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## ARE FOREIGN INVESTMENTS REPLACING DOMESTIC INVESTMENTS? – EVIDENCE FROM FINNISH MANUFACTURING

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**ABSTRACT**: This study analyses the relationship between firms' foreign and domestic investments using a panel dataset containing 218 Finnish manufacturing firms during the years 1998-2002. The study examines whether foreign investments increase or decrease domestic investments and whether the effect varies between investments directed to developed markets or emerging markets. Financial constraints' effect on the relationship is also investigated. The empirical part estimates an empirical investment equation following Bond and Meghir (1994). The estimations are carried out using the GMM (Generalised Method of Moments) instrumental variables method, which allows for endogenoity in the explanatory variables. The main result of the study is that foreign investments' effect on domestic investments varies depending on the direction of the investments and the firm's financial position. Foreign investments conducted by financially unconstrained firms increase domestic investments substantially where as emerging market investments of financially constrained firms decrease domestic investments moderately.

**KEY WORDS:** Foreign Direct Investment, Domestic Investment, Multinational Enterprises, Financial Constraint.

**OKSANEN**, Olli-Pekka, **KORVAAVATKO ULKOMAISET INVESTOINNIT KOTIMAISIA INVESTOINTEJA? – ESTIMOINTI SUOMALAISELLA PANEELIAINEISTOLLA.** Helsinki, ETLA, Elinkeinoelämän Tutkimuslaitos, The Research Institute of the Finnish Economy, 2006, 59 s. (Keskusteluaiheita, Discussion Papers; ISSN 0781-6847; no. 1001).

**TIIVISTELMÄ:** Tässä tutkimuksessa tarkastellaan yritysten ulkomaisten ja kotimaisten investointien keskinäistä suhdetta hyödyntäen 218 suomalaisesta teollisuusyrityksestä koostuvaa paneeliaineistoa vuosilta 1998-2002. Tutkimus selvittää, lisäävätkö vai vähentävätkö ulkomaiset investoinnit yritysten kotimaisia investointeja ja riippuuko vaikutus siitä, ovatko investoinnit suuntautuneet kehittyneille tai kehittyville markkinoille. Lisäksi tutkitaan rahoitusrajoitteiden vaikutusta kotimaan- ja ulkomaaninvestointien suhteeseen. Empiirisessä osassa estimoidaan Bondin ja Meghirin (1994) malliin pohjautuva investointiyhtälö. Estimoinnissa käytetään GMM (Generalised Method of Moments) menetelmää, joka hyödyntää instrumentoituja muuttujia ja sallii siten endogeenisuuden selittävissä muuttujissa. Tutkimuksen keskeisin tulos on, että yritysten ulkomaaninvestointien vaikutus kotimaaninvestointeihin vaihtelee ulkomaaninvestointien kohdentumisen ja yritysten rahoitustilanteen mukaan. Ei-rahoitusrajoitteisten yritysten ulkomaaninvestoinnit ovat kasvattaneet kotimaisia investointeja selvästi. Vastaavasti rahoitusrajoitteisten yritysten kehittyville markkinoille suuntautuneet investoinnit ovat lievästi pienentäneet kotimaaninvestointeja.

**AVAINSANAT**: suorat sijoitukset ulkomaille, kotimainen investointi, ulkomainen investointi, monikansallinen yritys, rahoitusrajoite.

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# 1. INTRODUCTION

## 1.1. FOREWORD

International transactions in the form of cross-boarder trade and foreign direct investment (FDI) have grown rapidly in value from the beginning of the 1980s and multinational enterprises have become a dominant force in the world economy. Already in 1998 in certain OECD countries, notably the United States, Japan and Finland, the level of production achieved by foreign subsidiaries' of national firms was far greater than total exports from these countries. This phenomenon highlights the importance of direct investment in capturing overseas markets (OECD 2001, 28). Multinational activity is thus wide ranging and shapes the functioning of local economies profoundly. In addition to having significant effects on host countries of foreign investments, multinational enterprises also affect economies of their home countries.

Consequently, the impact that domestic companies' foreign expansion has on home country operations is a widely debated issue. Although majority of the multinational activity is between developed economies, discussion has been further provoked by the apparent transfer of low value added functions from high-income countries towards the developing economies. Home countries of multinational enterprises (MNEs) are concerned over the adverse effects this may have on domestic exports, production and employment.

It is generally accepted that MNEs' foreign and domestic operations are interrelated. Stevens and Lipsey (1992, 2-4) distinguish between two different types of interactions, namely production interactions and financial interactions. Production interactions arise from firms' profit maximising behaviour in choosing the optimal location for its activities. Financial interactions come about because investments in different locations compete for scarce funds.

Academic literature studying the relationship between foreign and home production is wide-ranging, but inconclusive. Majority of the empirical studies concentrate on examining whether foreign direct investments and home country exports are complements or substitutes to each other. This is of course a central question with evident welfare implications. However, production can take many forms and the value added can be high or low. On long term, the labour market will adjust to whatever initial changes in labour demand and unemployment will return to its natural level. In the long term what's more of interest is the wage level and thus labour productivity mainly determined by the countries' capital stock.

The relationship between foreign direct investments and home capital stock is not straightforward. On the level of the whole economy, outward foreign investments transfer capital abroad. This outflow can however be compensated with capital flowing to the opposite direction. Literature provides several different hypotheses over the effects (Caves 1996, 118-119). According to the classical view, foreign investments reduce the domestic capital stock, when they are conducted in order to exploit factor price differences and to produce similar goods abroad as are produced at home. The reverse classical hypothesis relies on the market crowding effect. According to this view, an investment made by a foreign owner merely overrides the investment otherwise made by a domestic firm. As the same crowding out effect functions at the home country as well, the reverse classical hypothesis claims, that a foreign direct investment leaves the capital stock of both countries unaffected. Finally, the anti classical view presents foreign and domestic investments to be unrelated and isolated transactions. Therefore, a foreign investment does not affect the source country's capital stock, but does raise the capital stock of the receiver country.

These three hypotheses still leave room for at least one more (Haaparanta 1990, 34). The expansion hypothesis views foreign production as a complement to domestic production if the foreign production supplements home production (Koizumi and Kopecky 1980). Foreign investments induced by strategical reasons may increase domestic investments as the firm may end up gaining market share.

The literature provides no clear-cut evidence about the relationship between foreign and domestic investments. Depending on the model adopted, results are highly varying. Most often the tested models are based on either industry or country level aggregated data and the ones using firm level data are a minority. However, what happens on a level of an individual firm should be of great interest because of the predominance of MNEs in the world economy. Leaving aside the possible crowding out effects that firm level data is not well suited to test, the relationship between an individual firm's foreign and domestic investments provides a natural starting point for further analysis.

## 1.2. OBJECTIVES AND LIMITATIONS

This study will address the relationship between foreign and domestic investments in Finnish manufacturing, where the overall pace of foreign expansion has been rapid from the beginning of the 1990s. In 2002, already around 33 percent of the employees of Finnish manufacturing companies resided abroad in contrast with only 15 percent in 1987 (BOF, Statistics Finland)[1].

Currently the majority of the foreign operations of Finnish manufacturing companies are carried out in the developed economies with similar income levels, but the growth rate of foreign direct investments is highest in the countries with lower GDP levels. Since both the factor and product markets in those countries are very different from developed countries, it seems likely that foreign investments made there may have differing implications. Therefore one of the evident motivations for this study is to examine the domestic impacts of the experience in Finland labelled as the "China phenomenon".

The analysis is conducted by using a unique firm level database covering Finnish manufacturing MNEs operations home and abroad. The objective is to determine whether foreign investments are substitutes or complements to home investments and if the effects differ between investments made into developed and developing countries. The estimated structural investment model has been originally developed by Bond and Meghir (1994) to examine firm investments in the presence of financial constraint. The equation has been also estimated with Finnish data by Ali-Yrkkö (1998). In this study, the model is adjusted by letting the foreign investments enter the equation separately.

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[1] Number of employees in Finnish owned manufacturing subsidiaries and branch offices abroad are taken from the Bank of Finland's "foreign direct investments in the balance of payments" –database. The number of manufacturing employees in Finland is from the Statistics Finland. Although these two figures are not directly tantamount, they can be used in unison to highlight the change between two periods.

The analysis is conducted in a partial equilibrium framework in that it restricts to analyse the explanatory value of a firm's foreign investments in explaining its domestic investments. Therefore, it does not tell anything about the foreign investments effect on domestic investments as a whole. As the use of production factors by the foreign investors change, so does the market clearing equilibrium. It is likely that some of the investments previously made by the foreign investors are now conducted by other actors in the economy.

## 1.3. STRUCTURE OF THE THESIS

The theoretical part of the thesis is organised to emphasise the two different types of interactions between the domestic and foreign operations of multinational enterprises. The empirical part examines the interrelation between foreign and domestic investments in Finland based on a panel dataset.

Chapter 2 discusses previous empirical studies related to the relationship between foreign and domestic operations. The chapter is divided to separately present evidence on foreign direct investments and home exports, home investments and home employment.

Chapter 3 concentrates on production interactions. It starts with a brief overview of the evolution of the theory of MNEs. Emphasis is given on integrated models combining general equilibrium trade theory with industrial organisation elements. Especially a hybrid knowledge-capital model developed by Markusen (2002) is presented. The chapter ends with a discussion about the home country effects through the production interactions

Chapter 4 focuses on the financial interactions. The chapter briefly discusses investment theories and then introduces sources of market imperfections that give rise to financial interactions.

Chapter 5 combines the two sources of interactions and forms hypothesis based on them.

Chapters 6 and 7 introduce the methods used in this study to examine the interrelation between the domestic and foreign investments. Chapter 6 develops an empirically testable investment function with imperfect capital markets based on Bond and Meghir (1994). Chapter 7 focuses on the GMM estimation method that is used to estimate the equation presented in chapter 6.

Chapter 8 contains the actual empirical analysis. It introduces the dataset, examines it and finally presents estimation results.

The final chapter summarises and concludes the paper.

## 1.4. ESSENTIAL CONCEPTS

*Multinational enterprises* (MNEs) can be defined in several ways. Essentially MNE is a company operating in more than one country as opposed to a single country firm. Throughout the paper a more precise definition following Markusen (2002, 5) is adopted. According to the definition, multinational enterprises are firms that engage in *foreign direct investments* (FDI), defined as investments in which the firm acquires a controlling interest in a foreign firm or sets up a subsidiary in a foreign country. *Portfolio investments* on the other hand are defined as investments without controlling interest, controlling interest meaning over 10 percent share of the voting rights in the affiliate.

There are two differing concepts of FDI. The concept reflected in the balance of payments accounts defines FDI as a particular flow of capital across international boundaries from home countries to host countries. This view is somewhat limited, as the MNE's operations are not always financed from the MNE's home country. To emphasise this, the other concept of FDI views it as a set of economic activities carried out in a host country by firms controlled or partly controlled by firms in some other (home) country (Lipsey 2002, 2).

In the paper, the latter definition of FDI is used. It deviates from the one used in balance of payments statistics in that it incorporates also investments made from outside the MNE's home country. Therefore in addition to reinvested earnings and inter-company loans it includes the investments financed with financial capital borrowed or otherwise raised either from the host country or from third party countries.

*MNEs can be categorised as horizontal or vertical depending on the mode of multinational operations. Horizontal multinationals* engage *in horizontal direct investments* and their foreign operations are *horizontally integrated*. That is, the MNE produces abroad products or services roughly similar to those the firm produces at home. *Vertical multinationals* in turn take up *vertical direct investments* in order to fragment the production process geographically by stages of production. The terminology is not clear-cut. All horizontal investments generally have a vertical element, in that firm level services such as management, engineering, marketing and finance are often supplied from parent to the subsidiary. (Markusen 2002, 5)

# 2. EMPIRICAL EVIDENCE ON HOME COUNTRY EFFECTS

Most of the empirical studies examining the relationship between foreign and home activies can be divided into three categories. The relationship between foreign investments and home exports has evoked the most interest, since it directly influences the foreign demand of home country production. The two other lines of empirical research aim to determine factor market impacts, namely the effects on home employment and investments.

Since the issue is as much political as anything else, the range of studies is wide. An extensive survey on findings is given by Lipsey (2002). He also emphasises that the results depend heavily on the level on which the studies are conducted (pp.7-8). The subject can be studied on a level of an individual firm, industry or the whole economy and the concern can be only on the effects of investments made to a particular country or on the effects of foreign investments on aggregate. Furthermore, it must be noted that not only the outward FDI matters. The most interesting and most difficult issue to measure is how the worldwide allocation of resources ultimately affects the home country. Sometimes, the inward FDI may give some vague implication of that.

In general, most of the empirical work points the relationship between foreign and domestic activities to be complementary, but the evidence is not overwhelming and many studies find opposite relationship. Depending on the circumstances, the relation can be positive or negative. The fact that firm's competitiveness does not coincide with nation's competitiveness whenever the firm is free to choose the location of its activities optimally (no investment barriers) is central in determining the relationship. For those firms that have the most similar comparative advantages as the home country, the relationship is more likely to be positive than for other firms. With some aggregation, it would seem plausible to conclude that in vertical investments the relationship is more often positive than in horizontal ones. The argument lies on the assumption that vertical investments seek complementary comparative advantages whereas in the case of horizontal FDI the comparative advantages are substitutionary.

## 2.1. FDI AND EXPORTS

On a firm level, FDI and exports are generally found to be complements rather than substitutes. This complementary relationship was among the first supported by Lipsey and Weiss (1981, 1984), in studies based on U.S. multinationals. The complementary view was later verified by Brainard (1997) and Hejazi and Safarian (2001). However, the problem with determining the FDI-exports relationship is that the two are usually jointly determined and tend to rise hand in hand. To circumvent the problems posed by endogenoity, Swedenborg (2001) used Swedish data to study the effects that changes in foreign production has on firm exports over time by using instrumental variables estimation and found evidence of complementarity. The result was in line with her previous studies but in contradiction with Svensson (1993, 1996) who found FDI to decrease home exports not just to the host country but to the neighbouring countries as well.

## 2.2. FDI AND DOMESTIC INVESTMENTS

As FDI and exports are usually found to complement each other, one would expect a similar relationship to hold for FDI and domestic investments. However, the empirical evidence is mixed and far from conclusive. The first studies examining this relationship appeared already in the 1970s. A study made by Caves and Reuber (1971) on Canadian firms found a positive relationship, which increased in periods of expansion and decreased in periods of economic slack. Later both Herring and Willett (1973) and Noorzoy (1980) found also evidence of complementarity employing industry level data on U.S. multinationals.

Some of the later studies have discovered a negative relationship. Stevens and Lipsey (1992) investigated the effects foreign investments have on domestic investments through capital constraints on a very limited sample and found a negative relationship between the two. Similar results followed from a study conducted by Belderbos (1992) on Dutch food and metal industries. The constructed investment distribution model assumed a fixed level of investments that the firm allocated according to its location decisions.

General equilibrium study by Feldstein (1995) used economy wide aggregate data to find a one to one negative relationship between the foreign and domestic investments. He concluded that the results were in line with the Feldstein-Horioka puzzle (Feldstein and Horioka 1980). According to the puzzle, even with no restrictions on international capital flows, savings are predominantly invested locally and are imperfectly mobile internationally. Therefore, on an aggregate level, net foreign direct investments transfers capital abroad without offsetting portfolio investments flowing to opposite direction. On the other hand, Borensztein et al. (1998) found a positive relationship when they estimated aggregate investment functions for 69 countries and added patterns of FDI.

More recently, some scholars have argued for the importance of industry-specific variations in the effects. Braunerhjelm et al. (2002) divide firms into two groups finding a substitutionary relationship for r&d-intensive, horizontally organized industries and a complementary relationship for vertically organised industries. Hejazi and Pauly (2003) found no general relationship between FDI and domestic investments, and the effects varied according to the different underlying motivations for FDI.

### 2.3. FDI AND DOMESTIC EMPLOYMENT

The domestic employment effects have most often been studied by estimating cross price elasticities between multinationals' foreign and domestic labour demand. Brainard and Riker (1997a and 1997b) estimated these elasticities using a panel dataset of US multinationals for 1983-1992. According to the results, a substitutionary relationship exists between labour in countries with similar skill intensities, whereas labour inputs in countries with different skill intensities complement each other. Braconier and Ekholm (2000) and Konings and Murphy (2001) find similar results. Slaughter (1995) narrows the examination to production workers and finds low degree of substitution between domestic and foreign employment. However, when the capital stock is allowed to vary the relationship turns to complementarity.

The problem with all of the above-mentioned studies is that they only examine the relationship between parent company and already established subsidiaries, but neglect the effects of sudden production relocations and plant openings. Since the expansion of foreign production is very much a discontinuous development, a lot remains unanswered. Barba Navaretti and Castellani (2003) examined the differences in domestic employment development between purely domestic firms and firms that had newly invested abroad. They found differences to be insignificant, which means that new foreign investments did not decrease labour demand at home.

## 3. PRODUCTION INTERACTIONS

It is widely accepted that the foreign and domestic operations of multinational enterprises are interrelated. Only if companies totally isolate and segregate their local activities would there be no operational interactions between different regional activities. According to the contemporary view of the multinationals with firm and plant level scale economies and differentiated products, this is of course not the case. Production interactions between different locations arise from firms' profit maximising behaviour in decisions concerning the optimal location of the different activities. In order to understand these interrelations and their nature, the theoretical background of multinationals and reasons for foreign direct investments must be presented.

### 3.1. EVOLUTION OF THE THEORY OF MULTINATIONAL ENTERPRISES

During the 20th century the MNE's foreign operations changed from predominately acquiring of raw materials from less developed countries into serving several markets and producing in multiple locations. The theories explaining cross border capital flows have evolved in connection with the mode of multinationals operations and increased in complexity (Dunning et al.

1986, 34). The issue has been approached from the viewpoint of trade economics, industrial organisation and business studies alike.

Traditionally two very distinct streams of literature existed. The general-equilibrium trade theory assumed perfect competition and constant returns to scale, while partial-equilibrium industrial organisation models based on the theory of the firm explained why individual firms engage in foreign direct investments. Neither line of research provided satisfactory not to mention comprehensive models for explaining the MNEs or their effects on trade. The emergence of the so-called new trade theory and the theories on geography and trade contributed in combining these two streams. Constructed general-equilibrium models combine increasing returns to scale and imperfect competition as well as multiplant production (MNEs). (Markusen 2002, 3-4)

### 3.1.1. Trade theory approach

Before distinct theories describing multinational enterprises as economic entities had been developed, international capital movements were almost entirely explained through a neoclassical financial theory of portfolio flows. The models based largely on the Hescher-Ohlin trade theory extended by Mundell (1957) where cross border capital movements and trade were seen as simple substitutes. The theory assumed a world with perfect competition and no transaction costs where capital movements rise in response to differences in rates of return to capital. MNEs were viewed merely as capital arbitragers who transferred capital from capital abundant to labour abundant countries. Differing factor endowments dictated the site of production. (Dunning, Cantwell and Corley 1986, 34; Dunning and Rugman 1985, 229).

