ETLA
ELINKEINOELÄMÄN TUTKIMUSLAITOS
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
Lönnrotinkatu 4 B 00120 Helsinki Finland Tel. 358-9-609 900
Telefax 358-9-601 753 World Wide Web: http://www.etla.fi/

Keskusteluaiheita – Discussion papers

No. 1011

Markku Kotilainen

ECONOMIC SHOCKS, PROGRESSIVENESS OF TAXATION, AND INDEXATION OF TAXES AND PUBLIC EXPENDITURE IN EMU*

* The paper is a part of the project "Tax/benefit systems and growth potential of the EU" (TAXBEN, Project no. SCS8-CT-2004-502639), financed by the European Commission under FP 6 of Research. It is deliverable 11A of the project. An earlier version of the paper was presented at the workshop of the TAXBEN project in Paris the 19th of January 2006. Co-financing from the Yrjö Jahnsson Foundation is gratefully acknowledged. The author thanks Kari Alho and participants of the Paris workshop for comments, and Anthony de Carvalho for checking the English of the text. The author takes, however, full responsibility for any errors and omissions.

ISSN 0781-6847 03.04.2006

KOTILAINEN, Markku, **ECONOMIC SHOCKS, PROGRESSIVENESS OF TAXATION, AND INDEXATION OF TAXES AND PUBLIC EXPENDITURE IN EMU.** Helsinki: ETLA. Elinkeinoelämän Tutkimuslaitos, The Research Institute of the Finnish Economy, 2006, 29 p. (Keskusteluaiheita, Discussion Papers, ISSN, 0781-6847; No. 1011).

ABSTRACT: We study the effects of demand, tax and supply shocks in one- and two-country macroeconomic models with fixed exchange rates, with our main emphasis on the stabilisation properties of progressive taxation. The models try to depict outcomes for the EMU countries. In the one-country model we obtain *a priori* results. In the case of the two-country model, we calculate the solution by using realistic estimates for the parameters. In the *one-country model* progressive taxation tends to stabilise output in the cases of demand and tax shocks. In the case of a supply shock, tax progressiveness tends to stabilise output if taxes are fully indexed. If they are not, the outcome depends especially on the size of the demand effect of taxes. Progressive taxation stabilises prices definitely only in the case of a tax shock. In the cases of demand and supply shocks, the outcome depends in opposite ways on the relative strengths of the demand and supply effects of taxes. In the *two-country model* progressive taxation tends to increase output stability in both countries in the face of a demand shock. Progressiveness stabilises prices if wages and prices react only modestly to changes in taxes, but destabilises them when these reactions are strong. In the case of a tax shock, progressive taxation tends to stabilise the output and prices of both countries. In the case of a supply shock, output and prices are not very sensitive to progressiveness. When tax indexation is low, progressiveness can, however, destabilise the output of the country where the shock originates. All in all, progressive taxation tends to stabilise output or has a neutral effect in most cases. The effects on price stabilisation are, however, more controversial.

KEY WORDS: Economic and Monetary Union, EMU, Taxation, Public Expenditure, Progressiveness of Taxation, Indexation

JEL Codes: E32, E62, E63, E64, F33, F41, F42

Table of Contents

1 Introduction

Progressive income taxation is common practice in the old member states of the EU. The new members have, however, challenged this practice. Lithuania, Latvia, Estonia and Slovakia currently have proportional income tax systems. Romania, which will join the EU in some years, also has this kind of tax system. In the rest of the world, Hong Kong, Serbia, Ukraine, Russia and Georgia also use flat personal income tax systems.

Proportional income taxation has several microeconomic advantages, which are closely related to incentives to work (see for example Krueger and Conesa, 2002). Also, arguments are often made that inefficiencies can arise due to differences between proportional capital income taxes and high marginal income taxes. There is some evidence of positive growth effects from proportional taxation, too (Li and Sarte, 2004). The counterarguments to proportional income taxation are usually based on income distribution. In addition to the above-mentioned viewpoints, there is a traditional macroeconomic aspect that also deserves attention, namely how different tax systems affect stabilization of an economy facing different kinds of shocks.

In the following we will study the properties of different kinds of income tax systems in the context of EMU by using a simple two-country theoretical macroeconomic model. In addition to the extent of tax progressiveness, the authorities have to decide on the inflationary adjustments to be made on taxation and public expenditure. In extreme cases, inflation can be totally neglected on the one hand or taxes and public expenditure can be fully indexed to changes in prices on the other. We study the stabilization properties of these practices, too.

We examine the stabilization properties of different tax schemes in the context of an economy facing three unanticipated shocks: demand, tax and supply shocks. The shocks are assumed to be serially uncorrelated with zero mean. Demand shocks can be exogenous changes in foreign demand, consumer preferences, etc. Policy-related demand shocks are typically changes in public expenditure. Changes in taxes have both a demand and supply component. They are thus a mixture of demand and supply shocks. A typical supply shock is an exogenous change in productivity, oil prices, or other factor affecting producer prices. If supply shocks are temporary, automatic stabilizers to cushion the effects can easily be justified. If, however, the shocks are permanent, it can be argued that the stabilizers delay the necessary adjustment.[1] One policy measure with supply side effects is a change in social security payments. We can interpret this as being separate from a change in fiscal policy, when pension contributions are collected in a separate pension fund, not in the state budget.

When the (temporary) shocks originate in the market, we would like to stabilize them to some extent. In the case of policy-induced shocks, the focus is usually on the effectiveness of the policy tool in question. Automatic stabilizers reduce, in this situation, a part of the effect of the measure. They can, however, be welcomed also in this case if the policy measures are a result of some chaotic or irresponsible political process.

[1] Even in the case of permanent shocks, it can, however, be argued that some smoothing element in the adjustment is welfare improving.

We can roughly summarise the results obtained in the study with respect to progressiveness. Progressive taxation tends to stabilise output or has a neutral effect in most cases. The effects on price stabilisation are, however, more controversial, since they can be stabilising, rather neutral or destabilising depending on the case at hand.

In Section 2 the model is described and the research problem is defined in detail. In Section 3 the effects of demand, tax and supply shocks on the crucial variables are presented in the baseline scenario. In Section 4 the Taylor rule based monetary policy reaction function is analysed and the sensitivity of stabilization properties with respect to price and output variables is presented in the cases of different shocks. Section 5 analyzes the progressiveness of taxation. We first study the stabilization properties of progressive taxation with a one-country model. In the two-country analysis, we have two scenarios. In the first one the effect of taxes on wages and prices is rather modest. In the second scenario this effect is strong. Sections 6 and 7 present an analysis of the effects of indexation of taxes and public expenditure to inflation, respectively. In Section 8 we summarize the paper.

2 The Model

The model is based on the traditional static Mundell-Fleming model for two countries. The model is similar to that used in Kotilainen (1992, 1995 and 1998). It is written in logarithmic form. The variables depict their variation from steady state. The two countries have a fixed bilateral exchange rate. The idea is that these countries describe two big Euro Area economies, which influence each other. The countries can be called "Germany" and "France" for purposes of example. The model has typical demand equations for both countries (equations (1) and (5)), supply curves (equations (4) and (8)), equations for public expenditure ((2) and (6)), equations for taxation ((3) and (7)). Additionally, we assume a Taylor rule based reaction function for the monetary authority ("ECB"), which will be used in Section 4. The model, assuming symmetry between countries, is as follows:

(1) $y_1 = -\mu(i - \pi^e) + \sigma (p_2-p_1) + \varepsilon y_2 + g_1 - \psi t_1$,

(2) $g_1 = f_1 - (1-\lambda)\Phi p_1$,

(3) $t_1 = \upsilon_1 + \xi y_1 + (1-\omega)\xi p_1$,

(4) $p_1 = \alpha p_2 + \beta y_1 + \eta t_1 - s_1$,

(5) $y_2 = -\mu(i - \pi^e) + \sigma (p_1-p_2) + \varepsilon y_1 + g_2 - \psi t_2$,

(6) $g_2 = f_2 - (1-\lambda)\Phi p_2$,

(7) $t_2 = \upsilon_2 + \xi y_2 + (1-\omega)\xi p_2$,

(8) $p_2 = \alpha p_1 + \beta y_2 + \eta t_2 - s_2$.

The monetary policy reaction function presented below in equation (9) is applied in Section 4.1 for period 2 (so we will solve the previous equation system first and discuss

the monetary policy later). For comparison, we present in Section 4.2 also the case where monetary policy reaction occurs in period 1 (using the same weights for the output and price targets). We do not, however, use this monetary policy reaction function when studying the effects of progressiveness and indexation of taxes and public expenditure, because this version of the Taylor rule is very specific. We also want to keep the effects of these factors transparent.

(9) $i = r^* + a_p(p_1+p_2)/2 + a_y (y_1+y_2)/2$.

The variables with subscript 1 refer to country 1 ("Germany") and those with 2 to country 2 ("France"). The model can be written and analysed in asymmetric form, too, if there are grounds to assume asymmetry with respect to some parameter.[2] Because the full model is too complicated to obtain simple analytical results, we use numerical estimates for the parameters of the model. When simplifying the model, also *a priori* results can be obtained. This is the case in the one-country version of the model presented in Section 5.1. (See the appendix for more on the numerical estimates of the parameters and the motivation behind them.)

The notation used is as follows: y = output, i = nominal interest rate, π^e= expected inflation, μ= semi elasticity of output with respect to the nominal interest rate, p = producer price, σ = elasticity of output with respect to changes in price competitiveness of the country, g = public expenditure, t = taxes measured as the log of gross to net real income, ψ = elasticity of output with respect to changes in taxes, f = exogenous demand/fiscal shock, λ = indexation of public expenditure, Φ = elasticity of aggregate demand with respect to public expenditure (scale parameter), υ = fixed (exogenous) tax, ξ = tax progressiveness parameter (if $\xi< 0$, taxation is regressive; if $\xi =0$ we have proportional taxation; if $\xi>0$, taxation is progressive), ω = indexation of taxes, α = elasticity of domestic prices with respect to foreign prices, β = elasticity of domestic prices with respect to domestic output, η = elasticity of prices with respect to taxes, s = exogenous supply shock, i = common interest rate for countries 1 and 2, r* = long-run equilibrium nominal interest rate, a_p = the weight on the price target in the monetary reaction function, and a_y = the corresponding weight on the output target.

The expected real interest rate is $i - \pi^e$, where π^e is expected inflation (change in p). Expected inflation is, however, zero because shocks are assumed to be serially uncorrelated with zero mean. That is why the real expected interest rate can be replaced by i in the demand curve.

The demand equations are standard and do not need clarification. The equation for public expenditure includes an exogenous demand shock f_1 or f_2, and the effect of a possible indexation of public expenditure, λ. When $\lambda = 1$, public expenditure is fully indexed. In this case, changes in prices are fully taken into account in the determination of public expenditure, i.e., the real value of public expenditure is the same *ex ante* and *ex post*. When $\lambda = 0$, the real value of public expenditure is, *ex post,* smaller (larger) than *ex ante* by the full amount of the price increase (decline). The tax equations consist of a fixed tax υ_1 or υ_2, the income effect (the degree of progressiveness as a multiplier) and the

[2] Al-Eyd and Barrell (2005) find asymmetry between Germany and France with respect to some parameters. This asymmetry is not taken into account here, because "Germany" and "France" are here theoretical concepts representing two big union countries rather than existing economies.

price effect (the degree of progressiveness and the indexation term as multipliers). Indexation has the same meaning here as it does in the case of public expenditure.

The supply curves are reduced-form equations of the so-called Gray-Fisher labour market model (Gray, 1976). We write the labour market sub model for country 1 in logarithmic form as follows:

(10) $y_1 = \gamma_1 n_1 + u_1$,

(11) $n_1^d = \chi_1(p_1 - w_1)$,

(12) $w_1 = \Omega_1\{\tau_1 p_1 + (1-\tau_1)p_2\} + \kappa_1 y_1 + \varsigma t_1 + q_1$.

The notation is as follows: n_1 = labour, w_1= nominal wage, γ_1= elasticity of output with respect to labour, χ_1= responsiveness of labour demand with respect to the producer price-wage ratio, Ω_1= responsiveness of nominal wages with respect to consumer prices, τ_1= the share of domestic goods in the consumer price index, κ_1= responsiveness of nominal wages to changes in output, u_1= an exogenous productivity shock (positive when the term is positive), ς = elasticity of wages with respect to taxes, and q_1= an exogenous change in wages paid by the employers due to, for example, a change in social security payments made (a decline in q_1 means a decline in wages). (For more about the model, see Kotilainen, 1995 and 1998.)

Equation (10) shows that output is a function of labour and productivity (u_1). Equation (11), in turn, says that labour demand is a function of the excess of producer prices over wages paid by the employer. The wage presented in equation (12) depends on the consumer price, the output gap, taxes and a shock (q_1), such as a change in indirect labour costs (e.g., pension contributions).

