Foreign Direct Investment, Trade and Firm Performance: A Case Study of Hungary

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Abstract

The thesis analyses two important aspects of the foreign direct investment (FDI) in Hungary. First, we examine its role in promoting exports from Hungary and the process by which this facilitates the integration of the Hungarian economy with those of her major trading partners in the EU. Using time series methodology and covering the period between 1992-2000, we find the presence of long-term structural relations between some key variables pertaining to these EU countries and Hungary and note the crucial role of the FDI in the process. The results also show that FDI inflows to Hungary are complementary to investments in countries from which FDI flows originate and that these flows once again play a crucial role in linking Hungary with her major trading partners.

Second, using a large data set on manufacturing firms, we examine the contribution of foreign direct investment to the significant improvement in technology that has taken place in Hungary following transition. We find that, except for the very beginning of transition, the direct impact of FDI on the performance of the manufacturing firms in Hungary has been rather small. However, this is not the case with the indirect (spillover) impacts. We also find that while neither imports nor learning gained in the process of exporting are important channels for technological improvements, the general presence of foreign firms does play a crucial role. The performance of large domestic firms benefited from a larger general presence of foreign firms throughout the whole period of our observations (1992-1998), whereas small firms suffered at the beginning and remained unaffected thereafter. Our calculations suggest significant net benefits in terms of technological improvements. These results are in contradistinction to much of the international microeconometric evidence which suggests that the negative impacts of FDI are overwhelming, particularly in the short-term.

Our conclusion is that the FDI has played a crucial role in reintegrating the Hungarian economy with the countries in the EU. It has also, at the same time, played a largely beneficial role in improving the performance of the domestic economy.

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Glossary

The following abbreviations are used throughout the thesis:

AB	Arellano-Bond estimator
ADF	Augmented Dickey-Fuller test
AH	Aitken-Harrison article
AR	Autoregressive part of a time series
CEE	Central and East European
CEEC	Central and East European countries
CPI	Consumption price index
CSO	Central Statistical Office
DH	Djankov-Hoekman article
DRS	Decreasing returns to scale
ECM	Error correction model
GLS	Generalised least squares estimator
GMM	Generalised method of moments estimator
HUF	Hungarian currency (forint)
IRS	Increasing returns to scale
IV	Instrumental variable estimator
OECD	Organisation of Economic Cooperation and Development
OLS	Ordinary least squares estimator
MA	Moving average component of a time series
NATO	North Atlantic Treaty Organisation
NIC	Newly industrialising country
PPI	Production price index
PPP	Purchasing power parity
TFP	Total factor productivity
UNCTAD	United Nations Council of Trade and Development
VECM	Vector error correction model
WG	Within group estimator
WTO	World Trade Organisation

2SLS	Two stage least squares estimator
3SLS	Three stage least squares estimator

Chapter 1: Introduction

This thesis examines two aspects of the impact of foreign direct investment (FDI) in Hungary. First, its impact on exports is considered; this is followed by an analysis of its effect on technological progress. Recent econometric methods are used to establish empirical regularities. A simple comparative static framework is proposed to underpin the interpretation of our results on exports. In the empirical analysis, both the long and short-term impacts are considered. The behaviour of technological progress is established for both the pre-transition period and the subsequent period, and the impact of foreign ownership on technological progress is also analysed. The methodology used in this analysis is more flexible and reliable than that found in the previous literature. We therefore believe that the results of our work contribute to a better understanding of the true impact of FDI on the performance of the economy.

The choice of the topic may not appear obvious. There have been numerous studies on FDI, but these have been based mainly on case studies and casual evidence. Systematic empirical work, however, is only quite recent and this means that the methodology adopted has often been rather unsound. We wanted to see to what extent a more careful choice of methodology sheds a different light on the role of the foreign investor. This in itself is a good reason for research, but there was another, more important motive. In Hungary, foreign direct investment plays a crucial role in the economy. As a result, if FDI is beneficial for the host country, then it should have a visible effect, considerably enhancing the welfare and production of the country. If FDI is detrimental, it could have devastating effect due to its considerable weight. The results of attempts to measure its impact are therefore of great importance to the country.

Hungary was formerly part of the bloc of communist countries, which did not allow the presence of foreign ownership, and private ownership of company assets was also virtually non-existent. From 1990 onwards, this system was abandoned and the structure of ownership underwent rapid transformation. For an outsider, the fact that foreign-owned firms were already playing a crucial role in the economy little more than five years after the collapse of the old system must be puzzling. This clearly requires some explanation, so we will first of all outline the background to this situation.

In the late 1980s, Hungary broke away from the one-party system and the economic system associated with it, and a broad process of structural transformation got under way. However, it must be recognised that the system in Hungary was not as rigid as in other countries. A policy of gradual liberalisation had been pursued since the late 1960s.[1] Contrary to the expectations and hopes of the reformers, this slow process of liberalisation did not lead to more efficient production and technological progress. These remained as meagre as ever. Despite all the effort, therefore, the growth problems commonly observed in other communist countries from the late 1970s also appeared in Hungary. The economic crisis that followed eventually led to the collapse of the one-party system and the first free elections in fifty years.

The growth problems of this group of countries have been analysed by many economists (e.g., Kornai, 1992). It is commonly agreed that by that time it was no longer possible to expand the level of production by simple accumulation, using cheap labour released from agriculture, by drawing women into the labour force, or by running up foreign debt. Policy-makers in the Party had to find other solutions to prevent further economic decline. They gave more autonomy to company managers and small enterprises, but the benefits of this policy shift were not enough to save the system from collapse. At the end of the decade they gave up power virtually from one day to the next, and walked out quietly. The changes that followed meant a departure from the old political and economic system, and the first democratically elected government adopted drastic reforms in order to build a functioning market economy. In parenthesis, however, it is only fair to point out that some of the bold economic reform measures were put in place before the collapse of the system.

These economies were founded on central control. The small reforms adopted decades before its collapse meant that the state had relinquished some control, but this did not

[1] Bevan (1999) discusses these policies in more detail in his thesis.

save it in the end. Even during the decades of gradual liberalisation the Party's position and rhetoric remained unambiguously opposed to private ownership. While in some sectors of the economy (small-scale services) private ownership was allowed to exist, foreign ownership of any form was out of question.[2] Indeed it was seen, and presented to the public, as the road to slavery and poverty.

From 1989, the pace of relinquishing the central control of the economy speeded up, and in a very short time almost all the economic taboos of the former system had been destroyed. All this took place against the backdrop of a Soviet Union that was still in existence and people, with or without reason, were afraid of what could happen in a geopolitical neighbourhood that was still attached to the 'old ways'. Hungarians wanted their country to accede to as many international and western organisations as possible with a view to ensuring that the breakaway was final. The most important, and geographically close, were the European Union and NATO.

For Hungary, transition started with a host of drastic measures adopted from 1989 onwards. These measures included introducing entrepreneurial freedom, abolishing massive subsidies to state enterprises, ending foreign trade monopolies, passing new commercial legislation, and introducing a single exchange rate. Tax rates on imports were slashed and all exports became tax-free. Setting up the institutions compatible with a market economy took longer than the simple liberalisation measures mentioned above. However, it is now widely recognised by international organisations (e.g., EBRD Report, 2000), that the institutional foundations supplementing the drastic liberalisation measures are in place and are functioning satisfactorily. Nonetheless, one has to admit that it will take considerably longer to change patterns of behaviour.

A key aspect of the new era is that it has become much easier to form business relations with the countries of Europe. Under the old regime, these relations usually meant trade relations. In the new era, however, investment flows have also become very important. A large proportion of the capital flows to the country are related to ownership deals, and to control of firms. Foreign-owned firms now dominate many

[2] The fact that the possibility of foreign investment, and the vision of a large private sector coexisting with state enterprises became an accepted part of the party rhetoric, shows the depth of the crisis in the late 1980s.

economic activities. In order to understand why foreign ownership has become so prominent in such a short period of time, one must examine the initial conditions.

The most burning institutional issue of the transition was privatisation. The privatisation method adopted in Hungary was not unique; it was very similar to the privatisation of the East German state-owned sector. A government agency sold firms to bidders, who paid in cash. This method favours investors with cash, and so investors from abroad began to play a prominent role in the domestic economy. Naturally, this has not been the only privatisation method used, and in reality all Central and Eastern European (CEE) countries have applied a combination of methods. However, privatisation for cash was by far the most common in Hungary, with the result that foreign direct investment began to play an important role in the economy from the very start.[3]

There were a number of reasons why the chosen privatisation policy favoured FDI. First, some believed that the first democratically elected government wanted to prevent managers appointed under the old system from becoming owners, preferring even foreign owners instead. Although many of the 'inherited' managers did in fact have the skills required in the new era, the new government and potential investors understandably had little trust in them. The government therefore tended to favour foreigners, rather than former managers, as the new owners.

Second, other observers emphasise that one reason behind this privatisation strategy was the decades of futile reforms that preceded it. Economists no longer believed in experimenting and discarded all the new and clever ownership schemes that had been devised. Most Hungarian economists preferred simple, straightforward sales for cash, with a view to finding owners who would assume full responsibility for the firms and meet their obligations. In countries where reform efforts in the decades prior to transition were less pronounced, ownership schemes favouring local owners, who essentially had small amounts of assets to invest, were preferred. These countries thus

[3] One must remark that the stock of foreign direct investment in some other CEE countries has become as large or even larger than in Hungary by now, but the prominent role played by FDI is a recent development there.

managed for some time to avoid a situation where foreign owners played a massive role in their economy.

A third argument in favour of foreign investors might have been the fact that Hungary was heavily indebted at the beginning of transition. The country had to sell assets to foreigners to reduce its foreign currency debt obligations. The drastic slump in economic activity following the reforms substantially reduced government revenues. In order to avoid insolvency or hyperinflation (both were commonly observed in transition countries) the sale of assets for foreign currency could not really be circumvented.

Fourth, welcoming FDI seemed to be a good way of easing foreign currency constraints. For the policy-makers of the former system, exports were always a headache. Planners always had the tendency to overestimate the competitiveness of the country's products. As a result, attempts to accelerate growth tended to end up producing balance of payments crises. By the early 1980s Hungary had accumulated a very large foreign debt, and it was by mere luck that the country managed not to default on her debts after the Latin American debt crisis. The 'stop' phase of a classic stop-go cycle followed, while at the same time a policy of modest economic liberalisation was pursued with the aim of improving efficiency of production. However, a party congress in the mid-1980s initiated a new 'go' phase with ambitious aims. It was based on the belief that international competitiveness had been restored by the mild reforms initiated prior to the congress.

The decision of the congress had catastrophic consequences. The level of foreign debt again doubled, growth did not materialize and there were large trade imbalances. Failure to increase exports and increasing import demand for investment goods also played a role.[4] At the same time it was observed that in many countries an increasing presence of FDI was associated with increasing exports. Hungary started transition

[4] This was a time when many economists in Hungary came to the conclusion that the value of Hungary's potential exports was 4 bn USD, of which 1-1.5 bn would be the revenue from agriculture and food. It was believed that the inability to generate more export revenue was determined by fate, and planners were using numbers as benchmarks. Hence, for economists, it was very difficult to believe in the reality after transition started. Exports, particularly non-agricultural exports, grew rapidly without leading to a collapse in terms of trade. It also turned out that appreciation of the currency was not devastating for exports as had been expected.

with a record of severe balance-of-payment problems and a failure to increase exports. So the possibility of improving foreign currency revenues through FDI was also a reason for favouring foreign investors in privatisation deals.

Last but not least, foreign policy considerations had also prompted consecutive governments to promote foreign ownership. Viewed from Hungary, economic prosperity and political freedom were strongly associated with European democracies. Therefore, it did not take long for Hungary (along with others in the region) to apply for membership of the EU. Interestingly, the application was submitted (1993) during a deep recession in the EU. At the same time, there were wars taking place in the Balkans. Application for membership of the EU came only a year after Hungary had reached the trough point of the transition shock. The state of the economy at the time was still rather grim. It was not surprising, therefore, that an application from a country like Hungary, whose economic prospects were unclear, to say the least, provoked caution on the part of officials in the Member States. Consecutive Hungarian governments chose to tackle this problem by adopting the policy of trying to involve EU countries, notably by selling Hungarian companies to EU firms.

In the early 1990s, it was widely believed that neither exports nor FDI-inflows were going to be enough to avoid having to default on the huge debt that the country had accumulated (Winters, 1993; Portes, 1993). It would be interesting, therefore, to see how FDI contributed to the fortunate course of events that helped Hungary to avoid defaulting on her foreign debts. Many attribute good export performance to the increasing presence of FDI, so it was a natural choice to focus on this aspect of FDI. This is the first issue that is pursued in this thesis.

Another impact of FDI considered here is that it can lead to an improved level of technology. This can happen directly, when the foreign owner transfers technology to his firm in the host country, but also indirectly, through spillovers from other foreign firms in the country. We believe that this interaction is crucial, as many analysts attribute the failure of the old system to lack of technological progress and poor efficiency. The present study shows that Hungary did indeed show meagre technical progress in the 1980s. Now, the question is whether the massive inflows of FDI managed to help break this pattern, and to what extent it influenced the performance of non-foreign-owned firms.

What do our results show? First, the role of FDI in trade relations with Hungary's three main trading partners was studied. A long-term structural relationship was found to be present with Germany and Austria, but not with Italy. It turned out that FDI plays a crucial role when this relationship exists. Some evidence of worsening relative prices in trade with Austria was also found, but the opposite applied in the case of German trade.[5] It seems that exports to Germany are very sensitive to foreign demand in the long term. However, when the structural equations were investigated, it emerged that, in the short term, exports seem to be insensitive to foreign demand. This unusual finding might be explained by the high proportion of intermediate products in trade. Another unexpected pattern was also observed: FDI flows in Hungary were positively related to demand conditions in the foreign country. A plausible interpretation for this surprising result is that investment in Hungary was complementing rather than substituting investment in Germany and Austria. This finding is the opposite of what has been suggested in the published empirical literature. Furthermore, we found that despite the considerable trade between them, the Hungarian economy has no effect on the German economy. The opposite was true in the case of Austria, however. Indeed, the results suggested that Austrian policy-makers would do well to keep an eye on the economic indicators of Hungary. Ten years ago, when Hungary started to come out of isolation, this was almost certainly not the case. This result probably shows that the relationship has evolved as one might have expected: after decades of isolation there is once again significant interaction between neighbouring countries.

An attempt was then made to establish the pattern of total factor productivity (TFP) growth with a set of industry data constructed especially for this purpose. Despite possible errors of measurement, some patterns can be taken as almost certain. In general, the growth rate of TFP was indeed meagre during the 1980s. There was a huge increase in both the mean and the variance of TFP growth from the late 1980s. High TFP growth rates continued in the 1990s. This pattern persisted even after

[5] The findings on trade with Germany are more important as this makes up the bulk of Hungary's trade.

simple passive restructuring was over. There is contradictory evidence in the literature concerning just how unusual the TFP growth rates observed in CEE countries actually are. Our results suggest that they are much higher than is usual in other parts of the world, but we expect the growth rate to decline progressively in the future, as it is simply too high to sustain at present. The question that naturally arises now is: to what extent did the massive FDI inflow contribute to the high TFP growth rate?

Calculations show that, among small firms, the presence of a foreign owner meant a TFP growth rate that was around 9 per cent higher than that of domestic firms at the beginning of the sample period (1993). By the end of the sample period (1998), this advantage was reduced to about 3 per cent. However, in the case of large firms this advantage was very slight, being generally less than 3 per cent and typically very close to zero. This indicates that large domestic firms were not at much of a disadvantage in terms of their technological performance. However, the advantage of foreign-owned firms could simply be the result of reverse causation. It may well be that we only observe superior performance in the case of foreign-owned firms because investors choose to invest in better performing firms in the first place. We corrected for this source of bias in cross-section estimates. The results showed that selection was present in the beginning of the sample period only and in general the true impact of FDI on performance was probably even smaller than had been established using simple estimators.

We then tried to identify possible channels of technology transfer using panel methods. These models allow firm-specific assets to appear in the model. Using these methods, it has recently been found in the literature that FDI had a negative impact on the performance of local firms. It has also been found that they try to compensate for this adverse effect by means of various types of technology improvements.

Our results indicate that learning by exporting and importing is not relevant in explaining the performance of the two groups of firms. However, the general presence of FDI seems to be very important. The calculations show that, at the beginning of the transition process, large firms benefited considerably from the increasing general presence of FDI, while small firms suffered. In the latter period of transition the benefits to large firms became much smaller, but they were still positive, whereas for small firms there no longer appeared to be detrimental effects. These calculations indicated that, due to the sizeable share of larger firms, the net effect of FDI spillovers was positive in the first period. They added about 8 per cent to the TFP growth rate of manufacturing per annum. In the latter period of transition it has become much smaller. It may therefore be concluded that the impact of a foreign owner on the performance of his own firm is very small. However, the indirect effect due to the strong general presence of foreign firms in the economy added considerably to the performance of manufacturing.

Technology transfer is indeed taking place, then, but the channel through which it occurs is somewhat unusual. In the recent literature it was found that the increase in the general presence of FDI had an adverse effect on firm performance. In our research the extent of the impact a foreign owner has on the technology of the firm he owns suggests that FDI is not crucial, either in the positive or in the negative sense. However, the indirect role of FDI is much more important, and its increasing presence in Hungary's firm sector has resulted in large net benefits. All this suggests that FDI had a largely beneficial role in the Hungary's transition, although it did have a large negative effect on small firms in the early phase of the transformation process. These results contradict much of the international microeconometric evidence that suggests that the harmful impacts of FDI are overwhelming, particularly in the short term.

In sum, FDI has played a crucial role in reintegrating the Hungarian economy into Europe. At the same time, it has also played a largely beneficial role in improving the performance of the domestic economy.

The derivation of these results is presented as follows. *Chapter 2* introduces the definition of FDI, and summarises basic patterns of FDI observed globally, in CEECs, and in Hungary. Then follows a discussion of the theories of foreign direct investment. These theories try to explain why firms set up production abroad instead of supplying the foreign market with exports. This chapter also outlines the reasons why particular aspects of FDI were chosen for analysis in the subsequent chapters.

Chapter 3 discusses how the recent literature sees the trade integration of Hungary into the EU. Possible interpretations of these findings are presented based on the existing trade elasticity literature, and the main implications of these approaches are summarised. Then, a simple comparative static model is proposed to help explain our findings.