### 3.1.2. The industrial organisation approach

The traditional trade theory view was inconsistent with the observed pattern of direct investments predominantly taking place between industrialised countries. However, the capital arbitrage view remained the dominant theory until Hymer (1960) pointed out in his dissertation that the very essence of MNEs lied in market imperfections. Hymer argued that a multinational enterprise operating in a foreign country is essentially in a disadvantaged position relative to local firms. MNEs incur costs related to for example cultural differences and communication that local firms do not. Therefore, for a firm to become multinational, it must posses some firm-specific proprietary assets to overcome these extra costs. According to Hymer, these proprietary assets come mainly in the form of economies of scale or superior production technology.

**Product life-cycle**

The industrial organisation view introduced by Hymer and later elaborated by Kindleberger (1969) formed the basis for modelling the multinational enterprise and theories were developed further. Dunning, Cantwell and Corley (1986) tie Vernon's (1966) product life-cycle (P.L.C) theory into development as an early model combining the location and ownership advantages. The theory explains the location of innovations according to country characteristics.

The P.L.C model suggests that firms tend to undertake commercial innovations most relevant in the market they operate and therefore best meet the demand. Thus, product and process innovations in high-income capital abundant countries tend to be labour saving and directed to high-income consumers. The model also describes the sequential evolution of international production following from the described innovation pattern. (1) In the development phase of the product's life-cycle, the initial demand is small, production skilled labour intensive and output directed to home market. (2) The growth phase is characterised with rapid expansion of demand at home, as the product becomes widely accepted. To meet the demand, production becomes more standardised. The increasing foreign demand is largely met with exports. (3) In the mature phase, the demand in the innovating market reaches saturation. The product becomes standardised and plant level scale economies increasingly important. As a result, production is transferred abroad. (Parry 1980, 27-28)

**Internalisation**

However, an important aspect of multinational activity remained unexplained. Instead of becoming a multinational, a firm can always alternatively capitalise on its proprietary assets through arms length agreements such as licensing. Why is it better to organise different economic activities under common ownership and not to rely on the market mechanism? According to Caves (1996, 1) the basic reason for MNEs existence lies in Coase's (1937) notion of transaction costs and the boundaries of a firm. Whereas Hymer emphasised the importance of proprietary assets, he somewhat neglected the true transaction cost approach (Dunning and Rugman 1985, 229).

Buckley and Casson (1976) most systematically introduced the transaction cost approach to the framework of multinational production. They reasoned that when multinational enterprises decide to serve foreign markets via direct investments there must exist some internalisation advantage over alternative modes of doing business such as exporting or licensing. The ideas presented were in similar lines with Williamson (1981, 1544-1546), who argued that these advantages stem from cost differences between internal and external transactions caused by market failures like bounded rationality and agent opportunism.

**The eclectic paradigm of international production (OLI framework)**

One of the most often cited concepts for understanding the MNE activity is the eclectic paradigm presented by Dunning (1977). The theory combines many branches of previous theory in one organising framework. According to Dunning (1988, 1) the model's intention is to offer a holistic framework by which it is possible to identify and evaluate the significance of the factors influencing both the initial act of foreign production and the growth of such production. Therefore, the so-called OLI framework is a very general description of factors affecting and inducing international production.

The OLI framework assumes that three conditions must all be satisfied for a firm to undertake foreign operations. Since the multinational is by default in a disadvantaged position for serving the foreign market relative to local firms, it must posses some ownership advantages to overcome these cost-based deficiencies. These advantages can come from possessing products or processes that are proprietary for the firm. Firm specific proprietary assets can also be intangible such as a trademark or reputation. The host country on the other hand must offer some location advantages that induce local production, not only exporting to the market. Differences in production costs as well as trade costs like tariffs and transportation costs are natural sources of such advantages. The importance of physical market presence can also be included as a trade cost. Finally, internalisation advantages must prevail for a firm to establish a subsidiary instead of using arms length agreements such as licensing. (Markusen 1995, 173-174)

### 3.1.3. Integrated models, the new trade theory

Although industrial organisation view of the FDI activity had seen major advances, the trade theory explanations remained largely the same. The models were simple Hecsher-Ohlin type with perfect competition and constant returns to scale. The beginning of the 1980s however, saw the rise of the so-called new trade theory, which encompasses the traditional trade theories with industrial organisation elements (i.e. OLI framework). The general-equilibrium trade theory models were extended to include imperfect competition, increasing returns to scale and product differentation. These theories generated a pattern of intra- and inter-industry trade supported by empirical evidence. However, the models generally neglected multinationals restricting the analysis on single plant firms. (Markusen and Venables 1996, 2)

The attempts to include multiplant activity in the general-equilibrium trade theory led to two different set of theories describing two types of MNE activity. The vertical models first developed by Helpman (1984) and Helpman and Krugman (1985) concentrated on explaining the geographical dispersion of different stages of production. In these models that Brainard (1993, 6-8) refers to as factor-proportions explanations, MNEs typically consist of two activities with differing factor intensities. A headquarters activity that produces blueprints and management is relatively skilled-labour intensive while the production activity is unskilled-labour intensive. Firms will have an incentive to fragment these different activities geographically, if countries differ considerably in their factor endowments and factor prices will therefore not equalise internationally. The models relied on zero trade costs, giving little incentive for horizontal FDI. The trade-off in the models is between incurring disintegration costs and benefiting from the factor price differences.

However, although vertical FDI has lately grown in importance, horizontal FDI is empirically far more important. The horizontal models explaining multinational activity, where MNE produces approximately identical products in different locations were first introduced by Markusen (1984). Firm level scale economies are vital for the theory and it is assumed that two plant firms' firm level fixed costs are less than double compared to single plant firms. The theory is extended in Horstmann and Markusen (1987; 1992) and Brainard (1993), who refers to it as the proximity-concentration hypothesis. The proximity-concentration trade-off, i.e the degree of plant-level scale economies versus trade costs, determines whether markets are served through exports or local production. The models assume no differences in factor intensities between different activities and therefore no incentives for vertical FDI.

## 3.2. THE KNOWLEDGE-CAPITAL MODEL

The vertical and horizontal approaches are not contradictory but rather complement each other. The so-called knowledge-capital model developed by Markusen (2002, 127-152) integrates the basic ideas of both theories. The model allows for both motives for taking up FDI and vertical, horizontal and purely national firms can rise endogenously as a function of parameter values.

The three defining assumptions for the knowledge-capital model are, as listed by Markusen (2002, 129):

1. Fragmentation: the location of knowledge-based assets may be fragmented from production. Any incremental cost of supplying services of the asset to a single plant is small.

2. Skilled-labour intensity: knowledge based assets are skilled labour intensive relative to final production
3. Jointness: the services of knowledge-based assets are (at least partially) joint ("public") inputs into multiple production facilities. The added cost of a second plant is small compared to the cost of establishing a firm with a local plant.

The first two assumptions motivate the separation of headquarters and final production giving rise to vertical (type-v) multinationals. If the extra costs associated with serving a separated (foreign) instead of an integrated (domestic) plant with managerial and technical know-how (headquarters services) are small and factor prices differ considerably, it may be feasible to fragment the headquarter services to another country depending on the market sizes. The cost of fragmentation can be measured by the ratio of fixed costs for a type-v firm to fixed costs for a domestic (type-d) firm. In the extreme situation of very high fragmentation costs, the ratio would be close to two and the production would be almost impossible to fragment. If the ratio is one, fragmentation would be costless.

The jointness assumption motivates horizontal (type-h) multinationals and is associated with the ability to use a headquarters service such as a blueprint in one location without reducing its worth in another location. Jointness refers to the costs of running two plants instead of one and it can be measured by the ratio of fixed costs for a type-h firm to fixed costs for a domestic firm. Again, a ratio of two designates no jointness and the ratio of one full jointness.

### 3.2.1. The model construction

The remainder of this chapter describes the knowledge-capital model as presented in Markusen (2002, 127-152).

The knowledge-capital model has two countries producing same two goods Y and X. The production of both goods involves unskilled labour (L) and skilled labour (S). Labour can move from one industry to another but not from country to country. Y is used as the numeraire. Subscripts (i,j) stand for countries 1 and 2 respectively, except when denoted (i=1,2).

The production of good Y is given by a constant elasticity of substitution (CES) production function identical in both countries,

$$Y_i = (aL_{iy}^{\alpha} + (1-a)S_{iy}^{\alpha})^{1/\alpha} \qquad \text{i,j} = 1,2, \qquad (3.1)$$

where $L_{iy}$ and $S_{iy}$ are the unskilled and skilled labour used in the Y sector in country i.

Good X is produced with increasing returns to scale in cournot oligopoly. There are both firm-level and plant-level scale economies and free entry and exit by firms. (The term regime is used to denote the set of firms active in equilibrium.) The model allows for six firm types that rise endogenously according to the parameter values. Letters (d,h,v) will be used to denote domestic (purely national) firms, horizontal multinationals and vertical multinationals.

| | |
|---|---|
| Type-$d_i$ | National firms with a single plant and headquarters in country i. Type-$d_i$ firms can export to country j. |
| Type-$d_j$ | National firms with a single plant and headquarters in country j. Type-$d_j$ firms can export to country i. |

Type-$h_i$ Horizontal multinationals with plants in both countries and headquarters located in country i.

Type-$h_j$ Horizontal multinationals with plants in both countries and headquarters located in country j.

Type-$v_i$ Vertical multinationals with a single plant in country *j* and headquarters located in country i. Type-$v_i$ firms can export to country i.

Type-$v_j$ Vertical multinationals with a single plant in country *i* and headquarters located in country j. Type-$v_j$ firms can export to country j.

The model requires further empirically robust assumptions about the factor intensities of the different activities. Therefore, it is assumed that:

1. Headquarter activities are more skilled-labour intensive than production. Hence, the integrated headquarters and production plant is more skilled labour intensive than a separated production plant but less skilled labour intensive than headquarters alone.
2. Production plant alone is more skilled labour intensive than the Y-sector as a whole.

With these assumptions, the skilled labour intensities for activities are:

HEADQUARTERS ONLY > INTEGRATED X PRODUCTION > PRODUCTION PLANT ONLY > Y-SECTOR

Other notations in the model are:

| | |
|---|---|
| $N_i^k$ | number of type-k (k = d,h,v) firms active in country i (i=1,2) |
| $p_i$ | price of X (in terms of Y) in country i |
| $w_i$ | wage of unskilled labour in country i |
| $z_i$ | wage of skilled labour in country i |
| $c_i$ | marginal cost of X production in country i for all firm types |
| $c_{iw}$ $c_{iz}$ | factor-price derivatives of $c_i$ give the X-sector unit input requirements for factors L and S in i |
| $t_i$ | transport cost for X |
| $M_i$ | income of country i |
| $X_{ij}^k$ | sales of a type-k firm headquartered in country i with sales in market j |
| $m_{ij}^k$ | mark-up of a type-k firm headquartered in country i with sales in market j |
| $fc_i^k$ | total fixed costs of a type-k firm headquartered in country i |
| $F_i^k$ | fixed costs incurred in units of skilled labour by a type-k firm in country i |
| $G_i$ | fixed costs incurred in units of unskilled labour by a type-k firm in country i (associated only with plants so firm type is irrelevant) |

Note here that the double subscript ij denotes the headquarter country and the country of sales. Only the firm type together with the headquarter country tell the country of production.

The model assumes that marginal costs, transport costs and fixed costs are all fixed coefficient technologies meaning that factor intensities of the cost functions are identical across countries. Marginal cost differences between countries are therefore determined solely by factor prices, not technology ($c_{iw}$=$c_{jw}$ and $c_{iz}$= $c_{jz}$ and the country subscripts can be dropped). Marginal cost functions can thus be written

$$c_i(w_i, z_i) = w_i c_w + z_i c_z \qquad i=1,2. \qquad (3.2)$$

The transport costs can be thought of having the same factor intensities as marginal costs. If $\tau$ is the ratio of transport costs to the marginal costs, then transport costs can be written

$$t_i(w_i, z_i) = w_i \tau c_w + z_i \tau c_z = \tau c_i(w_i, z_i) \qquad i=1,2. \qquad (3.3)$$

It is assumed that fixed costs incurred in unskilled labour, G, are associated with plants only and the same amount of unskilled labour is required for a plant regardless of where it is situated ($G_i=G_j$, subscripts can be dropped). F denotes the skilled labour requirement. The total fixed costs for firms headquartered in country i are (identical set of functions with subscripts reversed define the fixed costs for firms headquartered in country j):

$$fc_i^d(w_i, z_i) = z_i F_i^d + w_i G \qquad (3.4)$$

$$fc_i^h(w_i, z_i, w_j, z_j) = z_i F_i^h + w_i G + z_j F_j^h + w_j G \qquad (3.5)$$

$$fc_i^v(w_i, z_i, z_j) = z_i F_i^v + w_i G + z_j F_j^v \qquad (3.6)$$

i,j = 1,2.

The jointness assumption requires that the total fixed costs for a type-h firm are less than double the fixed costs for a type-d firm. It can be further assumed that the skilled labour requirements for a type-h firm are greater but less than double the skilled-labour requirements for a type-d firm. Part of the extra skilled labour requirements for a type-h firm are incurred at home and part of it at the host country, because managerial and coordination activities require additional home country skilled labour. For firms based in country i,

$$2F_i^d > F_i^h + F_j^h > F_i^h > F_i^d \qquad i,j = 1,2. \qquad (3.7)$$

Because technology transfer involves costs, fragmentation is not perfect and skilled labour requirements for type-v firms can be assumed to be higher than for type-d firms, but less than for type-h firms. Thus,

$$F_i^h + F_j^h > F_i^v + F_j^v > F_i^d \qquad i,j = 1,2. \qquad (3.8)$$

In equilibrium zero profit conditions must hold and the country i income can be expressed with the labour returns

$$M_i = w_i L_i + z_i S_i \qquad i=1,2, \qquad (3.9)$$

where $L_i$ and $S_i$ are the unskilled and skilled labour endowments of country i. The consumption of good Y in country i is $Y_{ic}$ and for good X the consumption is the sum of each x producing firm's sales in country i,

$$X_{ic} = N_i^d X_{ii}^d + N_j^d X_{ji}^d + N_i^h X_{ii}^h + N_j^h X_{ji}^h + N_i^v X_{ii}^v + N_j^v X_{ji}^v \qquad i,j = 1,2. \qquad (3.10)$$

Utility function of a representative consumer in each country is Cobb-Douglas type:

$$U_i = X_{ic}^{\beta} Y_{ic}^{1-\beta} \qquad i=1,2. \qquad (3.11)$$

Since consumers exhaust their income between X and Y, the demands for goods are

$$X_{ic} = \beta M_i / p_i \text{ and } \quad Y_{ic} = (1-\beta) M_i \qquad i=1,2. \qquad (3.12)$$

Equilibrium in the X sector is determined by pricing inequalities that limit the sales of a type-k firm in market i. For each firms' sales, marginal revenue must equal marginal costs and given free entry, profits must be nonpositive. When $m_{ij}^k$ is the proportional mark-up over marginal costs, the pricing inequalities for firms headquartered in country i are (identical set of functions with subscripts reversed exist for firms headquartered in country j): (associated variables in brackets)

$$p_i(1-m_{ii}^d) \le c_i(w_i,z_i) \qquad (X_{ii}^d) \qquad (3.13)$$
$$p_j(1-m_{ij}^d) \le c_i(w_i,z_i)+t_i(w_i,z_i)=c_i(w_i,z_i)(1+\tau) \qquad (X_{ij}^d) \qquad (3.14)$$
$$p_i(1-m_{ii}^h) \le c_i(w_i,z_i) \qquad (X_{ii}^h) \qquad (3.15)$$
$$p_j(1-m_{ij}^h) \le c_j(w_j,z_j) \qquad (X_{ij}^h) \qquad (3.16)$$
$$p_j(1-m_{ij}^v) \le c_j(w_j,z_j) \qquad (X_{ij}^v) \qquad (3.17)$$
$$p_i(1-m_{ii}^v) \le c_j(w_j,z_j)+t_j(w_j,z_j)=c_j(w_j,z_j)(1+\tau) \qquad (X_{ii}^v) \qquad (3.18)$$

i,j = 1,2.

The zero-profit conditions can be written as a requirement that the mark-up revenues cannot exceed the fixed costs. These zero-profit conditions correspond to the number of active firms of each type, whereas the marginal revenue – marginal costs inequalities 3.13-3.18 are related to the amount of production and sales. The zero-profit conditions are:

$$p_i m_{ii}^d X_{ii}^d + p_j m_{ij}^d X_{ij}^d \le fc_i^d(w_i,z_i) \qquad (N_i^d) \qquad (3.19)$$
$$p_j m_{jj}^d X_{jj}^d + p_i m_{ji}^d X_{ji}^d \le fc_j^d(w_j,z_j) \qquad (N_j^d) \qquad (3.20)$$
$$p_i m_{ii}^h X_{ii}^h + p_j m_{ij}^h X_{ij}^h \le fc_i^h(w_i,z_i,w_j,z_j) \qquad (N_i^h) \qquad (3.21)$$
$$p_j m_{jj}^h X_{ii}^h + p_i m_{ji}^h X_{ji}^h \le fc_j^h(w_j,z_j,w_i,z_i) \qquad (N_j^h) \qquad (3.22)$$
$$p_i m_{ii}^v X_{ii}^v + p_j m_{ij}^v X_{ij}^v \le fc_i^v(z_i,w_j,z_j) \qquad (N_i^v) \qquad (3.23)$$
$$p_j m_{jj}^v X_{jj}^v + p_i m_{ji}^v X_{ji}^v \le fc_j^v(z_j,w_i,z_i) \qquad (N_j^v) \qquad (3.24)$$

i,j = 1,2.