Inserting (12) in (11) and then (11) in (10) we obtain:

(4)* $p_1 = \{(\Omega_1(1-\tau_1))/(1-\Omega_1\tau_1)\}p_2 + \{(1+\gamma_1\chi_1\kappa_1)/(\gamma_1\chi_1(1-\Omega_1\tau_1))\}y_1 + \varsigma_1/(1-\Omega_1\tau_1)\}t_1 - \{u_1 - \gamma_1\chi_1 q_1\}/\{\gamma_1\chi_1(1-\Omega_1\tau_1)\}$.

Equation (4)* is consistent with (4). We can denote the multiplier of p_2 by α_1, that of y_1 by β_1, that of t_1 by η_1, and the whole last term by s_1. We get thus:

$\alpha_1 = \{\Omega_1(1-\tau_1)\}/(1-\Omega_1\tau_1)$,

$\beta_1 = (1+\gamma_1\chi_1\kappa_1)/\{\gamma_1\chi_1(1-\Omega_1\tau_1)\}$,

$\eta_1 = \varsigma_1/(1-\Omega_1\tau_1)$, and

$s_1 = (u_1 - \gamma_1\chi_1 q_1)/\{\gamma_1\chi_1(1-\Omega_1\tau_1)\}$.

When $\Omega_1 = 1$, then $\alpha_1 = 1$, and when $\Omega_1 = 0$, then $\alpha_1 = 0$. Full (zero) indexation of wages to consumer prices thus corresponds to full (zero) indexation of domestic producer prices with respect to foreign prices. When $\alpha_1 = 0$, we have nominal wage rigidity with respect to changes in foreign prices, and when $\alpha_1 = 1$, we have corresponding real wage rigidity (assuming $\tau_1 < 1$).

We also see that the higher ς_1 is, the higher also η_1 is, because we can usually assume that $\Omega_1\tau_1 < 1$. The term Ω_1 is the degree of wage indexation and τ_1 is the share of domestic goods in the consumer price index.

From the last term we see that an increase in productivity (u_1) and an exogenous decline in wages, for example due to a decline in social security payments (q_1), paid by the employer have an analogous effect on s_1 and, accordingly, on domestic producer prices. Both are thus positive supply shocks, and their effects can be traced by changing s_1.

In the EMU, the monetary policy is common to both countries and, accordingly, the interest rate is the same for them. The interest rate is assumed to be fixed during period 1: the central bank has no information yet on the effects of the shocks (except in Section 4.2). It is assumed that it follows the data and reacts accordingly. This assumption can also be motivated by the fact that we do not know the reaction function of the ECB very well. The policy is based on the judgement of the ECB Council, and in reality the reaction pattern is not necessarily stable over time.

In equation (9), the monetary policy rule of the central bank is based on the Taylor rule. The interest rate depends on the equilibrium nominal interest rate r* and on the levels of prices and economic activity in the monetary union. The last two are defined as the average of the individual country variables. The central bank takes price and output developments into account. The weights used are a_p for the price target and a_y for the output target. If a_y is zero, only direct price developments are taken into account. If $a_y>0$, output developments are seen either as motivations to change the interest rate or as risks for price stability. Some positive weight on the output variable is thus warranted on the basis of a sole inflation target.

In Section 3, we will study the effects of exogenous demand, tax and supply shocks without monetary policy responses. The properties of differently weighted monetary policy reaction functions under varying shocks are discussed in Section 4.

3 Effects of Demand, Tax and Supply Shocks

In the following, we will use the baseline numerical values of the parameters described in detail in the appendix. The reason for numerical analysis is the complexity of the two-country model. The parameters have the following values: μ (semi elasticity of output with respect to the nominal interest rate) = 0.3; σ (elasticity of output with respect to changes in price competitiveness of the country) = 0.1; ψ (elasticity of output with respect to changes in taxes) = 0.4; Φ (elasticity of output with respect to public expenditure) = 0.3; α (elasticity of domestic prices with respect to foreign prices) = 0.3; β (elasticity of domestic prices with respect to domestic output) = 0.2; η (elasticity of prices with respect to taxes) = 0.1, ξ (tax progressiveness parameter) = 0.4; λ (indexation of public expenditure) = 1; ω (indexation of taxes) = 1. The parameters, particularly those concerning price effects, are intended to describe rather short-term elasticities.

To obtain the short-run effects of the shocks, we solve the system of equations (1) – (8) for output, price, public expenditure and tax variables of both countries, and derive the equations partially with respect to f_1, υ_1 and s_1, each in time.

A debt-financed change in public expenditure is a typical example of a pure **demand shock**. We study it here through an increase in f_1. The effects in the baseline case are as follows:

$\delta y_1/\delta f_1=0.915$ $\delta y_2/\delta f_1=0.247$ $\delta p_1/\delta f_1=0.216$ $\delta p_2/\delta f_1=0.138$

$\delta g_1/\delta f_1=1$ $\delta g_2/\delta f_1=0$ $\delta t_1/\delta f_1=0.366$ $\delta t_2/\delta f_1=0.099$.

An increase in public expenditure in "Germany" therefore leads to a clear increase in domestic output and to some increase in output in "France" through an increase in German activity and an improvement in "French" competitiveness. The last mentioned occurs because "German" prices increase more than "French" prices. Taxes (in relation to output) increase noticeably in "Germany" due to the strong increase in output and the progressiveness of income taxation. In "France" taxes increase less. Changes in prices do not affect total public expenditure or taxes because they are assumed to be fully indexed.

An exogenous **cut in taxes** (a decline in υ_1) in country 1 ("Germany") has qualitatively slightly different effects, because it is a demand and supply shock at the same time. The former occurs through the demand equation (1) (increased disposable income), and the latter through the supply curve (4) (improved employment). The effects are as follows:

$\delta y_1/\delta \upsilon_1=0.371$ $\delta y_2/\delta \upsilon_1=0.094$ $\delta p_1/\delta \upsilon_1=-0.005$ $\delta p_2/\delta \upsilon_1=0.021$

$\delta g_1/\delta \upsilon_1=0$ $\delta g_2/\delta \upsilon_1=0$ $\delta t_1/\delta \upsilon_1=-0.851$ $\delta t_2/\delta \upsilon_1=0.038$.

An exogenous cut in taxes (keeping the progressiveness parameter constant) leads to an increase in domestic as well as foreign output. The effect on foreign output comes through the increase in "German" activity. The competitiveness of "Germany" improves slightly through the supply effect of the tax cut. The activity effect on prices, however, tends to diminish the overall effect. Taxes (in relation to output) decline in "Germany" due to the exogenous tax cut even if the increase in output (and progressiveness of taxation) tends to offset this decline. In "France" the slight increase in output leads to a small rise in taxes.[3] (For the effects of changes in taxes in a two-country model, see also Alho, 2001.)

The magnitudes of the effects of the demand and tax shocks can not be compared directly, because the original shocks are of a different magnitude. We can, however, compare their relative effects. With respect to the output effects, the effect in country 2 is relatively smaller in the case of a tax shock, because the competitiveness effect is slightly negative for country 2 (the opposite is so in the case of a demand shock).

---

[3] The effects of temporary tax cuts are negligible in models which are strongly based on the permanent income hypothesis (so-called Ricardian equivalence), where current tax cuts are expected to be followed by tax increases later. It is, however, generally thought that not all consumers behave this way. Some consumers are liquidity constrained and consume a large part of their tax cuts. Often the consumers do not know the true nature of the shock, either. These factors tend to increase the efficiency of fiscal policy (see for example Blanchard, 2000). In our model, the short-run effect of tax cuts on output is depicted by parameter ψ. This parameter takes into account the balance between the behaviour of these two kinds of consumer groups.

A positive **supply shock**, modelled by an increase in s_1, can be interpreted as, for example, an increase in productivity in country 1 or a decline in indirect labour costs (such as pension contributions). The effects are as follows:

$\delta y_1/\delta s_1=0.051$ $\delta y_2/\delta s_1=-0.051$ $\delta p_1/\delta s_1=-1.089$ $\delta p_2/\delta s_1=-0.339$

$\delta g_1/\delta s_1=0$ $\delta g_2/\delta s_1=0$ $\delta t_1/\delta s_1=0.021$ $\delta t_2/\delta s_1=-0.021$.

The supply side policy is clearly of a "beggar-thy-neighbour" nature, i.e., domestic output increases but the foreign counterpart declines, in this case by as much as domestic output increases. Domestic prices decline and the competitiveness of country 1 improves. Prices decline also in country 2, but clearly less. The magnitude of the "beggar-thy-neighbour" effect depends on parameter α. The greater α is, the more domestic prices respond to foreign prices (directly through import prices of inputs or indirectly through an increase in productivity or a decline in indirect labour costs). (See Kotilainen, 1995.) The magnitude of the total output effect depends on the elasticity of output with respect to competitiveness (in the rather short run σ=0.1 is assumed). Taxes in relation to output increase slightly in "Germany" due to the slight increase in output and due to progressiveness in income taxation. In "France" the opposite occurs for similar reasons.

4 Monetary Policy Reaction of the Union-Wide Central Bank

4.1 Monetary Policy Reaction in Period 2

Because common monetary policy is the most crucial element in the functioning of the EMU, we briefly study the stabilisation properties of different monetary policy rules before examining the progressiveness and indexation parameters.

We put emphasis on the weights of the price and output variables in the Taylor rule expressed in equation (9).[4] We assume here that the policy is based on recent price and output developments (the solution of the model consisting of equations (1)-(8)). We also assume that the progressiveness parameter ξ is 0.4, and that public expenditure and taxes are fully indexed, i.e., no money illusion in their determination occurs.

We first study the effects of a pure positive **demand shock**, for example an increase in public expenditure (an increase in f_1 in the model), on the interest rate reaction based on the Taylor rule. On the basis of the baseline solution of the model, the aggregate output and inflation of the monetary union change as follows:

$(\delta y_1/\delta f_1 + \delta y_2/\delta f_1)/2 = 0.581$ $(\delta p_1/\delta f_1 + \delta p_2/\delta f_1)/2 =0.354$.

The Taylor rule is now $i_{+1} = r^* + a_p*0.354 + a_y*0.581$, where i_{+1} refers to the interest rate in the second period. The higher is the weight on the output target a_y, the more the

[4] We must keep in mind that monetary policy measures affect the union exchange rate, too. This effect works to the same direction as the interest rate effect if the policy of the Union is regarded as credible, i.e. the policy does not endanger the stability of for example prices and public finances. For a similar two-country model in a floating exchange rate world, see Kotilainen (1995) and (1998).

interest rate rises. An increase in the interest rate tends to stabilise both economies. This case is not problematic from the point of view of the union as a whole, because both variables lead to an increase in the interest rate (the extent of which depends on the magnitude of the reaction parameter). From a fiscal policy point of view, the monetary policy reaction offsets part of the output expansion. Country 1 can still have some expansion. In country 2, however, depending on the strength of the monetary policy reaction, just a part of the original positive spillover from country 1 will be felt. In principle even a negative output and price effect is possible.[5]

In the case of a **tax cut** in country 1, union output and prices change in the baseline case as follows:

$(\delta y_1/\delta \upsilon_1 + \delta y_2/\delta \upsilon_1)/2 = 0.233$ $\quad$ $(\delta p_1/\delta \upsilon_1 + \delta p_2/\delta \upsilon_1)/2 = 0.008.$

The Taylor rule relation is now: $i_{+1} = r^* + a_p*0.008 + a_y*0.233$. In this case the interest rate reaction is stronger, the greater is the weight placed on the output target. If the interest rate is set on the basis of the price target, the increase will be minimal. But if price stability is regarded as crucial, and if the increase in output was created on purpose, then it is not a problem. Expansionary tax policy in country 1 is thus efficient. On the other hand, if output stability is regarded as an objective, the monetary reaction is not sufficient.

In the case of a positive **supply shock** in country 1, union output remains stable and prices decline:

$(\delta y_1/\delta s_1 + \delta y_2/\delta s_1)/2 = 0$ $\quad$ $(\delta p_1/\delta s_1 + \delta p_2/\delta s_1)/2 = -0.714.$

The Taylor rule relation is now: $i_{+1} = r^* + a_p*(-0.714) + a_y*0$. If the output change has the sole weight, there will not be any reaction in the interest rate. If the price target in turn has a great weight, there will be a cut in the interest rate. If the target is to stabilise prices, this policy will be the correct one, and we get, additionally, an increase in union output. If output stability is also a target, this policy leads in the wrong direction, especially in country 1. From a policy point of view, in the case of cost-reducing supply side measures in either of the countries, the governments can count on supporting measures from the central bank if the monetary policy relies mechanically on the price target.