In *Chapter 4* an attempt is made to quantify the important determinants of Hungary's exports, and give an explanation for their observed behaviour. One of our purposes in this chapter is to ascertain the extent to which FDI inflows are responsible for the long-term behaviour of exports, and the role of foreign demand and prices is also explored. The analysis of time series also tries to recover evidence about the impact of Hungary's economy on some countries of the EU. This is important, as there is a great deal of discussion concerning the adverse influence of capital outflows from the EU to CEECs. To this end, long-term trade elasticities are obtained using co-integration analysis, while the structural elasticities are recovered with a vector error correction model. At the end of the chapter we analyse the implications of a long-term link and the international structural relations underlying it.

The study set out to relate FDI not only to exports but also to technological progress. Due to problems of interpretation and of measurement, however, we discuss the empirical and methodological results of an example in the recent literature dealing with TFP growth in East Asia, and its implications for the problem that is the focus of our research. Using a simple index method, TFP growth rates are calculated from 1980 to 1996 across industries in *Chapter 5*. An attempt is then made to link the TFP growth rates to FDI inflows and R&D expenditure.

However, TFP series that contain noise from pre-transition series can be very unreliable. Instead, it might be better to use post-transition firm-level data to ascertain the impact of FDI on productivity. *Chapter 6* summarises the empirical literature on this issue and clarifies the methodology that is amenable to our analysis.

We gained access to a large firm dataset that contained balance sheet information and some other variables about firms with double entry bookkeeping. Using this dataset, a microeconometric analysis of the impact of FDI on TFP growth was carried out, details of which are contained in *Chapter 7*. First, cross-section methods were applied that were absent from the literature dealing with ownership and performance. Then, models were applied that allow firms to have intangible, firm-specific assets and the impact of FDI was analysed under this assumption. Using a panel framework, we attempt to identify sources of technology spillovers. Our expectations are that the presence of more FDI, imports and learning-by-exporting is conducive to better performance, so we should be able to measure these effects. The dataset allows us to distinguish between small and large firms, and also to identify patterns present early in transition that disappear later on. As the literature has already shown, the assumption of firm-specific assets can make a considerable difference. However, applied research in the field has completely ignored the problem of endogeneity of production factors in cross-section data and in panels. These issues are addressed, and it is demonstrated that they do, in fact, make a difference. At the end of the chapter, simple calculations are carried out for the aggregate impact of FDI on the TFP growth of manufacturing. In the concluding chapter (*Chapter 8*), the relevance of the results obtained in the earlier chapters is discussed, and their implications set out.

Chapter 2: Foreign Direct Investment: Basic Facts and Theories

This chapter gives a brief outline of foreign direct investment, its role and relevance, and the most important results of research related to FDI in the context of transition in central-eastern Europe. Before embarking on any analysis of the impact of FDI, we need to know what constitutes FDI.

In *Section 2.1*, a definition of FDI is given. Also discussed in this section are the main problems encountered if the usual definition is applied. In *Section 2.2*, the general trends in FDI behaviour are described, based on the information published in the World Investment Report. After this, the CEE countries and Hungary are placed on the map of FDI flows, and some simple observations are made regarding the importance of FDI in this region in comparison with the rest of the world. The second half of the chapter examines the reasons why companies pursue production abroad instead of exporting there. To put this differently, why do companies opt to fully own plants abroad instead of supplying their market by other means (*Section 2.3*)? *Section 2.4* reflects on some of the more important empirical articles explaining FDI flows to CEE countries, and in *Section 2.5* the literature on the impact of FDI is summarised.

2.1 What is FDI?

Multinational enterprises are made up of the parent firm (in the foreign country) and subsidiaries in the home country. The parent company has a control over the assets of the affiliate through owning part of the subscribed capital of the firm. It is common to classify a firm as foreign-controlled when the foreign holdings exceed 10 per cent (UNCTAD, 1999). Other measures and criteria are also used to classify a firm as foreign-controlled. However, this is probably the criterion that is most frequently used in national statistics. There are minor deviations from this in the definitions used by other international organisations. For instance, the WTO puts the accent on the activeness of the owner. This implicitly emphasises the distinction between financial and non-financial investments. The former is regarded as a passive owner, while the latter kind of owner is considered more likely to participate actively in controlling the operation and managing the subsidiary.

FDI has three components. One is the capital invested in the stock of the company, the second is the capital reinvested from the profits, and the third are the loans from the owner. However, for this thesis we only had access to data covering the first of the above components of FDI. This practical difficulty is common, and it also implies that much of the work done in the field is based on data that systematically underestimates the size of FDI. If a stock measure is used, these systematic errors accumulate. Therefore, only the impact of current flows of foreign direct investment can be analysed, while the other components are ignored.

Net flows are often utilised instead of gross measures. In the sample period, the outflows from Hungary were small in size, so no attention is paid to them in the analysis; instead, only gross inflows are used. It should be noted that there was a considerable increase in the regular outflows from 1999 onwards. These outflows are still small compared with probable returns of the FDI stock. However, these are not taken into account here, as they are beyond the time horizon of our analysis.

2.2 General trends in FDI flows

It is almost taken for granted that merchandise trade grows faster than output. It is commonly documented that this happened in the late 19^{th} century, and it has taken place since the end of WW2 as well. It was also observed that rapid growth of exports was often associated with an increasing presence of FDI (e.g., Bowen, Hollander and Viaene, 1998). This is a surprising combination as the point of exporting and international trade is to supply the foreign market from the home country. So one might intuitively expect there to be a negative relation between the two variables. The more goods can be supplied from the home country to meet demand from abroad, the less need there is to shift production to the foreign country, and one might therefore expect the size of FDI to be smaller. The deviation of FDI and exports from this pattern requires some explanation; the answers are discussed in the second half of the chapter.

In the late 19th century, international trade and FDI flows grew rapidly, but this trend reversed in the interwar period. After WW2, flows started to rise rapidly again among the developed countries and nowadays these flows still make up the bulk of total FDI flows. This is partly because, initially, developing countries were averse to foreign capital inflows. This was particularly the case regarding FDI as it implied direct control of firms by foreigners. Naturally, there was no FDI at all in the centrally planned economies of central and eastern Europe, and this remained so essentially until the start of transition. Many developing countries started to allow FDI to flow and play a significant role only from the 1970s onwards. For the most part, however, capital flows to these countries still took the form of bank credits. FDI flows to developing countries started to increase considerably only after the Latin American debt crisis in the mid-1980s. The Mexican crisis in 1994 did not have much effect on flows. However, the Asian crises in 1997-98 reduced flows to developing countries considerably. It is noteworthy that the region that seemed to be the least affected by this development was central and eastern Europe. Nonetheless, total flows to this region declined as well, but not at the same rate as flows to other regions.

Table 2.1. Inflows and outflows of FDI in different parts of the world in 1997 (in per cent of the total)

	USA	EU	Japan	Rest of the world
FDI inflow	19.8	35.8	0.8	43.6
FDI outflow	25.1	44.1	7.9	22.9

Source: World Investment Report (1999)

2.3 FDI trends in CEECs and the position of Hungary

From the late 1980s there has been a steep rise in FDI flows to CEE countries. Before this time, there was none. In the early stages of transition, the countries that were nearest to the EU, quickest to privatise, and had the most advanced inherited economies took up most of the inflows. FDI flows to the region became more rapid in the mid-1990s, but came to a halt in 1998 (*Table 2.2*). The large rise in flows, however, appears minuscule when compared with flows to other parts of the world.

Table 2.2. The stock of inflows and outflows in central and eastern Europe (in million USD)

	1987-92 (average)	1993	1994	1995	1996	1997	1998
FDI outflow	44	292	286	460	1105	3425	1903
FDI inflow	1576	6757	5932	14266	12406	19532	17513
Of which							
Poland	183	1715	1875	3659	4498	4908	5129
Czech Rep.	533	653	868	2561	1429	1301	2540
Russia		1211	640	2016	2479	6243	2183
Romania	61	94	342	420	265	1229	2063
Hungary	675	2339	1146	4453	1983	2085	1935
Bulgaria	34	40	105	90	109	505	401
Ukraine	.	200	159	267	521	624	926
Slovakia	91	168	245	195	251	177	466

Source: World Investment Report (1999)

One can see in *Table 2.3* that (in 1998) FDI flows were concentrated among the countries of the OECD. It also shows how small the flows to CEE countries in fact are. The bulk of FDI flows outside the developed world are taken up by Asia and Latin America.

Table 2.3. The regional distribution of FDI flows in 1998

	Inflow	Outflow
Developed countries	71.5	91.6
Developing countries	25.8	8.1
Of which		
Africa	1.2	0.1
Latin America	11.1	2.4
Asia	12.0	5.3
Other	1.5	0.3
central and eastern Europe	2.7	0.3

Source: World Investment Report (1999)

However, the relative size of flows to various parts of the world can be misleading, as the regions themselves can vary considerably in size in terms of population, or in terms of their economy. So in *Table 2.4* an attempt is made to rectify this problem for some of the transition countries. It turns out that there are substantial differences across the countries in terms of FDI intensity of production. Hungary and the Czech

Republic are the most FDI-intensive. It must be noted, however, that the FDI intensity of most countries has risen greatly since 1998 as large privatisation deals took place involving foreign investors in Poland, Slovakia and the Czech Republic. However, we did not account for these as they took place after the end of the period of analysis covered by this thesis.

Table 2.4. The FDI intensity of CEE countries in 1997

	FDI per capita	FDI stock /GDP
Poland	689	11.6
Czech Rep.	738	22.8
Russia	70	3.2
Romania	123	10.4
Hungary	2184	34.7
Bulgaria	119	9.4
Slovakia	259	8.2

Source: World Investment Report (1999)

As mentioned in *Chapter 1*, the privatisation scheme pursued in Hungary favoured foreign investors. The fact that foreign investors obtained a large share of the assets in Hungary early on in the transition was due to a number of factors discussed earlier. There is no doubt that the share of FDI in the domestic economy became very high very rapidly.[6] The role of foreign owners is most dominant in manufacturing. The beneficial or harmful effects of FDI should therefore be relatively easy to observe in this sector. This is why manufacturing was chosen as the focus for our analysis.

Table 2.5. The share of foreign owners in the subscribed capital of firms by industries in 1998

Agriculture	7.5
Manufacturing	59.7
Of Which	
Food	61.8
Chemical	55.6
Machinery	66.4
Energy	31.9
Trade	43.3
Transport and communication	24.1
Financial services	57.2
Total	37.9

Source: CSO

[6] The highest shares can be observed in manufacturing and financial services (*Table 2.5*).

2.4 Theories on foreign direct investment

The question that these theories attempt to answer is why firms establish production abroad instead of exporting from home. There are a variety of answers to this, and they have changed considerably over time. They range from simple explanations relating to returns on investment, to the eclectic approach that gathers together different explanations and proposes that they are jointly valid. Below, the most widespread approaches in the field are summarised.

2.4.1 Classical theories

This group of explanations is based on the simple idea that firms invest wherever they can achieve the highest return on their investment. If foreign returns are higher, this means an incentive to invest abroad. This approach was widespread after WW2, when returns on investment in Europe were much higher than those in the US.[7] However, the subsequent decline in European returns did not stop US investment from flowing to Europe. In turn, it was argued that risk and portfolio decisions are key to understanding the behaviour of FDI flows. In order to maximise expected profit it is sensible to invest in a portfolio of firms in countries with various levels of risk and rates of return. It is not optimal to supply the markets from one country. This explanation can account for the observation that FDI grows. However, this theory predicts that the variety of activities in which foreign-owned producers engage should increase over time. It is optimal to produce a product in many countries and we should observe no specialisation and declining trade. This explanation may be true for some countries, but not for others.

The size of the market to be supplied and production constraints in the home country can also be important. It can happen that a country's export product is too successful.

[7] This approach is related to the Heckscher-Ohlin model where factor price equalisation can take place not only through trade, but through factor flows as well (Bowen, Hollander and J.-M. Viaene, 1998).

In this case, production is too small relative to the size of the markets where the export product is in demand and constraints can prevent further expansion of exports. Examples of such constraints might be local credit constraints, a government policy preventing the firm from expanding, or inadequate availability of local resources. These can all prompt domestic firms to expand production abroad instead of at home. However, this explanation cannot account for the observation that exports and FDI very often grow together. According to this theory, it is better to supply the foreign market from abroad, and hence there should be less export and more FDI. Also, it does not explain why production abroad should take place in the form of ownership of the foreign supplier.

2.4.2 The eclectic approach

Hymer (1976) proposed an alternative explanation. In his view, if a firm plans to invest abroad there are numerous disadvantages it has to contend with. Local rivals are more familiar with domestic law, language, preferences, and culture, and so the foreign newcomer must have advantages in other areas to compensate for the disadvantages. If a firm invests abroad, it must therefore be taken as a sign that they possess such factors. These factors are usually regarded as specific to the firm. They must also be easy and relatively cheap to transfer across plants. These can include procedures that proved productive for the firm in the past (in terms of management or marketing), such as company culture, brand names associated with the firm, and specific scientific or engineering knowledge. However, firm-specific advantages rarely arise spontaneously (except, for example, inherited traditions of the owner of a firm). In most cases they have to be developed at a cost. These costs can be so great that it may not be possible to recoup them on the local market alone, so there is a need to expand the production base. Inasmuch as this expansion takes place abroad, this theory may provide a valid explanation of FDI.

This approach gives an insight into the production advantages of firms with firm-specific assets, but it does not explain why firms should prefer FDI to other ways of supplying the foreign market, such as exports, licensing agreements, or joint ventures. There is nothing to prevent firms from recuperating their firm-specific costs by exporting goods produced at plants based in the home country instead of abroad. In sum, Hymer (1976) suggests that there are many types of costs that propel the firm to increase its production base. However, it is difficult to say why the increase should take place abroad. He says merely that the fact that FDI is observed in the host country in itself proves the existence of these factors.[8]

In turn, the internalisation approach tries to specify those factors that Hymer (1976) has not specified. It suggests that a foreign firm will opt for ownership of a foreign plant instead of licensing to a local firm or exporting when the latter channels are too costly. When they own the foreign subsidiary they internalise the foreign production process. Why would they do that? Obtaining marketing or R&D-related knowledge abroad would be too costly.[9] Setting up an export supply network abroad can be very costly as well. In this case, the cheapest solution for the firm is to set up a firm abroad and transfer the knowledge within the firm.

It is not obvious why it would be costly for the firm to enter into a licensing agreement or a joint venture abroad. Under these arrangements, firm-specific knowledge becomes difficult to monopolise once cooperation is under way. From then on, there is nothing to prevent the domestic partner from misusing the information gained. However, if the investor tries to impose too strict a limit on the knowledge input into the product produced abroad, the brand name and the goodwill of the firm may be dented. This can turn out to be costly as well, and may prompt the firm to seek full ownership of the foreign firm instead.

Locational advantages behind FDI flows are also incorporated into the empirical models. Distance is used analogously for modelling FDI as in gravity models for trade flows. Accordingly, one can expect distance to be negatively related to FDI flows. However, unlike the gravity equation for trade (Anderson, 1979) gravity models for FDI still lack a theoretical foundation.

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[8] The ideas of this approach were set out in a formal model by Horstmann and Markusen (1989). Earlier, Batra and Ramachandran (1980) showed how the new classical trade model can be modified to account for firm-specific costs, and demonstrated the importance of tax policies.

[9] Because knowledge is firm-specific, it must very scarce and costly to obtain it abroad.

The eclectic approach has become the most widely accepted at present. Its name reflects the fact that there is no single explanation for FDI flows. Dependent on the circumstances, motivation for investing abroad can vary greatly. The theory incorporates the three approaches summarised above relating to motives for FDI. Detailing his ideas in a series of books, Dunning (e.g., Dunning 1981, 1992) set out a model that attempted to gather together the most important explanations in a single framework, called the eclectic approach. The model is also often called OLI, where O stands for ownership advantages based on Hymer (1976), L for locational advantages, and I for cost internalisation. Because of its flexibility, it is often used as a basis for empirical analysis (Meyer, 1998; Éltető and Sass, 1997). In Dunning's view, putting these three models together gives a satisfying explanation for most FDI.

Naturally, there can be many other incentives for FDI flows, or factors that discourage it. These are often taken for granted, and treated as exogenous in the firm's decision regarding FDI. Such is the role of government incentives, protection, business cycles and the sequencing of investments. However, in reality there is interaction between investors and these variables are influenced by investor behaviour (Blomstrom and Kokko, 1998). In practice, the cross-section and panel methods typically used ignore the endogeneity issue completely.

The eclectic approach suggests that there are many determinants of FDI flows. The omitted variable bias can therefore be a serious issue in a regression framework. This is why, in FDI regressions, researchers usually try to account for even more determinants than those implied by the eclectic approach. As a result of the lack of a single, robust theory that stood up to econometric testing across countries, applied work in the field has become predominant. Noting the advances in theory, we therefore review which motives for FDI have been found important in the countries of central and eastern Europe.

2.5 The empirical literature on FDI

The study of the determinants and impact of FDI has become a very popular field of research on CEE countries. This is understandable, as restructuring and privatisation are at the heart of the economics of transition. One form of privatisation was the sale of firms to foreign owners. The most advanced CEE countries privatised to foreigners most extensively, but there have been considerable differences among them as far as motives for FDI are concerned. Initially, the inflow of FDI occurred predominantly in the Czech Republic, Hungary and to some extent Poland. Most of the empirical research, therefore, used samples from these countries.

These studies investigated the issue of why FDI was taking place, and what possible impact it had on other important variables of the economy. Naturally, empirical work with aggregate data could hardly be carried out due to small sample sizes and due to the series of structural breaks that occurred, so this literature is typically based on the analysis of firm data. In what follows we examine the motives found to be significant in empirical work. Only studies with a sample size exceeding 100 were considered.

2.5.1 Studies on the motives for FDI in CEE countries

The popularity of Dunning's eclectic approach shows the problems of finding a single key determinant of FDI. This implies practical difficulties for applied work. A large number of variables is required and it is difficult to establish a good specification. It also requires the collection of more data and results hold less well across countries and industries. Individual firms can have very different motives for investing abroad, and this contributes to the difficulty of establishing empirical regularities. In the papers checked in the course of the present study, there was no single motive that proved significant in all of the articles. Typically, market share, factor costs and location were found to be the most important.