In a Cournot model with homogenous products, the optimal mark-up is given by the firm's market share divided by the Marshallian price elasticity of demand in that market. With the Cobb-Douglas formulation in equation 3.12, the price elasticity is exactly one and the optimal mark-up is just the firm's market share. With equation 3.12, the mark-up is

$$m_{ij}^k = \frac{X_{ij}^k}{X_{jc}} = \frac{p_j X_{ij}^k}{\beta M_j} \qquad k = d,h,v \text{ and } i,j = 1,2. \qquad (3.25)$$

Substituting the mark-ups into the MR = MC inequalities 3.13-3.18 gives the production of X in country i (identical set of functions with subscripts reversed gives the production in country j):

$$X \ge \beta M_i \frac{p_i - c_i(w_i,z_i)}{p_i^2} \qquad \text{for } X_{ii}^d, X_{ii}^h, X_{ji}^h, X_{ji}^v \qquad (3.26)$$
$$X \ge \beta M_j \frac{p_j - c_i(w_i,z_i)(1+\tau)}{p_j^2} \qquad \text{for } X_{ij}^d, X_{jj}^v \qquad i,j = 1,2. \qquad (3.27)$$

Substituting these equations further into the zero-profit conditions 3.19-3.24 gives

$$\beta\left[M_i\left(\frac{p_i-c_i}{p_i}\right)^2 + M_j\left(\frac{p_j-c_i(1+\tau)}{p_j}\right)^2\right] \le fc_i^d(w_i,z_i) \qquad (N_i^d) \qquad (3.28)$$

$$\beta\left[M_i\left(\frac{p_i - c_j(1+\tau)}{p_i}\right)^2 + M_j\left(\frac{p_j - c_j}{p_j}\right)^2\right] \le fc_j^d(w_j, z_j) \qquad (N_j^d) \qquad (3.29)$$

$$\beta\left[M_i\left(\frac{p_i - c_i}{p_i}\right)^2 + M_j\left(\frac{p_j - c_j}{p_j}\right)^2\right] \le fc_i^h(w_i, z_i, w_j, z_j) \qquad (N_i^h) \qquad (3.30)$$

$$\beta\left[M_i\left(\frac{p_i - c_i}{p_i}\right)^2 + M_j\left(\frac{p_j - c_i}{p_j}\right)^2\right] \le fc_j^h(w_i, z_i, w_j, z_j) \qquad (N_j^h) \qquad (3.31)$$

$$\beta\left[M_i\left(\frac{p_i - c_j(1+\tau)}{p_i}\right)^2 + M_j\left(\frac{p_j - c_j}{p_j}\right)^2\right] \le fc_i^v(z_i, w_j, z_j) \qquad (N_i^v) \qquad (3.32)$$

$$\beta\left[M_i\left(\frac{p_i - c_i}{p_i}\right)^2 + M_j\left(\frac{p_j - c_i(1+\tau)}{p_j}\right)^2\right] \le fc_j^v(w_i, z_i, z_j), \qquad (N_j^v) \qquad (3.33)$$

where the left hand side (mark-up revenues) minus the right hand side (fixed costs) equals profits. The inequalities can thus be written in a more compact form:

$$\Pi_i^d = a_i M_i + b_j M_j - fc_i^d \le 0 \qquad i,j = 1,2 \qquad (N_i^d) \qquad (3.34)$$

$$\Pi_j^d = b_i M_i + a_j M_j - fc_j^d \le 0 \qquad (N_j^d) \qquad (3.35)$$

$$\Pi_i^h = a_i M_i + a_j M_j - fc_i^h \le 0 \qquad (N_i^h) \qquad (3.36)$$

$$\Pi_j^h = a_i M_i + a_j M_j - fc_j^h \le 0 \qquad (N_j^h) \qquad (3.37)$$

$$\Pi_i^v = b_i M_i + a_j M_j - fc_i^v \le 0 \qquad (N_i^v) \qquad (3.38)$$

$$\Pi_j^v = a_i M_i + b_j M_j - fc_j^v \le 0, \qquad (N_j^v) \qquad (3.39)$$

recalling from equations 3.4-3.6, that

$$fc_i^d(w_i, z_i) = z_i F_i^d + w_i G$$

$$fc_i^h(w_i, z_i, w_j, z_j) = z_i F_i^h + w_i G + z_j F_j^h + w_j G$$

$$fc_i^v(w_i, z_i, z_j) = z_i F_i^v + w_i G + z_j F_j^v .$$

### 3.2.2. Implications

Since the model involves a number of inequalities, it is very complex and difficult to solve with comparative statistics. Markusen has worked out the issue by using numerical simulations to generate predictions and test the model in general equilibrium. However, equations 3.34-3.39 allow drawing some broad partial equilibrium conclusions about multinational activity. Trade costs are assumed to be positive and therefore $a_i > b_i$ (i = 1,2). To analyse the effect the change of different attributes has on MNE activity, it is further assumed that countries i and j are first similar in size and factor endowments (factor prices are equal between countries).

There can be several types of firms simultaneously active in equilibrium. How many of each type, is determined by equations 3.34 – 3.39. For example, an initial rise in profits of type-h firms means that there are supernormal profits to be earned for them. This however, induces type-v and type-d firms to turn themselves to type-h driving down the supernormal profits. In the general-equilibrium model with free entry, new firms enter the market pushing the profits of all firm types further down to their normal level. However, in the new equilibrium, there are now more type-h firms than before. Therefore, in assessing how each factor affects the number of active firms of each type, it suffices to examine how the profits of type-k firms change due to a change in the particular factor. This is done below by altering the parameters one by one.

**Symmetric change in incomes:**
If income rises with the same amount in both countries, $dM_i = dM_j < 0$, then

$$d\pi_i^h = d\pi_j^h > \ d\pi_i^d = d\pi_j^d = d\pi_i^v = d\pi_j^v > 0\,.$$

Because of the transport costs, the profits of type-h multinationals rise more than profits of type-d and type-v firms. Thus, a symmetrical rise in world income induces horizontal multi-national activity.

**Asymmetric change in incomes:**
If the distribution of world income changes, $dM_i = -dM_j > 0$, then

$$d\pi_i^d = d\pi_j^v > \ d\pi_i^h = d\pi_j^h = 0 > d\pi_j^d = d\pi_i^v \ .$$

Type-$d_i$ and type-$v_j$ firms benefit the most, since their production and sales are concentrated in country i. Type-h firms are not affected by the shift, because the positive effects in country i are cancelled out in country j. Firms with production in j are actually worse off since smaller share of their sales are in country i due to the transport costs.

**Asymmetric change in factor endowments:**
The effects of factor price differences between countries are a bit more cumbersome to examine without the information about the exact factor intensities in X production. Therefore, it is first considered what happens to profits of type-d and type-h firms excluding type-v firms when the incomes remain constant and the relative price of skilled labour falls in one country with an accompanying rise in the other, $-d\frac{z_i}{w_i} = d\frac{z_j}{w_j} > 0$. The profits change

$$d\pi_i^d > d\pi_i^h > \ 0 > d\pi_j^h > d\pi_j^d \ .$$

If it is assumed that the skilled labour intensity of production is low enough so that when skilled labour becomes cheaper and unskilled more expensive, the fixed costs changes dominate the mark-up revenue changes, then all the firms headquartered in i benefit. Type-d firms benefit the most, since their skilled labour fixed costs are incurred fully at home, whereas for type-h they are divided between the countries. If type-v firms are now added into the model, it can be seen that equations 3.34 and 3.37 as well as 3.35 and 3.38 are otherwise equal, but differ in fixed costs. Therefore, if factor prices change enough, the profits of type-v firms located in the country where skilled labour is cheap will rise more than the profits of type-d firms.

**Change in trade costs:**
The level of trade costs plays naturally a role as well. If the trade costs increase, $d\tau>0$, then

$$d\pi_i^h = d\pi_j^h = 0 > \ d\pi_i^d = d\pi_j^d = d\pi_i^v = d\pi_j^v\,.$$

Trade cost increase raises the $b_i$ (1=1,2) coefficient in 3.34-3.39 and therefore decreases the profits of both type-d and type-v firms while type-h firms are unaffected.

Drawing the previous points together it can be concluded, that horizontal multinationals are most likely to rise, when countries are similar in size and factor endowments. When countries differ considerably in factor endowments, motivation for vertical multinationals is stronger. Type-v firms are further encouraged when the other country is small and skilled labour abundant. High trade costs naturally favour horizontal multinationals against other types of firms.

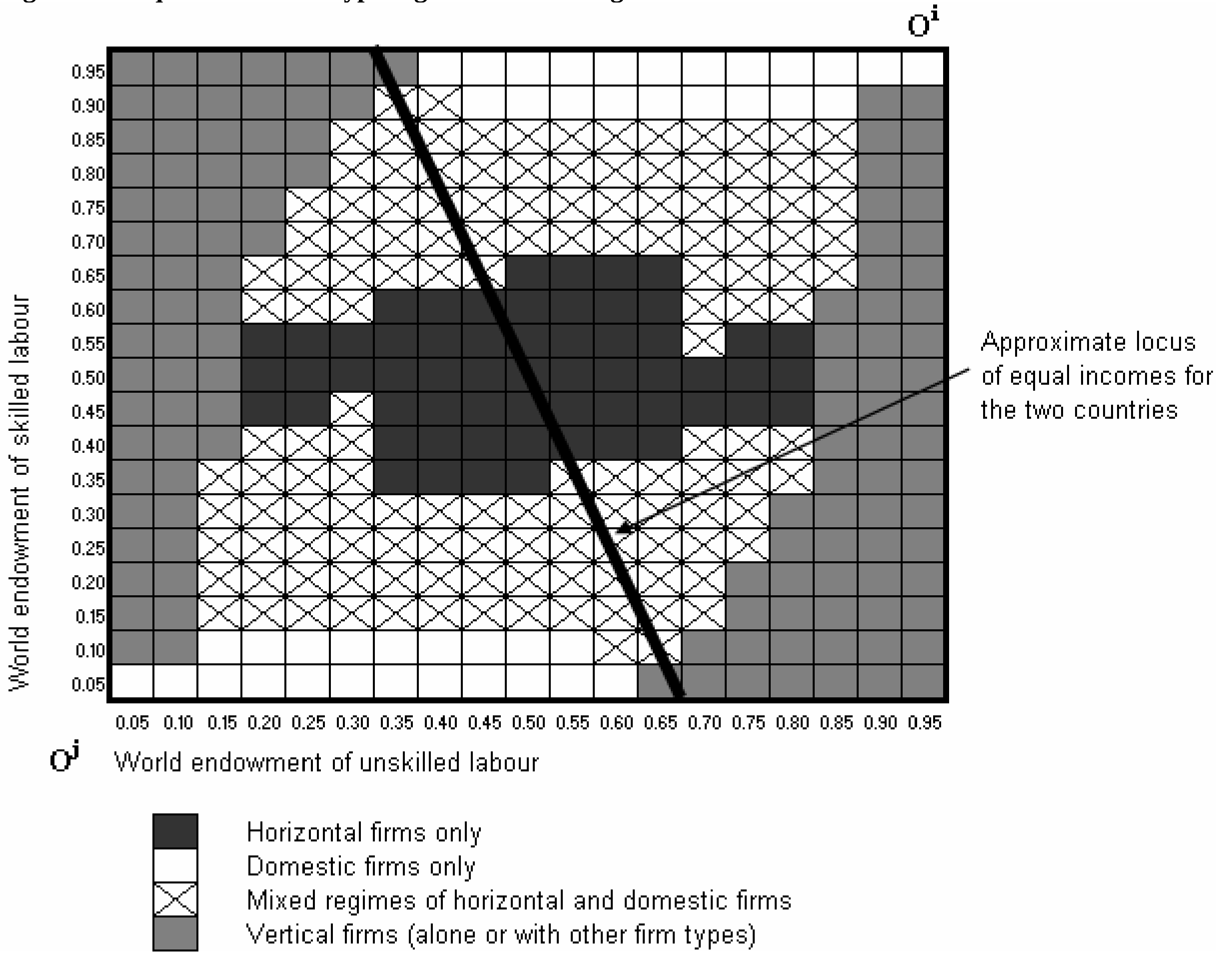
A general note is that both the mark-up revenues and fixed costs of type-h firms are higher than they are for type-d and type-v firms. The latter incur transport costs while type-h firms have to bear extra fixed costs for running another plant. Essentially, the branch plant is a high fixed cost option and exporting a high variable cost option.

In general, the knowledge-capital model implies that:

1) Horizontal multinationals tend to dominate when total world income is high, trade costs are high and when the two countries are relatively symmetric in incomes and in factor endowments
2) Type-d and type-v firms will dominate type-h firms when the total income is low and countries are asymmetric in size and in factor prices.
3) Type-v firms will have an advantage over type-d firms, when the factor prices are sufficiently different and compensate for the extra fragmentation costs incurred. Type-v firms gain, when they can locate the headquarters in a skilled labour abundant country and the plant in a country, where the market is large and unskilled labour relatively cheap.

The partial equilibrium predictions are also supported by the general equilibrium simulations conducted by Markusen (2002). In the simulations, the model was calibrated at the centre of the world Egdeworth box, where countries are similar in size and in factor endowments, and only type-h firms are active. The results were generated by changing the underlying parameters. Figure 3.1 illustrates the simulation results in an Edgeworth box. Factor intensities in production and in fixed costs are given and 20 percent trade costs are assumed. The straight line depicts the locus of equal income for the two countries. To the left from the line, country i has a higher income than country i. To the right the situation is reversed.

**Figure 3.1: Equilibrium firm type regimes over an Edgeworth box**




The figure demonstrates, how the active firm types change, as the distribution of world factor endowments changes. In the centre, where countries are identical in size and in factor endowments, only type-h firms exist. When countries differ in size (income) but the relative factor endowments are not too extreme both type-d and type-h are active. This is illustrated by moving away from the centre along the bottom left – upper right diagonal. When the other country is large, and skilled labour abundant, only domestic firms are active (bottom left and upper right hand sides). When the countries differ considerably in their relative endowments, the vertical firms become prominent. This applies especially, when the other country is small and skilled labour abundant. This is exhibited on both sides of the Edgeworth box and in the upper left and bottom right corners.

### 3.2.3. Empirical evidence

The pure horizontal model predicts that multinational activity is higher the more similar income levels and factor prices countries have and lower the more different they are, leaving no motive for FDI flowing from developed to developing countries. The vertical approach conversely states exactly the opposite. Since a dominant share of world foreign direct investments takes place between the most developed industrialised countries where the factor prices differ the least, it seems evident that at least the vertical model alone gets little empirical support. The predictions generated by the knowledge-capital model are in better accordance with empirics.

Most of the empirical work finds evidence in favour of the horizontal model, whereas the vertical approach is often rejected (e.g. Brainard 1993; 1997 and Ekholm 1995; 1998; 2001). Results of the studies incorporating the hybrid knowledge-capital conducted by Markusen and Maskus (1999 and 2001b) and Carr et al. (2001) follow the same line. Vertical model is rejected whereas both the horizontal model and the knowledge-capital model get empirical support, although tests fail to distinguish between the two[2].

The results are generally interpreted to support the view that FDI is most important between relatively similar countries. Although the vertical model may be a good characterisation for individual firms and industries, in aggregate data it is an inadequate predictor of multinational activity.

# 4. FINANCIAL INTERACTIONS

The purely neoclassical model of firm behaviour assumes no financial interactions between multinationals' foreign and home investments. The neoclassical model rests on assumptions of perfect capital markets, where the firm faces a fixed interest rate and can borrow up to the point where the marginal product of capital equals that rate. In such a case, if the MNEs foreign and home operations are completely separate and therefore no production interactions exist, the foreign operations will not affect home activities in any way. However, it is widely acknowledged that this is not the case. Capital markets are seldom perfect and MNEs investment decisions affect subsequent investment possibilities.

## 4.1. EVOLUTION OF THEORIES EXPLAINING FIRM INVESTMENTS

Firm investment decisions involve foregoing current funds in the hope of earning profits in the future. Models explaining investments formalise and explain the nature of this trade off. Developments in techniques appraising single investment projects and evaluating their profitability have greatly enriched the awareness and contributed into the development of such models. The discounted cash flow methods and specifically net present value approach (Dean 1951) help considerably in understanding the inter-temporal nature of investment pay off.

Early theoretical models describing investment behaviour were quite limited in their treatment of different attributes. The accelerator model of investments developed by Clark (1917) explains investment decisions solely with capacity utilisation. The simple model relates investments to the change between previous and current period sales with a constant multiplier. The theory was later modified to include a lag structure incorporating the effect of sales of several earlier periods emphasising investments as an ongoing process with substantial lags between recognition of opportunity and execution (Goodwin 1948). This model is known as the flexible accelerator and it has evoked interest over the years due to its simplicity and appropriateness for empirical testing.

[2] The results and used methods have been confronted by e.g. Blonigen et al. (2003). They claim that the tests de facto reject the knowledge-capital model as the skilled labour abundance between the countries are significantly negatively related with the affiliate activity.

### 4.1.1. The static neoclassical investment model

The general starting point for modern investment theories is the static neoclassical investment theory developed by Jorgensen (1963). Essentially, the theory views firms as maximising the present value of their future profits with the user cost of capital as the relevant discount rate. The user cost is defined as the sum of the opportunity cost, physical depreciation rate, tax effects and the capital gain or loss resulting from the changes in the capital goods' prices. According to the theory, firms employ capital up to the point where the marginal revenue product of capital equals its user cost, giving the firms' long run optimal capital stocks. The model further assumes that capital stocks adjusts immediately to these long run optimum levels leaving aside the short run adjustment process, namely investments[3].

Subsequent work by Eisner and Strotz (1963), Lucas (1967) and Gould (1968) extended the theory to include investments by formally modelling the adjustment process. When altering the capital stock, firm faces adjustment costs related to for example installing the new capital and training workers to operate the new machines. Furthermore, the adjustment costs are assumed strictly convex rising proportionally with the rate of change of the capital stock resulting in a gradual move towards the new optimum.

### 4.1.2. The Tobin's q model of investment

In line with the neoclassical model is the Tobin's q approach (Tobin 1969), which assumes the existence of similar adjustment costs as the former. The model argues that investments depend on the ratio of the market value of capital to its replacement cost defined as the so-called q variable. What is relevant for the investments is the marginal q, which states how much the market value of the firm increases with one additional unit of capital relative to the cost of that unit of capital. According to the theory, a firm should invest as long as the market value of capital exceeds the replacement cost, in other words marginal $q > 1$.

The theory is very similar to the neoclassical model as in perfectly functioning markets the market value of capital equals its net present value. Essentially, when investing as long as marginal q exceeds one, what firms are doing is equating the marginal revenue product of capital with the user cost of capital. Thus, the q approach is really a different formulation of the same problem equating the market value with replacement cost instead of marginal revenue product with the user cost (Hay and Morris 1991, 441-442).

Although the marginal q is hard to measure, it has a readily observable approximation, the average q, which is for listed companies simply the inverse of the familiar book-to-market ratio, reflecting the market value of all the assets held by the firm relative to their replacement costs. There are several reasons why the average q is likely to be very different from the marginal q. For the two measures to be the same, investors would have to appraise all new investment undertakings equal to previous ones. However, it can be shown that assuming perfect product market competition (i.e. flat demand curve and constant returns to scale) and constant returns in the costs of adjustment, the marginal q and average q coincide (Hayashi 1982).

[3] For empirical purposes, Jorgensen (1967) modelled an ad hoc distributed lag structure for capital stock slowly to adjust to its optimal level.

### 4.1.3. Other theories

Later on, the above-mentioned theories have been developed further to account for different aspects of investment behaviour. The fact that investment outcomes are not certain has drawn much attention. Uncertainty about future profits has several implications for investment decisions. Adjusting the capital stock is always costly, but the costs may be asymmetrical in that it is cheaper for a firm to build up capital stock than it is to reduce it. Thus, investments are to some extent irreversible. When a firm increases its capital stock, it commits to this higher level for some time. (Romer 2001, 389-390)

The investment irreversibility is the core of the option theory of investment. Since investments are irreversible and future profits uncertain, the firm may be better of waiting and investing only when better informed instead of realising the investment outlays right away. The value of this call option is higher the more uncertain the expected outcomes are. Uncertainty can also create put options (Abel et. al. 1995, 2). If the future value of the investment is likely to increase, by investing now the firm acquires an option to sell it later with a higher price. For example, in a case of new technology, it may be worthwhile to invest immediately as waiting might cease the possibilities (i.e. raise the price) to do so when competitors enter the market.

The existence of option value means that the standard net present value techniques do no longer apply. Although the irreversible investments and the option theory have been lately widely studied, empirical evidence is still somewhat lacking.

### 4.1.4. Empirical considerations

In essence, the neoclassical model derives an investment function, where investments depend on the expected future profits and the user cost of capital. Therefore, the model predicts that the expected future demand and prices are major determinants of current investments. The question for empirical work is how these expectations should be measured.