4.2 Monetary Policy Reaction in Period 1

For comparison we present below the case where monetary policy reacts already during the first period (when the shock occurs). We assume that the central bank follows the Taylor rule so that it puts equal weights of 0.5 on the price as well as the output target. The Taylor rule is as follows:

(9)' $i = r^* + 0.5(p_1+p_2)/2 + 0.5(y_1+y_2)/2.$

[5] If country 1 was big enough, this could occur already through the appreciating exchange rate (which is not modeled here). In practice, however, no individual EMU country is big enough to create a sizeable exchange rate or monetary policy reaction.

The results are obtained by solving simultaneously the model system consisting of equations (1)-(8) and (9)'. Because the above-presented rule is very specific, we do not use it in the rest of the study. We report in the following the effects of the shocks and compare them to the case without any monetary policy reaction.

In the case of a positive **demand shock** occurring in country 1, the interest rate of the union increases, i.e. $\delta i/\delta f_1=0.915$. The other effects are as follows:

$\delta y_1/\delta f_1=0.805$ $\delta y_2/\delta f_1=0.137$ $\delta p_1/\delta f_1=0.223$ $\delta p_2/\delta f_1=0.100$

$\delta g_1/\delta f_1=1$ $\delta g_2/\delta f_1=0$ $\delta t_1/\delta f_1=0.322$ $\delta t_2/\delta f_1=0.055$.

Monetary policy thus reduces output variability somewhat in both countries, and accordingly also in the whole union: $(\delta y_1/\delta f_1 + \delta y_2/\delta f_1)/2 = 0.471$. It increases price variability slightly in country 1, because taxes increase now less than without monetary policy reaction. In country 2, however, price variability decreases somewhat through the relatively larger decline in output variability compared to country 1. The net effect on prices of the whole union is stabilising: $(\delta p_1/\delta f_1 + \delta p_2/\delta f_1)/2 = 0.162$.

In the case of a **tax cut** occurring in country 1, the interest rate of the union increases, i.e., $\delta i/\delta \upsilon_1=0.098$. The other effects are as follows:

$\delta y_1/\delta \upsilon_1=0.337$ $\delta y_2/\delta \upsilon_1=0.060$ $\delta p_1/\delta \upsilon_1=-0.016$ $\delta p_2/\delta \upsilon_1=0.009$

$\delta g_1/\delta \upsilon_1=0$ $\delta g_2/\delta \upsilon_1=0$ $\delta t_1/\delta \upsilon_1=-0.865$ $\delta t_2/\delta \upsilon_1=0.024$.

Monetary policy decreases output variability slightly in both countries. In the whole union the same occurs: $(\delta y_1/\delta \upsilon_1 + \delta y_2/\delta \upsilon_1)/2 = 0.198$. The Taylor rule based monetary policy reaction raises (negative) price variability marginally in country 1 due to a somewhat greater decline in taxes and smaller upward pressure on prices from activity. In country 2, however, price variability declines marginally because taxes increase less than without monetary policy reaction. In the whole union $(\delta p_1/\delta \upsilon_1 + \delta p_2/\delta \upsilon_1)/2 = -0.003$, thus there is a change in the sign of the effect. Monetary policy is only marginally price stabilising.

When a positive **supply shock** occurs in country 1, the interest rate falls: $\delta i/\delta s_1= -0.289$. The other effects are as follows:

$\delta y_1/\delta s_1= 0.152$ $\delta y_2/\delta s_1= 0.050$ $\delta p_1/\delta s_1=-1.055$ $\delta p_2/\delta s_1=-0.305$

$\delta g_1/\delta s_1=0$ $\delta g_2/\delta s_1=0$ $\delta t_1/\delta s_1=0.061$ $\delta t_2/\delta s_1= 0.020$.

The Taylor rule based decline in the interest rate leads to much higher output variability in country 1 and to marginally smaller output variability in country 2. In country 2 the sign of the effect turns from negative to positive due to the cut in the interest rate. In the whole union this kind of monetary policy is clearly output destabilising: $(\delta y_1/\delta s_1 + \delta y_2/\delta s_1)/2 = 0.101$. Without monetary policy output would be unchanged. The declines in prices in both countries are slightly smaller because of the higher positive activity effect and because of tax changes affecting in the same direction. In the whole union, $(\delta p_1/\delta s_1 + \delta p_2/\delta s_1)/2 = - 0.680$.

We present the output and price effects of aTaylor monetary policy rule in each country and in the union as a whole, for each shock discussed above, in Table 1. The comparison is done with respect to the case of no monetary policy. The results in the table suggest that, from a union-wide point of view, the Taylor rule policy is problematic in the case of a supply shock, when it leads to a destabilising output reaction.

Table 1 Effects of a Taylor Monetary Policy Rule on the Stability of Output and Prices

	Demand Shock Country 1		**Change in Taxes in Country 1**		**Supply Shock in Country 1**	
	Output	*Prices*	*Output*	*Prices*	*Output*	*Prices*
Country 1	Stabilising	Slightly Destabilising	Stabilising	Slightly Destabilising	Destabilising	Marginally Stabilising
Country 2	Stabilising	Stabilising	Stabilising	Slightly Stabilising	Marginally Stabilising	Slightly Stabilising
Union	Stabilising	Stabilising	Stabilising	Marginally Stabilising	Destabilising	Slightly Stabilizing

Note: Compared to the case without monetary policy reaction.

5 Economic Stability and Progressiveness of Taxation

In standard models, the stabilisation properties of progressiveness are studied only through the demand channel. These models yield the result that automatic stabilisers (like the progressiveness of taxation) stabilise output and inflation in the case of a demand shock, and stabilise output but destabilise inflation in the case of a supply shock (see, for example, Blanchard, 2000; Brunila et al, 2002).

Buti et al (2002) put a large weight on the supply channel, and they obtain the result that rising tax rates (which are combined with high marginal rates) enhance market distortions and yield higher output instability in the event of supply shocks and greater inflation instability in the event of demand shocks (see also Martinez-Mongay and Sekkat, 2005). Kleven and Kreiner (2003) put the whole emphasis on the supply side and show in a theoretical model that taxes can work through this channel as automatic destabilisers.

Agell and Dillén (1994) use a monopolistic competition model with price-setting agents to analyse progressive taxation. They show that progressive taxes are output stabilising because they affect the pricing rules directly. Progressiveness induces more price flexibility and less output variability.[6]

[6] For empirical studies (with econometric models) on composite indicators of automatic stabilisers (compiled from various factors), see Brunila et al., (2002) (EU's QUEST model), Barrell et al. (2002) (NIESR's NiGEM model), Buti et al. (2002) (OECD's INTERLINK model) and Cohen and Follette (2000) (US Federal Reserve Board's FRB/US model). In broad terms, these studies imply that automatic stabilisers stabilise output in the face of demand shocks but are less stabilising in the face of supply shocks. Auerbach and Feenberg (2000) study empirically the stabilization properties of taxation in the United States. The authors observe that about 8 per cent of initial shocks to GDP is offset by tax-induced consumption responses (mainly by progressive income taxes and payroll taxes) – in spite of clear cuts in the progressiveness of taxation since the early 80's. This study does not differentiate between different types of shocks.

In what follows, we study the demand as well as supply effects and analyse their relative magnitudes. We illustrate the effects of progressiveness for country 1 by inserting the tax equation (3) in the demand equation (1) and in the supply equation (4). We rewrite the demand equation as follows:

(13) $y_1 = -[\{\sigma + \psi (1 - \omega)\xi\}/(1 + \psi\xi)]\, p_1 + M$, where

$M = \mu (i - \pi^e) + \sigma p_2 + \varepsilon y_2 + g_1 - \psi \upsilon_1$.

When we have full indexation of taxes, i.e. $\omega=1$, we see that an increase in progressiveness ξ decreases the absolute value of the multiplier of p_1. Higher progressiveness thus steepens the demand curve. When $\omega=0$ and $\sigma<1$ (which is obvious), an increase in progressiveness raises the absolute value of the multiplier, i.e., the demand curve becomes flatter. A steeper demand curve tends to reduce the output deviation in the case of a supply shock, while a flatter curve tends to increase it.

For the supply curve we obtain

(14) $p_1 = [(\beta + \eta\xi)/\{1 - \eta (1-\omega) \xi\}]\, y_1 + W$, where $W = \alpha p_2 + \eta \upsilon_1 - s_1$.

When $\omega=1$, the multiplier of y_1 is $\beta + \eta\xi$. An increase in progressiveness thus leads to a steeper supply curve. When $\omega=0$, the supply curve becomes even steeper. The effect of this steepening on the deviation of output and prices depends on the position of the demand curve.

Progressiveness affects economic variables, therefore, through demand and supply. The relative magnitudes of these effects depend on the sizes of the parameters. Parameters ψ and η are crucial in this respect. They depict the relative strength of the demand and supply effects. Both parameters are multipliers of the progressiveness parameter ξ. A large ψ tends to steepen the demand curve *a priori*, when taxes are fully indexed ($\omega=1$), and to flatten it when $\omega=0$ ($\sigma < 1$). A large η tends to steepen the supply curve. The degree of indexation of taxes (ω) affects the results, too, especially in the case of a supply shock. Naturally, the interplay between the countries also affects the results.

Before moving to the two-country model, we analyse the effects of progressiveness in a one-country context (Section 5.1). This already shows that the stability effects of progressive taxation depend on several parameters, especially on the degree of tax indexation (ω) and on the relative magnitudes of the demand and supply effects (parameters ψ and η).

5.1 Stability Effects of Progressiveness in a One-Country Model

We present the effects of the three shocks below. Public expenditure is assumed to be fully indexed, but the tax indexation parameter ω is not fixed. The model consists of equations (1) – (4). The exchange rate is fixed and the economy does not have any effect on the rest of the world, so we can regard it as a small EMU country.

In the case of a positive **demand shock,** the effects on output, prices and taxes (as a ratio to output) are as follows:

$$\delta y/\delta f = \{1 - (1-\omega)\eta\xi\}/\{1 + \beta\sigma + (\eta\sigma + \psi)\xi - (1 - \omega)(\eta - \beta\psi)\xi\},$$

$$\delta p/\delta f = (\beta + \eta\xi)/\{1 + \beta\sigma + (\eta\sigma + \psi)\xi - (1- \omega)(\eta - \beta\psi)\xi\},$$

$$\delta t/\delta f = \{(1 + \beta - \beta\omega)\xi\}/\{1 + \beta\sigma + (\eta\sigma + \psi)\xi - (1 - \omega)(\eta - \beta\psi)\xi\}.$$

Output, prices and taxes all increase after the shock (we can assume that the denominator is positive[7]). We see that an increase in the progressiveness parameter ξ tends to stabilise output, when taxes are fully indexed (ω=1) (the denominator increases). This is probable also in the case when taxes are not indexed, because the response of prices to taxes (η) is rather small in the short run.

The effect of progressiveness on the price development depends positively on the strength of the tax effect on prices η and on the relative magnitude of parameter β, i.e., the effect of output on prices (indirect effect through the stabilising effect on output). It depends negatively on the strength of the tax effect on demand ψ (marginal propensity to consume) and on the responsiveness of output to changes in competitiveness σ (openness of the economy). The more taxes affect demand and the more open the economy is, the more attractive progressiveness is from a price stabilisation point of view. Progressiveness is, in turn, less attractive the more taxes and output affect prices. In the case of a positive demand shock, taxes and output increase and tend to raise prices. In the baseline scenario with fully indexed taxes, an increase in progressiveness tends to destabilise prices (even though the effect of taxes on prices is weak, i.e. η= 0.1). [8]

In the case of a positive **tax shock** (a tax cut), the effects on output, prices and taxes are as follows:

$$\delta y/\delta \upsilon = (\eta\sigma + \psi)/\{1 + \beta\sigma + (\eta\sigma + \psi)\xi - (1-\omega)(\eta - \beta\psi)\xi\},$$

$$\delta p/\delta \upsilon = (\beta\psi - \eta)/\{1 + \beta\sigma + (\eta\sigma + \psi)\xi - (1-\omega)(\eta - \beta\psi)\xi\},$$

$$\delta t/\delta \upsilon = -\beta(1 + \beta\sigma)/\{1 + \beta\sigma + (\eta\sigma + \psi)\xi - (1-\omega)(\eta - \beta\psi)\xi\}.$$

Output increases following a tax cut. Prices rise if the effect of declining taxes on prices is weak, i.e. η is small and the effect of taxes on demand is strong (ψ is big). Additionally, the price effect depends on the responsiveness of prices to activity (β).

An increase in progressiveness offsets part of the tax cut, and this tends to stabilise output as well as prices if taxes are fully indexed. This occurs even with zero tax indexation if $(\eta\sigma + \psi) > (\eta - \beta\psi)$. This happens if prices react only modestly to taxes (η is small). From a policy point of view, high tax progressivity weakens the effect of tax policy.

