects of foreign shocks on the output of the small country in different exchange rate regimes (the baseline calculation, fixed price model)

We assume the following parameter values:

$k = k_3 = 0.67$ } Kremers & Lane (1990) for the EMS — $\Phi = \Phi_3 = 0.46$ — $\mu = \mu_3 = 0.2$

$\sigma = 0.1$; $\varepsilon = 0.3$

$\varepsilon_3 = 0.6$; $\sigma_3 = 0.3$; $\theta = 0.3$

Now we get the following absolute values for output effects in different exchange rate regimes:

$$|0.156| \qquad |0.504| \qquad |0.606|$$

$$(R.1.)\ \left|\frac{\delta y_3}{\delta f_1}(basket)\right| < \left|\frac{\delta y_3}{\delta f_1}(floating)\right| < \left|\frac{\delta y_3}{\delta f_1}(EMU-peg)\right|$$

$$|0.156| \qquad |-0.294| \qquad |0.504|$$

$$(R.2.)\ \left|\frac{\delta y_3}{\delta f_2}(basket)\right| < \left|\frac{\delta y_3}{\delta f_2}(EMU-peg)\right| < \left|\frac{\delta y_3}{\delta f_2}(floating)\right|$$

$$|0.106| \qquad |-0.527| \qquad |-0.767|$$

$$(M.1.)\ \left|\frac{\delta y_3}{\delta m_1}(basket)\right| < \left|\frac{\delta y_3}{\delta m_1}(floating)\right| < \left|\frac{\delta y_3}{\delta m_1}(EMU-peg)\right|$$

$$|0.464| \qquad |-0.527| \qquad |1.337|$$

$$(M.2.)\ \left|\frac{\delta y_3}{\delta m_2}(basket)\right| < \left|\frac{\delta y_3}{\delta m_2}(floating)\right| < \left|\frac{\delta y_3}{\delta m_2}(EMU-peg)\right|$$

Also in the case of a money supply shock occurring in country 1 the basket regime leads to a smaller deviation than "the EMU-peg regime". In the former case the effect is positive and in the latter case negative. When the money supply shock occurs in country 2, both regimes lead to a positive change in the output of country 3. In absolute terms the change is again smaller in the basket regime. The difference is $\theta\sigma_3(1+\varepsilon)/2k\sigma = 2.91\theta$. This is greater than in the case of real shocks. This result was deemed rather likely according to the theoretical model above. By subtracting the difference between output effects in the goods demand shock case from those in the money supply shock case we get: $\theta\sigma_3(1+\varepsilon-k)/2k\sigma$. The expression is positive if $(1+\varepsilon) > k$.

After calculating the corresponding output effects also in the floating rate regime, we notice that even then the currency basket exchange rate regime stabilizes the output of the small country the most against all foreign shocks studied. Floating is the second best in cases R.1., M.1. and M.2., and the "EMU-peg regime" in case R.2.

In another experiment where the competitiveness elasticity and the elasticity with respect to foreign real income are lower, the basket regime stays the best according to this criterion, but the "EMU-peg regime" is now the second best in cases R.1., R.2. and M.1. Floating is the second best in case M.2. (For this alternative scenario, see appendix 3.)

The "EMU-peg regime" is thus "the worst" in both experiments in the face of a monetary shock occurring in country 2 ("EMU"). On the other hand, it is the second best (better than floating) in both experiments when there is a demand for goods shock originating in country 2.

Flexible prices

In the case of domestic shocks we find in section 4.2. that floating exchange rates stabilize the output of a small country better against goods demand shocks than fixed rates. In the case of a money supply (or money demand) shock fixed exchange rates in turn are better in stabilizing the output. When the small country faces a productivity shock, fixed rates stabilize the output better if no monetary policy response is assumed in the case of floating rates. But if the money supply adjusts fully to the change in the price level, floating rates insulate the domestic output against the effects of the shock.

In the case of foreign shocks the situation is different. From the small country's point of view a foreign real shock is not only real, and a monetary shock is not only monetary. Both shocks are composite shocks. A real shock occurring in one of the big countries changes the outputs of the big countries, but also exchange rates and interest rates. The monetary shock also has important real effects.

We can not show the ranking of the regimes with respect to the deviation of output from zero *a priori*, because we do not know the signs of the changes. We are, however, in most cases able to determine the difference between the post-shock levels, assuming that the pre-shock outputs were the same in all regimes.

The magnitudes of the deviations, even their signs, depend on the values of the parameters. The output effects of the shocks in different exchange rate regimes according to the baseline calculation are presented in table 4 on page 133. (For the parameter values see page 38.) The symbols R.1., R.2., M.1. and

M.2. mean the same as above. Symbols S.1. and S.2. refer to supply (productivity) shocks in countries 1 and 2, respectively. For an alternative calculation, where the values of the "open economy variables" σ, σ_3, ε and ε_3 are assumed to be lower, see appendix 6.

In the baseline calculation the difference between the export demand effects of the monetary and goods demand shocks (of the same size) on the small country is not big. Interest rate, exchange rate and price effects, however, differ more. A goods demand shock has a greater interest rate effect than a monetary one. The exchange rate of the big countries in turn reacts more in the case of a corresponding monetary shock. The price levels of the big countries change in opposite directions in the case of both shocks, but in the case of monetary shocks the difference is greater due to the stronger exchange rate reaction. (See table 5, p. 134.)

On the basis of the interest rate reactions a goods demand shock occurring in the big countries in a floating rate world is more monetary than a corresponding monetary shock from the small country's point of view. This partly explains the result obtained in the baseline calculation that floating rates are not very good in stabilizing the output of the small country against foreign goods demand shocks. The main reason for this result is, however, that floating rates reinforce the export demand effect in the case of foreign goods demand shocks and counteract them in the case of monetary shocks. If there is for example an increase in the demand for goods in country 1, the foreign demand for the products of country 3 increases, but additionally the exchange rate depreciates. In the case of a positive monetary shock, the exchange rate of the small country appreciates and partly offsets the effect of foreign demand on the domestic output.

Table 4. The effects of foreign shocks on the output of the small country (the baseline calculation, endogenous price model)

$$|0.056| \qquad |0.185| \qquad |0.192|$$

$$(R.1.)\ \left|\frac{\delta y_3}{\delta f_1}(basket)\right| < \left|\frac{\delta y_3}{\delta f_1}(floating)\right| < \left|\frac{\delta y_3}{\delta f_1}(EMU\text{-}peg)\right|$$

$$|-0.003| \qquad |0.133| \qquad |0.246|$$

$$(R.2)\ \left|\frac{\delta y_3}{\delta f_2}(EMU\text{-}peg)\right| < \left|\frac{\delta y_3}{\delta f_2}(basket)\right| < \left|\frac{\delta y_3}{\delta f_2}(floating)\right|$$

$$|-0.009| \qquad |-0.028| \qquad |0.168|$$

$$(M.1.)\ \left|\frac{\delta y_3}{\delta m_1}(floating)\right| < \left|\frac{\delta y_3}{\delta m_1}(EMU\text{-}peg)\right| < \left|\frac{\delta y_3}{\delta m_1}(basket)\right|$$

$$|0.025| \qquad |0.313| \qquad |0.509|$$

$$(M.2.)\ \left|\frac{\delta y_3}{\delta m_2}(floating)\right| < \left|\frac{\delta y_3}{\delta m_2}(basket)\right| < \left|\frac{\delta y_3}{\delta m_2}(EMU\text{-}peg)\right|$$

$$|-0.010| \qquad |-0.031| \qquad |0.122|$$

$$(S.1.)\ \left|\frac{\delta y_3}{\delta s_1}(floating)\right| < \left|\frac{\delta y_3}{\delta s_1}(EMU\text{-}peg)\right| < \left|\frac{\delta y_3}{\delta s_1}(basket)\right|$$

$$|0.052| \qquad |0.198| \qquad |0.351|$$

$$(S.2.)\ \left|\frac{\delta y_3}{\delta s_2}(floating)\right| < \left|\frac{\delta y_3}{\delta s_2}(basket)\right| < \left|\frac{\delta y_3}{\delta s_2}(EMU\text{-}peg)\right|$$

Table 5. Some important effects of the foreign shocks (baseline calculation, endogenous price model)

effect	goods demand shock		monetary shock		productivity shock	
	Δf_1	Δf_2	Δm_1	Δm_2	Δs_1	Δs_2
Δe	-2.354	2.354	3.383	-3.383	2.646	-2.646
Δi	0.960	0.960	-0.670	-0.670	-0.744	-0.744
Δ(foreign demand)	0.349	0.531	0.110	0.273	0.122	0.266
Δc_3 (floating)	0.556	0.399	-0.758	-0.348	-0.773	-0.931
Δc_3 (union)	0.582	-0.867	-0.696	0.704	-0.843	0.068
Δc_3 (basket)	0.179	0.020	-0.108	0.052	-0.333	-0.442
Δy_3 (floating)	0.185	0.246	-0.009	0.025	-0.010	0.052
Δy_3 (union)	0.192	-0.003	-0.028	0.509	-0.031	0.351
Δy_3 (basket)	0.056	0.133	0.168	0.313	0.122	0.198

The crucial factor when comparing the effects of the shocks in the exchange rate union and in the basket regime is whether the change of the exchange rate, which in the union case is determined by the big countries, tends to offset the other effects or whether it will reinforce them. When there is a goods demand shock in the union partner country and when there is a monetary shock in the rest of the world, the exchange rate union stabilizes the output more than the basket regime. But when there is a goods demand shock in the rest of the world and when there is a monetary shock in the union partner country, the basket peg regime stabilizes the output better.

The effects of a foreign productivity shock (supply shock) are almost the same as those of a monetary shock if the money supply is kept unchanged. This is logical because in both cases there is a change in real balances.

The crucial feature of the basket peg regime is that it stabilizes the effective exchange rate. This implies that the basket peg regime stabilizes also the relative prices, i.e. competitiveness, and the domestic price level more against foreign shocks than the other two regimes, where the effective exchange rate changes. (For the changes in the domestic price level and competitiveness, see appendices 4 and 5.)

When evaluating the alternative exchange rate regimes the crucial question is which variable is to be stabilized. Is it output only, or should prices, competitiveness and other possible variables have some weight, too? In this respect the effects of the variability in the different variables should be analysed. We address this question in section 4.4.2.

4.4.2 An overall evaluation of the regimes

Until now we have confined ourselves to studying the effects of various kinds of shocks in different exchange rate regimes. We have thus not made any effort to say something about the relative ability of the regimes to insulate the small economy against all the shocks studied. It is clear that we are not able to conclude *a priori* which regime has the best insulation properties. The ranking of the regimes depends crucially on the nature and on the origin of the shocks, and on their relative variances. Additionally, because we are not able to obtain many *a priori* results concerning the effects of the shocks, we have to study them by using different values of the parameters of the model. The ranking between the regimes depends also on whether we include only output in the social welfare function, or whether we put emphasis on other objectives, too, especially on the variability of the domestic price level.

In this section we present a framework for making a synthesis of the relative ability of the regimes to insulate the small economy against the shocks studied. As a method we use quadratic loss functions (see for example Boyer, 1978; Flood and Marion, 1982; originally Theil, 1964). This kind of a loss function is of an ad hoc nature. It is not derived from a microeconomic welfare analysis. It is, however, empirically relevant. We first put the emphasis on the variability of output.

We write a loss function (L^o) for each exchange rate regime with respect to all output effects of the shocks considered as follows:

$$(74) L^o_{f,u,b} = \sigma^2_{f_1}\left(\frac{\delta y_3}{\delta f_1}\right)^2 + \sigma^2_{f_2}\left(\frac{\delta y_3}{\delta f_2}\right)^2 + \sigma^2_{m_1}\left(\frac{\delta y_3}{\delta m_1}\right)^2 + \sigma^2_{m_2}\left(\frac{\delta y_3}{\delta m_2}\right)^2$$

$$+ \sigma^2_{s_1}\left(\frac{\delta y_3}{\delta s_1}\right)^2 + \sigma^2_{s_2}\left(\frac{\delta y_3}{\delta s_2}\right)^2 + \sigma^2_{f_3}\left(\frac{\delta y_3}{\delta f_3}\right)^2 + \sigma^2_{m_3}\left(\frac{\delta y_3}{m_3}\right)^2 + \sigma^2_{s_3}\left(\frac{\delta y_3}{s_3}\right)^2.$$

The letters f, u and b refer to floating, the exchange rate union and the basket peg regime, respectively. The loss function is thus written for each regime.

The superscript o refers to output; the loss of welfare is measured with respect to the deviation of the output from a "normal" level. The first multiplicative factor in the expression refers to the variance of the respective shock: σ^2_{f1} for example is the variance of the goods demand shock occurring in country 1. The second multiplicative factor in turn refers to the quadraticized effect of each shock on the small open economy (country 3). The loss function as a whole measures the loss of welfare due to all foreign and domestic shocks studied in the previous sections. Maximization of welfare thus means minimization of the loss due to the effects of the shocks.

If we knew the variances of the shocks and their effects on the small country under different exchange rate regimes, we could calculate numerical values for the loss functions. We have already presented the effects of the shocks under two alternative scenarios of parameter values and conducted sensitivity analyses. For the variances of the shocks it is difficult, however, to give any precise values. In principle they could be calculated empirically in the cases of the USA, the EMS countries and Finland, for example. However, in addition to the problems related to finding proper empirical counterparts and to the estimation procedures, it is questionable whether estimates based on historical data can serve as a very reliable guide in assessing the variances of the shocks at the present and in the future. The institutions and policies have changed and are changing all the time. It is also difficult to say much about the variances *a priori*.

In the following calculations we use the numerical values of the multipliers obtained in the two simulations performed. Concerning the variances of the shocks we first assume that they are the same for all shocks and that they are independent of each other. The idea behind this assumption is that the expected values of the variances are the same. In addition to this, we calculate some critical values for the variances. The procedure used is limited in generality. It is, however, at least one possible scenario. How likely it is depends on the realism of the parameter estimates used.

We first calculate the loss functions in the case of the fixed price model. After assuming that the variances of all the shocks are the same (σ^2_{shock}) and summing up the quadratic multipliers of the effects of the shocks, we obtain **in the baseline scenario** the following loss functions:

$$L^o_f = \sigma^2_{shock} * 3.291,$$
$$L^o_u = \sigma^2_{shock} * 3.830,$$
$$L^o_b = \sigma^2_{shock} * 1.275.$$

We can thus write:

$$L^o_b < L^o_f < L^o_u.$$

The ranking of the regimes is the same if we consider the effects of the foreign shocks only (see table 3, p. 129). In the case of domestic shocks the two fixed rate regimes insulate the economy more than the floating rate regime, because under floating a monetary shock leads to a greater change in output (= $1/k_3$) than a real shock under fixed rates (= 1). Real shocks are insulated fully in the case of floating and monetary shocks in the case of fixed rates. (See section 4.2., pp. 43-47.)

In the alternative scenario (in a less open economy) we obtain the following loss functions (for the parameters, see appendix 3):

$$L^o_f = \sigma^2_{shock} * 3.230,$$
$$L^o_u = \sigma^2_{shock} * 2.012,$$
$$L^o_b = \sigma^2_{shock} * 1.112.$$

With respect to all shocks we can thus write:

$$L^o_b < L^o_u < L^o_f.$$

If we consider only the effects of the foreign shocks, floating is ranked before the exchange rate union. This difference is due to the better insulation of domestic shocks in the fixed rate regime (see the baseline case).

In the endogenous price model we obtain the following loss functions in **the baseline scenario**:

$$L^o_f = \sigma^2_{shock} * 0.894,$$
$$L^o_u = \sigma^2_{shock} * 1.338,$$
$$L^o_b = \sigma^2_{shock} * 1.118.$$

The ranking between the regimes is thus:

$$L^o_f < L^o_b < L^o_u.$$

In **the alternative scenario** (in a less open economy) we obtain:

$$L^o_f = \sigma^2_{shock} * 0.746,$$
$$L^o_u = \sigma^2_{shock} * 1.160,$$
$$L^o_b = \sigma^2_{shock} * 1.044.$$

The ranking is the same as in the baseline calculation.

If we study the effects of the foreign shocks only, the order of the regimes in both scenarios is the same as in the case of all shocks.

When studying the effects of domestic shocks, we obtain a result that floating insulates the output of the small country more than the fixed rate regimes. This result is the opposite of that obtained in the fixed price model. The difference is due to the strong effect of a goods demand shock in the fixed rate regime, whereas the effect of a monetary shock in the floating rate regime is clearly weaker in the case of endogenous prices.[18] A part of the adjustment occurs in this case through changes in the price level. (For these differences see section 4.2.)

Next we study the sensitivity of the aggregate loss function with respect to α_3. We assume that all other parameters are the same as in the baseline scenario, i.e. also $\alpha = 0.1$. We calculate now the values of α_3 which minimize the loss function in terms of output deviation.

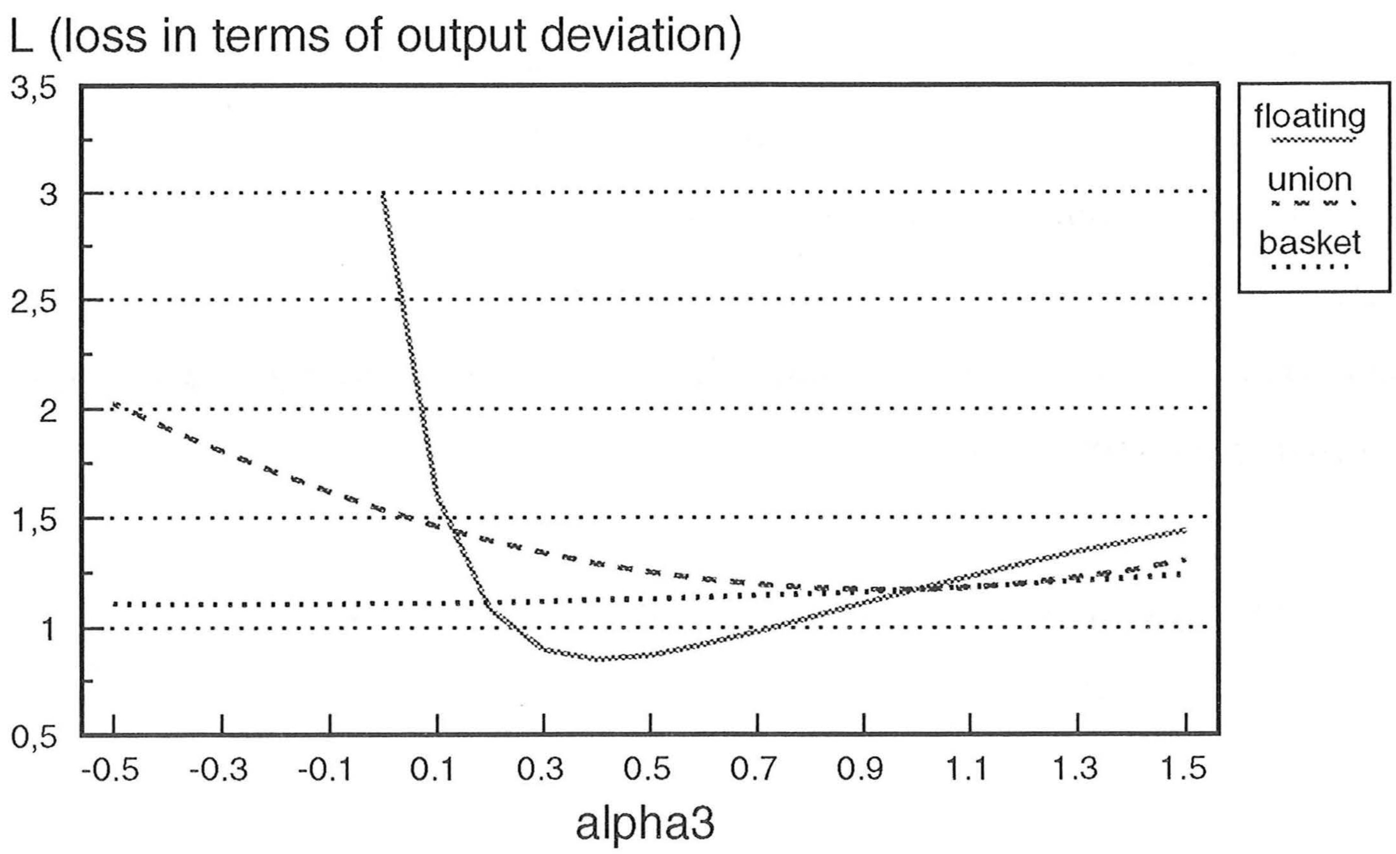
In the floating rate regime $\alpha_{3opt} = 0.336386$. The corresponding value of the loss function is $L^o_f = \sigma^2 * 0.868$.

In the exchange rate union $\alpha_{3opt} = 0.9359$ and $L^o_u = \sigma^2 * 1.171$. In the basket peg regime the corresponding figures are $\alpha_{3opt} = -0.234351$ and $L^o_b = \sigma^2 * 1.106$.

[18]If $\alpha_3 = 1$, the output is fully insulated against domestic monetary shocks in the floating rate regime (see expression (21), p. 46).

The loss functions with respect to output deviation are presented for each exchange rate regime in figure 17. In the floating rate regime the loss is very high with fixed prices at home and somewhat flexible prices abroad ($\alpha = 0.1$). This is mainly due to domestic shocks and partly due to foreign shocks. Increasing indexation of domestic prices to foreign ones, however, decreases the output deviation drastically. In the case of fixed prices the basket peg regime insulates the output the most.

Figure 17. The loss functions with respect to output deviation in different exchange rate regimes, sensitivity with respect to the indexation of prices in the home country (α_3)



We can summarize the results of the above-mentioned examples <u>where the variances of all shocks are assumed to be the same</u> as follows: **In the examples based on <u>the fixed price model</u> the basket peg regime insulates the output of the small open economy on average more than the other**

two regimes. But in the examples based on the model where producer prices are allowed to change floating insulates the output the most on average (assuming $\alpha_3 < 1$).

The exchange rate union insulates the output the least in all examples against the foreign shocks studied, except when foreign prices are somewhat flexible and domestic prices are rigid (figure 17). The poor performance of the union is especially due to the vulnerability of this regime in the case of monetary and productivity shocks occurring in the union partner country.

In the case of domestic shocks fixed rate regimes insulate the output more than floating in the fixed price model. This is why the exchange rate union is ranked above floating with respect to all shocks in the case of the less open economy (alternative scenario), and for low values of α_3 in figure 17. When producer prices are allowed to change, floating, however, insulates the output more than the two fixed exchange rate regimes against domestic shocks.

The joint sensitivity of the output loss function with respect to α_3 and α is presented in appendix 7. It is seen there that the main conclusions presented above hold for different degrees of indexation of prices in the big country. It is seen also that high indexation of prices in all countries leads to a large deviation of output. In the case of floating a combination of a low degree of indexation at home and a high degree of indexation abroad leads to a large deviation, too.

Above we assumed that the variances of all the shocks studied are the same. Next we assume that the variances of different kinds of shocks are the same inside countries, but that shock-proneness differs between countries. We thus write:

$$\sigma^2_{1shock} = \sigma^2_{f1} = \sigma^2_{m1} = \sigma^2_{s1},$$
$$\sigma^2_{2shock} = \sigma^2_{f2} = \sigma^2_{m2} = \sigma^2_{s2},$$
$$\sigma^2_{3shock} = \sigma^2_{f3} = \sigma^2_{m3} = \sigma^2_{s3}.$$

From now on we confine ourselves only to the model with endogenous prices. **In the baseline scenario** we obtain the following values for the loss functions:

$$L^o_f = \sigma^2_{1shock}*0.034 + \sigma^2_{2shock}*0.064 + \sigma^2_{3shock}*0.796,$$
$$L^o_u = \sigma^2_{1shock}*0.039 + \sigma^2_{2shock}*0.382 + \sigma^2_{3shock}*0.917,$$
$$L^o_b = \sigma^2_{1shock}*0.046 + \sigma^2_{2shock}*0.155 + \sigma^2_{3shock}*0.917.$$

We see above that:

(1) floating insulates the output the best against the shocks of all countries, and accordingly the best on average irrespective of the values of the country specific variances, and

(2) the exchange rate union insulates the output clearly the least when the shocks originate in the union partner country (due to monetary and productivity shocks, see table 4 on page 133).

Next we compare the exchange rate union and the basket peg regime. By subtracting L^o_b from L^o_u from the above equations we obtain:

$$L^o_u - L^o_b = -\sigma^2_{1shock}*0.076 + \sigma^2_{2shock}*0.227.$$

$L^o_u - L^o_b < 0$ if the relative variance $\sigma^2_{1shock}/\sigma^2_{2shock} > 2.979$. The exchange rate union thus insulates the output more than the basket peg regime if country 1 is more than three times as shock-prone as country 2.[19]

Now we widen our loss function approach by taking into account the variability of domestic producer prices, in addition to the variability of output. This procedure can be rationalized by the argument that stability of the producer prices makes the working environment of the firms, and indirectly of consumers, more predictable. The variability of producer prices deserves for this reason <u>some</u> weight in the social welfare (loss) function. Including the price target is to some extent contradictory, however, because the variability of competitiveness, and accordingly of prices, is one of the channels through which output variations are reduced in the case of some shocks. In the baseline calculation it is assumed that producer prices are affected by foreign trade prices according to the input-output relationships of the economies. The difference between changes in the producer and consumer prices is thus not very great.

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[19]In principle we could do a similar analysis for the relative variances according to the <u>nature of the shock</u>, by assuming that similar shocks have the same variances in all countries. This is not, however, very useful, because domestic and foreign shocks have basically very different impacts on the small economy.

We write the aggregate loss function in the case of floating as follows:

$$L_f = a\, L^p_f + (1\text{-}a)\, L^o_f,$$

where L_f refers to the total loss of welfare under floating, and L^p_f and L^o_f to the losses with respect to variability of prices and output, respectively. The weight of the price target is denoted by a ($0 \leq a \leq 1$). The loss functions for the other exchange rate regimes are formulated analogously.

We consider next **the baseline scenario** of <u>the endogenous price model</u>. (In the fixed price model minimization of output variation is the only target.) The variances of all the shocks are again assumed to be the same, irrespective of the nature or the origin of the shock. We can now write:

$$L_f = a\sigma^2_{shock}*1.320 + (1\text{-}a)\sigma^2_{shock}*0.894,$$
$$L_u = a\sigma^2_{shock}*1.620 + (1\text{-}a)\sigma^2_{shock}*1.338,$$
$$L_b = a\sigma^2_{shock}*0.972 + (1\text{-}a)\sigma^2_{shock}*1.118.$$

According to the price target the ranking of the loss functions of the regimes is as follows:

$$L^p_b < L^p_f < L^p_u.$$

With respect to the output target we can write:

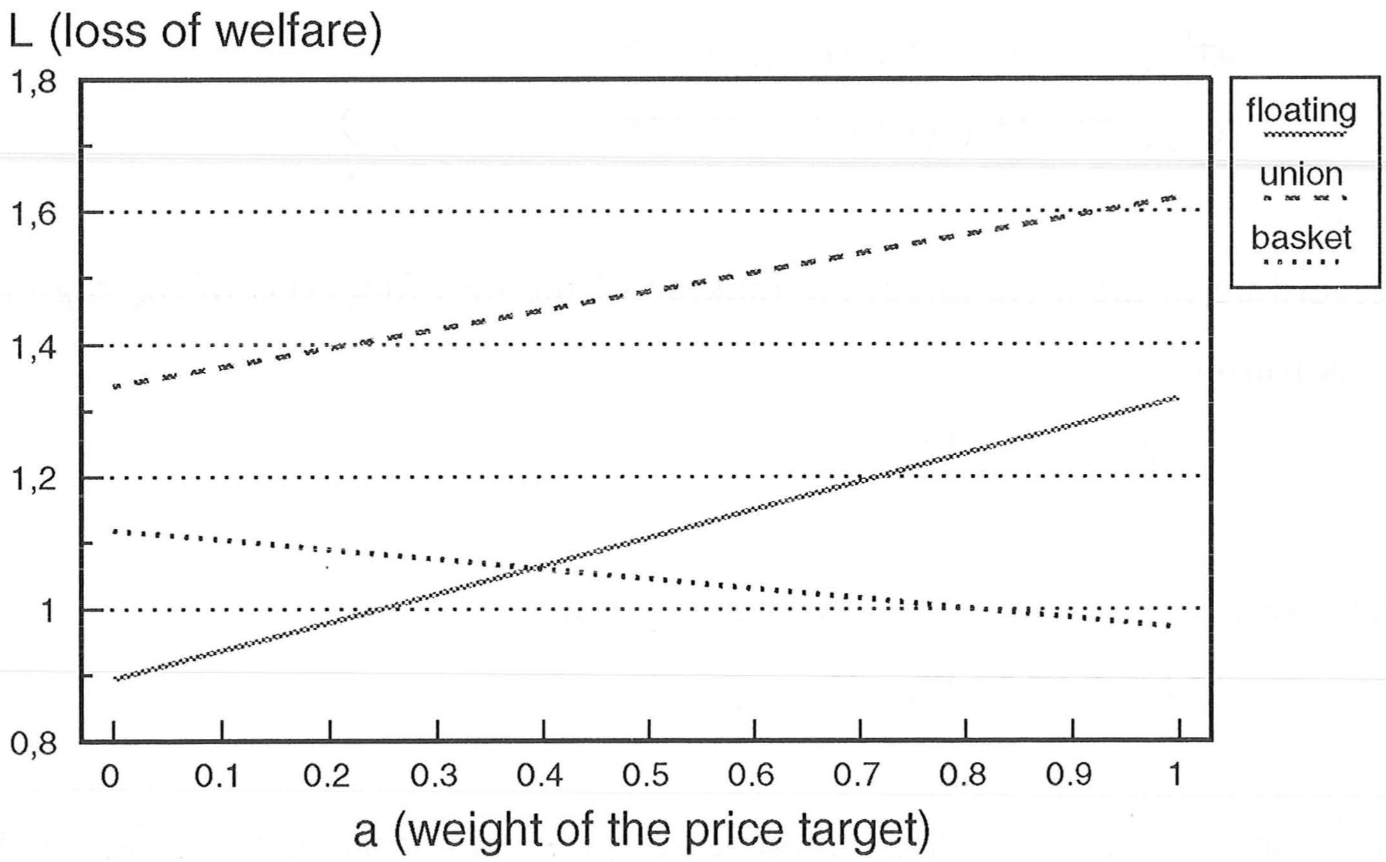
$$L^o_f < L^o_b < L^o_u.$$

Because the exchange rate union leads in the baseline calculation to the highest value of the loss function with respect to both targets we can conclude:

$(L_b \ \& \ L_f) < L_u$, for all $0 \leq a \leq 1$.

The ranking between floating and the basket peg regime depends on the relative weights of the output and price targets. A high weight for the output target favours floating, and a high weight for the price target favours the basket peg regime. If $a < 0.392$, floating is preferred, and vice versa. We illustrate the situation with figure 18, where the values of the loss functions, calculated in the baseline case for different exchange rate regimes, are presented for different values of the price target a ($0 \leq a \leq 1$).

Figure 18. The values of the aggregate loss functions for different exchange rate regimes in the baseline calculation: sensitivity with respect to the weight of the price target a ($0 \leq a \leq 1$) (standardization: $\sigma^2_{shock} = 1$)



Basically the same conclusions are obtained **in the alternative scenario** (in a less open economy), too. The exchange rate union leads to the greatest loss of welfare with all values of a. When comparing floating and the basket peg regime, the critical value of a is now somewhat lower. If a > 0.309, the basket peg regime is preferred to floating.

The poor performance of the exchange rate union in the examples studied is due in particular to the great output effects in the cases of monetary and productivity shocks occurring in the union partner country (see table 4 on page 133). If the variances of these shocks could be assumed to be small, the attractiveness of the exchange rate union would increase. The insulation properties of the exchange rate union with respect to prices are also clearly worse than those of especially the basket peg regime (see appendix 4). This is due to the "half-float nature" of the exchange rate union in a floating rate world. Domestic producer prices react thus to the changes in the exchange rate between the big economies.

The comparison of the exchange rate regimes presented above does not attempt to be general; it is rather an example of the use of the model. The model itself and the method used have, however, more generality.

The limitations and reservations of the conclusions drawn above can be divided into two categories: (1) those related to the use of the model, and (2) those related to the model itself. The former set of limitations includes, for example, reservations related to the numerical values of the parameters used, to the shocks studied and to the assumptions concerning the variances of the shocks. These assumptions can easily be changed according to new information and according to the countries studied. The latter set of limitations includes the general philosophy and structure of the model and the various specifications. Other kinds of models or specifications, and criteria used, can lead to different kinds of rankings between the regimes.

The floating exchange rate regime is, for example, modelled in this study in a way that reflects the importance of economic fundamentals in the determination of the exchange rate. This is a kind of an "ideal" floating. Allowing the exchange rate to be affected more by factors related to the functioning of the foreign exchange market (speculative bubbles, etc.) can change the conclusions. In the model specifications used we do not yet take into account the effects of expectations. The possibilities for limited flexibility within the exchange rate union and the currency basket regime are neglected, as well as the implications of differing degrees of credibility of the exchange rate in different regimes. We have also assumed that the values of the parameters are the same in all exchange rate regimes. This assumption may be realistic in the short run, when we can assume that there is no learning process. In the longer run, and when expectations are added into the model, this assumption does not necessarily hold (the so-called Lucas critique) (see page 28).

The assumption of symmetry between the large countries must also be kept in mind when reading the results of the baseline scenario. The examples calculated in the case of asymmetry of real wage rigidity give some insight into how the foreign variables can change from the baseline scenario. The symmetry assumption used in the reference scenario is, however, motivated by the uncertainty related to empirical parameter estimates. For example, real wage rigidity can also change in time.

Dynamization of the model and incorporation of rational expectations will be done in the next chapter. Many aspects relevant for the choice of an exchange rate regime must, however, be analyzed outside the model, and with the help of other kinds of models.

4.5 Summary

In this chapter exchange rate unions are compared to currency basket and floating rate regimes in the framework of a static three-country macroeconomic (IS-LM) model, where exchange rate and price expectations are static. In the model we have two big countries and a small open economy. The models for the two big countries are solved simultaneously, whereas the small country is modelled in a recursive way, i.e. the small economy is affected by the big countries but not the other way round. The alternative regimes are analyzed in the case of the small open economy. The exchange rate between the big economies is determined freely in the foreign exchange market.

Two versions of the model are used. In the first version producer prices are fixed, the model is thus a Keynesian short-term (Mundell-Fleming) model. In the second version an aggregate supply equation is added into each country model, whereby the determination of producer prices is made endogenous. In the extreme case domestic prices respond fully to changes in the exchange rate and in foreign prices.

Floating rates are modelled in a way where "economic fundamentals" determine the exchange rate through the money and goods market equilibrium conditions in the presence of free capital mobility and perfect asset substitutability. In the cases of the exchange rate union and in the currency basket regime, we study only cases where the exchange rate is credibly fixed.

The approach used in the comparison of the regimes is a traditional one: to study how exogenous domestic and foreign shocks affect the small open economy, and in which regime the effects are minimized. This approach is legitimized by the costs related to short-term variations in economic variables. The shocks studied are a goods demand shock, a monetary shock and a productivity shock, which all can occur in the home country or in either of the big countries. Because any measure of goodness of a regime is incomplete, much emphasis is put on the transmission channels of the shocks.

In the cases of domestic goods demand and monetary shocks the general conclusions of the traditional Mundell-Fleming research are confirmed in the fixed as well as in the endogenous price model: floating rates are preferred in the case of goods demand shocks and fixed rates in the case of monetary shocks. Endogenizing prices, however, modifies the conclusions: insulation properties are not as dichotomic as in the fixed price model, but more a matter of degree. In the case of productivity shocks it is shown that a fixed exchange rate insulates the output more than floating if the money supply remains unchanged. If prices are fully flexible, there is no difference between the exchange rate regimes in terms of output stabilization.

The main contribution of the study is in the widening of the IS-LM framework into a recursive model with two big countries and a small country, and in a systematic comparison of the three exchange rate regimes in the face of various foreign shocks. In the fixed price model *a priori* results concerning the signs of the changes are obtained in the big country model and for floating rates in the case of the small country. When comparing the exchange rate union and the basket peg regime we notice, however, that few *a priori* conclusions can be drawn about the variations of economic variables. The conclusions depend on the relative size of the various effects, and thus on the parameters of the model. In the case of endogenous prices it is even more difficult to obtain *a priori* results already in the big country model.

In addition to some discussion about the net effects with different combinations of the values of the parameters, we calculate two numerical simulations of the model and conduct sensitivity analyses. The parameter estimates used are partly based on empirical studies, but because of difficulties in finding direct empirical counterparts, the parameter values used must be considered more as "guesstimates" than estimates. In the baseline scenario we have a rather open economy concerning the elasticities with respect to relative prices and foreign demand. In an alternative scenario we have a more closed real economy.

In the numerical simulations conducted, the basket peg regime stabilizes the output of the small country more than the alternative regimes if producer prices are fixed. A stable effective exchange rate thus leads in this case to the most stable output. Floating generates the second best outcome in three of the four cases in the open economy (baseline) scenario, and the exchange rate union correspondingly in three cases in the alternative (less open economy) scenario. The exchange rate union stabilizes the output the worst in both scenarios when there is a monetary shock in the union partner country.

In the simulations with the endogenous price model we notice that a stable effective exchange rate does not necessarily lead to the most stable development of the output. A change in the exchange rate and accordingly in competitiveness reduces in some cases the effect of the other factors, having a stabilizing effect on output. But in some other cases changes in competitiveness reinforce the other effects. The result depends crucially on the nature and on the origin of the shock. In the main simulations conducted it is assumed that domestic prices respond to changes in foreign prices according to input-output relations of the economy, and on the basis of the mark-up pricing practice of the firms.

It is found in the simulations that the basket peg regime tends to stabilize the output more than the alternative regimes if there is a goods demand shock in "the rest of the world". If a similar shock occurs in the potential union partner country, the exchange rate union and the basket peg regime stabilize the output the best, the relative performance depending on the parameter values. Flexible exchange rates are not good stabilizers against foreign goods demand shocks when the exchange rate of the large countries is floating, because the exchange rate tends to reinforce the effect of the changing export demand. The same conclusion applies to the exchange rate union if the shock occurs in "the rest of the world".

In the case of foreign monetary shocks floating tends to reduce the effects due to changes in the interest rate and in the foreign demand. An exchange rate union has a similar effect if the shock occurs in "the rest of the world", but if it occurs in the union partner country, the other effects are essentially reinforced. In the simulations conducted the basket peg regime stabilizes the output less than the other regimes when a monetary shock occurs in "the rest of the world". When the shock occurs in the potential union partner country, it takes an intermediate position.

In the case of productivity shocks when the money supply is kept unchanged, the results are very similar to those obtained in the case of monetary shocks. This is due to similar changes in real money balances.

At the end of the chapter we present a method for analyzing the stabilizing properties of the exchange rate regimes against a combination of all the shocks studied. We present a quadratic loss function for each regime, first with respect to deviations in output only, and after that a loss function where deviations in prices are also taken into account.

In order to be able to calculate the values of the loss functions, we need the multipliers of the effects of the shocks and the variances of the shocks. The multipliers we have calculated already in the numerical simulations. As for the variances it is difficult to present any *a priori* judgements, neither do we have any empirical estimates. We therefore calculate the values of the loss functions when assuming that the variances of the shocks are the same, i.e. that their expected values are the same. Additionally, we assume that the variances of the shocks are independent of each other. We also calculate some critical variances.

In the experiment with the same variances for all shocks, we obtain in the baseline scenario of the fixed price model the lowest value of the aggregate loss function (the highest welfare) for the basket peg regime. The loss is the greatest in the exchange rate union, whereas floating takes an intermediate position.

When prices are allowed to change, floating performs the worst with very low degrees of price indexation. But already a modest increase in indexation improves the stabilization properties of floating, and the union leads again to the greatest loss in terms of output stabilization.

The weak performance of the union is due to the poor stabilization properties in the cases of monetary and productivity shocks occurring in the union partner country. If the variances of these shocks were small, the attractiveness of the exchange rate union would increase.

In the fixed price version of the model the basket peg regime leads to the smallest loss of welfare. In the endogenous price version (baseline scenario) the ranking between floating and the basket peg regime depends on the weight of the price target in the aggregate loss function. Because the basket peg regime stabilizes producer prices the best against all foreign shocks, increasing the weight of the price target makes the basket peg regime preferable to floating. But with low weights for the price target, floating leads to the lowest value of the loss function and thus to the highest welfare.

5 A DYNAMIC THREE-COUNTRY MODEL

5.1 Introduction

In the previous chapter the model used is a static one with static expectations. In the current chapter a dynamic recursive three-country model with rational expectations is built, and the exchange rate regimes are analyzed in this framework. In the model of the previous chapter the agents do not have any view of the adjustment of the economy. In this chapter the main emphasis is put on the adjustment paths of different variables over time.

In the model of chapter 4 interest rates are equalized between countries, and real interest rates do not differ *ex ante* either. In the model of this chapter the expectation channel makes it possible for the nominal as well as real interest rates to differ.

In the big countries the nominal interest rates can be different due to the floating exchange rate. In the small country the difference of the domestic nominal interest rate from the international one is determined in the floating rate regime on the basis of exchange rate expectations, too. In the basket peg regime the nominal interest rate equals the trade-weighted average of the big country rates. In the exchange rate union it equals the rate of country 2.

Real interest rates are determined on the basis of the nominal rates and inflation, the expectations of which affect the expected real interest rate, too. Exchange rate and price expectations are crucial determinants in the adjustment of the economy to exogenous shocks.

The long run equilibrium of the model is determined according to the neoclassical assumptions, among others that the capacity output is not affected by the shocks. The short run adjustment, instead, is Keynesian. This feature is reflected in the rigidly adjusting price level. Exchange rates, interest rates, output and inflation are in turn jump variables, which adjust to the shocks immediately.

The model is basically a demand-determined model, where the supply reactions are not explicitly taken into account like in the previous chapter. In the current one the supply curve is replaced by a Phillips curve, where the effects of demand pressure on the price level are taken into account, but there is no direct channel from foreign prices to the domestic producer prices. In this sense the model can be regarded as most suitable in cases where price and wage indexation are low. The "long run" of the model is accordingly rather short. How long the relevant time period is, depends on the contract period of wages, on the timing of the shock during this period, and on the pass-through of foreign input prices to domestic producer prices.

The regimes are analyzed in the current chapter in a similar way than in the previous one. After the presentation of the model unexpected exogenous domestic shocks are studied. Then the effects of each foreign shock are studied first in the big countries, and after that in the small country in different regimes.

Economic agents do not make any assumptions or forecasts about the duration of the initial shocks, i.e. they react as if the shocks were permanent. The effects of the shocks on output, however, vanish during the adjustment process.

5.2 Structure of the model

The model is a recursive three-country version of the extended Mundell-Fleming model. In a one-country and floating exchange rate context the origins of the dynamic version go back to Dornbusch (1976).[20] When Dornbusch presented his model it was put under the heading of the asset market approach (see for example Williamson, 1983, 228). The structure of the model is, however, developed on the basis of the Mundell-Fleming framework. Buiter (1986) uses a similar two-country model. The models of each country consist of the money market equilibrium condition (LM curve), goods market equilibrium (IS curve), the Phillips curve and of the uncovered interest rate parity.

The big country models are solved simultaneously, whereas the small country is treated in a recursive way, i.e. it does not affect the big countries. The big countries are assumed to be symmetric. The differences in reactions between countries are thus due to the origin of the shocks.

The model is presented in natural logarithms (except interest rates) as follows:

<u>Country 1 ("the USA"):</u>

$$(75)\ m_1 - p_1 = ky_1 - \Phi i_1$$

$$(76)\ y_1 = -\mu r_1 + \sigma(e + p_2 - p_1) + \varepsilon y_2 + f_1$$

$$(77)\ \mathring{p}_1 = \psi(y_1 - \bar{y}_1)$$

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[20]Dornbusch (1976) uses the nominal interest rate (instead of real) in the IS equation, which makes the solution of the model essentially simpler.

$$(78)\ r_1 = i_1 - \mathring{p}_1$$

$$(79)\ i_1 = i_2 + \mathring{e}$$

Country 2 ("EMU" or "a hard EMS"):

$$(80)\ m_2 - p_2 = ky_2 - \Phi i_2$$

$$(81)\ y_2 = - \mu r_2 - \sigma(e + p_2 - p_1) + \varepsilon y_1 + f_2$$

$$(82)\ \mathring{p}_2 = \psi(y_2 - \bar{y}_2)$$

$$(83)\ r_2 = i_2 - \mathring{p}_2$$

$$(84)\ c \equiv e + p_2 - p_1$$

Country 3 ("Finland"):

$$(85)\ m_3 - p_3 = k_3 y_3 - \Phi_3 i_3$$

$$(86)\ y_3 = - \mu_3 r_3 + \sigma_3[\theta(e_{31} + p_1 - p_3) + (1 - \theta)(e_{32} + p_2 - p_3)] + \varepsilon_3[\theta y_1 + (1 - \theta)y_2] + f_3$$

$$(87)\ \mathring{p}_3 = \psi_3(y_3 - \bar{y}_3)$$

$$(88)\ r_3 = i_3 - \mathring{p}_3$$

$$(89)\ c_{31} \equiv e_{31} + p_1 - p_3$$

$$(90)\ c_{32} \equiv e_{32} + p_2 - p_3$$

$$(91)\ c_3 \equiv \theta c_{31} + (1 - \theta)c_{32}$$

(92)' $i_3 = i_2 + \mathring{e}_{32}$ (floating)

(92)'' $i_3 = i_2$ (EMU-peg, credible)

(92)''' $i_3 = \theta i_1 + (1 - \theta)i_2$ (basket peg, credible)

The symbols are as follows: m = nominal money stock, p = price level (GDP deflator), k = income elasticity of money demand, i = nominal interest rate,

Φ = interest rate semielasticity of money demand, y = real output, μ = real interest rate semielasticity of goods demand, r = real interest rate, σ = elasticity of goods demand with respect to relative prices ("competitiveness elasticity"), e = the price of the currency of country 2 in terms of the currency of country 1, ε = elasticity of goods demand with respect to foreign real income, ψ = the elasticity of inflation with respect to deviation of the domestic output from the long-run level, θ = the share of country 1 in the foreign trade of country 3, f = exogenous goods demand shock, e_{31} and e_{32} = prices of the currencies of country 1 and country 2 in terms of the currency of country 3, respectively. Additionally, relative prices ("competitiveness") are defined as follows: $c \equiv e + p_2 - p_1$, $c_{31} \equiv e_{31} + p_1 - p_3$, and $c_{32} \equiv e_{32} + p_2 - p_3$. All coefficients of the model as defined above are non-negative. We also assume that $0 < \varepsilon_1, \varepsilon_2, \varepsilon_3 < 1$ and $0 \leq \theta \leq 1$. A dot and a line above a variable refer to the rate of change and to the long-run level of the variable, respectively.

Real money demand in the model depends positively on the domestic national income y and negatively on the nominal interest rate. Goods demand depends negatively on the real interest rate and positively on relative prices ("competitiveness") and on foreign demand measured with foreign national income. The countries produce tradeable goods which can be somewhat different as aggregates. This difference is reflected in the values of σ:s. The purchasing power parity condition (PPP) is not required in the model. The form in which the interest rate parity condition is written implies that the assets of different countries are assumed to be perfect substitutes. It implies also that the agents are on average risk neutral. (For the theory behind the IS and LM curves, see pp. 32-33.)