The q model offers one possible way to do this as the model simply assumes that the q variable contains all the relevant information about the future profitability. Because of the easy availability of the data on average q, a lot of empirical work has focused on this approach. However, the empirical performance of the model has been dissatisfactory, partly due to the oversimplifying assumptions regarding the use of average q such as the nature of the adjustment costs and the prevalence of correct stock valuation at all times. This has led to the search for other empirically testable formulations of the neoclassical theory (Bond and Van Reenen 2002, 16). One of these is the one suggested by Abel and Blanchard (1986) and the Euler equation approach introduced by Abel (1980).

The Abel and Blanchard model (1986) aims at fixing the problems encountered with using the average q. The approach concentrates on constructing the marginal q instead, and thus avoids using the average q and share price data. They first argue that the marginal q is the expectation of a present value of a stream of marginal profit. They then generate a prediction of future marginal profits by specifying the production function yielding an estimate of the marginal q. However, the procedure is complex and requires many assumptions that can be restrictive.

The Euler equation approach (Abel 1980) is less restrictive and also avoids the use of share price data and future expectations. The equation is constructed by combining the first order conditions to eliminate the shadow price of capital and to replace it with the expected marginal profit from investment. Then the resulting Euler equation is estimated instead of the original equation. Future expectations can be replaced with the realised values from the next period.

## 4.2. CAPITAL MARKET IMPERFECTIONS

Realised firm investments are the product of two separate factors, demand for investments and the supply of funds. The intersection of the two determines the level of undertaken investment projects. The described investment models explain the demand side of the story when the funds are supplied with constant costs. Both the neoclassical theory and the Tobin's q approach rest heavily on assumptions of perfect, frictionless capital markets, where the Modigliani-Miller theorem (MM) (Modigliani and Miller 1958) of capital structure indifference applies. In the MM world, firms in the same risk class share the same weighted cost of funds and financial factors such as internal liquidity, leverage or dividend payments play no role in firms' real investment decisions. Therefore, firms financing and investment decisions are independent from each other and the cost of funds is external to the firm. This implies that firms can finance all their investments with a constant cost of finance and investments are not competing with each other.

In reality however, capital markets are far from perfect and internal (retained earnings) and external finance (debt and new equity issues) are not perfect substitutes. Asymmetric information, conflicting interests and the existence of issue costs increase the cost of debt finance and new share and bond issues. Different tax treatment of dividends, capital gains and debt further divert the picture.

### 4.2.1. Taxation and capital structure

The most obvious source of financial market distortions is taxation. Although taxation is generally considered relevant, the literature provides no clear-cut view over its effects. In terms of taxation, the firm's objective is to minimise the taxes paid on corporate income. The tax treatment of dividends, capital gains and debt all play a role and thus the way in which taxation influences financing decisions varies from tax system to another.

In most tax systems, debt has one important advantage over other forms of financing[4]. Companies' interest payments are considered as costs and are therefore tax deductible expenses while dividends and retained earnings draw from taxed profits. The interest tax shield can be a valuable asset if the firm can be sure to earn positive profits in the future. In case of negative profits, the tax deductibility plays no role and the cost of debt finance equals the cost of equity finance. (Brealey and Myers 1995, 475-477).

The overall benefit of debt depends on corporate tax rate as well as investors' personal taxation. The classical corporation tax regards corporations and their owners as separate tax entities and therefore double-taxes their income, first the corporation and then the owners on

[4] This was also acknowledged by the extended version of the MM proposition (Modigliani and Miller 1958; 1963).

dividends and realised capital gains (Kari and Ylä-Liedenpohja 2002, 1). In addition to that, creditors pay taxes on their interest income at a rate, which is often equal to the tax rate of dividends. Thus dividends are taxed twice while interests only once and debt's tax advantage over dividends is exactly equal to the corporate tax rate.

The firm can alternatively restrain from paying dividends and retain the earnings, thereby increasing the value of the firm. Equity income realises now in the form of capital gains. Capital gains are often taxed at a lower rate than dividend and interest income, which means that the interest tax shield is less valuable. If the corporate tax rate combined with the capital gains tax rate is low enough relative to the tax rate of interest income, the tax advantage of debt is insignificant or even reversed. Furthermore, the realisation of capital gains can be postponed to a later date, which decreases the present value of the tax bill and lowers the effective tax rate (Brealey and Myers 1995, 480-482).

If the firm pays dividends, it raises the funds from retained earnings by borrowing or through new equity issues. Under the classical system, debt thus has a taxation based cost advantage over new equity issues but not necessarily over retained earnings.

The Finnish corporation tax system has been somewhat different from that described above and has therefore different implications for the cost of finance. The classical corporation tax leads to an inefficient resource allocation in that it diverts funds away from the corporate sector and restrains the supply of funds to finance business formation (Harberger 1962). To circumvent this, Finland, like many other European countries in the 1980s and 1990s, introduced the so-called imputation system in order to integrate the taxation of corporations and their owners[5]. The imputation system in effect avoids the double taxation of dividends by crediting the paid corporate taxes on distributed profits against the shareholder's income tax on dividends. (Kari and Ylä-Liedenpohja 2002, 1)

Without going much to the details of the Finnish tax systems, the imputation system in general has certain implications when combined with a single tax rate on interest and dividend income as well as capital gains[6]. The uniform tax rate on equity and interest income combined with a single taxation of dividends means that the interest tax shield has any relevance only against the capital gains. Taxation therefore raises only the relative cost of internal finance. As far as taxation is concerned, the firm is better of paying maximum dividends and raising the funds needed for investments from either new equity issues or borrowing.

### 4.2.2. Bankruptcy costs

A firm is said to be financially distressed, when it faces difficulties in fulfilling promises given to its creditors. Ultimately, the firm may have to default. If the firm is a limited liability company, the current owners simply leave the firm in a case of bankruptcy and the creditors become the new owners. However, the procedure involves costs that are borne by the creditors.

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[5] The imputation system has been abandoned from the beginning of the year 2005 and is replaced with a system resembling the classical corporation taxation.

[6] The implications of the Finnish tax system are fairly difficult to model exactly and beyond the scope of this thesis. Among other things, the addition of such elements as unutilised past tax surpluses, varying procedures in treating the capital gains depending on the length of the ownership and the different tax treatment of dividend income from unlisted companies divert the picture. Furthermore, the system itself has seen a few changes making the modelling ever more complicated.

Bankruptcy costs are either direct or indirect (Brealey and Myers 1995, 487-490). Direct costs include the costs of undertaking the bankruptcy such as legal and administrative costs. Indirect costs are the extra costs associated with running the business, when the firm goes through bankruptcy procedures as legal considerations may limit the best possible use of company's resources. Additionally, bankruptcy decreases the value of the firm's assets (Brealey and Myers 1995, 495). Most assets are more valuable for the firm as a going concern than what their resale value is. This concerns especially firm specific intangible assets such as reputation and know how. Therefore, bankruptcy costs vary greatly between different industries and different firms.

Financial distress is costly because it increases the probability of bankruptcy and realisation of bankruptcy costs. Creditors consider this and demand higher margins in interest rates compared to default free alternatives. High leverage makes bankruptcy more likely and therefore the extra compensation demanded by creditors increases with debt ratio. This means that the firm's marginal interest rate is increasing and not constant.

### 4.2.3. Conflicting interests

In most large companies, the firm's ownership and control are separated from each other. Shareholders have usually delegated the running of the firm to professional managers who act as their agents to maximise the value of the firm. However, it is not always in the managers' best interest to maximise the value of shareholders holdings, but to maximise their own utility instead. This is called the principal-agent problem (Jensen and Meckling 1976). Agency costs are incurred when agents depart from value maximising decisions and principals incur costs in monitoring agents and influencing their actions (Brealey and Myers 1996, 371).

Debt finance may decrease the principal-agent costs, because the interest and principal payments limit the free funds available for managers (Jensen 1986). Furthermore, the possibility of bankruptcy gives the managers stronger incentives to seek lucrative investment opportunities (Grossman and Hart, 1982). At the same time, the creditors take over part of the agency costs (Kanniainen and Södersten 1994).

Conflicting interests between the shareholders and creditors on the other hand increase the cost of debt finance (Jensen and Meckling 1976). The existence of debt introduces a moral hazard when firms are induced to engage in riskier projects than they would if they had to bear the full risk of the projects by them selves. The shareholders who have control over the firm through their middlemen are tempted to maximise the value of their shares instead of the value of all outstanding securities. The moral hazard is ever more present when firms are financially distressed. Thus, firms with heavy debt burden may even favour risky projects with negative net present values over safer ones, as the shareholders expected pay off increases although the overall value of the firm does not (Myers 1977). In a good state, the proceeds from the less risky project will go paying off debt while shareholders are left with nothing. In the case of the riskier projects, the lender bears all the downside potential while the proceeds are divided.

### 4.2.4. Asymmetric information

Asymmetric information between different agents in the financial markets increases the cost of external finance. The statement follows similar lines as the groundbreaking work by Akerlof (1970), who showed how markets can break down when potential buyers cannot verify the quality of the product.

Some firms are more likely to default than others are, but it is difficult for outsiders to distinguish between the two beforehand. The managers are always better informed about the firm's prospects than the creditors. Because the creditors cannot observe the risk associated with a particular company, they add a premium to all interest rates to compensate for the possibility of default and bankruptcy costs.

However, increasing the interest rate beyond some point may decrease the return to lenders as it may lead to adverse selection. The demanded premium may be small enough to induce firms with high risk, high pay off projects, and discourage firms with more certain but lower pay off projects (Jaffe and Russel 1976). Higher interest rates create also a moral hazard. As in the case of conflicting interests, when the creditors' share of the pay off increases, the firm is less interested to maximise the pay off and more keen on taking up riskier projects. This may lead to credit rationing as creditors may refuse finance from a firm offering to pay a higher interest rate. (Stiglitz and Weiss 1981, 394)

Asymmetric information does not concern only creditors but also current and potential shareholders. Since outside investors are always less informed about the firm's state of affairs and future prospects, management's actions contain valuable information to the market. Increase in regular dividends for example signals management's confidence in future earnings and vice versa (Miller and Rock 1982). The same effect increases the costs of new equity issues. If the management believes that the company's share price will increase in the future, issuing new equity at current price favours new shareholders against the old ones. The firm is better off issuing debt and waiting for the share price to rise. If the share is considered over valued, managers will prefer issuing equity since it favours the present owners. Therefore, equity issue announcement signals management's pessimism and the other way around. (Myers and Majluf 1984)

### 4.2.5. Issue costs

Issuing new debt or equity is not without its costs. Legal and administrative tasks involved with the issue cost money and have to be often carried by intermediaries such as investment banks and law firms. Although larger issues are more costly than smaller ones, there are considerable economies of scale involved in the procedure. Therefore, in a case of large issues, transaction costs can be highly irrelevant but they might make a small issue infeasible. For this reason, firms are reluctant to finance their marginal investments with new equity issues. They are considered only, when a large amount of new finance is required. With borrowing, firms have other options besides issuing corporate bonds. They can use bank loans or lines of credit instead, which are more appropriate for small scale-, but sometimes also for large-scale financing. The bottom line is however, that when issue costs are introduced, internally generated funds have a cost advantage over other forms of financing.

### 4.2.6. Implications of imperfections

How exactly do the above-mentioned imperfections constrain firms in their financing decisions is somewhat unclear. Debt has several advantages over other forms of finance. It provides an interest tax shield against corporate taxes and controls the management-owner agency costs by limiting free funds and increasing the possibility of bankruptcy. However, leverage also increases the cost of financial distress and may in itself induce management behaviour that is suboptimal for creditor.

The static trade-off theory suggests that when borrowing, firms trade off the cost of increased financial distress against the benefit of interest tax shield. According to the view, firms thus have a desired debt level that they want to obtain. This would suggest, that firms with relatively safe assets and therefore low costs of financial distress, and on the other hand firms making ample profits and gaining most from interest tax shields should exhibit highest debt levels. However, in real life the most conservative capital structures are often observed among the well-established profit making companies. (Brealey and Myers 1996, 496-497)

The pecking order model put forth by Myers and Majluf (1984) is another attempt to present the capital structure adjustment process in presence of information asymmetries. According to the view, firms first exhaust internally generated funds, then issue debt until they hit their debt capacity constraint, that is until the cost of financial distress becomes too high, and issue new equity only as a last resort. In the model, firms do not perceive an optimal capital structure nor are constrained in their financing decisions before they hit their debt capacity constraint. However, they may feel constrained as the amount of financial slack decreases. To retain an option to issue safe debt if required to, managers are willing to maintain some precautionary spare debt capacity.

There are several other theories explaining firms' capital structure decisions that establish a relationship between the level of leverage and different endogenous factors. What is common for almost all of them is that capital structure is relevant and financial decisions do play a role. According to the simple hierarchy of finance, external finance is more expensive than internal and in a case of debt finance, it further increases with leverage.

## 4.3. Empirical evidence of financial constraints

Financial market imperfections have been studied widely and empirical literature in this field is rich. Meyer and Kuh (1957) were one of the first advocates of the significance of financial constrains. The Modigliani-Miller theorem (1958) effectively diverted the interest towards separating the investment decisions and financial factors from each other and considering the two as separate. In empirical work, this in turn led to the testing of different models for investment demand (Tobin's q, neoclassical model, accelerator model, etc) without inclusion of financial factors (Hubbard 1998, 202-203).

The testing of financial constraints is not without its problems. The question researchers have to address is does the firms' net worth (financial conditions) affect the investment decisions. In practice, this requires finding a proxy for changes in net worth that affects the supply of funds, not the demand. The most often used proxy is cash flow, sometimes also the ratio of indebtedness. However, cash flow as well as other measures of financial constraints can be correlated with the investment opportunities. For example, improved opportunities may announce themselves as a rise in current profitability. (Hubbard 1998, 204-205)

Because of the possible correlation, adding financial factors to the ordinary investment models not only tests for the existence of financial constraints but also for the feasibility of the overall specification (Bond and Van Reenen 2002, 64). Therefore, i.e. the inclusion of cash flow in estimation can improve the explanatory power of the estimation even though there were no financial constraints.

The so-called sample-splitting tests have become the standard way of circumventing this problem. The idea is that even though financial factors may improve the goodness of fit for all firms, if financial constraints are relevant determinants of investment the improvement will be biggest for the most constrained firms. The sample is thus divided into more and less financially constrained firms. The differences in the coefficients of financial factors between the groups are then interpreted to highlight the effect that constraints have on investments.

Usually the criteria for grouping firms into being financially constrained with higher and lower likelihoods are chosen ad hoc. Therefore, the model used for generating predictions does not directly tell how the firms should be grouped (Ali-Yrkkö 1998, 23). Different criteria are used, when testing for information asymmetries than in testing for principal-agent problems. Optimally, the criteria should not be correlated with other factors besides financial constraints. If it is, firms in a certain category might differ from the firms in the other category with more than one respect possibly influencing the coefficients. Furthermore, the criteria should be exogenous to the estimated equation. Otherwise, the criteria (such as current firm size) might reflect the results of past investments creating a sample selection bias (Bond and Van Reenen 2002, 66).

**Tests using the q model**

The seminal work studying differences in investment-cash flow sensitivities is by Fazzari, Hubbard and Petersen (1988). Their estimation was done using the q model with cash flow as an added financial variable. They split their sample of 422 US firms into three parts according to the dividend payout ratios arguing that firms with high cost of external finance choose a low dividend payout ratio. Their empirical results show that cash flow is a major determinant of investments and the effect is even magnified for firms a priori considered as financially constrained.

Following Fazzari et al. (1988) a string of researchers have found cash flow to have an effect on investment. Also using the q model, Hoshi, Kashyap and Scharfstein (1991) grouped Japanese firms to financially more and less constrained according to firms' bank i.e. keiretsu affiliations. They found that investments of firms with tight connections with banks are less determined by cash flow than those of the control group.

However, the tests based on the q model are somewhat suspect due to the difficulty of measuring marginal q. Erickson and Whited (2000) demonstrate that measurement error in q can explain excess sensitivity results. Under the assumption of perfect measurement, they demonstrate that firms with a bond rating display excess sensitivity of investment to cash flow. Correcting for measurement error removes the cash flow sensitivity for both the unconstrained and the constrained subsets of firms.

**Tests based on Euler equation**

The Euler equation approach avoids many of the pitfalls of the q model such as the stringent conditions for equating the marginal q with the average q[7]. Among other things, the model does not rely on noisy share price data and cash flow should not enter the specification merely as a proxy for future profitability (Hubbard 1998, 221). Neither is the examination limited to openly traded firms.

Gertler, Hubbard and Kashyap (1991) use this method to test for information asymmetries. They find that asymmetries raised the interest costs for companies and thereby reduced investments. Other studies based on the Euler equation that reject the frictionless neoclassical model include Gilchrist (1991),Whited (1992) and Hubbard, Kashyap and Whited (1995).

All of the above-mentioned studies have used some sort of a priori way of grouping firms into being financially more and less constrained. Furthermore, with the exception of Hubbard et al. (1995) the firms classified as financially constrained are not allowed to vary over time. Bond and Meghir (1994) based their grouping on a theoretical hierarchy of finance model instead of an ad hoc measure that allowed a firm to be classified as constrained in one period and unconstrained in another. Using Euler equation specification for a sample of UK firms they concluded that excess sensitivity of investments to cash flow was more pronounced in periods when firms pay unusually low dividends

Several studies have followed Bond and Meghir (1994) and applied a similar model to analyse firm investments for different samples of firms using different classifying criteria. Rondi et al. (1994) estimate the model for Italian firms using dividends and the mode of ownership as a grouping criteria. They find that the effect of financial factors on investment varies across firms according to their institutional characteristics. In particular, state-owned firms appear to be more sensitive to cash flow than privately owned companies are, and quoted firms show more sensitivity to internal finance than unquoted firms do.

Cho (1996) analysed investments in Korean firms classifying them according to industrial relations, age, size, export efforts and industry. Investments of firms considered constrained did not exhibit excess sensitivity to cash flow compared with the control group. Hansen and Lindberg (1997) used the model for Swedish firms that were grouped according to the size and retention behaviour. Their results showed that cash flow increased investments of small firms while having no effect on large firms' investments.

The same model has also been applied for Finnish data. Ali-Yrkkö (1998) examined the main determinants of investments for the 500 largest firms in Finland. The ability to pay interest expenses was chosen as an indicator of financial constraints after the use of dividends and equity emissions was rejected based on the data. According to the results, a positive cash flow increased fixed investments particularly in companies with low ability to pay financial expenses.

**The Kaplan and Zingales critic**

Kaplan and Zingales (1997) have criticised empirical work in line with Fazzari et al. (1988) by arguing that the relationship between investment-cash flow sensitivities and financial constraints is under explored. They claim that the implicit assumption that investments of financially more constrained firms exhibit higher sensitivity to cash flow lacks theoretical reason-

[7] Ali-Yrkkö (1998, 24-30) provides a good overview of studies testing financial constraints with the Euler equation.

ing. They regrouped the firms classified as constrained by Fazzari et al. (1988) into financially more and less constrained according to statements contained in annual reports. The results show that firms classified as less financially constrained exhibit significantly greater investment-cash flow sensitivity than do firms classified as more financially constrained.