In the case of a positive **supply shock**, output increases and prices decline. Taxes increase in relation to output, and contribute in a stabilising way to the above-mentioned variables, when $\sigma + \omega > 1$. The degree of tax indexation must thus be rather high (σ = 0.1 in the baseline scenario, see the appendix). The effects are as follows:

---

[7] The negative term $(1-\omega)(\eta-\beta\psi)\xi$ is small in relation to the positive terms, and it must be even smaller than unity. In practice the maximum value for η is 1, and for ξ clearly less than 1 (about 0.5).

[8] In the two-country model to be presented in Section 5.2, however, an increase in progressiveness in both countries tends to stabilise prices in the baseline scenario.

$$\delta y/\delta s = \{\sigma + (1-\omega)\psi\xi\}/\{1 + \beta\sigma + (\eta\sigma + \psi)\xi - (1-\omega)(\eta - \beta\psi)\xi\},$$

$$\delta p/\delta s = -(1 + \psi\xi)/\{1 + \beta\sigma + (\eta\sigma + \psi)\xi - (1-\omega)(\eta - \beta\psi)\xi\},$$

$$\delta t/\delta s = \{(\sigma + \omega - 1)\xi\}/\{1 + \beta\sigma + (\eta\sigma + \psi)\xi - (1-\omega)(\eta - \beta\psi)\xi\}.$$

A high value of the progressiveness parameter ξ tends to stabilise output if taxes are fully indexed ($\omega = 1$). This is not, however, clear *a priori* if taxes are less than fully indexed. A stabilising effect is less probable than in the case of a demand shock because the progressiveness term ξ is here additive in the numerator.

The effect of progressiveness on price developments is not clear *a priori* even with full indexation of taxes. The outcome depends on the relative size of the parameters. Prices decline more with increasing progressiveness the greater is the effect of the term $\xi\psi$, i.e., the greater is the (negative) effect of increasing taxes on demand. A high value for the term $\eta\xi\sigma$, instead, tends to diminish the decline. This term is greater the higher is the effect of (increasing) taxes on prices (parameter η). This is the opposite to the situation in the case of a demand shock. Additionally, the effect depends on the size of the term $\beta\sigma$. In the baseline scenario, an increase in progressiveness tends to decrease the deviation in prices. A value of 0.1 for the parameter η is big enough to produce this result.

5.2 Stability Effects of Progressiveness in a Two-Country Model

We now study the stability of the two economies in the face of the three types of shocks, with different degrees of income tax progression and without any monetary policy reactions. We thus try to explore whether a high or low (or no) degree of progression tends to stabilise the economy more. We have the tax progression parameter ξ in two places in the tax equations (3) and (7), i.e., before the output and price variables. We vary the parameter ξ between 0 and 1, representing a move from proportional taxation to ultra progressive taxation, respectively.

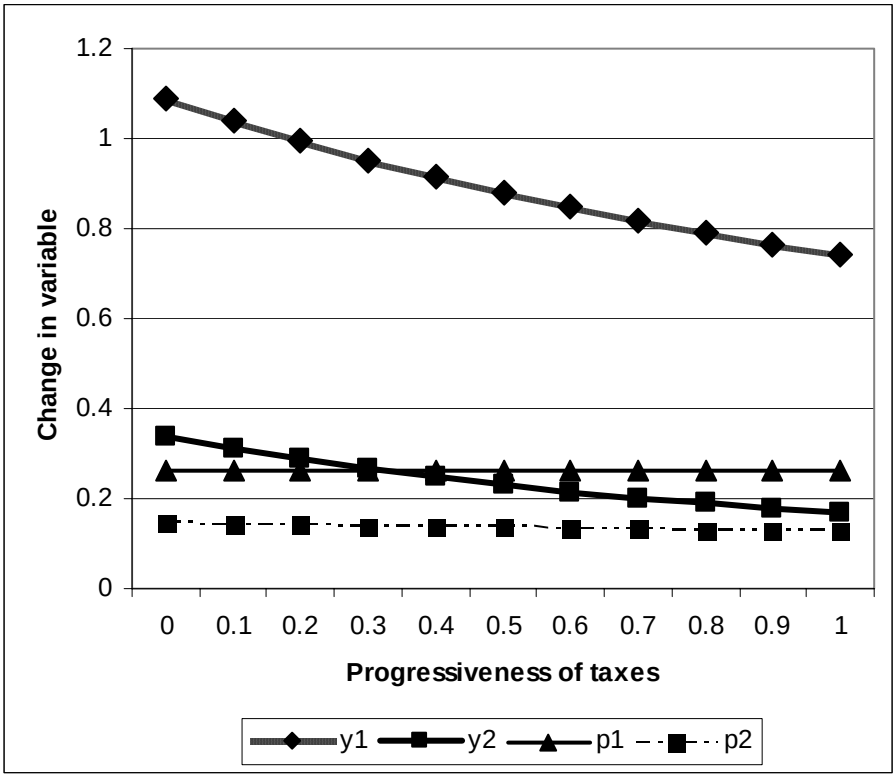
In the first scenario, we set $\psi = 0.4$ and $\eta = 0.1$. We thus assume that the effect of taxes on demand is larger in the short run than the effect on prices (and accordingly on wages), where we assume a lag due to contract agreements. The effect of taxes on wage demands depends also on whether employees think that the tax revenues are used usefully or not. Workers can, for example, give some weight for public services like children's day care, public health care, etc. These kinds of factors can more easily be taken into account in a centralised than in a decentralised wage negotiation system. We present this scenario, where wages react weakly to taxes, in Section 5.2.1. In Section 5.2.2 we present a case where the reaction of prices to changes in taxes is strong ($\eta = 0.5$). This case is relevant in countries where taxes are strongly disliked and where wages are flexible to react quickly to changes in taxes (short contract period or market wage).

5.2.1 A Rather Weak Supply Reaction to Taxes

In the baseline we assumed that $\xi = 0.4$. Now we vary this parameter value from 0 (proportional taxation) to 1. We ignore the case of regressive taxation ($\xi < 0$) because it is not empirically relevant. The assumptions for the demand and supply side tax parameters are: $\psi = 0.4$ and $\eta = 0.1$.

In the case of a **demand shock** in country 1, progressiveness of taxation tends to stabilise both economies. In Figure 1 the sensitivity is presented assuming that indexation of taxes with respect to prices is unity. When the indexation is lower, an increase in progressiveness reduces the variation of all variables faster (through the additional price channel).

Figure 1 **Positive Demand Shock in Country 1 (f_1): Sensitivity of Output (y_1 and y_2) and Prices (p_1 and p_2) with Respect to the Degree of Progressiveness of Taxes (ξ) (η=0.1, ω=1)**



Tax progressivity tends to stabilise output because it dampens the rise in consumption and investment. This reduces slightly the variability of prices, too, through a smaller output gap. This effect is greater than the price effect through the supply side, which tends to increase the variability of prices. Taxes in relation to output are naturally higher with higher progressiveness.

In the case of a **tax shock** occurring in country 1, progressive taxation tends to stabilize the output of both countries. Increasing progression partly offsets the effect of the original shock (Figure 2). When the change is due to an exogenous shock, this is good. When the change in taxes is done on purpose, we can conclude that marginal taxation reduces a part of the aimed output effect. To have a larger output effect, a decline in the general tax level should thus be accompanied by a reduction in progressiveness. The effects of progressiveness on price developments are only marginally stabilising. Prices change very little due to opposite demand and supply effects.

Figure 2 **Tax Reduction in Country 1 (υ_1): Sensitivity of Output (y_1 and y_2) and Prices (p_1 and p_2) with Respect to the Degree of Progressiveness of Taxes (ξ) (η=0.1, ω=1)**

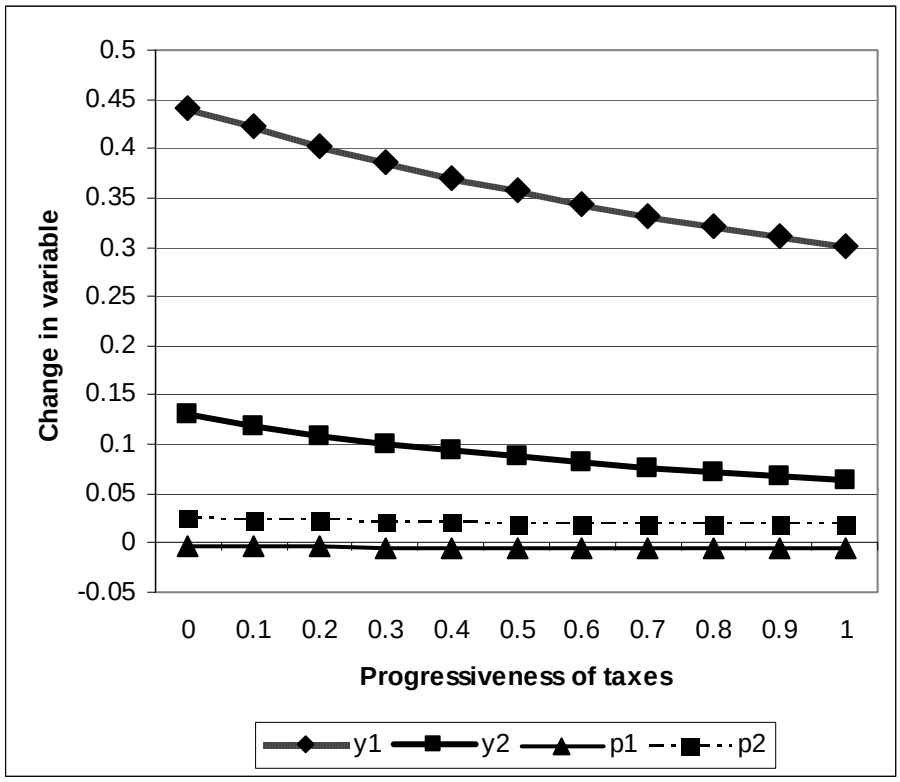
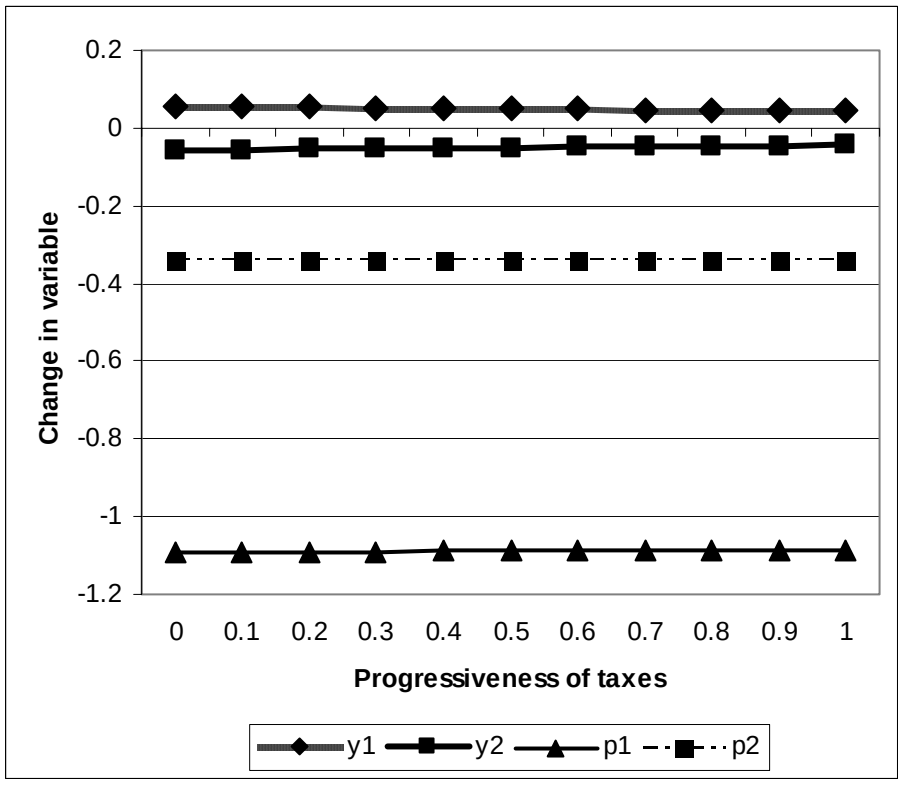