The model has rational exchange rate expectations and rational price expectations on the part of the investors in the sense of perfect foresight. The exchange rate is set in an efficient forward looking asset market, and it can make discrete "jumps" at a point in time as a response to "news". Domestic costs p_i are predetermined, given in time, but their rates of change respond to excess demand or supply. There is no "core inflation" in this model as in that of Buiter (1986). The zero level of inflation is thus to be interpreted as the normal inflation.

The model has in the short run "Keynesian" and in the long run classical features. Goods demand and monetary shocks can change the output in the short run but in the long run it remains unchanged unless there is a change in the fundamental factors affecting $\overline{y}$, the capacity output (a productivity shock).

The big country model is reduced to a form where we have 7 equations and an equal amount of unknowns (r_1 and r_2 are replaced and the definition for c is not used in the solution). The endogenous variables are y_1, y_2, $\mathring{p}_1$, $\mathring{p}_2$, e, i_1 and i_2. In the small country model y_3 and $\mathring{p}_3$ are endogenous in all exchange rate regimes. In the floating exchange rate regime one of the bilateral exchange rates, e_{31} or e_{32}, is endogenous. We can write the other one with the help of e, according to the triangular arbitrage, for example $e_{31} = e_{32} - e$. In the currency basket exchange rate regime the bilateral exchange rates change according to the trade weights so that the effective (trade-weighted) exchange rate remains constant. In the case of an exchange rate union, the exchange rate, and accordingly the interest rate, of the small country are the same as in country 2. The interest rate is an unknown variable in the floating and currency basket regimes.

The uncovered interest rate parity in the case of the basket peg regime (equation (92)''') is obtained by solving $\mathring{e}_{31}$ and $\mathring{e}_{32}$ from the bilateral interest parity conditions $i_3 = i_1 + \mathring{e}_{31}$ and $i_3 = i_2 + \mathring{e}_{32}$ and by inserting the results into the trade-weighted currency index $\theta\mathring{e}_{31} + (1 - \theta)\mathring{e}_{32} = 0$. It is assumed that the index is known by the economic agents.

5.3 Domestic shocks

Because we do not make any distinction between the exchange rate union and the basket peg regime with respect to, for example, credibility, these regimes behave in the same way in the case of domestic shocks. We thus analyze in this section the effects of unexpected exogenous domestic shocks in the floating and fixed exchange rate regimes.

5.3.1 Long-run equilibrium

In the long-run equilibrium inflation and changes in the exchange rate must be zero by definition. The domestic interest rate must, accordingly, equal the foreign one. After inserting $\mathring{p}_3 = \mathring{e}_{32} = 0$ and $i_3 = i_2$ into the small country model and denoting the long-run equilibrium values by a line above the variable, we obtain in the floating exchange rate regime the following equilibrium conditions:

$$(93)\ \overline{p}_3 = m_3 + \Phi_3 i_2 - k_3\overline{y}_3$$

$$(94)\overline{e_{32}}=\frac{\sigma_3 m_3+(\sigma_3\phi_3+\mu_3)i_2+(1-\sigma_3 k_3)\overline{y_3}-f_3+\sigma_3(\theta-1)p_2-\theta\sigma_3 p_1+\theta\sigma_3 e-\theta\epsilon_3 y_1+\epsilon_3(\theta-1)y_2}{\sigma_3}.$$

A positive goods demand shock (an increase in f_3) spurs an appreciation of the exchange rate of the small country but does not affect the price level in the long run. An increase in money supply increases the price level and prompts the depreciation of the exchange rate proportionally. An increase in productivity, in turn, (reflected as an increase in the capacity output $\overline{y}_3$) decreases the long-run price level and obviously leads to a depreciation of the exchange rate (if "the competitiveness elasticity" times the income elasticity of money demand is less than one, i.e. $\sigma_3 k_3 < 1$). The depreciation is due to the increased output, which must be sold also abroad. The depreciation even in the "long run" reflects the short-run nature of the model. Nominal wages do not respond to the change in productivity in this model.

In the fixed exchange rate regime the money supply is endogenous, it responds immediately to satisfy the money demand. We write now the long-run equilibrium condition for $\overline{p}_3$ as follows:

$$(95)\overline{p_3}=\frac{f_3-\mu_3 i_2-\overline{y_3}-\theta\sigma_3 e+\theta\sigma_3 p_1+\sigma_3(1-\theta)p_2+\theta\epsilon_3 y_1+(1-\theta)\epsilon_3 y_2}{\sigma_3}.$$

A positive goods demand shock increases the long-run price level. Monetary policy is fully neutral in the long run. A positive productivity shock decreases the price level.

5.3.2 Dynamics of the model

In the floating rate regime the dynamic equations for $\mathring{p}_3$ and $\mathring{e}_{32}$ are as follows:

$$(96)\quad \begin{vmatrix} \mathring{p}_3 \\ \mathring{e}_{32} \end{vmatrix} = \begin{vmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{vmatrix} \begin{vmatrix} p_3 \\ e_{32} \end{vmatrix} + \begin{vmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} & b_{16} & b_{17} & b_{18} & b_{19} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} & b_{26} & b_{27} & b_{28} & b_{29} \end{vmatrix} \begin{vmatrix} m_3 \\ i_2 \\ f_3 \\ \overline{y}_3 \\ p_1 \\ p_2 \\ e \\ y_1 \\ y_2 \end{vmatrix}.$$

where

$$a_{11} = \frac{-\mu_3\psi_3 - \phi_3\psi_3\sigma_3}{\Lambda}, a_{12} = \frac{\phi_3\psi_3\sigma_3}{\Lambda},$$

$$a_{21} = \frac{1 - \mu_3\psi_3 - k_3\sigma_3}{\Lambda}, a_{22} = \frac{k_3\sigma_3}{\Lambda},$$

where $\Lambda = k_3\mu_3 + \Phi_3(1 - \mu_3\psi_3)$.

The system has one negative and one positive characteristic root, i.e. the system is saddle point stable if $a_{11}a_{22} - a_{12}a_{22} < 0$. This condition is satisfied if $\mu_3(k_3\Phi_3^{-1} - \psi_3) + 1 > 0$. We assume that this condition holds. For the stability condition it is sufficient if $\mu_3\psi_3 < 1$, i.e that the IS curve is steeper than the

Phillips curve, when $\mathring{p}_3$ is on the vertical axis and y_3 on the horizontal axis. The condition is understandable from an empirical point of view. Both the interest rate semielasticity of goods demand (μ_3) and the elasticity of inflation with respect to the deviation of output from the "normal" level (ψ_3) are obviously smaller than one.

In the fixed exchange rate regime we write the differential equation for $\mathring{p}_3$:

$$(97)\ \mathring{p}_3 = \frac{\psi_3\sigma_3}{\mu_3\psi_3 - 1} p_3 + \begin{vmatrix} d_{11} & d_{12} & d_{13} & d_{14} & d_{15} & d_{16} & d_{17} & d_{18} \\ d_{21} & d_{22} & d_{23} & d_{24} & d_{25} & d_{26} & d_{27} & d_{28} \end{vmatrix} \begin{vmatrix} i_2 \\ f_3 \\ \overline{y}_3 \\ p_1 \\ p_2 \\ e \\ y_1 \\ y_2 \end{vmatrix}$$

The system is stable if $\mu_3\psi_3 < 1$, which is a sufficient (but not a necessary) condition in the floating rate regime, too (see the previous page).

5.3.3 Effects of a domestic goods demand shock

In the floating exchange rate regime the long-run effects are obtained directly from equations (93)-(94). For the short-run impacts we use the following equation system:

(98) $i_3(0) = i_2(0) + \mathring{e}_{32}(0)$

(99) $y_3(0) = - \mu_3(i_3(0) - \mathring{p}_3(0)) + \sigma_3[\theta(e_{32}(0) - e + p_1 - p_3(0)) + (1 - \theta)(e_{32}(0) + p_2 - p_3(0))] + \varepsilon_3[\theta y_1 + (1 - \theta)y_2] + f_3$

(100) $e_{32}(0) = \bar{e}_{32} + a_{21}(p_3(0) - \bar{p}_3)/(\rho_{3fl} - a_{22})$

(101) $\mathring{e}_{32}(0) = \rho_{3fl}(e_{32}(0) - \bar{e}_{32})$.

(102) $\mathring{p}_3(0) = \rho_{3fl}(p_3(0) - \bar{p}_3)$.

A zero after the variables in the equations refers to the short run. Equation (100) is obtained by equating the saddlepath property of the exchange rate presented in (101) with another expression for $\mathring{e}_{32}$ presented in equation (96). We obtain the short-run impacts after inserting the long-run effects and the expression for the stable characteristic root ρ_{3fl} into the above equation system.

A goods demand shock has no impact on output or inflation. There is a jump appreciation of the exchange rate by $1/\sigma_3$ after a positive shock.[21] The exchange rate immediately achieves its long-run level. The interest rate is not affected. It is all the time determined internationally. (About the time path of the effects in the baseline scenario, see figures 19a and b.) (About the parameters of the baseline scenario see appendix 2.)

In the fixed exchange rate regime the long-run effect on the price level is obtained from equation (95). The short-run effects are obtained from an equation system consisting of the IS curve, the long-run effects, the negative characteristic root and the saddlepath property for inflation.

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[21]This is the same result as that obtained in the fixed price version of the static model (see p. 44).

We obtain the result that output and inflation "jump" in the short run after a positive goods demand shock according to the formulas:

$$(103)\ \frac{\delta y_3(0)}{\delta f_3} = \frac{1}{1-\mu_3\psi_3},$$

$$(104)\ \frac{\delta \dot{p}_3(0)}{\delta f_3} = \frac{\psi_3}{1-\mu_3\psi_3}.$$

The expressions are positive under the stability condition presented earlier. In the long run output and inflation reach their pre-shock level, but the price level and money stock remain higher than before the shock (see figure 19b).

Figure 19a. Effects of a domestic goods demand shock, floating

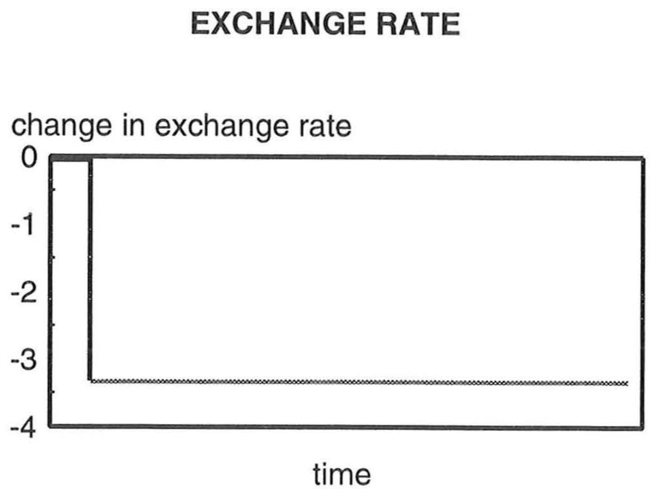
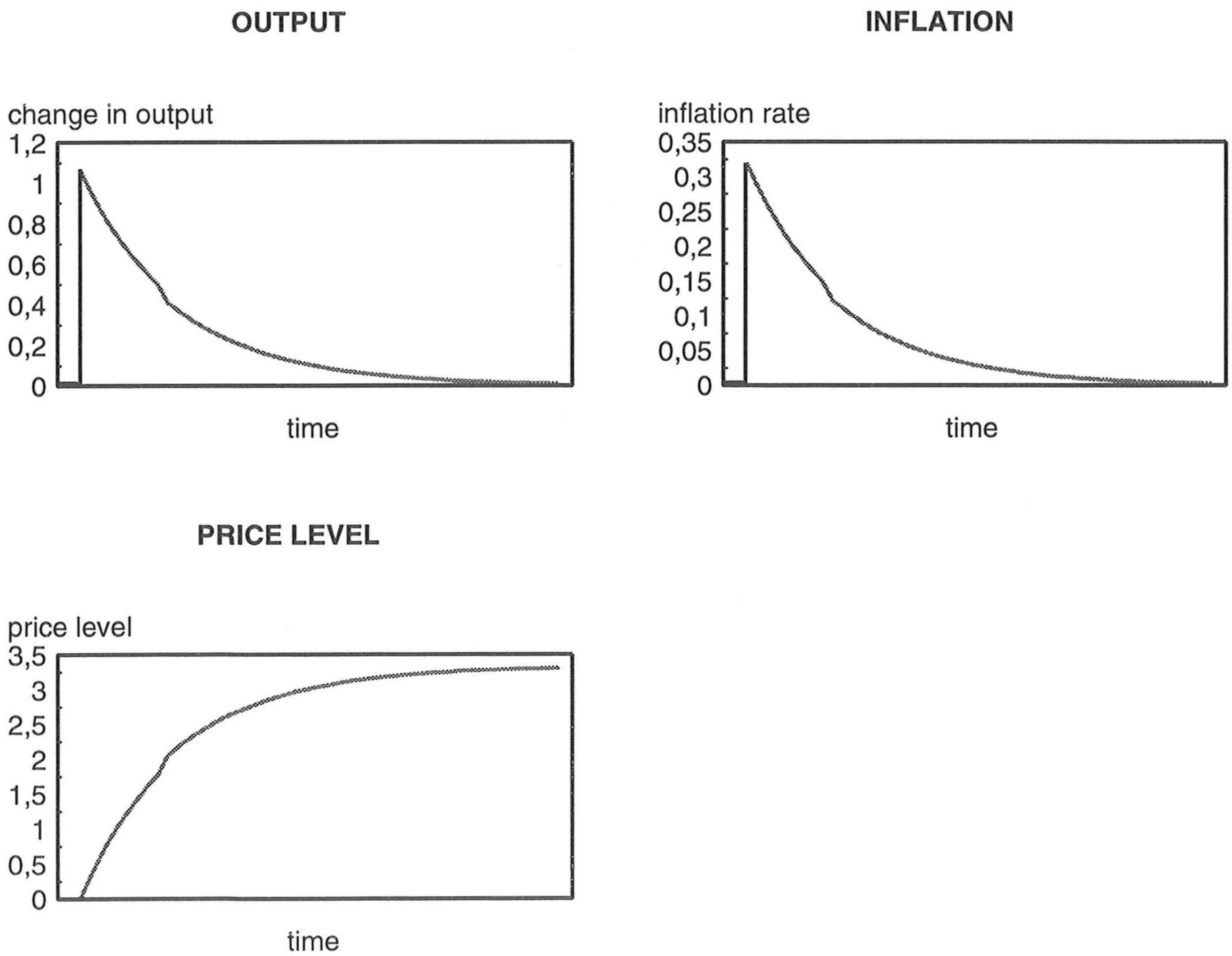


Figure 19b. Effects of a domestic goods demand shock, fixed exchange rate



5.3.4 Effects of a domestic monetary shock

In the floating rate regime there is a jump depreciation with an overshooting after an increase in the money stock, or a decrease in money demand, under the stability assumption and the assumption that $k_3\sigma_3 + \mu_3\psi_3 < 1$ (a sufficient condition). The overshooting occurs due to the slow adjustment of the price level. It can be shown that output also jumps upwards in the short run:

$$(105)\ \frac{\delta y_3(0)}{\delta m_3} = \frac{(1-\mu_3\psi_3-k_3\mu_3\rho_{3fl}-\phi_3\rho_{3fl}+\mu_3\phi_3\psi_3\rho_{3fl})(\sigma_3-\mu_3\rho_{3fl})}{1-\mu_3\psi_3-k_3\mu_3\rho_{3fl}-\phi_3\rho_{3fl}+\mu_3\phi_3\psi_3\rho_{3fl}-k_3\sigma_3},$$

$$(106)\ \frac{\delta e_{32}(0)}{\delta m_3} = \frac{1-\mu_3\psi_3-k_3\mu_3\rho_{3fl}-\phi_3\rho_{3fl}+\mu_3\phi_3\psi_3\rho_{3fl}}{1-\mu_3\psi_3-k_3\mu_3\rho_{3fl}-\phi_3\rho_{3fl}+\mu_3\phi_3\psi_3\rho_{3fl}-k_3\sigma_3},$$

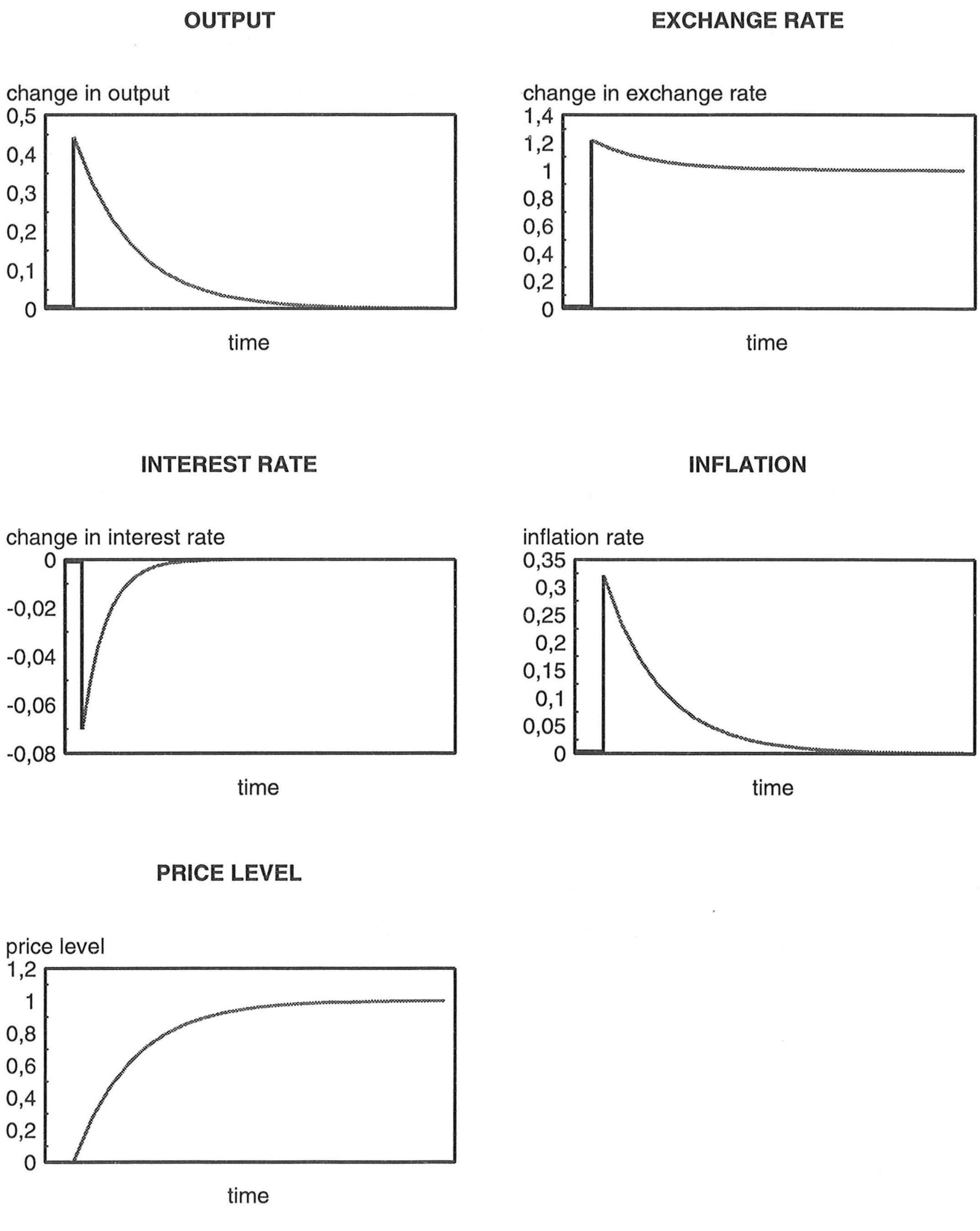
$$(107)\ \frac{\delta i_3(0)}{\delta m_3} = \frac{k_3\sigma_3\rho_{3fl}}{1-\mu_3\psi_3-k_3\mu_3\rho_{3fl}-\phi_3\rho_{3fl}+\mu_3\phi_3\psi_3\rho_{3fl}-k_3\sigma_3},$$

$$(108)\ \frac{\delta \dot{p}_3}{\delta m_3} = -\rho_{3fl}.$$

The symbol ρ_{3fl} refers to the negative characteristic root in the floating rate regime. Inflation also jumps by the amount $-\rho_{3fl} > 0$. In the long run the price level increases in proportion to the shock. The interest rate jumps downwards in the short run if $k_3\sigma_3 + \mu_3\psi_3 < 1$. (See figure 20 for the effects in the baseline scenario.)

In the fixed exchange rate regime a change in the domestic money component leads to an equal change, but with the opposite sign, in foreign reserves. There is no change in other variables.

Figure 20. Effects of a domestic monetary shock, floating exchange rates



5.3.5 Effects of a domestic productivity shock

In the floating exchange rate regime a positive domestic productivity or some other supply shock leads in the long run to a decrease in the price level and obviously to a depreciation of the exchange rate (expressions (93) and (94)); the output increases by definition (the effects in the baseline scenario are presented in parenthesis):

$$\delta\bar{y}_3/\delta\bar{y}_3 = 1,\ \delta\bar{p}_3/\delta\bar{y}_3 = -\ k_3\ (= -\ 0.67),$$
$$\delta\bar{e}_{32}/\delta\bar{y}_3 = (-\ k_3\sigma_3 + 1)/\sigma_3\ (= 2.663).$$

In the short run this kind of a shock leads in the baseline scenario to an increase in the domestic output, to a depreciation of the exchange rate, to an increase in the interest rate and to a decline in inflation. The depreciation is due to the need to export the increased production abroad. Nominal wages do not respond directly to the productivity shock in this short-run model. The effects are presented below:

$$\delta y_3(0)/\delta\bar{y}_3 = 0.703,\ \delta e_{32}(0)/\delta\bar{y}_3 = 2.517,$$
$$\delta i_3(0)/\delta\bar{y}_3 = 0.047,\ \delta\mathring{p}_3(0)/\delta\bar{y}_3 = -\ 0.215.$$

In the cases of the output and exchange rate the signs cannot be shown *a priori*. In principle it is possible that the rising real interest rate could compensate for the positive initial effect. But for the nominal interest rate and inflation the signs of the effects are clear even *a priori* (for the interest rate under the assumption $k_3\sigma_3 + \mu_3\psi_3 < 1$). The nominal interest rate increases and inflation declines. The formulas for the interest rate and inflation effects are as follows:

$$(109)\ \frac{\delta i_3(0)}{\delta \overline{y_3}} = \frac{-k_3^2 \rho_{3fl} \sigma_3}{1-\mu_3\psi_3-k_3\mu_3\rho_{3fl}-\phi_3\rho_{3fl}+\mu_3\phi_3\psi_3\rho_{3fl}-k_3\sigma_3},$$

$$(110)\ \frac{\delta \dot{p}_3(0)}{\delta \overline{y_3}} = k_3\rho_{3fl} < 0.$$

According to the baseline scenario the exchange rate "undershoots" the long-run level in the short run, which is reflected in the increase of the interest rate. The depreciation of the exchange rate is motivated by the need to export the increased production. The undershooting is due to the declining long-run price level. This is seen in equation (100), as declining long-run prices lead to a situation, where the second addendum on the right is negative (the multiplier is negative).

The real interest rate increases due to the increase in the nominal rate and due to the decline in inflation. The output "undershoots" in the short run the long-run level and adjusts during time to the long-run level. (For the effects in the baseline scenario, see figure 21.)

In the fixed exchange rate regime a positive domestic productivity shock leads to a decline in the price level by $1/\sigma_3$ (= 3.333) in the long run (equation (95)).

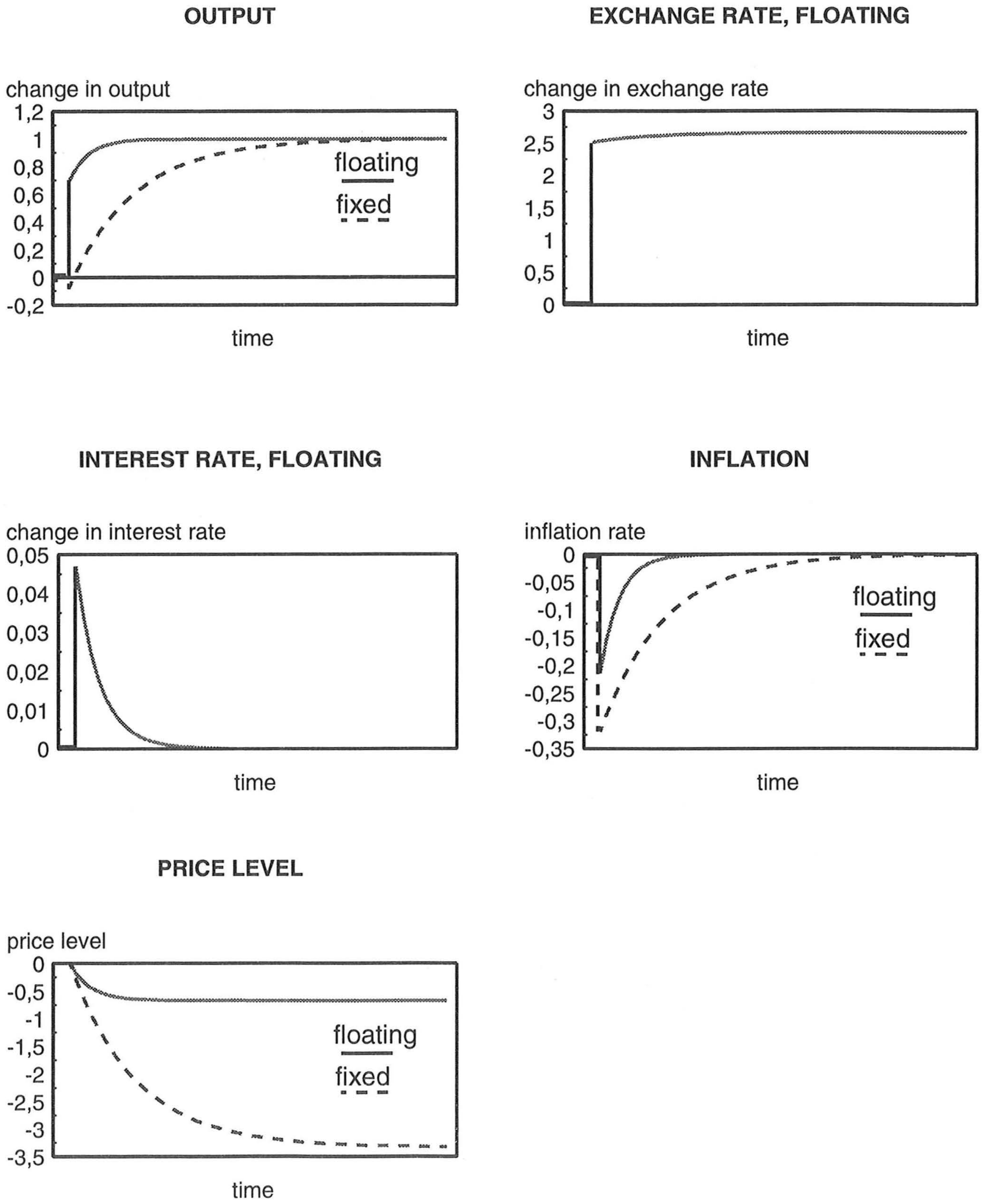
In the short run there is a decline in production and a deceleration in inflation under the stability assumption $\mu_3\psi_3 < 1$. The output decreases because of the increase in the real interest rate due to declining prices. The effects are as follows:

$$(111)\frac{\delta y_3(0)}{\delta \overline{y_3}}=\frac{\mu_3\psi_3}{\mu_3\psi_3-1}<0(=-0.064),$$

$$(112)\frac{\delta \dot{p}_3(0)}{\delta \overline{y_3}}=\frac{\psi_3}{\mu_3\psi_3-1}<0(=-0.319).$$

After the initial decline the output starts to increase and achieves in the long run the same level as in the floating rate regime. In the baseline scenario fixed rates thus lead to a more gradual change in output in the short run than floating rates. Inflation instead changes more in the fixed rate regime.

Figure 21. Effects of a domestic productivity shock (baseline scenario)



5.4 Method of solution of the big country model

5.4.1 The Aoki method

We assume that the large countries have identical structures. Differences in country performance are thus due to different policies, different exogenous shocks, or different initial conditions. This assumption makes it possible to use the method of differences and averages developed by Aoki in the solution of the big country model (see Aoki, 1981; Miller, 1982; Buiter, 1986).

We divide the big country model into two submodels: the model of differences and the model of averages. The model of differences is written as follows:

$$(113)\ m^d - p^d = ky^d - \Phi i^d$$
$$(114)\ y^d = -\mu i^d + \mu \mathring{p}^d + 2\sigma e - 2\sigma p^d - \varepsilon y^d + f^d$$
$$(115)\ \mathring{p}^d = \psi y^d - \psi \bar{y}^d$$
$$(116)\ i^d = \mathring{e},$$

where $m^d = m_1 - m_2$, $p^d = p_1 - p_2$ etc.

The model of averages is written:

$$(117)\ m^a - p^a = ky^a - \Phi i^a$$
$$(118)\ y^a = -\mu i^a + \mu \mathring{p}^a + \varepsilon y^a + f^a$$
$$(119)\ \mathring{p}^a = \psi y^a - \psi \bar{y}^a,$$

where $m^a = (m_1 + m_2)/2$, $p^a = (p_1 - p_2)/2$ etc.

In the system of differences we have two forward looking variables $\mathring{e}$ and $\mathring{p}^d$, and in the system of averages just one forward looking variable $\mathring{p}^a$. The variables of each country can be solved through the differences and averages, for example $m_1 = 1/2m^d + m^a$, $m_2 = -1/2m^d + m_a$ etc.

5.4.2 Long-run equilibrium in the big country model

To obtain the long-run solution we again replace $\mathring{p}_1 = \mathring{p}_2 = \mathring{e} = 0$ and $i_1 = i_2$. Output in each country is at its exogenously given full-employment level. We denote the long-run variables with a line above the variable.

In the system of differences the long-run equilibrium is as follows:

$$(120)\ \overline{p}^d = m^d - k\overline{y}^d$$

$$(121)\ \overline{e} = \frac{-f^d + 2\sigma m^d + (1+\epsilon-2k\sigma)\overline{y^d}}{2\sigma}.$$

We see that an exogenous increase in the difference of goods demand spurs an appreciation of the exchange rate by the multiplier $1/2\sigma$. An increase in the difference of the money supply (due to an increase in m_1 or a decrease in m_2) increases the difference of the price level and leads to a depreciation of the exchange rate proportionally. An exogenous improvement in the productivity of country 1 in turn decreases the difference of the price level and prompts a depreciation of the exchange rate (assuming $1 + \varepsilon > 2k\sigma$).

The long-run solution for the system of averages is as follows:

$$(122)\overline{p^a}=m^a-(k+\frac{\phi}{\mu}(1-\epsilon))\overline{y^a}+\frac{\phi}{\mu}f^a,$$

$$(123)\overline{i^a}=\frac{1}{\mu}f^a+\frac{\epsilon-1}{\mu}\overline{y^a}.$$

An exogenous increase in the average goods demand increases the long-run price level and the long-run interest rate. An increase in the money supply in turn increases the price level proportionally, but has no effect on the average nominal interest rate. Because inflation is zero in the long run by definition, there is no change in the real interest rate, either. An improvement in the average productivity decreases the price level and the interest rate. These results are analogous to those of closed country models.

5.4.3 Dynamics of the model

In the system of differences the two differential equations are written as follows:

$$(124)\begin{vmatrix}\dot{e}\\ \dot{p}^d\end{vmatrix}=\begin{vmatrix}l_{11} & l_{12}\\ l_{21} & l_{22}\end{vmatrix}\begin{vmatrix}e\\ p^d\end{vmatrix}+\begin{vmatrix}n_{11} & n_{12} & n_{13} & n_{14}\\ n_{11} & n_{12} & n_{13} & n_{14}\end{vmatrix}\begin{vmatrix}m^d\\ f^d\\ e\\ \overline{y^d}\end{vmatrix},$$

where

$$l_{11}=\frac{-2k\sigma}{\Lambda^d},l_{12}=\frac{2k\sigma-1-\epsilon+\mu\psi}{\Lambda^d},$$

$$l_{21}=\frac{-2\phi\psi\sigma}{\Lambda^d},l_{22}=\frac{\mu\psi+2\phi\psi\sigma}{\Lambda^d},$$

where $\Lambda^d = -\ \Phi[1 + \mu(\Phi^{-1}k - \psi) + \varepsilon]$.

The system is saddlepoint stable, i.e. the characteristic equation has one negative and one positive root, if $l_{11}l_{22} - l_{12}l_{21} < 0$. This requirement is met if $\mu(\Phi^{-1}k - \psi) + 1 > -\ \varepsilon$.

In the system of averages the differential equation for the price level is as follows:

$$(125)\dot{p}^a=\frac{\mu\psi}{-\phi(1+\frac{k\mu}{\phi}-\epsilon-\mu\psi)}p^a+\begin{vmatrix}n_{11} & n_{12} & n_{13}\end{vmatrix}\begin{vmatrix}m^a\\ f^a\\ \overline{y^a}\end{vmatrix}.$$

The system is stable if the multiplier of p^a is negative, i.e. if $\mu(k\Phi^{-1} - \psi) + 1 > \varepsilon$.

When comparing the stability conditions of the system of differences and that of averages, we notice that the latter implies also the former. We assume that the latter condition is satisfied. The stability condition of the system of differences amounts to assuming that in a diagram with the nominal interest rate on the vertical axis and output on the horizontal axis, the IS curve - after the Phillips curve is used to substitute out the expected rate of inflation - is either downward sloping or upward sloping and steeper than the LM curve (about these stability conditions see Buiter, 1986, 549.)

5.5 Goods demand shocks in the big countries

5.5.1 Shocks in country 1

5.5.1.1 Effects on the big countries

To obtain the effects of an unexpected exogenous goods demand shock occurring in country 1, we differentiate the system of differences with respect to f^d and the system of averages with respect to f^a in the long and in the short run. The effects of an f_1 shock are analogous to an f^d shock, because $f^d = f_1 - f_2$, but in the case of averages we have to divide f^a by 2 to get the effects of a f_1 shock.

The long-run solutions for each country are obtained on the basis of equations (120) - (123) and from the assumptions concerning the long-run results presented on pages 175-176. In the system of differences the long-run effects of a fiscal shock are as follows:

$$\delta\bar{y}^d/\delta f^d = \delta\bar{p}^d/\delta f^d = \delta i^d/\delta f^d = 0,$$
$$\delta e/\delta f^d = -1/2\sigma.$$

In the system of averages the long-run effects are written:

$\delta\bar{y}^a/\delta f^a = \delta e/\delta f^a = 0$, $\delta\bar{p}^a/\delta f^a = \Phi/\mu$,

$\delta i^a/\delta f^a = 1/\mu$.

The short-run results are obtained after inserting the long-run results for $\bar{p}^d$, $\bar{e}$ and $\bar{p}^a$ and stability conditions for the exchange rate and prices, with the expression for the stable (negative) characteristic root ρ, into the original equation system. For the differences the equation system is as follows:

$$(126) e(0) = \bar{e} + \frac{l_{12}}{\rho - l_{11}}(p^d(0) - \bar{p}^d)$$

$$(127)\ i^d(0) = \rho(e(0) - \bar{e})$$

$$(128)\ y^d(0) = -\mu i^d(0) + \mu\mathring{p}^d(0) + 2\sigma e(0) - 2\sigma p^d(0) - \varepsilon y^d(0) + f^d$$

$$(129)\ \mathring{p}^d(0) = \rho(p^d(0) - \bar{p}^d).$$

A zero in parenthesis after the variable refers to the short-run impact. Equation (126) is obtained by equating the saddlepath condition for the exchange rate $\mathring{e}(0) = \rho(e(0) - \mathring{e})$ with the equality obtained from equation (124), i.e. $\mathring{e} = l_{11}(e(0) - \bar{e}) + l_{12}(p^d(0) - \bar{p}^d)$. Equation (126) tells, whether the exchange rate equals, undershoots or overshoots the long-run level. The denominator Λ^d in l_{12} and l_{11} is negative due to the stability assumption, which means that l_{11} is positive. The term l_{12} is positive if $2k\sigma + \mu\psi < 1 + \varepsilon$, which is empirically obvious. Because ρ is negative, the whole multiplier $l_{12}/(\sigma - l_{11})$ is negative under the assumptions presented. This means that an increase in the differences of the long-run price levels leads to an overshooting and a decrease to an undershooting of the exchange rate.

After differentiating the above system with respect to f^d we obtain the short-run results for the differences:

(130) $\delta e(0)/\delta f^d = -1/2\sigma$,

(131) $\delta i^d(0)/\delta f^d = \delta y^d(0)/\delta f^d = \delta \mathring{p}^d(0)/\delta f^d = 0$.

We notice that the exchange rate reaches its long-run level immediately after the shock. This is because there is no difference in the long-run price levels between the big countries. Also in the short run the effects of the shocks on the outputs, interest rates and inflation are symmetrical.

The effects of a goods demand shock on the average performance of the big countries are obtained from the system of averages. The effects are as follows:

$$(132)\ \frac{\delta \mathring{p}^a(0)}{\delta f^a} = \frac{\phi\psi}{k\mu + \phi - \epsilon\phi - \mu\phi\psi},$$

$$(133)\ \frac{\delta y^a(0)}{\delta f^a} = \frac{\phi}{k\mu + \phi - \epsilon\phi - \mu\phi\psi},$$

$$(134)\ \frac{\delta i^a(0)}{\delta f^a} = \frac{k}{k\mu + \phi - \epsilon\phi - \mu\phi\psi}.$$

The expressions presented above are <u>all positive</u> under the stability assumption $\mu(k\Phi^{-1} - \psi) + 1 > \varepsilon$. An increase in the average goods demand thus leads to an increase in the average output, inflation and the interest rate.

An increase in f^d corresponds to an equal increase in f_1. We thus obtain the effect of a goods demand shock f_1 on the exchange rate directly from expression (130). An increase in f_1 leads to an impulse, which is only half of f^a. Therefore, we have to divide the average effects presented in expressions

(132) - (134) by two to obtain the (symmetrical) effects on each country's output, inflation and interest rates.

We can conclude that a goods demand shock occurring in country 1 leads to an appreciation of that country's currency, to a symmetric increase in outputs, interest rates and inflation in both countries. These results are qualitatively similar to those obtained in the static demand determined fixed price version of the model presented in the previous chapter. In the endogenous price version of the model we, however, notice that the symmetry result collapses when foreign prices have a direct effect on the domestic price level.

After using the numerical estimates of the parameters of the baseline scenario presented in appendix 2 we obtain the following short-run effects:

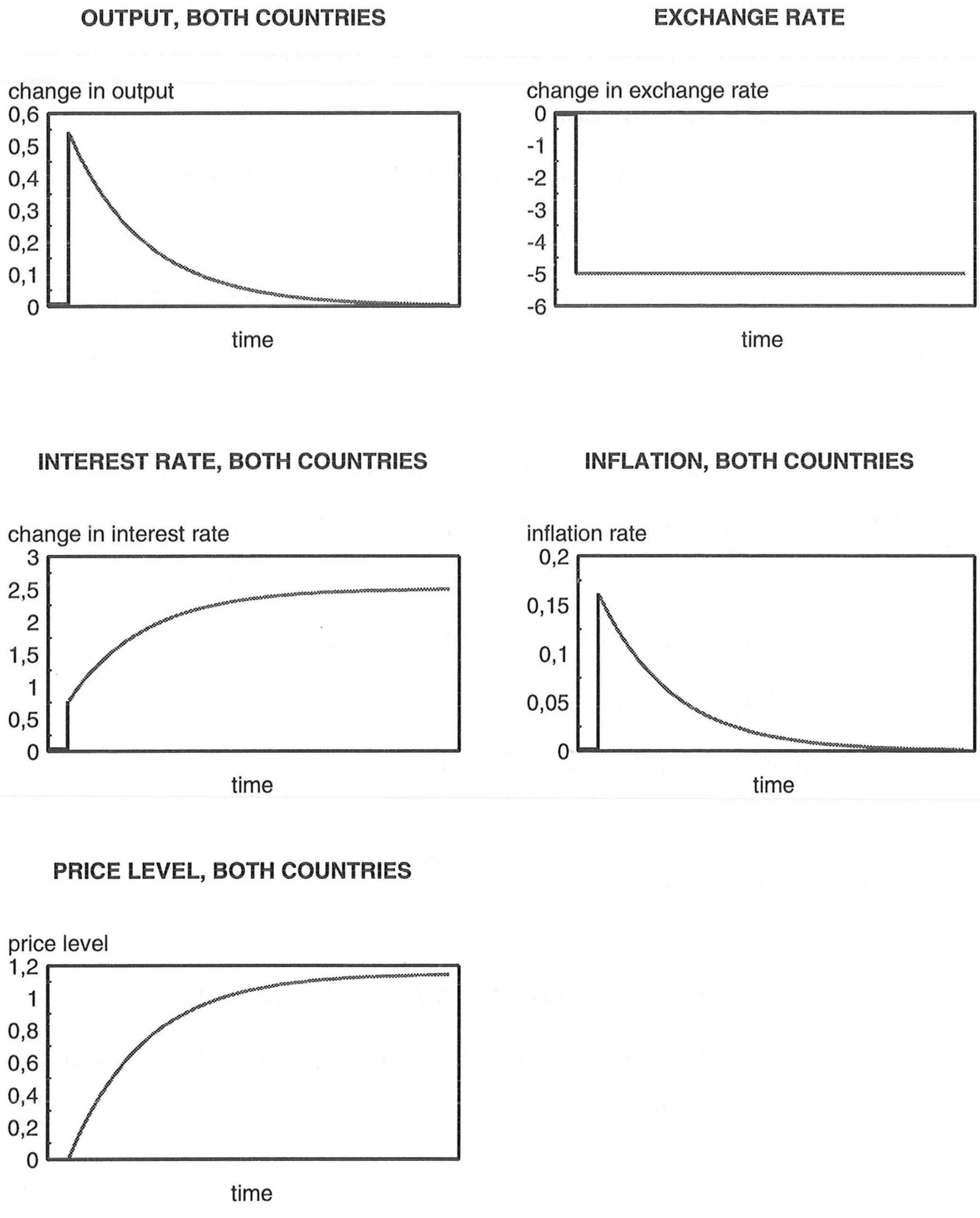
$$\delta y_1(0)/\delta f_1 = \delta y_2(0)/\delta f_1 = 0.537,\ \delta e(0)/\delta f_1 = -5,$$
$$\delta i_1(0)/\delta f_1 = \delta i_2(0)/\delta f_1 = 0.782,$$
$$\delta \mathring{p}_1(0)/\delta f_1 = \delta \mathring{p}_2(0)/\delta f_1 = 0.161.$$

The long-run effects are as follows:

$$\delta \bar{y}_1/\delta f_1 = \delta \bar{y}_2/\delta f_1 = \delta \mathring{\bar{e}}/\delta f_1 = \delta \mathring{\bar{p}}_1/\delta f_1 = \delta \mathring{\bar{p}}_2/\delta f_1 = 0,$$
$$\delta \bar{e}/\delta f_1 = -1/(2\sigma) = -5,\ \delta \bar{i}_1/\delta f_1 = \delta \bar{i}_2/\delta f_1 = 1/(2\mu) = 2.5,\ \delta \bar{p}_1/\delta f_1 =$$
$$\delta \bar{p}_2/\delta f_1 = \Phi/(2\mu) = 1.15.$$

When comparing the short- and long-run effects of a goods demand shock occurring in country 1, we notice that the exchange rate jumps immediately after the shock to the long-run level (figure 22). The outputs and inflation rates also jump but they converge over time to the old exogenously

Figure 22. Effects of a positive goods demand shock occurring in country 1 on the big countries



determined long-run level. Interest rates jump initially, and start thereafter to adjust to the new long-run level, which in the case of a positive goods demand shock is higher than the original level. The price level adjusts gradually to the new long-run level.

5.5.1.2 Effects on the small country

In calculating the effects of a goods demand shock occurring in country 1 on the small country, we use the results of the big country model as inputs, and calculate the corresponding effects in the short and long run.

Floating exchange rate regime

We obtain the long-run effects by inserting the big country effects presented on page 181 into equations (93) and (94) and by using the general assumptions made about the long run. The long-run effects of a goods demand shock occurring in country 1 on the small country are as follows (the effects in the baseline scenario are presented in parentheses):

$\delta\bar{y}_3/\delta f_1 = 0$,
$\delta\bar{e}_{32}/\delta f_1 = \mu_3/(2\mu\sigma_3) - \theta/(2\sigma) + (\Phi_3 - \Phi)/(2\mu)$ (= 0.167), $\delta\bar{c}_3/\delta f_1 = \mu_3/(2\mu\sigma_3) > 0$ (= 1.667), $\delta\bar{i}_3/\delta f_1 = \delta\bar{i}_1/\delta f_1 = \delta\bar{i}_2/\delta f_1 = 1/(2\mu)$ (= 2.5), $\delta\bar{p}_3/\delta f_1 = \Phi_3/(2\mu) > 0$ (= 1.15).

The interest rate of the small country increases in the long run together with the interest rates of the big countries, but the improving competitiveness keeps the output unchanged at the exogenously given level. The price level is higher than before the shock.

The short-run impacts are obtained in an analogous way by inserting the big country short-run effects into the equation system of the small country ((98)-(102)). Additionally we use the long-run effects of the small country presented above.

We use the results obtained in the big country model as inputs for the small country model. Even though it is possible to obtain *a priori* results in the big country model, the effects on the small country become complex. We therefore present the effects in the baseline scenario. The short-run effects of a goods demand shock occurring in country 1 are in this case as follows (the time paths of the variables are presented in figure 23, p. 189):

$$\delta y_3(0)/\delta f_1 = 0.831,\ \delta e_{32}(0)/\delta f_1 = 0.418,$$
$$\delta e_3(0)/\delta f_1 = 1.918,\ \delta i_3(0)/\delta f_1 = 0.702,$$
$$\delta \mathring{p}_3(0)/\delta f_1 = 0.368.$$

An increase in foreign demand and the depreciation of the effective exchange rate (and accordingly an improvement in competitiveness) spawns a rise in the output. The rising interest rate tends to decrease the output, but this effect is too small to compensate for the positive effects.

Exchange rate union

In the exchange rate union the bilateral exchange rate between countries 3 and 2 is fixed. This also means that the interest rates are the same in these countries.

We obtain the long-run price level by inserting the big country effects into equation (95), and the change in competitiveness by substituting the long-run price level and the foreign variables in the expression for competitiveness c_3. We obtain the following results:

$$\delta\bar{y}_3/\delta f_1 = 0,\ \delta\bar{c}_3/\delta f_1 = \mu_3/(2\mu\sigma_3),$$
$$\delta\bar{i}_3/\delta f_1 = \delta\bar{i}_1/\delta f_1 = \delta\bar{i}_2/\delta f_1 = 1/(2\mu),$$
$$\delta\bar{p}_3/\delta f_1 = \frac{\sigma(\sigma_3\Phi - \mu_3) + \mu\sigma_3\theta}{2\mu\sigma_3\sigma}.$$

Competitiveness changes in the exchange rate union by the same amount as in the case of floating, but the source of the improvement is different. Now just the exchange rate e between countries 1 and 2 and the domestic price level contribute to the adjustment. In the floating rate regime the domestic exchange rate is an additional channel of adjustment.

The short-run impacts are obtained by using the IS curve, the saddlepath property of prices, the negative characteristic root of the fixed rate regime, the long-run effects and the short-run effects of the big countries. We present again just the numerical results of the baseline scenario (about the values of the parameters, see appendix 2; 70 % of foreign trade is assumed to be exercised with country 2):

$$\delta y_3(0)/\delta f_1 = 0.635,\ \delta e_3(0)/\delta f_1 = 1.5,$$
$$\delta i_3(0)/\delta f_1 = \delta i_2(0)/\delta f_1 = 0.782,$$
$$\delta\mathring{p}_3(0)/\delta f_1 = 0.094.$$

An increase in foreign demand contributes to the output by the same amount as in the case of floating, but competitiveness improves by less and the real interest rate increases more. The changes in the effective exchange rate and in the interest rate are determined by country 2. The increase in output is accordingly smaller than in the floating rate regime.