However, the Kaplan and Zingales (1997) study has many limitations. First, their sample lacks sufficient heterogeneity as it includes only firms previously labelled as financially constrained. Second, their results do not provide any alternative explanation for the finding that different types of firms exhibit different investment-cash flow sensitivities. Third, they study the relationship in a static model with no adjustment cost and it is not clear whether their results extend into models that are more complex. (Bond and Van Reenen 2002, 69-70)

**Conclusions from empirical evidence**
It can be concluded that the view that firms' financing and investment decisions are interrelated is well supported with evidence. All the above-mentioned studies find some relation between cash flow and investment at least for some firms in the sample. Capital market imperfections do play a role and the firm may be constrained for several reasons and to varying degrees making cash flow a determinant of investments. As a result, depending on the underlying conditions different investment projects may compete for the same scarce funds.

# 5. SYNTHESIS OF THE TWO SOURCES OF INTERACTIONS

The discussed production and financial interactions allow drawing some synthesis over the relationship between the foreign and domestic investments of firms. On the production side, it seems evident that the relationship varies greatly depending on whether the FDI is vertical or horizontal in nature. Vertically oriented foreign investments increase the demand for production residing at home making the relationship between investments more complementary than substitutionary. Similarly, it may be hypothesized that horizontally oriented investments transfer out home production more than they increase demand for administrative tasks. The relationship should therefore be more substitutionary than complementary.

This is of course a great simplification. When the firm engages in vertical FDI, it may well be that it effectively transfers abroad part of its production previously undertaken at home. In the short run, the initial investment effectively decreases home production. However, in the long run home production may increase as the overall demand for the part of production still residing at home increases. Similarly, horizontal FDI can increase the foreign demand for the firm's production significantly by helping overcome important impediments for market access. In such a case, the negative effects on home production may be dismal, but the overall investments in r&d and administration may increase. However, on aggregate it is reasonable to assume that vertical FDI has less negative effects on home investments than horizontal FDI does and vice versa.

Based on the knowledge-capital model presented in chapter 3 it can be assumed that vertical MNEs are more prevailing between countries whose relative factor endowments and prices are sufficiently different. Similarly, horizontal FDI dominate vertical FDI, when the factor prices in home and host country are close to each other. Factor prices often differ systematically according to the overall income levels. Poor countries are relatively abundant in labour and rich countries in capital. Leaving aside transport costs it is therefore reasonable to assume that investments to host countries that are on the same income level as the home country are more substitutionary. Similarly, investments to host countries on a different income level are more complementary to domestic investments.

Financial interactions have a part to play as well. If firms are financially constrained their investments depend partly on the availability of internally generated funds. In such circumstances, investments undertaken abroad decrease the funds available for domestic investments. Therefore, in the absence of production interactions, foreign investments of financially constrained firms should have a negative impact on domestic investments.

# 6. THE EMPIRICAL SPECIFICATION OF THE INVESTMENT FUNCTION

For an empirical analysis of the relationship between firms' foreign and domestic investments an empirically testable form for the investment function is needed. This study uses a specification utilising the Euler equation developed by Bond and Meghir (1994) that allows for financial interactions. The model is chosen because of the advantages of the Euler approach discussed in chapter 4. Furthermore, the model basis its financial classification of firms on a theoretical framework rather than on some ad hoc method. The same specification has previously been used by Rondi et al. (1994), Cho (1996), Hansen and Lindberg (1997) and Ali-Yrkkö (1998). Results of previous studies were briefly presented in chapter 4.

The model classifies firms as financially constrained according to the financial pecking order theory (Myers 1984). In the case of no financial constraints the investment function is the basic dynamic neoclassical investment model with convex adjustment costs. If firms are financially constrained in their investment decisions, the investment function includes measures of financial conditions.

## 6.1. THE BASIC THEORETICAL INVESTMENT MODEL

Following the neoclassical view, firm's objective is to maximise the present value of its future profits. If $V_t$ is the discounted value of the firm at period t, $L_t$ the costlessly adjustable factors of production and $K_t$ the capital stock , the problem can be expressed as

$$V_t(K_{t-1}) = \max_{L_i, I_t}\left\{\pi(K_t, L_t, I_t) + \beta_{t+1}^t E_t\left[V_{t+1}(K_t)\right]\right\}. \qquad (6.1)$$

Gross investment $I_t$ takes place at the start of the period and is instantly productive, but changes in the capital stock involve strictly convex adjustment costs. The expectations $E_t[...]$ are conditional on the information available at the start of period t. The firm's objective is to maximise the wealth of the marginal shareholder who is assumed risk neutral. Therefore, without taxes the firm's nominal required rate of return between periods t and t + 1 equals the risk free rate $r_t$ and the discount factor is $\beta^t_{t+1} = 1 / 1 + r_t$.

Capital stock evolves according to the equation of motion

$$K_t = (1-\delta)K_{t-1} + I_t, \qquad (6.2)$$

where $\delta$ is the depreciation rate.

Maximising 6.1 subject to 6.2 produces first order conditions for optimal investments and capital

$$-\left(\frac{\partial \pi}{\partial I}\right)_t = \lambda_t \,. \tag{6.3}$$

$$\lambda_t = \left(\frac{\partial \pi}{\partial K}\right)_t + (1-\delta)\beta_{t+1}^{t} E_t(\lambda_{t+1}), \tag{6.4}$$

where $\lambda_t = (1 / (1 - \delta)) (\partial V_t / \partial K_{t-1})$ is the shadow value of inheriting one additional unit of capital in period t.

There are three principal ways of obtaining empirical investment functions using 6.3 and 6.4. Since 6.4 equals the q model of investment, it can be estimated using the q approach and simply relying on stock market data to measure the shadow value of capital $\lambda_t$. The main limitations of the method have to do with the discussed difficulties of equating the marginal q with the average q. The Abel and Blanchard (1986) method avoids the use of average q and employs a forecasting model for $(\partial \Pi / \partial K)_t$ to estimate $\lambda_t$. This involves additional assumptions about the profit function and formation of expectations, which if invalid, may lead the model to be misspecified (Marshall, Rhee and Summers 1990).

The third option following Abel (1980) is to combine 6.3 and 6.4 to eliminate $\lambda_t$. The Euler equation can now be written only in terms of observables as

$$-(1-\delta)\beta_{t+1}^{t} E_t\left[\left(\frac{\partial \pi}{\partial I}\right)_{t+1}\right] = -\left(\frac{\partial \pi}{\partial I}\right)_t - \left(\frac{\partial \pi}{\partial K}\right)_t . \tag{6.5}$$

Equation 6.5 can be estimated by evaluating the expectation term at realised value. Under the assumption of rational expectations, an appropriate method of moments estimator (GMM) can be used to obtain consistent parameter estimates.

## 6.2. INVESTMENT AND FINANCIAL POLICY

The presented basic model does not leave any role for financial policy as it assumes the Modigliani-Miller theorem to hold. In reality the costs associated with different sources of finance may differ and the firm may be faced with a financial pecking order (Myers and Majluf 1984) described in section 4.2.6, where it may be advantageous to use one source of finance in preference to another. To highlight the implications of cost differences, a simple hierarchy of finance model is formally presented below. In order to keep things clear, the model assumes symmetric information between market participants. In such a setting, the cost differences between different sources of finance rise due to differences in tax treatment, transaction costs associated with the issue of new equity and debt and bankruptcy costs. Information asymmetries between market participants could lead to a similar hierarchy as demonstrated by Myers and Majluf (1984).

### 6.2.1. The hierarchy of finance model

The model assumes only two sources of discrimination between retained earnings and new share issues. First, the personal taxation of capital gains may differ from the treatment of dividend income. Second, the issue of new equity involves transaction costs. For notation, the personal tax rate on dividend income for the marginal shareholder in period t is defined to be $m_t$ and $\theta_t$ the dividend received (before personal taxation) when the firm distributes one unit of post-corporate tax earnings[8]. The effective capital gains tax rate $z_t$ is the present value of the tax paid by the marginal shareholder on a unit of capital gains between periods t and t + 1, whit $\zeta_{t+1}$ being the value of the tax in period t + 1[9]. The interest rate on riskless bonds between periods t and t + 1 is $\iota_t$.

Given the above notation, the capital market arbitrage condition for the investor can be written as

$$[1+(1-m_{t+1})\iota_t][V_t-(1-m_t)\theta_t D_t+N_t]=E_t[V_{t+1}]-\zeta_{t+1}(E_t[V_{t+1}]-V_t-N_t), \qquad (6.6)$$

where $D_t$ is dividends paid and $N_t$ the value of new share issues in period t. Solving 5.5 forward gives the value of the firm in period t,

$$V_t=E_t\left[\sum_{j=0}^{\infty}\beta_{t+j}^{t}\left(\gamma_{t+j}D_{t+j}-N_{t+j}\right)\right], \qquad (6.7)$$

where $\gamma_t = (1 - m_t)\,\theta_t / (1 - z_t)$ is the relative tax advantage of dividend income against capital gains. The discount factor $\beta^t_{t+j} = \Pi^{j}_{i=1}(1 + r_{t+i-1})^{-1}$ for periods $j \geq 1$ and $\beta^t_t = 1$ for j = 0 is analogous to the basic model but now with $r_t = (1 - m_{t+1})\iota_t / (1- \zeta_t)$.

The sources and uses of funds identity for the firm issuing debt $B_t$ for one period is

$$D_t=\pi_t+(1-f_t)N_t+B_t-[1+(1-\tau_t)i_{t-1}]B_{t-1}. \qquad (6.8)$$

$\pi_t$ denotes the net revenue generated in period t, $f_t$ is a transaction charge associated with a unit of new share issues (no economies of scale), $i_{t-1}$ is the interest payable on bonds issued in period t – 1 and $\tau_t$ is the rate of corporate income tax in period t.

The issue of debt introduces the possibility of a default. The probability of the bankruptcy and the interest charged by lenders depends on the amount borrowed. It is assumed that in the case of bankruptcy the ownership of the firm is transferred to its creditor. It is further assumed that bankruptcy carries deadweight costs in the amount of $X_t$. If $q^t_{t+1}$ is the probability perceived in period t that the firm will go bankrupt in period t +1 and $m^B_t$ is the income tax rate paid on interest income by the marginal lender, the value of the firm can be expressed as (see Bond and Meghir 1994 for derivation)

$$\begin{aligned}V_t=&E_t\left[\sum_{j=0}^{\infty}\beta_{t+j}^{t}\left(\gamma_{t+j}\pi_{t+j}+\left(\gamma_{t+j}(1-f_{t+j})-1\right)N_{t+j}\right)\right]\mathrm{t}\\&-\gamma_t(1+(1-\tau_t)i_{t-1})B_{t-1}\\&-E_t\left[\sum_{j=1}^{\infty}\beta_{t+j}^{t}q_{t+j}^{t+j-1}\gamma_{t+j}X_{t+j}\right]\\&+E_t\left[\sum_{j=1}^{\infty}\beta_{t+j}^{t}\left(1-q_{t+j}^{t+j-1}\right)\gamma_{t+j}\left(\tau_{t+j}-m_{t+j}^{B}\right)i_{t+j-1}B_{t+j-1}\right]\\&+E_t\left[\sum_{j=1}^{\infty}\left(\beta_{t+j-1}^{t}\gamma_{t+j-1}-\beta_{t+j}^{t}\gamma_{t+j}\left(1+\left(1-m_{t+j}^{B}\right)\iota_{t+j-1}\right)\right)B_{t+j-1}\right].\end{aligned} \qquad (6.9)$$

The first line in equation 5.8 gives the value of the firm when it issues no debt. The second line represents the repayments of previous period debt. The third line gives the expected value of bankruptcy costs and the two last lines give the present value of the net tax advantages resulting from the issue debt.

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[8] Under the imputation system the parameter $\theta_t = (1 - s_t)^{-1}$, where s is the rate of imputation. Under a classical system $\theta_t$=1.

[9] Therefore $z_t = \zeta_{t+1} / (1 + (1 - m_{t+1})\ \iota_t)$

The value function 5.8 is optimised subject to non-negativity constraints on dividend payments ($D_t \geq 0$) and new share issues ($N_t \geq 0$) that are associated with Kuhn Tucker multipliers $\lambda^D_t$ and $\lambda^N_t$ respectively. The probability of a bankruptcy $q^t_{t+1}$ and the interest rate $i_t$ are assumed to depend on the rate of leverage ($B_t / p^I_t$) where $p^I_t$ is the price of a unit of capital goods in period t. Furthermore, bankruptcy costs $X_t$ depend on the amount borrowed $B_t$, but not on $K_t$.

In this case, the Euler equation corresponding to equation 5.4 and characterising the optimal path of investment can be written as

$$-(1-\delta)\beta^t_{t+1}E_t\left[\left(\gamma_{t+1}+\lambda^D_{t+1}\right)\left(\frac{\partial\pi}{\partial I}\right)_{t+1}\right]=-\left(\gamma_t+\lambda^D_t\right)\left(\frac{\partial\pi}{\partial I}\right)_t-\left(\gamma_t+\lambda^D_t\right)\left(\frac{\partial\pi}{\partial K}\right)_t-v_t\left(\frac{B^2_t}{p^I_t K^2_t}\right), \tag{6.10}$$

where

$$v_t=E_t\left[\beta^t_{t+1}\left(\gamma_{t+1}+\lambda^D_{t+1}\right)\left(q^t_{t+1}\left(\frac{X_{t+1}}{B_t}\right)+\left(q^t_{t+1}i_t-i_t\left(1-q^t_{t+1}\right)\right)\left(\tau_{t+1}-m^B_{t+1}\right)\right)\right]. \tag{6.11}$$

The first order condition characterising the optimal level of new share issues is

$$\lambda^N_t=-\left(\gamma_t+\lambda^D_t\right)\left(1-f_t\right)+1. \tag{6.12}$$

**Empirical implications**

Equation 5.9 has many implications for a value maximising firm's financing and investment policies. In a case of no debt financing, the firm can pay its shareholders an additional unit of dividends valued at $\gamma_t$ by issuing $(1 - f_t)^{-1}$ units of new shares. Therefore, if $\gamma_t < (1 - f_t)^{-1}$, the firm will prefer retained earnings as a source of finance[10]. New equity is issued only after internally generated funds are exhausted. This implies three financial regimes in the model.

*Regime 1* $D_t > 0, N_t = 0$

The firm generates sufficient net revenue to finance all its investments from retained earnings and pay positive dividends. The Kuhn-Tucker multiplier $\lambda^D_t$, which measures the shadow value of internal finance is zero and with no debt, the Euler equation 5.9 reduces to its basic form 5.4 provided that the tax discrimination parameter $\gamma_t$ remains constant. The firm is not constrained.

*Regime 2* $D_t = 0, N_t = 0$

The firm generates insufficient net revenue to finance all the investments it would like to make at the cost of internally generated funds. The firm does not issue new shares as the marginal investment projects would not be profitable with the higher costs of new equity finance. Investments depend on the shadow value of internal finance $\lambda^D_t$ and the firm is constrained in its investments decisions by its internal funds.

[10] As Ali-Yrkkö (1998) has noted the condition hold in Finland between 1993-1995 only if $f_t > 0{,}25$, which is intuitively very high figure for transaction cost. For the period 1994-2004 the condition for transaction costs is even higher, namely $f_t > 0{,}27$. However, this does not mean that the model is inapplicable. In addition to the direct issue costs, share issues may involve costs related to asymmetric information as discussed in section 4.2.6. Most importantly, the signalling effects of an issue announcement may be significant.

*Regime 3* $D_t = 0, N_t > 0$

The firm generates insufficient net revenue to finance all the investments it would like to make at the cost of internally generated funds. However, the firm does issue new shares as the marginal investments are attractive enough to justify the higher costs of finance. The level of new issues must satisfy 5.11 implying that $\gamma_t + \lambda^D_t = (1 - f_t)^{-1}$. The term $\gamma_t + \lambda^D_t$ therefore drops out from 5.10 and the Euler equation reduces to 5.4 provided that $f_t$ is constant between periods t and t + 1. The firm is not constrained by its internal finance.

If there are no bankruptcy costs and no tax advantages associated with the use of debt finance, debt is a perfect substitute to internally generated funds and different regimes break down. With bankruptcy costs and tax advantages different regimes exist as presented even when debt finance is allowed. Firms in regime 1 will trade off the benefit of debt's tax advantage against the increased probability to go bankrupt (higher interest rates). They will follow an optimal debt policy and borrow up to the point where they are indifferent between one extra unit of debt and one extra unit of retained earnings. Firms in regime 2 can only invest more by borrowing and their investments are determined by the marginal cost of debt finance. For firms in regime 3 the cost of debt finance rises sufficiently to justify the use of equity issues to finance part of the marginal investments.