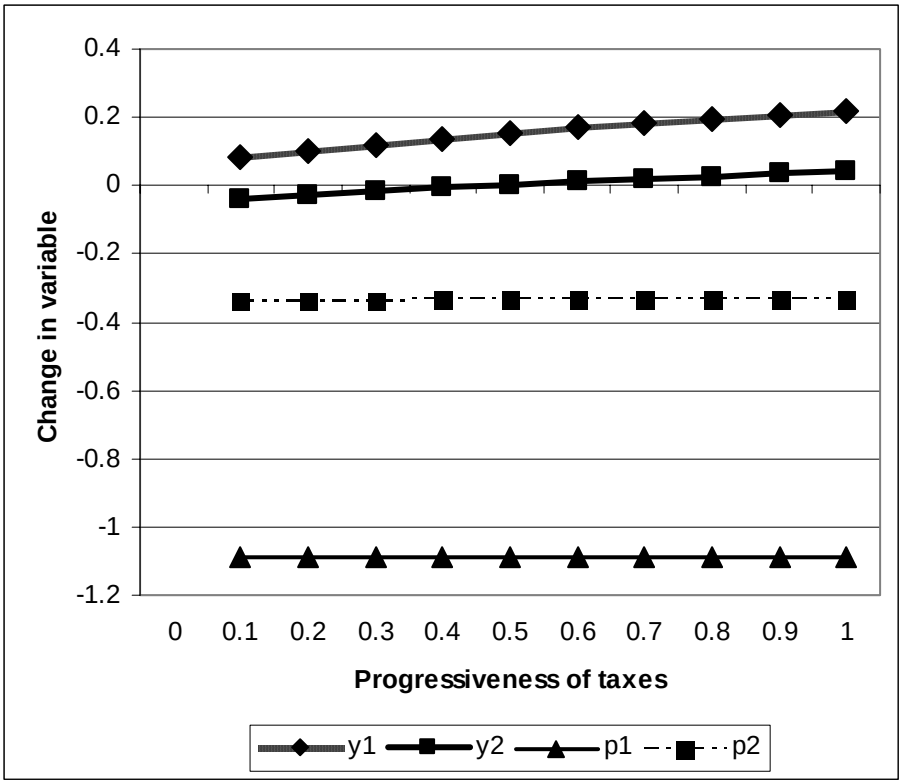
Figure 3 **Positive Supply Shock in Country 1 (s_1): Sensitivity of Output (y_1 and y_2) and Prices (p_1 and p_2) with Respect to the Degree of Progressiveness of Taxes (ξ) (η=0.1, ω=1)**



In the case of a **supply shock** in country 1 ("Germany"), the degree of progressiveness does not matter very much in the short run when the effect of changes in competitiveness on output in the countries is rather small, and when taxes are fully indexed (Figure 3). The "beggar-thy-neighbour" nature of a supply shock, like a reduction of pension contributions, remains with all degrees of progressiveness.

The effect of progressiveness becomes stronger when the competitiveness elasticity of output is higher and/or when the effect of a substantial change in prices is taken into account by a low degree of tax indexation. The latter case is presented in Figure 4. An increase in progressiveness raises the variation in the output of country 1. On the other hand, when the original shock is produced on purpose to expand output, a larger effect is obtained in the case of progressive taxation, if taxes are less than fully indexed to price developments. In country 2, the output deviation becomes smaller until ξ=about 0.45. For example, in Finland this is the marginal income tax of a median taxpayer. Prices are not very sensitive to progressiveness of taxation.

Figure 4 Positive Supply Shock in Country 1 (s_1): Sensitivity of Output (y_1 and y_2) and Prices (p_1 and p_2) with Respect to the Degree of Progressiveness of Taxes (ξ) (η=0.1, ω=0.5)

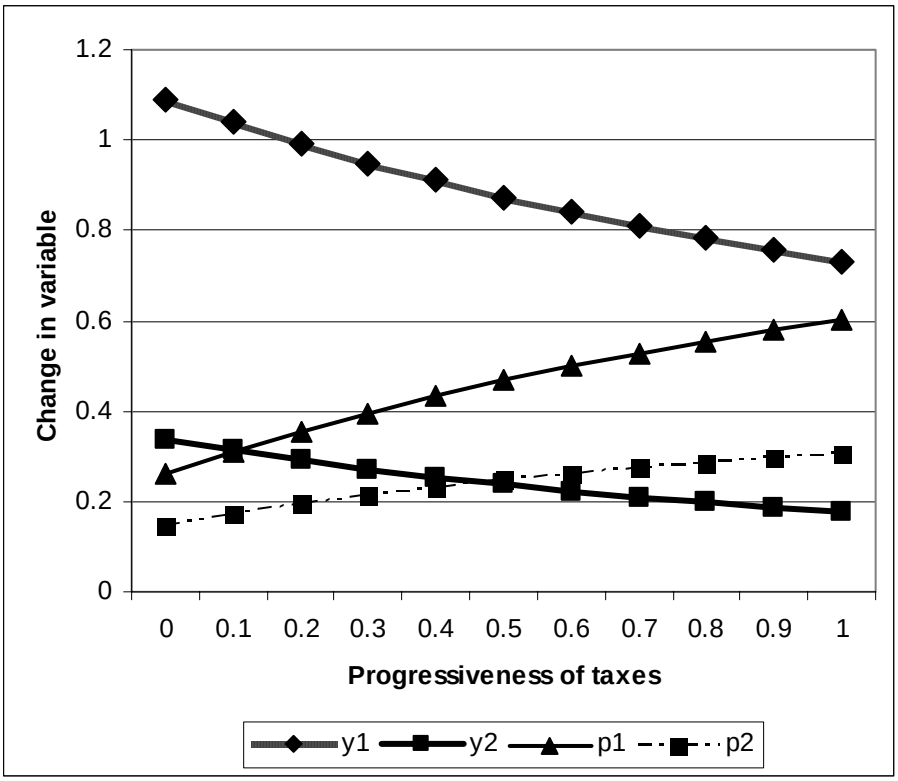


5.2.2 A Strong Supply Reaction to Taxes

We present now a case where the elasticity of prices with respect to taxes η equals 0.5. The results are, however, qualitatively similar when the price reaction to taxes is unity, i.e., η= 1. These assumptions mean that employees do not respect the public expenditure that is financed by taxes, and they demand compensation in the form of higher wages. Higher wages, in turn, are reflected in higher prices. The response of output to taxes ψ is 0.4 as in the previous case. We again change the progressiveness parameter ξ from 0 to 1.

In the case of **a demand shock** in country 1, output becomes more stable in both countries as tax progressiveness increases. Price stabilisation, however, weakens in both countries. The result is the same as that obtained by Buti et al. (2002). (See also the one-country case in Section 5.1.) Increasing taxes tend to weaken the output growth effect, whereas the strong effect of increasing taxes on prices strengthens the increase in prices. Because prices increase in both countries, the union-wide central bank could in this case raise the interest rate, which would dampen the increase in prices. If the shock is an unintended demand shock originating in the market, the opposite fiscal policy response is also effective.

Figure 5 **Positive Demand Shock in Country 1 (f_1): Sensitivity of Output (y_1 and y_2) and Prices (p_1 and p_2) with Respect to the Degree of Progressiveness of Taxes (ξ) (η=0.5 and ω=1)**



In the case of a **tax cut** in country 1 increasing tax progression tends to diminish the original tax cut effect in country 1, which tends to stabilise output as well as prices in that country. In country 2 the effect is similar. Taxes are higher than with lower progressiveness, which tends to stabilise output. Also, the decline in prices becomes smaller.

In the case of a **supply shock** occurring in country 1, output and prices are not very sensitive to progressiveness of taxation. An increase in progressiveness tends to slightly stabilise the output of both countries and the prices of country 1. Price variation in country 2, however, increases slightly with increasing progressiveness. When progressiveness affects the economy only through activity, i.e., taxes are fully indexed (ω=1), the original decline in prices is taken into account in the tax cuts. A positive supply shock tends to increase the output of country 1 and to decrease that of country 2 in the short run.

Figure 6 **Tax Reduction in Country 1 (υ_1): Sensitivity of Output (y_1 and y_2) and Prices (p_1 and p_2) with Respect to the Degree of Progressiveness of Taxes (ξ) (η=0.5 and ω=1)**

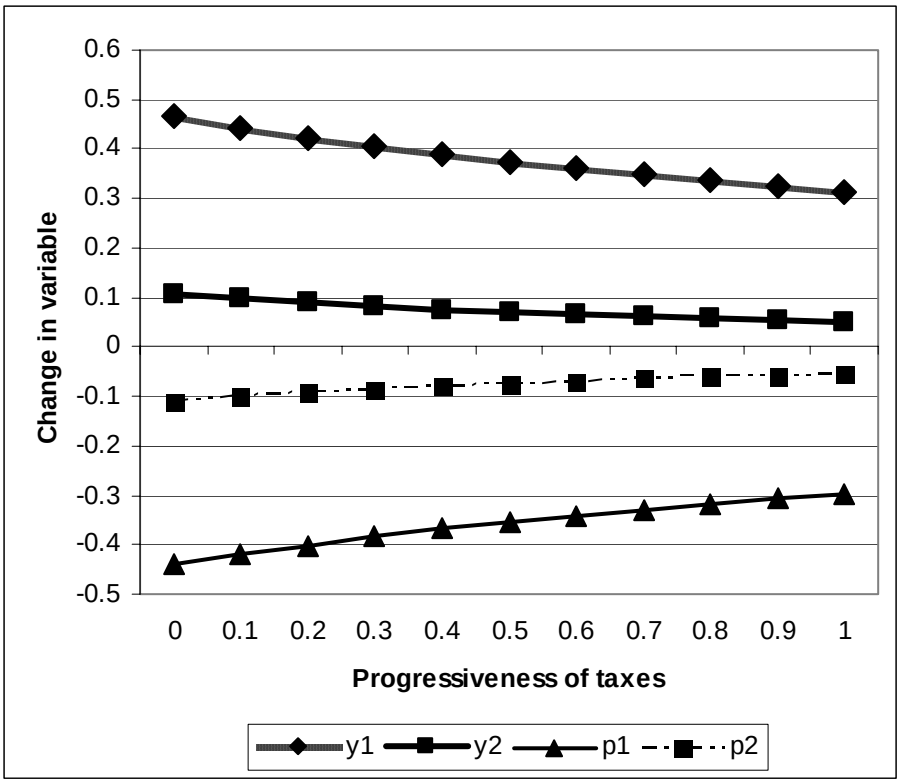
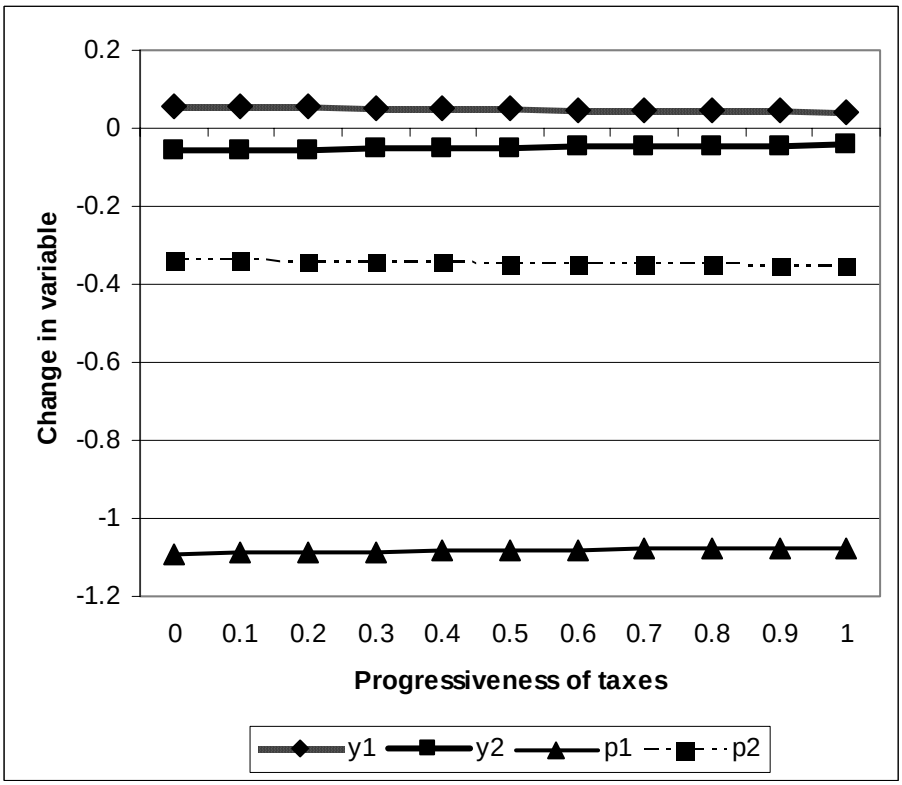


Figure 7 **Positive Supply Shock in Country 1 (s_1): Sensitivity of Output (y_1 and y_2) and Prices (p_1 and p_2) with Respect to the Degree of Progressiveness of Taxes (ξ) (η=0.5 and ω=1)**



The increase in taxes, in relation to output, in country 1 and their decline in country 2 are greater the higher the tax progressivity. This tends to stabilise the output of both countries through the demand channel. A strong reaction of prices to taxes, in turn, tends to dampen the decline in prices in country 1 and to strengthen the decline in country 2. These price reactions tend to stabilise the competitiveness between the countries.