The studies carried out to date fall into two basic categories. One is based on surveys of foreign-owned firms in CEE countries. The other surveys firms in the EU that have invested, or were planning to invest, in the region. Interestingly, both lines of literature suggest that the main motive for investment was to gain a share of the market in the CEE countries. Location and factor costs were, at best, supplementary factors.

Using a sample of Belgian firms, Konnings and Janssens (1996) suggest that a crucial factor was gaining a new market. Some of the firms in their sample regarded labour costs as important. However, the firms that were sensitive to labour costs tended to choose outsourcing rather than FDI. Meyer (1998) analysed a sample of British and German firms and again found market share to be the main motive. Using Italian firm data, Mutinelli and Piscitello (1996) found both market share and labour costs to be very important.

Further surveys have been carried out in the host countries. With samples of Hungarian firms, Éltető and Sass (1997) and Szanyi (1995) identified market share as the primary motive for foreign investment. Witkowska and Wysokinska (1994), meanwhile, using Polish firm data, suggested instead that that the primary motive was labour costs. Although it seems that labour costs were never a very important motive for investment in Hungary, its importance is probably declining even further. Outsourcing, which is very sensitive to the cost of labour, was observed to be losing ground rapidly to other forms of cooperation with foreign firms (Hamar, 2001; Szanyi, 1995).

In other parts of the world, FDI has proved more difficult to explain. This is why Dunning's eclectic approach became widespread in the 1980s in the first place. However, the empirical findings from the transition countries suggest a very simple picture. With one exception, there was no indication of more than one determinant playing a leading role in FDI flows to the region. This determinant was the market share in the host country. This is all the more interesting, since market share is something that foreign firms could establish simply by exporting, without buying or setting up a foreign plant.

Can Dunning's flexible theory be reconciled with the dominance of market share as a motive? As was pointed out above, ownership advantages alone are only necessary conditions for FDI. They are only sufficient when they are combined with cost internalisation. When both are present, FDI takes place.[10] In theory, acquiring and

[10] However, much of the literature deals FDI experiences in specific countries, and hence they do not take account of Dunning's third factor: (country) location. It is thought that after a decision is made

setting up a plant abroad does not in itself increase a firm's market share in that country. This depends on the behaviour of the rest of the firms in the industry. In practice, however, market share typically increased after both privatisation deals and greenfield investments. Domestic firms can rarely match the expansion of foreign-owned firms, and foreign rivals do not immediately follow (Éltető and Sass, 1997; Major, Vezzoni and Szalavetz, 1999). Increasing market share can be a result of Dunning's explanation. This implies that Dunning's theory may indeed be reconciled easily with the importance of market share in CEE countries. In practice, however, researchers have rarely managed to separate out the components of his explanation.[11]

This also suggests that foreign investors have a good chance of recuperating the costs of developing firm-specific assets by means of FDI. They can avoid the risks and costs associated with exporting, licensing and joint ventures. The evidence summarised here suggests that, in the case of the CEE countries, this has probably been achieved by increasing their market share through establishing production capacities.

2.5.2 The impact of FDI – choosing an aspect to examine

Now, leaving aside the determinants of FDI, and taking the presence of FDI for granted, let us consider its impact on the domestic economy. Ultimately, we are interested in what FDI does to Hungary, and not why it is there.

The empirical literature on FDI in Hungary has shown interesting patterns of foreign-owned firms. One study (Éltető and Sass, 1997) found that foreign-owned firms were large, 70 per cent of their material input was imported, and more than 80 per cent of their exports were intra-firm trade. They were also observed to be far more productive, capital-intensive and export-oriented (Éltető, 2001; Major, Vezzoni and Szalavetz, 1999), and more efficient (Szanyi, 2001; Halpern and Kőrösi, 2000) than domestic firms.

concerning an investment, it is country-specific locational advantages that determine the specific host country. This is completely ignored in empirical work in this area.

The question naturally arises that if foreign-owned firms are so drastically different from firms in domestic ownership, how did they change the behaviour of important variables in the economy? This question is particularly pertinent since, as observed above, over 50 per cent of the trade sector and one-third of the total firm sector is in foreign ownership (*Table 2.5*). It would therefore be very difficult to do any research on Hungary without touching upon the issue of FDI.

There are probably many ways of approaching this very general problem. The approach adopted here is to examine the issue in the light of on pre-transition events and observations. As a first step, the major economic problems of pre-transition Hungary are identified. Then an attempt is made to assess the impact of FDI on those problems. Are these problems present in the new era? If they are not, what role did FDI play in their disappearance? It immediately becomes apparent that this is an almost impossible task. It is limited both by the data and by the problem of comparing observations from two completely different worlds, with transition wedged between the two. However, by avoiding treating the two eras in a single analytical framework, it is possible to carry out valuable empirical analysis.

The most burning problem of the centrally planned economies of central and eastern Europe was lack of growth and poor TFP performance from the late 1970s. It is therefore important to say something about the productive performance of the economy. If foreign ownership matters in this respect, it should show up as a significant determinant of TFP performance. For this reason, it would be very relevant to analyse this aspect of the growth experience of Hungary in the 1990s. The first question that needs to be asked, therefore, is whether FDI has helped to revive the growth rate of TFP?

Under central planning, the other major problem Hungary and other CEE countries faced was that whenever the economy started to grow, it was always curtailed by balance-of payments difficulties. The culprit at the time was the poor performance of the export industry. Throughout the 1980s, exports remained more or less constant

[11] We have not considered classical explanations of FDI, as they only present the necessary conditions for it.

and failed to grow significantly. At a time when exports were rising very rapidly in the world as a whole, this was a clear sign of a lack of international competitiveness. Now, the question is whether FDI helped to relieve the balance of payments difficulties by contributing to increasing exports? In the early 1990s, the country was expected to collapse under the heavy burden of inherited debt. Since then, these difficulties have eased considerably. However, very little is known that is based on systematic analysis of the issue.

The problem of TFP can be broken down into two questions. Has FDI improved the productive performance of the economy simply by having more foreign-owned firms around? If foreign firms are more productive,[12] then their increasing presence increases the average productivity of the economy simply by changing the composition of firms. We have seen that foreign-owned firms control a large part of the economy and that they are very different from domestic firms. In this set-up it is natural to expect that there should be considerable interaction between the two groups. So, a second question arises. Has the interaction between the two groups been negative or positive? Depending on the manifestations and scale of its indirect impact, along with the direct effects of FDI, the overall impact of FDI on productive performance can be negative or positive.

2.5.3 Can anything new be said about the impact of FDI?

Some work has been undertaken at macroeconomic level in previous research on TFP relating to Hungary (Darvas and Simon, 2000; EBRD, 1997). However, the determinants of TFP are not considered at all in this research. At the micro level, only efficiency and its link to FDI have been explored (Halpern and Kőrösi 1998, 2000; Szanyi, 2002). Technological progress in relation to FDI has not been researched systematically for Hungary.

Interestingly, there are more case studies authored by foreign researchers on TFP, and on the direct and indirect impact of foreign ownership in CEE countries on

[12] The theory of ownership advantages (Hymer, 1976) would suggest this pattern to be valid.

performance.[13] One such paper on Hungary fails to use a correct estimation method (Schoors and van der Tol, 2001). Work on other transition countries has included the Czech Republic and Bulgaria (Djankov and Hoekman, 1998, 2000a, 2000b) and Slovenia, Estonia and Slovakia (Dmijan, Knell and Rojec, 2000). However, these papers also used inappropriate methodologies, so their results should be regarded with some caution. Two articles in particular had a significant influence on the methodology adopted for subsequent research. Although these did not relate to transition countries, they must be mentioned for this reason. Aitken and Harrison (1999) and Haddad and Harrison (1993) were the first to use panel techniques to demonstrate the indirect (spillover) impact of FDI on domestic firms. The present study applies more recent and flexible methodologies than those used in their framework.

The other question to be analysed in detail is the impact of FDI on exports. Surprisingly, the literature on this issue is likewise scant. Among a sample of Belgian firms, Konings and Janssens (1996) found a weak link between foreign investment and imports from the host country. The most extensive work on the issue was carried out by Djankov and Hoekman (1996). They analysed industry-level data, and found that the only significant factor explaining the variation of exports was FDI. Interestingly, neither geographical distance nor foreign income played a role. Based on a sample of Hungarian firms, Éltető and Sass (1997) argued that exports related to FDI were concentrated in high-tech, knowledge-intensive industries. At the same time they found that outsourcing (which does not count as FDI) was typical in activities with low skill content.

At the macroeconomic level, there have not been many attempts to investigate the role of FDI in trade among CEECs either. Halpern and Székely (1993) only investigated pre-transition data. Jakab, Kovács and Oszlay (2001) estimated a large country panel and found a positive significant impact of FDI. There have been estimations of time series export equations (Jakab, Kovács and Lőrincz, 2000), but they have not accounted for FDI at all. Only price and income elasticities were calculated, and the income elasticities thus obtained were probably upwardly biased. The weight of FDI

[13] There has been considerably more work carried out in connection with the impact of privatisation on performance (Bevan, Estrin and Schaffer, 1999).

in the economy, along with the industry-level evidence, make it unlikely that FDI could be ignored. If FDI were taken into account, more realistic elasticities for relative prices and foreign income could be obtained.

As mentioned earlier, it must borne in mind that researchers certainly faced constraints due to data problems and barriers imposed by the empirical methodology. It is nevertheless surprising how little econometric effort has been made regarding basic questions like these. In this thesis it is argued that, despite the difficulties, more could have been done on these issues than has been the case.

It is clear that there are many questions waiting to be answered, and we believe that the present study can contribute to the ongoing work. Now, let us turn our attention to this issue and investigate the link between exports and FDI in more detail.

Chapter 3: The Literature on Empirical Modelling of Exports

In the literature on export modelling, the economic models used have tended to be quite simple. This is because it is easier to obtain robust results with simple models than with those that take additional aspects of trade into account. However, some aspects ignored by the simple models may well be important for policy-makers. So, after reviewing the main results and the methodologies described in the literature on trade, a simple comparative static model to explain export behaviour is presented that accounts for more policy-relevant determinants of exports than usual. In this chapter, our analysis will proceed as follows.

First, the structure of the chapter is outlined. *Section 3.1* discusses the implications of our research for the literature on the real integration of transition countries into the EU. The success or failure of exports can be regarded as a step on the way towards Hungary's integration into the EU.

In *Section 3.1.1* the basic facts of foreign trade developments in Hungary are noted. This is helpful, as these observations crop up not solely in this chapter, but also later in this thesis. They assist in the interpretation of many of our findings.

Section 3.1.2 then goes on to consider the role played by foreign direct investment in the export equation, and explains how capital stock measures became a frequent explanatory variable in trade equations. We discuss the dangers of using capital stock and some of the problems involving the use of FDI as a measure of productive capacity.

Afterwards, in *Section 3.1.3*, the discussion moves on to deal with the evolution of trade modelling from a single-equation export demand function to simultaneous equation models. The discussion also focuses on the contentious issues of measuring partial trade elasticities.

In *Section 3.1.4*, the changes brought about by the inclusion of capital measures in the trade regressions are examined in detail, and this section also looks at what the new trade elasticity literature has to say on the issue.

The economic models so far used, and the signs they predict for the determinants of exports, are explored in *Section 3.2*. It is argued that it is desirable to extend the usual models, by adding some further assumptions.

To facilitate the interpretation of the long-term export elasticities, a comparative static model is set up. In the model, an attempt is made to account for more causal relations than is usual in the applied literature on trade. The equations of our comparative static model are presented in *Section 3.2.1*, and the choice of specification is explained.

Finally, in *Section 3.2.2*, the results of the comparative exercise with the variables of the model are presented.

3.1 Real integration through exporting

Foreign direct investment (FDI) has become prominent in the Hungarian economy. It was hoped that this would have a positive influence on exports, if not on other crucial variables. The problems relating to the export performance of these countries in the 1980s were perceived as being rooted, among other things, in the poor products of the traded sector. It is not surprising, therefore, that exports were expected to collapse following liberalisation of trade with the EU. In fact, such a collapse failed to materialise. It is unlikely that that we will able to pinpoint the exact role played by FDI in preventing the collapse of exports, as there were many other reforms taking place at the same time. However, as general economic conditions and the regulatory environment stabilised, the chances for undertaking meaningful, systematic analysis of the relation between FDI and exports have increased.

In what follows, an attempt is made to undertake such an analysis of the role of FDI in exports in Hungary. Naturally, exports can be both positively and negatively related to FDI inflows. In practice, however, it is commonly observed that FDI inflows contribute to an increase in exports (Djankov-Hoekman, 1996). Our analysis aims to determine whether this is in fact true. Despite the popularity of this topic, there has been little systematic analysis relating to Hungary.

The primary question is to what extent FDI has contributed to improved export performance. However, this question leads to a more general issue. Ultimately, we would like to establish whether FDI has actually contributed to the integration of Hungary into the EU. If it has, FDI must have a strong and positive link to exports.

The results of the export modelling are relevant for the research on integration.[14] If there is no real integration through trade, then we should find no long-term structural relationship when modelling exports to the countries of the EU. If the opposite turns out to be the case, then it casts doubt on the validity of the results of Buch and Döpke (1998), who argue that there is no sign of real, close integration of these countries.[15]

Without denying that foreign demand plays a role, it should be pointed out that other important factors are present that may compensate for demand deficiency abroad. A recession in the EU is not necessarily a negative development for CEE countries. It can increase the cost sensitivity of producers and can lead to increased FDI flows (Hatzius, 2000). This research aims to discover whether the increasing presence of FDI had benefits for the exports of CEEs, and for their real integration into the EU, and whether FDI inflows were indeed induced by recession abroad. A further aim of the present research is to explore the structural factors that seem to provide a crucial link between some countries of the EU and Hungary.

Other important trade parameters can, however, be obtained via the modelling exercise. One such parameter, for instance, is the behaviour of export prices in relation to foreign prices. If these are negatively correlated to exports, this may indicate the presence of immiserising growth. In this case, the welfare of the country

[14] There is a literature that concentrates solely on the co-movements of the relevant economies. Some of this literature found that CEE countries were well advanced in integrating their economies into that of the EU (Boone and Maurel, 1998), while others found no evidence of structural integration between the two regions (Buch and Döpke, 1998). Interestingly, in these models it was assumed that it was exports that connect the two regions. However, they did not test this link.

[15] It must be noted that industry-level analysis usually supports the hypothesis of strong integration (Djankov and Hoekman, 1996; Freudenberg and Lemoine, 1999).

does not necessarily increase as a result of expanding production. If it has a positive sign, this means that exports are driven not by reduced product prices, but by other factors. The role of foreign demand is equally interesting. One might expect that growth of the foreign economy would bring benefits to the countries exporting there. On the other hand, for instance, an EU slow-down might prevent dynamic growth in the transition countries. These observations should result in a positive parameter for foreign demand in an export regression.

Before going into the details of trade modelling, however, it would be useful to look at the main facts concerning the trade of CEECs, and of Hungary in particular.

3.1.1 Patterns in Hungary's trade

The basic facts concerning the transformation of foreign trade are gathered together here in five points. It is important to bear these in mind, as they may help us later to interpret aggregate export elasticities.

1. Radical trade liberalisation in the early 1990s resulted in Hungary's trade shifting away from the former COMECON countries to the EU. This surprised researchers, as it was thought that such a switch would pose great problems due to the weakness of these countries in terms of international competitiveness. It was expected that the balance of payments of these countries would collapse after trade liberalisation. Many CEE countries therefore tried to pre-empt this by means of a sharp initial devaluation of their currency. In the Hungarian case there was no sharp devaluation. Surprisingly, Hungary's trade balances did not immediately worsen.

2. The inherited structure of trade suggested that CEE countries had a comparative advantage in labour and capital-intensive products, some in raw material-intensive products. The dynamics of subsequent trade appeared to justify this, with the notable exception of Hungary. While in the case of the other CEECs researchers observed a specialisation in labour and capital-intensive activities, for Hungary it

was found that skill-intensive products dominated exports towards the OECD countries (EBRD Report, 1999).

3. The possible reason for this was that FDI began to dominate the skill-intensive sectors (Éltető and Sass, 1997) very early on due to privatisation policies that implicitly favoured foreign investors. The export industries on which foreign investment concentrated from an early stage of transition were electronics and machinery.

Table 3.1. The share of foreign-owned firms in the totals of various balance-sheet items within manufacturing (percentages)

	1992	1996	1998
1.Number of firms	20.8	21.3	18.4
2.Invested assets	29.2	71.4	76.9
3.Investment	42.5	82.5	85.3
4.Own capital	28.0	72.3	78.0
5.Net sales	27.4	64.3	71.0
6.Domestic	25.7	56.5	58.1
7.Exports	31.7	78.8	86.4
8.Material input	26.5	62.5	70.7
9.Wage bill	26.6	55.1	59.9
10. Depreciation	28.5	76.6	78.8
11. Operational profit	-25.2	78.8	84.2
12. Subscribed capital	34.9	68.0	73.7
13. Number of staff	24.5	40.6	47.5

Source: Hamar, 2001 (based on tax office data)

Table 3.2. The share of foreign-owned firms in exports and imports (percentage)

	1992	1993	1994	1995	1996	1997	1998	1999
Export	30.4	38.1	39.5	55.2	68.3	73.4	74.4	74
Import	32.8	38.7	43.7	43.7	61.0	70.1	72.9	71.2

Source: Hamar, 2001 (based on trade data)

4. These industries started to play a key role in exports. *Table 3.1* and *Table 3.2* indicate the crucial role FDI has assumed in Hungary. At the beginning, a small

number of large foreign firms were engaged in producing machinery for export markets. Later, middle-sized firms appeared on a large scale. By 1999, companies with a foreign stake of more than 10 per cent were responsible for 74 per cent of all Hungarian goods exports, and 71 per cent of all its imports. Exports and imports were predominantly intermediate products, and consisted mainly of machinery and components (Freudenberg and Lemoine, 1999). The magnitude of this shift is indicated by the fact that in 1992 these shares were still close to 30 per cent. The largest exporting firms can be identified as producing car parts (e.g. engines, gears) and electronic products (e.g. screens, RAM, parts for mobile phones) on a very large scale (Hamar 2001).