### 6.2.2. The empirical specification

The empirical model of investment is obtained by first defining the functional form for the net revenue function as

$$\pi_t = p_t F(K_t, L_t) - p_t G^d(I_t^d, K_t) - p_t G^f(I_t^f, K_t) - w_t L_t - p_t^I I_t^d - p_t^I I_t^f, \qquad (6.13)$$

where domestic investments $I^d$ and foreign investments $I^f$ are distinguished from each other.

$$G^i(I_t^i, K_t) = \frac{1}{2} b K_t \left[ \left( \frac{I^i}{K} \right)_t - c \right]^2, \qquad \text{i=d,f} \qquad (6.14)$$

is a symmetric adjustment-cost function which is linearly homogenous in investment and capital. $F(K_t,L_t)$ is constant returns to scale production function, $p_t$ is the price of the firm's output, $w_t$ is the vector of prices for the variable inputs $L_t$ and $p^I_t$ is the price of investment goods both home and abroad. To allow for imperfect competition $p_t$ is let to depend on the net output $Y_t = F_t - G^d_t - G^f_t$ with constant price elasticity of demand ($\varepsilon > 1$). Partial differential of the revenue function with respect to domestic investments is

$$\left( \frac{\partial \pi}{\partial I^d} \right)_t = \left( \frac{\partial p}{\partial I^d} \right)_t \left( F_t - G_t^d - G_t^f \right) - p_t \left( \frac{\partial G^d}{\partial I^d} \right)_t - p_t^I, \qquad (6.15)$$

where

$$\left( \frac{\partial G^d}{\partial I^d} \right)_t = b \left[ \left( \frac{I^d}{K} \right)_t - c \right] \qquad (6.16)$$

$$\left( \frac{\partial p}{\partial I^d} \right)_t = \frac{p_t}{\left( F_t - G_t^d - G_t^f \right) \varepsilon} b \left( \left( \frac{I^d}{K} \right)_t - c \right) \qquad (6.17)$$

The differential with respect to capital is

$$\left(\frac{\partial \pi}{\partial K}\right)_t = \left(\frac{\partial p}{\partial K}\right)_t \left(F_t - G_t^d - G_t^f\right) + p_t\left(\frac{\partial F}{\partial K} - \frac{\partial G^d}{\partial K} - \frac{\partial G^f}{\partial K}\right)_t . \tag{6.18}$$

It is assumed that $Y_t$ is linearly homogenous in $F(K_t,L_t)$. This together with the homogeneity of $G^i(I^i,K)$ allows to write

$$\left(\frac{\partial G^d}{\partial K}\right)_t = \left(\frac{G^d}{K}\right)_t - b\left[\left(\frac{I^d}{K}\right)_t^2 - c\left(\frac{I^d}{K}\right)_t\right] \tag{6.19}$$

$$\left(\frac{\partial p}{\partial K_t}\right)_t = -\frac{p}{\left(F_t - G_t^d - G_t^f\right)\varepsilon}\left\{\left(\frac{F}{K}\right)_t - \left(\frac{\partial F}{\partial L}\frac{L}{K}\right)_t - \left(\frac{G^d}{K}\right) + b\left[\left(\frac{I^d}{K}\right)_t^2 - c\left(\frac{I^d}{K}\right)_t\right] - \frac{G_t^f}{K_t} + b\left[\left(\frac{I^f}{K}\right)_t^2 - c\left(\frac{I^f}{K}\right)_t\right]\right\} \tag{6.20}$$

Putting this together and letting $a = 1 - (1 / \varepsilon) > 0$, 6.15 and 6.16 can be written

$$\left(\frac{\partial \pi}{\partial I^d}\right)_t = -bap_t\left(\frac{I^d}{K}\right)_t + bcap_t - p_t^I \tag{6.21}$$

$$\left(\frac{\partial \pi}{\partial K}\right)_t = ap_t\left(\frac{Y}{K}\right)_t - ap_t\left(\frac{\partial F}{\partial L}\frac{L}{K}\right)_t + bap_t\left(\frac{I^d}{K}\right)_t^2 - bacp_t\left(\frac{I^d}{K}\right)_t + bap_t\left(\frac{I^f}{K}\right)_t^2 - bacp_t\left(\frac{I^f}{K}\right)_t , \tag{6.22}$$

It is further assumed that the marginal product of variable factors ($\partial F / \partial L$) can be replaced with the first order condition ($w / ap$). Substituting 6.21 and 6.22 into 6.10 yields an empirical Euler equation without financial regimes of the form

$$\left(\frac{I^d}{K}\right)_{t+1} = c\left(1 - \phi_{t+1}\right) + \left(1 + c\right)\phi_{t+1}\left(\frac{I^d}{K}\right)_t - \phi_{t+1}\left(\frac{I^d}{K}\right)_t^2 + c\phi_{t+1}\left(\frac{I^f}{K}\right)_t - \phi_{t+1}\left(\frac{I^f}{K}\right)_t^2 - \frac{\phi_{t+1}}{ba}\left(\frac{C}{K}\right)_t + \frac{\phi_{t+1}}{ba}J_t + \frac{\phi_{t+1}}{b(\varepsilon - 1)}\left(\frac{Y}{K}\right)_t - \frac{\left(1 + r_t\right)v_t}{b(1 - \delta)a}\left(\frac{B}{K}\right)_t^2 - v_{t+1} , \tag{6.23}$$

where $\phi_{t+1} = (1 + \rho_{t+1}) / (1 + \delta)$ and $1 + \rho_{t+1} = (1 + r_{t+1}) / (p_t / p_{t+1})$, $\rho_{t+1}$ being the real discount rate, $(C / K)_t = (p_tY_t - w_tL_t) / (p_tK_t)$ is the ratio of real cash flow to capital stock, $J_t = (p^I_t / p_t)\{1 - p^I_{t+1}(1 - \delta) / [(1 + r_t) p^I_t]\}$ is the user cost of capital, $(B / K)^2_t = (p^I_t / p_{t+1})[B_t / (p^I_tK_t)]^2$ reflects borrowing and $v_{t+1}$ is the forecast error.

In the equation the coefficient on the lagged domestic investment rate $(1 + c)\ \phi_{t+1}$ is positive and greater than one. The coefficient on the lagged domestic investment is also positive. The coefficient on both the lagged domestic and foreign investment squared ($-\phi_{t+1}$) is negative and greater than one in absolute value. Coefficients on the lagged cash flow and user cost terms are negative and depend on the magnitude of the adjustment costs. The output term (Y / K) controls for imperfect competition and its coefficient is positive. The term $(B / K)_t$ controls for non-separability between investment and borrowing decisions and its coefficient can be shown to be negative. Closer study shows that the combined effect of lagged foreign investments depends on the normal rate of foreign investments, c, and the realised rate. If they are equal, the effect is zero. If the realised investment rate exceeds the normal level, the impact is negative and vice versa.

In the estimation of the equation it is assumed that the real discount rate ($\phi_{t+1}$) and the coefficients on the output and debt terms remain constant through time and across firms and they are treated as parameters.

# 7. BASICS OF DYNAMIC PANEL DATA ESTIMATION

In the estimation, this study uses a dataset where the time period is short while the number of firms is relatively large. The advantage with this kind of panel data is that it enables to discover the underlying firm level dynamics. Aggregated time series data might obscure the microeconomic logic while single period cross section data would not allow for the dynamics.

The estimation of dynamic panel data models introduces some econometric issues. In case of a simple time series data the dependent variable is determined by the observable explanatory variables and the error term which contains all the unobserved effects. With multiple firms in the panel, the unobservables contain also firm specific effects, which vary from firm to firm. In dynamic models, where the explanatory variables contain lagged dependent variables, this makes one or more of the explanatory variables to be correlated with the error term. Because of this problem of endogeneity, standard OLS estimations yield inconsistent estimates of the underlying relationships. More sophisticated methods that require the time dimension to grow large to yield consistent parameter estimates are effectively excluded, since the panel data covers only a limited time period.

The widely used way of circumventing this problem with panel data is to use generalised method of moments (GMM) estimators (Hansen 1982). The approach relies on the use of instrumental variables in the estimation and does not place strict exogenoity requirements for the explanatory variables. The following presentation of the GMM methods follows Arellano and Bond (1991) and Bond (2002). The principles of the GMM method are first explained by describing GMM in univariate autoregressive models. The approach is then extended to multivariate models that provide a reference to the estimation conducted in this study.

## 7.1. GMM IN UNIVARIATE AUTOREGRESSIVE MODELS

The simple autoregressive model to be considered is

$$y_{it} = \alpha y_{i,t-1} + u_{it}, \qquad i = 1,\ldots,N, \quad t = 2,\ldots,T, \quad |\alpha| < 1, \tag{7.1}$$

where $y_{it}$ is an observation on some series for individual i on period t, $y_{i,t-1}$ is the observation on the same series for the same individual in the previous period. The error term is $u_{it}$, which can be decomposed as

$$u_{it} = \eta_i + v_{it}, \tag{7.2}$$

where $v_{it}$ is the stochastic disturbance term assumed to be independent across individuals. The term $\eta_i$ is the firm specific unobservable effect attributable to e.g. management perspectives, skills and habits that introduce heterogeneity in the means of the $y_{it}$ series across individuals. The firm specific effects are considered to change only slowly and actually stay constant during the period in question. The number of individuals for which data is available (N) is assumed to be large while the number of time periods (T) is assumed to be small.

The key assumption is that the disturbances $v_{it}$ are not serially correlated. With time invariant $\eta_i$, the explanatory variable $y_{i,t-1}$ is therefore necessarily positively correlated with the error term ($\eta_i + v_{it}$). Standard results for omitted variable bias indicate that in this case the OLS estimator of $\alpha$ in the equation 7.1 is biased upwards.

One way of dealing with this sort of inconsistency in the estimation is to use the within groups estimator to eliminate the firm specific effect. Equation 7.1 is transformed to measure variables' deviations from their mean values in each observation. The equation can then be written

$$y_{it} - \frac{1}{N-1}\left(y_{i2} + \ldots + y_{iT}\right) = \alpha\left[y_{i,t-1} - \frac{1}{N-1}\left(y_{i1} + \ldots + y_{it} + \ldots + y_{i,T-1}\right)\right] + \left(\eta_i - \eta_i\right) + \left[v_{it} - \frac{1}{N-1}\left(v_{i2} + \ldots + v_{i,t-1} + \ldots + v_{iT}\right)\right]. \quad (7.3)$$

However, on the right hand side of equation the component $-\frac{y_{it}}{N-1}$ is negatively correlated with $v_{it}$ and $-\frac{v_{i,t-1}}{N-1}$ is negatively correlated with $y_{i,t-1}$ and they together dominate positive correlations such as $-\frac{v_{i,t-1}}{N-1}$ and $-\frac{y_{i,t-1}}{N-1}$ (Nickell 1981). This correlation vanishes only, when T becomes large and it makes the within group OLS estimator to be downwards biased in samples where N is large while T is small.

The first-differencing of the equation 7.1 also eliminates the firm specific effects. With this approach the equation becomes

$$y_{it} - y_{i,t-1} = \alpha\left(y_{i,t-1} - y_{i,t-2}\right) + \left(v_{it} - v_{i,t-1}\right), \quad (7.4)$$

where $v_{i,t-1}$ is again correlated with $y_{t,t-1}$. However, this can be sidestepped by using instrumental variables. In this context, the generalised methods of moments provides a convenient framework for obtaining efficient estimators when the error terms are not serially correlated. The variables that are used as instruments have to correlate with the original variables they are instruments for, but not to correlate with the error term. Writing the equation 7.3 at t = 3 gives

$$y_{i3} - y_{i,2} = \alpha\left(y_{i,2} - y_{i,1}\right) + \left(v_{i3} - v_{i,2}\right). \quad (7.5)$$

It can be seen that $y_{i1}$ correlates with the term ($y_{i2} - y_{i1}$), but not with the term ($v_{i3} - v_{i2}$) and is therefore the only valid instrument for ($y_{i2} - y_{i1}$) in period 3. In period 4, both $y_{i1}$ and $y_{i2}$ can be used as instruments for ($y_{i3} - y_{i2}$) since they are correlated with the term but not with ($v_{i4} - v_{i3}$). Continuing this way allows writing the instrument matrix of the form

$$Z_i = \begin{bmatrix} y_{i1} & 0 & 0 & \ldots & 0 & 0 & \ldots & 0 \\ 0 & y_{i1} & y_{i2} & \ldots & 0 & 0 & \ldots & 0 \\ . & . & . & \ldots & . & . & \ldots & . \\ . & . & . & \ldots & . & . & \ldots & . \\ 0 & 0 & 0 & \ldots & y_{i1} & y_{i2} & \ldots & y_{i,T-2} \end{bmatrix}. \quad (7.6)$$

The rows in the matrix correspond to the first-differenced equations for periods t = 3,4,…, T for individual i and satisfy the moment condition

$$E\left[Z_i^{'}\Delta v_i\right]=0 \qquad \text{for i = 1,2,…, N,} \tag{7.7}$$

where $\Delta v_i = (\Delta_{i3}, \Delta_{i4}, \ldots, \Delta_{iT})'$.

Combining the instrument matrices for all individuals we get the instrument set for the GMM estimation $Z = [Z_1', \ldots, Z_N']'$. The asymptotically efficient GMM estimator is based on all the moment conditions implying that

$$\frac{1}{N}\sum_{i=1}^{N} Z_i^{'}\Delta v_i = \frac{1}{N} Z^{'}\Delta v. \tag{7.8}$$

The GMM estimator α is obtained from minimising the equation

$$J_N = \left(\frac{1}{N}\Delta v' Z\right) W_N \left(\frac{1}{N} Z^{'}\Delta v\right), \tag{7.9}$$

using the optimal weight matrix

$$W_{1N} = \left[\frac{1}{N}\sum_{i=1}^{N} Z_i^{'} H Z_i\right]^{-1}, \tag{7.10}$$

where H is a (T-2) square matrix with 2's on the main diagonal, -1's on the first of diagonals and zeros elsewhere[11]. The resulting first step GMM estimator α is

$$\hat{\alpha} = \left(\Delta y_{-1} Z A_N Z^{'}\Delta y_{-1}\right)^{-1}\left(\Delta y_{-1} Z A_N Z^{'}\Delta y\right), \tag{7.11}$$

where numerical subscript denotes lags. The first step estimator is valid as long as the variances of the disturbance term are homoscedastic. When the variances of the disturbance term are not constant (heteroscedasticity) a two-step procedure is needed to get consistent parameter estimates. The so-called second step estimator is derived from the error terms ($\hat{v}_i$) produced by the first step estimator. The difference between the two estimators is the weight matrix. The weight matrix in the second step GMM estimator is

$$W_N = \left[\frac{1}{N}\sum_{i=1}^{N} Z_i^{'}\Delta\hat{v}_i \Delta\hat{v}_i^{'} Z_i\right]^{-1}. \tag{7.12}$$

However, in practice a lot of applied work has focused on the results of the first step estimator. Simulation studies suggest only modest efficiency gains from the use of the second step estimators even in the presence of considerable heteroscedasticity (Arellano and Bond 1991). Furthermore, the use of first step estimation results in the weight matrix weakens the reliability of the asymptotic properties of the second step estimator.

## 7.2. GMM IN MULTIVARIATE AUTOREGRESSIVE MODELS

Extending the GMM method from univariate autoregressive models to multivariate setting is relatively straightforward. The autoregressive-distributed lag model with additional explanatory variables can be written in the simplest form as

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[11] This is because of the difference format of the disturbance term. In case of level formats H would be an identity matrix.

$$y_{it} = \alpha y_{i,t-1} + \beta x_{it} + (\eta_i + v_{it}), \qquad i = 1,\ldots,N, \quad t = 2,\ldots,T, \quad |\alpha| < 1, \qquad (7.13)$$

where $x_{it}$ is a vector of current and lagged values of additional explanatory variables. The disturbance term $v_{it}$ is again considered serially uncorrelated. The $x_{it}$ variable may or may not be correlated with $\eta_i$ and it may be strictly exogenous, predetermined or endogenous with respect to $v_{it}$. Different moment conditions are available depending on what is assumed about the correlation between $x_{it}$ and the two components of the error term.

When $x_{it}$ is assumed to be correlated with the firm specific effect $\eta_i$, the procedure for selecting the instuments resembles closely the one used in the univariate case. In this case, $y_{it}$ and $x_{it}$ are both correlated with the firm specific effect and a method of first-differencing is again needed to eliminate $\eta_i$ from the equation. The resulting transformed equation is

$$y_{it} - y_{i,t-1} = \alpha(y_{i,t-1} - y_{i,t-2}) + \beta(x_{it} - x_{i,t-1}) + (v_{it} - v_{i,t-1}). \qquad (7.14)$$

If $x_{it}$ is taken to be endogenous, it can be correlated with $v_{i,t}$ and earlier disturbances, but uncorrelated with $v_{i,t+1}$ and later disturbances. In this case, $x_{it}$ is treated symmetrically with the dependent variable $y_{it}$ and $x_{i,t-2}$ and longer lags are valid instrumental variables for $(x_{it} - x_{i,t-1})$. The complete instrument matrix (t = 3, 4, …, T) for individual i is therefore

$$Z_i = \begin{bmatrix} y_{i1} & x_{i1} & 0 & 0 & 0 & 0 & \ldots & 0 & \ldots & 0 & 0 & \ldots & 0 \\ 0 & 0 & y_{i1} & y_{i2} & x_{i1} & x_{i2} & \ldots & 0 & \ldots & 0 & 0 & \ldots & 0 \\ . & . & . & . & . & . & \ldots & . & \ldots & . & . & \ldots & . \\ . & . & . & . & . & . & \ldots & . & \ldots & . & . & \ldots & . \\ 0 & 0 & 0 & 0 & 0 & 0 & \ldots & y_{i1} & \ldots & y_{i,T-2} & x_{i1} & \ldots & x_{i,T-2} \end{bmatrix}. \qquad (7.15)$$

When $x_{it}$ is considered predetermined, it can be correlated with $v_{i,t-1}$ and earlier disturbances, but uncorrelated with $v_{i,t}$ and later disturbances. Now in addition to the instrumental variables available with endogenoity, also $x_{i,t-1}$ will be a valid instrument for $(x_{it} - x_{i,t-1})$ . In a case of strictly exogenous $x_{it}$, the complete time series $x'_i = (x_{i1}, x_{i2},\ldots, x_{iT})$ will be valid instrumental variables in each of the first differenced equation.

The choice between these different alternative assumptions can usually be based on testing the overidentification restrictions. This can be done using e.g. the Sargan statistic, which tests for the validity of the additional instruments $Z_2$ given the instruments $Z_1$. As the set of moment conditions specified under a relatively weak assumption (e.g. $x_{it}$ is endogenous) is a strict subset of the set of moment conditions specified under a stronger assumption (e.g. $x_{it}$ is predetermined), a more specific difference Sargan test can be used to test for the validity of the additional instruments. The test compares the Sargan statistics for the two estimations based on different assumptions about the correlation and returns the difference between the weaker and stronger assumption. This difference is asymptotically the $\chi 2$ statistic, which critical value can be used to determine the validity of the assumptions.

# 8. EMPIRICAL ANALYSIS

The empirical part of this paper analyses the effects of foreign investments on domestic investments in a sample of Finnish manufacturing firms during the years 1998-2002. The analysis is conducted by using a unique firm level dataset containing information on domestic and foreign investments as well as financial statements. The dataset is used to estimate the basic investment equation 6.23, which can be written for empirical purposes as

$$\left(\frac{I^d}{K}\right)_{it} = \beta_1\left(\frac{I^d}{K}\right)_{i,t-1} - \beta_2\left(\frac{I^d}{K}\right)^2_{i,t-1} + \beta_3\left(\frac{I^f}{K}\right)_{i,t-1} - \beta_4\left(\frac{I^f}{K}\right)^2_{i,t-1}$$
$$\beta_5\left(\frac{C}{K}\right)_{i,t-1} + \beta_6\left(\frac{Y}{K}\right)_{i,t-1} + \beta_7\left(\frac{B}{K}\right)^2_{i,t-1} + \beta_8 J_{i,t-1} + d_t + \kappa_i + v_{it}\,, \qquad (8.1)$$

where (the calculation of the variables is explained in the appendix)
$I^d$ = Domestic capital expenditure
$I^f$ = Foreign capital expenditure
K = Capital stock
C = Cash flow
Y = Output
B = Borrowing
J = User cost of capital
d = Time dummy variable
κ = Firm specific effect
v = Disturbance term

The empirical part is twofold. First, the dataset is introduced with descriptive statistics of the parameters and the effects of foreign investments and financial constraints are examined with a simple statistical analysis. This is followed by the actual estimation of equation 8.1 as well as estimations of some alternative specifications.

## 8.1. DATA DESCRIPTION

The dataset used in this study is formed by merging two different databases. The overall firm investments separated into domestic and foreign investments and further into those made at emerging markets[12] are from foreign operations surveys conducted by the Confederation of Finnish Industry and Employers (TT)[13]. This data is supplemented with financial statement data provided by Balance Consulting and Talouselämä magazine.

On a firm level, survey data is crucial for identifying the part of investments made abroad. Most of the companies do not separate their investments by location in their publicly available financials. Even the firm level FDI data drawn from the balance of payments statistics would not correctly describe the magnitude of foreign investments. In the TT's survey, foreign investments were defined as actual capital expenditure in a foreign country, not as financial capital flowing abroad. In the balance of payments statistics, only the flows are observed.

[12] The database contains the amount of total foreign investments as well as investments to a selected set of countries. The emerging market investments are here defined as the combined investments made in the countries included in the database whose gdp/capita is less than 50 % of the Finnish gdp/capita ratio. Geographical considerations are not taken into account and therefore some current EU member countries are included as emerging markets. These emerging market investments are then subtracted from the total to derive developed market investments. The considered emerging market countries are Argentina, Brazil, Chile, China, Estonia, Philippines, Hong Kong, Hungary, India, Indonesia, Japan, Latvia, Lithuania, Malaysia, Malta, Peru, Poland, Russia, Singapore, Slovakia, Slovenia, South Korea, Taiwan, Thailand, Turkey, Venezuela and Zech republic. Although not an exhaustive list, these countries as a group represent the greatest recipients of emerging market investments from Finnish firms and only a small fraction of emerging market FDI flows to other countries.