Currency basket exchange rate regime

In the basket peg regime the effective exchange rate is stabilized on the basis of a trade-weighted index. Competitiveness changes only through changes in prices. The interest rate of country 3 is a trade-weighted average of the interest rates of countries 1 and 2 as is shown in equation (92)''' and on page 161.

We obtain the following long-run effects:

$$\delta\bar{y}_3/\delta f_1 = 0,\ \delta\bar{c}_3/\delta f_1 = \mu_3/(2\mu\sigma_3),$$
$$\delta\bar{i}_3/\delta f_1 = \delta\bar{i}_1/\delta f_1 = \delta\bar{i}_2/\delta f_1 = 1/(2\mu),$$
$$\delta\bar{p}_3/\delta f_1 = (-\mu_3 + \sigma_3\Phi)/(2\mu\sigma_3).$$

Compared to the effects in the exchange rate union we notice that the price level remains in this case lower in the long run (there is one positive term less in the expression for the long-term price level in the basket peg regime). This is due to the lack of the inflationary depreciation of the effective exchange rate (e can be disregarded in expression (95)).

The short run impacts are obtained as in the previous case. In the baseline scenario we obtain the following results:

$$\delta y_3(0)/\delta f_1 = 0.156,\ \delta e_{31}(0)/\delta f_1 = (1\text{-}\theta)/(2\sigma) = 3.5,$$
$$\delta e_{32}(0)/\delta f_1 = -\ \theta/(2\sigma) = -\ 1.5,\ \delta i_3(0)/\delta f_1 = 0.782,$$
$$\delta \mathring{p}_3(0)/\delta f_1 = \psi_3(\Phi\sigma_3 - \mu_3)/2\mu(1 - \mu_3\psi) = -\ 0.049.$$

The effect of competitiveness is approximately neutral. The rising real interest rate compensates partly for the positive export demand effect.

Comparison of the effects in different exchange rate regimes

The time paths of different variables in the different exchange rate regimes according to the baseline scenario are presented in figure 23.[22] There we can see that in the case of a positive goods demand shock occurring in country 1 the basket peg regime leads to the smallest deviation in output in the short run and the floating rate regime to the largest. This is due to the developments in competitiveness and in the real interest rate. (For changes in these variables, see table 6.) The adjustment towards the long-run equilibrium is, however, quicker in the case of floating than in the two other regimes.

In the basket peg regime the effective exchange rate remains unchanged whereas in the case of floating it depreciates with a jump and overshoots the long-run level. In the exchange rate union the currency depreciates together with that of country 2, but by less than in the case of floating. Changes in the effective exchange rate, and accordingly in competitiveness, thus reinforce the positive goods demand effect coming from the large countries in the floating and "EMU-peg" regimes.

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[22]The effects of big country dynamics on the small country are taken into account in this as well as in the other figures presenting the adjustment of the small country variables.

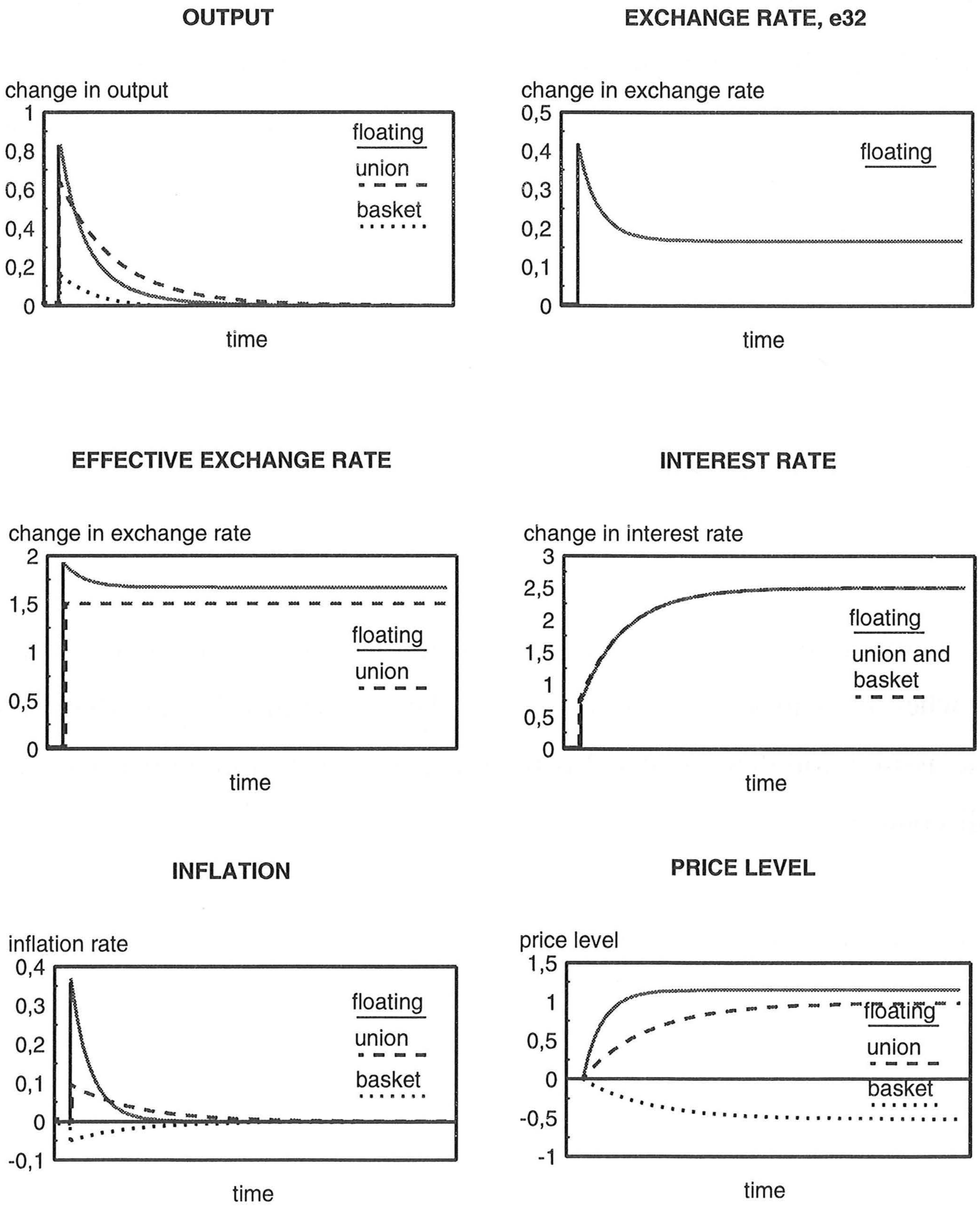
Table 6. Short-run effects of a positive f_1 shock in the small country in the baseline scenario

regime	Δy_3	Δc_3	Δr_3
floating	0.831	1.711	0.334
union	0.635	1.567	0.688
basket	0.156	0.210	0.831

In the floating rate regime the real interest rate increases less than in the exchange rate union and in the basket peg regime, which also contributes to the greater short-run increase in the output, compared to the other regimes. In the exchange rate union and in the basket peg regime the nominal interest rate is the same as in countries 1 and 2, but the inflation rates differ.

The insulation properties of the regimes resemble those cases studied in chapter 4, where reactions of domestic prices to the foreign ones are small (α_3 is small). When compared to the results obtained there we see that, in addition to changes in competitiveness, also the change in the real interest rate tends to stabilize the output in the basket peg regime.

Figure 23. Effects of a positive goods demand shock occurring in country 1 on the small country in different exchange rate regimes (baseline scenario)



5.5.2 Shocks in country 2

5.5.2.1 Effects on the big countries

In the case of a goods demand shock occurring in country 2 instead of country 1 the effects are similar due to symmetric economic structures. The countries just change places. The currency of country 2 appreciates now. Output, interest rate, inflation, as well as long-run price effects are the same in both countries as in the case when the shock occurs in country 1. (See figure 22, p. 182.)

5.5.2.2 Effects on the small country

Because of the symmetrical effects on the other variables, the effect through the big country exchange rate e is the crucial difference when compared to the case when the shock occurs in country 1. This difference in the effect is due to the assumption that country 2 is the more important trading partner for the small country.

Floating exchange rate regime

In the long run the only difference in the small country effects compared to the case when the shock occurs in country 1 is in the bilateral exchange rates. Because country 2 is the more important trading partner, the bilateral exchange rate between countries 3 and 2 is at a higher level by the factor θ/σ, i.e. depreciates more than in the case when the shock occurs in country 1. The exchange rate between countries 1 and 2 changes in a way, which leads to the same effective exchange rate and competitiveness in both cases. We next present all the relevant long-run effects:

$$\delta\bar{y}_3/\delta f_2 = 0,$$
$$\delta\bar{e}_{32}/\delta f_2 = \mu_3/(2\mu\sigma_3) + \theta/(2\sigma) + (\Phi_3 - \Phi)/(2\mu),$$
$$\delta\bar{c}_3/\delta f_2 = \mu_3/(2\mu\sigma_3) > 0, \ \delta\bar{i}_3/\delta f_2 = \delta\bar{i}_1/\delta f_2 = \delta\bar{i}_2/\delta f_2 = 1/(2\mu),$$
$$\delta\bar{p}_3/\delta f_2 = \Phi_3/(2\mu) > 0.$$

According to the baseline scenario the short-run effects are as follows:

$$\delta y_3(0)/\delta f_2 = 0.831, \ \delta e_{32}(0)/\delta f_2 = 3.418,$$
$$\delta e_3(0)/\delta f_2 = 1.918, \ \delta i_3(0)/\delta f_2 = 0.702,$$
$$\delta \mathring{p}_3(0)/\delta f_2 = 0.368.$$

The bilateral exchange rates are different compared to the case when the shock occurs in country 1, but the other effects are the same. (For the intuition, see pp. 183-184.)

Exchange rate union

The bilateral exchange rate with the more important trading partner country 2 is fixed. This means that the effective exchange rate changes only due to the change in the large country exchange rate e.

In the long run output is at its exogenously determined level and competitiveness changes as much as in the case of floating. The effective exchange rate changes differently, but changes in prices compensate for the effect of this difference on competitiveness. The long-run effects are as follows:

$$\delta\bar{y}_3/\delta f_2 = 0,\ \delta\bar{c}_3/\delta f_2 = \mu_3/(2\mu\sigma_3),$$
$$\delta\bar{i}_3/\delta f_2 = \delta\bar{i}_1/\delta f_2 = \delta\bar{i}_2/\delta f_2 = 1/(2\mu),$$
$$\delta\bar{p}_3/\delta f_2 = \frac{\sigma(\sigma_3\Phi - \mu_3) - \mu\sigma_3\theta}{2\mu\sigma_3\sigma}.$$

Change in the price level is by θ/σ greater than in the case where the shock originates in country 1, but competitiveness changes by an equal amount (see page 185).

In the short run the effects in the baseline scenario are as presented below:

$$\delta y_3(0)/\delta f_2 = -\ 0.323,\ \delta e_3/\delta f_2 = -\ 1.5,$$
$$\delta i_3/\delta f_2 = \delta i_2/\delta f_2 = 0.782,$$
$$\delta\mathring{p}_3/\delta f_2 = -\ 0.193.$$

The appreciation of the effective exchange rate and the increase in the real interest rate contribute negatively to the change in output. The positive effect due to the increase in foreign demand after an increase in goods demand in country 2 is not enough to compensate for the negative effects. Theoretically it could be the other way round, too. Inflation is lower than before the shock. The long-run price level is accordingly lower than in the initial equilibrium.

Currency basket exchange rate regime

The long-run effects are the same as in the case when the shock occurs in country 1. There is no difference in the change of the effective exchange rate, foreign demand or price level.

$$\delta\bar{y}_3/\delta f_2 = 0,\ \delta\bar{c}_3/\delta f_2 = \mu_3/(2\mu\sigma_3),$$
$$\delta\bar{i}_3/\delta f_2 = \delta\bar{i}_1/\delta f_2 = \delta\bar{i}_2/\delta f_2 = 1/(2\mu),$$
$$\delta\bar{p}_3/\delta f_2 = (-\mu_3 + \sigma_3\Phi)/(2\mu\sigma_3).$$

The same analogy holds also in the short run. The effects in the small country are the same because the effects in the big countries are symmetric except for the exchange rate. And the effective exchange rate in turn is kept unchanged in both cases. This result is the same as in the static fixed price model.

$$\delta y_3(0)/\delta f_2 = 0.156,\ \delta e_{31}(0)/\delta f_2 = (\theta-1)/(2\sigma) = -\ 3.5,\ \delta e_{32}(0)/\delta f_2 = \theta/(2\sigma) = 1.5,\ \delta i_3(0)/\delta f_2 = \delta i_2(0)/\delta f_2 = \delta i_1(0)/\delta f_2 = 0.782,$$
$$\delta\mathring{p}_3(0)/\delta f_2 = \psi_3(\Phi\sigma_3 - \mu_3)/2\mu(1 - \mu_3\psi) = -\ 0.049.$$

Comparison of the effects in different exchange rate regimes

After a positive goods demand shock occurring in country 2 the output of the small country increases the most in the floating rate regime in the baseline scenario. (Changes in output, competitivenes and the real interest rate are collected in table 7.) The positive foreign demand effect is reinforced by the depreciating effective exchange rate. Also the real interest rate increases less than in the other regimes. The domestic nominal interest rate rises in the short run less than the foreign one because of the expectation of the appreciation of the small country's currency after the overshooting jump occurring immediately after the shock. (About the time paths of the variables, see figure 24.)

In the basket peg regime the positive effect on output is smaller because of the stable effective exchange rate. The increase in foreign demand is, according to the baseline scenario, strong enough to compensate for the negative effect due to the increasing real interest rate.

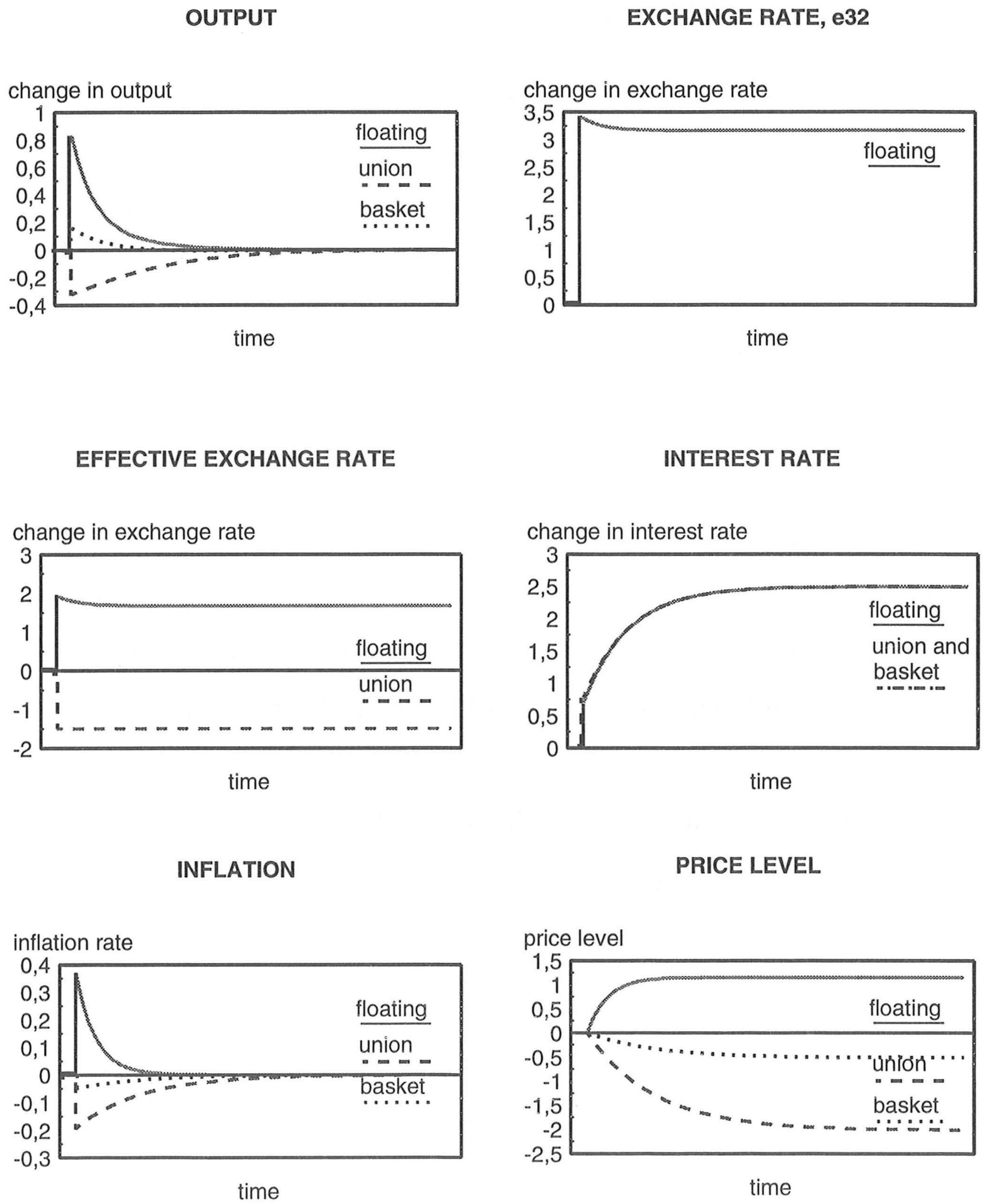
Table 7. Short-run effects of a positive f_2 shock in the small country in the baseline scenario

regime	Δy_3	Δc_3	Δr_3
floating	0.831	1.711	0.334
union	-0.323	-1.146	0.975
basket	0.156	0.210	0.831

In the exchange rate union with country 2 the output declines due to the appreciation of the effective exchange rate and due to the increasing real interest rate. In the baseline scenario the decline in output is smaller than the increase in the case of floating.

When compared to the results obtained in chapter 4 we see again the similarity of the effects to the case where the response of domestic prices to the foreign ones (α_3) is small. In the current model the effects of changes in competitiveness are reinforced by changes in the real interest rate. In chapter 4 the real interest rate is *ex ante* the same in all regimes.

Figure 24. Effects of a positive goods demand shock occurring in country 2 on the small country in different exchange rate regimes (baseline scenario)



5.6 Monetary shocks in the big countries

5.6.1 Shocks in country 1

5.6.1.1 Effects on the big countries

The effects of a monetary shock are obtained in the same way as those of a fiscal shock. We first solve the differences and averages systems with respect to m^d and m^a, and then calculate the corresponding effects for each country. Analyzing the effects of a money supply shock is analogous to that of a money demand shock.

The long-run effects are obtained from equations (120)-(123). The effects are clearcut. The output is at the exogenously given long-run level, the price level of country 1 rises, and the exchange rate depreciates, by the same proportion as the money supply increases. The interest rate and the price level of country 2 remain unchanged. The effects are collected in the following:

$$\delta\bar{y}_1/\delta m_1 = \delta\bar{y}_2/\delta m_1 = 0, \ \delta\bar{e}/\delta m_1 = 1,$$
$$\delta\bar{i}_1/\delta m_1 = \delta\bar{i}_2/\delta m_1 = 0,$$
$$\delta\bar{p}_1/\delta m_1 = 1, \ \delta\bar{p}_2/\delta m_1 = 0.$$

The short run effects of a monetary shock occurring in country 1 are obtained by combining the effects in the system of differences and that of averages.

In the system of differences we obtain the following effects:

$$(135)\ \frac{\delta y^d(0)}{\delta m^d}=\frac{(1+\epsilon-\mu\psi-k\mu\rho^d-\phi\rho^d-\epsilon\phi\rho^d+\mu\phi\psi\rho^d)(\mu\rho^d-2\sigma)}{(1+\epsilon)(k\mu\rho^d+\phi\rho+\epsilon\phi\rho^d-\mu\phi\psi\rho^d-2k\sigma)},$$

$$(136)\ \frac{\delta e(0)}{\delta m^d}=\frac{-1-\epsilon+\mu\psi+k\mu\rho^d+\phi\rho^d+\epsilon\phi\rho^d-\mu\phi\psi\rho^d}{k\mu\rho^d+\phi\rho^d+\epsilon\phi\rho^d-\mu\phi\psi\rho^d-2k\sigma},$$

$$(137)\ \frac{\delta i^d(0)}{\delta m^d}=-\frac{\rho^d(1+\epsilon-\mu\psi-2k\mu\sigma)}{k\mu\rho^d+\phi\rho^d+\epsilon\phi\rho^d-\mu\phi\psi\rho^d-2k\sigma},$$

$$(138)\ \frac{\delta \dot{p}^d(0)}{\delta m^d}=-\rho^d>0.$$

The term ρ^d in the expressions is the negative characteristic root of the differences system. The denominator is negative in expressions (135) - (138) on the basis of the stability assumption (p. 177). A sufficient condition for the positiveness of the output effect is additionally that the inequality $1 - \mu\psi > -\varepsilon$ is met. This is rather obvious, because the interest rate semielasticity of goods demand (μ) as well as the elasticity of inflation with respect to the deviation in production (ψ) can be assumed to be less than one. The same inequality is sufficient to lead to a depreciation of the exchange rate. A sufficient condition for the negative effect on the interest rate differential is somewhat more stringent: $1 - \mu\psi - 2k\sigma > - \varepsilon$.

In the system of averages the effects of a monetary shock are as follows (after substituting the negative characteristic root into the expressions):

$$(139)\ \frac{\delta y^a(0)}{\delta m^a} = \frac{\mu}{k\mu + \phi - \epsilon\phi - \mu\phi\psi},$$

$$(140)\ \frac{\delta i^a(0)}{\delta m^a} = \frac{-1 + \epsilon + \mu\psi}{k\mu + \phi - \epsilon\phi - \mu\phi\psi},$$

$$(141)\ \frac{\delta \dot{p}^a(0)}{\delta m^a} = \frac{\mu\psi}{k\mu + \phi - \epsilon\phi - \mu\phi\psi}.$$

The denominators of the above expressions are positive on the basis of the stability assumption of the averages system: $\mu(k\Phi^{-1} - \psi) + 1 > \varepsilon$. This means that a positive monetary shock in the two-country system leads to an increase in the average output and in the inflation rate. If $\mu\psi + \varepsilon < 1$, the interest rate decreases after this kind of a shock.

On the basis of the above results (and using the assumptions presented) we can conclude that a positive monetary shock occurring in country 1 leads to the following effects:

1.) the output of the big countries increases as an aggregate; the output of country 1 increases but the effect on country 2 remains uncertain on the basis of the assumptions used,

2.) the exchange rate e depreciates,

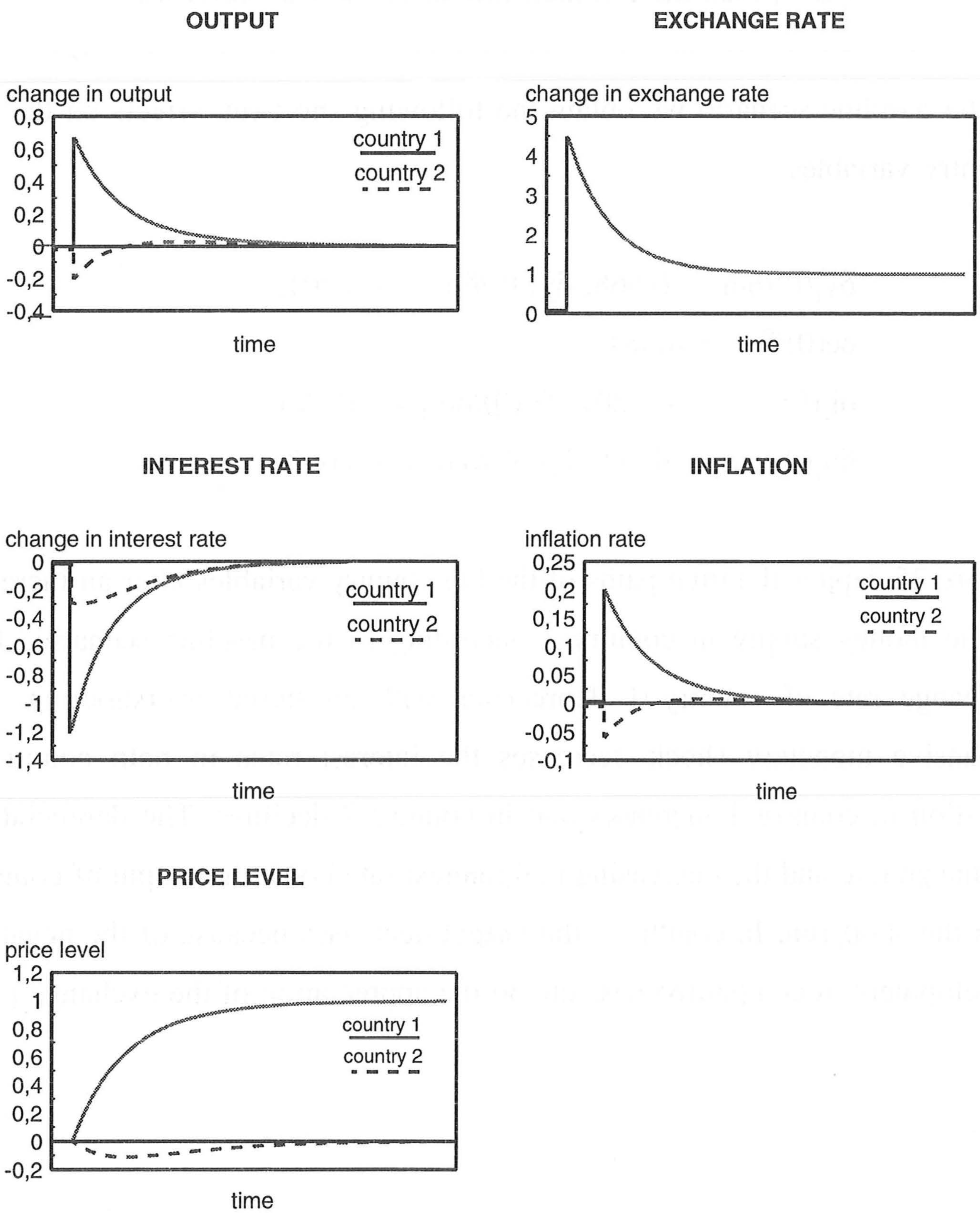
3.) the average interest rate and the interest rate of country 1 obviously decrease (see the assumptions presented above); the development of the interest rate of country 2 is more uncertain, 4.) the average inflation and the inflation of country 1 increase; the development of the inflation rate in country 2 depends on the relative magnitudes of the negative characteristic roots: if $|\sigma^d| > |\sigma^a|$, then the inflation rate in country 2 decreases.

In the baseline scenario we obtain the following short-run effects on the big country variables:

$\delta y_1(0)/\delta m_1 = 0.668$, $\delta y_2(0)/\delta m_1 = -0.201$,
$\delta e(0)/\delta m_1 = 4.481$,
$\delta i_1(0)/\delta m_1 = -1.201$, $\delta i_2(0)/\delta m_1 = -0.293$,
$\delta \mathring{p}_1(0)/\delta m_1 = 0.200$, $\delta \mathring{p}_2(0)/\delta m_1 = -0.060$.

Figure 25 depicts the time paths of the big country variables after an increase in the money supply in country 1 according to the baseline scenario. The exchange rate of country 1 depreciates with an initial overshooting. An expansive monetary shock decreases the interest rates in both countries. Inflation in country 1 increases and in country 2 declines. The depreciating exchange rate and the decreasing real interest rate boost the output of country 1 in the short run. In country 2 the output decreases because of the negative development in competitiveness due to the appreciation of the exchange rate.

Figure 25. Effects of a positive monetary shock occurring in country 1 on the big countries (baseline scenario)



5.6.1.2 Effects on the small country

When there is a positive shock in country 1, this creates an increase in foreign demand from this country, but a decline from country 2 (in the baseline scenario). Because country 2 is assumed to be the more important trading partner, the overall effect of the foreign demand is only slightly positive. The other effects vary between exchange rate regimes.

Floating exchange rate regime

In the long run only the effective exchange rate changes, it appreciates by θ (the share of country 1 in the foreign trade of the small country) ($\delta\bar{e}_3/\delta m_1 = -\theta$). This is due to the change in the big country exchange rate e, and accordingly in e_{31}. The exchange rate e_{32} does not change.

In the short run the effective exchange rate appreciates with an overshooting jump. The nominal interest rate declines by the same amount as in country 2. Inflation does not change, which means a declining real interest rate. Foreign demand contributes positively to the output, but only by a small amount, because the output of the more important trading partner, country 2, decreases. The output of the small country declines, because the negative competitiveness effect outweights the positive foreign demand and real interest rate effects. The effects according to the baseline scenario are presented below:

$$\delta y_3(0)/\delta m_1 = -0.309,\ \delta i_3(0)/\delta m_1 = -0.293,$$
$$\delta e_{32}(0)/\delta m_1 = 0,\ \delta e_3(0)/\delta m_1 = -1.344,$$
$$\delta \mathring{p}_3(0)/\delta m_1 = 0.$$

Exchange rate union

The effects of a monetary shock occurring in country 1 are the same in the exchange rate union as in the floating rate regime in the long as well as in the short run. This is due to the same long-run development of the exchange rate and prices. In both regimes changes in the effective exchange rate outweigh the foreign demand and real interest rate effects.

In the static model the effects are similar in these two regimes, but not identical. In that model there is a difference in the change in the effective exchange rate. This is due to a small change in e_{32} in the floating rate regime in the static model. In the current model e_{32} remains, due to the expectational channel, unchanged also in the floating rate regime (see equations (93) and (94) after inserting into them the long-run effects presented for the big countries).

Currency basket exchange rate regime

In the long run there is a change in the price level ($\delta\bar{p}_3/\delta m_1 = \theta$). This change equilibrates the goods market at the exogenously given long-run level of output. The effective exchange rate remains unchanged.

In the short run the output increases according to the baseline scenario. This is due to the stable effective exchange rate, the declining real interest rate, and due to the slightly increasing foreign demand. Inflation increases in the basket peg regime, but remains unchanged in the other two regimes. The short-run effects in the baseline scenario are as follows:

$\delta y_3(0)/\delta m_1 = 0.155$, $\delta \mathring{p}_3(0)/\delta m_1 = 0.029$,

$\delta i_3(0)/\delta m_1 = - 0.565$.

Comparison of the effects in different exchange rate regimes

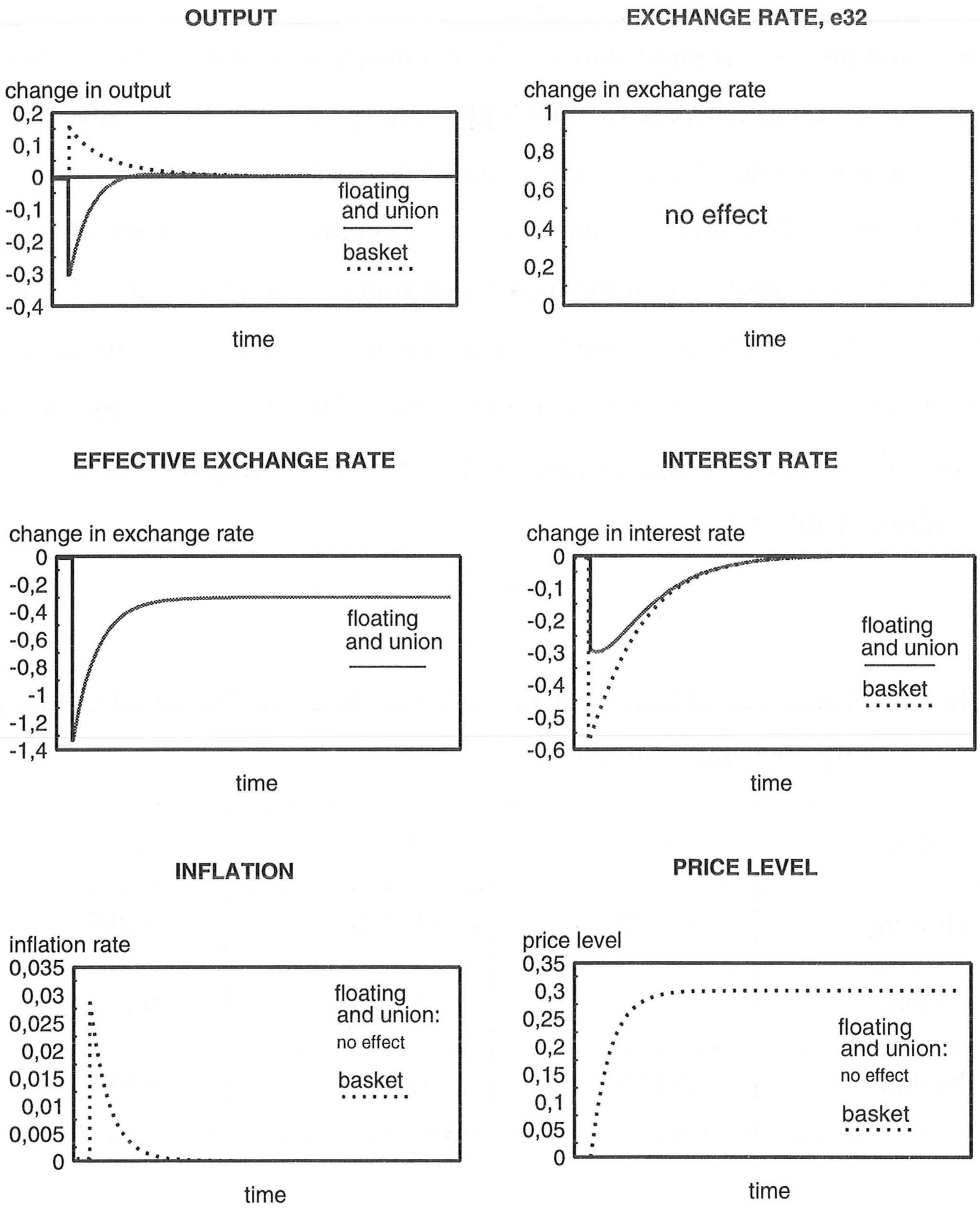
In the floating rate regime and in the exchange rate union the essentially deteriorating competitiveness outweighs the positive effects due to the increasing foreign demand and the declining interest rate. A positive monetary shock occurring in country 1 thus leads to a decline in the output of country 3 (as in that of country 2). In the basket peg regime competitiveness is almost stable, and the slightly increasing export demand together with the declining real interest rate leads to an increase in output. The increase in the baseline scenario is smaller than the decline in the cases of floating and the exchange rate union. (Table 8.)

Table 8. Short-run effects of a positive m_1 shock in the small country in the baseline scenario

regime	Δy_3	Δc_3	Δr_3
floating	-0.309	-1.326	-0.293
union	-0.309	-1.326	-0.293
basket	0.155	-0.011	-0.594

The time paths of the variables in different regimes are presented in figure 26.

Figure 26. Effects of a positive monetary shock occurring in country 1 on the small country in different exchange rate regimes (baseline scenario)



The main qualitative difference between the short-run effects obtained in chapters 4 and 5 is that floating leads in the current model to the same outcome as the exchange rate union. This is due to the same reaction of e_{32} in both regimes due to expectations. In the current model also differences in real interest rates affect the outcome. In chapter 4 they do not differ *ex ante*.

5.6.2 Shocks in country 2

5.6.2.1 Effects on the big countries

The effects of a monetary shock occurring in country 2 are the same as those of a corresponding shock occurring in country 1, the countries just change places. In the long run the price level of country 2 and the exchange rate change in proportion to the shock, the former in the same direction, the latter in the opposite direction (because of the definition of the exchange rate).

In the short run the effects presented in expressions (135)-(141) concern also country 2. It can be shown under the assumptions presented on pages 197 - 198 that the output of country 2 increases after a positive monetary shock occurring in this country. (About the effects see also figure 25 on p. 200.)

5.6.2.2 Effects on the small country

A positive monetary shock in country 2, under the assumptions made, leads to a higher increase in the foreign demand of the small country than in the case when the shock occurs in country 1, because country 2 is assumed to be the more important trading partner.

Floating exchange rate regime

In the long run there is just a change in the equilibrium value of the exchange rate between countries 3 and 2: $\delta\bar{e}_{32}/\delta m_2 = -1$. The effective exchange rate changes correspondingly: $\delta\bar{e}_3/\delta m_2 = \theta - 1$ ($\bar{e}_{31}$ remains unchanged). The effective exchange rate appreciates after a positive m_2 shock if there is some trade with country 2, i.e. $\theta < 1$.

In the short run the output of the small country increases after a positive shock in the baseline scenario. The exchange rate with country 2 appreciates immediately to its long-run level. The effective exchange rate, however, does not reach the equilibrium level immediately because of the overshooting of the big country exchange rate e (figure 27). The effective exchange rate depreciates first, and the expectation of an appreciation decreases the interest rate. Inflation remains unchanged, because there is no expectation of a change in the long-run price level. This means that the real interest rate decreases, too. Short-run impacts in the baseline scenario are written below:

$$\delta y_3(0)/\delta m_2 = 0.588,\ \delta e_{32}/\delta m_1 = -1,$$
$$\delta e_3(0)/\delta m_2 = 0.344,$$
$$\delta i_3(0)/\delta m_2 = \delta i_2(0)/\delta m_2 = -1.201,$$
$$\delta \mathring{p}_3(0)/m_2 = 0.$$

Exchange rate union

In the long run the exchange rate $\bar{e}_{31}$ changes together with the rate between the big countries. The rate $\bar{e}_{31}$ depreciates by a multiplier of 1 in the long run if there is a permanent increase in m_2. The effective exchange rate depreciates by the multiplier θ (the share of country 1 in foreign trade). The long-run price level increases by the multiplier 1 as in country 2.

In the short run, according to the baseline scenario, the effective exchange rate increases more than in the case of floating (because of the large change in e). The nominal interest rate decreases by the same amount as in country 2. Because inflation is higher in the exchange rate union, the real interest rate decreases more than in the floating rate regime. The effective exchange rate and the real interest rate thus reinforce the positive export demand effect, and more than in the floating rate regime. In the baseline scenario the impacts are as follows:

$$\delta y_3(0)/\delta m_2 = 0.907,\ \delta e_3/\delta m_1 = 1.344,$$
$$\delta i_3(0)/\delta m_2 = \delta i_2(0)/\delta m_2 = -\ 1.201,$$
$$\delta \mathring{p}_3(0)/m_2 = 0.096.$$

Currency basket exchange rate regime

In the long run the main change that occurs is the increase in the long run price level: $\delta \bar{p}_3/\delta m_2 = 1 - \theta$. This change is required to keep the output at the exogenously given long-run level. The effective exchange rate is not allowed to change, $\delta \bar{e}_{31}/\delta m_2 = 1 - \theta$ and $\delta \bar{e}_{32}/\delta m_2 = -\ \theta$.

In the short run the output increases according to the baseline scenario if the m_2 shock is positive. The exchange rate effect is neutral but the real interest rate reinforces the export demand effect. The decline in the nominal interest rate, as the weighted average of the big country interest rates, is not compensated for by an increase in inflation. The effects are presented below:

$\delta y_3(0)/\delta m_2 = 0.443$, $\delta i_3(0)/\delta m_2 = -0.929$,
$\delta \mathring{p}_3(0)/\delta m_2 = 0.067$.

Comparison of the effects in different exchange rate regimes

Short-run changes in the most important variables are collected in table 9.

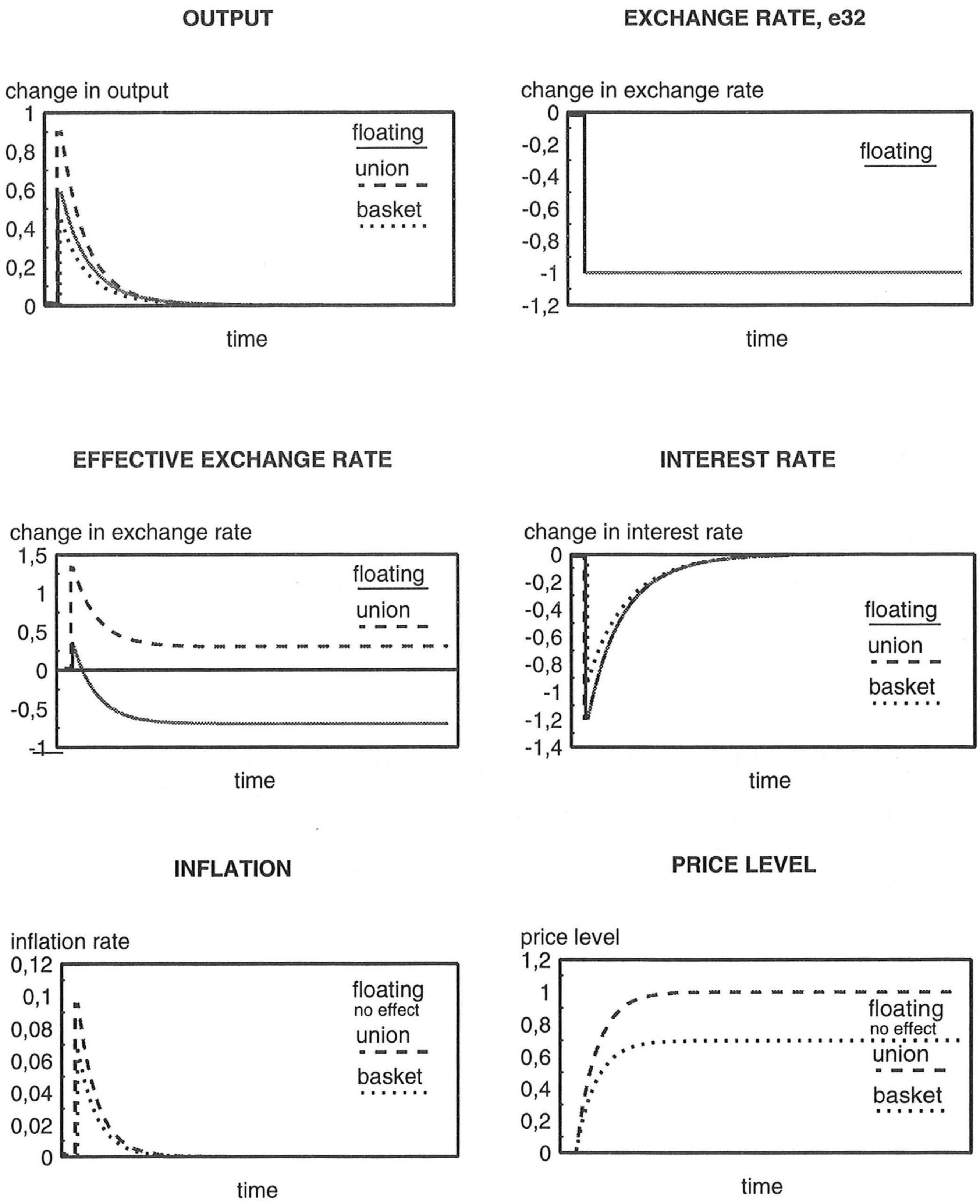
Table 9. Short-run effects of a positive m_2 shock in the small country in the baseline scenario

regime	Δy_3	Δc_3	Δr_3
floating	0.588	0.466	-1.201
union	0.907	1.370	-1.297
basket	0.443	0.131	-0.996

The time paths of different variables in different exchange rate regimes are presented in figure 27. We notice that according to the baseline scenario the exchange rate union leads to the greatest variation of the output from the long-run level. This is due to the shock reinforcing effects of the exchange rate (and competitiveness). The effect of the foreign demand on output is boosted also by the declining interest rate. In the floating rate regime these effects are weaker. In the basket peg regime the effective exchange rate is stabilized, and the total effect on output is the smallest of the regimes studied.

Inflation accelerates the most in the exchange rate union and the least in the floating rate regime (no change in inflation).

Figure 27. Effects of a positive monetary shock occurring in country 2 on the small country in different exchange rate regimes (baseline scenario)



When compared to the results obtained in chapter 4 we notice that in addition to changes in competitiveness, also the changes in the real interest rate make the insulation of output smaller in the exchange rate union than in the two other regimes.

5.7 Productivity shocks in the big countries

5.7.1 Shocks in country 1

5.7.1.1 Effects on the big countries

Supply shocks are modelled as exogenous changes in the long-run output due to changes in productivity. The effects on the big countries are obtained by the method of averages and differences as in the cases of goods demand and monetary shocks.

The long-run output is assumed to change in country 1, whereas the output of country 2 remains unchanged. The other effects are obtained from equations (120)-(123). The effects are as follows (the effects in the baseline scenario are presented in parenthesis):

$$(142)\ \delta\bar{y}_1/\delta\bar{y}_1 = 1,$$

$$(143)\ \delta\bar{y}_2/\delta\bar{y}_1 = 0,$$

$$(144)\frac{\delta\bar{e}}{\delta\bar{y}_1}=\frac{1+\epsilon}{2\sigma}-k(=5.830),$$

$$(145)\frac{\delta\bar{i}_1}{\delta\bar{y}_1}=\frac{\delta\bar{i}_2}{\delta\bar{y}_1}=\frac{\epsilon-1}{2\mu}<0(=-1.750),$$

$$(146)\frac{\delta\bar{p}_1}{\delta\bar{y}_1}=-\frac{\phi(1-\epsilon)}{2\mu}-k<0(=-1.475),$$

$$(147)\frac{\delta\bar{p}_2}{\delta\bar{y}_1}=-\frac{\phi(1-\epsilon)}{2\mu}<0(=-0.805).$$

We see above that the exchange rate of country 1 obviously depreciates in the long run (k is small compared to the first part of the expression). This is explained by the need to sell the additional output abroad to keep the supply and demand in balance. The global interest rate declines. The price levels of both countries decline, that of country 1 by more.

The short-run impact for the exchange rate is obtained directly from the system of differences. The rest of the effects are determined on the basis of the system of differences as well as that of averages. We must divide the effects of a change in $\bar{y}^a$ by 2 to get the effects of a change in $\bar{y}_1$.

We are not able to determine the signs of output and exchange rate effects in the system of differences *a priori*. The difference in the interest rates increases if $1 + \varepsilon > \mu\psi + 2k\sigma$. Inflation in country 1 declines compared to that in country 1 under the normal stability assumption: $\delta\mathring{p}^d(0)/\delta\bar{y}^d = k\rho^d < 0$.

In the system of averages the analytical results are as follows:

$$(148)\ \frac{\delta y^a(0)}{\delta \overline{y^a}} = \frac{-\mu\phi\psi}{k\mu + \phi - \epsilon\phi - \mu\phi\psi},$$

$$(149)\ \frac{\delta i^a(0)}{\delta \overline{y^a}} = \frac{-k\mu\phi}{k\mu + \phi - \epsilon\phi - \mu\phi\psi},$$

$$(150)\ \frac{\delta \dot{p}^a(0)}{\delta \overline{y^a}} = \frac{-\phi(k\mu + \phi - \epsilon\phi)}{k\mu + \phi - \epsilon\phi - \mu\phi\psi)}.$$

The denominators in the expressions are positive on the basis of the stability assumption presented on page 177.

The average output of the countries thus decreases immediately after a positive productivity shock occurring in country 1. The average interest and inflation rates decline.