5. Due to the sheer volume of their activities, these companies enjoy tax breaks. Many of them pursue their activities in special zones, where they are exempted from import duties on inputs and often from profit tax as well. At the beginning of the 1990s, these exemptions were granted on the grounds that the local value added on inputs was very little, and so a small duty would have meant a prohibitive cost to the producer. However, the EU expects Hungary (and some EU countries like Ireland) to phase out special treatment of this sort. In the light of this, it is promising that exports from non-special zones have grown significantly faster of late (Hamar, 2001). The phasing out of this special treatment will also be more justifiable on the grounds that these firms have begun to engage in increasingly complex activities, with more local value added. Their production should therefore no longer be so sensitive to taxes.

These patterns will be useful in interpreting the results obtained from modelling exports with aggregate variables. However, the choice of these aggregate variables is not obvious. So, first we need to consider variables that usually cause problems to applied researchers in the field, and explain how the problems have been dealt with here. Before embarking on any kind of empirical investigation, the problems presented by the variables used in the modelling exercise should be clear.

3.1.2 Problems relating to analysis

The problems related to working with time series are now summarised. The length of the data series and the related problem of interpretation are considered first. Then the issue of measuring productive capacity is discussed.

Shortage of data is a common problem for applied researchers on transition. However, in time series analysis this issue is even more severe. The amount of data is limited not only in terms of availability, but also by the fact that not enough time has elapsed since the start of transition. In order to overcome this problem, we could use monthly data and increase the frequency of the observations. However, it must be noted immediately that this comes at a cost. Although the higher frequency makes some quantitative and qualitative inference possible, a great deal of care must be taken when interpreting the results. Using data with a higher frequency shifts the interpretation of the elasticities we estimate away from the usual trade elasticity explanation, towards interpretations related to trade within firms and theories of multinational firms.[16]

The other problem faced in the present study was how to implement the control for productive capacities in our export regression. This is a problem that has constrained the work of many scholars in connection with transition. While we do not claim to have solved this problem for Hungary – indeed probably no one can – we argue that the treatment of the problem can be improved by choosing a better proxy. In time series trade modelling, only a few estimations have been carried out that included a measure of productive capacity. For CEE countries, time series trade regressions had no control for productive capacities at all. Some applications use capital stock as a measure of productive capacity (Riedel, 1988; Muscatelli, Srinivasan and Vines, 1992; Muscatelli, Stevenson and Montagna 1995). Unfortunately, this path was not open to us, as these data were simply not available for transition countries.

[16] One must point out that the use of monthly real variables is not unusual (Buch and Döpke, 1998). However, they see no problem of interpretation.

In the case of Hungary, officials at the Central Statistical Office who were in charge of collecting and processing this kind of data told me that they would publish them for the first time in 2000. This has not yet happened, as they had difficulties in evaluating capital stock in public services. The problem is that no data have been published regarding capital stock in the private sector either. In such a case, one can either accumulate past investment (this is pursued in *Chapter 5*) or try to find a different measure for productive capacity.

Even if capital stock series were available, some might suggest that FDI is a better variable to represent the productive capacity of the country. One could argue that the most important economic event in Hungary in the 1990s was privatisation. Hungary is the only ex-socialist country where foreign direct investors were allowed to play a significant role from the very early stages of privatisation. It is believed that FDI inflows should perform better in proxying changes in productive capacity than any standard capital stock measure based on book value, accumulated investment, or using electricity consumption as a proxy. Let us consider the problems relating to these measures one by one.

The book value of capital stock was not available at aggregate level. It is available annually for manufacturing industries, and for a large sample of manufacturing firms, but not at frequencies amenable to time series analysis. Ten years of annual or even quarterly observations is simply not enough for an appropriate testing procedure. Also, particularly at the beginning of the 1990s, capital stock data are very unreliable.

There is another possible way of proceeding when no direct observation of capital stock is possible: using accumulation of past investment. Accumulation must cover a long time-span. However, this gives rise to the danger of accumulating time series that are not homogeneous in content. Investment meant something different prior to transition and after transition had started, and the system of national accounting was completely transformed in 1992. The problem of homogeneity of the series used in the estimation is present in all the literature cited, although often no reference at all is made to this problem.

Some researchers have tried to correct measurement errors in the use of capital stock, using energy or electricity consumption as an additional production factor (Burnside and Eichenbaum, 1996; Claessens and Djankov, 1997). Some have used energy consumption to proxy capital stock to measure unobserved/informal activities. The complementary behaviour of electricity consumption and the use of capital is quite well established (Greene, 1997). The problem in a transition country is that the lack of homogeneity of the series also ruins the stable relationship between electricity and capital stock. One reason for this is that the relative price of energy and capital has changed considerably, and this has also influenced their optimal use.

Having discussed the problems connected with using capital stock as a measure of productive capacity, we will explore the possibility of using foreign direct investment as a measure of productive capacity in the empirical modelling. But why should FDI be a good measure in the first place?

The limitations of the usual capital stock measures in connection with transition countries make us inclined to seek an alternative measure of productive capacity. We believe that FDI should be a fairly good measure. There have been theories (*Chapter 2*) suggesting that FDI plays an important role as a means of technology and knowledge transfer, and as a way of acquiring management skills. These are factors that complement the impact of FDI on productive capacity that is taking place through pure capital formation.

In fact, many believe that these complementary effects are perhaps more relevant than simple capital formation (Ruffin, 1985). Microeconometric studies have been carried out (e.g., Kokko, Zejan and Tansini, 2001) on this issue, indicating that increases in FDI improve productive capacities. According to this literature (Kokko, Zejan and Tansini, 2001; Aitken and Harrison, 1999; Djankov and Hoekman, 1998, 2000a), the most important type of FDI-related effects take place through a change in the ownership structure of the economy.[17] The presence of many foreign investors in a country should compel domestic producers to adopt the more productive methods employed by foreign firms, and thereby influence their performance and exports. The

[17] This issue is pursued in *Chapter 7*.

implication of this literature is that exports grow due to a direct or indirect knowledge transfer from foreign owners. This improves the performance of the individual firm, and is something that should show up in the aggregate export analysis as well. This line of literature suggests that exports should benefit from the presence of FDI, as the performance of the firms in general benefits. However, there has been little systematic work to measure the link between FDI and exports directly.

Only micro-studies (e.g., Aitken, Hanson and Harrison, 1997) and country panel studies (Jakab, Kovács and Oszlay, 2001) have tested the link between exports and FDI. The shortage of time series work is mainly due to deficiencies in the available data. However, when one controls for productive capacities with FDI, one cannot separate the impact of FDI on knowledge transfer from its impact on physical capital. It increases both the capital stock and the level of technology. However, it must be noted that the presence of FDI still has the advantage that it reduces the omitted variable bias. This is because FDI now captures not only the changes in physical capital, but also much of the variation in intangible assets. We therefore argue that, in the case of Hungary, FDI captures the increase in productive capacities in the export sector better than measures of physical capital.

When modelling trade, changes in productive capacities need to be accounted for. We have argued that FDI is a good measure for this. Now, the question that naturally emerges is what trade models are most commonly used, and what role do productive capacity, foreign demand and relative prices play in them?

3.1.3 Econometric approaches in the trade elasticity literature

It is often argued that foreign demand is crucial to the growth of poorer countries. The most important transmission mechanism that mediates between foreign demand and export supply is foreign trade. If foreign demand is important to the growth of the domestic economy, this will be manifested in rising exports. When rapid growth is taking place in markets abroad, countries exporting there can benefit greatly. Large demand elasticities indicate that the exporting country could benefit to a disproportionately large extent from growth abroad and there is no need to reduce the prices of its products. In turn, small export elasticities with regard to foreign income indicate that the home country is not able to benefit from increasing foreign demand. In this case, the common argument is that in order to increase exports, the home country has to reduce the prices of its export products (e.g., Faberberg, 1988; Krugman, 1989).

Besides foreign demand, the other determinant of domestic products' desirability is the relative product price between foreign and domestic markets. Countries may not benefit from larger foreign demand at unchanging prices. They may be forced to reduce their (unit) prices to compensate for their inability to benefit from increasing demand abroad. In this case a negative price parameter should be observed in the export equation. When this is true, growth in the export sector can be immiserising (Bhagwati, 1969). The negative price parameter can also be interpreted as more exports driving down the prices of the exported product. This would mean that terms of trade are worsening.

It must be noted that comparisons often focus not only on the prices of actually traded goods (terms of trade), but also on those of the whole traded sector. Using a common currency to compare price levels, this is called the absolute real exchange rate. It is commonly used to control for differing price behaviours of domestic and foreign production (Goldstein and Khan 1985, Krugman, 1989; Obstfeld and Rogoff, 1996). Ignoring transport costs and trade restrictions, small price differences can cause large swings in how much is exported. However, it should be pointed out that the benefits of small or large price elasticities for exports depend on the underlying price behaviour. For instance a small elasticity can be good for exports when one faces a price rise, but harmful when prices decline. Therefore, when a country faces exogenously declining relative prices of its goods it is beneficial to have high price elasticity. At the same time, this also means that if declining prices prevail when both price and income elasticities of export demand are small, there is little chance of successful export performance.

A great deal of effort has gone into econometric estimation of trade elasticities. These models contain trade and export equations that have many specifications (Goldstein and Khan, 1985; Deardorff, 1985). In the traditional export-demand equation the two crucial determinants of exports are real exchange rate and foreign demand. As already mentioned, there are many relative price variables used in these equations. One such common measure is the simple terms of trade. It compares the price indices of actual exports and imports. More often, it is the foreign and domestic production price index (PPI), consumption price index (CPI) or unit price that are used to construct a relative price measure. Researchers sometimes use measures for relative costs instead, assuming that prices are capped on cost (Faberberg, 1988; Marsh and Tokarick, 1996). The most common measures based on cost are unit labour cost, and unit cost. Both of these occur in empirical export modelling (Faberberg, 1988; Carlin, Glyn and van Reenen, 2001).

There is much less variation in the choice of measures for foreign demand. As a measure of foreign demand, most commonly used are foreign GDP, industrial output abroad, or the total imports of the foreign country. More recently, the use of imports has become more widespread. The argument behind its popularity is that importers, it may be argued, first decide on the total amount of their imports, and then how much they will buy from producers in a particular country. Let us now investigate the different types of econometric approaches applied in the field.

Scholars in the field use a variety of econometric methods. The choice of econometric model depends on the format of the dataset and on the underlying economic assumptions. With aggregate *cross-section* data, gravity models are commonly used (Anderson, 1979). In the gravity model, it is the geographical distance that is the key variable model (apart from relative prices and foreign income). Distance is a proxy for transport costs. Of course, there are many other potential control variables available, but distance, relative prices and foreign demand are almost always present (Deardorff, 1985). The distance between the trading partners is unchanging over time, so this is something time series analysis cannot identify, as it is present in the constant.

Recently, *panel models* (e.g., Mátyás, 1997) have been used not infrequently as an analytical tool for gravity models. Panel methods are useful, as they enable factors that change over time to be accounted for. These could not be dealt with in cross-section models.

For instance, one can regard the political system and the language as country-specific factors. There are factors that are specific to trade relations as well. These can include a trade regime that is specifically geared to a particular country, or the quality of the infrastructure that can ease or hinder trade with a particular country. The panel format enables a rich analysis to be carried out (Jakab, Kovács and Oszlay, 2001).

The problem for the researcher working with time series data is that the available FDI time series are even shorter for transition countries than they are for developing countries. It is not surprising, therefore, that economists modelling exports and trade in transition countries have often used panel models with large country cross-section data (Halpern and Wyplosz, 1996; Jakab, Kovács and Oszlay, 2001).

Despite its intellectual appeal, the evidence on the relevance of the panel specification is mixed. The fixed-effects specification of the gravity trade models by Mátyás (1997) included a factor specific to a particular trade relationship. Its application to the Asian-Pacific countries resulted in interesting sign shifts in some variables (Mátyás, Kónya and Harris, 1997). The results were interpreted as the country and relation-specific factors on the supply side overwhelming demand factors abroad. However, for a panel with a longer cross-section and time span, the specification recommended by Mátyás (1997) did not appear to be robust (Jakab, Kovács and Oszlay, 2000) and a less sophisticated model (a simple pool) proved to be a superior specification. The other interesting feature of that panel was that the authors managed to include FDI flows for a large sub-sample of countries and it proved highly significant. It also turned out to have higher elasticity than real exchange rate or foreign income.

However, it is not only in cross-section and panel trade analysis that important changes have taken place. In *time series research*, non-stationary analysis has gained popularity. The methodology is thought to be superior to its predecessors, as it accounts for the possibility that exports and their determinants might face shocks that have long-lasting effects on the paths of the individual variables. A recent example of this in the trade elasticity literature was an article by Hooper, Johnson and Marquez (2000), in which they carry out an estimation of trade elasticities for prices and income.

However, they only had to account for relative prices and foreign demand to find a satisfactory specification in a sample of OECD countries. It is recognised that in the time series modelling of exports, researchers usually account for fewer determinants than in cross-section (Jakab, Kovács and Lőrincz, 2000). One can argue that in the mature, developed countries there are no dramatic changes taking place in the economy and the behaviour of exports can be adequately described simply by relative prices and foreign demand. However, in countries where a large-scale structural transformation is taking place, these two variables alone are probably rarely sufficient to find a satisfactory specification.

The experiences of Japan and other Asian countries show that relative price and demand conditions on their own cannot explain long-run determinants of exports success (Goldstein and Khan, 1985). As far back as the 1970s, researchers were already pointing out that the export success of these countries depended crucially on supply factors (new technology, productive capacities) rather than on traditional demand elasticities. However, pure time-series testing on the importance of supply factors is scarce. This is mainly due to the short period for which data on productive capacities are available.

The estimation of the exports equation using time series methods became popular when pessimism about the trade elasticities of developing countries prevailed (Singer, 1950). At the time it was maintained that the main impediment to enhancing the welfare of poorer countries is the declining relative price of their products. It was also believed that price elasticities relating to exports were not only negative, but small as well. As a result, their exports benefited very little from declining prices.

However, the research on the presence of a declining trend in relative prices has brought results that cast doubt on these presumptions. Time series modelling of the terms of trade suggested that there was no negative trend for developing countries. If long enough series were considered, other measures of relative prices indicated no such trend either (Dornbusch and Vogelsang, 1991). When these series were included in export equations, the usual finding was that the price elasticities were negative.

Some early studies (Houthakker and Magee, 1969) discovered small price elasticities. At the same time, these studies established large income elasticities (Houthakker and Magee, 1969; Golstein and Khan, 1985). This means that early *time series* calculations did not justify the elasticity assumptions of Singer (1950).

In light of the successes of the Asian countries, Hooper (1978) estimated their export equations to ascertain which elasticities the Asian export boom was associated with. He argued that the high income elasticities observed in the exports of Asian countries to the US must be due to unaccounted for supply elasticities, rather than income sensitivity. In his opinion, price and income elasticities had been grossly overestimated, and the high income elasticities found earlier were simply due to the misspecification of the econometric model. Hence, the true foreign demand elasticities should be closer to Singer's pessimistic ideas. Optimism regarding the evolution of exports in poorer countries should therefore be based on supply factors instead. According to Hooper (1978), the most important determinants of exports were supply-side factors. He dealt with the problem by including capital stock in his trade equation.

It was only ten years after Hooper's work that there appeared new studies exploring the role of productive capacities in exports. Riedel (1988) pointed to the importance of supply factors for the success of Hong Kong, and the irrelevance of foreign demand. In turn, Muscatelli, Srinivasan and Vines (1992) and Muscatelli, Stevenson and Montagna (1995) presented estimation results on East Asian countries that suggested the opposite conclusion.

However, there is no time series modelling of post-transition export behaviour for Hungary, except for Jakab, Kovács and Lőrincz (2000). But they did not control for the supply side and changes in productive capacities. So there is very little time series evidence about the driving forces of exports. The question is, to what extent can one infer behaviour during transition from pre-transition observations?

Interestingly, transition was well under way when Halpern and Székely (1993) were still quite optimistic on the issue: "... if correction is made for specific features of export and import policies, stable relations, and therefore meaningful estimates can be achieved for this period (*i.e., 1968-1989 – the author*). If this claim is justified, these estimates can be invaluable sources of information for economic policy makers…". In practice, not many shared this optimism. Researchers mostly abstained from using time series data that included data from the socialist system, even when structural change could somehow be accounted for. In transition countries, the shortness of time series did not allow time series methods to become common, and they can only be used properly if the problems of homogeneity are properly addressed. However, as time series observations accumulate it is becoming more and more sensible to use these tools as well.

The limitations of the use of time series data must be clear. In general, this limitation is recognised and not many time series studies have been written in the transition context. However, this does not mean that using shorter time series and higher frequency of data results in patterns that cannot be interpreted. In fact, they can carry useful information. In order to be able to deal with this, we need to review the methodology and results of the most important papers using time series methods on dynamic countries.

3.1.4 Results of the new literature on export modelling

We have seen the basic empirical results in the early empirical trade literature. However, the results and the methodology of the latest articles on the subject need to be investigated. As there has been very little research done on Hungary, the empirical work on other countries can have a great deal of relevance for us. It can give us hints regarding changes that the new methodologies have brought about in the results. The purpose of this section is to summarise results on export modelling with the new time series methodology.

As already mentioned, early papers estimated a simple, single-equation framework, where the volume of exports was explained by relative prices and foreign income. Hooper (1978) suggested that this was unsatisfactory, as the supply side was not represented, and that this equation was therefore unable to explain the growth of countries where large increases in productive capacities took place. He simply added capital stock to the equation. It was found that this reduced the large income elasticity considerably. So it was concluded that it is not foreign demand, but the creation of capacities and price competition that was driving the exports of the Asian countries.

Ten years later, Riedel (1988) modified the single equation framework. He set up a simultaneous equation system and estimated each equation with 2SLS, and included a measure of capital stock on the supply side. Riedel's results suggested something similar to those arrived at by Hooper (1978). The income elasticity of exports was zero. At the same time, the price elasticity of exports was found to be very high. These results were interpreted as proof of the small country assumption. This evidence suggested that Hong Kong proved to be successful under intense price competition in the foreign market. The implication of this was that poorer countries could be successful exporters in products that have large price elasticity and face intense price competition.

The subsequent testing of the model by others suggested that the model was probably misspecified, and a more comprehensive specification suggested very different elasticities. In addition, the use of simple two-stage least squares with non-stationary variables was flawed.[18] The missing unit root and co-integration tests make it very probable that his regression results were spurious. However, this work was very useful as it provided the basis for more reliable results in the future.