When taxes are less than fully indexed (in our calculation ω=0.5), higher progressiveness leads to a more unstable output and price development in country 1. In country 2 the price development is more unstable, but output is more stable when progressiveness increases (until ξ reaches about 0.45). The outcome is thus about the same for output deviations as in the case where the response of prices to taxes is modest (Section 5.2.1). Prices are however, more responsive to progressiveness when the price reaction to taxes is higher.

6 Economic Stability and Indexation of Taxes

We saw already in the previous section that the degree of indexation of taxes can affect the stabilisation properties of progressive taxation. We now look at the sensitivity of stabilisation in the face of different shocks with respect to the tax indexation parameter ω. The impacts of tax indexation work through demand as well as supply. The greater tax indexation is, the steeper are the demand curves and the flatter are the supply curves (see Kotilainen, 1995.). Tax indexation can be either based on an automatic rule or on an explicit political decision. In the baseline, we assume that we have progressive income taxation (ξ=0.4) and that public expenditure is fully indexed (λ=1).

In the case of a positive **demand shock**, output and price deviations in both countries are slightly greater when indexation of taxes increases (Figure 8). This happens because increasing indexation takes into account the price increases that follow from a positive demand shock. This is the same result that was obtained by Kotilainen (1995) in a similar one country model *a priori* (with some realistic assumptions concerning the magnitudes of the parameters).[9] When price developments are taken more into account, the increase in taxation is smaller than with lower indexation.

A **tax cut** in country 1 boosts output through demand as well as supply. The former effect tends to increase prices, and the latter one to decrease them. As a net result, prices change very little in both countries. This means that indexation of taxes is of minor importance to the stability of output in both countries.

[9] Bruce (1981) is the seminal paper on tax indexation in a one-country case. Lassila (1995) modifies Bruce's paper's LM curve and obtains slightly different results. Kotilainen (1995) studies the effects of tax indexation in the cases of floating (with two LM curve specifications) and fixed exchange rate regimes in the face of three shocks: demand, monetary and supply shock. Kotilainen studies more cases than the previously mentioned studies and his results also differ in some respects from them.

Figure 8 **Positive Demand Shock in Country 1 (f_1): Sensitivity of Output (y_1 and y_2) and Prices (p_1 and p_2) with Respect to the Degree of Tax Indexation (ω)**

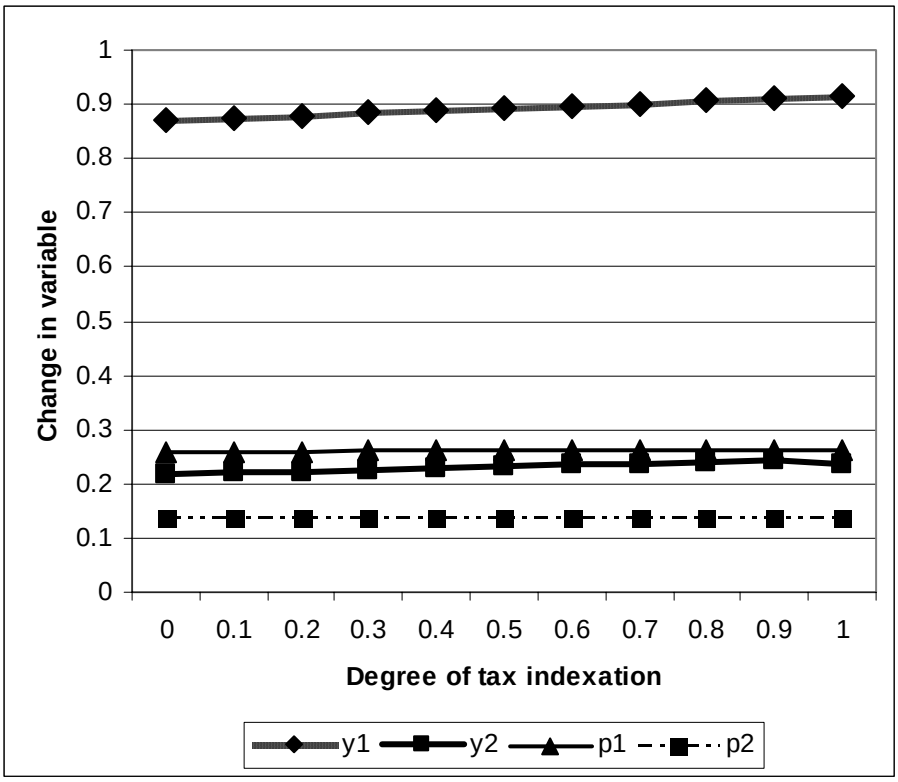
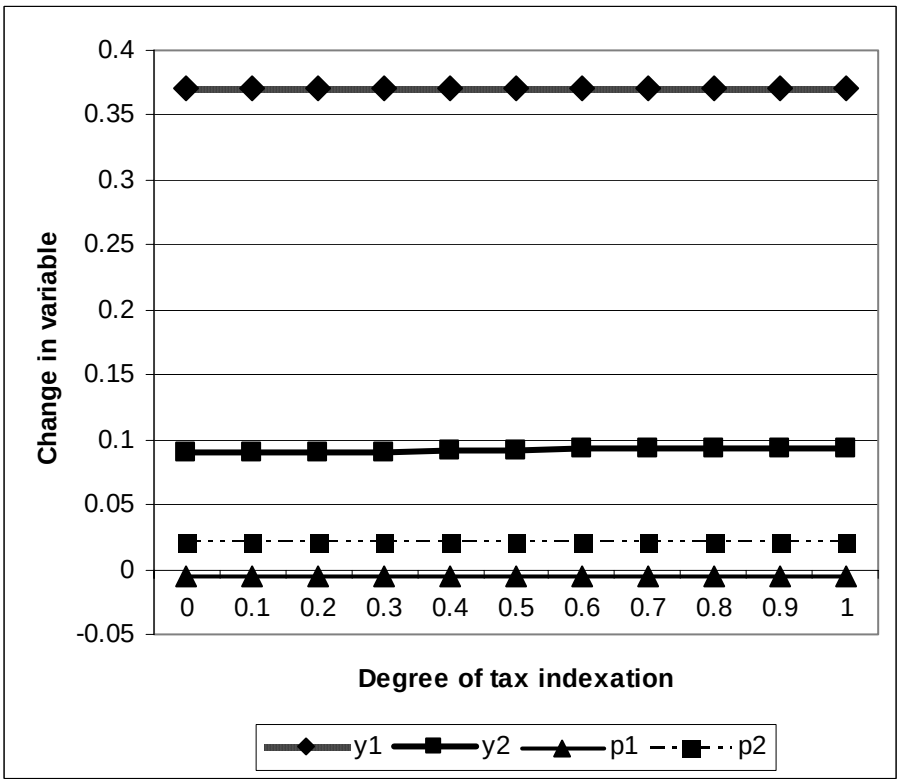
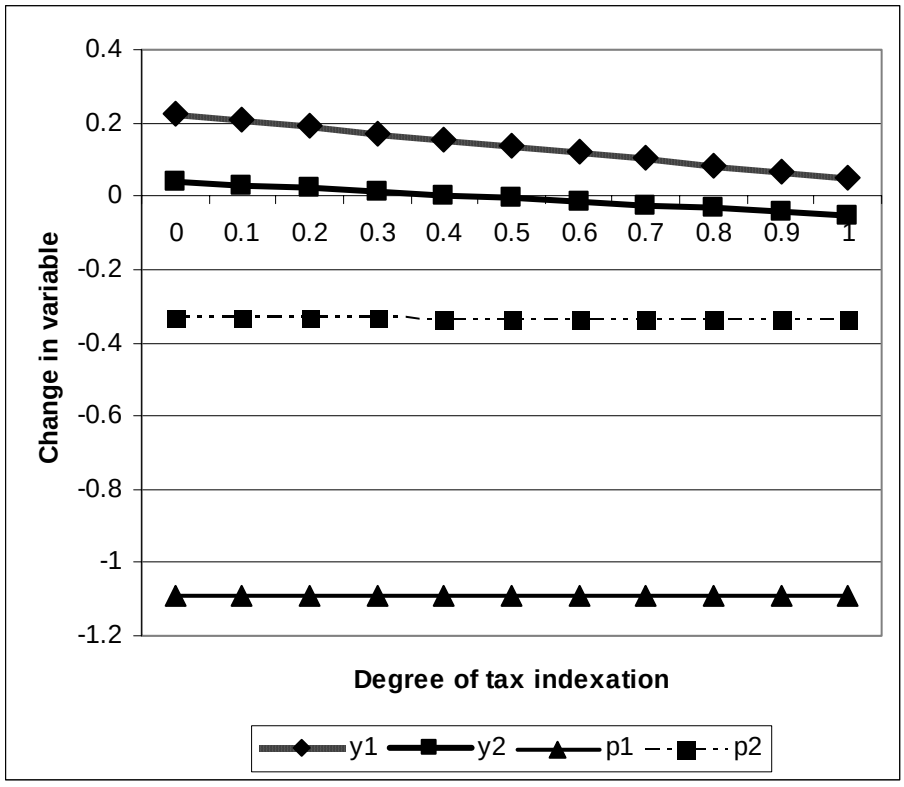


Figure 9 **Tax Reduction in Country 1 (υ_1): Sensitivity of Output (y_1 and y_2) and Prices (p_1 and p_2) with Respect to the Degree of Tax Indexation (ω)**



In the case of a positive **supply shock** (for example an increase in productivity or a cut in indirect labour costs), the deviation of output in country 1 decreases when tax indexation increases. This is because prices in that country decline considerably as a result of the supply shock. When this decline is taken more into account, the effect through the tax channel becomes smaller, and, accordingly, the whole output effect becomes smaller. With ω=1 and progressive taxation, taxes already dampen slightly the output increase. In country 2 the price effect of a supply shock occurring in country 1 is clearly smaller, and correspondingly, also is the effect of increasing tax indexation. The output effect is near zero in the baseline calculation and it shifts from positive to negative with indexation of about 0.5. Using a similar one-country model, Kotilainen (1995) observes *a priori* the same output stabilising effect of tax indexation in the case of a domestic productivity shock (with some realistic assumptions for the parameter values).

Figure 10 Positive Supply Shock in Country 1 (s_1): Sensitivity of Output (y_1 and y_2) and Prices (p_1 and p_2) with Respect to the Degree of Tax Indexation (ω)



7 Economic Stability and Indexation of Public Expenditure

Indexation of public expenditure means that parameter λ in equations (2) and (6) differs from zero. We assume that it varies between 0 and 1, the latter being the case of full indexation. We assume again that we have progressive income taxation (ξ=0.4) and that taxes are fully indexed (ω=1). When λ>0, price changes are taken into account in the determination of public expenditure. When indexation of public expenditure increases, the demand curve becomes steeper. We see this by inserting equation (2) in equation (1) (y on the horizontal and p on the vertical axis).

Figure 11 **Positive Demand Shock in Country 1 (s_1): Sensitivity of Output (y_1 and y_2) and Prices (p_1 and p_2) with Respect to the Degree of Tax Indexation (λ)**