The output of country 1 obviously increases but that of country 2 decreases by a greater margin. This creates a transitory deflationary pressure on the world economy immediately after the shock. The exchange rate of country 1 depreciates according to the baseline scenario immediately after the shock and that of country 2 appreciates correspondingly. This appreciation is the reason for the decline in country 2 output. Inflation rates decline in both countries under the normal stability assumption. The interest rate of country 1 obviously (if $1 + \varepsilon > \mu\psi + 2k\sigma$) remains higher than that of country 2, but the sign of the change is not known *a priori*. This interest rate differential refers to a depreciation expectation for the currency of country 1. The interest rate of country 2 declines immediately after the shock.

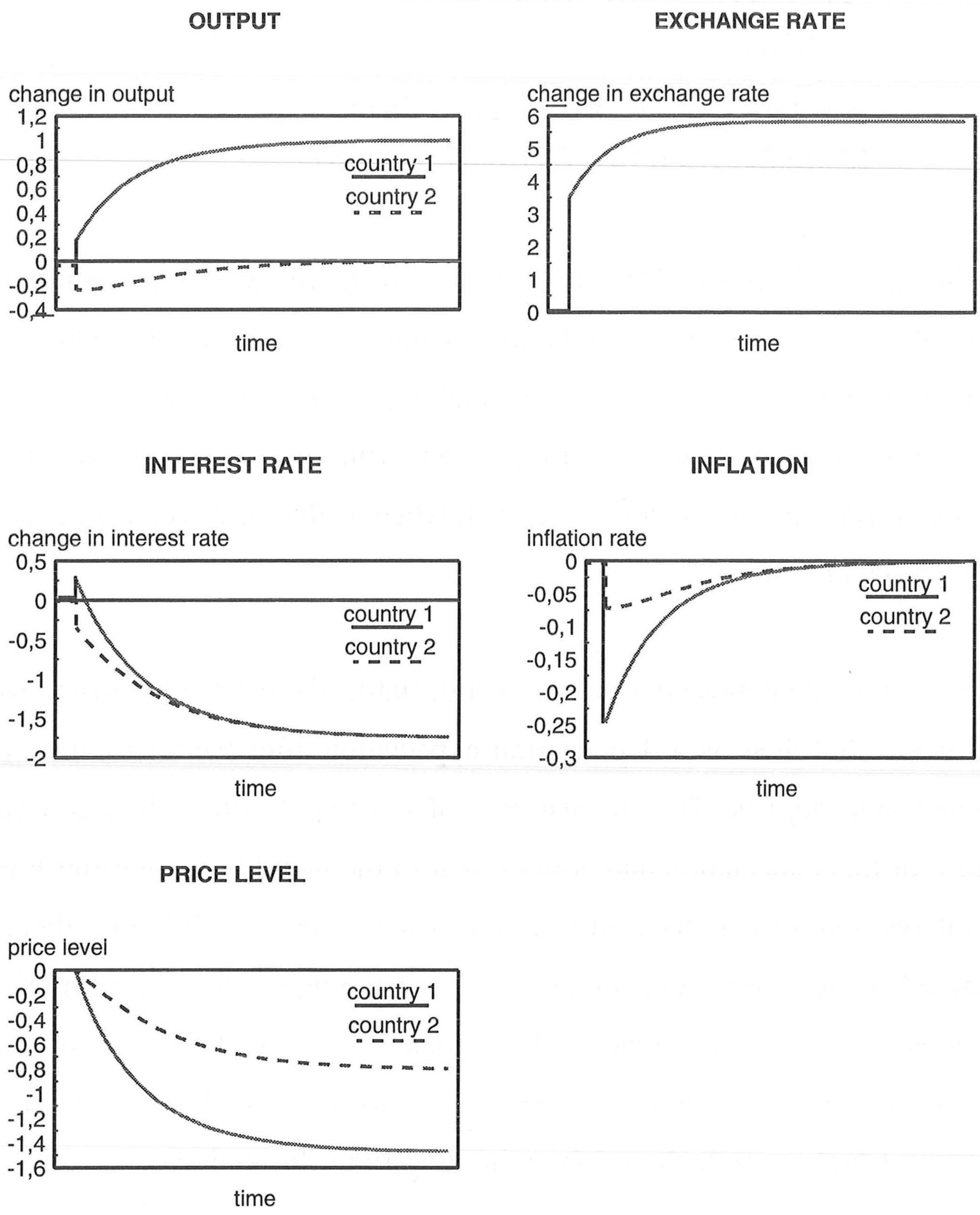
The short-run effects are illustrated by presenting the results in the baseline scenario:

$\delta y_1(0)/\delta \bar{y}_1 = 0.177$, $\delta y_2(0)/\delta \bar{y}_1 = -0.241$,
$\delta e(0)/\delta \bar{y}_1 = 3.497$,
$\delta i_1(0)/\delta \bar{y}_1 = 0.257$, $\delta i_2(0)/\delta \bar{y}_1 = -0.351$,
$\delta \mathring{p}_1(0)/\delta \bar{y}_1 = -0.247$, $\delta \mathring{p}_2(0)/\delta \bar{y}_1 = -0.072$.

The time paths of the variables are presented in figure 28. We notice that the output of country 1 jumps upwards immediately after a positive productivity shock occurring in this country, and that the output of country 2 jumps downwards by more than that. In the long run the output of country 1 increases further to its new long-run level, whereas that of country 2 gains its pre-shock level.

The exchange rate jumps after the shock, but "undershoots" the long-run level. This means that there is a depreciation expectation after the shock until the exchange rate adjusts. The interest rate of country 1 jumps first upwards because of this expectation and adjusts then to the new lower long-run level. The interest rate of country 2 in turn jumps downwards. In inflation there is an immediate decline in both countries, but in the long run the old equilibrium is achieved. Price levels remain in both countries lower than in the original equilibrium. The price level of country 1 is lower than that of country 2 (because of higher productivity) (see the long-run effects above).

Figure 28. Effects of a positive productivity shock occurring in country 1 on the big countries



5.7.1.2 Effects on the small country

In the long run the output of country 1 increases after a positive productivity shock occurring in country 1 ("the USA"), whereas that of country 2 remains at its exogenously given level. The aggregate foreign demand of the small country thus increases. In the short run the foreign demand for products of the small country declines in the baseline scenario. This is due to the declining output of country 2, which is assumed to be the more important trading partner. The other effects differ across the exchange rate regimes.

Floating exchange rate regime

In the long run the output of the small country is at its exogenously given long-run level. The interest rate declines after a positive $\overline{y}_1$ shock as in the big countries (expression (145)). The price level declines, too (expression (151)). We cannot, however, show *a priori* the sign of the change of the exchange rate. Decline in the foreign interest rate and increase in the output of country 1 tend to spur an appreciation in the effective exchange rate, whereas declines in the foreign price levels tend to make it depreciate (see equation (94)).

$$(151)\frac{\delta \overline{p_3}}{\delta \overline{y_1}}=\frac{(\epsilon-1)\phi_3}{2\mu}<0,$$

$$(152)\frac{\delta \overline{e_{32}}}{\delta \overline{y_1}}=\frac{\sigma(\epsilon-1)(\mu_3-\phi\sigma_3+\phi_3\sigma_3)+\mu\theta(\sigma_3-2\epsilon_3+\epsilon\sigma_3)}{2\mu\sigma\sigma_3},$$

$$(153)\ \frac{\delta \overline{e_3}}{\delta \overline{y_1}} = \frac{\sigma(\epsilon-1)(\mu_3-\phi\sigma_3+\phi_3\sigma_3)+2\theta\mu(k\sigma\sigma_3-\epsilon_3)}{2\mu\sigma\sigma_3}.$$

In the baseline scenario the long-run effects are as follows:

$\delta\overline{p}_3/\delta\overline{y}_1$ = - 0.805, $\delta\overline{e}_{32}/\delta\overline{y}_1$ = 0.183,
$\delta\overline{e}_3/\delta\overline{y}_1$ = -1.566.

According to the baseline scenario the output of the small country declines in the short run. The effective exchange rate appreciates with an initial undershooting. The exchange rate thus reinforces the negative impact of foreign demand. The nominal interest rate declines because of the appreciation expectation. The inflation rate declines. The real interest rate remains almost unchanged. The effects are presented below:

$\delta y_3(0)/\delta\overline{y}_1$ = - 0.375, $\delta e_{32}(0)/\delta\overline{y}_1$ = 0.008,
$\delta e_3(0)/\delta\overline{y}_1$ = - 1.041, $\delta i_3(0)/\delta\overline{y}_1$ = - 0.295,
$\delta\mathring{p}_3(0)/\delta\overline{y}_1$ = - 0.258.

Exchange rate union

In the long run the output remains again at its exogenously given level. The exchange rate with respect to the currency of country 2 remains unchanged. The effective exchange rate changes, accordingly, due to a change in e. The long-run price level changes in adjusting the aggregate demand equal to the aggregate supply. We do not know, however, the sign of the change *a priori* (for the conflicting effects, see equation (95)) (the effects according to the baseline scenario are presented in parentheses).

$$(154)\frac{\delta\overline{p_3}}{\delta\overline{y_1}}=\frac{\sigma(1-\epsilon)(\mu_3-\phi\sigma_3)+\mu\theta((2\epsilon_3\sigma-\sigma_3-\epsilon\sigma_3)}{2\mu\sigma\sigma_3}(=-0.988),$$

$$(155)\frac{\delta\overline{e_3}}{\delta\overline{y_1}}=-\frac{\theta(1+\epsilon-2k\sigma)}{2\sigma}(=-1.749).$$

In the <u>short run</u> the effective exchange rate appreciates less than in the long run after a positive $\overline{y}_1$ shock (as in country 2). According to the baseline scenario the appreciation is about the same as in the floating rate regime. The nominal interest rate decreases because of the fall in the interest rate of country 2. Inflation declines slightly. The real interest rate accordingly decreases. This effect is, however, not strong enough to compensate for the negative foreign demand and exchange rate effects on output. Impacts in the short run according to the baseline scenario are presented below:

$\delta y_3(0)/\delta\overline{y}_1$ = - 0.333, $\delta e_3(0)/\delta\overline{y}_1$ = - 1.049,
$\delta i_3(0)/\delta\overline{y}_1$ = - 0.351, $\delta\mathring{p}_3(0)/\delta\overline{y}_1$ = - 0.095.

Currency basket exchange rate regime

The effective exchange rate remains stable in this regime all the time. In the <u>long run</u> the price level adjusts to equilibrate the aggregate demand and supply, which is at its exogenously given pre-shock level. Because of the conflicting effects the sign of the change in the price level cannot be shown *a priori* (see equation (95), without the term e). The expression for it is as follows:

$$(156)\ \frac{\delta \overline{p_3}}{\delta \overline{y_1}} = \frac{(1-\epsilon)(\mu_3-\phi\sigma_3)+2\theta\mu(\epsilon_3-k\sigma_3)}{2\mu\sigma} (=0.761).$$

The short-run effects are presented according to the baseline scenario below:

$\delta y_3(0)/\delta\overline{y}_1 = -\ 0.021$, $\delta i_3(0)/\delta\overline{y}_1 = -\ 0.169$,
$\delta\mathring{p}_3(0)/\delta\overline{y}_1 = 0.073$.

The output declines slightly due to the decreasing foreign demand. The positive real interest rate effect is too small to compensate for this. The decline in output is smaller than in the floating rate regime and in the exchange rate union, because the effective exchange rate is stable and does not reinforce the negative export demand effect.

Comparison of the effects in different exchange rate regimes

The basket peg regime leads to the smallest short-run change in output, whereas the floating rate regime leads to the greatest change (table 10). This is mainly due to the stable effective exchange rate in the basket peg regime.

Table 10. Short-run effects of a positive $\overline{y}_1$ shock in the small country in the baseline scenario

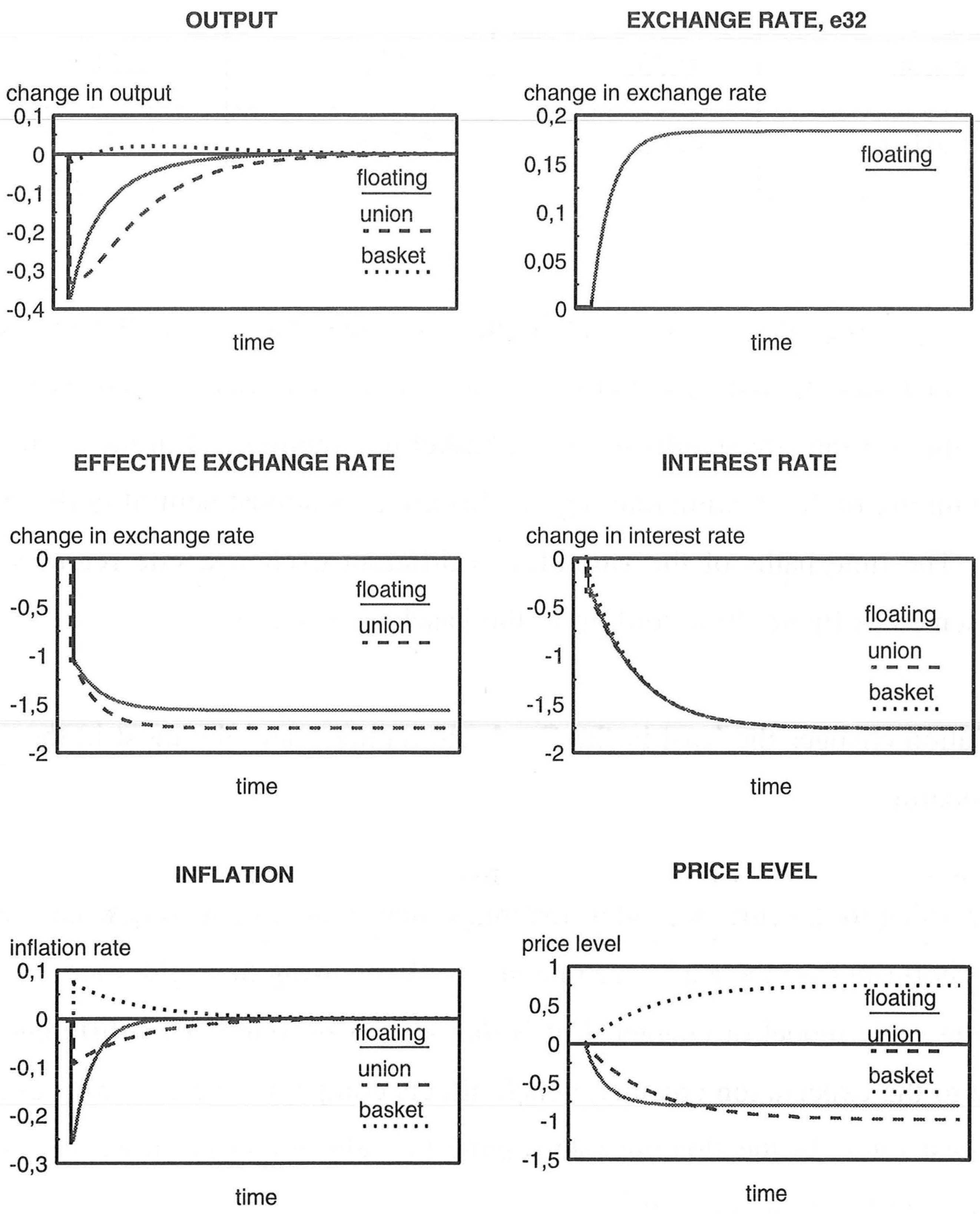
regime	Δy_3	Δc_3	Δr_3
floating	-0.375	-0.914	-0.037
union	-0.333	-1.079	-0.256
basket	-0.021	-0.198	-0.242

In the floating rate regime and in the exchange rate union the effective exchange rate appreciates, and competitiveness deteriorates. Changes in the real interest rate are stabilizing in the basket peg regime and in the exchange rate union. In the floating rate regime this effect is almost neutral in the short run. The time paths of the variables in different exchange rate regimes are presented in figure 29 according to the baseline scenario.

Inflation changes the least in the fixed rate regimes, and the most in the case of floating.

According to the current model floating insulates the output somewhat less in the short run than the exchange rate union. When using the rigid price version of the static model of chapter 4, it is the other way round. This difference is due to the expectation channel, which affects competitiveness as well as real interest rates. In the floating rate regime the adjustment is, however, faster than in the exchange rate union.

Figure 29. Effects of a positive productivity shock occurring in country 1 on the small country in different exchange rate regimes (baseline scenario)



5.7.2 Shocks in country 2

5.7.2.1 Effects on the big countries

When the shock occurs in country 2 instead of country 1, the effects on the big countries are again the same, except that the countries change places. The output of country 2 increases now in the short as well as in the long run, but the output of country 1 decreases in the short run and reaches its pre-shock level in the long run.

5.7.2.2 Effects on the small country

The export demand of the small country increases now, if the shock is positive, because in the baseline scenario country 2 is assumed to be the more important trading partner. This effect is common in all exchange rate regimes. The rest of the effects depends on the regime.

Floating exchange rate regime

In the long run the price level of the small country declines if the $\overline{y}_2$ shock is positive. This is due to the decline in the international interest rate (see the LM curve) (equation (93)). The sign of the change in the exchange rate can not be shown *a priori* (see equation (94)). The effects are as follows (effects in the baseline scenario are presented in parentheses):

$$(157)\frac{\delta\overline{p_3}}{\delta\overline{y_2}}=\frac{\phi_3(\epsilon-1)}{2\mu}<0(=-0.805),$$

$$(158)\frac{\delta\overline{e_{32}}}{\delta\overline{y_2}}=\frac{\sigma(\epsilon-1)(\mu_3+\phi_3\sigma_3-\phi\sigma_3)+2\mu\sigma(k\sigma_3-\epsilon_3)+\theta\mu(2\epsilon_3-\sigma_3-\epsilon\sigma_3)}{2\mu\sigma\sigma_3}(=-3.847),$$

$$(159)\frac{\delta\overline{e_3}}{\delta\overline{y_2}}=\frac{(\epsilon-1)(\mu_3+\phi_3\sigma_3-\phi\sigma_3)+2\mu(k\sigma_3-\epsilon_3)+2\theta\mu(\epsilon_3-k\sigma_3)}{2\mu\sigma_3}(=-2.098).$$

In the baseline scenario the effective exchange rate appreciates.

In the short run the effects are in the baseline scenario as follows:

$\delta y_3(0)/\delta\overline{y}_2$ = - 0.975, $\delta e_{32}(0)/\delta\overline{y}_2$ = - 4.022,
$\delta e_3(0)/\delta\overline{y}_2$ = - 2.973, $\delta i_3(0)/\delta\overline{y}_2$ = 0.314,
$\delta\mathring{p}_3(0)/\delta\overline{y}_2$ = - 0.258.

The exchange rate e_{32} appreciates with an overshooting (see figure 30).[23] The effective exchange rate follows the same pattern. The domestic interest rate increases in the short run because of the depreciation expectation. The rise in the real interest rate is added by the declining inflation. These negative developments more than compensate for the positive export demand effect. The output declines accordingly.

[23]The overshooting of e_{32} is due to the combination of the appreciation of $\overline{e}_{32}$ and and the decline in $\overline{p}_3$. When $\overline{e}_{32}$ depreciates and $\overline{p}_3$ declines (as in the case of a positive $\overline{y}_1$ shock), there is an undershooting of e_{32}. (See expression (100) and pp. 215-216.)

Exchange rate union

In the long run the effects on the price level and on the effective exchange rate are as follows:

$$(160)\ \frac{\delta \overline{p_3}}{\delta \overline{y_2}} = \frac{(1-\epsilon)(\mu_3 - \phi\sigma\sigma_3) + 2\mu\sigma(\epsilon_3 - k\sigma_3) - \theta\mu(2\epsilon_3\sigma - \sigma_3 - \epsilon\sigma_3)}{2\mu\sigma\sigma_3} (=3.042),$$

$$(161)\ \frac{\delta \overline{e_3}}{\delta \overline{y_2}} = \frac{\theta(1+\epsilon-2\sigma k)}{2\sigma} (=1.749).$$

In the baseline scenario the long-run price level increases and the effective exchange rate depreciates. The latter is due to the change in the exchange rate in country 2. The price level rises due to the increasing export demand, the declining interest rate and the depreciating exchange rate (see equation (95)).

In the short run the output increases due to the growing export demand, the depreciating exchange rate and due to the declining real interest rate:

$\delta y_3(0)/\delta \overline{y}_2 = 0.352$, $\delta e_3(0)/\delta \overline{y}_2 = 1.049$,
$\delta i_3(0)/\delta \overline{y}_2 = \delta i_2(0)/\delta \overline{y}_2 = -0.257$,
$\delta \mathring{p}_3(0)/\delta \overline{y}_2 = 0.291$.

Currency basket exchange rate regime

The effective exchange rate is stabilized in the short as well as in the long run. In the long run the price level changes as follows:

$$(162)\ \frac{\delta \overline{p_3}}{\delta \overline{y_2}} = \frac{(1-\epsilon)(\mu_3-\phi\sigma_3)+(1-\theta)2\mu(\epsilon_3+k\sigma_3)}{2\mu\sigma_3} (=1.293).$$

According to the baseline scenario it increases after a positive productivity shock occurring in country 2. This is due to the increasing export demand and the declining interest rate. The declining international price level affects in the opposite direction (see equation (95), after eliminating the term with e).

In the short run the effects are as follows:

$\delta y_3(0)/\delta \overline{y}_2 = 0.041$, $\delta i_3(0)/\delta \overline{y}_2 = 0.075$,
$\delta \mathring{p}_3(0)/\delta \overline{y}_2 = 0.124$.

The output is almost stabilized. The increasing export demand affects output positively. The real interest rate effect is only slightly positive. Competitiveness deteriorates as a result of inflation, which is higher than abroad (p. 213).

Comparison of the effects in different exchange rate regimes

In the baseline scenario the largest deviation of output from the long-run level occurs in the floating rate regime, where the positive effect of export demand is more than compensated for by the appreciating effective exchange rate and the increasing real interest rate (table 11).

Table 11. Short-run effects of a positive $\overline{y}_2$ shock in the small country in the baseline scenario

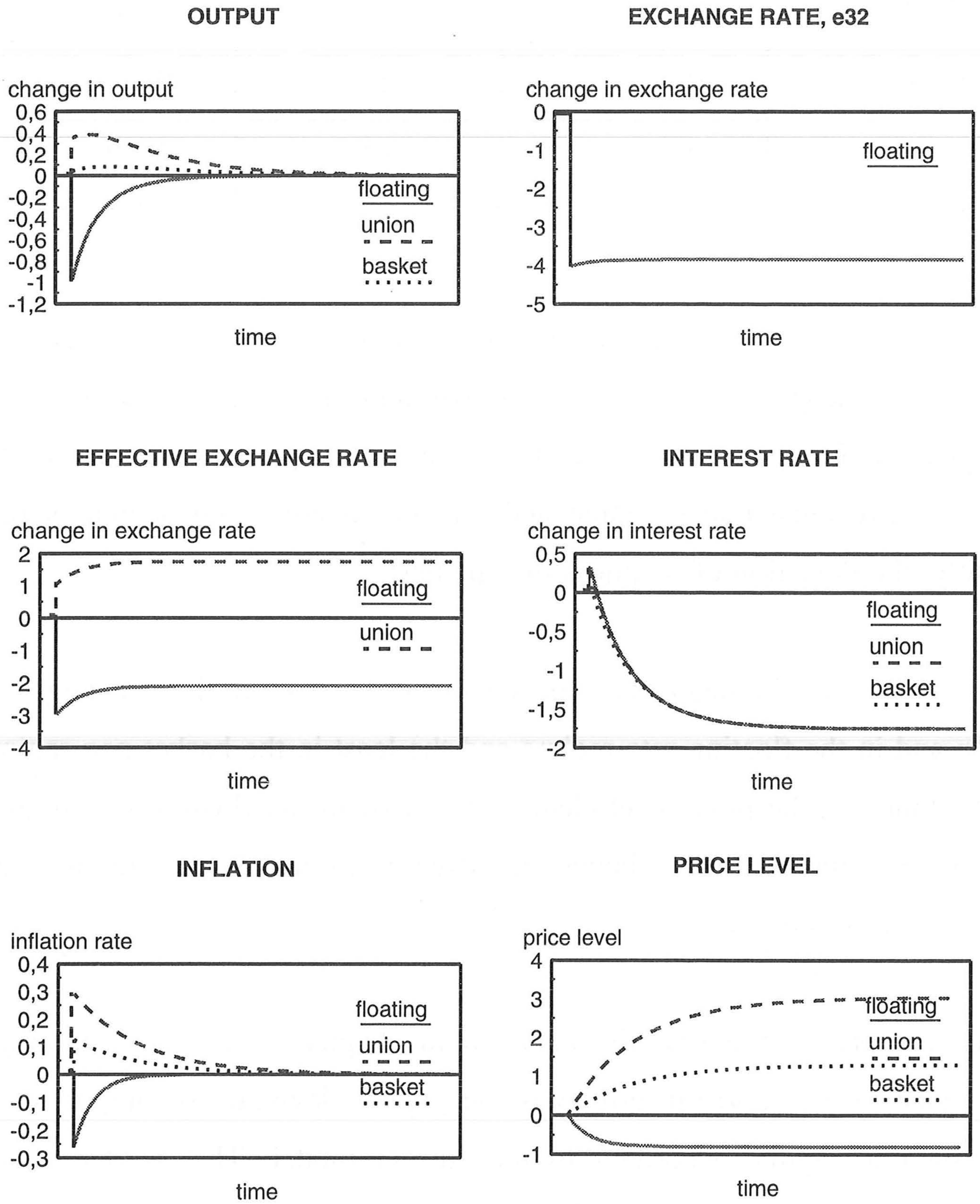
regime	Δy_3	Δc_3	Δr_3
floating	-0.975	-2.910	0.572
union	0.352	0.564	-0.034
basket	0.041	-0.319	-0.049

The deviation is large also in the exchange rate union, where the depreciating effective exchange rate and the slightly declining real interest rate reinforce the positive foreign demand effect. In the basket peg regime, where the effective exchange rate is stable and the real interest rate decreases only slightly, the deviation of output is the smallest.

Inflation deviates immediately after the shock the most in the exchange rate union and in the floating rate regime and the least in the basket peg regime. In the long run the price level changes the least in the floating rate regime. The time paths of the variables in different exchange rate regimes are presented in figure 30.

When compared to the results obtained in chapter 4, the most important difference in the short-run effects is the greater deviation of output in the floating rate regime according to the current model. This is due to the increasing real interest rate, which reinforces the negative output effect of the deteriorating competitiveness.

Figure 30. Effects of a positive productivity shock occurring in country 2 on the small country in different exchange rate regimes (baseline scenario)



5.8 Evaluation of the regimes in the cases of different shocks using a dynamic rational expectations model

When studying the effects of a domestic goods demand shock, we notice that a floating exchange rate insulates the other domestic economic variables fully in the short run. This result is the same as that obtained in the fixed price version of the static model of chapter 4. In the models, where we have supply reactions and prices are endogenous, this full insulation result no longer holds. In the fixed exchange rate regime the output changes according to the current model more than proportionally. In the static fixed price model mentioned above the reaction is proportional. According to the current model inflation rises after a positive shock.

In the case of a domestic monetary shock the ranking of the regimes is the opposite: the fixed rate regime insulates the economy fully already in the short run, whereas floating leads to a change in the output. Inflation accelerates after a positive shock. With respect to output these results are again similar to those obtained in static fixed price models.

According to the baseline scenario fixed rates insulate the output in the short run more against domestic productivity shocks, too. This cannot be shown *a priori*. Better insulation of output in the fixed rate regime is again an analogous result compared to those of the previous models. Floating leads to a depreciation of the exchange rate after a positive productivity shock. This is explained by the need to sell the increased production abroad. In the fixed rate regime deceleration of inflation leads merely to an increase in the real interest rate, which compensates for the positive productivity effect. This insulation property of the fixed rate regime can be interpreted to be positive if the shock is temporary or if the costs of a slow output adjustment are lower than those of a fast adjustment.

The results obtained in the baseline scenario in the cases of foreign shocks are collected in the table presented on the next page. We notice that the deviation of output is in the short run the smallest in the currency basket exchange rate regime. This is again the same result as that obtained in the static demand determined model. Adding a supply curve to the model, which is done in chapter 4, makes the floating rate regime the most attractive with intermediate degrees of price indexation.

The good shock insulating property of the basket peg regime in the short run is due to the stable effective exchange rate. The real interest rate changes also more often in a more stabilizing, or less destabilizing way, in this than in the two other regimes.

In comparison to the previous models the performance of the floating rate regime is much worse according to the current model. The deviation of output is the greatest in the cases of foreign goods demand and productivity shocks. When a monetary shock occurs in country 1 the performance of floating is the same as that of the exchange rate union. In these cases the effective exchange rate changes in a way which reinforces the effect of the foreign demand.

Table 12. Some important effects of the foreign shocks in the short run according to the dynamic model (baseline scenario)

effect	goods demand shock		monetary shock		productivity shock	
	Δf_1	Δf_2	Δm_1	Δm_2	$\Delta\bar{y}_1$	$\Delta\bar{y}_2$
Δe	-5	5	4.481	-4.481	3.497	-3.497
Δi_1	0.782	0.782	-1.201	-0.293	0.257	-0.351
Δi_2	0.782	0.782	-0.293	-1.201	-0.351	0.257
Δ(foreign demand)	0.537	0.537	0.060	0.380	-0.116	0.052
Δe_3 (floating)	1.918	1.918	-1.344	0.344	-1.041	-2.973
Δe_3 (union)	1.500	-1.500	-1.344	1.344	-1.049	1.049
Δe_3 (basket)	0.000	0.000	0.000	0.000	0.000	0.000
Δi_3 (floating)	0.702	0.702	-0.293	-1.201	-0.295	0.314
Δi_3 (union)	0.782	0.782	-0.293	-1.201	-0.351	0.257
Δi_3 (basket)	0.782	0.782	-0.565	-0.929	-0.169	0.075
$\Delta\mathring{p}_3$ (floating)	0.368	0.368	0.000	0.000	-0.258	-0.258
$\Delta\mathring{p}_3$ (union)	0.094	-0.193	0.000	0.096	-0.095	0.291
$\Delta\mathring{p}_3$ (basket)	-0.049	-0.049	0.029	0.067	0.073	-0.144
Δy_3 (floating)	0.831	0.831	-0.309	0.588	-0.375	-0.975
Δy_3 (union)	0.635	-0.323	-0.309	0.907	-0.333	0.352
Δy_3 (basket)	0.156	0.156	0.155	0.443	-0.021	0.041

The exchange rate union leads in the short run to the greatest deviation in output in the case of a monetary shock occurring in country 2, the most important trading partner and at the same time the exchange rate union partner. The poor performance of the exchange rate union against these kinds of shocks has remained in all models used in the project. This is due to the shock-reinforcing reaction of the effective exchange rate and the real interest rate. When a monetary shock occurs in country 1 the insulation is the same as in the floating rate regime. The insulation property of the exchange rate union against a productivity shock occurring in country 1 is not good, either, because of the "perverse" exchange rate reaction, even if floating leads to a somewhat greater deviation of output from the long-run level.

The deviation of inflation from the long-run level is the smallest in the basket peg regime in the cases of foreign goods demand and productivity shocks, and in the floating rate regime in the cases of foreign monetary shocks. Inflation is rather well insulated in all regimes against foreign monetary shocks.

The results concerning the short-run effects of the foreign shocks presented above are dependent on the parameters used. The main channels of the effects are, however, understandable intuitively, like the role of the exchange and interest rates. In the previous model versions the results have not been very sensitive to the parameters used when they move in "realistic" ranges.

5.9 Summary

The current model is a dynamic one with rational expectations with respect to exchange rates and inflation. The model is a short-run Keynesian and long-run neoclassical model. Production in this model is demand determined.

The results with respect to the stabilization of output against shocks are similar to those obtained in the rigid price version of the static demand determined model. The current model, however, brings the dynamic response of the economy and new channels for the effects.

A priori results are the object of the research as far as possible. A rather simple model for one country grows, however, beyond analytical treatment. In these cases the research is continued by means of numerical simulations.

In the cases of domestic shocks it is shown that the floating rate regime insulates the economy fully against goods demand (fiscal) shocks and the fixed rate regimes against monetary shocks. These results are analogous to those obtained in the simple static Mundell-Fleming models. In the baseline scenario fixed exchange rate regimes insulate the output in the short run more also against domestic productivity shocks.

In the cases of foreign shocks it is shown, by means of simulations, that the currency basket exchange rate regime leads in the short run to the smallest deviation of output from the long-run level against all shocks studied. This result is similar to that obtained in the static fixed price model used previously, but differs from that of the models with a supply curve.

The exchange rate union is problematic when monetary shocks occur in the union partner country. In this case it leads to the greatest deviation of output from the long run level. This result is obtained in all the four model versions used so far.

Floating does not perform very well according to the current model. It leads to the greatest deviations of output in the cases of both foreign goods demand and productivity shocks. Floating and the exchange rate union perform equally poorly when there is a monetary shock in country 1.

The deviation of inflation from the long-run level is the smallest in the basket peg regime in the cases of foreign goods demand and productivity shocks, and in the floating rate regime in the cases of foreign monetary shocks.

The dynamic model presented in chapter 5 is most applicable to cases where the explicit or implicit indexation of prices and wages is low. In this kind of a situation the supply effects, which are lacking in this model, are not relevant. The adjustment to shocks occurs during a period when contract wages are fixed and when effects of foreign input prices do not essentially pass through to the domestic price level. This situation is relevant in practice, because wage contracts are often negotiated for one year. If a shock occurs in the beginning of this period, the "short run" can be rather long.

6 THREE CRITERIA FOR OPTIMUM CURRENCY AREAS

6.1 Degree of price indexation

In this section we study the degree of price flexibility as a criterion for an optimum currency area. Intuitively it can be suggested that the more flexible prices are the more attractive fixed exchange rates, and in this respect currency unions, are when measured with a deviation of output from a "normal" level. Price and wage flexibility is an alternative for the mobility of factors of production as presented by Mundell (1961). We study the price flexibility criterion on the basis of the results obtained in the previous chapters.

We can make a distinction between the cost push flexibility reflected in parameter α_3 and the demand pull flexibility reflected in parameter β_3 in the static model and in parameter ψ_3 in the dynamic model. The former presents the reaction of domestic prices to foreign prices and the latter the reaction to the demand for domestic goods. In the static model we notice that the results are sensitive to the value of α_3 but not very sensitive to the value of β_3. In the following presentation we concentrate on the degree of cost push price flexibility (the degree of nominal price indexation) measured by parameter α_3 in the static model.[24]

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[24]For the working mechanisms behind the results presented in this section, see chapter 4.

We measure the attractiveness of the exchange rate union here as well as in the following sections in terms of **relative output deviation**, i.e. how the change in the parameter under consideration affects L^o_u/L^o_f and L^o_u/L^o_b. The exchange rate union becomes relatively more attractive when the above mentioned ratios decline. The effect on the absolute output deviation, i.e. how a change in the parameter affects the output deviation in the exchange rate union, is also seen in the figures.

In the case of **a domestic goods demand shock** we notice in expressions (16) and (19) that zero indexation leads to full insulation in the floating rate regime. When $\alpha_3 = 1$ the output effect is the same as in the fixed rate regime. We can thus conclude that <u>fixed rates are the more attractive the greater the indexation</u>. In this case the gain of floating rates becomes small. Fixed rates never insulate, however, the output more than floating.

When there is **a domestic monetary shock** a fixed rate regime leads to full insulation of output irrespective of the degree of indexation. The same result is obtained in the floating rate regime when prices are fully indexed, i.e. if $\alpha_3 = 1$ (expression (21)). When indexation is lower the output changes. We can now conclude that <u>fixed rates are the more attractive (relatively) the lower the indexation</u>.

In the case of **a domestic productivity shock** fixed rates lead to a smaller change in output than floating assuming $\alpha_3 < 1$ and $k_3\sigma_3 < 1$, and to the same change when $\alpha_3 = 1$. The smaller α_3 is, the less the increase in foreign prices (due to depreciation) is reflected in the domestic price level in the floating rate regime. Competitiveness is accordingly in this regime better and output higher when α_3 is low. We can conclude that under the assumption presented above fixed rates are the more attractive (relatively) the lower the indexation.

We see in figure 31 on page 236 that in the case of **a goods demand shock occurring in country 1** floating and the exchange rate union lead to a very similar result with respect to insulation of output (according to the baseline calculation).[25] The floating rate with respect to the rest of the world is the crucial reason for this similarity. The higher α_3 is, the more the depreciating exchange rate (in the case of a positive f_1 shock) is reflected in the domestic price level and ultimately in competitiveness and output in these regimes. Compared to the basket peg regime we can conclude that the exchange rate union is the more attractive (relatively) the higher the degree of indexation. When compared to floating no clear conclusions can be drawn.

When **a goods demand shock occurs in country 2** (the union partner country) the exchange rate union is the most attractive with a medium or low degree of indexation. When α_3 increases, the appreciation of the exchange rate (together with that of country 2) is reflected as a smaller deterioration of competitiveness. The net effect of the increasing foreign demand and competitiveness thus becomes more positive. With full indexation the regimes do not differ from each other.

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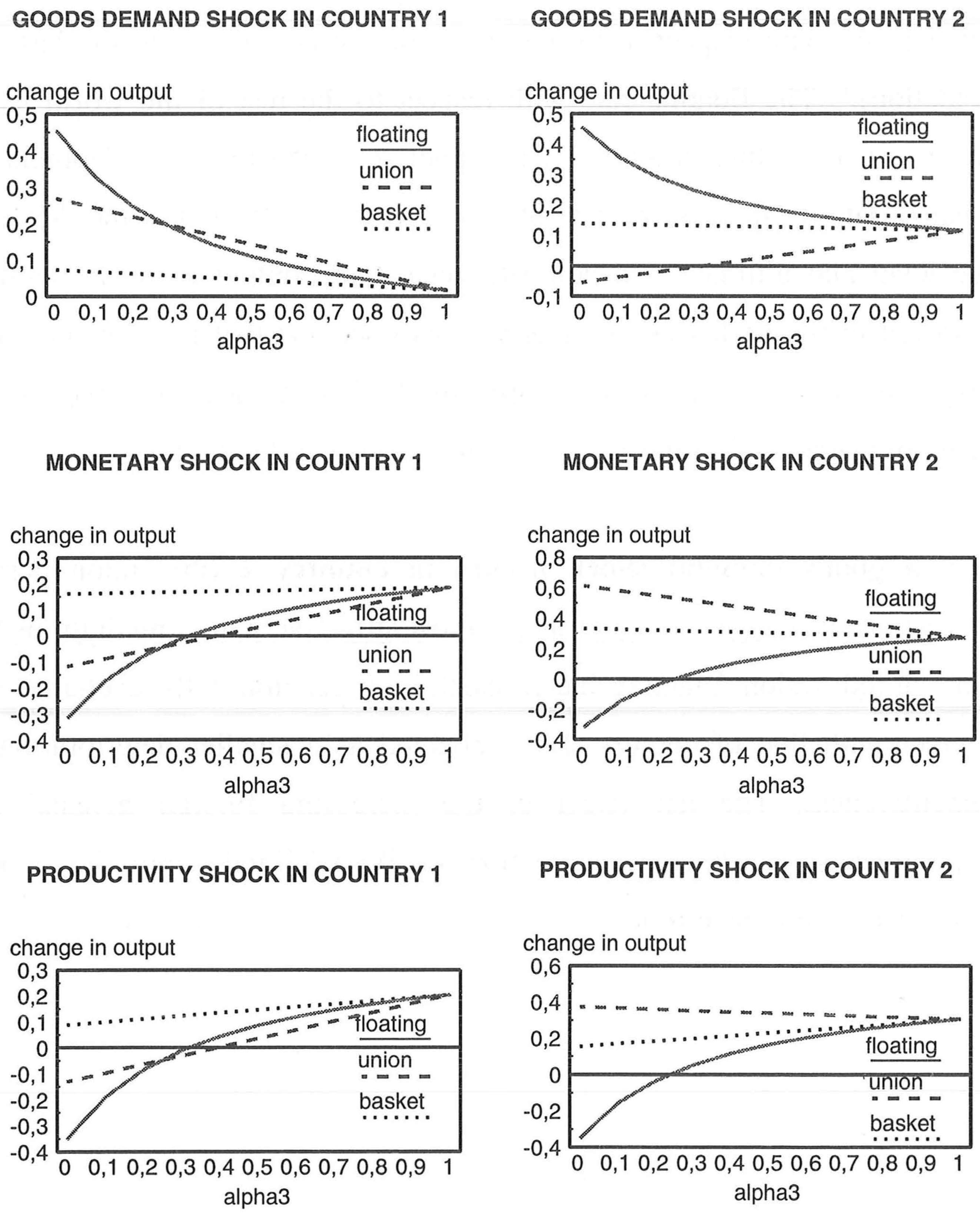
[25]In the figures presented in chapter 4 the degree of indexation in the big countries change together with that of the small country ($\alpha_3 = 3 * \alpha$). In this chapter the indexation of the small country changes alone.

Figure 31. Sensitivity of output with respect to the degree of price indexation (α_3) in the case of foreign shocks (baseline scenario of the static model, $\alpha = 0.1$)



When **a monetary shock occurs in country 1** the exchange rate union is again the most attractive with a medium or low degree of indexation. The reason for this is the same as in the case of an f_2 shock: a further increase in α_3 leads to a smaller deterioration of competitiveness, and accordingly to a higher output.

When **a monetary shock occurs in country 2** (the union partner country) the exchange rate union is the most attractive with a high degree of indexation and the least attractive with a low indexation. When α_3 increases, the depreciation of the exchange rate leads to higher domestic prices, to a smaller improvement in competitiveness and consequently to a smaller change in output. The deviation of output becomes also smaller because the other effects are positive, too.

In the case of **a productivity shock occurring in country 1** the exchange rate union is the most attractive with a medium degree of indexation and, when compared to the basket peg regime, the least attractive with low indexation. A further increase in α_3 strengthens the effect of the appreciating exchange rate on the domestic price level and consequently on competitiveness. A smaller deterioration in competitiveness leads to a higher output. In the case of low values of α_3 the output declines, and in the case of high values it increases.

When **a productivity shock occurs in country 2** (the union partner country) the exchange rate union is the most attractive with a high degree of indexation and the least attractive with a low degree of indexation. The higher α_3 is, the more the domestic price level increases as a result of the depreciation of the exchange rate, and the less the competitiveness improves. Because the other effects of a positive s_2 shock are positive, too, this decline in the improvement of competitiveness decreases the deviation of output.

In only two out of nine cases (shocks) does a low degree of indexation lead to the most attractive outcome for the exchange rate union compared to the other regimes. These cases are domestic monetary and productivity shocks. In all other cases the exchange rate union is the most attractive with medium or high degrees of price indexation. In the cases when the union is the most attractive with medium indexation the insulation of the union is still better than in the other regimes also with high degrees of indexation. When there is a goods demand shock in country 2 and a monetary or productivity shock in country 1, the relative performance of the exchange rate union is not, however, very sensitive to indexation.

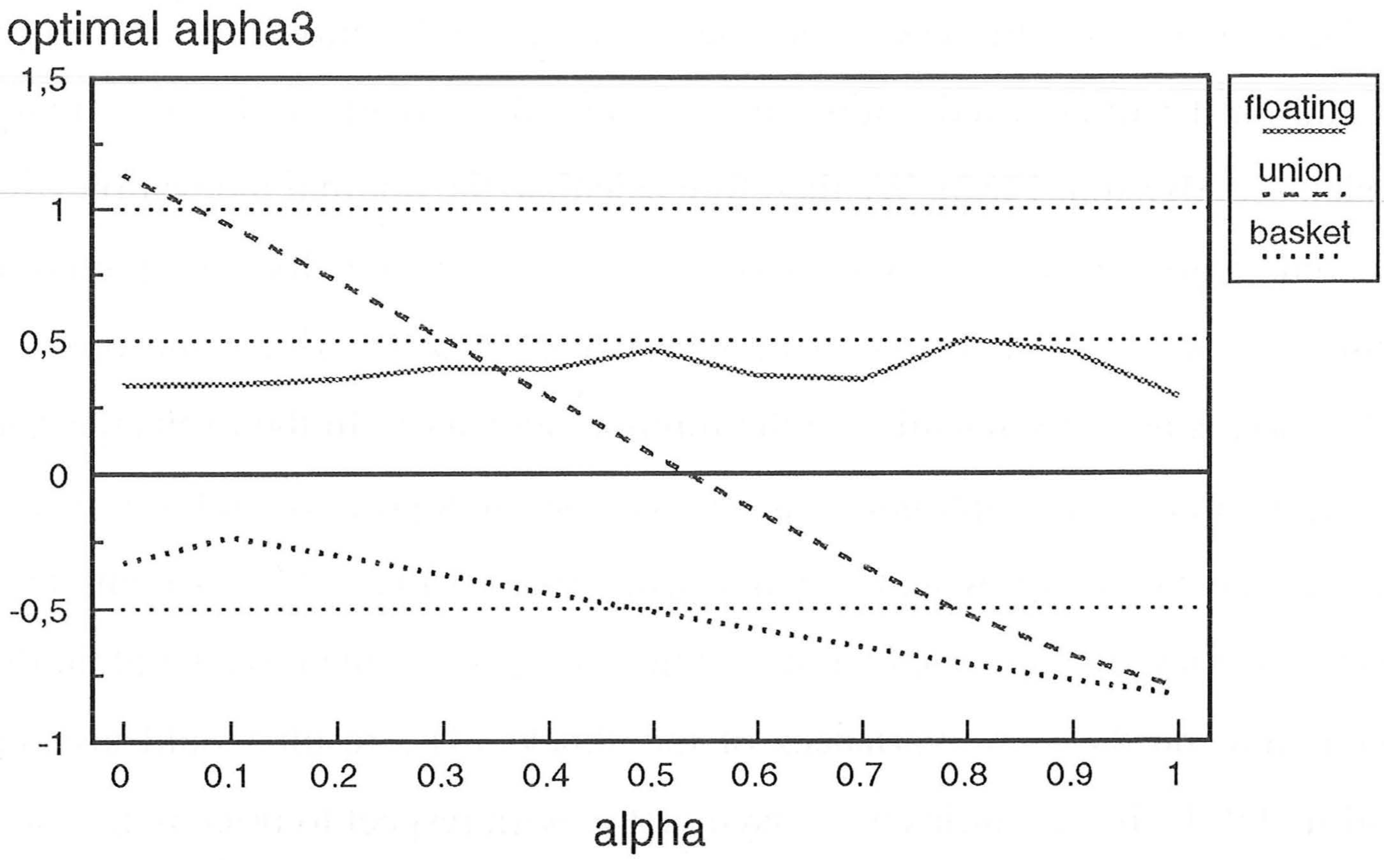
In figure 17 on page 141 we see that, when measured with the aggregate loss function with respect to output deviation, the exchange rate union leads to a lower loss of welfare than floating with very low degrees of price indexation. But when compared to the basket peg regime the loss is higher, except when domestic prices are fully indexed. In this case there is no difference between the regimes. In this sense the relative performance of the exchange rate union is the best with full indexation. The same conclusion holds for different values of foreign indexation, which is seen in appendix 7.

Assuming that the exchange rate union is chosen as the exchange rate regime we may ask, what degree of indexation is optimal in this case. On page 140 we already calculated optimal degrees of price indexation in different regimes in the baseline scenario, where the foreign indexation is positive but rather small ($\alpha = 0.1$). We noticed that the optimal degree of price indexation is the highest in the exchange rate union. For floating the smallest deviation of output is achieved with a medium degree of price indexation and for the basket peg with a negative price indexation.