[13] The data is drawn from two surveys, whose overall results are published in reports of Confederation of Finnish Industry and employers (Teollisuuden ja Työnantajain keskusliitto 2003 and 2004)

These two measures are seldom equivalent. For instance, if a Finnish firm is financing a foreign investment with funds raised locally from a foreign country, the investment is not defined as a foreign direct investment. Data on capital expenditure thus gives more accurate information on the expansion of foreign activities by multinational enterprises.

### 8.1.1. The dataset

The foreign operations survey database comprises investment data for 265 Finnish manufacturing firms between years 1998 – 2002. For 47 of these firms the financial statement data was not available or it consisted of less than three observations. Only firms with three or more observations were included in the final dataset. The final unbalanced[14] dataset thus consists of 218 firms with 1038 observations (breakdown given in tables 8.1 and 8.2).

**Table 8.1 Number of observations per firm**

| Number of annual observations | 3 | 4 | 5 | **3 - 5** |
|---|---|---|---|---|
| Number of firms | 15 | 22 | 181 | **218** |
| Share of the firms | 6,9 % | 10,1 % | 83,0 % | **100,0 %** |

**Table 8.2 Number of observations per year**

| Year | Number of firms |
|---|---|
| 1998 | 198 |
| 1999 | 206 |
| 2000 | 217 |
| 2001 | 215 |
| 2002 | 202 |
| **Total** | **1038** |

Descriptive statistics of the parameters appearing in equation 6.23 are given in table 8.3. The calculation of the parameters is described in the appendix.

**Table 8.3 Descriptive statistics**

| Variable | Lag | Count | Average | Standard deviation | Minimum value | Maximum value |
|---|---|---|---|---|---|---|
| Domestic investments/Capital stock | | 1038 | 0,19 | 0,23 | -0,28 | 3,08 |
| Domestic investments/Capital stock | -1 | 820 | 0,20 | 0,26 | -1,55 | 3,08 |
| (Domestic investments/Capital stock)$^2$ | -1 | 820 | 0,11 | 0,57 | 0,00 | 9,47 |
| Foreign investments/Capital stock | -1 | 820 | 0,03 | 0,11 | 0,00 | 1,48 |
| (Foreign investments/Capital stock)$^2$ | -1 | 820 | 0,01 | 0,10 | 0,00 | 2,19 |
| Operating profit/Capital stock | -1 | 820 | 0,53 | 1,06 | -10,20 | 12,75 |
| Turnover/Capital stock | -1 | 820 | 5,43 | 8,06 | 0,04 | 90,22 |
| (Debts/Capital stock)$^2$ | -1 | 820 | 0,54 | 0,60 | 0,00 | 5,13 |
| User cost of capital | -1 | 820 | 0,15 | 0,08 | 0,04 | 0,73 |

[14] For some firms the time series is not complete and consists of only three or four observations instead of five.

### 8.1.2. The effects of foreign investments and financial constraints

Since the theoretical models imply that financial constraints and foreign investments have an effect on the domestic investments, this should be reflected in the dataset. The preliminary testing of the hypothesis is conducted by grouping the firms based on their financial position and foreign investments. The mean parameter values and the changes in them are then analysed for these different groups of firms.

For dividing the firms according to their foreign investment undertakings, a firm is considered to have been engaged in foreign investments in period t if it has made any foreign investment in period t or prior to that period. Following the same rule, the firms are grouped further into those that have made investments into developed and emerging markets. The groupings based on developing and emerging market investments are not exclusive but overlapping. Therefore, the fact that a firm has made foreign investments into emerging markets does not mean that it has not engaged in developed market investments.

Firms are considered financially constrained by using three different classifications. The first classification stems from the theoretical hierarchy of finance model introduced in chapter 6.2.1. Accordingly, firms are considered financially unconstrained in period t, if they have paid dividends and issued no shares in period t-1 and otherwise as financially constrained.

Second classification follows from Ali-Yrkkö (1998), who used the same theoretical investment model on Finnish data but added an additional classification measure, namely the firm's ability to pay its interest expenses. Here, firms are classified as financially constrained in period t if their profits have not covered their interest expenses in period t-1. The profit is defined as the income the firm has left for interest expenses after covering half of its capital depreciations. It is calculated as an average of operating profit and net operating profit (operating profit + (depreciation/2)).

The third classification is a composite of the two previous ones. It classifies firms as financially constrained if the firms are financially constrained according to either of the two classifications.

Table 8.4 shows the percentages of firms falling into the above-mentioned categories by year of observation. The amount of firms engaged in foreign investments has risen steadily over the period. Perhaps surprisingly the shares of firms engaged in developed market and emerging market foreign investments have risen almost in tandem and there is no rapid upsurge of firms investing to emerging markets.

The percentage of financially constrained firms has been rising throughout the observation period with a sudden jump in year 2001. This highlights the general economic downturn after the turn of the century. Comparison of the percentages reveals that the two actual classification methods (classification 1 and 2) overlap each other partially. About 2/3 of the firms classified as financially constrained according to the classification 2 are also considered constrained according to the classification 1.

**Table 8.4 Percentage of firms in each category, %**

| Year | Investments before period t directed to | | | Financially constrained in period t-1 | | |
|---|---|---|---|---|---|---|
| | Foreign markets | Developed markets | Emerging markets | Classification 1 | Classification 2 | Classification 3 |
| 1998 | 26,9 | 19,8 | 18,8 | - | - | - |
| 1999 | 27,8 | 22,0 | 20,0 | 49,5 | 3,0 | 51,0 |
| 2000 | 28,6 | 23,5 | 22,6 | 50,7 | 3,4 | 51,2 |
| 2001 | 30,4 | 24,8 | 23,8 | 56,7 | 4,7 | 57,7 |
| 2002 | 33,0 | 26,0 | 25,5 | 56,4 | 8,0 | 57,4 |

Classification 1 = Unconstrained if paid dividends and issued no shares
Classification 2 = Constrained if profits do not cover interest expenses
Classification 3 = Constrained based on either of the classifications 1 or 2

As the financial situation as well as the foreign investments of the firm is hypothesised to have an effect on the firm's investments, a closer look at investment rates is needed. Table 8.5 exhibits the changes in the yearly investment rates according to the different groupings of firms. The change is calculated as the average absolute percentage point change in the domestic investment rate (domestic investments/capital stock).

On average, the domestic investment rates moderately declined for all firms. However, the decline was smaller for firms that had engaged in foreign investments. The difference was minimal for firms engaged in emerging market investments but considerable for firms that had invested into developed markets. This is unanticipated as the comparison method is subject to a misspecification that would suggest the opposite result. As the investment ratio is calculated as the ratio of domestic investments to total capital stock, the previous period foreign investments increase the nominator thereby automatically decreasing the resulting domestic investment rate. Therefore, the results of table 8.5 appear to suggest, that foreign investments indeed have a positive effect on the domestic investment rate, although the conclusion cannot be claimed to be robust.

The figures in table 8.5 enable to compare the different classification methods for financially constrained firms. With all the classifications, the yearly change in the domestic investment rates has been more negative for firms classified as financially constrained than for firms outside the classifications. However, the differences between them are quite considerable. Classification 2 based on the ability to pay interest seems to have the highest potential to explain investment rate changes as it has had the most negative impact on domestic investment rates. The results are similar to Ali-Yrkkö (1998) who also concluded that the firm's ability to pay interest seemed to be the strongest indicator for financial constraints.

**Table 8.5 Change in yearly domestic investment rates**

| Classification | Absolute yearly percentage point change in $I^d/K$ rate<br>Firms in classification | Firms outside classification |
|---|---|---|
| **All** | -1,3 | |
| **Investments abroad** | | |
| Foreign markets | -1,2 | -1,3 |
| Developed markets | -0,7 | -1,4 |
| Emerging markets | -1,3 | -1,3 |
| **Financially constrained** | | |
| Classification 1 | -1,7 | -0,7 |
| Classification 2 | -5,8 | -1,0 |
| Classification 3 | -1,8 | -0,6 |

Classification 1 = Unconstrained if paid dividends and issued no shares
Classification 2 = Constrained if profits do not cover interest expenses
Classification 3 = Constrained based on either of the classifications 1 or 2

Table 8.6 gives the mean variable values for the firm groupings based on foreign investment activity. The difference between the investment rates for firms that have made foreign investments and those that have not highlights the point made previously about the foreign investments effect on investment rate. The domestic investment rates are automatically smaller for firms engaged in foreign investments as their total capital stock is larger. With regard to other parameters, it seems that the relative profitability of the firms operating only in Finland is a bit higher than the profitability of firms investing also abroad. As the turnover rates are also higher, this suggests that the purely domestic firms might have lower capital/labour ratios. Adding the fact that foreign investing firms have higher debt to capital stock ratios implies that these firms are more indebted than the firms that have not invested abroad.

**Table 8.6 Mean variable values depending on whether the firm has engaged in FDI or not**

| | Investments before period t directed to | | | | | |
|---|---|---|---|---|---|---|
| | Foreign markets | | Developed markets | | Emerging markets | |
| Variable | Yes | No | Yes | No | Yes | No |
| Domestic investments/Capital stock | 0,15 | 0,21 | 0,13 | 0,21 | 0,15 | 0,21 |
| Foreign investments/Capital stock | 0,11 | 0,00 | 0,11 | 0,01 | 0,12 | 0,01 |
| Developed market FDI/Capital stock | 0,07 | 0,00 | 0,09 | 0,00 | 0,06 | 0,01 |
| Emerging market FDI/Capital stock | 0,05 | 0,00 | 0,02 | 0,01 | 0,06 | 0,00 |
| Operating profit/Capital stock | 0,42 | 0,54 | 0,31 | 0,57 | 0,46 | 0,52 |
| Turnover/Capital stock | 3,37 | 6,24 | 2,91 | 6,15 | 3,60 | 5,91 |
| $(\text{Debts/Capital stock})^2$ | 0,42 | 0,61 | 0,37 | 0,61 | 0,44 | 0,58 |
| User cost of capital | 0,14 | 0,15 | 0,15 | 0,15 | 0,14 | 0,15 |

Table 8.7 carries the same information as 8.6 but for financially constrained and unconstrained firms. With classification 1, the domestic investment rates of financially constrained firms are notably lower than the investment rates of financially unconstrained firms. This is phenomenon is not present with classification 2. With both of the classifications, the operating profit ratios are higher with unconstrained firms. The average values of financial position variables are as expected. Constrained firms have higher debt to capital ratios and higher user costs of capital than their unconstrained counterparts do.

Absolute domestic investment rates are a bit lower for financially constrained firm, but the differences are not big. However, the financial position parameters differ considerably although the differences with classification 1 are smaller as might have been expected. With classification 2, the turnover rate is considerably lower and the debt rate as well as the user cost of capital is higher for financially constrained firms than for financially unconstrained firms.

**Table 8.7.Mean variable values depending on the financial status of the firm**

| | Financially constrained in period t-1 | | | | | |
|---|---|---|---|---|---|---|
| | Classification 1 | | Classification 2 | | Classification 3 | |
| Variable | Yes | No | Yes | No | Yes | No |
| Domestic investments/Capital stock | 0,17 | 0,21 | 0,18 | 0,19 | 0,17 | 0,21 |
| Foreign investments/Capital stock | 0,04 | 0,03 | 0,00 | 0,04 | 0,04 | 0,03 |
| Developed market FDI/Capital stock | 0,02 | 0,02 | 0,00 | 0,02 | 0,02 | 0,02 |
| Emerging market FDI/Capital stock | 0,02 | 0,01 | 0,00 | 0,02 | 0,02 | 0,01 |
| Operating profit/Capital stock | 0,48 | 0,49 | -0,47 | 0,53 | 0,46 | 0,52 |
| Turnover/Capital stock | 5,67 | 4,99 | 9,37 | 5,16 | 5,81 | 4,80 |
| $(\text{Debts/Capital stock})^2$ | 0,69 | 0,35 | 1,31 | 0,50 | 0,69 | 0,34 |
| User cost of capital | 0,16 | 0,14 | 0,20 | 0,15 | 0,16 | 0,14 |

Classification 1 = Unconstrained if paid dividends and issued no shares
Classification 2 = Constrained if profits do not cover interest expenses
Classification 3 = Constrained based on either of the classifications 1 or 2

## 8.2. ESTIMATION RESULTS

As the investment equation 8.2 contains firm specific elements, the estimations are carried out using the GMM method with first differencing the equation as described in chapter 7. With this approach, the explanatory variables do not need to be exogenously determined to derive consistent estimation results.

In the model, the lagged values of the dependent variable are necessarily correlated with the firm specific effect. As the foreign investment rates are also potentially correlated with the fixed effect, they are all instrumented with t-2 and earlier values. All the estimations are conducted by using EViews 5.0 statistical software.

To account for the heteroscedasticity in the disturbance terms the results are reported for both the one-step and two-step versions of the GMM estimators. Although the two-step version can be used to derive consistent parameter estimates under heteroscedasticity, the two-step weight matrix makes the asymptotic distribution approximation less reliable as was noted in chapter 7.1. According to simulation studies, the standard errors associated with the two-step estimators therefore tend to be too low (Bond and Windmeijer 2002). In this context this means, that although the two-step versions give more accurate information on the relationship, the standard errors, and the reported statistical validity must be interpreted with caution.

In addition to the coefficient values and standard errors of the first-step and two-step GMM estimation, the standard test statistics are reported for all the estimations. These include the Sargan test for overidentifying restrictions and the Wald statistics for the joint significance of the explanatory variables. The Sargan tests use the minimised values of two-step estimators for both the one-step and two-step versions as they are both based on the same set of moment conditions and the tested overidentification restrictions are the same (Bond 2002, 150). Due to the fact that the EViews software package does not contain the standard Arellano and Bond (1991, 282) m1 and m2 tests against serial autocorrelation in residuals, residual autocorrelation is only examined by reporting the simple correlation coefficient between the residuals and the residuals lagged for two periods.

### 8.2.1. Estimations without financial regimes

Table 8.8 presents the estimation results for the baseline Euler specification not allowing for different financial regimes. This means that the coefficients are not allowed to differ with firm's financial position. Estimation A is simply the estimation of equation 8.2. In Estimation B the model is complemented with financial position dummy variables. Estimation C estimates a modified version of the structural model, where the foreign investments are separated to those directed to developed markets and to those directed to emerging markets. Columns labelled 1-step and 2-step represent estimation results of one-step and two-step versions of the estimation respectively.

From the basic estimation A it can be concluded that the estimation appears to reject the structural model implied by equation 6.23. According to the theoretical model, the coefficient on the lagged domestic investment should be positive and greater than one. However, in the estimation the coefficient is much smaller and not significantly different from zero. The same observation applies to all coefficients in the estimation. Even more, the sign of the coefficient on the lagged foreign investment and its squared term, cash flow and debt are the opposite from that implied by the structural model, although none of them are significantly different from zero. The Wald test does not reject the null hypotheses that the observed variables have no effect on the dependent.

Estimation B adds dummy variables describing the firm's financial position into the estimation. The signs of the coefficients differ from predicted. With the two-step version the one period lagged dividends has a negative impact on a 5 percent significance level and the stock issues a negative impact on a 10 percent significance level on firm's domestic investment ratio. This might be due to firms' willingness to pay steady dividends even in periods when this means foregoing some investment opportunities. When the firm alternatively issues shares, it has the ability to finance all its positive investment projects. However, the Wald statistics testing for the joint significance of the financial dummy variables is high, and does not reject the hypothesis that the variables have no effect on the dependent.

Focusing on the results of estimation C, it seems that foreign investments have different effects on domestic investments depending on where they were directed. The coefficient on the lagged emerging market investments is close to minus one and is statistically different from zero on a 1 percent significance level (two-step version). This is just the opposite from what was suggested by the structural model. Similarly the squared term of emerging market investments is of the "wrong" sign. The signs on developed market investment terms are "correct" but the coefficient values much smaller than predicted.

**Table 8.8 Estimations without financial regimes**

Dependent variable: $(I^d/K)_t$

| Variables | Coefficient (Standard errors in parenthesis) Estimation A | | Estimation B | | Estimation C | |
|---|---|---|---|---|---|---|
| | 1-step | 2-step | 1-step | 2-step | 1-step | 2-step |
| Domestic investments (-1) | 0,104003 | 0.152653*** | 0,127639 | 0.165915*** | 0,092980 | 0.109048*** |
| | (0,118578) | (0.048790) | (0,133826) | (0.051575) | (0,113369) | (0.029561) |
| Domestic investments$^2$ (-1) | -0,017745 | -0.010525 | -0,014243 | -0.030785 | -0,018822 | -0.034263 |
| | (0,099255) | (0.023496) | (0,107617) | (0.034677) | (0,096262) | (0.018726) |
| Foreign investments (-1) | -0,030992 | -0.238465 | 0,229513 | -0.129664 | | |
| | (0,399602) | (0.237432) | (0,425570) | (0.288396) | | |
| Foreign investments$^2$ (-1) | 0,124758 | 0.403518 | -0,182364 | 0.270262 | | |
| | (0,569186) | (0.395018) | (0,573155) | (0.437630) | | |
| Developed market investments (-1) | | | | | 0,116678 | 0.081816 |
| | | | | | (0,229397) | (0.069714) |
| Developed market investments$^2$ (-1) | | | | | -0,229550 | -0.124772 |
| | | | | | (0,349018) | (0.105344) |
| Emerging market investments (-1) | | | | | -0,745979 | -0.803791*** |
| | | | | | (0,416758) | (0.132586) |
| Emerging market investments$^2$ (-1) | | | | | 0,204153 | 0.210663* |
| | | | | | (0,732662) | (0.109886) |
| Operating profit (-1) | 0,061916 | 0.006405 | 0,056370 | -0.001156 | 0,065093 | 0.044215 |
| | (0,059964) | (0.031306) | (0,056842) | (0.029608) | (0,060487) | (0.033783) |
| Turnover (-1) | 0,000629 | 0.009315 | 0,002021 | 0.010073 | 0,000124 | 0.000193 |
| | (0,010379) | (0.006832) | (0,010409) | (0.007157) | (0,010455) | (0.007075) |
| Debts$^2$ (-1) | 0,011444 | 0.000872 | 0,007449 | 0.000232 | 0,012534 | 0.007170 |
| | (0,010039) | (0.011232) | (0,010986) | (0.010947) | (0,010028) | (0.008454) |
| User cost of capital (-1) | -0,063604 | -0.048155 | -0,079140 | -0.088122 | -0,059820 | -0.000682 |
| | (0,106896) | (0.090940) | (0,122623) | (0.098035) | (0,107239) | (0.086742) |
| Dividends | | | -0,055476 | -0.029497 | | |
| | | | (0,087708) | (0.033972) | | |
| Dividends (-1) | | | -0,199241 | -0.151290** | | |
| | | | (0,200240) | (0.069106) | | |
| Stock issues | | | 0,016124 | 0.025255* | | |
| | | | (0,018095) | (0.014427) | | |
| Stock issues (-1) | | | -0,000719 | 0.002719 | | |
| | | | (0,020015) | (0.014960) | | |
| 2000 | 0,030797 | 0.009438 | 0,040209 | 0.019353 | 0,028919 | 0.012950 |
| | (0,020510) | (0.009571) | (0,027062) | (0.012436) | (0,020299) | (0.008850) |
| 2001 | 0,012455 | -0.000359 | 0,006613 | -0.001496 | 0,016012 | 0.014739* |
| | (0,014659) | (0.009780) | (0,016106) | (0.012042) | (0,014430) | (0.007975) |
| 2002 | -0,041038** | -0.028019*** | -0,036837* | -0.023328** | -0,040602** | -0.035363*** |
| | (0,019068) | (0.010547) | (0,018834) | (0.011394) | (0,019194) | (0.009301) |
| AR(2) | -0,5710 | -0,5463 | -0,5386 | -0,5392 | -0,5657 | -0,5678 |
| Wald (explanatory variables) | 0,2197 | 0,0000 | 0,6002 | 0,0000 | 0,0054 | 0,0000 |
| Wald (FDI variables) | 0,8043 | 0,5934 | 0,6428 | 0,6241 | 0,0079 | 0,0000 |
| Wald (financial dummy variables) | | | 0,4906 | 0,6241 | | |
| Wald (year dummy variables) | 0,1783 | 0,0365 | 0,2059 | 0,0712 | 0,1792 | 0,0002 |
| Sargan | 0,2382 | 0,2382 | 0,3465 | 0,3465 | 0,1218 | 0,1218 |

Estimation A = Basic Investment Euler equation without financial variables
Estimation B = Basic investment Euler equation with financial variables
Estimation C = Investment model with foreign investments divided into developed and emerging market investment

*Significant at 10 % level, **Significant at 5 % level, ***Significant at 1 % level

AR(2) is the autocorrelation coefficient examining the existence of second order autocorrelation in residuals. It reports the correlation between the residuals and two period lagged residuals and is not an actual test statistics as its distribution is not known.