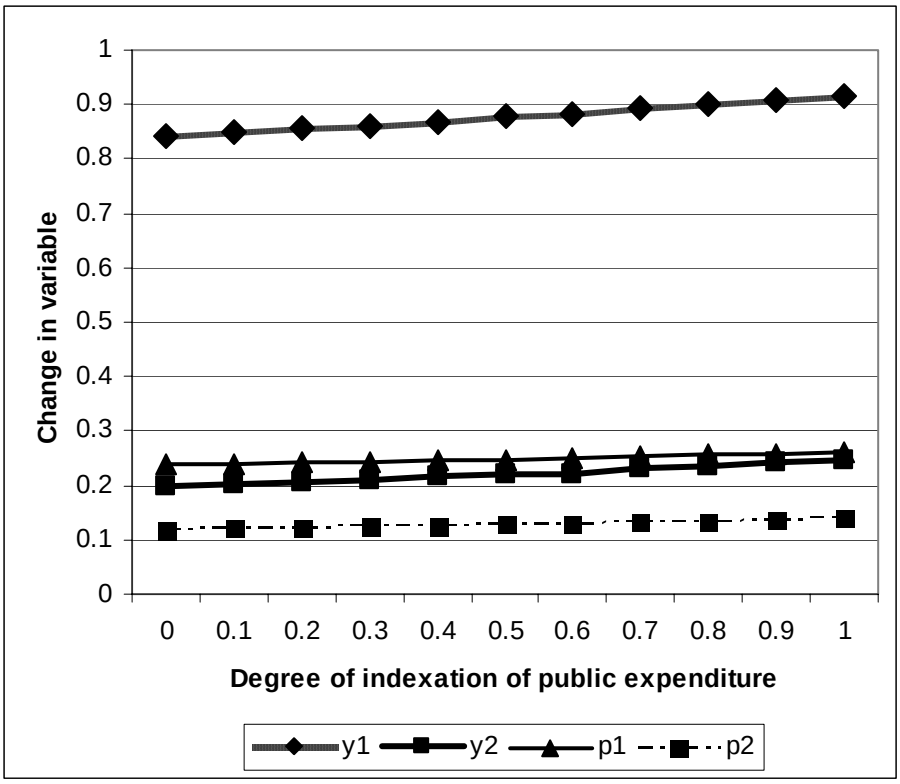
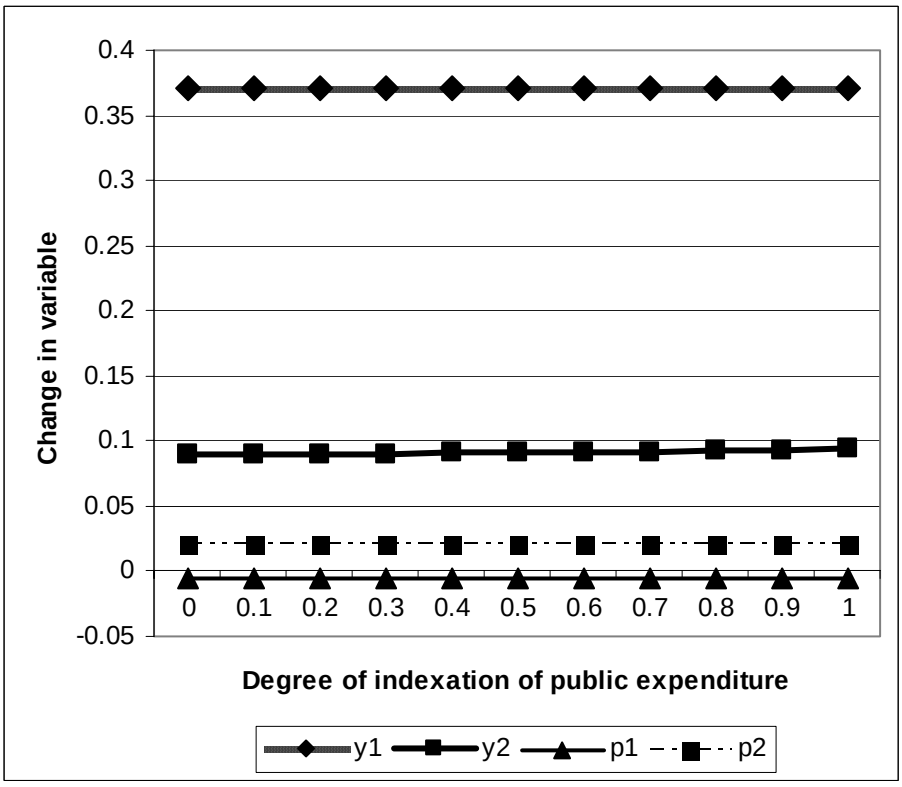


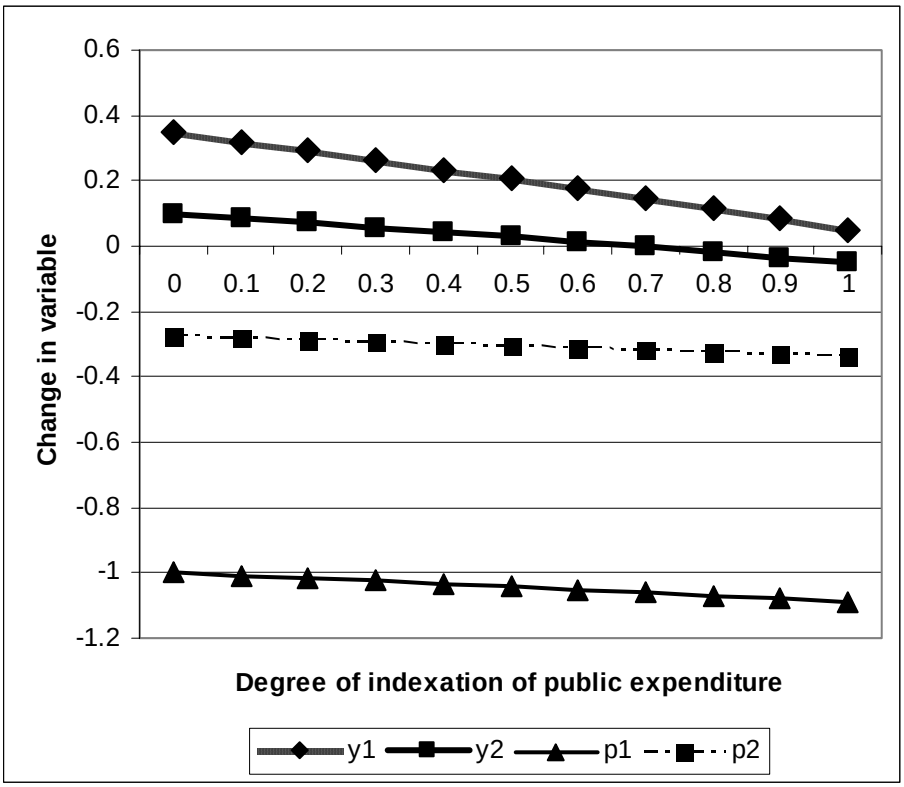
Figure 12 **Tax Reduction in Country 1 (υ_1): Sensitivity of Output (y_1 and y_2) and Prices (p_1 and p_2) with Respect to the Degree of Tax Indexation (λ)**



When we have a positive **demand shock,** an increase in the indexation of public expenditure leads to a greater deviation in output and prices in both countries. This is because of a larger weight of increasing prices. When increases in prices are deflated away to a greater extent, the final increase in public expenditure will be larger. Kotilainen (1995) obtains the same result *a priori* in a one-country case.[10]

In the case of a **tax cut** in country 1 the situation is the same as with tax indexation (Figure 12). Prices change only a little because of conflicting demand and supply effects, so indexation to them does not matter much.

Figure 13 Positive Supply Shock in Country 1 (s_1): Sensitivity of Output (y_1 and y_2) and Prices (p_1 and p_2) with Respect to the Degree of Tax Indexation (λ)



When there is a **supply shock** in country 1, increasing indexation of public expenditure decreases the deviation of country 1 output. For country 2, the output effect turns from positive to negative at indexation λ=0.7. Deviations in prices increase slightly in both countries when indexation increases.

[10] Kotilainen (1995) studies stabilisation properties of indexation of public expenditure in a recursive three-country model with two large countries ("USA" and "EMU") and a small open economy ("Finland"). The exchange rate between the large countries is flexible and the small country has three alternative regimes: 1) floating, 2) currency basket peg and 3) membership in EMU. The shocks are a demand, monetary and supply shock, which all can originate in the home country or in either of the big countries. In the small country there are thus altogether 27 cases to be studied.

8 Summary

We study the properties of different kinds of income tax systems in the context of the EMU countries. The emphasis is on progressiveness of taxation and on indexation of taxes and public expenditure. For that purpose we use a two-country macroeconomic model with a fixed bilateral exchange rate. The model tries to depict the situation in the larger EMU countries. We also use a one-country model, which is more relevant in the case of small EMU countries.

We analyze the effects of three kinds of shocks: an increase in demand, a tax cut and a positive supply shock (such as an increase in productivity or a decline in indirect labour costs). The tax shock is a mixed shock including demand as well as supply effects (through wages and prices). All shocks are assumed to occur in country 1 ("Germany"). They have, however, effects on country 2 ("France") through output and price spillovers as well as through changes in competitiveness. Because the model is too complicated for obtaining *a priori* results, we calculate the solution by using realistic estimates for the parameters.

We first present the effects without any monetary policy reactions. A demand shock in country 1 increases the output and prices of both countries, though more so in the country where the shock originates. In the case of a tax shock, the output effect in the country where the shock originates is clearly positive, whereas in the foreign country it is relatively smaller than in the case of a demand shock because that country's competitiveness deteriorates in this case. Prices change only marginally because the effects through lower costs and through increasing economic activity work in opposite directions. A pure supply shock has, in the short run, a "beggar-thy-neighbour" nature: the output of country 1 increases but that of country 2 declines. This effect is changed only if country 2 follows country 1 in reducing costs, i.e., through increases in productivity or reductions in indirect labour costs. (See Kotilainen, 1995.)

When studying Taylor-type monetary policy rules, we notice that in the case of a demand shock, following a price or output target tend to stabilise both union-wide output and prices. In the case of a tax shock, strict adherence to a price target does not tend to stabilise output, because prices change only marginally. Output in the monetary union thus tends to increase in the case of a positive shock and to decline in the case of a negative shock. In the case of a positive supply shock prices decline in both countries, whereas union-wide output remains rather stable due to opposing effects in the two countries. Following the price target would thus destabilise the output. If the shock is originally policy induced, monetary policy would, however, support the activist supply side policy through a cut in interest rates.

When studying the effects of progressive taxation we use the one- as well as the two-country model. In the one-country model we notice that progressive taxation tends to stabilise output in the cases of demand and tax shocks. In the case of a supply shock, progressiveness tends to stabilise output if taxes are fully indexed. If they are not, the outcome depends on the relative magnitudes of the parameters of the model. In particular, the smaller is the demand effect of taxes, the more likely it is that progressiveness will tend to stabilise output even with low indexation of taxes.

Progressive taxation stabilises prices definitely only in the case of a tax shock. In the cases of demand and supply shocks, the outcome depends in opposite ways on the relative strengths of the demand and supply effects of taxes. In the case of a demand shock, progressiveness tends to stabilise prices when the supply effect is weak, and in the case of a supply shock when the demand effect is weak.

In the two-country case we use the model version without monetary policy reactions. The motivation for this is that we want to keep the effects of the tax parameters transparent. Monetary policy often takes time, and we do not know the policy rule very well. Because the monetary policy of the central bank is based on discrete decisions, the reaction can also vary over time. We research two cases: 1) a case where the reaction of wages, and, accordingly, of prices to taxes is rather small, and 2) a case where wages and prices respond strongly to changes in taxes. The first assumption can be motivated by the short-run nature of the model (wages are sticky due to contracts often for one or two years) and by the assumption that employees put weight on the public expenditure financed by taxes. The second scenario is relevant in countries whose citizens strongly dislike taxes and where wages are determined flexibly on short notice.

We report, first, the results from the case where price reactions to changes in taxes are rather modest. In the case of a positive demand shock and a tax shock occurring in country 1, progressive taxation tends to stabilise the output and, to a smaller extent, prices of both countries, because it offsets part of the effect of the shock. If the tax shock is policy induced, the positive output effect can be strengthened by reducing the progressiveness of taxation. Price reactions are not sensitive to progressiveness. In the case of a supply shock, progressiveness does not matter much in the short term when taxes are fully indexed. When tax indexation is low, however, the substantial changes in prices are taken into account, and, accordingly, the effect of progressiveness becomes stronger through the price channel. In this case, the output deviation in the country, where the shock originates, increases when progressiveness increases. In the other country, the output deviation becomes smaller until a threshold level of about 0.5 in progressiveness.

When prices react strongly to changes in taxes, the output stabilisation property of increasing progressiveness holds in both countries in the case of a demand shock. But now the deviation of prices in both countries tends to increase. This is because increasing taxes tend to raise prices. Here we have a clear case for restrictive monetary policy. In the case of a tax shock, increasing progressiveness tends to stabilize the output of both countries by dampening part of the shock's effect. When prices react strongly and quickly to changes in taxation, higher progressiveness tends to dampen the original decline in taxes, and accordingly the decline in prices in country 1. In country 2, taxes increase more with progressive taxation and the decline in prices in this country is also smaller . In the case of a supply shock, output and prices are, again, not very sensitive to progressiveness. Output in both countries tends to deviate slightly less with higher progressiveness. Also prices in country 1 deviate slightly less with progressive taxation. Prices in country 2, however, deviate somewhat more. When taxes are less than fully indexed, the effects of progressiveness on output deviations are about the same as in the case of a weaker supply reaction to taxes. Prices become, however, more sensitive to progressiveness. Price deviations are enhanced when progressiveness increases.

As a general conclusion about the role of progressiveness in economic stabilisation, following various shocks, in the two-country model, it can be concluded that progressive taxation tends to increase the stability of output in both countries in the face of a **demand shock**. Progressiveness stabilises prices if wages and prices react only modestly to changes in taxes, but destabilizes them when these reactions are strong. In the case of a **tax shock** progressive taxation tends to stabilise the output and prices of both countries in both cases. From a policy point of view, progressive taxation partly offsets the output effects of a tax cut. In the case of a **supply shock** output and prices are not very sensitive to progressiveness. This result is consistent with studies using the INTERLINK, QUEST, NiGEM and FRB/US models (where, however, the full operation of all types of automatic stabilisers is assumed). Sensitivity increases when taxes are less than fully indexed to prices. In this case output deviations are slightly greater than with proportional taxation in the country where the shock originates, but slightly smaller in the other country.