In the case of foreign shocks optimal domestic indexation can, however, depend on the foreign indexation, too (for this dependence in a two-country model, see Marston, 1982). We therefore calculate the optimal indexation with different degrees of foreign indexation ($0 \leq \alpha \leq 1$). The results are reported in figure 32. We see that in the floating and basket peg regimes the optimal indexation is not very sensitive to the foreign indexation. In the exchange rate union, in contrast, the optimal domestic indexation is positive and high when foreign indexation is low and negative when foreign indexation is high. This result is naturally conditional on the parameter values of the model and on the assumption on the same variances of the shocks. The result would also be modified if the big countries were asymmetric with respect to price indexation (see footnotes 11-16). (The effects of this asymmetry are left aside in this study.)

We investigate the intuition of the relationship between the domestic and foreign price indexation in the exchange rate union by considering the case when $\alpha = 1$. In this case monetary shocks occurring in country 1 have no effect on the output of the small country. The floating exchange rate against country 1 compensates for the effect of the changing price level of this country. Now the effects in the cases of only foreign goods demand and productivity shocks as well as monetary shocks occurring in country 2 matter.

Figure 32. Sensitivity of the domestic optimal indexation of prices (α_3) with respect to foreign indexation (α) (measured with the aggregate loss function in terms of output deviation)



In the case of a positive f_1 shock full indexation in the big countries leads to a decline in the output of country 2 (the more important trading partner) (figure 3). The higher α_3 is now, the more the depreciation of the currency and the rising prices of the large countries are reflected in competitiveness, and the greater is the decline in output (see pp. 77-78).

In the case of a positive f_2 shock full indexation in the big countries leads to an increase in the output of country 2, and to a decline in that of the other big country. When α rises very high, the increase in the total foreign demand diminishes (figure 3). The rising international interest rate affects the output of the small country negatively. A high α_3 in turn means that the rising prices of the big countries are reflected more in the small country which erodes competitiveness from what it is when α_3 is low. The output of country 3 declines accordingly the more the higher the indexation in the small country (see pp. 85-86).

In the cases of positive foreign productivity shocks the outputs of both big countries grow more when α is high than when it is low (figure 14). If the value of α_3 is large in the case of an s_1 shock, the effect of the declining foreign prices and the appreciation of the domestic exchange rate on competitiveness is great, and the better competitiveness reinforces the increase in output.

In the case of a positive s_2 shock, in turn, a high value of α_3 is reflected as a greater effect of the declining foreign prices on the domestic price level. When $\alpha = 1$, the output of the small country is again the higher the greater the domestic indexation is.

A monetary shock occurring in country 2 is the only case where an increase in the indexation of prices diminishes the deviation of output. When $\alpha = 1$, the outputs of both big countries and the interest rate remain unchanged. The exchange rate of country 2, however, depreciates and the price level increases, both by unity. In this case a low indexation in country 3 leads to an increase in output, because competitiveness improves. Only full indexation ($\alpha_3 = 1$) eliminates the effect on output. The weight of this shock in the above presented utility function is, however, small compared to those of the four other shocks, where the relationship between domestic and foreign indexation is the reverse.

6.2 Degree of integration

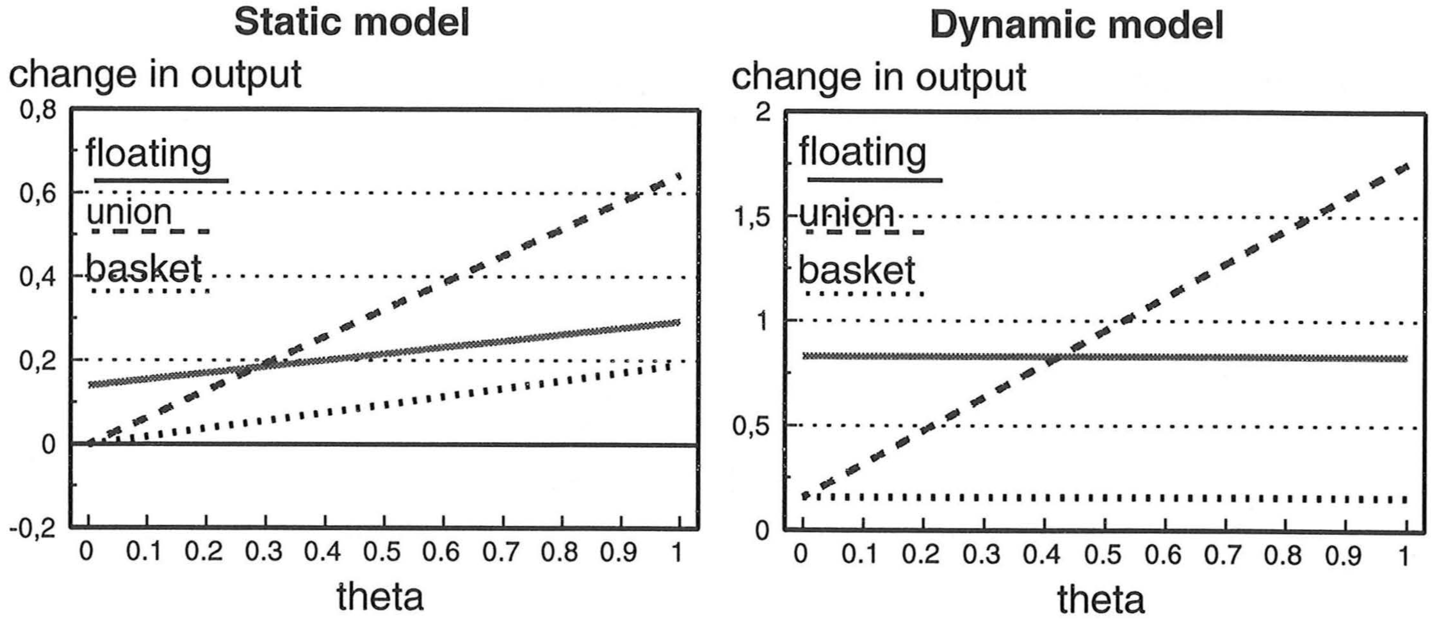
The degree of integration with the potential union partner (country 2) is measured in the static as well as in the dynamic model with 1 - θ. This expression measures the degree of goods market integration in the goods demand equation in both models, and in the supply equation of the static model (see pp. 30-33 and 158-159). In the following we present the degree of integration in terms of θ, the share of country 1 in the foreign trade of country 3. The smaller θ is, the higher the degree of integration with country 2.

In the following we study the attractiveness of the exchange rate union in a floating rate world with baseline scenarios of the static and the dynamic model. The criterion of evaluation is the deviation of the output from the normal level, in the case of the dynamic model it is the short-run effect. The figures showing the sensitivity analyses in these two models are presented side by side.

In figure 33 we notice that **in the case of a goods demand shock in country 1** the exchange rate union is the more attractive the higher the degree of integration with the union partner, i.e. the smaller the share of country 1 (θ) is.[26] This result is obtained in both models. The greater the share of country 2 in foreign trade is, the less export demand increases and the less competitiveness improves (see expression (57)). The basket peg regime leads, however, to a smaller deviation of output with all $0 < \theta \leq 1$.

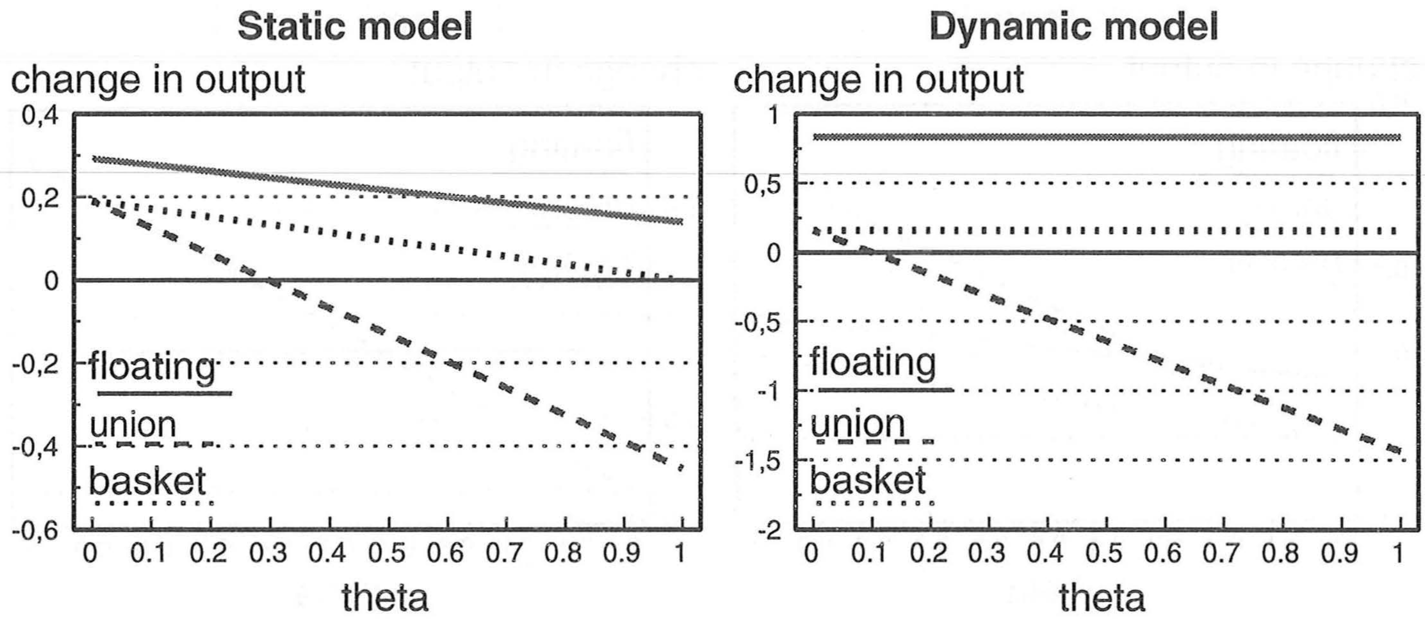
[26]With full integration ($\theta = 0$) the exchange rate union and the basket peg regime lead always to the same change in output.

Figure 33. Goods demand shock in country 1: short-run effects on the output of country 3, sensitivity with respect to the degree of integration (the lower θ is, the higher the degree of integration)



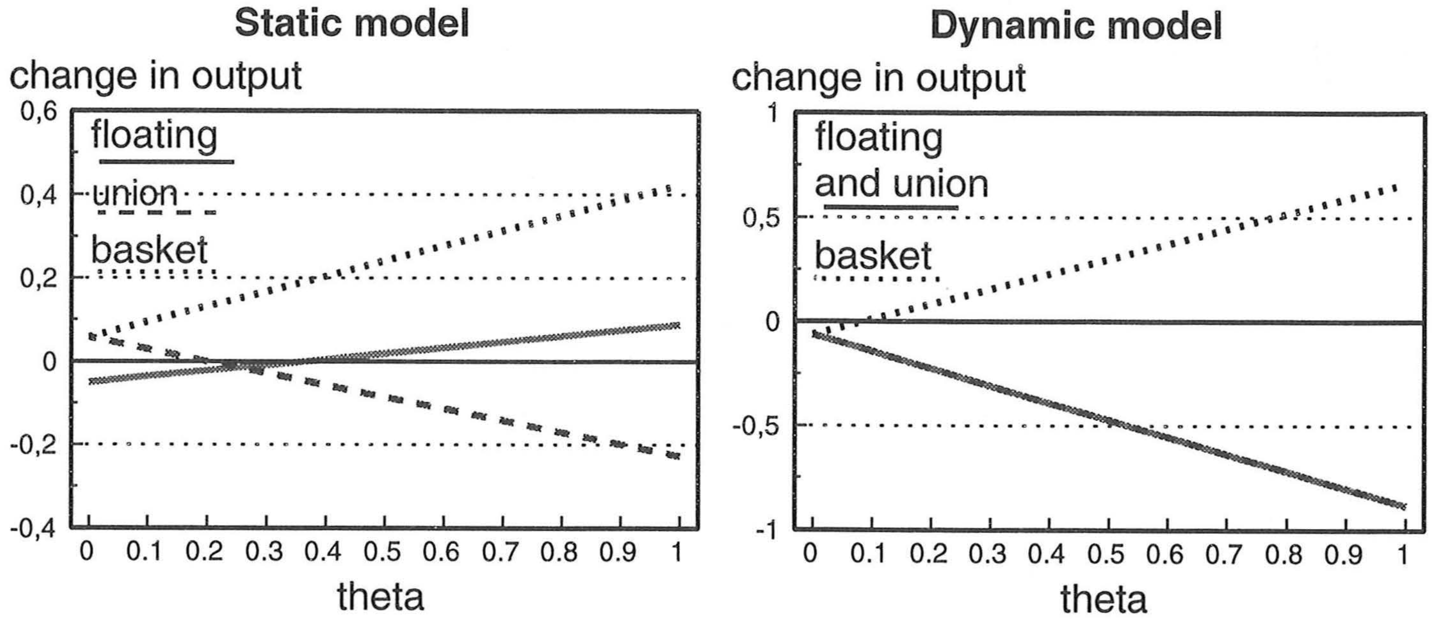
In the case of **a goods demand shock occurring in country 2** (the potential union partner) we obtain a similar result (figure 34). The exchange rate union is the most attractive with a high or medium degree of integration with the potential union partner. Minimization of output deviation occurs in both models with a somewhat lower than full integration. The smaller θ is, the smaller the appreciation of the currency, and accordingly the smaller the decline in output (for competitiveness the opposite of expression (57)). (With a very low θ the output, however, increases somewhat in the case of a positive f_2 shock.)

Figure 34. Goods demand shock in country 2: short-run effects on the output of country 3, sensitivity with respect to the degree of integration (the lower θ is, the higher the degree of integration)



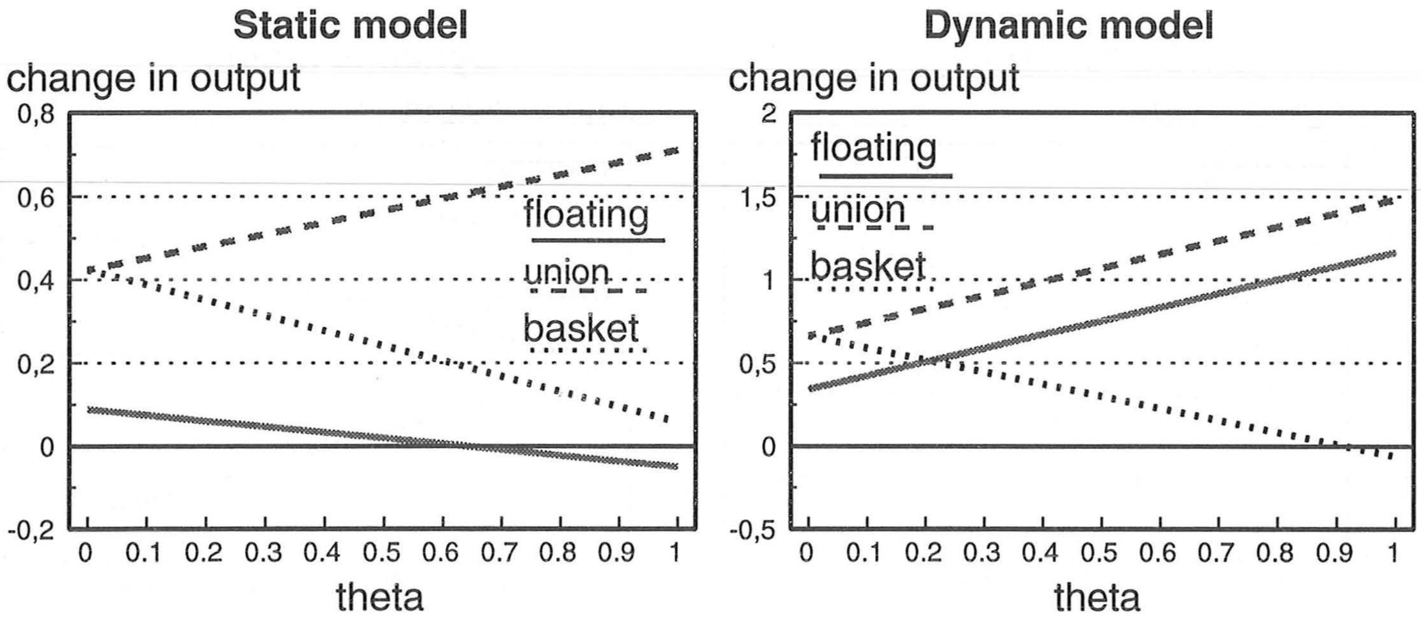
In the case of **a monetary shock occurring in country 1** the deviation of output is the smallest in all regimes with a high degree of integration with country 2, i.e. a low degree of integration with the country, where the shock occurs (figure 35). With a very high degree of integration with country 2, i.e. a low degree of integration with country 1, the effective exchange rate appreciates less and the output declines less in the exchange rate union (for competitiveness, see expression (68)). When θ is high, the negative exchange rate effect outweighs the positive export demand effect, which also increases with θ, because the exchange rate changes very much (see table 5, p. 134, and figure 25, p. 200). On the basis of this insulation property in absolute terms, and on the basis of the comparison with the floating rate regime in the static model, we conclude that the exchange rate union is the most attractive with a rather high degree of integration with country 2.

Figure 35. Monetary shock in country 1: short-run effects on the output of country 3, sensitivity with respect to the degree of integration (the lower θ is, the higher the degree of integration)



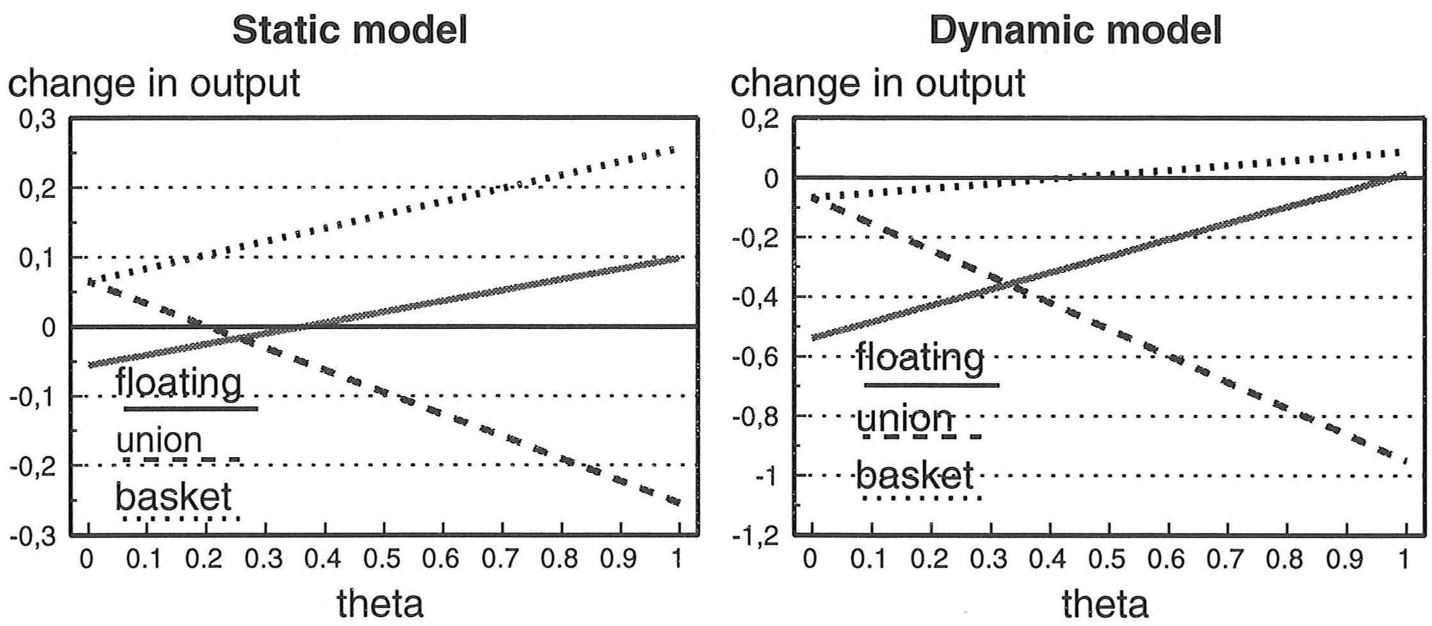
When **a monetary shock occurs in country 2** (the potential union partner) the exchange rate union leads to the smallest deviation of output in absolute terms with a high degree of integration with country 2 (the country where the shock originates) (figure 36). The conclusion is the same in relative terms, i.e. when compared to the alternative regimes. The greater the integration with country 2 is (the smaller θ is), the smaller the improvement in competitiveness and accordingly the smaller the increase in output (for competitiveness, the opposite of expression (68)). In the basket peg regime the export demand effect leads to a decline in the output effect when θ grows (because the weight of country 1, whose output is about unchanged, increases).

Figure 36. Monetary shock in country 2: short-run effects on the output of country 3, sensitivity with respect to the degree of integration (the lower θ is the higher the degree of integration)



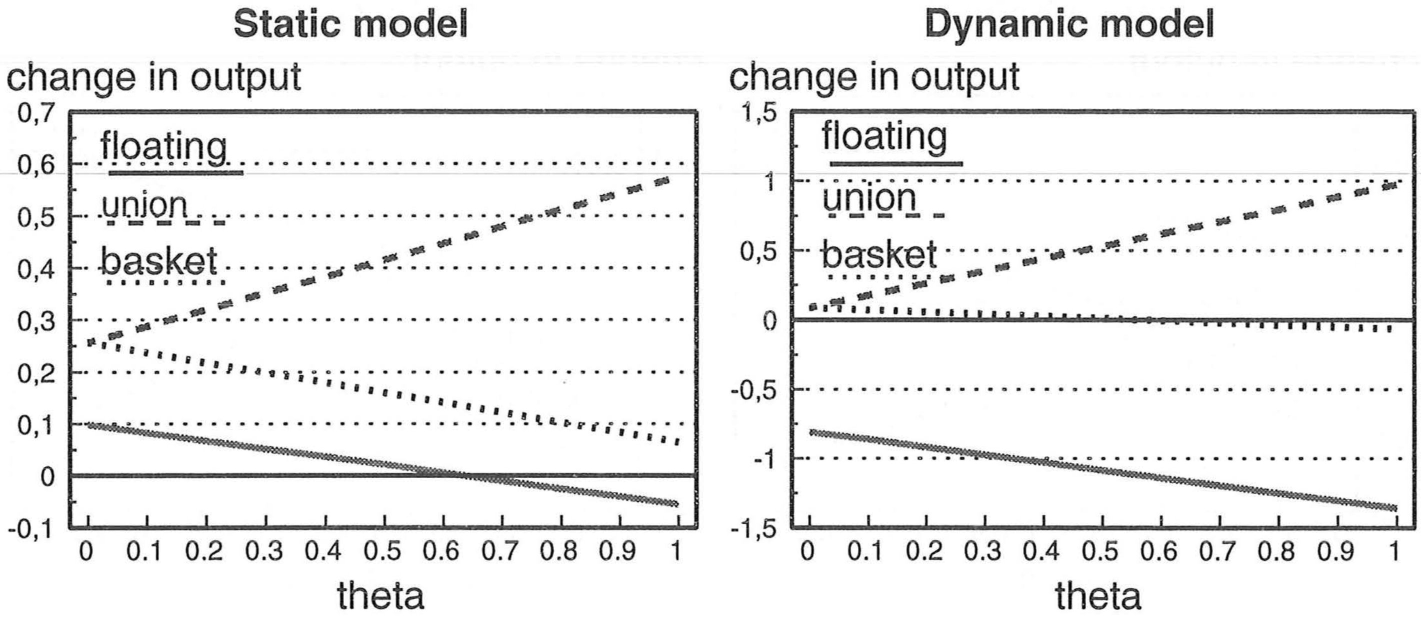
When **a productivity shock occurs in country 1** the deviation of output from the normal level in the exchange rate union is the smallest with a rather high degree of integration with country 2 (figure 37). When a positive productivity shock occurs in country 1, the effective exchange rate of this country depreciates and that of country 2 appreciates. With a fixed exchange rate e_{32} and a growing weight θ for e (see equations (9) and (86)), the competitiveness of country 3 worsens and the output declines. This effect again dominates the increasingly positive export demand effect due to the magnitude of the exchange rate change occurring in the big countries (tables 5 and 12, figure 28). In the static model, however, the effect is the smallest with some trade also with country 1. At this point the positive export demand and negative competitiveness effects balance each other.

Figure 37. Productivity shock in country 1: short-run effects on the output of country 3, sensitivity with respect to the degree of integration (the lower θ is, the higher the degree of integration)



In the case of **a productivity shock occurring in country 2** (the potential union partner) the exchange rate union is again the most attractive with a high degree of integration with country 2 (figure 38). With a high degree of integration with country 2 (small θ) the effect of the exchange rate on competitiveness due to the change in the big country exchange rate e becomes weaker and the deviation of the output diminishes, in absolute terms as well as in comparison to the other regimes.

Figure 38. Productivity shock in country 2: short-run effects on the output of country 3, sensitivity with respect to the degree of integration (the lower θ is, the higher the degree of integration)



On the basis of the above study we can conclude that the exchange rate union is more attractive, in comparison to the other regimes studied, with a high degree of foreign trade integration with the potential union partner rather than with a low degree of integration. This result is due to the more stabilizing or less destabilizing effective exchange rate with a low θ. When the share of the other big country (θ) grows, the effective exchange rate changes more. If the competitiveness effect outgrows the effect due to export demand the deviation of output increases when θ grows. It is, however, possible that minimization of the output effect is achieved with a smaller than full integration with the potential union partner, because then the competitiveness and export demand effects can balance each other (see figures 34, 35 and 37). The crucial factors in this respect are the relative magnitudes of the exchange rate and output effects in the big countries and the corresponding parameters of the small country.[27]

6.3 Degree of product differentiation

In this section we measure the degree of product differentiation with the "competitiveness elasticity" σ_3. It reflects the degree to which domestic output is responsive to changes in competitiveness. Even if σ_3 is the same in all exchange rate regimes, changes in output are sensitive to the value of it because exchange rates and prices change differently in different regimes.

If σ_3 is low, the domestic production is very differentiated i.e. domestic goods and services are so different from foreign ones that demand for them is not very responsive to changes in relative prices.[28] At the same time σ_3 reflects also the degree of openness of the economy. In a rather sheltered economy domestic production is not sensitive to competitiveness. In this respect we test jointly the differentiation and openness criteria. This test is, however, only partial, because σ_3 is just one measure of openness. It is reflected also in parameters ε_3 and α_3.

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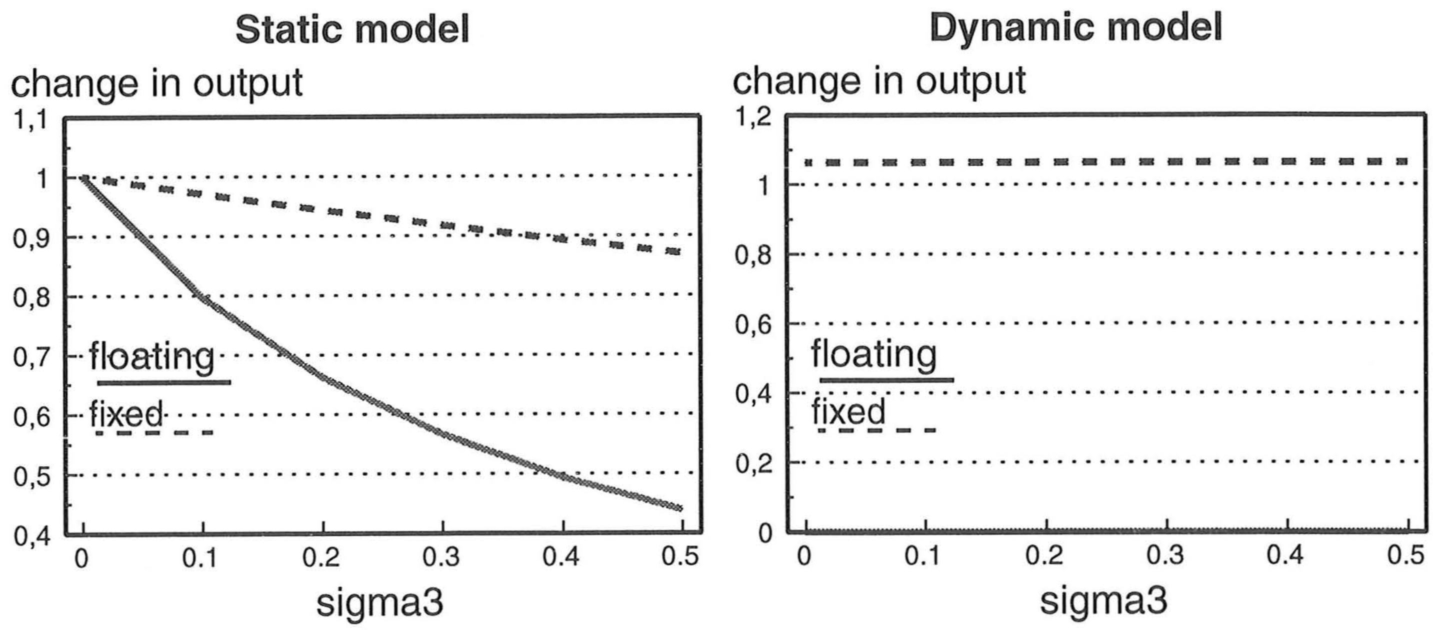
[27]In the model with temporary shocks (Kotilainen, 1993) minimization of the output effect is achieved more often than here with medium degrees of integration. This is due to the smaller change in the exchange rate of the big countries in that model.

[28]An alternative interpretation for σ_3 is the degree of specialization. This is, however, not good, because a high degree of specialization can make the country more responsive to changes in competitiveness through imports, even if the effects through exports are small. It is also questionable whether a small country can achieve significant market power through specialization. Specialization would also make the economy vulnerable to industry-specific shocks, whereas this is not necessary in the case of differentiation.

Next we study the differentiation criterion again with the help of the baseline scenarios of the static and dynamic models in the face of the nine shocks defined previously in the study. The sensitivity analysis is done for values of σ_3 from 0 to 0.5. The values higher than 0.5 are no more relevant, because in no country is the share of foreign trade so great and the sensitivity of output with respect to relative prices so high that the output would change for example by one percent when relative prices change by one percent (the situation when $\sigma_3 = 1$).

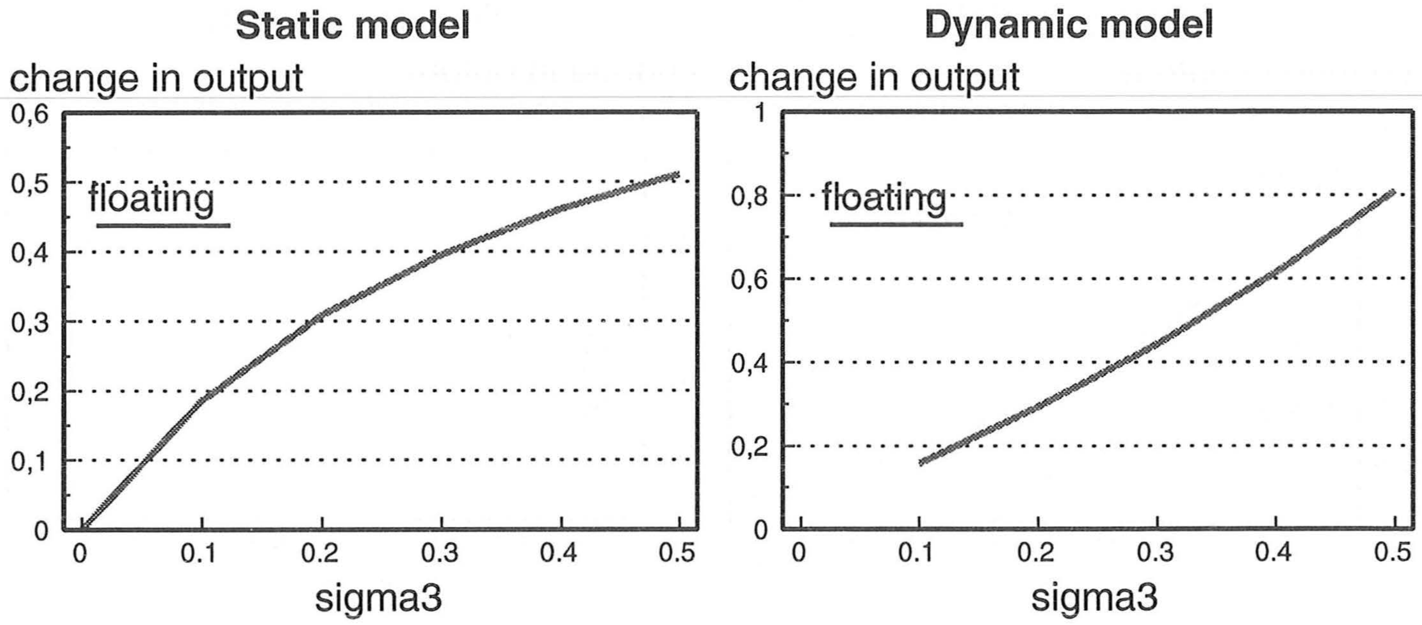
In the case of **a domestic goods demand shock** a high degree of product differentiation makes the fixed rate regime more attractive compared to the floating rate regime. But even with high differentiation fixed rates perform weaker than floating in absolute terms (figure 39). The greater σ_3 is, the more the appreciation of the exchange rate in the floating rate regime is reflected in output (the change of which is smaller). According to the dynamic model the deviation of output is not sensitive to σ_3 either in the fixed rate regime or in the floating rate regime, where full insulation is achieved.

Figure 39. Domestic goods demand shock in the small country: short-run effects on the output, sensitivity with respect to the degree of product differentiation (the lower σ_3 is, the higher the degree of differentiation)



In the case of **a domestic monetary shock** the fixed rate regime is the more attractive, when compared to floating, the lower is the degree of product differentiation, i.e the higher σ_3 is (figure 40). The fixed rate regime insulates the output fully according to both models. The floating rate affects the output the most with a high competitiveness elasticity. In the case of a positive monetary shock the depreciation of the currency affects the output the more the greater σ_3 is.

Figure 40. Domestic monetary shock in the small country: short-run effect on the output, sensitivity with respect to the degree of product differentiation (the lower σ_3 is, the higher the degree of differentiation)[29]

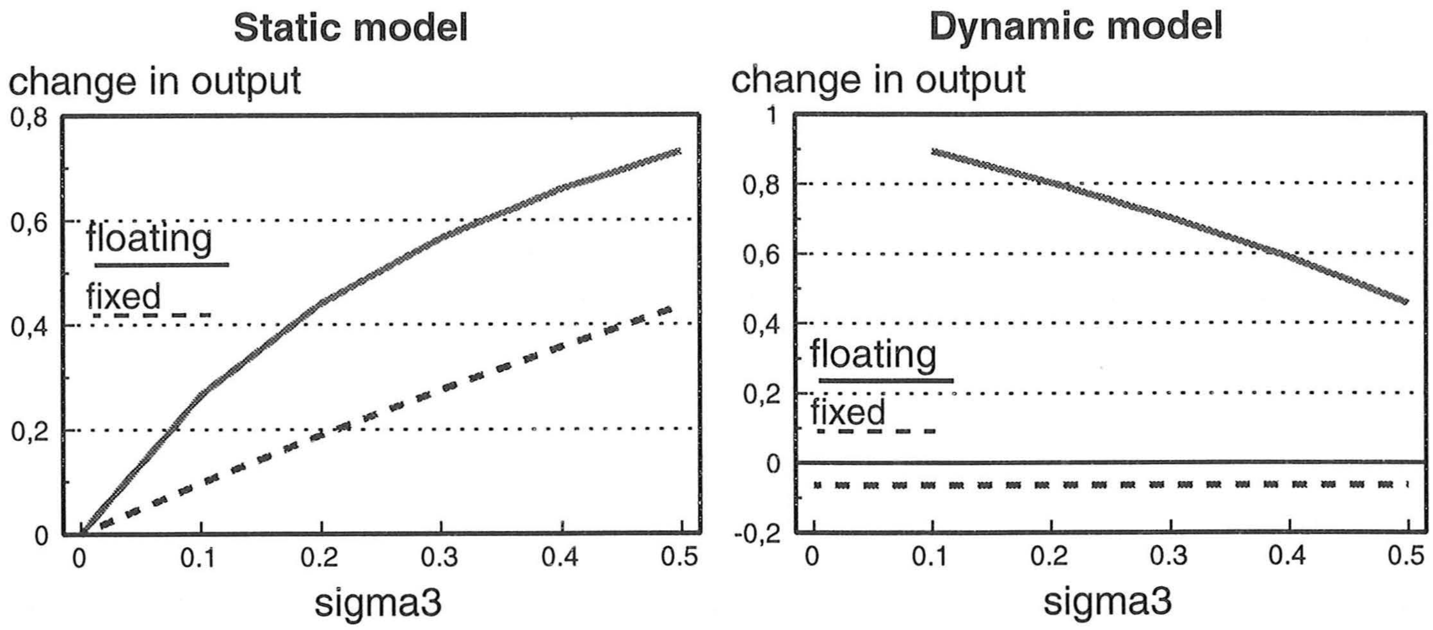


In the case of **a domestic productivity shock** no clear conclusion can be drawn. According to the static model the deviation in output is the smallest in both regimes with very small values of σ_3, i.e. with a very high product differentiation. In this case the changes in the exchange rate and prices are reflected the least as an improvement in competitiveness. The relative attractiveness of fixed rates increases, however, when product differentiation declines. (Figure 41.) In the dynamic model it is vice versa. This difference is due to the exchange rate reaction. When σ_3 is small, the depreciation of the exchange rate is very strong in the dynamic model and declines sharply when σ_3 grows. In the static model, where we have a supply curve according to the

[29]When $\sigma_3 = 0$, the effect on output is indeterminate in the dynamic model.

baseline scenario the exchange rate effect is weaker; and the higher σ_3 is, the more the supply side price effect is reflected in both regimes in the output.

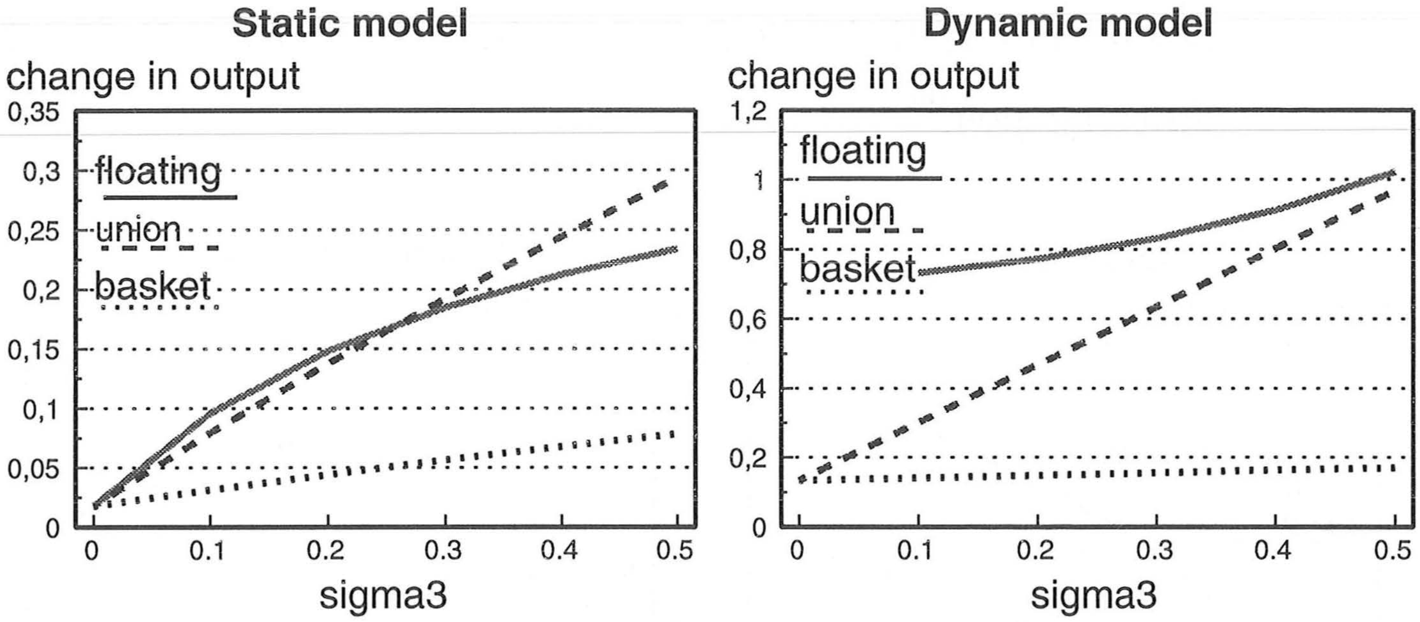
Figure 41. Domestic productivity shock in the small country: short-run effects on the output, sensitivity with respect to the degree of product differentiation (the lower σ_3 is, the higher the degree of differentiation)[30]



When **a goods demand shock occurs in country 1** the exchange rate union is the most attractive with a high degree of product differentiation (figure 42). The shock reinforcing effect of the depreciating exchange rate (when the f_1 shock is positive) becomes stronger when σ_3 grows. The more differentiated domestic products are (the lower σ_3 is), the less the depreciation affects the output. But even with a high degree of product differention the basket peg regime performs according to this measure better than the exchange rate union.

[30]When $\sigma_3 = 0$, the effect on output is indeterminate in the dynamic model.

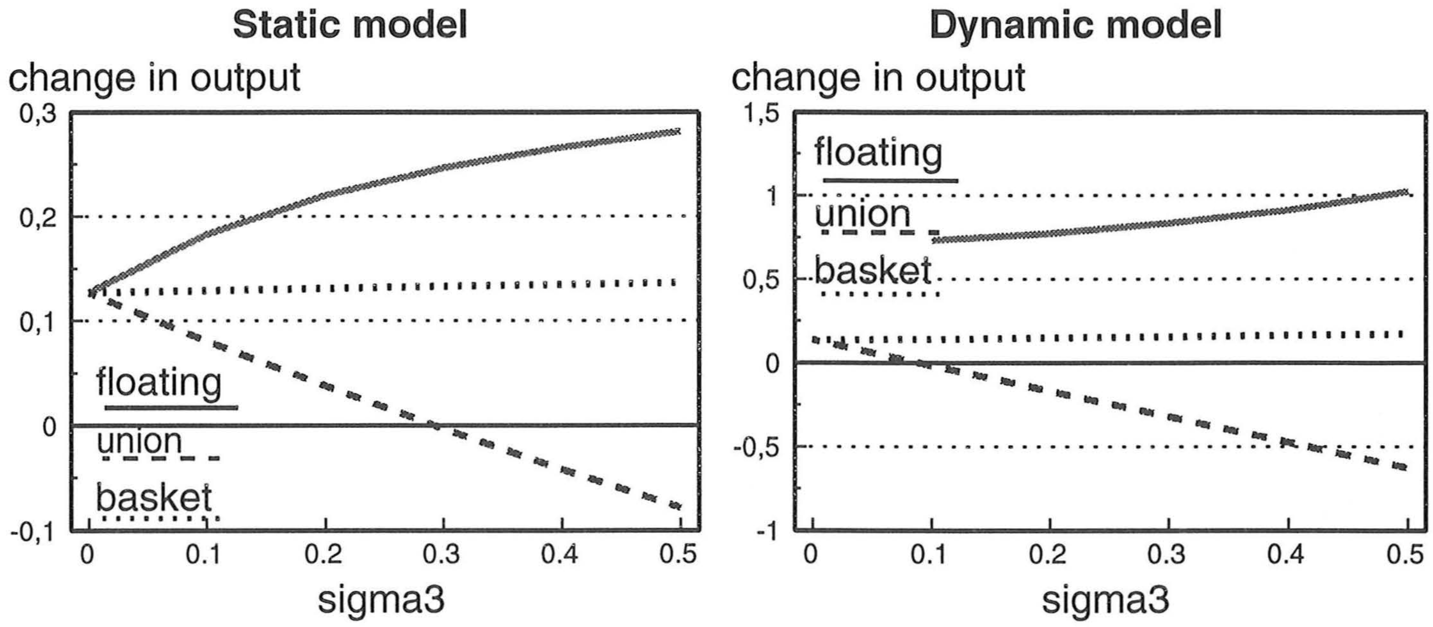
Figure 42. Goods demand shock in country 1: short-run effects on the output of country 3, sensitivity with respect to the degree of product differentiation (the lower σ_3 is, the higher the degree of differentiation)[31]



When **a goods demand shock occurs in country 2** (the potential union partner) a medium degree of product differentiation makes the exchange rate union the most attractive (figure 43). This is due to the properly strong exchange rate effect in this case. With a low value of σ_3 the exchange rate effect is not strong enough to compensate for the foreign demand effect. With a high value of σ_3, in turn, the exchange rate effect overcompensates so that the output deviation becomes greater in the opposite direction.

[31]When $\sigma_3 = 0$, the effect on output is indeterminate in the dynamic model.

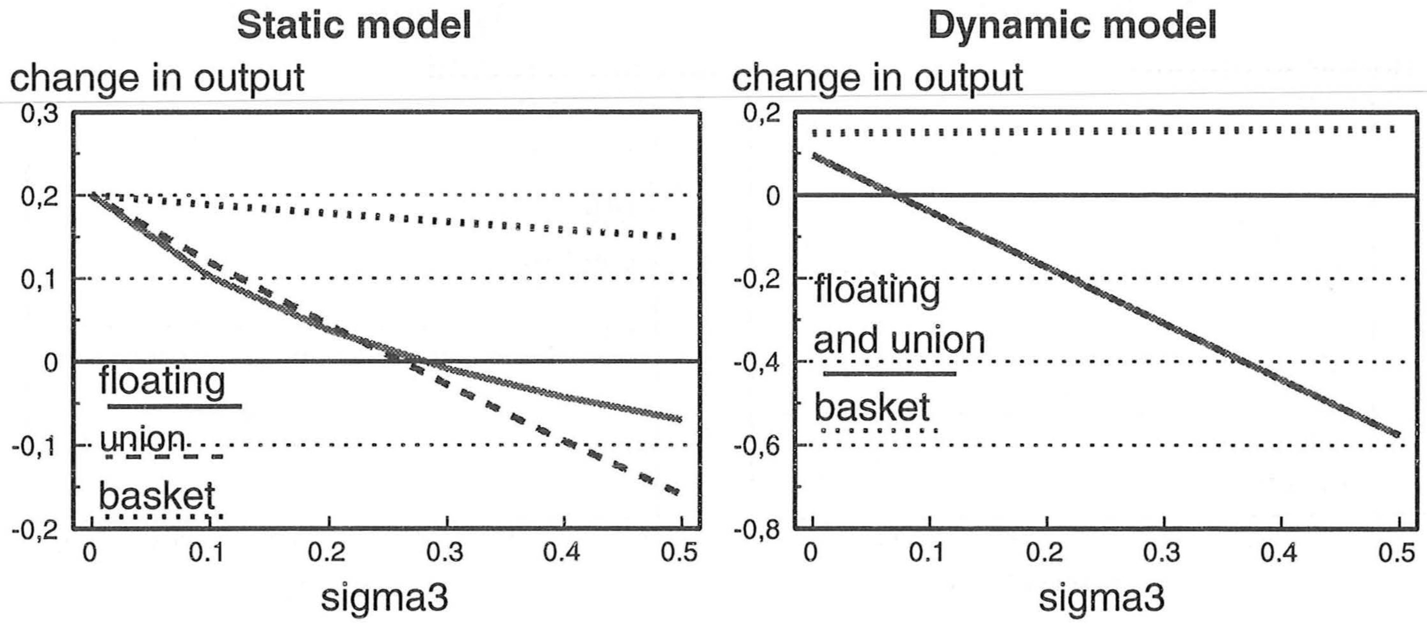
Figure 43. Goods demand shock in country 2: short-run effects on the output of country 3, sensitivity with respect to the degree of product differentiation (the lower σ_3 is, the higher the degree of differentiation)[32]



In the case of **a monetary shock occurring in country 1** output effects are in the exchange rate union exactly the same as in the floating rate regime in the dynamic model and very similar in the static model (figure 44). According to both models we can conclude that the exchange rate union performs relatively the best with a medium degree of product differentiation. In this case the competitiveness effect compensates for the export demand effect, which has an opposite sign.