Using Riedel's dataset on Hong Kong, Muscatelli, Srinivasan and Vines (1992) came to very different conclusions. They set up a simultaneous model, and they estimated it accounting for the endogeneity of some of the variables in the structural model. Next, they created error correction terms from each equation. These then were included in a vector error correction model that contained the export demand and the export supply equations. Their long-run elasticities of supply were found to be similar to those given by Riedel (1988). However, the demand elasticities were markedly different. It turned out that the foreign demand elasticity was very high, while the price elasticity was very low. They interpreted the results with caution. Instead of arguing that this means

[18] Without co-integration tests of the structural equation, the model should not have been estimated. It was not until recently that a result was found (Johnston and DiNardo, 1997, Phillips and Hansen, 1990) allowing simultaneous models containing non-stationary variables to be estimated with two-stage least

that foreign income conditions drive exports, they argued that the high demand elasticity probably captured the influence of non-price factors. In a subsequent article they tried to account for non-price factors explicitly.

In order to improve the interpretability of their elasticities, some included capital stock as a demand factor in the model (Muscatelli, Stevenson and Montagna, 1995). What argument could this idea be founded on? In their study they referred to the new growth theory and the increase in the variety and quality of products from East Asian countries. Krugman (1989) argued that increases in the variety of products lead to increasing desirability of a country's products. Hence, the growth in the number of firms producing this increased variety of products should be associated with a larger capital stock. It is argued that total capital stock should therefore be a good proxy for the number of varieties.

In line with the new growth theory, capital stock can be a demand factor, as it proxies either increasing variety (horizontal diversification) or better quality (vertical diversification) (Grossman and Helpman, 1991). In the paper by Muscatelli, Stevenson and Montagna (1995), therefore, capital stock serves as both a demand and a supply variable.

The estimation procedure followed in this study (Muscatelli, Stevenson and Montagna, 1995) was similar to that described in the earlier article. In the latter article the long-run elasticities were obtained with an ADL estimation of each equation. Then, vector error correction (VECM) models were used to double-check the validity of long-term elasticities obtained by the Phillips-Hansen co-integration method. They tested the experiences of a large number of Asian countries and found considerable variation in the elasticities across the countries. In the demand equations without capital, they estimated typically high price elasticities and high income elasticities. However, when they included capital stock in the demand equation to control for variety, results changed. Out of six Asian NIC countries they found price elasticity to be high in four countries, while income elasticity was high in only two of them. At the same time, the capital elasticity of export demand was found to be high for four

squares, provided each structural equation is co-integrated.

countries in the demand equation. Capital elasticities for export supply were also found to be high.

This finding increased the credibility of the argument that high demand elasticities found earlier were due to other, unaccounted for demand factors. The results suggested that the increasing variety in production could be one such important factor. However, the paper has shown that export supply elasticities with regard to productive capacities can be very high as well. This suggests that the role of the expansion of capital stock is crucial in increasing the exports of these countries.

It is curious that in some of the export equations no constant was included (Muscatelli, Stevenson and Montagna, 1995). This implies that the growth rate of exports has no autonomous part. This is rather questionable (Hendry, 1995). Also, in order to be able to use the Phillips-Hansen estimator, they had to use a number of other regressors (world prices, labour cost) to obtain co-integration in their structural equations. At the same time, their choice of endogenous variables from among the many variables in their model remained ad hoc.

Instead, Hooper, Johnson and Marquez, (2001) and Jakab, Kovács and Lőrincz (2001) opted to use a VECM that assumed that every variable was endogenous. The long-term multipliers obtained with the Johansen methodology can be interpreted as demand elasticities. Alternatively, the parameters of export prices, foreign demand and capital stock can be regarded as the long-term multipliers of an unknown simultaneous system. If we are only interested in these parameters, this can be an appropriate interpretation of an export equation. However, depending on how complicated the original structural model is, one may be able to draw conclusions from the estimates of the long-term multiplier about the structural parameters. This is the path our empirical investigation will follow.[19]

In sum, three strategies have been described for the time series estimation that can account for productive capacities. The first is the estimation of traditional export

[19] It should be noted that Hooper, Johnson and Marquez, (2001) found small price and high income elasticities for the exports of OECD countries. Jakab, Kovács and Lőrincz (2001) found rather large elasticities for Hungary. However, neither article allowed for changes in productive capacities.

demand equations (Houthakker and Magee, 1969; Hooper, 1978). With the second approach, one could estimate a two-equation system of supply and demand with a method (Phillips and Hansen, 1990) that corrected for the endogeneity of the variables of the equations (Muscatelli, Stevenson and Montagna, 1992; Muscatelli, Srinivasan and Vines, 1995). If the third strategy were followed, one would estimate an export equation using non-stationary methods (co-integration) in a framework that assumes the endogeneity of every variable. This method (Johansen, 1988) has already been used in the recent literature (Hooper, Johnson and Marquez, 2001; Jakab, Kovács and Lőrincz, 2001).

The time series literature suggests that the behaviour of trade elasticities varies a great deal across countries. One might therefore think that the structure of the economic relations between particular countries trading with each other should play a key role in explaining exports. This is something that the estimation of a simple demand equation, or even the simultaneous demand and supply system, may not be able to capture.

However, if the above point is valid, then in order to interpret the sign of the export elasticities we need to make assumptions about the economic structure. Now, therefore, the signs associated with different assumptions are reviewed. Let us first explore the simplest structures common in trade modelling.

3.2 The expected signs of parameters

Now we are going to deal with the popular specifications of export equations in time series modelling, and with the sign structure we can expect to appear. First, situations are considered where the model estimated is a single equation. Next, a comparative static model is set up. The discussion focuses on the reasons why the impact of some variables on the other variables of the system takes certain signs in the models. *Table 3.2* gives the notation used.

If the estimated relation is an *export demand function*, it takes the form $Z_D = Z_D(P, Y_D)$, where export demand depends on the price ratio between the foreign and home country *(P)* and on foreign demand (Y_D). In some papers, the productive capacity of the home country (K_Z) is also regarded as an extra determinant. It captures demand factors like quality and variety of products in the home country.

An increase in the foreign price and a decline in the domestic price can cause an increase in *P*. Technological progress (and a decline in unit price) in the immediate good (Z) producing sector of the home country economy can contribute to this development. However, nominal rigidities of prices have the opposite impact.[20] In practice this means that, in the short term, *P* and export volumes can be related with the opposite sign than the one predicted by the law of one price.[21]

Table 3.3. Variables and functions used in the comparative static exercise

K_{Y0}	Capital stock of the final good producing sector (in the foreign country)
K_Z	Capital stock in the immediate good producing sector (in the home country)
K	Capital stock in that part of the foreign country not producing final good Y
P_Y	Price of the final good (Y) in the foreign and the home country
P_Z	Price of the immediate output (Z) in the foreign and the home country
P	Price ratio of the final and the immediate product
X	Export of the immediate good producing sector (from the home country)
$Y_D(.)$, $Y_S(.)$	Demand for and supply of final products (Y) in the foreign country
Y_{D0}	Demand for the final good in the foreign country
$Z_D(.)$ $Z_S(.)$	Demand for and supply of immediate products (Z) in the home country
Π	Profits in the final good producing sector (in the foreign country)

If the estimated relation is an *export supply function*, it takes the form $Z_S=Z_S(P, K_Z)$. The estimation of this relation is rare. It is more common to assume that the supply of

[20] It can happen that an exporter has fixed its prices in foreign currency nominal terms in advance. Assume there is an adverse domestic price shock occurring, and he can only adjust production and export optimally (by reducing it) after fixing expires. This means that P_Z increases and *P* declines. So without the contractual obligation we should observe reducing exports. However, if the contract sets out increasing export volumes at fixed foreign currency prices, which is often the case in foreign-owned exporting firms in Hungary, then export would still be increasing for a while. Therefore, it can happen that we observe a negative relation between *p* and demand for exports.

[21] This means that in the econometric model longer lags are needed. If nominal rigidities are present we expect a reversed (negative) sign for the price variable in the short term, and normally behaving (positive) ones for the longer lags. With an export regression containing lags of *P*, one would expect negative signs for the short lags, and positive ones for the long lags. This is in fact often observed (Goldstein and Khan, 1985). The sign pattern of the price variable can be taken as a test for the presence of nominal rigidities.

export is infinitely elastic and it is only the variation of demand function that causes exports to change. In the export supply function an increase in input prices represented by (P_Y) has a negative impact on export. A rise in the price of the end product (P_Z) has a positive impact, and so does the expansion of productive capacities (K_Z). The increasing returns production function can have a peculiar effect. It makes the supply function downward-sloping, so the supply of the firm is increasing at a declining output price.

3.2.1 Equations of a model for a small home country

In this section we present the equations of the comparative static model, and argue for the chosen specification.[22] Most often, researchers model export as a demand function. Recently it has also become popular to model exports as a simultaneous demand and supply system. However, in reality there are many more other factors influencing export than are taken into account in these articles. A comparative static model could therefore be set up that is helpful in obtaining results that reflect the true determinants of export more accurately. Detailed discussion of the equation of this model is given in *Appendix 3.1*. In the body of the text only the salient features of the model are outlined.

In what follows we are going to set up a comparative static model that accounts for more possible causal relations than are captured in the above two equations. There will be three main extensions in the model to the usual export equations. First, we take into account the fact that the vast majority of trade is not in consumer goods, as suggested by the usual specification of the export demand function, but in intermediate goods. Second, we incorporate the endogeneity of investment flows to the home country into the model. This allows exports of intermediate goods to depend on demand (and investment) conditions in the foreign country.[23] The third extension is that we allow increasing returns to scale production. We base this assumption on the

[22] The signs of the partials of variables are indicated with a plus or minus sign at the top right hand of the variables.

[23] The evolving pattern of specialisation associated with capital flows has been tested by many researchers in the past (Bowen, 1983; Leamer, 1984), and some work has been done recently on transition countries too (Landesmann and Stehrer, 1999)

fact that the output and exports of the traded sector have been increasing very rapidly in Hungary (IMF Financial Statistics Yearbook, 2001). We hope that, with these extensions, our partial comparative static model will fit the characteristics of the Hungarian economy more accurately.

In the model there are two countries, two products, and two factors of production that vary: capital and the product of the other country. Labour stock is set as exogenous. In the case of Hungary, this can be defended on the grounds that the most dramatic changes in the labour market took place by the starting year of our sample (1992). It is also realistic to leave labour out of the model on the grounds that migration across countries is essentially non-existent. It is fair to say that the EU labour market is closed for those Hungarians who would like to work there for higher wages.[24]

Let us now turn our attention to the equations of the model. We have four endogenous variables in the system: relative prices *(P)*, profits abroad *(Π)*, exports of the intermediate product from the home country to the foreign country *(X)*, demand for the final product abroad (Y_D), and capital stock in the home country (K_Z).

The normalised function where all terms of the equation appear on the left-hand side is denoted as G_i. The system of equations contains four equations:

$G_1=0$

$G_2=0$

$G_3=0$

$G_4=0$

.

Our purpose is to derive the total differentials of the normalised equations of this system. In order to obtain this, each equation had to be differentiated partially with respect to each variable of the system. The variables that appeared in the equations were either fixed (which dropped out in the differentiation), or they were endogenous.

24 This helps us to omit wages from the system altogether, because there is no inter-country variation of labour stock due to changes in wage rates. Leisure does not play a role either. Hence, when we talk about variation in capital one may think of it as variation in per capita capital.

Our earlier notation is then extended. G_{ij} contains the partials of the system. Index i (the row of the matrix) indicates the number of the equation and j (the column of the matrix) stands for the endogenous variable with which we differenced the equation. So, for instance, G_{12} denotes the partial of the first equation with regard to the second endogenous variable, which is profits abroad (Π).

We set up the total differential of the system and we determine the sign of the partial derivatives of the individual equation with respect to each endogenous variable one by one:

$$\underset{4\times5}{G}\cdot\underset{5\times1}{u} = \underset{4\times1}{0}$$

$$u' = (dP, d\Pi, dX, dY_D, dK_Z)$$

.

Let us now turn our attention to the individual equations of the model.

The *first equation* of the system (G_1) stands for a market equilibrium in the foreign sector that produces Y. The equation consists of three terms. The supply of the final product (Y_S) is demanded by foreign agents (Y_D), and by producers in the home country (Y_{ZD}). Home country producers use the final good (Y) as input in producing the immediate product (Z). Supply of the final good Y depends on prices and capacities, while the demand depends on prices only.

$$\begin{aligned} &Y_D + Y_{ZD}(P\ ) - Y_S(P\ , K_0) = 0 \\ &G_1 = G_1(P^{?}, Y_D^{+}, K_0^{-}) = 0 \end{aligned} \tag{3.1}$$

We see that our normalised function G_1 stands for the excess demand for final good Y. Because increases in capacities (K_0) unambiguously reduce excess demand, it has a negative partial. An increase in foreign demand for the final good (Y_D) obviously increases it, so the partial is positive. The partial of the price parameter (P) is ambiguous. This is because it contains both the demand and the supply price elasticity (Refer to *Appendix 3.1* for details of the partials of the system).

We assumed that the final good is demanded in the foreign country (Y_D) and also in the home country (Y_Z). This reflects the fact that the bulk of imports from Germany to Hungary comprises investment goods and highly processed intermediate goods (Freudenberg and Lemoine, 1999). We also assumed that the foreign (German) economic agents who buy the final products are much less price-sensitive than the Hungarian ones, so their demand does not depend on the relative prices. K_0 was set at constant, assuming that it has not changed much, since manufacturing investment has was very low in Germany throughout the 1990s. It was also assumed that changes in world demand do not play a role. Trade is purely a bilateral matter.

The *second equation* of the system *(G_2)* stands for a market equilibrium in the foreign sector that produces Z. Three auxiliary equations are presented below. The first states the excess demand function for the immediate good *(Z)*. This good is only demanded in the foreign country, and only produced in the home county. All purchases therefore count as export *(X)*. This leads us to the second equation, which states that supply meets demand and that all production of and demand for the immediate product *(Z)* is exported. Because of the equality of demand and supply, the half of their sum also equals to export and this simple fact constitutes the third equation. This is the basis for our normalised equation *(G_2)*.

$$\begin{aligned}
&Z_D(P\ ) - Z_S(P\ ,\mathrm{K}_Z) = 0 \\
&X\ = Z_D(P\ ) = Z_S(P\ ,\mathrm{K}_Z) \\
&X\ - \frac{1}{2}\left(Z_D(P\ ) + Z_S(P\ ,\mathrm{K}_Z)\right) = 0 \\
&G_2 = G_2(P^?, X^+, K_Z^-) = 0
\end{aligned} \tag{3.2}$$

We introduced a new variable to denote the amount of the immediate product produced and exported *(X)*. Later on, the determinants of this variable will be examined. As far as the partials of the normalised equation are concerned, one can make several observations. First, an increase in capacities *(K_Z)* has a negative partial in the normalised equation. This is because an increase in capacities increases export supply *(Z_S)*, so any shortage of the export *(X)* is reduced. Second, an increase in exports, by definition, increases exports one-to-one. So its partial is positive and equal to one. However, the partial of the price parameter is ambiguous. This is due to the fact that it contains both supply and demand elasticities and they are of opposite signs. It is further complicated by the fact that we allowed increasing returns to scale.

The *third equation* of the system *(G_3)* stands for the equality of foreign demand and the profits generated in the foreign country.

$$\begin{aligned} &Y_D = \Pi \\ &G_3(Y_D^+, \Pi^-) = 0 \end{aligned} \qquad (3.3)$$

The equation suggests that the demand for final goods *(Y_D)* in the foreign country is determined by the total profits in the foreign country *(Π)*. Because we set up the equation as an identity, the derivative of G_3 with respect to foreign income and profit is –1 and +1, respectively.

One must note that it was also assumed that the price ratio *(P)* has no effect on the total level of profits in the foreign country. This suggests that that part of the company sector that trades with the home country is so small that it cannot influence the overall profit *(Π)* and income *(Y_D)* of the foreign economy. To put this in another way, the input and output decisions of the firms influence the profits of the final good-producing firm Hungary trades with, but not the overall profit of the income-generating sector of the German economy.

This is one way of introducing the small country assumptions. Because demand is only determined by profits and we take no note of consumer behaviour and the labour market, our system remains partial.

The *fourth equation* of the system *(G_4)* introduces the assumption that investment in the home country depends on the demand conditions in the foreign country. We assume that in the foreign country the level of capital stock is positively related to profits there. However, we assume that the stock of capital in the home country *(K_Z)* can be both positively and negatively related to foreign capital stock *(K)*.

$$\begin{aligned} &K_Z = f(K\ (\Pi)) \\ &G_4(\Pi^?, K_Z^+) = 0 \end{aligned} \tag{3.4}$$

The reason behind this is that there can be different incentives to invest abroad. We presume that the relation of the foreign capital stock *(K)* to that of the home country *(K_Z)* can go both ways. Assume that demand conditions are weak in the foreign country. In this situation, foreign firms may decide to reduce their investments both at home and abroad. If profits abroad *(Π)* are hit by a recession, then there are fewer resources available to invest, and investments of the firm suffer everywhere. However, it is equally realistic to assume that, as a reaction to a recession at home, firms increase investment abroad. This can be the case when firms become more cost-sensitive in bad times. In our set-up, this would mean that they substitute some of their home inputs with intermediate inputs (Z) from the home country. We did not restrict the relation of the home country capital stock *(K_Z)* to the profit conditions in the foreign country *(Π)*. The partial of G_4 with respect to foreign demand *(Π)* is therefore ambiguous. Naturally, capital stock *(K_Z)* is positively related to itself, so the sign of its partial in the normalised equation *(G_4)* is positive (and equal to one).

There are many other factors that could have been incorporated into the model. In theory, one could trace the impact of the variables by setting up extra equations. But then the model would become too complicated and any conclusions we could draw regarding the structural parameters would disappear. Another argument for keeping the number of variables low is that they can cause problems when it comes to estimating long-term equilibrium relations. The more variables we have in the system, the more probable it is that we find multiple co-integrating vectors in the time series analysis that may turn out to be difficult to interpret. Choosing the right interpretations is difficult, and this can lead to ambiguities in the econometric model.

So, from an empirical point of view, the model should contain as few variables as possible, and we argue that the simplifications correspond largely to the patterns of trade relations between Hungary and Germany. We believe that the simplifications made in the model were reasonable, considering the patterns of trade and FDI relations and the sizes of the economies concerned. Let us now derive the long-term multipliers of the model.