Wald is a $\chi 2$-distributed test of the signifigance of a set explanatory variables. The null hypothesis is that the set of variables have no effect on the dependent variable.

Sargan statistics tests the overidentification restrictions for the GMM estimator and it is asymtotically $\chi 2$-distributed. The null hypothesis being tested is that the instrumental variables are uncorrelated to some set of residuals and are therefore valid instuments

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This would imply that with normal level of emerging market investments, investments directed to emerging markets tend to decrease domestic investments. With developed market investments the effect is opposite and much weaker[15]. However, the results are highly suspect. For one, the Sargan statistics for this estimation is low implying that the instruments might not be valid. On the other hand, the Wald statistics testing for the joint signifigance of all the explanatory variables is much smaller than with estimation A or B and the null hypothesis can be rejected.

Overall, the estimations do not lend support to the structural model without hierarchy of finance. This is probably due to poor data and high variance of the variables. There is some amount of negative second order autocorrelation in all residuals. Sargan statistics for all three estimations are low, implying that not all instruments are valid. For this reason, in addition to instrumenting lagged domestic and foreign investments the estimations were also carried on with only instrumenting the lagged domestic investments as well as instrumenting all the variables including the output, user cost and debt variables. These different specifications did not improve the validity of the results so only the first ones are reported.

### 8.2.2. Estimations with financial regimes

Table 8.9 gives the estimation results for the models where simple financial regimes are allowed by using an interaction dummy variable. The firms are divided to financially constrained and unconstrained by using the classification 3 from chapter 8.1. According to the classification, firms are constrained if they have either issued shares or not distributed dividends or their profits have not covered their interest expenses in period t-1. Although this classification does not stem directly from the model, it is chosen based on the analysis in previous chapter. As the classification based on the firms' ability to pay its interest expenses proved relevant for investment, also the firms faced with such difficulties are classified as constrained.

The financial position dummy variable is given a sign of one if the firm is constrained according to the classification and zero otherwise. This dummy variable is then interacted with all of the explanatory variables. The coefficients of these interacted variables are given in the bottom of the table. The coefficients above tell the coefficient values for financially unconstrained firms. The bottom part tells the change in coefficient values when the firms are constrained in their investment decisions. The year dummy variable coefficients are common to all firms.

In table 8.9 the estimation D carries the information of the estimation where foreign investments were not separated based on where they were directed to. In estimation E, the foreign investment variables are again investigated separately.

[15]Since the signs of lagged foreign investments and their squared term are opposite, the effect varies depending on the level of investments. Here in this context, the normal level of emerging market investment means emerging market investment ratios with respect to capital that are positive and less than 3,7. With developed market investment ratios below 0,5 the developed market investments tend to increase domestic investments, after that the effect reverses. From here onwards the impact is reported based on the average level of investments on table 8.3.

**Table 8.9 Estimation: Financial position and developed and emerging market FDI**

Dependent variable: $(I^d/K)_t$

| Variables | Estimation D 1-step | Estimation D 2-step | Estimation E 1-step | Estimation E 2-step |
|---|---|---|---|---|
| | Coefficient (Standard errors in parenthesis) | | | |
| Domestic investments (-1) | -0,137127<br>(0,589170) | -0.019145<br>(0.170141) | 0,698057<br>(0,681865) | 0.682902***<br>(0.173683)** |
| Domestic investments$^2$ (-1) | 0,642911<br>(1,317971) | 0.470058<br>(0.300294) | -0,695540<br>(0,953825) | -0.592184***<br>(0.231345) |
| Foreign investments (-1) | 0,064186<br>(0,885158) | 0.200375<br>(0.246145) | | |
| Foreign investments$^2$ (-1) | -0,045615<br>(1,587231) | -0.321753<br>(0.424599) | | |
| Developed market investments (-1) | | | 0,562475<br>(0,361280) | 0.542987***<br>(0.090671) |
| Developed market investments$^2$ (-1) | | | -1,197274<br>(0,991554) | -1.331815***<br>(0.235799) |
| Emerging market investments (-1) | | | -0,105707<br>(0,945160) | 0.161853<br>(0.249689) |
| Emerging market investments$^2$ (-1) | | | -0,508145<br>(1,808629) | -1.053247**<br>(0.427759) |
| Operating profit (-1) | 0,124206<br>(0,172431) | 0.043153<br>(0.049811) | 0,116010<br>(0,176684) | 0.126826**<br>(0.055420) |
| Turnover (-1) | 0,013282<br>(0,023900) | 0.009308<br>(0.009379) | 0,012918<br>(0,025078) | 0.004700<br>(0.010516) |
| Debts$^2$ (-1) | -0,077544<br>(0,053285) | -0.090220***<br>(0.017343) | -0,089811*<br>(0,048626) | -0.086776***<br>(0.015366) |
| User cost of capital (-1) | -0,172431<br>(0,194065) | 0.006859<br>(0.143914) | -0,461987<br>(0,378067) | -0.461914***<br>(0.178176) |
| Change in coefficient value, when the firm is financially constraint (classification 3) | | | | |
| Domestic investments (-1) | 0,192193<br>(0,591394) | 0.081043<br>(0.170612) | -0,629876<br>(0,659547) | -0.632518***<br>(0.170493) |
| Domestic investments$^2$ (-1) | -0,732895<br>(1,305348) | -0.544638*<br>(0.306647) | 0,655786<br>(0,982891) | 0.534175**<br>(0.233683) |
| Foreign investments (-1) | -0,084048<br>(0,461345) | -0.173267<br>(0.238711) | | |
| Foreign investments$^2$ (-1) | 0,096526<br>(1,177766) | 0.300783<br>(0.441411) | | |
| Developed market investments (-1) | | | -0,325275<br>(0,375200) | -0.368035**'<br>(0.112564) |
| Developed market investments$^2$ (-1) | | | 0,954150<br>(0,974223) | 1.189227***<br>(0.253467) |
| Emerging market investments (-1) | | | -0,219777<br>(0,770720) | -0.423716**<br>(0.197162) |
| Emerging market investments$^2$ (-1) | | | 0,638621<br>(1,764598) | 1.075479***<br>(0.400398) |
| Operating profit (-1) | -0,093933<br>(0,152298) | -0.008237<br>(0.040686) | -0,066052<br>(0,146717) | -0.070744*<br>(0.040499) |
| Turnover (-1) | -0,016587<br>(0,022038) | -0.012877**<br>(0.005583) | -0,020517<br>(0,020922) | -0.011322<br>(0.007418) |
| Debts$^2$ (-1) | 0,096984*<br>(0,052181) | 0.104704***<br>(0.017028) | 0,109003**<br>(0,049253) | 0.097674***<br>(0.017591) |
| User cost of capital (-1) | 0,325189<br>(0,349679) | 0.123174<br>(0.181268) | 0,721815<br>(0,531823) | 0.619984***<br>(0.169210) |
| 2000 | 0,021942<br>(0,014192) | 0.009967<br>(0.008089) | 0,028007<br>(0,019037) | 0.015174*<br>(0.008315) |
| 2001 | 0,007053<br>(0,015017) | 0.007475<br>(0.006507) | 0,011558<br>(0,015444) | 0.015466**<br>(0.007211) |
| 2002 | -0,036095**<br>(0,016682) | -0.023576***<br>(0.007172) | -0,033233**<br>(0,016004) | -0.032684***<br>(0.007143) |

| | | | | |
|---|---|---|---|---|
| AR(2) | -0,5038 | -0,5388 | -0,4952 | -0,4839 |
| Wald (explanatory variables) | 0,0097 | 0,0000 | 0,0056 | 0,0000 |
| Wald (constraint interaction variables) | 0,3061 | 0,0000 | 0,4547 | 0,0000 |
| Wald (year dummy variables) | 0,1001 | 0,0091 | 0,1460 | 0,0000 |
| Sargan | 0,1515 | 0,1515 | 0,3853 | 0,3853 |

Estimation D = Investment equation with isolated financing constraint effects
Estimation E = Investment equation with isolated financing constraint effects where FDIs are divided into developed and emerging market investments

*Significant at 10 % level, **Significant at 5 % level, ***Significant at 1 % level

AR(2) is the autocorrelation coefficient examining the existence of second order autocorrelation in residuals. It reports the correlation between the residuals and two period lagged residuals and is not an actual test statistics as its distribution is not known.

Wald is a $\chi 2$-distributed test of the signifigance of a set explanatory variables. The null hypothesis is that the set of variables have no effect on the dependent variable.

Sargan statistics tests the overidentification restrictions for the GMM estimator and it is asymtotically $\chi 2$-distributed. The null hypothesis being tested is that the instrumental variables are uncorrelated to some set of residuals and are therefore valid instuments

Results for estimation D do not allow drawing conclusions on whether there are differences in investment decisions between the two sub samples of firms. With the unconstrained firms, the coefficients on the lagged domestic investment terms are the opposite from the theoretical model. This would suggest that domestic investments that are above the normal level tend to increase the domestic investments also on the next period for unconstrained firms. It might be that high domestic investments imply high investment opportunities that are not captured in operating profit and can be exploited by financially unconstrained firms. With financially constrained firms the effect vanishes. However, this outcome is not statistically significant and not present in estimation E so it is more likely to be an estimation bias.

Moreover, the coefficient on output is more positive with financially unconstrained firms than with financially constrained firms. In addition, the coefficient on debt is negative while it is positive with constrained firms and the result is significant on a one percent level (two-step). These together would imply that financially unconstrained firms would not finance their investments with debt but with retained earnings while the unconstrained firms would do the opposite. A result that fully contradicts theory. The foreign investment coefficients on the other hand support the view that with normal level of foreign investments they have an increasing effect on domestic investments when the firms are financially unconstrained and a decreasing effect when the firms are financially constrained.

When the foreign investments are separated into those directed to developed markets and into those directed to emerging markets in estimation E the estimation precision greatly improves and most of the coefficients get statistically significant values. In the estimation, the debt and profit terms do not differ much from estimation D. In contrast, the coefficients on domestic investments for unconstrained firms are now close to their theoretical values. For unconstrained firms, developed market investments increase the domestic investments. Emerging market investments have no substantial effect on unconstrained firms' domestic investments. For constrained firms the developed market investments' positive effect is weakened, as the coefficients on the variables are closer to zero. Emerging market investments seem to decrease moderately domestic investments of financially constrained firms.

Compared with the estimations of the previous sections model that did not allow for financial regimes, the results support the significance of financial constraints. The estimation precision is better, which is also highlighted in the improved Wald statistics that allows discriminating against the estimations A and B. In addition, the destination of foreign investments does have an effect on the domestic investments. Estimation D suggests that overall foreign investments have a minor positive effect on domestic investment. However, when the investments are separated into those directed into developed markets and emerging markets in estimation E, the interrelations become more apparent. With unconstrained firms, the developed market foreign investments increase domestic investments significantly, while emerging market investments have almost no effect. For financially constrained firms, the foreign investments do not have such a positive impact.

However, one needs to be sceptical with the results. The conducted estimations resemble closely the ones done by Ali-Yrkkö (1998) only with investments now separated to domestic and foreign investments plus a few other adjustments. Other studies with similar estimations include Bond and Meghir (1994) and Rondi at al. (1994). However, the results of this study differ strikingly from the others. The precision of the estimations presented here is much weaker and the coefficient estimates very different. The data naturally covers different periods and includes different firms, but the main difference is in the structural model used. In constructing the theoretical model, the capital stock was not separated into domestic and foreign capital stocks although the investments were. This was a methodological necessity as there is no data available that would contain this information. It seems that this procedure cuts too many corners and leaves the structural model unable to distinguish the subtleties of the parameters' effects. In addition to this structural misspecification, the survey data itself may not be on a high enough precision level for these purposes and may contain too much variance resulting from rounding and other types of survey methodology related issues.

# 9. SUMMARY AND CONCLUSIONS

The objective of this study is to examine the relationship between firm's foreign and domestic investments both theoretically and in practice. The research question is motivated by the great public interest towards the subject. As the foreign direct investments have continually grown in value and MNEs have developed into dominant forces in the world economy, the impact that domestic companies' foreign expansion has on home country operations has become a widely debated issue.

The empirical analysis examines the relationship between the firms' domestic and foreign investments on a panel dataset containing 218 Finnish manufacturing firms during the years 1998-2002. The empirical investment equation is estimated with the Finnish data at the end of chapter 7 by using the GMM (Generalised Method of Moments) method. The approach relies on the use of instrumental variables in the estimation and does not place strict exogenoity requirements for the explanatory variables.

The estimations suggest that foreign investments' effects on domestic investments vary depending whether they are directed into developed or emerging markets. However, the results differ considerably between different specifications. Some support is given to the existence of financial constraints, although the evidence is not robust. Overall, the results suggest that foreign investments increase domestic investments of financially unconstrained firms. When the investments are separated into those directed into developed markets and into those directed into emerging markets, the interrelations become more apparent, but are different from what was hypothesised. The developed market foreign investments increase domestic investments both with constrained and unconstrained firms, but the effect is stronger with unconstrained firms. Financially unconstrained firms' emerging market investments do not have substantial effect on domestic investment. With constrained firms, emerging market investments' effect is somewhat negative.

Based on this study, it can be concluded that firms foreign and domestic investments seem to be related and foreign investments do have an effect on domestic investments at the firm level. In addition, the destination of foreign investments does have an effect on the domestic investments. It would seem that developed market foreign investments increase domestic investments the most while emerging market investments have ambiguous effect. The estimation results are summarised in table 9.1, where the plus and minus signs reflect positive (complementary) and negative (substitutionary) relationship respectively and the number of signs the magnitude.

**Table 9.1. Summary of foreign investments effect on domestic investments**

| | | Financial constraint | |
|---|---|---|---|
| | | **No** | **Yes** |
| FDI | **Developed markets** | ++ | + |
| | **Emerging markets** | 0 | - |

(+ = positive, - = negative, 0 = no effect)

### Ideas for future research

This study concentrated on examining the investment interdependencies on a firm level. The empirical part of this study addressed the relationship between foreign and domestic investments on a firm level, but it said nothing about the relationship on an aggregate economy wide level. The question regarding the firm's foreign investments' effects on total home economy investments and the overall welfare implications were left outside the scope of this study.

This is of special concern, as one major aspect related to the firms' domestic and foreign investments is outsourcing. The boundaries of firms are constantly changing and the question is not only between producing abroad or at home but also between producing in-house or outsourcing. In small countries, the domestic MNEs are usually the most networked ones with the highest use of outsourcing. Since a great deal of their home production is produced through different outsourcing agreements, large part of the investments induced by increased demand are conducted outside the firms' boundaries. This leads to another question regarding the firm's foreign investments' effects on total home economy investments and the overall welfare implications.

# 10. APPENDIX

### Calculation of variables

$I^d$ = Domestic capital expenditure

Domestic capital expenditure is taken from a survey. It includes all stock investments that have resulted in over 10 per cent share of ownership in the invested company and excludes depreciations. The capital expenditures were adjusted to the 1995 prices by using the wholesale price index (Kansantalouden tilinpito, sarja: tukkuhintaindeksi, 1995=100)

$I^f$ = Foreign capital expenditure

See domestic capital expenditure. The Finnish whole sale price index was used for deflating the amounts because of lack of appropriate foreign price index.

K = Capital stock

The amount of fixed assets on the balance sheet. Deflated into 1995 prices by using the wholesale price index (Kansantalouden tilinpito, sarja: tukkuhintaindeksi, 1995=100)

C = Cash flow

Operating profit on the income statement. Deflated into 1995 prices by using the manufacturing producers price index (Kansantalouden tilinpito, sarja: tukkuhintaindeksi, 1995=100)

Y = Output

Turnover on the income statement. Deflated into 1995 prices by using the manufacturing producers price index (Kansantalouden tilinpito, sarja: tukkuhintaindeksi, 1995=100)

B = Borrowing

Long term debts on the balance sheet. Deflated into 1995 prices by using the manufacturing producers price index (Kansantalouden tilinpito, sarja: tukkuhintaindeksi, 1995=100)

J = User cost of capital

The user cost of capital is calculated as (Koskenkylä 1985, 1986, Pyyhtiä 1991)

$$J_{it} = \frac{p_t^I\left(r_{it} - E\left[p_t^I\right] + \delta^A\right)\left(1 - \tau_t \frac{\alpha}{r_{it} + \alpha}\right)}{p_t^o}$$

where

$p^I_t$ = price of capital goods

Wholesale price index (Kansantalouden tilinpito, sarja: tukkuhintaindeksi, 1995=100)

$r_{it}$ = The average interest rate paid by the firm

Calculated as the amount of interest paid divided by the amount of debt with interest

$E[p^I_t]$ = The expected change in the price of capital goods

The next period value of $p^I_t$ used as a proxy.

$\delta^A$= Industry specific depreciation rate

Calculated as the industry's combined depreciations divided by the combined capital stock during the whole observation period. This way the profit adjusting element of the depreciations cancel out and the figure represents the true depreciation of capital goods.

$\tau_t$= Corporate tax rate

Corporate tax rate for each year is taken from Finnish tax law of the corresponding year.

$\alpha_t$= The maximum depreciation allowed in taxation
From the finnish tax law
(Elinkeinotuloverolain muutos, (473/1998))
$p^o{}_t$ = The price of output
Manufacturing producers price index (Kansantalouden tilinpito, sarja: tukkuhintaindeksi, 1995=100)

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