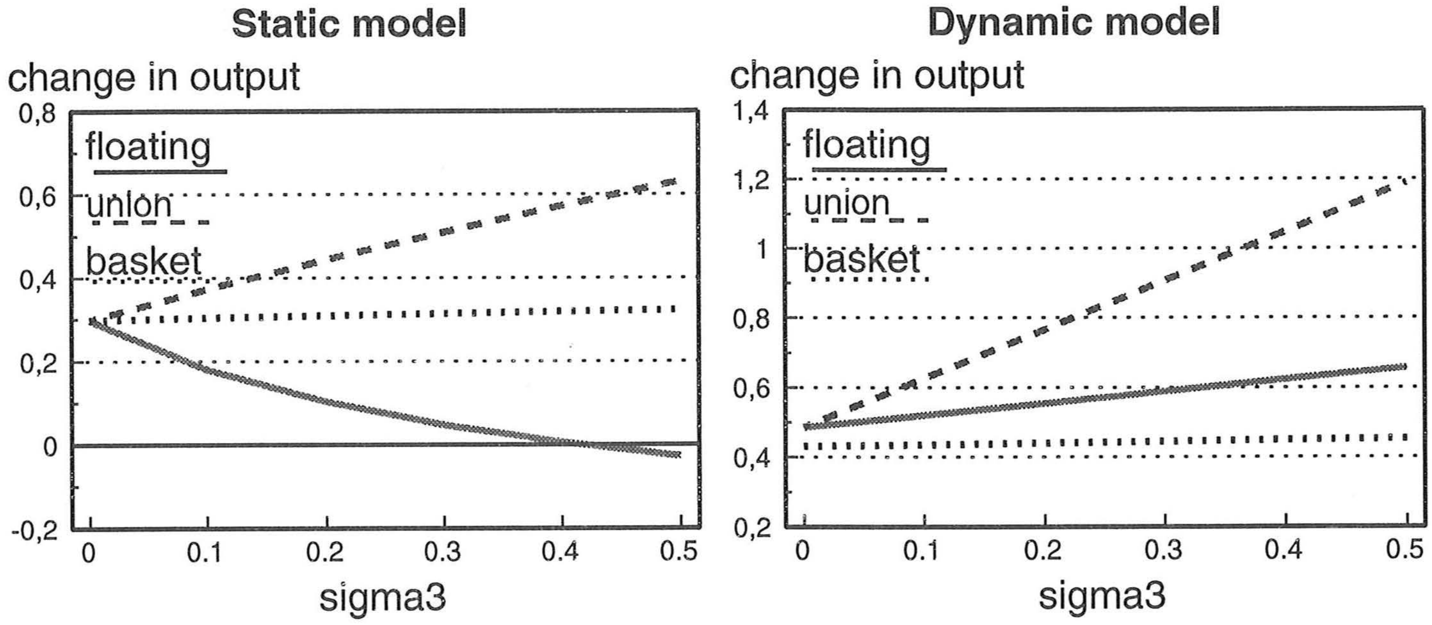
[32]When $\sigma_3 = 0$, the effect on output is indeterminate in the dynamic model.

Figure 44. Monetary shock in country 1: short-run effects on the output of country 3, sensitivity with respect to the degree of product differentiation (the lower σ_3 is, the higher the degree of differentiation)



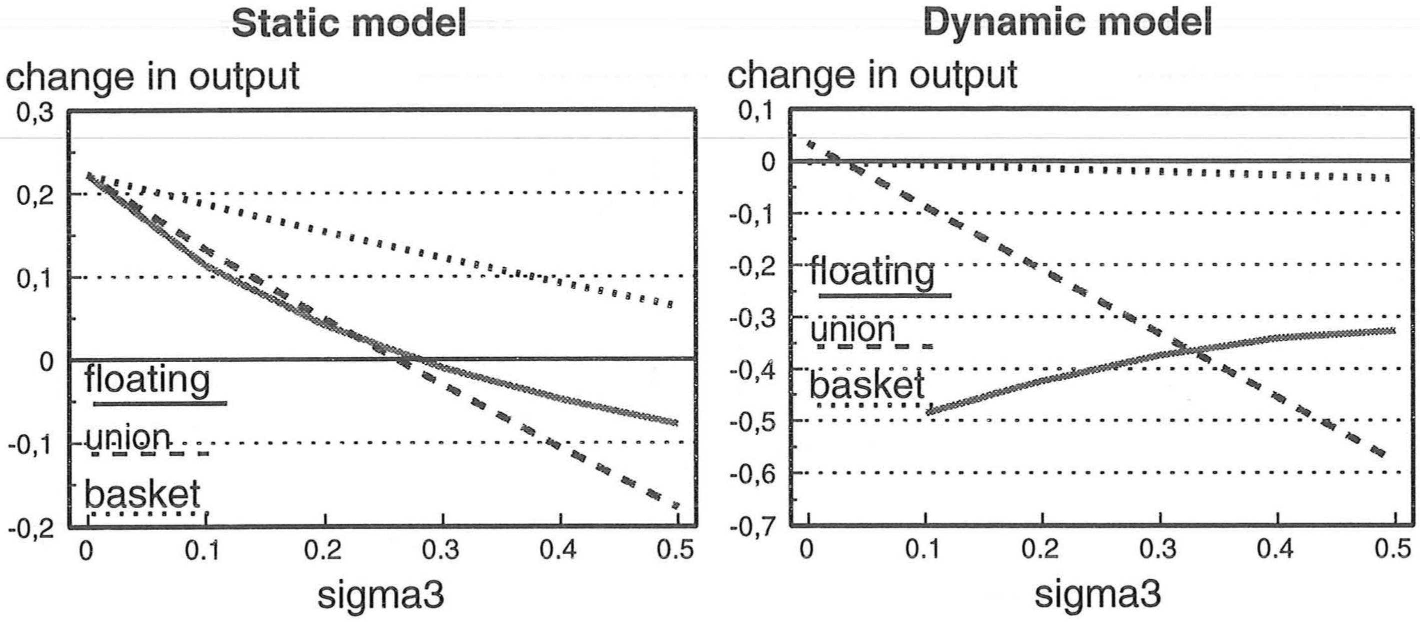
When **a monetary shock occurs in country 2** the exchange rate effect reinforces export demand and interest rate effects in the exchange rate union (tables 5 and 12). In this case the insulation of the output of the small country against the shock is the best when σ_3 is low, i.e. when products are so differentiated that their demand is not sensitive to changes in competitiveness (figure 45).

Figure 45. Monetary shock in country 2: short-run effects on the output of country 3, sensitivity with respect to the degree of product differentiation (the lower σ_3 is, the higher the degree of differentiation)



In the case of **a productivity shock occurring in country 1** the situation is very similar to that of a corresponding monetary shock. In this case interest rate and competitiveness affect in opposite directions (tables 5 and 12). According to the static model the exchange rate union is the most attractive with a medium degree of product differentiation (figure 46). According to the dynamic model minimization of output deviation from the normal level is achieved with a rather low degree of differentiation. The difference is due to the differing export demand effects in these models. In the demand-determined dynamic model the short-run export demand effect is negative if there is a productivity shock in the less important trading partner (table 12, figure 28). In the static model with a supply side the foreign demand effect is positive (table 5, figure 14).

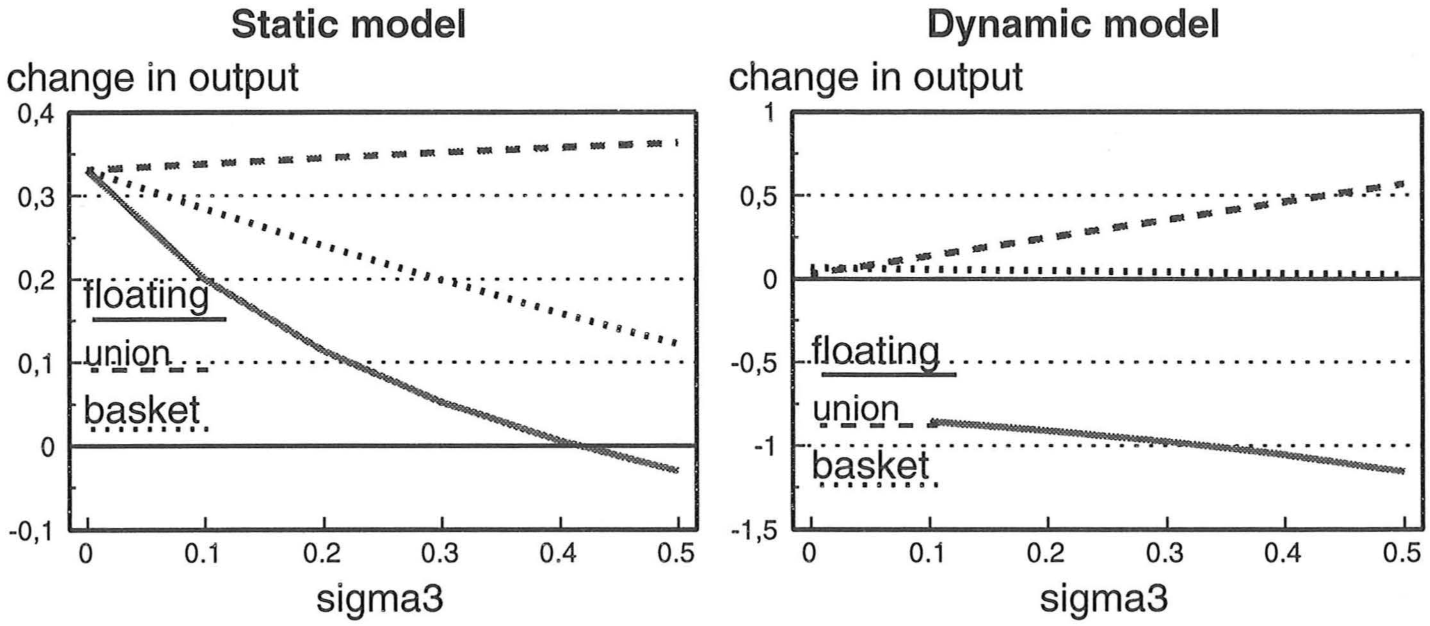
Figure 46. Productivity shock in country 1: short-run effects on the output of country 3, sensitivity with respect to the degree of product differentiation (the lower σ_3 is, the higher the degree of differentiation)[33]



When **a productivity shock occurs in country 2** the exchange rate effect reinforces the export demand and interest rate effects. Accordingly, deviation of output from the normal level is the smallest in the exchange rate union when production is very differentiated (σ_3 is small), i.e. when the effect of the exchange rate on output is as small as possible (figure 47).

[33]When $\sigma_3 = 0$, the effect on output is indeterminate in the dynamic model.

Figure 47. Productivity shock in country 2: short-run effects on the output of country 3, sensitivity with respect to the degree of product differentiation (the lower σ_3 is, the higher the degree of differentiation)[34]



We can conclude from this analysis that in four of nine cases the exchange rate union is the most attractive with a high degree of product differentiation, with a medium degree in three cases and with a low degree of differentiation in one case. In one case the conclusion cannot be drawn because the outcomes of the two models are so different. These results point to the hypothesis that the exchange rate union is more attractive with a high or medium degree of product differentiation rather than with a low degree.

[34]When $\sigma_3 = 0$, the effect on output is indeterminate in the dynamic model.

6.4 Summary

We have studied above three potential criteria for optimum currence areas: (1) the degree of price indexation, (2) the degree of foreign trade integration with the potential union partner, and (3) the degree of product differentiation. We notice that the conclusions are not fully straightforward for any of these criteria. For the two first-mentioned criteria the outcome is, however, more clear than for the last-mentioned one.

For the degree of price indexation we obtain the result that when foreign indexation is rather low, a high or medium degree of price integration makes the exchange rate union more attractive than a low one in all cases except in those of domestic monetary and productivity shocks. When foreign indexation is high, however, the optimal domestic indexation is low or negative.

An exchange rate union is more attractive when the foreign trade share of the potential union partner is high or medium-sized rather than low. This is due to the more stable exchange rate between the union partners in this case. When trade with third countries is extensive, also the effective exchange rate changes more. In some cases, however, a medium degree of foreign trade integration is optimal, because then the competitiveness and export demand effects balance each other more than in the case of a high degree of integration.

The degree of product differentiation appears to be a less general criterion than the two previous ones. In four of nine shocks the exchange rate union is the most attractive with a high degree of product differentiation, with a medium degree in three cases and with a low degree of differentiation in one case. In one case a conclusion cannot be drawn because the static and dynamic models lead to conflicting outcomes. The results point, however, to the hypothesis that the exchange rate union tends to be more attractive with a high or medium degree of product differentiation rather than with a low degree.

7 INDEXATION OF PUBLIC EXPENDITURE AND TAXES IN DIFFERENT EXCHANGE RATE REGIMES

Indexation has been traditionally connected to wages and prices (see chapter 6.1). This kind of an analysis has, however, been widened to taxation, too. This body of literature is not very wide. The classic contribution in this research area is Bruce (1981). He studies income tax indexation with a closed-country model in the face of demand and supply disturbances. Bruce concludes that tax indexation increases the magnitude of output changes resulting from demand disturbances and decreases the magnitude of output changes resulting from supply disturbances. This result is the opposite of that obtained by Gray (1976) in the case of wage indexation.

Holmes and Smyth (1972) as well as Mankiw and Summers (1986) show that tax cuts can be contractionary if consumer expenditure is used as a scale variable in the money demand equation. Lassila (1995) is based on this finding about the effects of tax indexation through the money market. He, however, uses real disposable income as this kind of a scale variable. He builds a model which has a traded and non-traded goods sector, floating exchange rates and progressive taxation. He shows that Bruce's (1981) results are not general, but depend on the price elasticities of the traded and non-traded goods markets.

The studies in the field of tax indexation have been carried out with different models either in a closed country or floating rate context. No analysis with the same model of the effects in different exchange rate regimes exists, as far as

I know. In this chapter the analysis is done having the exchange rate regime as the central criterion. In the case of indexation of public expenditure the analysis is also widened to the study of foreign shocks.

In section 7.1 we focus first on the study of indexation of public expenditure. The logic is the same as in the case of tax indexation, but now we do not need to worry about the progressive taxation. The relevance of the study is in checking how the stabilization properties of the different exchange rate regimes are affected by the degree of indexation of public expenditure. From a policy point of view we ask whether indexation of public expenditure can be used as a tool in making the stabilization properties of the exchange rate regimes better. Fully unindexed public expenditure means a given sum of nominal expenditure regardless of the rate of inflation. Fully indexed public expenditure, in turn, means that inflation is fully taken into account when determining the level of public expenditure. This can be done, for example, by means of supplementary government budgets. Full indexation of public expenditure is assumed implicitly in the previous chapters.

In section 7.2 we modify the small country model suitable for analyzing the effects of tax indexation in fixed and floating rate regimes. We study now the effects of indexing the progressive taxes to changes in the price level. In addition to price developments the tax rate is affected by changes in real income. The tax rate in turn affects wage demands and consequently prices through the supply curve. We omit here the foreign shocks, because tax indexation complicates the model so much that the effects would no longer be transparent.

7.1 Indexation of public expenditure

7.1.1 The model

We use in the analysis the static model presented in chapter 4. We assume that the big country model is exactly the same as before. This means implicitly that public expenditure is fully indexed. The small country model is modified as follows:

$$(163)\ m_3 - p_3 = k_3y_3 - \Phi_3i_3$$

$$(164)\ y_3 = -\mu_3r_3 + \sigma_3[\theta(e_{31} + p_1 - p_3) + (1 - \theta)(e_{32} + p_2 - p_3)] + \varepsilon_3[\theta y_1 + (1 - \theta)y_2] + g_3$$

$$(165)\ g_3 = f_3 - (1 - \lambda_3)\pi_3p_3$$

$$(166)\ p_3 = \alpha_3[\theta(e_{31} + p_1) + (1 - \theta)(e_{32} + p_2)] + \beta_3y_3 - s_3$$

$$(167)\ i_3 = i_1 = i_2 = r_3 = r_1 = r_2 \text{ (ex ante).}$$

In comparison to the original static model we have here an additional equation (165), which represents the indexation of public expenditure. The symbol g_3 denotes the endogenous real public expenditure, which is adjusted by changes in the price level p_3. The term π_3 denotes the elasticity of aggregate demand with respect to public expenditure. We can assume here that indexation of taxation is a separate issue and decided independently from the indexation of public expenditure. In this case the value of π_3 can be rather large. The symbol λ_3 denotes the indexation parameter. If $\lambda_3 = 1$, public expenditure is fully indexed, and we have just the exogenous (real) goods demand term f_3 as before. If $\lambda_3 = 0$, public expenditure is fully unindexed, and changes in the price level change its real value by a full amount. In theory indexation can be also overcompensating (when $\lambda_3 > 1$) or negative (when $\lambda_3 < 0$). The other symbols of the model are as in chapter 4.

After inserting equation (165) into (164) we see that the demand curve becomes steeper when public expenditure is indexed than without indexation.[35] Changes in prices are thus reflected less in goods demand. Without indexation, for example, decreasing prices tend to increase real aggregate demand. Indexation diminishes this effect, which is destabilizing in the case when output increases as a result of the shock.

The model is solved for different exchange rate regimes in the face of different shocks as before. In the following we study the effects of the degree of indexation on the economic variables, especially on the deviation of output.

7.1.2 Domestic shocks

In the case of **a domestic goods demand shock** the effects on output, prices and the exchange rate in the floating rate regime are as follows:

$$(168)\quad \frac{\delta y_3}{\delta f_3} = \frac{\alpha_3}{\alpha_3(1-k_3\pi_3+k_3\lambda_3\pi_3-k_3\sigma_3)+\sigma_3(\beta_3+k_3)},$$

$$(169)\quad \frac{\delta p_3}{\delta f_3} = \frac{-\alpha_3 k_3}{\alpha_3(1-k_3\pi_3+k_3\lambda_3\pi_3-k_3\sigma_3)+\sigma_3(\beta_3+k_3)},$$

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[35]Output is depicted on the horizontal axis and price on the vertical axis.

$$(170)\ \frac{\delta e_3}{\delta f_3} = \frac{-\beta_3 - k_3}{\alpha_3(1 - k_3\pi_3 + k_3\lambda_3\pi_3 - k_3\sigma_3) + \sigma_3(\beta_3 + k_3)}.$$

The denominator of the above expressions is obviously positive, because $\alpha_3 k_3 \pi_3$ and $\alpha_3 k_3 \sigma_3$ are small compared to the rest of the variables (for example, it is obvious that $k_3\pi_3 < 1$ and $k_3\sigma_3 \geq \alpha_3 k_3 \sigma_3$ (assuming $0 \leq \alpha_3 \leq 1$)). The effect of a positive domestic goods demand shock on output is accordingly positive if $\alpha_3 > 0$. (For the intuition in the case of full indexation, see pp. 43-44.) We see now that an increase in λ_3 increases the denominator and decreases the whole expression.

An increase in the indexation of public expenditure thus decreases the deviation of output from the equilibrium level.[36] The reason for this is that the price level decreases as a result of an appreciation of the currency, and the real public expenditure increases less when a decreasing price level is taken into account in determining the nominal level of public expenditure. The IS curve thus shifts less to the right in the case of indexation.

The goods demand curve is steeper in the case of indexation. Because also the supply curve shifts downwards due to the appreciation, a shift in a steeper demand curve leads to a smaller increase in output than a shift in a flatter demand curve. Similarly, we see that an increase in indexation decreases also the deviation of prices and exchange rate. The smaller decrease in prices is due to the smaller appreciation of the exchange rate. The supply curve shifts less downwards in the case of indexation, because the appreciation is smaller.

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[36]From a policy point of view this means that indexation of public expenditure reduces the effectiveness of fiscal policy.

In the fixed exchange rate regime an increase in the indexation of public expenditure increases the deviation of output and prices. This is seen in the following expressions:

$$(171)\frac{\delta y_3}{\delta f_3}=\frac{1}{1+\beta_3\pi_3-\beta_3\lambda_3\pi_3+\beta_3\sigma_3},$$

$$(172)\frac{\delta p_3}{\delta f_3}=\frac{\beta_3}{1+\beta_3\pi_3-\beta_3\lambda_3\pi_3+\beta_3\sigma_3},$$

The intuitive explanation for this is that an exogenous positive goods demand shock leads in the fixed rate regime to an increase in the price level. Taking this into account in the determination of public expenditure reinforces the magnitude of the initial shock. The IS curve shifts more to the right in the case of indexation. The supply curve does not shift in the fixed rate regime (prices of foreign inputs do not change). The shift of a steeper demand curve (in the case of indexation) leads to a greater change in output than a shift of a flatter demand curve (the case without indexation).

In the case of indexation changes in prices are greater than without indexation. This is due to the additional increase in output, which shifts the price level upwards.

When comparing the output effects in the floating and fixed rate regimes we see that the equality of effects in the case when $\alpha_3 = 1$ does not hold any more. This is due to the new channel of prices to the aggregate demand and due to the effects of indexation on the price level. The equality of output effects requires that also $\lambda_3 = 1$.

Floating insulates the output fully when $\alpha_3 = 0$. But when prices are indexed and public expenditure is unindexed, *a priori* conclusions cannot be drawn any more. It can even be shown that when $\alpha_3 = 1$ and $\lambda_3 = 0$, fixed rates lead to a smaller deviation of output than floating.[37] The outcome is the opposite to the traditional Mundell-Fleming result. This is due to the declining prices in the floating rate regime and rising prices in the fixed rate regime. Without indexation of public expenditure the increase in the aggregate demand is reinforced in the floating rate regime and dampened in the fixed rate regime.

In the case of **a domestic monetary shock** the effects of a rise in the degree of indexation on output deviation cannot be shown *a priori* in the floating rate regime. (See expression (173) below.) The effect depends on the magnitude of the response of domestic prices to foreign prices α_3. The value of the indexation parameter, which minimizes the output deviation is $\lambda_{3opt} = 1 + \sigma_3/\pi_3 - \sigma_3/(\alpha_3\pi_3)$.

If $\alpha_3 = 1$, $\lambda_{3opt} = 1$. If $\alpha_3 = 1$ and $\lambda_3 < 1$, output declines. An increase in the aggregate demand through indexation is thus needed to insulate the output. The smaller α_3 is, the smaller the optimal degree of indexation of public expenditure. In the baseline scenario, where $\alpha_3 = 0.3$ and $\pi_3 = 0.3$, an increase in indexation from 0 to 1 increases the deviation of output and decreases the deviation of prices.[38] The signs of the effects on the deviation of prices and the exchange rate are clear *a priori*: both deviations become smaller when

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[37]When $\alpha_3 = 1$ and $\lambda_3 = 0$, in the floating rate regime $\delta y_3/\delta f_3 = 1/(1 - k_3\pi_3 + \sigma_3\beta_3)$ and in the fixed rate regime $\delta y_3/\delta f_3 = 1/(1 + \beta_3\pi_3 + \sigma_3\beta_3)$.

[38]The assumption $\pi_3 = 0.3$ reflects the share of the public sector in the aggregate demand.

indexation of public expenditure grows (assuming that the denominator is positive) (expressions (174) and (175)).

$$(173)\frac{\delta y_3}{\delta m_3}=\frac{\alpha_3(\lambda_3\pi_3-\pi_3-\sigma_3)+\sigma_3}{\alpha_3(1-k_3\pi_3+k_3\lambda_3\pi_3-k_3\sigma_3)+\sigma_3(\beta_3+k_3)},$$

$$(174)\frac{\delta p_3}{\delta m_3}=\frac{\alpha_3+\beta_3\sigma_3}{\alpha_3(1-k_3\pi_3+k_3\lambda_3\pi_3-k_3\sigma_3)+\sigma_3(\beta_3+k_3)},$$

$$(175)\frac{\delta e_3}{\delta m_3}=\frac{1+\beta_3\pi_3-\beta_3\lambda_3\pi_3+\beta_3\sigma_3}{\alpha_3(1-k_3\pi_3+k_3\lambda_3\pi_3-k_3\sigma_3)+\sigma_3(\beta_3+k_3)}.$$

The controversy with respect to output effects is explained by the conflicting impacts of the rising price level after the (positive) shock. In expression (21) we see that the insulation of output is the better the higher the indexation of domestic prices to the exchange rate (α_3) (up to 1). On the one hand, higher indexation of public expenditure to the rising domestic price level tends to increase the real value of aggregate demand. On the other hand, this form of indexation dampens the appreciation of the exchange rate and accordingly the rise in the price level. The smaller depreciation weakens also the stimulating effect of an expansive monetary shock. The sign of expression (173) is not as clear as that of (21), where public expenditure is implicitly fully indexed.

Graphically the indexation of public expenditure is again depicted by a steeper demand curve than without indexation. In the case of a positive monetary shock the demand curve shifts to the right as a result of the improving competitiveness due to the depreciation of the currency. The supply curve, in turn, shifts upwards, because the depreciation makes inputs (including labour) more expensive (in the case of indexation by less). The graphs show, too, that the net effect on output in the case of indexation and without indexation is not clear *a priori*.

In the fixed exchange rate regime output and prices are fully insulated regardless of the degree of indexation.

In the case of **a domestic productivity shock** increasing indexation of public expenditure decreases the deviation of output and prices in the floating rate regime, assuming that the denominator of the following expressions is positive (see page 266):

$$(176)\ \frac{\delta y_3}{\delta s_3} = \frac{\sigma_3}{\alpha_3(1-k_3\pi_3+k_3\lambda_3\pi_3-k_3\sigma_3)+\sigma_3(\beta_3+k_3)},$$

$$(177)\ \frac{\delta p_3}{\delta s_3} = \frac{-k_3\sigma_3}{\alpha_3(1-k_3\pi_3+k_3\lambda_3\pi_3-k_3\sigma_3)+\sigma_3(\beta_3+k_3)},$$

$$(178)\ \frac{\delta e_3}{\delta s_3} = \frac{1-k_3\pi_3+k_3\lambda_3\pi_3-k_3\sigma_3}{\alpha_3(1-k_3\pi_3+k_3\lambda_3\pi_3-k_3\sigma_3)+\sigma_3(\beta_3+k_3)}.$$

Taking into account the declining price level in the determination of public expenditure decreases the aggregate demand from what it is without indexation and tends to stabilize output. The IS and LM curves shift less to the right in the case of indexation.

On the goods market the graphical explanation is as follows. The supply curve shifts downwards in the case of a positive productivity shock. The effect of the more expensive inputs due to the depreciation is smaller than the initial shock (see equation (166)). The demand curve shifts to the right because of the improving competitivensss. Due to the steeper demand curve in the case of indexation the output increases in this case by less than without indexation of public expenditure.

The exchange rate depreciates more when indexation increases, assuming $0 \leq \alpha_3 \leq 1$ and $1 - k_3\pi_3 + k_3\lambda_3\pi_3 - k_3\sigma_3 > 0$. In this case the numerator of the above expression increases faster than the denominator. Graphically this means that the supply curve shifts downwards in the case of indexation by less than without indexation.

In the fixed rate regime the deviation of output becomes smaller when the degree of indexation grows, because we can assume that the elasticity of prices with respect to the change in output (β_3) is clearly less than one. The effect of indexation is explained by the behaviour of prices. The decreasing price level occurring after a positive productivity shock is taken into account in the case of indexation. The real public expenditure is accordingly smaller than without indexation. The IS curve shifts less to the right than without indexation. The degree of indexation which minimizes the output deviation is $\lambda_{3opt} = 1 + \sigma_3/\pi_3$. Prices change more when indexation grows. This is due to the smaller change in output. Output and price effects are seen in the expressions below:

$$(179)\frac{\delta y_3}{\delta s_3}=\frac{\pi_3(1-\lambda_3)+\sigma_3}{1+\beta_3(\pi_3(1-\lambda_3)+\sigma_3)},$$

$$(180)\frac{\delta p_3}{\delta s_3}=\frac{-1}{1+\beta_3(\pi_3(1-\lambda_3)+\sigma_3)}.$$

When comparing the deviation of output in the case of no indexation of public expenditure ($\lambda_3 = 0$), we see that the outcome is more complicated than in the case of full indexation ($\lambda_3 = 1$) (chapter 4). We can no longer show *a priori* (or with reasonable assumptions on the parameter values) which regime leads to the smallest deviation. The equality of effects when $\alpha_3 = 1$ collapses, as in the case of other domestic shocks. This modification of the results is due to the differing size of the effects of indexation in the regimes.

We collect the effects of increasing indexation of public expenditure on the deviation of output and prices in tables 13 and 14, respectively. The symbol "+" means an increasing and "-" decreasing deviation of the variable from the normal level. Zero refers to the case when the outcome is insensitive to indexation.

Table 13. The effects of an increasing indexation of public expenditure on the deviation of output from the normal level (+, - or 0)

	Floating rates	Fixed rates
Domestic goods demand shock	-[1]	+
Domestic monetary shock	?	0
Domestic productivity shock	-[1]	-[2]

[1] Assuming that the denominator of the expressions is positive (see page 266).
[2] Assuming that $\beta_3 < 1$.

We see above that the effects of indexation on output differ between shocks. With respect to the deviation of prices the effects are more clearcut (table 14). Indexation of public expenditure tends to stabilize prices in the floating rate regime and to reinforce the deviation in the fixed rate regime.

Table 14. The effects of an increasing indexation of public expenditure on the deviation of prices from the normal level (+, - or 0)

	Floating rates	Fixed rates
Domestic goods demand shock	-[1]	+
Domestic monetary shock	-[1]	0
Domestic productivity shock	-[1]	+

[1] Assuming that the denominator of the expressions is positive (see page 266).

In the fixed rate regime the output effects are the opposite to those in the floating rate regime in the case of goods demand shocks. This is due to the differing price reactions in the two regimes. When monetary shocks occur, output is insulated in the fixed rate regime regardless of the degree of indexation. In the case of a productivity shock the effects have instead the same sign. This is due to the decreasing price level in both regimes. Taking into account the declining price level (indexation) makes the real value of public expenditure smaller than without indexation.

When combining the results in the cases of different shocks we use a loss function approach and assume that the variances of each shock are the same and the shocks are independent of each other (as in chapter 4.4.2). The optimal degree of indexation is obtained for the floating rate regime by minimizing the following loss function

$$L^{o}_{f}=\sigma^{2}_{shock}[(\frac{\delta y_3}{\delta f_3})^2+(\frac{\delta y_3}{\delta m_3})^2+(\frac{\delta y_3}{\delta s_3})^2]$$

with respect to λ_3. The multipliers of the loss function are obtained from expressions (168), (173) and (176). The symbols are as in chapter 4.

The value of λ_3, which minimizes the loss function is:

$$(181)\lambda_{3_{opt}}=\frac{(k_3+\pi_3+\sigma_3)\alpha_3^2+(\beta_3\sigma_3^2-\sigma_3+\beta_3\pi_3\sigma_3)\alpha_3-\beta_3\sigma_3^2+k_3\sigma_3^2}{\pi_3\alpha_3^2+\beta_3\pi_3\sigma_3\alpha_3}.$$

The second derivative of the loss function is at the extremum positive *a priori*, which guarantees a minimum.

When $\alpha_3 = 0$, the optimal indexation is ∞ (we can assume $k_3 > \beta_3$). When $\alpha_3 = 1$, it is greater than one. Because the negative terms of the expression are small compared to the positive ones, it is obvious that the optimal λ_3 is positive with relevant values of the parameters. It is even rather probable that $\lambda_{3opt} > 1$.[39]

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[39]The multiplier of α_3 is clearly greater in the numerator than in the denominator, and k_3 is obviously greater than β_3.

In the baseline scenario (see appendix 2), and assuming that $\pi_3 = 0.3$ (reflects the share of the public sector in aggregate demand), the optimal value of λ_3 is 2.10256.[40] The corresponding value of the loss function with respect to output deviation is σ^2_{shock}*0.773. With respect to deviation of prices the value of the loss function is σ^2_{shock}*0.653.

From the price deviation point of view the highest possible degree of indexation is optimal.

In the fixed rate regime the optimality of indexation of public expenditure depends on the relative effects in the cases of goods demand and productivity shocks (expressions (171) and (179)). A loss function for the output deviation is again formed as in the case of floating rates (assuming the same variances of the shocks). The loss function is minimized with the following value of λ_3:

$$(182)\lambda_{3_{opt}} = \frac{-\beta_3 + \pi_3 + \sigma_3}{\pi_3}.$$

The minimum is again shown *a priori* (the second derivative of the loss function is positive at the extremum).

[40]The relationship between the optimal degree of indexation of the public expenditure and price indexation (α_3) is a complex one. In the baseline scenario, when α_3 increases somewhat above zero the optimal degree of indexation of public expenditure decreases, but starts then to increase, and continues thereafter up to $\alpha_3 = 1$. This phenomenon is due to the effects of indexation in the case of a monetary shock (see pp. 268-270).

The more responsive domestic output is with respect to relative prices and the less responsive domestic prices are to changes in output, the more likely it is that the optimal indexation is positive. When output reacts strongly to the decline in the domestic relative prices (a high σ_3), output deviation increases in the case of a positive productivity shock. A higher indexation of public expenditure is thus needed to compensate for this effect. The smaller β_3 is, the less an increase in output tends to offset the declining trend of prices in the case of a positive productivity shock. As we have seen above, indexation of public expenditure is attractive in terms of output insulation when prices decline. When $\sigma_3 = \beta_3$, the optimal indexation is 1.

In the baseline scenario with $\pi_3 = 0.3$ the optimal value of λ_3 is 1 (because $\beta_3 = 0.3$). The corresponding value of the loss function with respect to output deviation is σ^2_{shock}*0.917. The value of the loss function with respect to deviation of prices is exactly the same.

The deviation of prices is smaller when no indexation of public expenditure is realized if we exclude negative indexation.

Next we study whether optimal indexation of public expenditure is *a priori* greater in the floating rate regime than in the fixed rate regime as it is in the baseline scenario. We define $\Delta\lambda_3 = \lambda_{3opt}$(floating) - λ_{3opt}(fixed). The result is as follows:

$$(183)\Delta\lambda_3=\frac{(\beta_3+k_3)\alpha_3^2+\beta_3^2\alpha_3+k_3\sigma_3^2-\alpha_3\sigma_3-\beta_3\sigma_3^2}{\pi_3\alpha_3^2+\beta_3\pi_3\sigma_3\alpha_3}.$$

The negative terms in the expression are rather small when compared to the positive ones. The hypothesis cannot, however, be shown to hold *a priori*. Positiveness of the expression is the more likely the higher the income elasticity of money demand k_3. (The greater k_3 is, the more the price level declines in the floating rate regime in the cases of positive goods demand and productivity shocks.)

Above we have assumed that the variances of all shocks are the same and independent of each other. When looking at table 13, we see that in the case of floating great variances of goods demand and productivity shocks in relation to that of monetary shocks increase the attractiveness of indexation in terms of output deviation. In the fixed rate regime, in turn, indexation of public expenditure is the more attractive the higher the variance of productivity shocks in relation to that of goods demand shocks. The common feature in both regimes is that relatively great variances of productivity shocks favour indexation of public expenditure.

7.1.3 Foreign shocks

In the case of foreign shocks the effects of indexation of public expenditure are more complex than in the case of domestic shocks. Even though changes in the price level are the crucial channel also now, the number of parameters is much greater than when the shocks are of a domestic origin. Simulations are accordingly the only way to study these effects. When studying foreign shocks, we can already make a distinction between the two variants of fixed rates: the exchange rate union and the currency basket exchange rate regime.

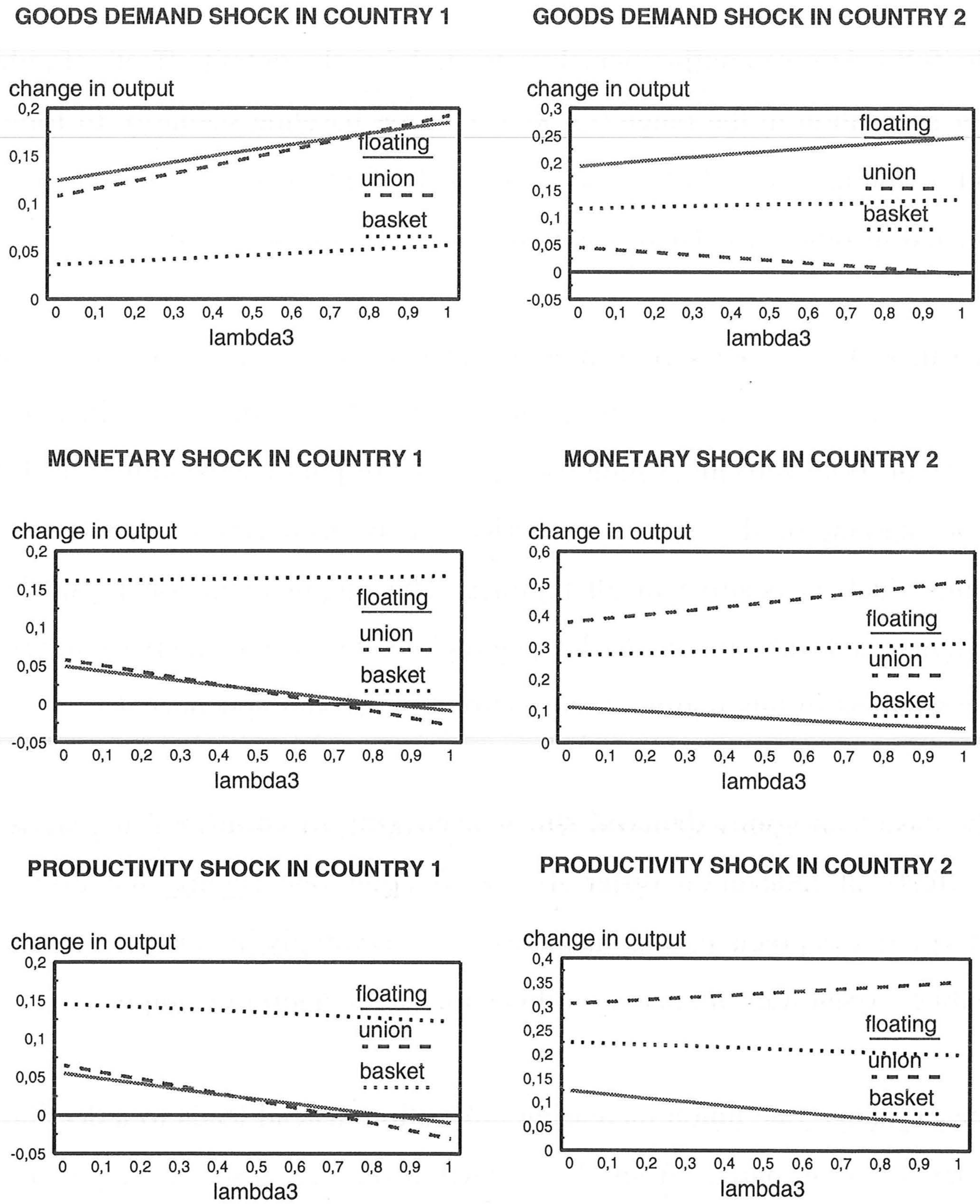
In the following we confine ourselves to studying the output effects of public sector indexation in the range $0 \leq \lambda_3 \leq 1$ in the baseline scenario. In foreign countries public expenditure is assumed to be fully indexed. The results are presented in figure 48. There we assume that the shocks are positive.

When there is **a goods demand shock in country 1**, increasing indexation increases the deviation of output in all regimes. This is due to the increasing price level. With zero indexation the real value of public expenditure declines by the amount of the increase in prices. This decreases the deviation of output, which is positive in all regimes. The output deviation is the least sensitive to indexation in the basket peg regime, because the increase in prices is the smallest in this regime. (See section 4.3.2.1 and appendix 4.)

In the case of **a goods demand shock occurring in country 2** the signs of the effects of indexation differ. In the floating rate regime the effective exchange rate depreciates and the price level accordingly increases. Indexation of public expenditure increases in this case the deviation of output.

In the exchange rate union increasing indexation instead leads to a decline in the deviation of output from the normal level. Because the appreciating effective exchange rate leads to a decline in the price level, taking into account this decline decreases the real public expenditure and stabilizes the output.

Figure 48. Sensitivity of output with respect to the degree of indexation of public expenditure (λ_3) in the cases of foreign shocks (baseline scenario)



In the currency basket exchange rate regime output is rather insensitive to indexation. Output deviation increases slightly with increasing indexation. This is due to the small rise in the price level.

In the case of **monetary shocks occurring in country 1** the price level decreases in the floating rate regime and in the exchange rate union because of the appreciation of the effective exchange rate. Increasing indexation in turn reduces the real public expenditure, which tends to stabilize the output. The optimal indexation is in both regimes somewhat lower than one. In the basket peg regime the price level increases slightly, and indexation of public expenditure increases the deviation of output.

When **a monetary shock occurs in country 2** (the potential exchange rate union partner), the price level declines in the floating rate regime due to the appreciating effective exchange rate. Taking into account this decline in the form of indexation decreases the real value of public expenditure. This tends to stabilize the output.

In the exchange rate union the effective exchange rate depreciates together with that of country 2, which rises the price level. Indexing the public expenditure to the price level leads to a higher level of real public expenditure than without indexation. Increasing indexation thus leads to a greater deviation of output.

In the currency basket exchange rate regime the price level increases somewhat. Increasing indexation of public expenditure tends to strengthen the deviation of output.

In the case of **a productivity shock in country 1** the price level declines in all regimes. Accordingly indexation of public expenditure reduces the increase in aggregate demand, and tends to stabilize the output. In the floating rate regime and in the exchange rate union the optimal degree of indexation is somewhat lower than one.

When **a productivity shock occurs in country 2**, the price levels decline in the floating and basket peg regimes. An increase in the indexation of public expenditure tends to stabilize the output in these regimes. In the exchange rate union the effective exchange rate depreciates together with that of country 2, which raises the price level. Indexation to this rising price level keeps the real public expenditure higher than without indexation. The deviation of output increases accordingly.

According to the simulations done in the baseline scenario, increasing indexation of public expenditure decreases the deviation of the domestic price level in the floating rate regime in the face of all foreign shocks studied. In the exchange rate union and in the basket peg regime the situation is also clearcut: increasing indexation increases the deviation of prices in all cases.

7.1.4 An overall evaluation

The effects of increasing indexation of public expenditure in different exchange rate regimes and in the cases of different shocks are collected in table 15. In the cases of domestic shocks the effects are presented *a priori*, and in the cases of foreign shocks according to the baseline scenario. We see there that the effects differ in each regime according to the shock studied.

The table shows that an increase in indexation of public expenditure leads to a fall in output deviation more often in the floating than in the fixed rate regimes. In six of nine shocks increasing indexation leads in the floating rate regime to a smaller deviation of output and only in two shocks to a higher deviation. This result is explained by such a change in the price level that indexation to this change tends to stabilize the output. In the case of domestic monetary shocks the effect is unknown *a priori*, but there is an increase in the deviation of output in the baseline scenario.

When comparing the outcomes in the exchange rate union and in the basket peg regime, we notice that increasing indexation leads more often to a fall in output deviation in the less fixed regime, i.e. in the exchange rate union. In this regime increasing indexation decreases the deviation of output in four, and in the basket peg regime in three out out of nine cases.

When there is a productivity shock either in the home country or in country 1, increasing indexation makes the deviation of output smaller in all regimes. This is due to the declining price level in the case of a positive shock. Taking this into account in the determination of public expenditure leads to a lower real public expenditure, which tends to stabilize the output.

When there is a goods demand shock in country 1, increasing indexation of public expenditure leads in all regimes to a greater deviation of output. This is again due to the increasing price level in the case of a positive shock, in the floating rate regime and in the exchange rate union due to the depreciating effective exchange rate, and in the basket peg regime due to the import inflation from the more important trading partner, country 2.

Table 15. The effects of an increasing indexation of public expenditure on the deviation of output from the normal level (+, - or 0) in different exchange rate regimes (domestic shocks *a priori*, foreign shocks in the baseline scenario)

	Floating	Union	Basket
Domestic goods demand shock	-[1]	+	+
Domestic monetary shock	?[2]	0	0
Domestic productivity shock	-[1]	-[3]	-[3]
Goods demand shock in country 1	+	+	+
Goods demand shock in country 2	+	-	+
Monetary shock in country 1	-[4]	-[4]	+
Monetary shock in country 2	-	+	+
Productivity shock in country 1	-[4]	-[4]	-
Productivity shock in country 2	-	+	-
Collection of results	- 6 shocks + 2 shocks ? 1 shock	- 4 shocks + 4 shocks 0 1 shock	- 3 shocks + 5 shocks 0 1 shock

[1] Assuming that the denominator of the expressions is positive (see page 265).
[2] Unclear *a priori*, + in the baseline scenario.
[3] Assuming that $\beta_3 < 1$.
[4] Up to somewhat less than full indexation.

The comparison presented above is not, however, enough to tell the attractiveness of indexation of public expenditure in the face of all shocks studied. For this we calculate the loss functions for each regime with respect to domestic as well as foreign shocks in the baseline scenario, and solve the value of the indexation parameter λ_3, which minimizes the output deviation. We again assume that the variances of all shocks are the same and independent of each other. (For the procedure, see section 4.4.2 and expression (74).)

In the floating rate regime the value of the indexation parameter λ_3, which minimizes the output deviation is 1.16288. The corresponding value of the loss function is $L^o_f = \sigma_{2shock}*0.894$.

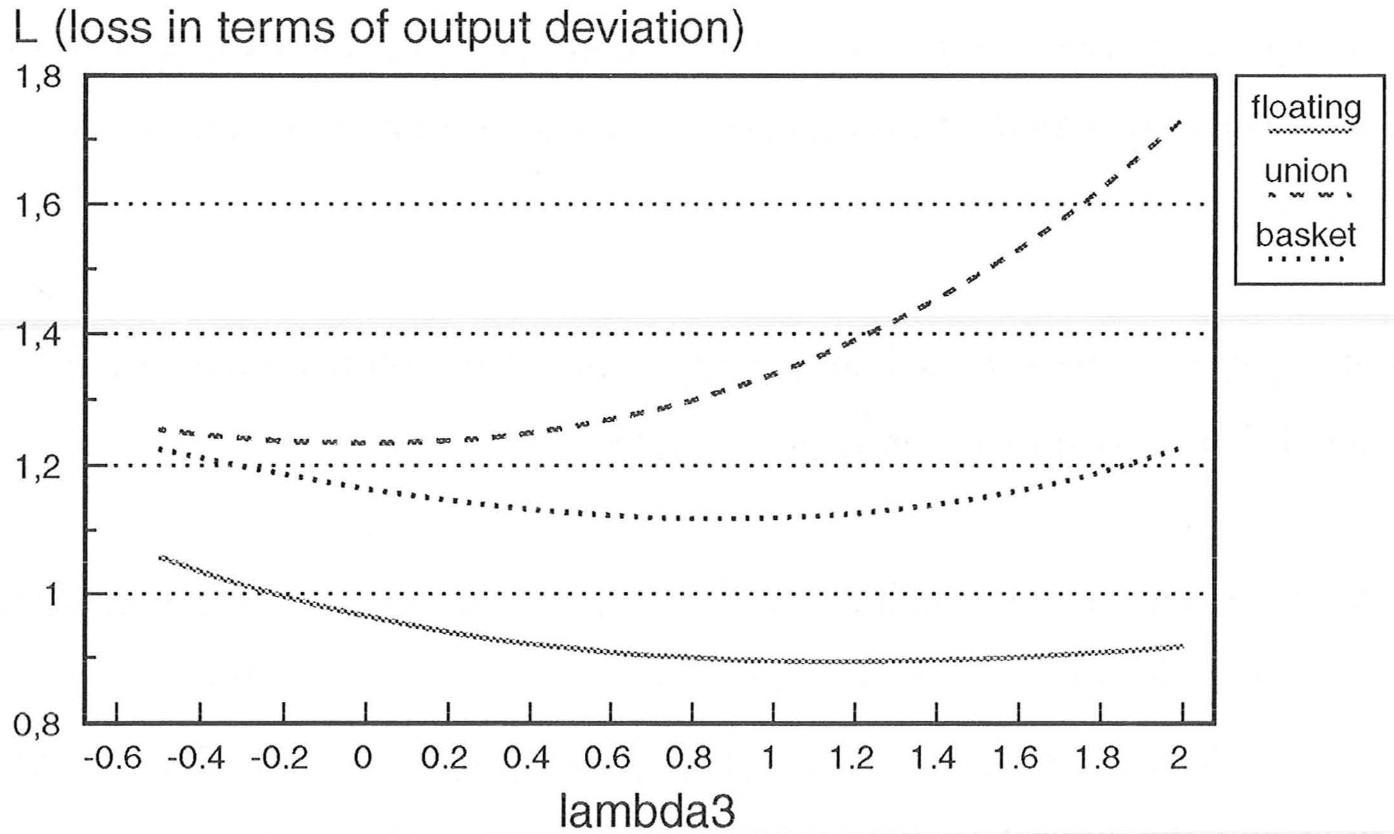
In the exchange rate union the output minimizing degree of indexation is $\lambda_3 = 0$. The corresponding loss function in terms of output deviation is $L^o_u = \sigma^2_{shock}*1.233$.