3.2.2 Long-term multipliers of the model under different assumptions

Before going any further, let us make a simplification. We use the *third equation* to replace foreign demand (Y_D) with profits abroad (Π). Naturally, the *third equation* is then dropped. The system of total differentials becomes even simpler:

$$\underset{3\times 4}{G}\cdot \underset{4\times 1}{u} = \underset{3\times 1}{0}$$

$u' = (dP, d\Pi_Y, dX, dK_Z)$

.

So the equation system becomes:

$G_1=0$

$G_2=0$

$G_4=0$

.

Now the system of total derivatives looks like the one below. The signs of the partials are indicated at the upper right hand corner of each partial:

$$\begin{bmatrix} G_{11}^{?} & G_{12}^{+} & 0 & 0 \\ G_{21}^{?} & 0 & G_{23}^{+} & 0 \\ 0 & G_{42}^{?} & 0 & G_{44}^{+} \end{bmatrix} \begin{bmatrix} dP \\ d\Pi_Y \\ dX \\ dK_Z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \qquad (3.5)$$

.

Despite the fact that there are ambiguously signed variables in the structural model, some of the multipliers may turn out to be unambiguously positive or negative. We hope that the long-term multipliers we find can be reconciled with the model, and that one may even be able to draw conclusions with regard to structural parameters of the system. First, the comparative static multipliers are derived.

In presenting the comparative static results we resorted to information in *Appendix 2.1* and *Appendix 3.2*. The former contains the derivation of the partials of the individual equations, and the latter shows exactly how the comparative static results are obtained.

Table 3.4. The comparative static signs under decreasing returns to scale

		Nominator (dx)			
Denominator (dy)		dX Export of the immediate good	dP Relative prices	dΠ Profits in the foreign country	dK_Z Capital in the home country
	dX	None	+	+	?
	dp	?	None	?	?
	dΠ	?	?	None	?
	dK_Z	?	+	+	None

Table 3.5. The comparative static signs under increasing returns to scale

		Nominator (dx)			
Denominator (dy)		dX Export of the home country	dp Relative prices	dΠ Profits in the foreign country	dK_Z Capital in the home country
	dX	None	?	+	?
	dp	?	None	?	?
	dΠ	?	?	None	?
	dK_Z	?	?	+	None

The signs we obtained from the comparative static exercise (*dy/dx*) under decreasing returns to scale (DRS) are presented in *Table 3.4*. *Table 3.5* contains the comparative static results (long-term multipliers) proposed under increasing returns to scale (IRS).

It may be seen from *Appendix 3.1* that the term $G_{12}G_{21}G_{44} + G_{11}G_{42}G_{24} = A$ is crucial in determining many of the signs. We may be able to determine its sign using the empirical estimates of the long-term multipliers. This is important as it will greatly simplify the quest for theoretically acceptable sign combinations of long-term elasticities.

By allowing increasing returns, we permitted more sign combinations of the long-term multipliers of the system to become theoretically acceptable. It can be seen immediately from *Table 3.3* and *3.4* that there are fewer ambiguous signs under decreasing returns to scales (the model is more restrictive) than under increasing returns, if $A<0$ is assumed. One can show that this means that, under decreasing returns for a given A, the long-term price and foreign demand elasticity must have the same sign. However, under increasing returns, the signs of the price and income elasticities can differ. This means that under increasing returns we have more freedom to interpret the long-term multipliers, and we have more chance to find a model that fits the empirical findings. We shall further expand on this when we evaluate the long-term empirical elasticities and discuss which specification of the comparative static model they seem to be consistent with.

The question that now arises is how exactly our comparative static model relates to the models assumed in the empirical literature. The traditional time-series export demand equation (Hooper, 1978; Krugman, 1989) has been replaced by simultaneous models (Goldstein and Khan, 1985; Muscatelli, Srinivasan and Vines, 1992; Muscatelli, Stevenson and Montagna, 1995). The early articles estimated the export demand equations that correspond to the one contained in the *second equation* of the model above. The later articles estimated the supply and demand components of the *second equation* jointly. We hope that our analysis gives new results, due to the information in the *first equation* and the *fourth equation*. This information has been not been accounted for in the existing literature.

Keeping the model small compelled us to combine supply and demand in one equation (the *second equation*). This came at a cost. It is unlikely that we will be able to identify the price elasticities from the structural model, only their differences or their sums.[25]

[25] This depends on which equation and the form of the production function assumed (decreasing or increasing returns).

However, we may still be able to extract useful information on important elasticities other than prices. Naturally, this is not to say that price or income elasticities would not be interesting or relevant for us. While acknowledging that there has been little research on these in the case of Hungary, we think it is more interesting to try to extract information from the data on the extensions that we have made to the model. This would include the dependency of FDI flows on demand conditions abroad, and the possibility of increasing returns to scale in production. It seems that these have been overlooked in the empirical literature we reviewed.

3.2.3 The conclusion of the chapter

The purpose of this chapter was to summarise the popular types of methodologies used to analyse exports and to summarise the main results arrived at by the research so far. The discussion concentrated on the results obtained by time series analysis. We have seen that both economic and the econometric models have changed considerably since this field of economics became established as a buoyant area for research. Much effort was subsequently dedicated to this field, as it was expected that robust and policy-relevant results would emanate from this work.

However, the studies that applied the most flexible economic models and econometric methods suggested that this was not the case. The results on export performance across countries are difficult to generalise. This suggests that the economic structures accounted for in the export equations may need extending. A comparative static model, which is more flexible than the models reviewed, was therefore set up to explain exports.

In the next chapter, an analysis of the long-term multipliers of exports is undertaken and some structural determinants of exports are identified. Although some work has been carried out on export modelling, these studies generally assumed a very simplistic economic structure to explain exports, which made it difficult to interpret the results. Below, an attempt is made to reveal empirical patterns in the export behaviour that have been ignored in previous research, and we hope to obtain some results that can be interpreted with more certainty.

Chapter 4: Time Series Estimation of Exports

The previous chapter presented the current state of the time series literature on trade, and the main shortcomings of the applied literature relating to transition countries. In this chapter, an econometric analysis of exports is carried out that reflects the new methods in the literature, and the results are used to draw conclusions with regard to the structural links between the countries of the EU and Hungary. The results will also help to evaluate the contribution of FDI to the growth of exports in the new era.

In *Section 4.1* we introduce the problem to be dealt with in this chapter. The main points of interest are presented and reference is made to the literature that is relevant for the methodology. Next, we summarise the main intuitions of the non-stationary methodology and describe the steps of the procedure applied.

In the *Section 4.2* we present the results. First we discuss the main patterns of the input data, and then the co-integrating vectors among the variables of our model are calculated. They are interpreted as long-term multipliers of the comparative static system discussed above. As a series of structural breaks puts the validity of these results in doubt, we had to recalculate the regression results for a subsample of the original series. We used a range of tests to make sure that the co-integrating vectors were valid. Finally, we analyse the self-correcting mechanism among the variables of the model.

Then, in *Section 4.3*, we discuss the implications of the co-integrating vectors with regard to the structural pattern of the comparative static model and we also obtain information on the Granger-causal relations among the variables from the vector error correction specification. These two methods give us insights about the actual structural links between the variables of the model we are interested in.

Finally, in *Section 4.4*, we discuss the policy implications of our findings. Due to the nature of the data and the trade between the countries, the interpretation of our results shifted from the elasticity-based explanation to discussing the consequences of within-firm (FDI-based) trade.

In the previous chapter we reviewed the most important points of the elasticity literature on export behaviour. We pointed out that it was surprising that measures of productive capacities have appeared in export modelling only quite recently. We also remarked that the economic models behind the export models could be too simple, and that this poses difficulties when it comes to interpreting the results. Acknowledging the shortcomings of our method, we proposed a more detailed comparative static model than is common in the export modelling literature.

This leads us to the purpose of this chapter. We have two objectives in mind. The first is to estimate the long-term multipliers of exports, and see what factors they are sensitive to. Our aim here is to ascertain what role is played by FDI. Our second objective is to draw conclusions about some of the structural patterns behind trade and investment links between the countries of interest. Two methods are applied. We obtain the empirical counterparts of the long-term multipliers of the system, and check if anything might be inferred from them concerning the structural patterns of the model. With the second method, we discard all knowledge of the structural model and explore the Granger causal relations among the variables. Our main interest is in the sensitivity of FDI flows to Hungary with respect to demand conditions abroad, an aspect that has been largely overlooked.

There has, in fact, been very little time series work done on this issue, so there are hardly any prior examples to which we can refer. While making remarks on the methodology is not the goal of this thesis, it is natural to ask where research on trade using the new time series methodology stands. The 'new' time series methodology, however, is no longer new. It has become popular as a result of a series of articles in the 1980s (Engle and Granger, 1987, and Johansen, 1988). There have also been a number of review books written (Banerjee, Dolado, Galbraith and Hendry, 1993; Enders, 1995; Kim and Maddala, 1998). This literature is new relative to the time-series articles that essentially established the trade elasticities literature up to the early 1980s. Re-evaluation of the results of the old literature on elasticities using the new methods is still going on.

We start our analysis in *Section 4.1.1* by with a brief look at the main ideas of the new, non-stationary time series methodology. Then, in *Section 4.1.2*, we summarise the main patterns of the data used in the subsequent work. Next, in *Sections 4.1.3* and *4.1.4*, we search for the presence of long-term, structural relations, first in the whole sample and then in a more homogeneous subsample.

4.1 Non-stationary methodology and the structure of the empirical investigation

Without going into the details of the techniques of the new time-series methodology, it is worth discussing the main intuitions behind it. A more detailed summary of the methods we apply can be found in *Appendix 4.1*.

As most time series in economics contain a trend, for a long time it was very difficult to distinguish causal relations from spurious regressions using the old methodology. This pattern almost certainly makes parameter estimates in a time series regression significant. Researchers often controlled for this problem by including a time trend in the regression. This was found to be insufficient, as not all time series revert to a deterministic trend and trend-stationary. It was also found that many non-stationary time series could be better described as a series that contains a *unit root*, and they need to be differenced to render them stationary. The practical importance of finding unit roots was that, unlike trend-stationary processes, they are long-memory processes. So the impact of a disturbance disappears very slowly, if ever. The implication of this was that because many macroeconomic time series have turned out to be unit root series, economists have had to think differently about the behaviour of the macroeconomic time series as well. The impact of random shocks may not disappear fast.

Co-integration between these variables means that there is an economic structure that does not allow the error term to explode. If the errors are not satisfactory, the system is not co-integrated and the underlying theory may be a flawed description of the economic relation under analysis. Engle and Granger (1987) propose a simple OLS regression to recover the patterns of these links. If co-integration is present, then one must be able to transform the model into an error correction format.

In our research, we make use of co-integration as well. But the way we treat the problem of endogeneity is different from much of the literature we have so far reviewed. These have mostly used 2SLS for this source of bias. Instead, we are going to apply Johansen's co-integration approach. We think that this specification is more flexible, as it assumes every variable to be endogenous. In much of the new trade literature, the choice of the endogenous variables was based on assumptions only. The Johansen method eases this problem by assuming the endogeneity of all variables of the model at the very start.

If we have a system of co-integrated variables, it implies that they have a common long-run trend. Then the system can be described as a combination of long-run behaviour and a behaviour that corrects for short-term deviations from the long-term stochastic trend. The signs of the parameters that belong to these ECMs should correspond to the signs predicted by the long-term elasticities; otherwise, the model is wrong. The parameters of the right-hand-side variables can be regarded as the structural parameters of the model.

Now the question arises, what kinds of question can be answered with the help of these techniques? Results that help in the evaluation of long-term trade elasticities can be obtained. These elasticities are the elements of the co-integrating vectors we identify. In addition to this, we may be able to excerpt information about the structural elasticities of the comparative static model from these long-term multipliers. However, this may not always be the case. Fortunately, as we indicated before, there is another route available. With the co-integrating vectors in hand, we can set up a VECM, and the parameters of the differenced variables in the VECM provide us with clues regarding the short-term, structural determinant of exports. This may sound easy and clear-cut at first, but it is a long process to obtain the elasticities we are interested in. So, first we present the main steps of the procedure applied. The steps for seeking co-integrating vectors and information about structural relations are the following:

1. The individual series are presented graphically.
2. Some series need to be corrected seasonally.
3. Using the Box-Jenkins procedure, we carry out the ARIMA identification and estimation of the series, and test for the presence of a unit root.[26]
4. The Engle-Granger and the Johansen test of co-integration are run.
5. If multiple vectors are found, restrictions need to be imposed on the model.
6. The stochastic trends identified in conjunction with the observed series are graphed.
7. We estimate the vector error correction model, check on the validity of the co-integrating vectors, and obtain information on the structural parameters of the model.

[26] It must be noted that Box-Jenkins procedure and unit root tests appear in the same row. This is because ARIMA identification itself can also be regarded as a unit root test.

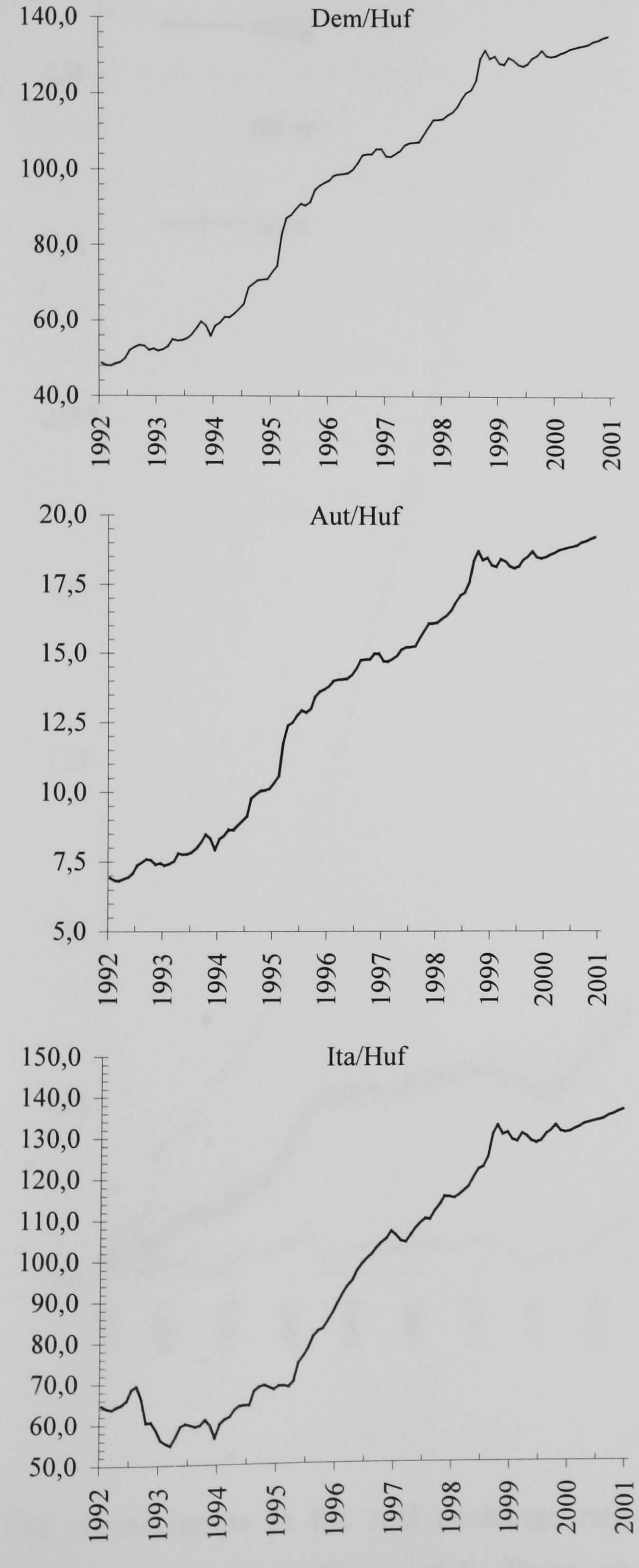
Despite the clear-cut order we proposed, there may be ambiguities regarding the methodology. This field of econometrics is still in a state of flux and, due to the lack of consensus in the answers given in the literature, we had to make some choices regarding the methodology on our own. We will indicate what these choices were at the relevant points in the discussion. First, we start the discussion by describing the dataset with which we worked.

4.1.1 The data

The purpose of this section is to give a general, descriptive summary of the behaviour of the variables included in the analysis, and some of the problems associated with them. The input data for the calculations appear in *Figures 4.1.-4.5.* We obtained all the series for the period between 1992 and 2001. The first step of our work involved collecting data for exports, nominal exchange rates, inflation for domestic and foreign prices, and FDI. As in Buch and Döpke (1998), we use monthly data. The data covered the three largest importers of products from Hungary: Germany, Austria, and Italy. The export data were obtained from the Hungarian Ministry of Economic Affairs (*Gazdaságí Minisztérium*). They were available only in US dollars, which had to be converted into the national currency of the importing country. The data for exchange rates, Hungarian price indices and FDI flows are from the National Bank of Hungary *(Magyar Nemzeti Bank*).