We can roughly summarise the results obtained in the one- and two-country models by saying that progressive taxation tends to stabilise output or has a neutral effect in most cases. The effects on price stabilisation are, however, more controversial, since they can be stabilising, rather neutral or destabilising depending on the case at hand.

In the case of a positive demand shock occurring in one country, the deviation of output and prices in both countries increases when indexation of taxes or public expenditure increases. This is because deflating the effect of rising prices tends to enhance the real effect. In the case of a tax shock, the price effect is so small, due to the conflicting demand and supply effects of taxes, that indexation does not matter much. In the case of a supply shock, taking into account the effect of declining prices in one country tends to lead to heavier taxation that, in turn, is likely to stabilise the output of that country. The effect is similar in the other country until some medium degree of indexation. The effects of tax indexation on prices are small. Increasing indexation of public expenditure, however, tends to destabilise prices.

References

Agell, J. and M. Dillén (1994) "Macroeconomic Externalities – Are Pigouvian Taxes the Answer?" *Journal of Public Economics*. Vo. 53, 111-126.

Al-Eyd, A. J. and R. Barrell (2005) "Estimating Tax and Benefit Multipliers in Europe". *Economic Modelling* 22, 759-776.

Alho, K. E. O. (2001) "The Stability Pact and Inefficiencies in Fiscal Policy Making in EMU". *Public Finance and Management*, Vol. 1, No. 1,

Auerbach, A. J. and D. Feenberg (2000) "The Significance of Federal Taxes as Automatic Stabilizers". NBER Working Paper, No. 7662. (Published also in *The Journal of Economic Perspectives*, Vol. 14, No. 3, 37-56.)

Barrell, R., I. Hurst and Á. Pina (2002) "Fiscal Targets, Automatic Stabilizers and their Effects on Output". National Institute of Economic and Social Research (NIESR). London, UK.

Blanchard, O. (2000) "Commentary". *Federal Reserve Bank of New York – Economic Policy Review*, 16(1), 69-74.

Bruce, N. (1981) "Some Macroeconomic Effects of Income Tax Indexation". *Journal of Monetary Economics*, 8, 271-275.

Brunila, A., M. Buti and J. in't Veld (2002) "Cyclical Stabilization under the Stability and Growth Pact: How Effective Are Automatic Stabilizers?" Bank of Finland Discussion Paper, No. 6/2002.

Buti, M., C. Martinez-Mongay, K. Sekkat and P. van den Noord (2002) "Automatic Stabilizers and Market Flexibility in EMU: Is There a Trade-off?" OECD Economics Department Working Paper, No. 335.

Cohen, D. and G. Follette (2000) "The Automatic Fiscal Stabilizers: Quietly Doing Their Thing. *Federal Reserve Bank of New York – Economic Policy Review*, 6(1), 35-68.

European Central Bank (2004) *The Monetary Policy of the ECB*. Frankfurt.

Gray, J. A. (1976) "Wage Indexation: A Macroeconomic Approach". *Journal of Monetary Economics*, 2, 221-235.

Kleven, H. J. and C. T. Kreiner (2003) "The Role of Taxes as Automatic Destabilizers in New Keynesian Economics". *Journal of Public Economics*, Vol 87, 1123-1136.

Kotilainen, M. (1992) "Exchange Rate Unions: A Comparison to Currency Basket and Floating Rate Regimes - A Three-Country Model". Research Institute of the Finnish Economy (ETLA), Discussion Paper, No. 399. Helsinki.

Kotilainen, M. (1995) *Exchange Rate Unions: A Comparison with Currency Basket and Floating Rate Regimes*. Research Institute of the Finnish Economy (ETLA), Series A 21. Helsinki.

Kotilainen, M. (1998) "Economic Policy in EMU". Research Institute of the Finnish Economy (ETLA), Discussion Paper, No. 627. Helsinki.

Krueger, D. and J. C. Conesa (2002) "On the Optimal Progressivity of the Income Tax Code". SIEPR Discussion Paper, No. 01-32. Stanford Institute for Economic Policy Research.

Lassila, J. (1995) "Income Tax Indexation in an Open Economy", *Journal of Money Credit and Banking*. Vol. 27, No. 2 (May 1995), 389-403.

Li, W. and P.-D. Sarte (2004) "Progressive Taxation and Long-Run Growth". *The American Economic Review*. December, 1705-1716.

Martinez-Mongay, C. and K. Sekkat (2005) "Progressive Taxation, Macroeconomic Stabilization and Efficiency in Europe". DG ECFIN Economic Papers, No. 233. Brussels: European Commission.

Appendix

Parameters Used in the Baseline Calculation of the Model

- μ (semi elasticity of output with respect to the nominal interest rate) = 0.3 (based on European Central Bank, 2004);
- σ (elasticity of output with respect to changes in price competitiveness of the country) = 0.1;
- ψ (elasticity of output with respect to changes in taxes) = 0.4;
- Φ (elasticity of aggregate demand with respect to public expenditure) = 0.3;
- α (elasticity of domestic prices with respect to foreign prices) = 0.3;
- β (elasticity of domestic prices with respect to domestic output) = 0.2;
- η (elasticity of prices with respect to taxes)= 0.1;
- ξ (tax progressiveness parameter) = 0.4;
- λ (indexation of public expenditure) = 1;
- ω (indexation of taxes) = 1.

The parameters, particularly those concerning price effects, describe rather short-term reactions. Many of the parameters have been taken directly from or calculated/evaluated in a loose way on the basis of the NiGEM model maintained by the National Institute for Economic and Social Research (London). The model has a similar short-term focus as the macroeconomic model used. In the NiGEM model the parameter values for Germany and France have been crucial starting points for the values adopted here. Often an average of the parameter values of these countries is taken. (For more on asymmetry with respect to some parameters (not taken into account here), see Al-Eyd and Barrell, 2005.)

E L I N K E I N O E L Ä M Ä N T U T K I M U S L A I T O S (ETLA)
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
LÖNNROTINKATU 4 B, FIN-00120 HELSINKI

Puh./Tel. (09) 609 900 Telefax (09) 601753
Int. 358-9-609 900 Int. 358-9-601 753
http://www.etla.fi

KESKUSTELUAIHEITA - DISCUSSION PAPERS ISSN 0781-6847

Julkaisut ovat saatavissa elektronisessa muodossa internet-osoitteessa:
http://www.etla.fi/finnish/research/publications/searchengine

No 977 JYRKI ALI-YRKKÖ – ANTHONY DE CARVALHO – PAAVO SUNI, Intia maailmantaloudessa. 03.06.2005. 31 s.

No 978 RAINE HERMANS – MARTTI KULVIK – ANTTI-JUSSI TAHVANAINEN, ETLA 2004 Survey on the Finnish Biotechnology Industries – Background and Descriptive Statistics. 22.04.2005. 40 p.

No 979 ELIAS OIKARINEN, The Diffusion of Housing Price Movements from Centre to Surrounding Areas. 25.04.2005. 36 p.

No 980 JYRKI ALI-YRKKÖ, Impact of Public R&D Financing on Employment. 06.05.2005. 24 p.

No 981 MAARIT LINDSTRÖM, Onko luovilla aloilla taloudellista merkitystä? Luovat alat, kulttuurialat ja taidekoulutetut eri toimialoilla. 19.05.2005. 26 s.

No 982 MARTTI NYBERG – MAARIT LINDSTRÖM, Muotoilun taloudelliset vaikutukset. 20.05.2005. 25 s.

No 983 NIKU MÄÄTTÄNEN, Vapaaehtoiset eläkevakuutukset, verotus ja säästäminen. 24.05.2005. 31 s.

No 984 TUOMO NIKULAINEN – MIKA PAJARINEN – CHRISTOPHER PALMBERG, Patents and Technological Change – A Review with Focus on the Fepoci Database. 25.05.2005. 26 p.

No 985 PEKKA SULAMAA – MIKA WIDGRÉN, Asian Regionalism versus Global Free Trade: A Simulation Study on Economic Effects. 27.05.2005. 12 p.

No 986 EDVARD JOHANSSON – PETRI BÖCKERMAN – RITVA PRÄTTÄLÄ – ANTTI UUTELA, Alcohol Mortality, Drinking Behaviour, and Business Cycles: Are Slumps Really Dry Seasons? 16.06.2005. 10 p.

No 987 ARI HYYTINEN – MIKA PAJARINEN, Why Are All New Entrrepreneurs Better than Average? Evidence from Subjective Failure Rate Expectations. 23.06.2005. 34 p.

No 988 RAINE HERMANS – MARTTI KULVIK, Initiatives on a Sustainable Development Strategy for Finnish Biotechnology. 22.06.2005. 25 p.

No 989 MIKA WIDGRÉN, Revealed Comparative Advantage in the Internal Market. 01.08.2005. 20 p.

No 990 ARI HYYTINEN – MIKA PAJARINEN, Yrittäjäksi ryhtyminen ja yrittäjyysasenteet Suomessa: Havaintoja kyselytutkimuksista. 10.08.2005. 19 s.

No 991 CHRISTOPHER PALMBERG – MIKA PAJARINEN, Alliance Capitalism and the Internationalisation of Finnish Firms. 01.11.2005. 39 p.

No 992 ELIAS OIKARINEN, Is Housing Overvalued in the Helsinki Metropolitan Area? 29.09.2005. 33 p.

No 993 MIKA MALIRANTA – PEKKA ILMAKUNNAS, Decomposing Productivity and Wage Effects of Intra-Establishment Labor Restructuring. 02.11.2005. 26 p.

No 994 VILLE KAITILA – MAARIT LINDSTRÖM – EWA BALCEROWICZ, Puolan liiketoimintaympäristö ja suomalaisten yritysten kokemukset. 10.11.2005. 72 s.

No 995 SERGEY SUTYRIN – VLADIMIR SHEROV, Russian Regions and Their Foreign Trade. 25.11.2005. 26 p.

No 996 HANNU PIEKKOLA, Public Funding of R&D and Growth: Firm-Level Evidence from Finland. 20.12.2005. 30 p.

No 997 AIJA LEIPONEN, Clubs and Standards: The Role of Industry Consortia in Standardization of Wireless Telecommunications. 08.12.2005. 44 p.

No 998 EWA BALCEROWICZ, Poland's Enterprise Environment – A Polish View. 10.01.2006. 19 p.

No 999 STEFAN NAPEL – MIKA WIDGRÉN, The European Commission – Appointment, Preferences, and Institutional Relations. 17.01.2006. 20 p.

No 1000 JUKKA LASSILA – TARMO VALKONEN, The Finnish Pension Reform of 2005. 20.01.2006. 20 p.

No 1001 OLLI-PEKKA OKSANEN, Are Foreign Investments Replacing Domestic Investments? – Evidence from Finnish Manufacturing. 19.01.2006. 59 p.

No 1002 ARTO SEPPÄ, Open Source in Finnish Software Companies. 25.01.2006. 36 p.

No 1003 TERTTU LUUKKONEN, Venture Capital Industry in Finland – Country Report for the Venture Fun Project. 27.02.2006. 48 p.

No 1004 ELIAS OIKARINEN, Price Linkages Between Stock, Bond and Housing Markets – Evidence from Finnish Data. 15.02.2006. 36 p.

No 1005 JUHA ALHO – NIKU MÄÄTTÄNEN, Aggregate Mortality Risk and The Insurance Value of Annuities. 21.02.2006. 15 p.

No 1006 MORRIS TEUBAL – TERTTU LUUKKONEN, Venture Capital Industries and Policies: Some Cross-country Comparisons. 28.02.2006. 23 p.

No 1007 MIKA PAJARINEN – PEKKA YLÄ-ANTTILA, Omistajuus ja yritysten menestyminen: Analyysia suomalaisella aineistolla. 01.03.2006. 42 s.

No 1008 KARI E.O. ALHO, Labour Market Institutions and the Effectiveness of Tax and Benefit Policies in Enhancing Employment: A General Equilibrium Analysis. 29.03.2006. 43 p.

No 1010 FRANCESCO DAVERI – MIKA MALIRANTA, Age, Technology and Labour Costs. 24.03.2006. 48 p.

No 1011 MARKKU KOTILAINEN, Economic Shocks, Progressiveness of Taxation, and Indexation of Taxes and Public Expenditure in EMU. 03.04.2006. 29 p.

Elinkeinoelämän Tutkimuslaitoksen julkaisemat "Keskusteluaiheet" ovat raportteja alustavista tutkimustuloksista ja väliraportteja tekeillä olevista tutkimuksista. Tässä sarjassa julkaistuja monisteita on mahdollista ostaa Taloustieto Oy:stä kopiointi- ja toimituskuluja vastaavaan hintaan.

Papers in this series are reports on preliminary research results and on studies in progress. They are sold by Taloustieto Oy for a nominal fee covering copying and postage costs.