In the currency basket exchange rate regime the optimal value of λ_3 is 0.86824. The loss function is $L^o_b = \sigma^2_{shock}*1.117$.

Contrary to the picture obtained on the basis of the number of cases, when increasing indexation stabilizes output (table 15), we see above that the optimal indexation of public expenditure is the highest in the floating rate regime and the lowest in the exchange rate union. The optimal degree of indexation in the basket peg regime is rather high. This is explained by the rather stable price development in this regime in the face of foreign shocks, and accordingly, by the low sensitivity of output changes with respect to the degree of indexation. The rather high optimal degree of indexation in the case of domestic shocks thus dominates the outcome (see expression (182) and the text below that).

The loss functions in terms of output deviation are presented in figure 49. We see there that the ranking of the regimes does not change in the baseline scenario ($\alpha_3 = 0.3$) when the degree of indexation remains within reasonable ranges.

Figure 49. The loss functions in terms of output deviation, sensitivity with respect to the indexation of public expenditure (λ_3) (baseline scenario, standardization $\sigma^2_{shock} = 1$)



In appendix 8 it is seen, however, that the situation can change with different values of price indexation (α_3) (if the share of the public sector is big enough). Different forms of indexation are dependent on each other (see for example expression (183)). It is seen in appendix 8 that the optimal degree of indexation of public expenditure depends in the exchange rate union very much on the degree of price indexation. In this regime indexation of public expenditure is attractive only with very high values of α_3. With lower values output deviation is reinforced. The figure shows additionally that when no indexation of public expenditure is implemented, the exchange rate union is more attractive in terms of output deviation with medium (rather than with low or high) values of price indexation (figure 58 in appendix 8). In chapter 4 and in section 6.1 full indexation of public expenditure is implicit in the model. According to the baseline scenario, indexation of public expenditure is attractive in all regimes in terms of output deviation when domestic prices are fully indexed to foreign ones, i.e. when $\alpha_3 = 1$ (figures 55-57 in appendix 8).

Indexation of public expenditure is the most attractive in the floating rate regime also in terms of the deviation of the domestic price level. A rise in indexation decreases the deviation in the floating rate regime in the face of all shocks studied. In the exchange rate union and in the currency basket exchange rate regime the situation is exactly the opposite: the deviation of prices increases with increasing indexation of public expenditure.

The reservation for the conclusions drawn is, in addition to the specification of the model, the fact that in the case of foreign shocks the effects are obtained by numerical simulations in the baseline scenario. Taking into account different degrees of indexation of foreign prices and public expenditure can also modify the conclusions. The study tells anyway many aspects which are of importance in evaluating the use of indexation of public expenditure in different exchange rate regimes.

7.2 Indexation of taxes

7.2.1 The model

We write the small country model by adding tax indexation into the static model as follows:

$$(184)\ m_3 - p_3 = k_3y_3 - d_3t_3 - \Phi_3i_3$$

$$(185)\ y_3 = - \mu_3r_3 + \sigma_3[\theta(e_{31} + p_1 - p_3) + (1 - \theta)(e_{32} + p_2 - p_3)] + \varepsilon_3[\theta y_1 + (1 - \theta)y_2] + f_3 - c_3t_3$$

$$(186)\ t_3 = \upsilon_3 + u_3y_3 + (1 - \omega_3)u_3p_3$$

$$(187)\ p_3 = \alpha_3[\theta(e_{31} + p_1) + (1 - \theta)(e_{32} + p_2)] + \beta_3y_3 + j_3t_3 - s_3$$

$$(188)\ i_3 = i_1 = i_2 = r_3 = r_1 = r_2 \text{ (ex ante)}.$$

Equation (186) expresses the indexation of taxes. This formulation is similar to that of Bruce (1981) and Lassila (1995). Taxes are presented as a ratio of gross to net real income, t_3 is the corresponding logarithm. The symbol υ_3 is a constant, which shows the tax ratio without shocks. If shocks occur, the real output as well as prices change. The degree of tax progression is shown by a positive u_3. If $u_3 < 0$, taxation is regressive. If $u_3 = 0$, taxation is proportional, what means that taxation parameters vanish from the model. The tax ratio increases only in the case of progressive taxation when prices and the real income increase, assuming that the tax schedule is unchanged.

The degree of indexation is presented by ω_3. If $\omega_3 = 1$, full indexation is implemented. If $\omega_3 \neq 1$, changes in the price level affect the tax ratio. Usually it is thought that $0 \leq \omega_3 \leq 1$, but the optimal degree of indexation can be also negative or greater than one.

The effects of tax indexation on aggregate demand are transmitted through the term ($- c_3t_3$). The symbol c_3 denotes the marginal propensity to consume. If prices rise (and $0 \leq \omega_3 < 1$), the increase in taxation reduces real aggregate demand according to the marginal propensity to consume. The less indexed taxation is, the more changes in prices affect the demand. The aggregate demand curve is thus steeper when taxes are indexed than without indexation. Until now the intuition is broadly the same as in section 7.1. Notice, however, that in addition to price developments also changes in real output affect the tax rate.

The effects of taxation are written into the supply curve, too. The reduced form supply curve is derived from the Gray-Fischer labour market submodel as in section 4.1 (equations (12) - (15)). We modify now the wage equation (14) by adding the effect of taxation. For country 3 we write as follows:

$$(189)\ w_3 = \Omega_3\{\tau_3p_3 + (1 - \tau_3)[\theta(e_{31} + p_1) + (1 - \theta)(e_{32} + p_2)]\} + \kappa_3y_3 + h_3t_3,$$

where h_3 = the response of wages to a change in the tax ratio. After inserting the wage equation into the labour demand equation (as (13)) and the new equation again into the production function (as (12)), we obtain the reduced form supply curve (187), where $j_3 = h_3/(1 - \Omega_3\tau_3)$. We see that the higher h_3 is, the higher also j_3 is, because we can usually assume that $\Omega_3\tau_3 < 1$. (Ω_3 = the degree of wage indexation and τ_3 = the share of domestic goods in the consumer price index.) Equation (187) can be written for y_3 (expression (187)'):

$$(187)' \quad y_3 = (1/\beta_3)p_3 - (\alpha_3/\beta_3)[\theta(e_{31} + p_1) + (1 - \theta)(e_{32} + p_2)] - (j_3/\beta_3)t_3 + (1/\beta_3)s_3.$$

The above equation shows that an increase (decrease) in taxation decreases (increases) output supply. After inserting equation (186) into (187) we see that the aggregate supply curve is flatter when taxes are indexed than without indexation. This means that a decline in prices decreases the goods supply more, because the tax ratio is higher than without indexation.

Empirical evidence on the effects of taxation on wages and accordingly on prices is inconclusive. There are studies which point to some positive relationship between taxes and wages (for a survey and conclusion about empirical studies on the Finnish economy, see Pehkonen, 1991).

The effects of taxation are written into the LM curve, too. On the basis of the notions of Holmes and Smyth (1972), Mankiw and Summers (1986) and Lassila (1995) about the importance of the specification of the scale variable in the money demand function, we use two specifications. In the first one $d_3 = 0$, which means that the scale variable is real gross income. When $d_3 = k_3$, the scale variable is the real disposable income. Changes in taxation affect in this case the demand for real money balances. The difference between these specifications is of importance in the floating rate regime. In the fixed rate regime the LM curve is dropped away, because the money supply is perfectly elastic when capital is fully mobile and there is no uncertainty about the level of the exchange rate.

7.2.2 Domestic goods demand shocks

We study again the effects of an exogenous change in domestic demand due to debt financed fiscal policy or due to an exogenous change in foreign demand. In this sense the shock is not necessarily domestic according to the origin, but it is just so specific for the small country that it has no effect (or has a negligible effect) on the big countries. Empirically this shock could be, for example, a drop in the Finnish/Soviet (Russian) trade, which occured in the late 1980's and in the early 1990's.

In **the floating rate regime** we study first the conventional case, where the real gross income is used as the scale variable in the money demand equation, i.e. $d_3 = 0$. The effects of a domestic goods demand shock on output and prices are now as follows:

$$(190)\ \frac{\delta y_3}{\delta f_3} = \frac{\alpha_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3k_3\sigma_3+\alpha_3c_3u_3-\alpha_3c_3k_3u_3+j_3\sigma_3u_3-j_3k_3\sigma_3u_3+\alpha_3c_3k_3u_3\omega_3+j_3k_3\sigma_3u_3\omega_3},$$

$$(191)\ \frac{\delta p_3}{\delta f_3} = \frac{-\alpha_3k_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3k_3\sigma_3+\alpha_3c_3u_3-\alpha_3c_3k_3u_3+j_3\sigma_3u_3-j_3k_3\sigma_3u_3+\alpha_3c_3k_3u_3\omega_3+j_3k_3\sigma_3u_3\omega_3}.$$

We can show that a sufficient condition for the positiveness of the denominator is that $k_3 \leq 1$ and $0 \leq \alpha_3 \leq 1$. The effect of a positive goods demand shock on output is thus positive when $\alpha_3 > 0$. Prices decline due to the appreciating exchange rate. Because in the denominator both terms which include the tax indexation parameter ω_3 are positive, we can conclude that an increase in tax indexation from 0 decreases the deviation of output and prices. The effect on the exchange rate is not clear *a priori.*

The decrease in output deviation is due to the effects of the declining price level on the aggregate demand and supply. Indexation of taxes to declining prices increases the tax ratio, which tends to reduce the aggregate demand (equation (185)) (a steeper aggregate demand curve). The increasing tax ratio tends to decrease also the output supply (equation (187)') (a flatter aggregate supply curve). The IS curve shifts less to the right in the case of indexation than without indexation. The higher tax ratio diminishes the decline in prices, too (equation (187)).

In the case when the scale variable in the LM equation is the real disposable income, i.e. $d_3 = k_3$, the LM curve is flatter than in the case when $d_3 = 0$. The indexation parameter now affects the LM curve through money demand, too. The results are accordingly less clearcut than in the previous case. The effects on output and prices are as follows:

$$(192)\quad \frac{\delta y_3}{\delta f_3} = \frac{a_3 + \alpha_3 k_3 \omega_3 u_3}{a_3 + b_3 + l_3 + q_3 + k_3 u_3(\alpha_3 + \alpha_3 c_3 + \beta_3 \sigma_3 + j_3 \sigma_3)\omega_3},$$

$$(193)\quad \frac{\delta p_3}{\delta f_3} = \frac{\alpha_3(-1 + u_3)}{a_3 + b_3 + l_3 + q_3 + k_3 u_3(\alpha_3 + \alpha_3 c_3 + \beta_3 \sigma_3 + j_3 \sigma_3)\omega_3},$$

where $a_3 = \alpha_3(1 - k_3u_3)$, $b_3 = (1 - \alpha_3)k_3\sigma_3(1 - u_3)$, $l_3 = \alpha_3c_3u_3(1 - k_3)$ and $q_3 = \beta_3\sigma_3(1 - k_3u_3)$. By assuming that $0 \le k_3 \le 1$, $0 \le \alpha_3 \le 1$ and $0 \le u_3 \le 1$, we see that a_3, b_3, l_3 and q_3 are all non-negative. The assumption about k_3 (the income elasticity of money demand) is reasonable and is consistent with many empirical studies. The price indexation parameter α_3 is generally assumed to vary between zero and one. The progressivity parameter u_3 can also reasonably be assumed to be clearly less than one, i.e. the effect of a one percent increase in the nominal output leads to a less than one percent increase in the average tax ratio.

On the basis of the above assumptions we can show that a domestic goods demand shock leads to an increase in output and to a decline in prices, as in chapter 4 (expressions (16) and (18)). We cannot, however, show *a priori* whether an increase in indexation from zero increases or decreases the deviation of output. The result depends on the degree of price indexation α_3. When $\alpha_3 = 1$, we can show that an increase in ω_3 decreases the deviation of output. (When $\alpha_3 = 0$, full insulation of output is attained.) We see, however, that an increase in indexation decreases the deviation of prices regardless of the value of α_3.

The ambiguous net effect of indexation on output deviation is due to the conflicting effects through the IS and LM equations. From the real sector the effect of indexation tends to decrease the deviation of output, as in the previous formulation of the floating rate regime. Through the LM equation the increase in indexation, however, decreases the demand for money (in the case of a positive shock), which tends to increase the deviation of output.

The optimal value of ω_3 with respect to output deviation is $\omega_3 = 1 - 1/(k_3u_3)$. This is negative on the basis of the assumptions presented above. Output is fully insulated with this value of ω_3.

In **the fixed rate regime** the effects of a positive goods demand shock on output and prices are as follows:

$$(194)\ \frac{\delta y_3}{\delta f_3}=\frac{1-j_3u_3+j_3u_3\omega_3}{1-j_3u_3+j_3u_3\omega_3+\beta_3\sigma_3+c_3u_3+\beta_3c_3u_3+j_3\sigma_3u_3-\beta_3c_3u_3\omega_3},$$

$$(195)\ \frac{\delta p_3}{\delta f_3}=\frac{\beta_3+j_3u_3}{1-j_3u_3+j_3u_3\omega_3+\beta_3\sigma_3+c_3u_3+\beta_3c_3u_3+j_3\sigma_3u_3-\beta_3c_3u_3\omega_3}.$$

The numerator in the expression for the change in output is obviously positive, because we can assume that the response of prices to taxes j_3 and the effect of progressiveness on the average tax ratio u_3 are rather small so that the product of the terms is clearly less than 1. If we assume additionally that as regards the degree of indexation of taxes $0 \leq \omega_3 \leq 1$, we see that the denominator of the expressions is positive. A positive goods demand shock leads thus to an increase in the output and prices. Indexation does not change the signs of the effects (see expressions (19) and (20)).

On the basis of the assumptions presented above we notice that an increase in the indexation of taxes from zero increases the deviation of output.[41] This is due to the same sign of the change in output and prices. In the case of a positive shock, taking into account the increasing price level in taxation decreases the tax burden, which tends to reinforce the positive output effect of the shock from the demand as well as supply side (see equations (186), (185) and (187)').

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[41]The first three terms in the denominators of expressions (194) and (195) are the same as those in the numerator of expression (194).

Increasing indexation strengthens the change in prices if $\beta_3 c_3 > j_3$. The relative magnitudes of these parameters cannot be known *a priori*. The increasing output due to rising indexation tends to strengthen the increase in prices (through the parameter β_3). A high value for c_3 (the marginal propensity to consume) in turn strengthens the deviation of output. The decreasing tax burden due to indexation in the case of a positive shock, on the other hand, tends to dampen the price increase through lower wage pressure (parameter j_3, equations (187) and (189)).

When comparing the deviations of output in different exchange rate regimes, we see that floating insulates the output more when $\alpha_3 = 0$ even when taxes are unindexed. When, however, domestic prices are indexed to foreign prices and taxes are unindexed, we are no longer able to draw *a priori* conclusions on the relative output deviations. This is related to the opposite effects of indexation on the output deviation in the regimes (the reverse of the analysis of the effects of increasing tax indexation).

7.2.3 Domestic monetary shocks

We study the effects of a positive monetary shock first in **the floating rate regime** in the case when the real gross income is used in the LM curve as the scale variable. The effects on output and prices are as follows:

$$(196)\ \frac{\delta y_3}{\delta m_3} = \frac{\sigma_3 - \alpha_3\sigma_3 - \alpha_3 c_3 u_3 - j_3\sigma_3 u_3 + \alpha_3 c_3 u_3\omega_3 + j_3\sigma_3 u_3\omega_3}{\alpha_3 + \beta_3\sigma_3 + k_3\sigma_3 - \alpha_3 k_3\sigma_3 + \alpha_3 c_3 u_3 - \alpha_3 c_3 k_3 u_3 + j_3\sigma_3 u_3 - j_3 k_3\sigma_3 u_3 + \alpha_3 c_3 k_3 u_3\omega_3 + j_3 k_3\sigma_3 u_3\omega_3},$$

$$(197)\ \frac{\delta p_3}{\delta m_3}=\frac{\alpha_3+\beta_3\sigma_3+\alpha_3c_3u_3+j_3\sigma_3u_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3k_3\sigma_3+\alpha_3c_3u_3-\alpha_3c_3k_3u_3+j_3\sigma_3u_3-j_3k_3\sigma_3u_3+\alpha_3c_3k_3u_3\omega_3+j_3k_3\sigma_3u_3\omega_3}.$$

When assuming again that $0 \leq \alpha_3 \leq 1$ and $0 \leq k_3 \leq 1$ we can show that the denominator of the above expressions is positive. Now we see that prices increase after a positive monetary shock. The effect of an increase in the indexation of the tax ratio from 0 also decreases the deviation of prices.

We cannot, however, say *a priori* whether the effect of a positive monetary shock on output is positive or negative. Output is fully insulated when

$$\omega_3=\frac{-\sigma_3+\alpha_3\sigma_3+\alpha_3c_3u_3+j_3\sigma_3u_3}{\alpha_3c_3u_3+j_3\sigma_3u_3}.$$

Output increases when indexation is greater than the above expression. We see that the sign of the optimal degree of indexation depends on the degree of indexation of prices (α_3). If α_3 is very small, optimal indexation can be negative. When it increases, the optimal indexation is positive. When $\alpha_3 = 1$, $\omega_{3opt} = 1$. We cannot thus say (on the basis of the assumptions presented above) whether an increase in the indexation of taxes increases or decreases the deviation of output. This result is the same as that obtained in the case of indexation of public expenditure.

The intuitive explanation behind the above-described effects of tax indexation is the following. In the case of a positive monetary shock the price level rises. The increase in the indexation of taxes to this rising price level leads to a decline in the tax ratio t_3 (equation (186)). This in turn tends to increase the goods demand as well as supply. The increase in indexation, however, also dampens the rise in prices itself, which affects in the opposite direction.

When α_3 is high, the effects of the depreciating exchange rate on the domestic price level become stronger, and the deviation of output diminishes. Insulation of output requires that, in addition to price indexation, also tax indexation is perfect (one) so that the increasing price level does not affect the real aggregate demand.

In the case when we have the real disposable income in the LM curve, the situation is very much the same as above. The effects of a positive monetary shock on output and prices are as follows:

$$(198)\ \frac{\delta y_3}{\delta m_3}=\frac{\sigma_3-\alpha_3\sigma_3-\alpha_3c_3u_3-j_3\sigma_3u_3+\alpha_3c_3u_3\omega_3+j_3\sigma_3u_3\omega_3}{a_3+b_3+l_3+q_3+k_3u_3(\alpha_3+\alpha_3c_3+\beta_3\sigma_3+j_3\sigma_3)\omega_3},$$

$$(199)\ \frac{\delta p_3}{\delta m_3}=\frac{\alpha_3+\beta_3\sigma_3+\alpha_3c_3u_3+j_3\sigma_3u_3}{a_3+b_3+l_3+q_3+k_3u_3(\alpha_3+\alpha_3c_3+\beta_3\sigma_3+j_3\sigma_3)\omega_3}.$$

The symbols in the denominators are the same as in (192) and (193). On the basis of the assumptions presented in the context of these equations, we know that the denominators are positive. The numerators in turn are the same as in expressions (196) and (197).

The conclusions are the same as in the case when the gross real income is used as the scale variable in the LM curve. An increase in indexation decreases the deviation of prices, but the effects on output deviation are not clear *a priori*.

In addition to the channels presented in the $d_3 = 0$ case, there is now the channel through the LM curve. Because of the rising price level, an increase in the indexation of taxes leads to a decline in the tax ratio (equation (186)). The declining tax ratio in turn increases money demand, which tends to reduce the increase in output. This effect has the opposite sign compared to the direct output effect working through the real economy.

In **the fixed exchange rate regime** output as well as prices are insulated against domestic monetary shocks. A monetary shock just leads to a change in the relation of the domestic and foreign components of the money supply.

7.2.4 Domestic productivity shocks

In **the floating rate regime** we study again first the case when the real gross income is used as the scale variable in the LM curve. The effect of a positive productivity shock on output and prices is as follows:

$$(200)\ \frac{\delta y_3}{\delta s_3}=\frac{\sigma_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3k_3\sigma_3+\alpha_3c_3u_3-\alpha_3c_3k_3u_3+j_3\sigma_3u_3-j_3k_3\sigma_3u_3+\alpha_3c_3k_3u_3\omega_3+j_3k_3\sigma_3u_3\omega_3},$$

$$(201)\ \frac{\delta p_3}{\delta s_3}=\frac{-k_3\sigma_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3k_3\sigma_3+\alpha_3c_3u_3-\alpha_3c_3k_3u_3+j_3\sigma_3u_3-j_3k_3\sigma_3u_3+\alpha_3c_3k_3u_3\omega_3+j_3k_3\sigma_3u_3\omega_3}.$$

The denominators of the above expressions are positive if $0 \leq k_3 \leq 1$, $0 \leq \alpha_3 \leq 1$ and $0 \leq u_3 \leq 1$ (a sufficient condition). On the basis of this we can show that the output increases and prices decrease after a positive shock. The signs of the effects are thus the same as in expressions (24) and (26).

We can also show that an increase in ω_3 from zero decreases the deviation of output and prices. This effect is due to the decreasing price level in the case of a positive shock. Taking this into account in the determination of taxation decreases the real aggregate demand through an increase in the tax ratio and tends to stabilize the output. The increasing tax ratio reduces the goods supply, too. The diminishing decline in prices is due to the effect of the increasing tax ratio on wages and prices.

The exchange rate depreciates, as without indexation. The effect of indexation on the exchange rate is not, however, clear *a priori*.

In the case when real disposable income is used as the scale variable in the LM curve, we can show, when using the same assumptions as above, that output increases and prices fall as a reaction to a positive productivity shock. We cannot, however, tell the effect of an increase in indexation on the deviation of output *a priori*. We can show, however, that an increase in tax indexation decreases the deviation of prices (expression (203)).

The effects on output and prices are as follows:

$$(202)\ \frac{\delta y_3}{\delta s_3}=\frac{\sigma_3(1-k_3u_3+k_3u_3\omega_3)}{a_3+b_3+l_3+q_3+k_3u_3(\alpha_3+\alpha_3c_3+\beta_3\sigma_3+j_3\sigma_3)\omega_3},$$

$$(203)\ \frac{\delta p_3}{\delta s_3}=\frac{-k_3\sigma_3(1-u_3)}{a_3+b_3+l_3+q_3+k_3u_3(\alpha_3+\alpha_3c_3+\beta_3\sigma_3+j_3\sigma_3)\omega_3},$$

where $a_3 = \alpha_3(1 - k_3u_3)$, $b_3 = (1 - \alpha_3)k_3\sigma_3(1 - u_3)$, $l_3 = \alpha_3c_3u_3(1 - k_3)$ and $q_3 = \beta_3\sigma_3(1 - k_3u_3)$. By assuming that $0 \leq k_3 \leq 1$, $0 \leq \alpha_3 \leq 1$ and $0 \leq u_3 \leq 1$, we see that a_3, b_3, l_3 and q_3 are all non-negative.

The degree of indexation minimizing the deviation in output can be determined as $\omega_3 = 1 - 1/(k_3u_3)$. This is negative on the basis of the assumptions presented above. Positive indexation increases thus the deviation of output when compared to the optimal indexation. We cannot, however, tell *a priori* what the effect is when compared to zero indexation.

The ambiguity of the output effects of indexation is again due to the conflicting effects working through the real and monetary sectors. The effects through the real sector tend to stabilize the output as in the $d_3 = 0$ case. The effect working through the LM curve has the opposite sign: the declining price level increases the tax ratio when indexation grows. This in turn decreases the money demand, which reinforces the output deviation.

In **the fixed exchange rate regime** the effects of a positive productivity shock on output and prices are as follows:

$$(204)\quad \frac{\delta y_3}{\delta s_3} = \frac{\sigma_3 + c_3u_3 - c_3u_3\omega_3}{1 - j_3u_3 + j_3u_3\omega_3 + \beta_3\sigma_3 + c_3u_3 + \beta_3c_3u_3 + j_3\sigma_3u_3 - \beta_3c_3u_3\omega_3},$$

$$(205)\quad \frac{\delta p_3}{\delta s_3} = \frac{-1 - c_3u_3}{1 - j_3u_3 + j_3u_3\omega_3 + \beta_3\sigma_3 + c_3u_3 + \beta_3c_3u_3 + j_3\sigma_3u_3 - \beta_3c_3u_3\omega_3}.$$

The tax indexation that insulates the output from the shock can be determined as $\omega_3 = 1 + \sigma_3/(c_3u_3)$, which is positive. We can show that an increase in tax indexation from zero decreases output deviation definitely when $j_3 > \beta_3 c_3$, because the numerator becomes smaller and the denominator becomes greater. At the extreme when $j_3 = 0$ we can also show that the decrease in the numerator is relatively greater than the decrease in the denominator. (A sufficient condition for this is that $\sigma_3 < 1$ and $\beta_3 < 1$, which is reasonable, see appendix 2.) We can thus conclude that an increase in the indexation of taxes decreases the deviation of output.

When there is a positive productivity shock, prices decline. When indexation of taxes increases, the tax ratio rises (equation (186)). This in turn diminishes aggregate demand and supply, which tends to stabilize output (equations (185) and (187)').

Prices decline after a positive productivity shock. We do not know, however, the effect of increasing indexation on the deviation of prices *a priori*. The deviation decreases if $j_3 > \beta_3 c_3$ (expression (205)). The intuition is the same as in the case of goods demand shocks.

When comparing the relative output deviations in the floating and fixed rate regimes, we notice that obtaining *a priori* results is more difficult than in chapter 4, where taxes are implicitly fully indexed. The outcome depends now more on the values of the parameters.

7.2.5 An overall evaluation

We summarize the effects of an increase in indexation of taxes from 0 on output deviation in table 16.

Table 16. The effects of an increasing indexation of taxes (from 0) on the deviation of output from the normal level (+, - or 0)

	floating $d_3 = 0$	floating $d_3 = k_3$	fixed
Domestic goods demand shock	-[1]	?	+[2]
Domestic monetary shock	?	?	0
Domestic productivity shock	-[3]	?	-[4]

[1] Assuming $0 \leq k_3 \leq 1$ and $0 \leq \alpha_3 \leq 1$ (sufficient condition).
[2] Assuming $j_3 u_3 < 1$ and $0 \leq \omega_3 \leq 1$ (sufficient condition).
[3] Assuming $0 \leq k_3 \leq 1$, $0 \leq \alpha_3 \leq 1$ and $0 \leq u_3 \leq 1$ (sufficient condition).
[4] Assuming $\sigma_3 < 1$ and $\beta_3 < 1$ (sufficient condition).

The results obtained for output deviations in the fixed rate regime are consistent with those obtained by Bruce (1981) in the cases of goods demand and productivity shocks. The demand shock Bruce studies is one aggregate demand shock, where increasing indexation leads to an increase in the deviation of output. In this study we have instead an exogenous aggregate demand shock and a separate monetary shock. Now output deviation is increased in the former case and is insensitive to indexation in the latter case.

In the floating rate regime the results are different from the results obtained by Bruce (1981) in his closed economy model. The sign of the effect is the same only in the case of a productivity shock, when gross income is used as the scale variable in the LM curve.

In the case of monetary shocks the conclusions concerning the relative output insulation properties of the floating and fixed rate regimes do not change qualitatively when indexation of taxes changes between 0 and 1. Fixed rates thus insulate the output more against monetary shocks independent of the value of ω_3. In the cases of goods demand and productivity shocks, however, the conclusion is much less clear when there is no tax indexation than in chapter 4, where we implicitly have full tax indexation. Without tax indexation the conclusion requires more restrictive assumptions for the parameters.

After assuming again that the variances of all shocks are the same and independent of each other, we can write the loss function with respect to output deviation for **a floating rate regime** (when $d_3 = 0$) as follows (assuming for simplicity that the variance of the shocks is one):

$$(206)\, L^{o}_{fa} = \frac{\alpha_3^{\,2}+\sigma_3^{\,2}+(\sigma_3-\alpha_3\sigma_3-\alpha_3 c_3 u_3+\alpha_3 c_3\omega_3 u_3-j_3\sigma_3 u_3+j_3\omega_3\sigma_3 u_3)^2}{(\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3 k_3\sigma_3+\alpha_3 c_3 u_3-\alpha_3 c_3 k_3 u_3+\alpha_3 c_3 k_3\omega_3 u_3+j_3\sigma_3\sigma_3-j_3 k_3 u_3+j_3 k_3\omega_3\sigma_3 u_3)^2}.$$

We cannot show *a priori* whether the optimal indexation is positive or negative. The outcome depends among other things on the value of the price indexation parameter α_3. When $\alpha_3 = 0$, the outcome is not clear either.

In the case of fully indexed prices ($\alpha_3 = 1$) we can, however, show that fully indexed taxes lead to a smaller value of the loss function than zero indexation. The optimal indexation of taxes is in this case positive *a priori*. The degree of indexation which minimizes the loss function is:

$$\omega_{3\,opt} = \frac{k_3 + k_3\sigma_3^{\,2} + c_3u_3 + \beta_3c_3\sigma_3u_3 + j_3\sigma_3u_3 + \beta_3j_3\sigma_3^{\,2}u_3 + c_3^2u_3^{\,2} + 2c_3j_3\sigma_3u_3^{\,2} + j_3^{\,2}\sigma_3^{\,2}u_3^{\,2}}{(c_3 + j_3\sigma_3)u_3(1 + \beta_3\sigma_3 + c_3u_3 + j_3\sigma_3u_3)}.$$

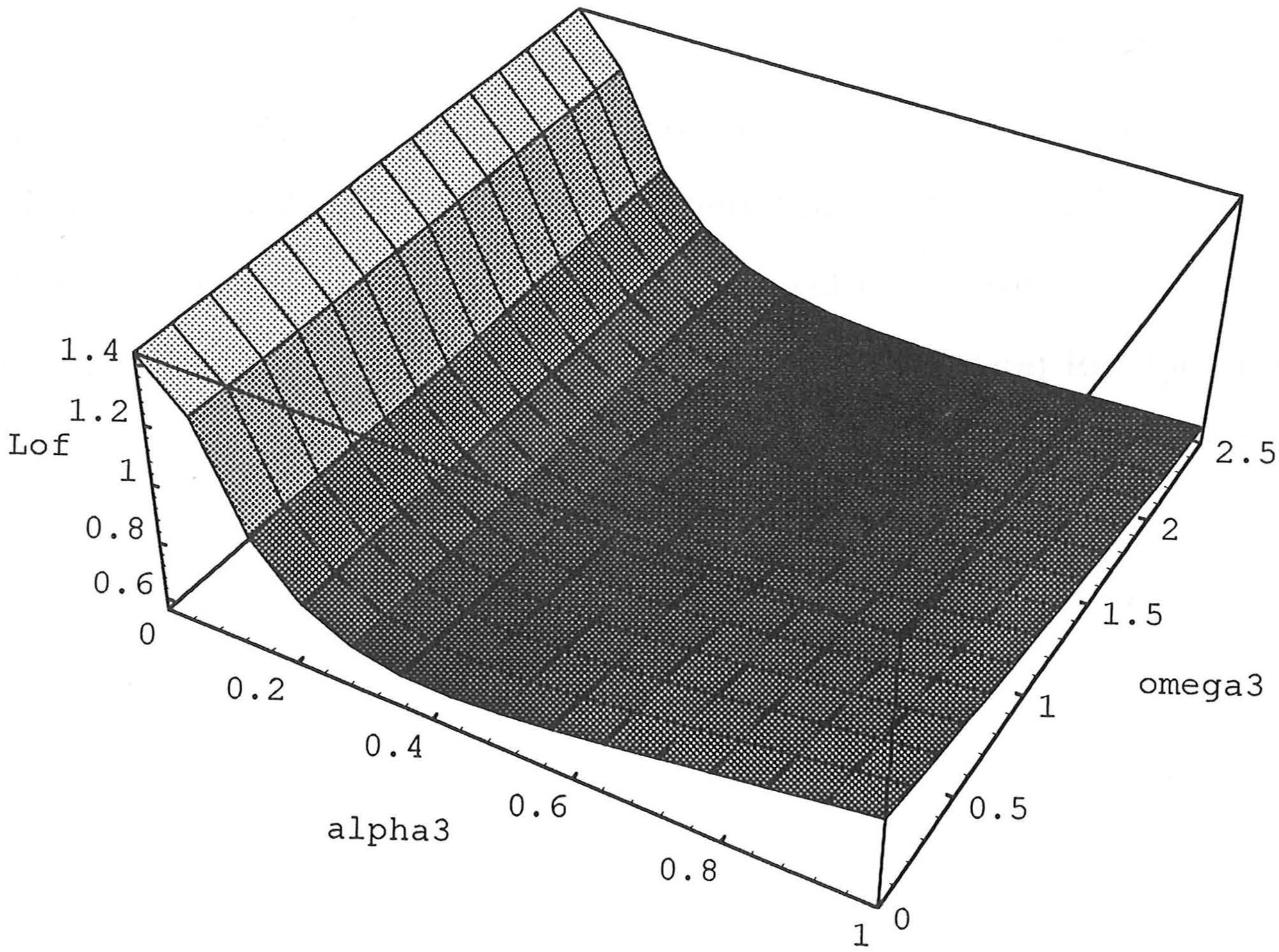
We use now the baseline scenario in calculating the optimal degree of tax indexation. We have to find empirical estimates for c_3 (the marginal propensity to consume), u_3 (the income elasticity of the tax ratio) and j_3 (the response of prices to the tax ratio). The marginal propensity to consume varies from year to year; we assume here that $c_3 = 0.9$. For u_3 we use the estimate 0.13, which is based on the Finnish data (Edgren, 1985).

The parameter $j_3 = h_3/(1 - \Omega_3\tau_3)$, where h_3 = response of wages to taxes, Ω_3 = response of nominal wages to a change in consumer prices and τ_3 = the share of domestic goods in the consumer price index. We assume that $h_3 = 0.25$, which is consistent with the range of estimates reported in Pehkonen (1991). For τ_3 we use the estimate 0.7, which is based on input-output calculations for the Finnish economy. The response of wages to consumer prices varies in time, we assume here that $\Omega_3 = 0.3$. The assumptions of the above parameter values are consistent with the value $\alpha_3 = 0.3$.

The value of the tax indexation parameter which minimizes the loss function in the baseline scenario is $\omega_{3opt} = 2.41237$. The corresponding value of the loss function is $L^{o}_{fa} = \sigma^{2}_{shock}*0.663$. The optimal degree of tax indexation is in this scenario positive with all values $0 \leq \alpha_3 \leq 1$.

The values of the loss function with different combinations of price and tax indexation are presented in figure 50. It is seen there that the loss function is less sensitive to tax indexation than to price indexation.

Figure 50. The loss function in terms of output deviation (L^{o}_{fa} = Lof), sensitivity with respect to price (α_3) and tax (ω_3) indexation, floating rates ($d_3 = 0$) (baseline scenario, standardization σ^{2}_{shock} = 1)



In the case when real disposable income is used as a scale variable in the LM curve ($d_3 = k_3$) it is even harder to obtain *a priori* results than in the previous case (as is seen in table 16, too). When compared to the case where $d_3 = 0$, this ambiguity is explained by the effect of increasing indexation on the demand for real money in the case of declining prices (goods demand and productivity shocks). An increase in indexation decreases the demand for money in the cases of positive goods demand and productivity shocks, which tends to reinforce the output deviation. This effect is the opposite to the direct effect working through the aggregate demand.

In the baseline scenario the optimal indexation is $\omega_{3opt} = 2.16725$. The corresponding value of the loss function is $L^{o}_{fb} = \sigma^2_{shock}*0.714$. The value of the loss function is not very sensitive to the degree of tax indexation in the baseline scenario (with $\alpha_3 = 0.3$) (see figure 51). The optimal degree of indexation is, however, very sensitive to the degree of price indexation α_3. When $\alpha_3 = 0$, $\omega_{3opt} = -5.495$, and when $\alpha_3 = 1$, $\omega_{3opt} = 7.259$. This makes the use of tax indexation less attractive. When $\alpha_3 = 0$, the loss function is not, however, very sensitive to tax indexation. (The loss function with different combinations of positive values of α_3 and ω_3 is very similar to that presented in figure 50.)

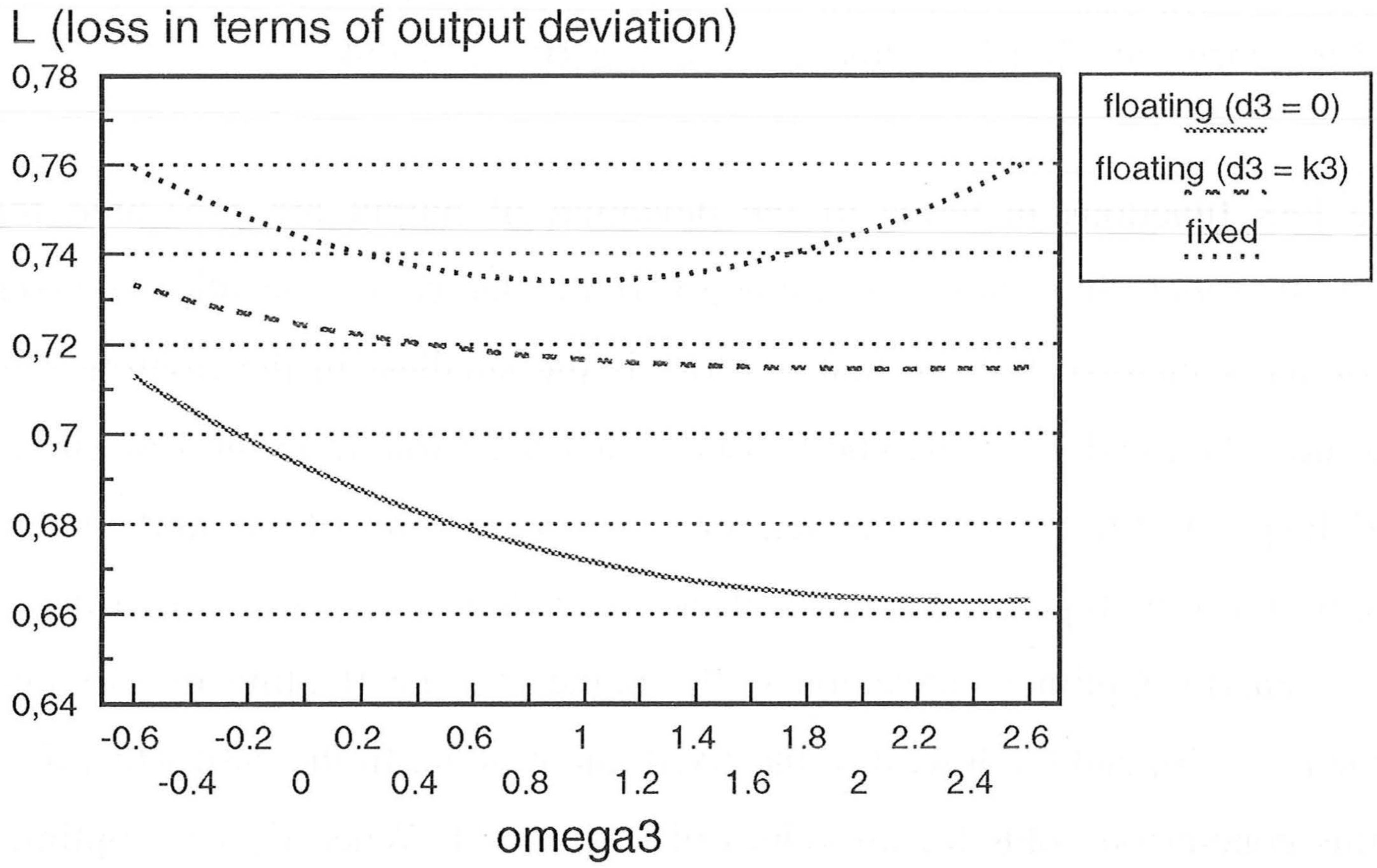
In **the fixed exchange rate regime** the optimal indexation of taxes is as follows:

$$\omega_{3\,opt} = \frac{\sigma_3 + c_3 u_3 + \beta_3 j_3 u_3 + c_3 \sigma_3 u_3 + c_3^2 u_3^2 + j_3^2 u_3^2 - \beta_3 - j_3 u_3}{u_3(c_3 + \beta_3 j_3 + c_3^2 u_3 + j_3^2 u_3)}.$$

This expression is obviously positive. This is due to the effects of indexation in the case of productivity shocks. Positiveness is the more likely the lower the response of domestic prices to a change in output (β_3) and in taxes (j_3). In the baseline scenario the optimal degree of tax indexation is $\omega_{3opt} = 0.9729$ and the corresponding loss function is $L^o_{fix} = \sigma^2_{shock}*0.734$.

The loss functions in terms of the deviation of output are presented for domestic shocks in figure 51 as a function of the degree of indexation of taxes (baseline scenario). We see that the loss is the smallest in the floating rate regime, when real gross income is used as a scale variable in the LM curve, and the greatest in the fixed rate regime. The loss in terms of output deviation is minimized with positive degrees of tax indexation in all cases according to this scenario. Optimal indexation is the highest in the floating rate regime (when $d_3 = 0$), and the lowest in the fixed rate regime. In the case when $d_3 = 0$ this conclusion holds for all values of $0 \leq \alpha_3 \leq 1$. When $d_3 = k_3$, optimal indexation is negative for very low values of α_3.

Figure 51. The loss functions in terms of output deviation, sensitivity with respect to the tax indexation (ω_3) (baseline scenario, standardization $\sigma^2_{shock} = 1$)



The effects of increasing indexation are in the floating rate regime more clearcut with respect to the deviation of prices than with respect to the deviation of output. In table 17 we see that the deviation of prices decreases in the cases of all shocks and in both formulations of the model. In the fixed rate regime, in contrast, the sign of the effect depends on the relative magnitudes of the parameter values. The deviation declines if $j_3 > \beta_3 c_3$. According to the baseline scenario presented before in this section, the effect of indexation on prices is small in the fixed rate regime anyway.

Table 17. The effects of an increasing indexation of taxes (from 0) on the deviation of prices from the normal level (+, - or 0)

	floating $d_3 = 0$	floating $d_3 = k_3$	fixed
Domestic goods demand shock	-[1]	-[2]	?[3]
Domestic monetary shock	-[1]	-[2]	0
Domestic productivity shock	-[2]	-[2]	?[3]

[1] Assuming $0 \leq k_3 \leq 1$ and $0 \leq \alpha_3 \leq 1$ (sufficient condition).
[2] Assuming $0 \leq k_3 \leq 1$, $0 \leq \alpha_3 \leq 1$ and $0 \leq u_3 \leq 1$ (sufficient condition).
[3] Decreases if $j_3 > \beta_3 c_3$.

Bruce (1981, 273) obtains the result that changes in the price level resulting from either type of shock are increased in magnitude by tax indexation. The results obtained in this study are the opposite to those of Bruce in the floating rate regime: increasing indexation of taxes decreases the deviation of prices. In the fixed rate regime increasing indexation leads to a rising deviation of prices in the cases of goods demand and productivity shocks only when the effect of taxes on the price level is small compared to the price effect of output deviation. In the case of a monetary shock the outcome is insensitive to indexation.

7.3 Summary and conclusions

7.3.1 Summary

We see above that in the cases of domestic shocks the signs of the effects of indexation on output deviation are the same for indexation of public expenditure and of taxes when we have real gross income as the scale variable in the LM curve.

In the case of productivity shocks increasing indexation of public expenditure and taxes decreases the deviation of output in the floating as well as in the fixed rate regime. In the case of goods demand shocks indexation decreases the deviation of output in the floating rate regime and increases it in the fixed rate regime. This difference is due to the opposing changes of prices in these regimes. In the floating rate regime the price level declines after a positive shock. Indexation to a declining price level reduces aggregate demand, which tends to stabilize the output. In the fixed rate regime the situation is the opposite.

When there is a domestic monetary shock the outcome depends in the floating rate regime crucially on the degree of price indexation. When prices are fully indexed to foreign prices, the optimal degree of indexation of public expenditure and taxes is one. With lower indexation of prices the sign of the effect of indexation is not known *a priori*. In the fixed rate regime output is insensitive to indexation.

When we have real disposable income as the scale variable in the LM curve of the floating rate model we are no more able to draw *a priori* conclusions even in the cases of goods demand and productivity shocks. The outcome depends crucially on the degree of price indexation, but also on some other parameter values. This is due to the conflicting effects of indexation through real and monetary sectors.

In chapter 4, where we have implicitly full indexation of public expenditure and taxes, we obtain output deviation results that are in accordance with the traditional Mundell-Fleming results. Floating insulates the output more against goods demand shocks and fixed rates against monetary shocks. Under reasonable assumptions on the parameter values we can also show that fixed rates are preferred in the case of productivity shocks.

When public expenditure or taxes are less than fully indexed, we are no longer able to obtain *a priori* results in the cases of goods demand and productivity shocks. When domestic prices are fully indexed to foreign prices and when public expenditure is unindexed, it can even be shown that fixed rates insulate the output more than floating against domestic goods demand shocks.

The effects of indexation on the deviation of prices are more clearcut than those on the deviation of output. In the floating rate regime (in both specifications of the model) indexation of public expenditure and taxes decreases the deviation. In the fixed rate regime indexation of public expenditure increases the deviation of prices in the cases of goods demand and productivity shocks. The effects of indexation of taxes are not, however, clear *a priori*. There is an increase in the deviation if the effect of taxation on the price level is small, compared to the effect of output deviation on prices. In the case of monetary shocks prices are insensitive to indexation.

We use also the baseline scenario in calculating the effects of indexation of public expenditure and taxes. In the former case we study domestic as well as foreign shocks. In the latter case we confine ourselves to domestic shocks.

We notice in both cases that, when assuming the same variances for all shocks, the optimal indexation is the highest in the floating rate regime. In the case of tax indexation this holds for all values of $0 \leq \alpha_3 \leq 1$ when real income is the scale variable in the LM curve. When real disposable income is the scale variable, the optimal indexation is negative for low values of α_3, and accordingly smaller than in the fixed rate regime.