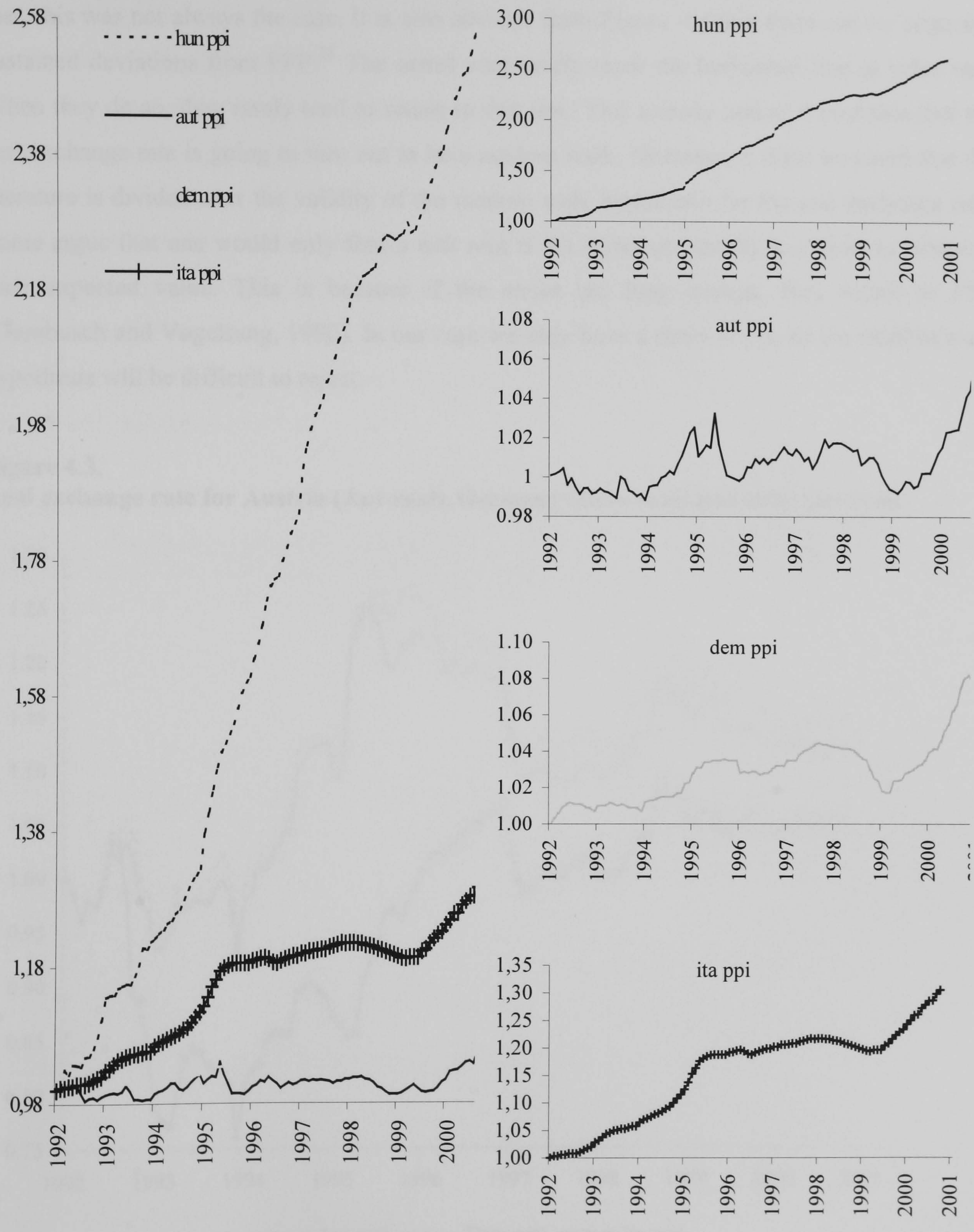
We now summarise some of the relevant, easily observable patterns of these series. *Figure 4.1* shows how closely the exchange rates move together. This should be no surprise, as the foreign currencies were pegged to each other. However, the Italian lira's eccentric behaviour in the early 1990s can be explained by the lira dropping out of the ERM, and its subsequent rapid devaluation. This change probably fed back into inflation, as one can observe a jump in the inflation series in Italy after the depreciation (*Figure 4.2*). This depreciation caused the inflation of the lira to deviate from that of the rest of the currencies for some time. In *Figure 4.2* the dynamics of industrial prices can be seen. It is interesting to observe how high Hungarian inflation was throughout the sample period. Now, the question is whether the series of devaluations of the Hungarian currency depicted in *Figure 4.1* was enough to keep the purchasing power parity constant. If the law of one price holds, then the ratio of foreign price to domestic price is one. In *Figure 4.3* we observe the behaviour of the real exchange rate. This gives us information on the extent to which domestic prices tend to deviate from the law of one price.[27] It is again interesting to note the marked influence of the large devaluation of lira on the real exchange rate.

Figure 4.1.
Monthly, unadjusted exchange rates per unit of Austrian, German and Italian currency (Aut/Huf, Dem/Huf and Itl/Huf, respectively)



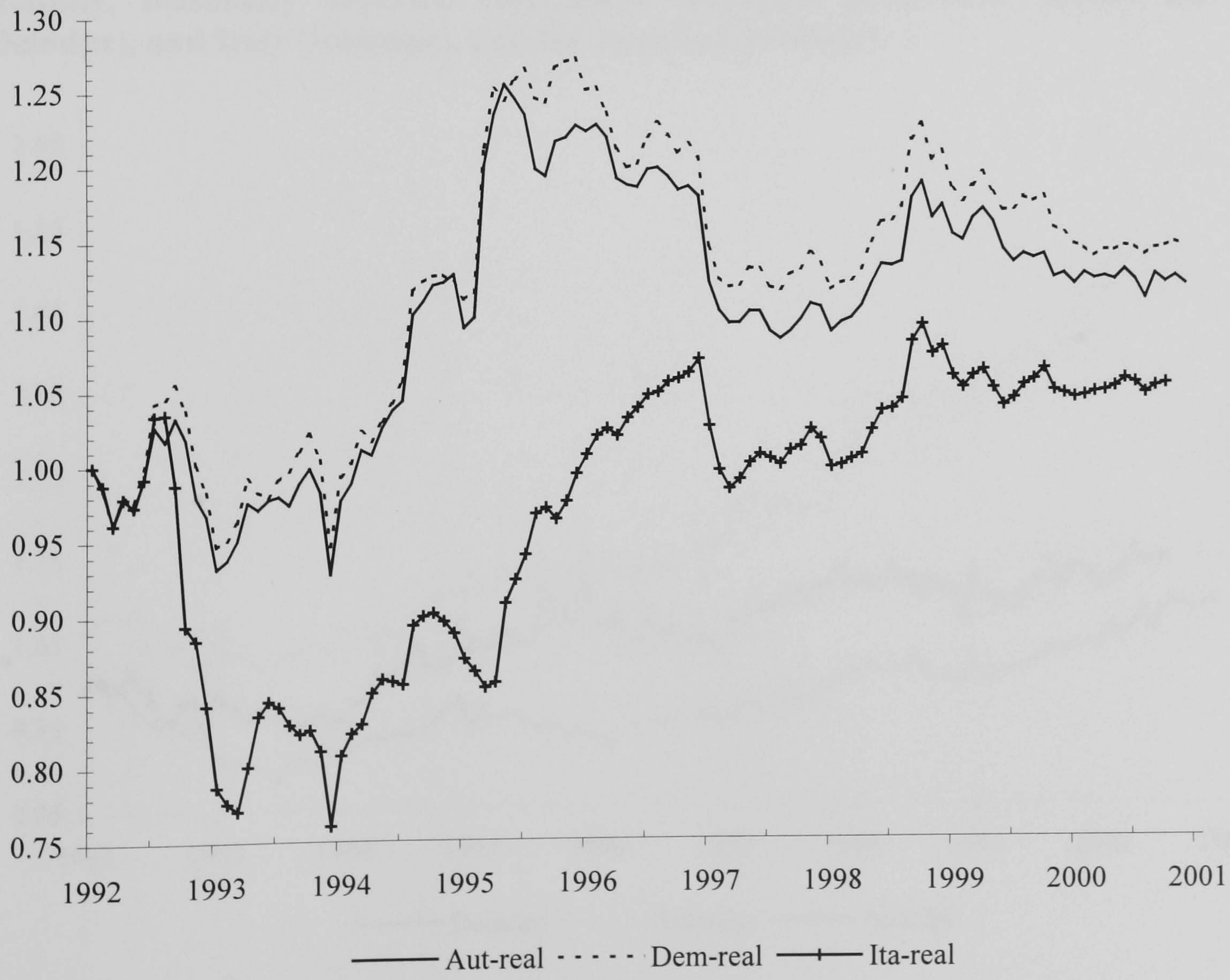
[27] When we calculated the real exchange rate index, we used series that had been cleared of seasonal influences. This is why the series in *Figure 4.3* are so smooth.

Figure 4.2.
Monthly, seasonally adjusted cumulative production price indices for Hungary (hun ppi), Austria (aut ppi), Germany (dem ppi) and Italy (ita ppi)



The major jumps in the real exchange rate include devaluations under the adjustable peg exchange rate regime *(Figure 4.3)*. These are downward jumps up to 1995. The jump at the beginning of 1995 marks a large devaluation that was part of a macroeconomic stabilisation package supported by international organisations. In 1997, the impact of the Asian crisis is easy to identify. Also, it should be noted that the real exchange rate of the lira moves closely together with the other two currencies after it was announced that it was going to join the EMU. Before that, this was not always the case. It is also obvious from *Figure 4.3* that there can be large and sustained deviations from PPP.[28] The series very rarely cross the horizontal line at value one. When they do so, they rarely tend to return to that line. This already makes it probable that the real exchange rate is going to turn out to be a random walk. However, it must be noted that the literature is divided over the validity of the random walk hypothesis for the real exchange rate. Some argue that one would only find a unit root if the series are simply too short to return to their expected value. This is because if the series are long enough, they return to PPP (Dornbusch and Vogelsang, 1990). In our case we only have a short series, so the random walk hypothesis will be difficult to reject.

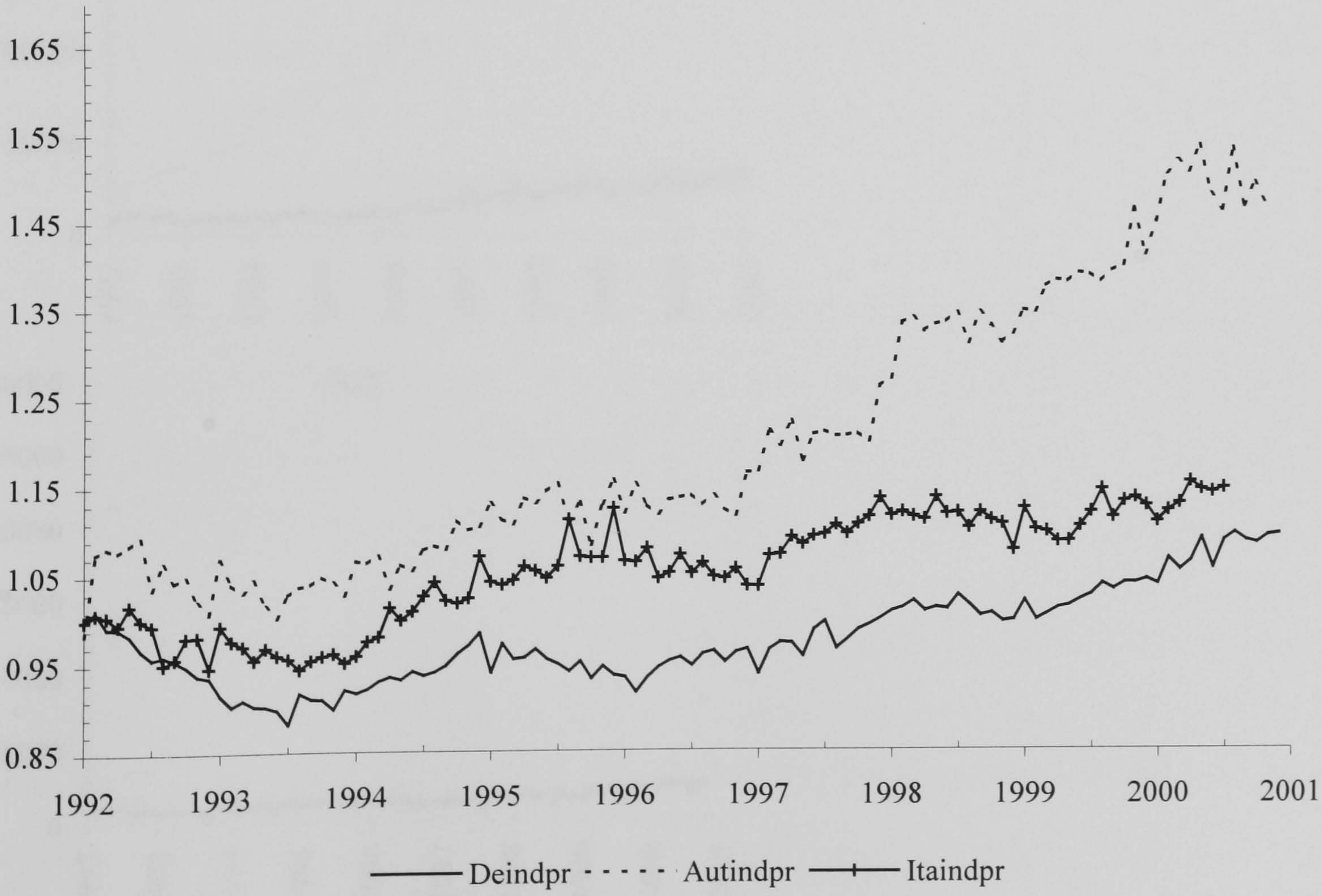
Figure 4.3.
Real exchange rate for Austria (Aut-real), Germany (Dem-real) and Italy (Ita-real)



[28] In the regression analysis we used the reciprocal of this. In this case, the devaluation shows up as a rise in the curve and not as a decline.

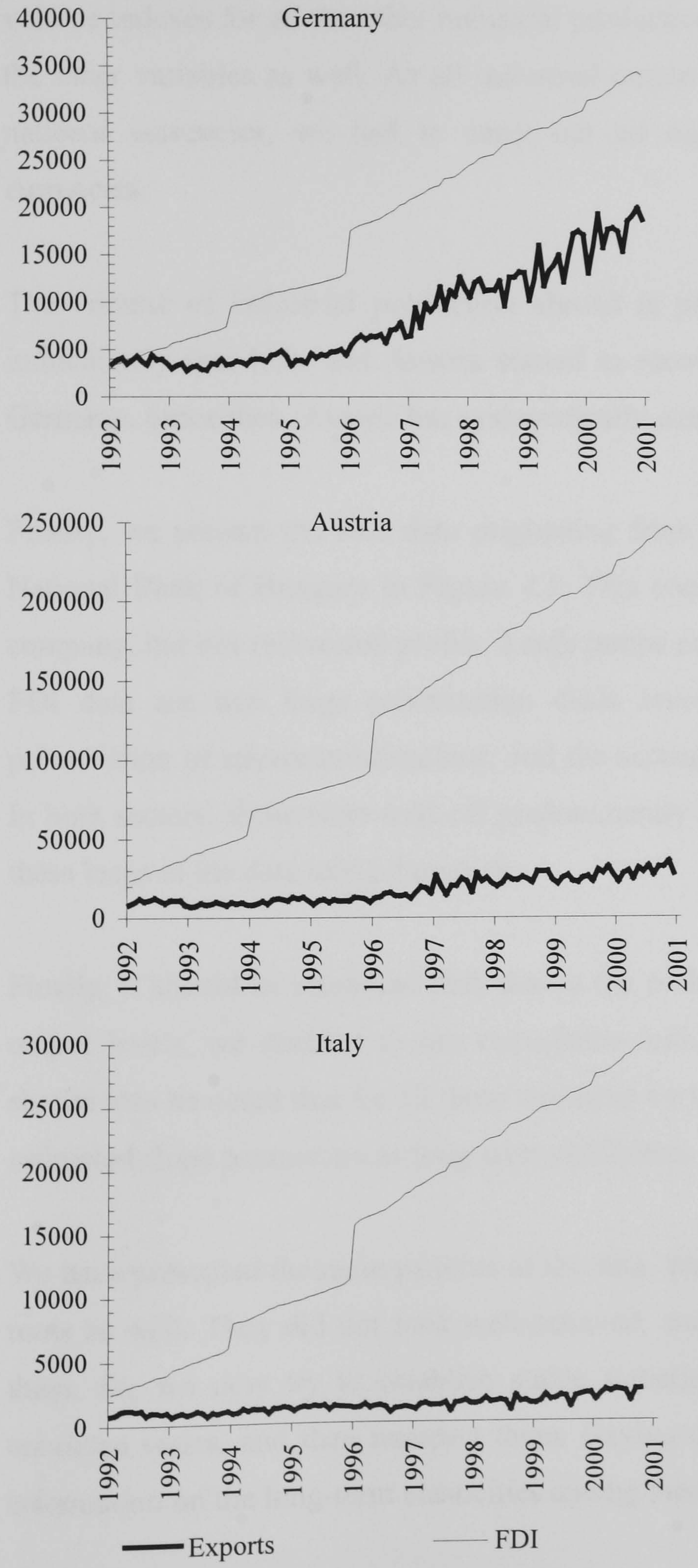
Our measure of the real exchange rate was based on production price indices. As mentioned earlier, one could choose other price indices to construct the real exchange rate. The main reason why we selected this particular measure was the role of industrial (intermediate) goods in exports. It is a reasonable choice, as most of the international trade between the EU and Hungary consists of industrial (immediate) goods and not consumer goods (Freudenberg and Lemoine, 1999). Another reason for choosing production price index was that we decided to discard the terms of trade as a relative price measure. This is because it reflects the prices of actual trade, and ignores the potential impact of price developments in the rest of the traded sector.[29] It is not only the price behaviour of industry that is relevant for us, but output as well. We shall use it as a proxy for foreign demand. The reason for this choice was again the fact that the largest part of foreign trade is not consumer goods, but is made up of intermediate and investment goods. Therefore, variation in foreign industrial production should be a good measure of changing demand for Hungarian exports.

Figure 4.4.
Monthly, seasonally adjusted cumulative industrial production indices for Germany (Deindpr), and Italy (Itaindpr), and for Austria (Autindpr)



[29] For instance, if there are favourable price developments taking place, we would want to allow production to be diverted from other uses to export. The prices of actual trade (terms of trade) are a poor control for this. This is because favourable price shocks should appear first in the production price index before they feed into trade price indexes and ultimately influence export. Therefore, the use of the production price index is more correct.

Figure 4.5.
Monthly, seasonally unadjusted behaviour of aggregate stock of FDI, and exports to Germany, Austria, and Italy (million DEM, 10 million Austrian schilling, 100 million Italian lira respectively)



Initially we wanted to use industrial output levels. We managed to obtain most of the data on these from the national statistical offices. However, we then had the problem that only the volume index series were given to us for Italian industrial output. This meant that we had to use volume indexes for all the other industrial production data instead. But this had repercussions on the other variables as well. As all industrial output is represented by volume indexes based on national currencies, we had to carry out all our calculations based on constant national currencies.

The volume of industrial production abroad is presented in *Figure 4.4*. It should be noted immediately that Italy and Austria started to recover from the recession of the 1990s before Germany. Since then, Austria has systematically outperformed both Italy and Germany.