In the case of indexation of public expenditure we notice that the optimal indexation is higher in the basket peg regime than in the exchange rate union, where it is zero in this scenario. This is due to the smaller changes in prices in the basket peg regime than in the union in the face of foreign shocks.

7.3.2 Conclusions

The attractiveness of indexation of public expenditure and taxes depends on the relative variances of the shocks. On the basis of domestic shocks we can conclude *a priori* that both forms of indexation are attractive in the floating rate regime (when real gross income is used as the scale variable in the LM curve) if the variance of monetary shocks is low in relation to those of the two other types of shocks. We have also shown that when prices are fully indexed to foreign prices, fully indexed taxes lead to lower output deviation than zero indexation, assuming that the variances of the shocks are the same and independent of each other. With low indexation of prices the outcome is not clear *a priori*.

If it can be shown empirically that real disposable income is the relevant scale variable in the LM curve, the attractiveness of the tax indexation depends on the indexation of prices. If we cannot control this, the effects of tax indexation are uncertain.

In the fixed exchange rate regime indexation of public expenditure and taxes is the more attractive the higher the variance of the productivity shocks in relation to goods demand shocks. Assuming the same variances of these shocks the optimal degree of indexation is obviously positive with relevant parameter values.

Concerning the relative performance of the regimes in insulating the output against domestic goods demand shocks, it is shown that floating is not in all cases superior to fixed rates when public expenditure and taxes are unindexed.

The calculation with the baseline scenario points to the conclusion that indexation of public expenditure is not attractive in the exchange rate union with a wide range of price indexation. The conclusion is the same with respect to output and price deviation. This is due to the direction of the change in prices. Indexing to prices destabilizes output and prices in the face of many shocks. Indexation of public expenditure decreases output deviation only with full or almost full indexation of prices. In the floating and basket peg regimes indexation of public expenditure is a potential tool in output stabilization. In these regimes the effects are not as sensitive to the degree of price indexation as in the exchange rate union.

8 SUMMARY AND EVALUATION OF THE RESULTS

In this study exchange rate unions are analyzed and compared with currency basket and floating rate regimes in the framework of two three-country macroeconomic models. In the models we have two big countries and a small open economy. The two-country models are solved simultaneously, whereas the small country is modelled in a recursive way, i.e. the small country is affected by the big countries but not the other way round. Alternative regimes are analyzed from the standpoint of the small open economy. The exchange rate between the big economies is determined freely in the foreign exchange market. The big countries can be called the "USA" (country 1) and the "EMS" or "EMU" (country 2). The third country represents "Finland" or some other small open economy. An exchange rate union with country 2 depicts the characteristics of a small country's (Finland's) EMU membership.

The models used belong to the tradition of extended Mundell-Fleming models. The first model is a static model with static expectations. The model has a supply side, through which producer prices are made endogenous. As special cases we have a fixed price, demand-determined model at one end of the spectrum, and a model with fully flexible prices at the other end. The second model is a dynamic rational expectations model.

Floating rates are modelled in a way where "economic fundamentals" determine the exchange rate through the money market and goods market equilibrium conditions in the presense of free capital mobility and perfect asset substitutability. In the cases of the exchange rate union and the currency basket regime, we study only cases where the exchange rate is credibly fixed.

The approach used in the comparison of the regimes is a traditional one: to study how unexpected exogenous domestic and foreign shocks affect the small open economy, and in which regime the effects are minimized. This approach is legitimized by the costs related to short-term variations in economic variables. The main types of the shocks studied are goods demand, monetary and productivity shocks, which all can occur in the home country or in either of the big countries.

In chapter 2 we present a brief survey of the literature on exchange rate regimes. There we notice that in the vast literature a consistent treatment of alternative exchange rate regimes in the face of foreign disturbances is lacking. Overall, there are few studies where exchange rate regimes are analyzed in a three or multi-country setting. Modelling more than two countries is essential for the analysis of the transmission of foreign shocks to the small economy.

In chapter 3 we present the theoretical approach used and provide motivation for the current framework. We argue that an extended Mundell-Fleming model is still a very useful, practical and manageable tool in analyzing economic problems in a multi-country setting. The possibilities of this framework have not yet been fully exploited.

In chapter 4 we analyze the exchange rate regimes in the framework of the static model with static expectations. In the cases of domestic goods demand and monetary shocks the general conclusions of the traditional Mundell-

Fleming research are confirmed: floating rates are preferred in the case of goods demand shocks and fixed rates in the case of monetary shocks. Endogenizing prices, however, modifies the conclusions: insulation properties are not as dichotomic as in the fixed price model, but more a matter of degree. In the case of productivity shocks it is shown under reasonable assumptions concerning the parameter values that a fixed exchange rate insulates the output more than floating if the money supply remains unchanged.

The main contribution of the study is in the widening of the IS-LM framework into a three-country model, and in a systematic comparison of the three exchange rate regimes in the face of various foreign shocks. In the fixed price model *a priori* results concerning the signs of the changes are obtained in the big country model and for floating rates in the case of the small country. When comparing the exchange rate union and the basket peg regime we notice, however, that few *a priori* conclusions can be drawn about the variations of economic variables. The conclusions depend on the relative size of the various effects, and thus on the parameters of the model. In the case of endogenous prices it is even more difficult to obtain *a priori* results already in the big country model.

In addition to some discussion about the net effects with different combinations of the values of the parameters, we calculate two numerical simulations of the model and conduct sensitivity analysis. The parameter estimates used are partly based on empirical studies, but because of difficulties in finding direct empirical counterparts, the parameter values used must be considered more as "guesstimates" than estimates. In the baseline scenario we have a rather open economy concerning the elasticities with respect to relative prices and foreign demand. In an alternative scenario we have a more closed real economy.

In the numerical simulations conducted, the basket peg regime stabilizes the output of the small country more than the alternative regimes if producer prices are fixed. A stable effective exchange rate thus leads in this case to the most stable output. Floating generates the second best outcome in three of the four cases in the open economy (baseline) scenario, and the exchange rate union correspondingly in three cases in the alternative (less open economy) scenario. The exchange rate union stabilizes the output the worst in both scenarios when there is a monetary shock in the union partner country.

In the simulations with the endogenous price model we notice that a stable effective exchange rate does not necessarily lead to the most stable development of the output. A change in the exchange rate and accordingly in competitiveness reduces in some cases the effect of the other factors, having a stabilizing effect on output. But in some other cases changes in competitiveness reinforce the other effects. The result depends crucially on the nature and on the origin of the shock. In the main simulations conducted it is assumed that domestic prices respond to changes in foreign prices according to input-output relations of the economy, and on the basis of the mark-up pricing practice of the firms.

It is found in the simulations that the basket peg regime tends to stabilize the output more than the alternative regimes if there is a goods demand shock in "the rest of the world". If a similar shock occurs in the potential union partner country, the exchange rate union and the basket peg regime stabilize the output the best, the relative performance depending on the parameter values.

Flexible exchange rates are not good stabilizers against foreign goods demand shocks in a floating rate world, because the exchange rate tends to reinforce the effect of the changing export demand. The same conclusion applies to the exchange rate union, if the shock occurs in "the rest of the world".

In the case of foreign monetary shocks floating tends to reduce the effects due to changes in the interest rate and in the foreign demand. The exchange rate union has a similar effect if the shock occurs in "the rest of the world", but if it occurs in the union partner country, the other effects are essentially reinforced. In the simulations conducted the basket peg regime stabilizes the output less than the other regimes when a monetary shock occurs in "the rest of the world". When the shock occurs in the potential union partner country, it takes an intermediate position.

In the case of productivity shocks when the money supply is kept unchanged, the results are very similar to those obtained in the case of monetary shocks. This is due to similar changes in real money balances.

At the end of chapter 4 we present a method for analyzing the stabilizing properties of the exchange rate regimes against a combination of all the shocks studied. We present a quadratic loss function for each regime, first with respect to deviations in output only, and after that a loss function where deviations in prices are also taken into account.

In order to be able to calculate the values of the loss functions, we need the multipliers of the effects of the shocks and the variances of the shocks. The multipliers have already been calculated in the numerical simulations. As for the variances it is difficult to present any *a priori* judgements, and we do not have any empirical estimates either. We therefore calculate the values of the loss functions when assuming that the variances of the shocks are the same, i.e. that their expected values are the same. The variances are also assumed to be independent of each other. We calculate some critical variances, too.

In the experiment with the same variances for all shocks, we obtain in the case of fully fixed prices the greatest value of the aggregate loss function (the lowest welfare) for the exchange rate union, and the smallest loss for the basket peg regime. The weak performance of the union is due to the poor stabilization properties in the cases of monetary and productivity shocks occurring in the union partner country. If the variances of these shocks were small, the attractiveness of the exchange rate union would increase.

It is shown in the sensitivity analysis that with very low indexation of domestic to foreign prices floating leads to a greater deviation of output than the exchange rate union. But when indexation increases, the attractiveness of floating improves essentially when compared to the other regimes. Floating leads to the smallest deviation already with modest indexation. The basket peg regime outperforms the exchange rate union in terms of output deviation except with full indexation. When domestic producer prices respond fully to changes in the foreign price level, there is no difference between the exchange rate regimes in terms of output stabilization. These results apply to domestic as well as to foreign shocks.

In the baseline scenario, where indexation of prices is modest, the ranking between floating and the basket peg regime depends on the weight of the price target in the aggregate loss function. Because the basket peg regime stabilizes producer prices the best against all foreign shocks, increasing the weight of the price target makes the basket peg regime preferable to floating.

But with low weights for the price target, floating leads to the lowest value of the loss function, and thus to the highest welfare.

In chapter 5 we build a dynamic three-country model with rational expectations for the analysis of the exchange rate regimes. This model differs from that used in chapter 4 in the respect that nominal interest rates can differ between countries in the floating and basket peg regimes. In the IS curve we have now the expected real interest rate. In chapter 4 the interest rate in the IS curve is (because of static expectations) the same as during the current period.

The main emphasis in chapter 5 is on the adjustment paths of different economic variables after the shocks. The model is a demand determined short-run Keynesian and long-run classical model. This model is most suitable in cases where the response of domestic prices to the foreign ones is small. The relevance of the model depends on the time period of wage contracts and on the spillover time of foreign prices into the domestic price level. The longer these time periods are, the longer the relevant time period of the model. The short-run results obtained in this model are similar to those obtained with the static sticky price model.

In the case of a domestic goods demand shock floating is preferable according to this model, because it insulates the output fully, whereas fixed rates lead to a change in output. In the case of a domestic monetary shock it is the other way round. When there is a productivity shock in the home country the results are no longer as dichotomic. There is a change in output in both regimes. If the shock is positive, floating leads to a jump increase in output due to the depreciating exchange rate. In the fixed rate regime output declines slightly first due to the increasing real interest rate and increases then to the new level more slowly than in the case of floating.

For foreign shocks it is shown that the currency basket exchange rate regime leads to the smallest deviation of output in the short run in all cases. This result is similar to that obtained in the fixed price static model. The similarity is due to the demand determined model structure in these cases. These kinds of models seem to be the most suitable in cases when the duration of the shock is short so that domestic prices do not have time to react to changes in the foreign ones. According to the model of chapter 4 floating seems to be more attractive in the cases where this reaction is stronger.

The exchange rate union is the most problematic when there is a monetary shock in the union partner country. Floating does not perform well according to this model. It leads to the greatest deviation of output in the cases of both foreign goods demand and productivity shocks. Floating and the exchange rate union perform equally badly when there is a monetary shock in country 1.

The deviation of inflation from the long-run level is the smallest in the basket peg regime in the cases of foreign goods demand and productivity shocks, and in the floating rate regime in the cases of foreign monetary shocks.

In chapter 6 we study three potential criteria for optimum currency areas with the baseline scenarios of the static and/or dynamic models: (1) the degree of price indexation, (2) the degree of foreign trade integration with the potential union partner, and (3) the degree of product differentiation (responsiveness to changes in competitiveness). In this study we assume that the exchange rate union is chosen and consider under which circumstances it is the most attractive in terms of output insulation in relation to alternative regimes.

We conclude that when foreign price indexation is low, the exchange rate union is the most attractive in terms of output stabilization with medium or high degrees of price indexation in all other cases except when there is a domestic monetary or productivity shock. In these two cases a low degree of indexation is preferred. When foreign indexation is high, the optimal domestic price indexation in the exchange rate union is low or even negative.

With respect to the degree of integration with the potential union partner we notice that the exchange rate union is more attractive, in comparison to the other regimes, with a high degree of integration with the potential union partner. Minimization of output deviation is, however, not always achieved with full integration, because with a somewhat lower degree of integration the effective exchange rate can change and compensate for the opposite effects.

When studying the effects of product differentiation we notice that in seven out of nine cases the exchange rate union is the most attractive with a high or medium degree of product differentiation, when measured with output deviation. In the case of a domestic monetary shock a low degree of differentiation is preferred. In the case of a domestic productivity shock no clear conclusion can be drawn.

In chapter 7 we study the effects of indexation of public expenditure and taxes in different exchange rate regimes according to the static model.

The simulations conducted point to the hypothesis that indexation of public expenditure is the most attractive in terms of output deviation in the floating rate regime and the least attractive in the exchange rate union. The effects of public expenditure indexation depend, however, on the degree of price indexation. When domestic prices are fully indexed to the foreign ones, indexation of public expenditure is attractive in all regimes.

In the basic model used in chapter 4 public expenditure is implicitly fully indexed. With no indexation of this kind the attractiveness of floating rates decreases with high degrees of price indexation in terms of output deviation. It is shown in section 7.1.2 that when prices are fully indexed to foreign ones and public expenditure is unindexed, fixed rates insulate the output more against domestic goods demand shocks than floating. The exchange rate union is accordingly seen in a better light in relation to floating, when public expenditure is not indexed. The basket peg regime performs, however, even in this case better than the union. This is due to the better insulation properties of the basket peg regime against foreign shocks.

Indexation of public expenditure decreases the deviation of output the most in the case of productivity shocks. This is due to the opposite changes in output and prices. Taking into account the declining price level in the determination of public expenditure in the case of a positive shock decreases aggregate demand and tends to stabilize output. Indexation decreases the deviation of output in all other productivity shocks except in the exchange rate union when the shock occurs in the union partner country. In this case the exchange rate depreciates after a positive shock, which leads to an increase in the price level. Indexation reinforces in this case the output effect of the shock.

With respect to the deviation of the price level indexation of public expenditure is attractive in the floating rate regime in the face of all shocks studied. In the exchange rate union and in the basket peg regime exactly the opposite is true.

Indexation of taxes is studied in chapter 7 only in the cases of domestic shocks. The static model is widened to incorporate the effects of indexation of progressive taxation. These effects work through aggregate demand as well as through supply. For floating rates we use two versions of the model. In one the real gross income is used as the scale variable in the LM curve, while in the other version the scale variable is the real disposable income.

It is seen that the output effects of tax indexation are sensitive to the formulation of the floating rate regime. When real gross income is the scale variable, indexation decreases the deviation of output in the cases of goods demand and productivity shocks. Only in the case of monetary shocks is the sign of the effect not clear *a priori*. The effect is sensitive to the degree of price indexation. When real disposable income is used as the scale variable, the effects are not clear *a priori* in the face of any of the shocks.

In the fixed rate regime indexation of taxes increases the deviation of output when goods demand shocks occur, and decreases it when productivity shocks occur. In the case of monetary shocks ouput is fully insulated, and thus insensitive to indexation.

The effects on the deviation of prices are more clearcut. This deviation is decreased by increasing indexation according to both formulations of the floating rate model and in the cases of all shocks. In the fixed rate regime the deviation of prices increases if the effect of taxes on prices is small, except in the case of monetary shocks, where the effects are insensitive to indexation.

It is seen in the study that the conclusions concerning the insulation properties of the exchange rate regimes are not general, but very dependent on the nature and origin of the shock and on the structure of the economies. The degrees of various kinds of indexation are of crucial importance for the results. The aim of this study has been to analyze explicitly those conditions and the often conflicting effects of various shocks.

In addition to many rather specific results the perhaps most general results are that the exchange rate union is very problematic in the cases of monetary and productivity shocks occurring in the potential union partner country. If these kinds of shocks occur very frequently, difficulties will arise. If they are, instead, rare, the favourable properties of an exchange rate union, many of which have not been analyzed in this study, can compensate for these costs.

The limitations and reservations of the conclusions drawn in this study can be divided into two parts: (1) those related to the use of the model, and (2) those related to the model itself. The former limitations can be reduced by using new information concerning the values of the parameters when empirical knowledge accumulates, and by conducting further sensitivity analysis. The latter limitations are a problem of all economic models. In this respect evaluations done outside the model and with other kinds of models are needed in the research and discussion on exchange rate regimes.

When choosing an exchange rate regime in real life we have to carry out a careful cost-benefit analysis of the regimes, and take into account all relevant aspects. In this evaluation we need all accumulated theoretical and empirical knowledge.

In addition to the structural characteristics of the regimes analyzed in this study, we have, for example, to take into account their possibly differing credibility characteristics. A basket peg regime does not differ essentially from an exchange rate union in terms of credibility in a unilateral EMS or EMU peg. If a country is, however, a member in a firm monetary union, the credibility of the fixed rate is clearly higher than in a unilateral basket peg. The structural characteristics analyzed in this study do not vanish, but an additional credibility aspect must be taken into account. The precise impact of credibility is in turn a matter for other studies.

In addition to macroeconomic aspects we have to take into account the microeconomic effects of the regimes in terms of transactions costs, possible effects on foreign trade and growth, etc. We also have to be aware of the existing situation at home as well as abroad. As is seen in this study, too, no exchange rate regime is good in all situations.

Basically a decision on an exchange rate regime is political by nature. The weights for the different aspects are determined, in a representative democracy, by the political decision makers. The economists, however, bear the responsibility for providing them with all the relevant facts.

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Exchange Rate Arrangements

Currency pegged to				
US dollar	French franc	Other currency	SDR	Other composite
Antigua & Barbuda	Benin	Bhutan (Indian rupee)	Libya	Bangladesh
Argentina	Burkina Faso	Estonia (deutsche mark)	Myanmar	Botswana
Bahamas, The	Cameroon	Kiribati (Australian dollar)	Seychelles	Burundi
Barbados	C. African Rep.	Lesotho (South African rand)		Cape Verde
Belize	Chad	Namibia (South African rand)		Cyprus
Djibouti	Comoros	San Marino (Italian lira)		Czech Republic
Dominica	Congo	Swaziland (South African rand)		Fiji
Grenada	Côte d'Ivoire			Iceland
Iraq	Equatorial Guinea			Jordan
Liberia	Gabon			Kuwait
Lithuania	Mali			Malta
Marshall Islands	Niger			Mauritania
Micronesia, Fed. States of	Senegal			Morocco
Nigeria	Togo			Nepal
Oman				Slovak Republic
Panama				Solomon Islands
St. Kitts & Nevis				Thailand
St. Lucia				Tonga
St. Vincent and the Grenadines				Vanuatu
Syrian Arab Rep.				Western Samoa
Turkmenistan				
Venezuela				
Yemen, Republic of				

APPENDIX 1
(continued)

Flexibility limited in terms of a single currency or group of currencies		More flexible		
Single currency	**Cooperative arrangements**	**Adjusted according to a set of indicators**	**Other managed floating**	**Independently floating**
Bahrain	Austria	Chile	Algeria	Afghanistan, Islamic State of
Qatar	Belgium	Ecuador	Angola	Albania
Saudi Arabia	Denmark	Nicaragua	Belarus	Armenia
United Arab Emirates	France		Brazil	Australia
	Germany		Cambodia	Azerbaijan
	Ireland		China, P.R.	Bolivia
	Luxembourg		Colombia	Bulgaria
	Netherlands		Croatia	Canada
	Portugal		Dominican Rep.	Costa Rica
	Spain		Egypt	El Salvador
			Eritrea	Ethiopia
			Georgia	Finland
			Greece	Gambia, The
			Guinea-Bissau	Ghana
			Honduras	Guatemala
			Hungary	Guinea
			Indonesia	Guyana
			Israel	Haiti
			Korea	India
			Lao P.D. Rep	Iran, I. R. of
			Latvia	Italy
			Macedonia, FYR of	Jamaica
			Malaysia	Japan
			Maldives	Kazakhstan
			Mauritius	Kenya
			Pakistan	Kyrgyz Rep.
			Poland	Lebanon
			Russian Federation	Madagascar
			Singapore	Malawi
			Slovenia	Mexico
			Sri Lanka	Moldova
			Sudan	Mongolia
			Tunisia	Mozambique
			Turkey	New Zealand
			Uruguay	Norway
			Viet Nam	Papua New Guinea
				Paraguay
				Peru
				Philippines
				Romania
				Rwanda
				São Tomé and Principe
				Sierra Leone
				Somalia
				South Africa
				Suriname
				Sweden
				Switzerland
				Tajikistan. Rep. of
				Tanzania
				Trinidad and Tobago
				Uganda
				Ukraine
				United Kingdom
				United States
				Uzbekistan
				Zaire
				Zambia
				Zimbabwe

Source: International Financial Statistics, September 1995.

APPENDIX 2

THE NUMERICAL VALUES OF THE PARAMETERS USED IN THE BASELINE SCENARIOS OF THE STATIC AND DYNAMIC MODELS

When studying the effects of shocks originating in the big countries, we use the following numerical values for the parameters in the baseline scenario:

<u>common parameters:</u>

$k = k_1 = k_2 = k_3 = 0.67$, $\Phi = \Phi_1 = \Phi_2 = \Phi_3 = 0.46$,

$\mu = \mu_1 = \mu_2 = \mu_3 = 0.2$, $\beta = \beta_1 = \beta_3 = \beta_3 = 0.3$,

$\psi = \psi_1 = \psi_2 = \psi_3 = 0.3$

<u>big country parameters:</u>

$\sigma = 0.1$, $\varepsilon = 0.3$, $\alpha = 0.1$

<u>small country parameters:</u>

$\sigma_3 = 0.3$, $\varepsilon_3 = 0.6$, $\theta = 0.3$, $\alpha_3 = 0.3$.

Descriptions of the symbols are presented on pages 30-31, 158-159, 264 and 288-289. We assume throughout the study that the big countries are symmetric. We thus denote these parameters without a subscript. The smallness of the third country normally implies higher values for the elasticities with respect to foreign demand and relative prices than for the big countries.

The numerical values presented above are assumed to reflect rather short-term relationships between the variables. Money demand coefficients with respect to income and interest rates are adopted from Kremers and Lane (1990).

These values are estimated for the EMS countries as an aggregate, but they are used as an approximation for all countries. In reality these parameter values differ between countries, but because they differ in reality also in time and according to the aggregate used, and because the main point in the study is comparing the systemic differences between exchange rate regimes, abstracting from the differences seems legitimate. When comparing the exchange rate union and the currency basket regime, the possibly differing money demand elasticities of the small economy are irrelevant. In these regimes the money supply is fully elastic when capital is mobile; the LM curve of the small country can thus be omitted. The elasticity of inflation with respect to the deviation of output from the long-run level is taken from Gordon (1990).

The rest of the parameter values are determined on the basis of econometric studies for the Finnish economy, for example on the basis of the econometric model of The Research Institute of the Finnish Economy (ETLA) (Vartia, 1974) and the Bank of Finland Quarterly Econometric Model (BOF) (Tarkka and Willman (ed.) (1985). Because most of the parameter estimates needed do not have a direct counterpart in the studies, the values adopted must be considered more or less as "guesstimates". The values of σ, ε and α are between one third and a half of the small country parameters (in the EU countries about one third of foreign trade occurs with non-EU countries).

Fixed price model: The effects of foreign shocks on the output of the small country (alternative calculation)

We assume the following parameter values:

k = 0.67 } Kremers & Lane (1990) for the EMS; $\mu = 0.2$; $\sigma = 0.1$

$\Phi = 0.46$; $\varepsilon = 0.15$

$\varepsilon_3 = 0.3$; $\sigma_3 = 0.2$; $\theta = 0.3$

Now we get the following absolute values for output effects in different exchange rate regimes:

$$\begin{array}{ccc} |0| & |0.304| & |0.438| \end{array}$$

$$(R.1.)\ \left|\frac{\delta y_3}{\delta f_1}(basket)\right| < \left|\frac{\delta y_3}{\delta f_1}(EMU\text{-}peg)\right| < \left|\frac{\delta y_3}{\delta f_1}(floating)\right|$$

$$\begin{array}{ccc} |0| & |-0.304| & |0.438| \end{array}$$

$$(R.2.)\ \left|\frac{\delta y_3}{\delta f_2}(basket)\right| < \left|\frac{\delta y_3}{\delta f_2}(EMU\text{-}peg)\right| < \left|\frac{\delta y_3}{\delta f_2}(floating)\right|$$

$$\begin{array}{ccc} |0.129| & |-0.385| & |-0.556| \end{array}$$

$$(M.1.)\ \left|\frac{\delta y_3}{\delta m_1}(basket)\right| < \left|\frac{\delta y_3}{\delta m_1}(EMU\text{-}peg)\right| < \left|\frac{\delta y_3}{\delta m_1}(floating)\right|$$

$$\begin{array}{ccc} |0.309| & |-0.556| & |0.824| \end{array}$$

$$(M.2.)\ \left|\frac{\delta y_3}{\delta m_2}(basket)\right| < \left|\frac{\delta y_3}{\delta m_2}(floating)\right| < \left|\frac{\delta y_3}{\delta m_2}(EMU\text{-}peg)\right|$$

<u>Endogenous price model</u>: The effects of foreign shocks on the price level of the small country in different exchange rate regimes (the baseline calculation)

| 0.079 | | 0.318 | | 0.332 |

$$(R.1.)\ \left|\frac{\delta p_3}{\delta f_1}(basket)\right| < \left|\frac{\delta p_3}{\delta f_1}(floating)\right| < \left|\frac{\delta p_3}{\delta f_1}(EMU\text{-}peg)\right|$$

| 0.066 | | -0.187 | | 0.277 |

$$(R.2.)\ \left|\frac{\delta p_3}{\delta f_2}(basket)\right| < \left|\frac{\delta p_3}{\delta f_2}(EMU\text{-}peg)\right| < \left|\frac{\delta p_3}{\delta f_2}(floating)\right|$$

| 0.026 | | -0.302 | | -0.337 |

$$(M.1.)\ \left|\frac{\delta p_3}{\delta m_1}(basket)\right| < \left|\frac{\delta p_3}{\delta m_1}(floating)\right| < \left|\frac{\delta p_3}{\delta m_1}(EMU\text{-}peg)\right|$$

| 0.157 | | -0.254 | | 0.520 |

$$(M.2.)\ \left|\frac{\delta p_3}{\delta m_2}(basket)\right| < \left|\frac{\delta p_3}{\delta m_2}(floating)\right| < \left|\frac{\delta p_3}{\delta m_2}(EMU\text{-}peg)\right|$$

| -0.091 | | -0.335 | | -0.375 |

$$(S.1.)\ \left|\frac{\delta p_3}{\delta s_1}(basket)\right| < \left|\frac{\delta p_3}{\delta s_1}(floating)\right| < \left|\frac{\delta p_3}{\delta s_1}(EMU\text{-}peg)\right|$$

| -0.104 | | 0.180 | | -0.377 |

$$(S.2.)\ \left|\frac{\delta p_3}{\delta s_2}(basket)\right| < \left|\frac{\delta p_3}{\delta s_2}(EMU\text{-}peg)\right| < \left|\frac{\delta p_3}{\delta s_2}(floating)\right|$$

Endogenous price model: The effects of the foreign shocks on the competitiveness of the small country in different exchange rate regimes (baseline calculation)

$$\begin{array}{cccc} & |0.179| & |0.556| & |0.582| \\ (R.1.) & \left|\frac{\delta c_3}{\delta f_1}(basket)\right| < & \left|\frac{\delta c_3}{\delta f_1}(floating)\right| < & \left|\frac{\delta c_3}{\delta f_1}(EMU\text{-}peg)\right| \end{array}$$

$$\begin{array}{cccc} & |0.020| & |0.399| & |-0.687| \\ (R.2.) & \left|\frac{\delta c_3}{\delta f_2}(basket)\right| < & \left|\frac{\delta c_3}{\delta f_2}(floating)\right| < & \left|\frac{\delta c_3}{\delta f_2}(EMU\text{-}peg)\right| \end{array}$$

$$\begin{array}{cccc} & |-0.108| & |-0.758| & |-0.696| \\ (M.1.) & \left|\frac{\delta c_3}{\delta m_1}(basket)\right| < & \left|\frac{\delta c_3}{\delta m_1}(floating)\right| < & \left|\frac{\delta c_3}{\delta m_1}(EMU\text{-}peg)\right| \end{array}$$

$$\begin{array}{cccc} & |0.052| & |-0.348| & |0.704| \\ (M.2.) & \left|\frac{\delta c_3}{\delta m_2}(basket)\right| < & \left|\frac{\delta c_3}{\delta m_2}(floating)\right| < & \left|\frac{\delta c_3}{\delta m_2}(EMU\text{-}peg)\right| \end{array}$$

$$\begin{array}{cccc} & |-0.333| & |-0.773| & |-0.843| \\ (S.1.) & \left|\frac{\delta c_3}{\delta s_1}(basket)\right| < & \left|\frac{\delta c_3}{\delta s_1}(floating)\right| < & \left|\frac{\delta c_3}{\delta s_1}(EMU\text{-}peg)\right| \end{array}$$

$$\begin{array}{cccc} & |0.068| & |-0.442| & |-0.931| \\ (S.2.) & \left|\frac{\delta c_3}{\delta s_2}(EMU\text{-}peg)\right| < & \left|\frac{\delta c_3}{\delta s_2}(basket)\right| < & \left|\frac{\delta c_3}{\delta s_2}(floating)\right| \end{array}$$

Endogenous price model: The effects of foreign shocks on the output of the small country in different exchange rate regimes in the alternative calculation (the case of low "open economy parameter" values)

We assume the following values for the parameters:

$k = k_3 = 0.67$, $\Phi = \Phi_3 = 0.46$, $\mu = \mu_3 = 0.2$, $\beta = \beta_3 = 0.3$
$\sigma = 0.07$, $\varepsilon = 0.15$, $\alpha = 0.1$
$\sigma_3 = 0.2$, $\varepsilon_3 = 0.3$, $\alpha_3 = 0.3$, $\theta = 0.3$

Now we get the following absolute values for the output effects in different exchange rate regimes:

$$|-0.055| \qquad |0.061| \qquad |0.063|$$

$$(R.1.)\ \left|\frac{\delta y_3}{\delta f_1}(basket)\right| < \left|\frac{\delta y_3}{\delta f_1}(EMU\text{-}peg)\right| < \left|\frac{\delta y_3}{\delta f_1}(floating)\right|$$

$$|-0.011| \qquad |0.108| \qquad |-0.126|$$

$$(R.2.)\ \left|\frac{\delta y_3}{\delta f_2}(basket)\right| < \left|\frac{\delta y_3}{\delta f_2}(floating)\right| < \left|\frac{\delta y_3}{\delta f_2}(EMU\text{-}peg)\right|$$

$$|0.005| \qquad |0.013| \qquad |0.151|$$

$$(M.1.)\ \left|\frac{\delta y_3}{\delta m_1}(EMU\text{-}peg)\right| < \left|\frac{\delta y_3}{\delta m_1}(floating)\right| < \left|\frac{\delta y_3}{\delta m_1}(basket)\right|$$

$$|0.041| \qquad |0.231| \qquad |0.376|$$

$$(M.2.)\ \left|\frac{\delta y_3}{\delta m_2}(floating)\right| < \left|\frac{\delta y_3}{\delta m_2}(basket)\right| < \left|\frac{\delta y_3}{\delta m_2}(EMU\text{-}peg)\right|$$

APPENDIX 6
(continued)

$$(S.1.)\ \left|\frac{\delta y_3}{\delta s_1}(EMU\text{-}peg)\right| < \left|\frac{\delta y_3}{\delta s_1}(floating)\right| < \left|\frac{\delta y_3}{\delta s_1}(basket)\right|$$

$$\quad\quad |0.006| \quad\quad\quad |0.014| \quad\quad\quad |0.123|$$

$$(S.2.)\ \left|\frac{\delta y_3}{\delta s_2}(floating)\right| < \left|\frac{\delta y_3}{\delta s_2}(basket)\right| < \left|\frac{\delta y_3}{\delta s_2}(EMU\text{-}peg)\right|$$

$$\quad\quad |0.045| \quad\quad\quad |0.154| \quad\quad\quad |0.271|$$

Figure 52. The loss function in terms of output deviation (Lof), sensitivity with respect to domestic (α_3) and foreign (α) price indexation, floating rates (baseline scenario, standardization $\sigma^2_{shock} = 1$)

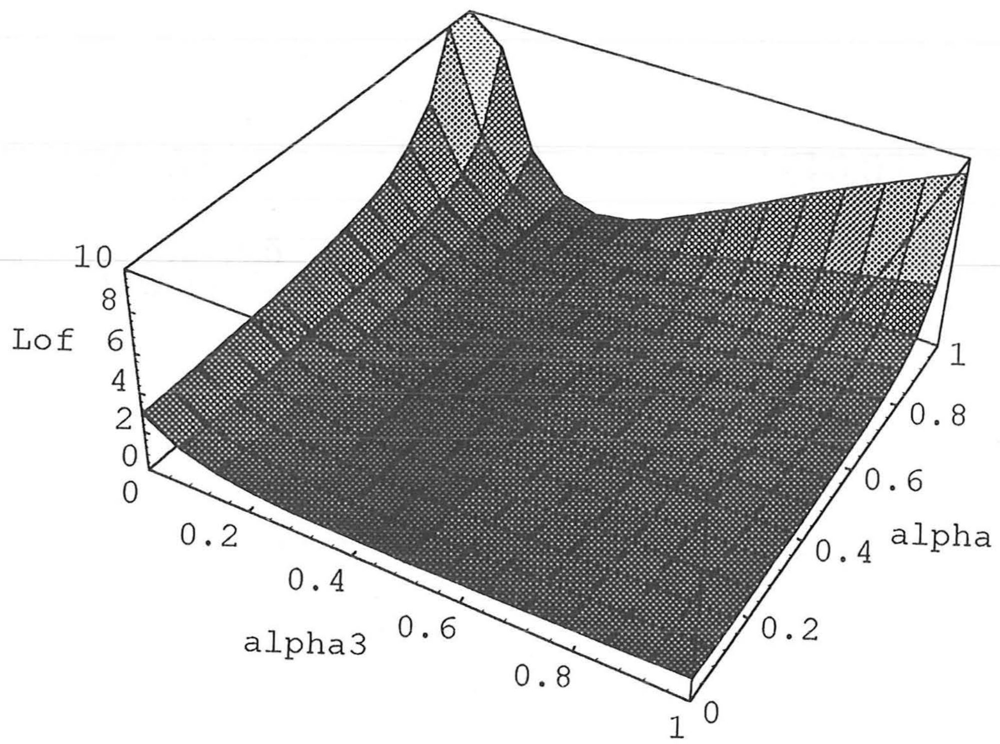

Figure 53. The loss function in terms of output deviation (Lou), sensitivity with respect to domestic (α_3) and foreign (α) price indexation, exchange rate union (baseline scenario, standardization $\sigma^2_{shock} = 1$)

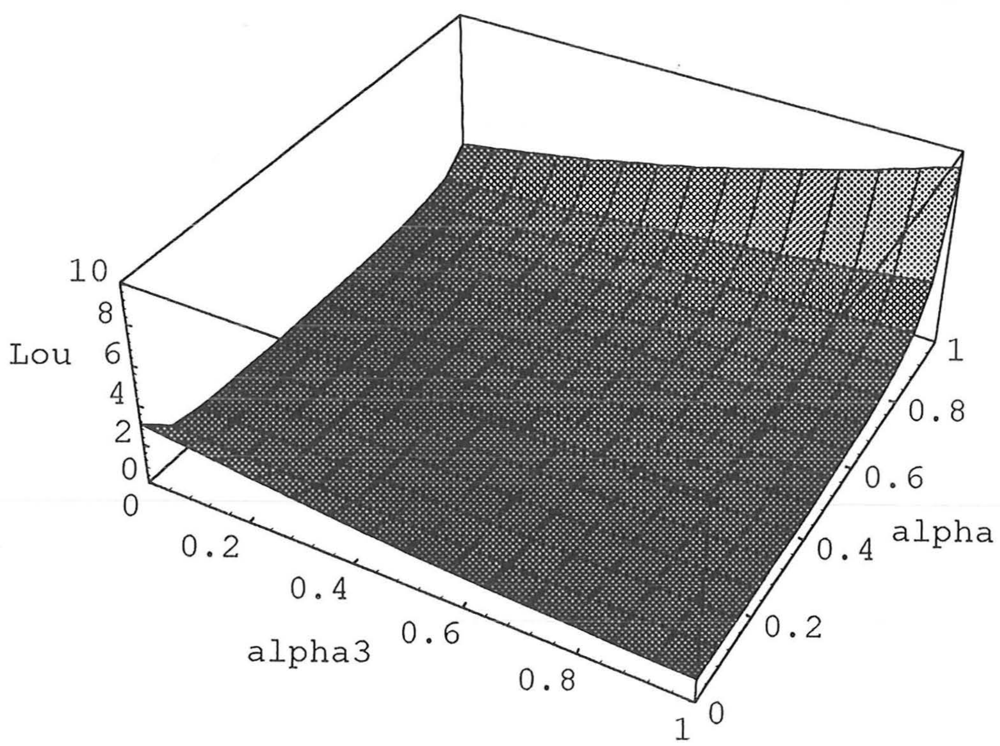

Figure 54. The loss function in terms of output deviation (Lob), sensitivity with respect to domestic (α_3) and foreign (α) price indexation, basket peg regime (baseline scenario, standardization $\sigma^2_{shock} = 1$)

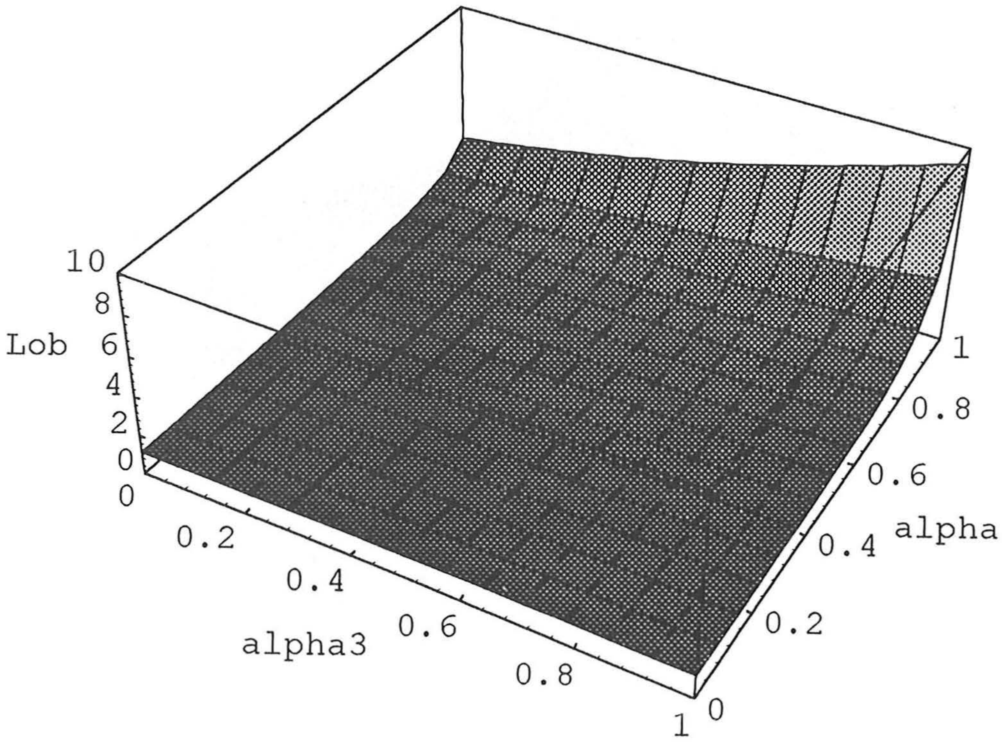

Figure 55. The loss function in terms of output deviation (Lof), sensitivity with respect to price (α_3) and public expenditure (λ_3) indexation, floating rates (baseline scenario, standardization $\sigma^2_{shock} = 1$)

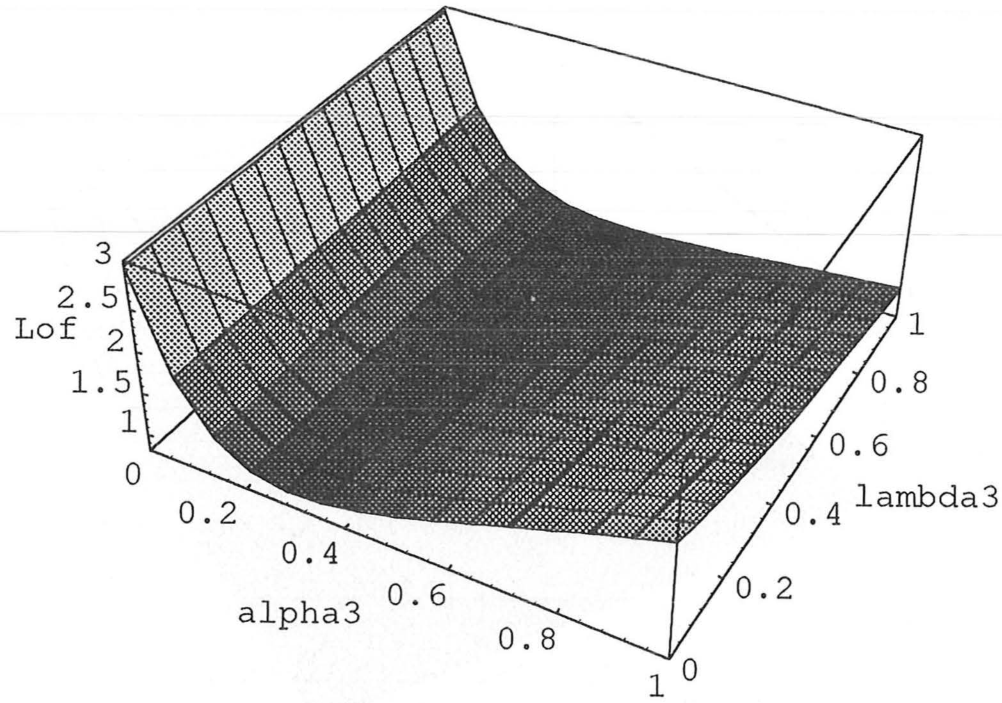

Figure 56. The loss function in terms of output deviation (Lou), sensitivity with respect to price (α_3) and public expenditure (λ_3) indexation, exchange rate union (baseline scenario, standardization $\sigma^2_{shock} = 1$)

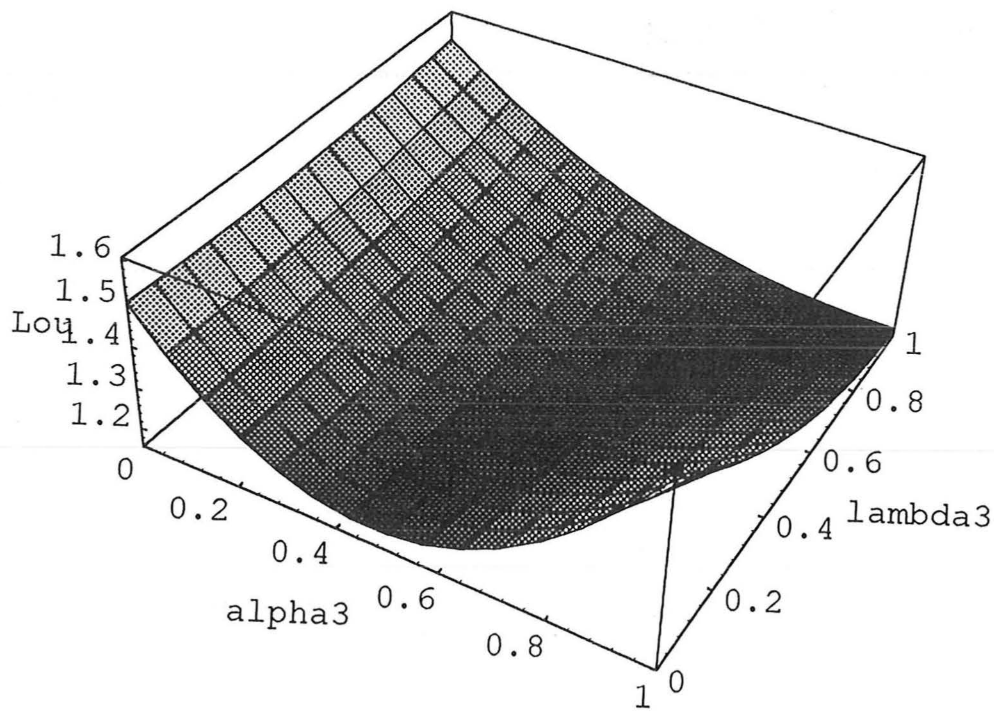

Figure 57. The loss function in terms of output deviation (Lob), sensitivity with respect to price (α_3) and public expenditure (λ_3) indexation, basket peg regime (baseline scenario, standardization $\sigma^2_{shock} = 1$)

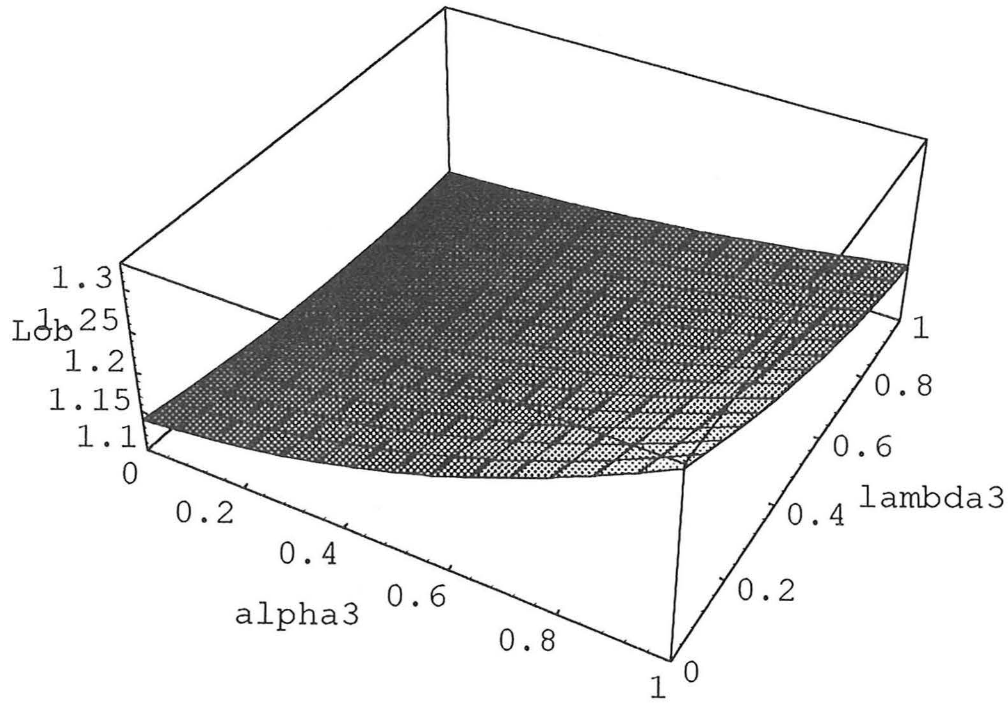

Figure 58. The loss function in terms of output deviation, sensitivity with respect to price indexation (α_3), zero indexation of public expenditure ($\lambda_3 = 0$) (standardization $\sigma^2_{shock} = 1$)