Finally, we present the FDI data originating from the monthly current account reports of the National Bank of Hungary in *Figure 4.5*. This contains gross inflows, and loans by the parent company, but not reinvested profits. Large jumps can be seen in the series. The two leaps in the FDI data are two large privatisation deals involving foreigner buyers. The first was the privatisation of telecommunications, and the second was the privatisation of the utilities sector. In both sectors, firms were sold off predominantly to investors from the EU. We controlled for these leaps in the data using dummies.

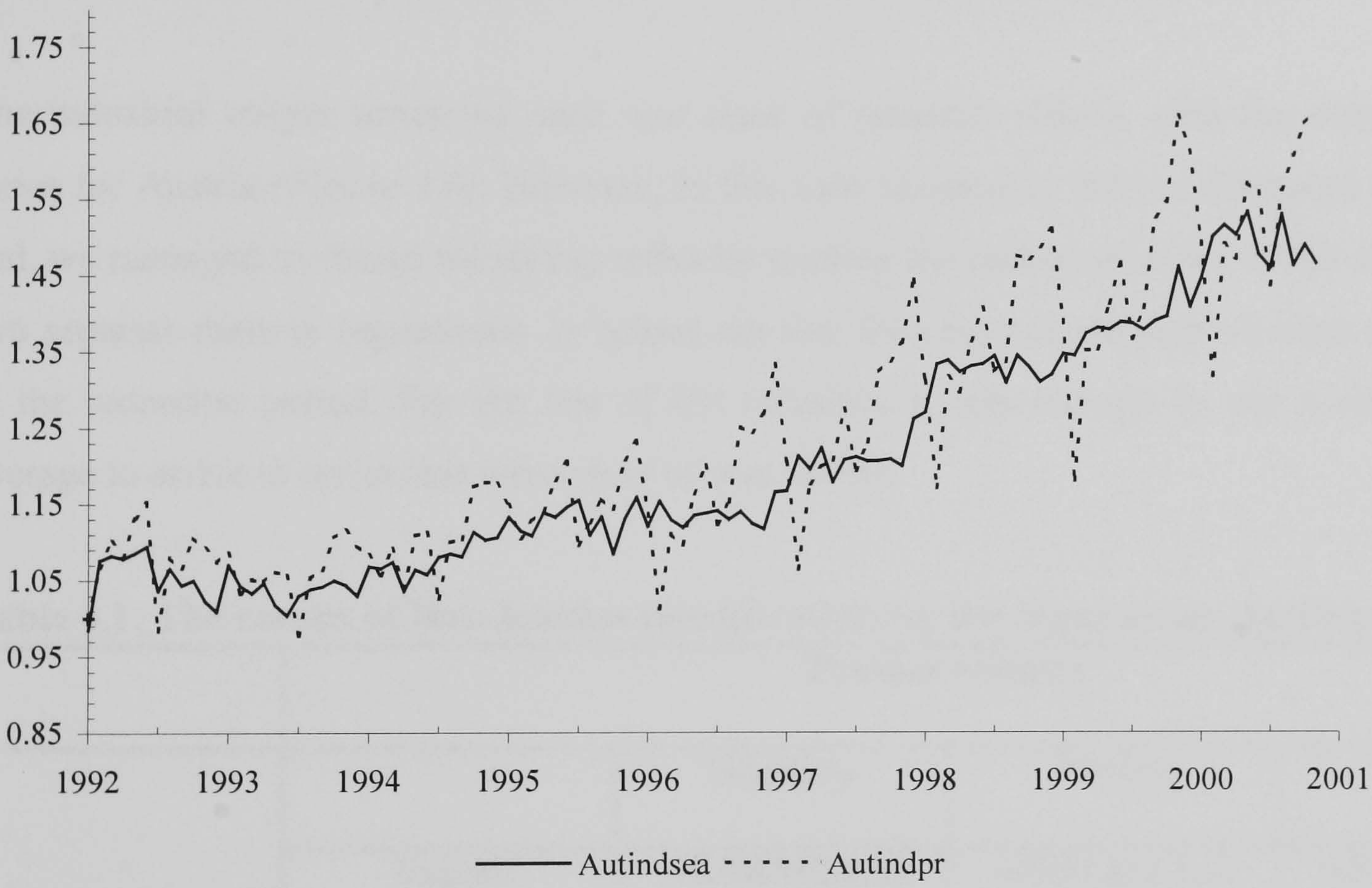
Finally, it should be remarked that, due to the problems we had in obtaining data on industrial output levels, we decided to use cumulative indices for every variable in the regressions. It should also be noted that for all these variables we use logarithms with a view to interpreting the estimated slope parameters as long-term elasticities.

We have presented the main patterns of the data. These contained leaps, trends, and possibly unit roots as well. They did not look well-behaved, and yet our purpose is to find relations among them. So, we now try to establish stable statistical relations among these seemingly totally unrelated series, and then interpret them. Having done this, we turn our attention to obtaining information on the long-term elasticities among these variables.

4.1.2 The quest for co-integrating vectors in the full sample

The long-term elasticities can be obtained as elements of the co-integrating vector. So, first we had to choose a co-integration technique. We use the Engle-Granger and the Johansen methodology to test for co-integration.

Figure 4.6.
Monthly, seasonally unadjusted and adjusted volume index of industrial output for Austria (Autindpr and Autindsea)



Nonetheless, when it comes to evaluating the results, we prefer the Johansen approach. This is because the latter facilitates identification of multiple co-integration vectors and alternative interpretations of the econometric model. This is attractive from a theoretical point of view, but the presence of multiple vectors can also be dangerous when we have no theoretical construct to explain them.[30] The crucial advantage of the method for us is that it allows simultaneity of the variables of the model. In sum, we favour this method as it allows more potential theories to be

[30] A disadvantage of these methods should also be mentioned. Monte Carlo studies have shown that the Johansen test is more likely to err than many other methods in not rejecting a parameter combination as a co-integrating vector (Kim and Maddala, 1998).

incorporated in the testing procedure, and because it also allows the endogeneity of every variable. However, there are many problems to correct for and test before we can actually carry out the relevant co-integrating regressions.

Before embarking on the analysis we had to clear our series from seasonal influences. Had seasonal variation remained in the variables in the regression, it could have caused major problems later. As the ARIMA identification process shows *(Table 4.1)*, seasonal adjustment was successful and no significant autocorrelation parameter appears at lag 12. This is important, as its presence would render the choice of lag length invalid by raising the value of the criterion functions at lag 12. This would force us to choose a longer lag length in the VECM than is necessary in reality. It would waste many degrees of freedom and would bias parameter estimates. It is therefore very important that no seasonality remains in the series.

The industrial output series we used was clear of seasonal effects, with the exception of the series for Austria *(Figure 4.6)*. However, in this case seasonality did not disappear easily. In the end, we managed to obtain satisfying series by treating the recession of the 1990s and the rest in two separate dummy regressions. In turned out that the seasonal parameters were much smaller in the recession period. For the rest of the variables it was enough to use a simple moving average to arrive at series that were clear of seasonality.

Table 4.1. The results of Box-Jenkins identification for the input series starting 1992:1

		Partner country		
		Germany	Austria	Italy
Data series	Export	ARIMA(2,1,1)	ARIMA(2,1,1)	ARIMA(2,1,0)
	Real exchange	ARIMA(1,1,0)	ARIMA(1,1,1)	ARIMA(4,1,0)
	Ind. production	ARIMA(4,1,0)	ARIMA(2,1,0)	ARIMA(3,1,0)
	FDI stock	ARIMA(1,1,0)	ARIMA(1,1,0)	ARIMA(1,1,0)

In order to see the properties of the individual countries more clearly, we carried out the Box-Jenkins identification and estimation procedure for each series for each country. The results obtained seem to be quite normal, except for two series for Italy (real exchange and industrial production) and Germany's industrial production. All these series have an unusually long autoregressive part (*Appendix 4.1*). When we chose the length of the autoregressive component, we took care not to mistake the long autoregressive part (AR) for a moving average (MA) process.

Table 4.2. The notation for the variables used in the export regressions

LEXPORTS	Log of Hungarian exports to the foreign country
LFDISA	Log of FDI
LRARFMOD	Log of real exchange rate
LINDPRMO	Log of industrial production abroad
ECM	Error correction component
C	Constant

Following the advice of Kennedy (1995) and Johnston and DiNardo (1997), we have not attributed much importance to the Box-Pierce statistics, as Monte Carlo evidence shows that they perform very badly. Instead, we followed the over-identification approach. The results of this procedure give us an indication of the possible lag length of the VAR later, and may reveal interesting patterns in the series (refer to *Table 4.3* for the variables of the model).

The application of the Box-Jenkins methodology was also useful as it represents a first unit root test for the input series. If a series has a unit root, its autocorrelation function converges towards zero very slowly. After differencing, however, the series should become stationary. The AR patterns of the series confirmed this for all the series. At the same time, it must be pointed out that the long AR structure in some of the series should make us suspicious regarding the properties of these series.

Fortunately, there are many unit root tests available. The most common are the various versions of the Dickey-Fuller tests. It should be noted, however, that Maddala and Kim (1998) suggest that the Durbin-Watson statistic (whichever version) is a better, stricter, and easier to implement test statistic than any known version of the usual Dickey-Fuller test. Still, in applied non-stationary time series analysis, the various versions of the Dickey-Fuller test enjoy most popularity. For this reason, we also tested for unit root using the augmented Dickey-Fuller (ADF) and the Phillips-Perron test[31] in conjunction with the Durbin-Watson statistic. The

[31] The Phillips-Perron test is a more flexible version of the ADF test.

augmented Dickey-Fuller and Phillips-Perron tests make the results comparable with the literature, but the behaviour of the series had to be checked using the Durbin-Watson statistic as well. We present the results of the Phillips-Perron test in *Table 4.3* (the notation of the variables is indicated in *Table 4.2*).

Table 4.3. The p-values of Phillips-Perron tests for various specifications of the regression equation in the series starting from 1992:1

	LEXPORTS	LFDISA	LRARFMOD	LINDPRMO
DEM CT	0.15664	0.88546	0.80366	0.38926
DEM C	0.97505	0.78907	0.49291	0.94267
DEM	0.73280	0.74703	0.52396	0.43246
DEMDIFI CT	1.38361D-14	1.74880D-09	6.58697D-08	3.27449D-14
DEMDIFI C	2.74323D-16	6.23101D-10	2.37014D-09	4.64929D-16
DEMDIFI	3.35782D-16	1.70337D-08	6.69546D-10	2.49899D-16
AUT CT	0.053684	0.87855	0.80196	0.086795
AUT C	0.82761	0.79489	0.51664	0.92019
AUT	0.71769	0.73805	0.43698	0.95039
AUTDIFI CT	2.13875D-11	2.67962D-09	6.14678D-09	6.22957D-09
AUTDIFI C	5.04275D-13	8.30306D-11	1.02858D-10	9.38279D-11
AUTDIFI	2.75348D-13	2.00379D-08	3.27069D-11	1.59373D-12
ITA CT	0.023834	0.92965	0.37272	0.050237
ITA C	0.73761	0.78665	0.60068	0.72446
ITA	0.71618	0.75036	0.21965	0.70542
ITADIFI CT	9.79105D-13	4.65330D-09	2.63565D-06	3.06586D-12
ITADIFI C	2.11179D-14	1.72682D-09	1.28142D-07	7.35662D-14
ITADIFI	2.47330D-14	2.20569D-08	2.24623D-08	7.02853D-14

Note: DEM, AUT and ITA in the equation names indicate German, Austrian, and Italian input data respectively. The suffix DIFI at the end of the equation name denotes test statistics from a differenced, short-term equation (with error-correction specification). The others are long-term equations. Explanation of the signs after the name of the equation: CT = there was both a constant and a trend in the equation; C = there was only a constant in the equation; ς = neither a constant nor a trend was present in the equation;

When the data are clear of seasonal influences, the series consists of the cyclical component (differences) and the trend component. The second unit root test conducted suggested that all our series are unit roots, and therefore have a stochastic trend. We carried out the test in three specifications in levels and differences to see whether differencing rendered them stationary.

One can see from the table (*Table 4.3)* that when it is assumed that the data-generating process contains both a constant and a trend, the industrial output series and exports in the case of Italy contain no unit root. However, looking at the actual series suggests that these two series had no drift in them. Therefore, it is only the tests that contain neither a trend nor a constant that can apply. However, these tests suggest the presence of a unit root (*Table 4.3*). It should be noted that the presence of unit roots was also confirmed by the Durbin-Watson tests. From now on, we regard these series as random walks.

We can now turn our attention to co-integration tests. First, we searched for Engle-Granger co-integration. The Engle-Granger method suggested that there was no co-integration vector among these variables for any of the countries. Although we had a few borderline cases, the ADF test and the Phillips-Perron tests never suggested a satisfying error structure together. However, the more flexible Johansen test suggested otherwise, and the presence of one co-integrating vector in the German case was accepted. At the same time, none could be found in the Austrian or Italian case. It should also be noted that the co-integrating relationship always disappeared when any of the explanatory variables was excluded from the system. This means that all of them are necessary for a satisfactory description of the long-run behaviour of exports.

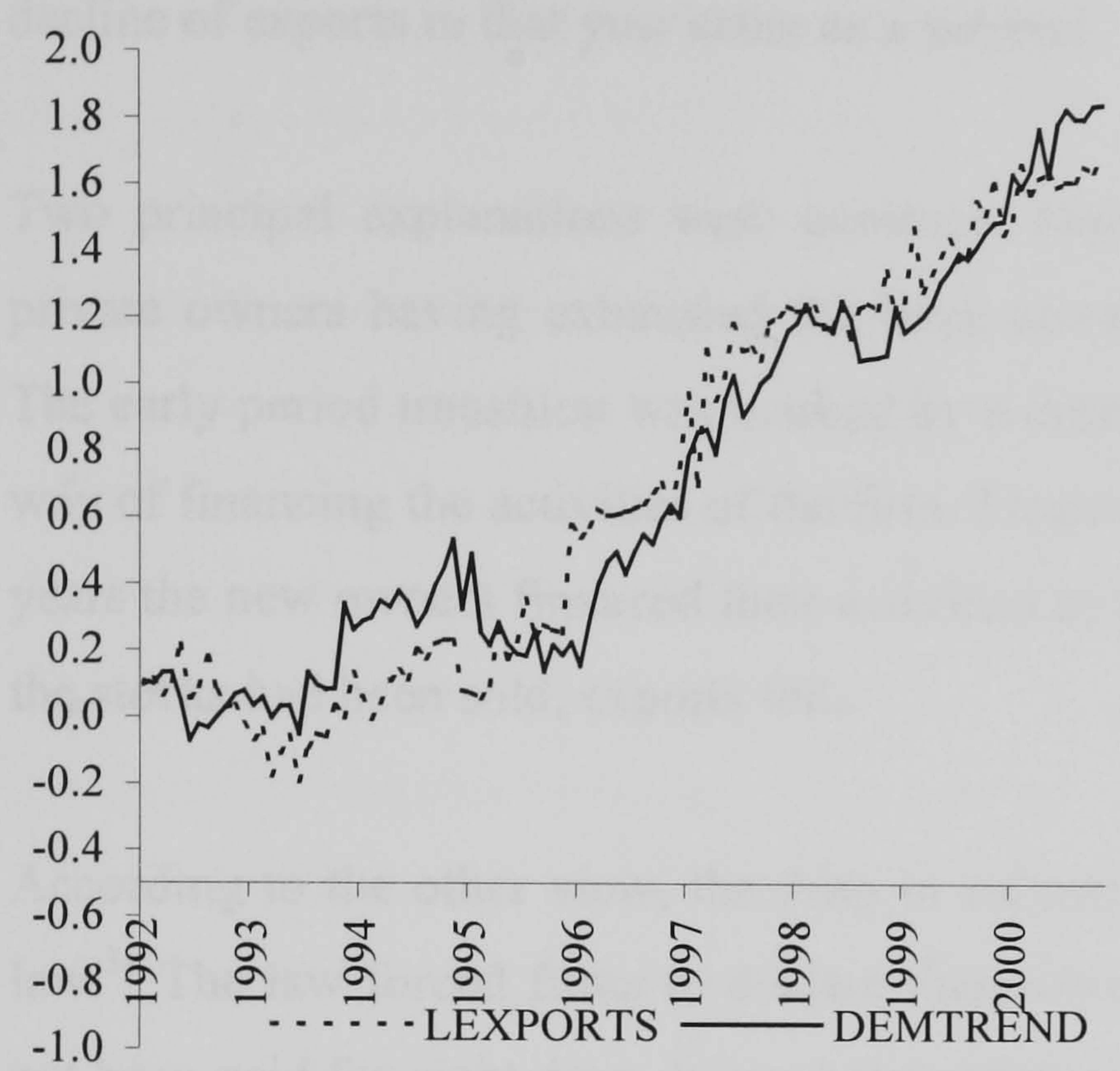
The results show that the long-term elasticities of exports with regard to FDI and foreign demand are positive (*Table 4.4*). The results imply that a 1 per cent change in the volume of German industrial output involves an increase of more than 4 per cent in the volume of Hungary's exports to Germany. The demand elasticity is found to be very high. To some extent this is complemented by the impact of the changes in FDI. When there is a 1 per cent increase in the volume of FDI, an increase of almost 1 per cent in exports to Germany can be expected. The long-term impact of the real exchange is high and negative. The sign is in line with the prediction of PPP.

Table 4.4. The co-integrating vector of Hungary's trade with Germany (sample:1992:1-2000:12)

LEXPORTS	1,0000
LFDISA	-0,7808
LRARFMOD	1,9238
LINDPRMO	-4,7756

We observed in *Figure 4.3* that there is only very slow adjustment, if any, between foreign prices and domestic prices. Despite this, in the co-integration analysis the long-term elasticities indicate rapid adjustment towards PPP. A result like this from a multiple regression means that other variables of the regression model may be blamed for the observed deviations from PPP in *Figure 4.3*. For instance, FDI inflows can contribute to the real appreciation of the currency and at the same time increase exports, and can cause a positive correlation to appear between the two variables. Controlling for this impact brings out the true relation between prices and exports.

Figure 4.7. The stochastic trend and the log of exports for Germany (DEMTREND and LEXPORTS, respectively) obtained using the co-integrating vector in Table 4.4.



The co-integrating vector suggests that there is no truth in the expectation that foreign demand plays an unimportant role and exports are driven mainly by FDI. It is clear that, in the long run, foreign demand has a very high elasticity. In fact, the trend of exports to Germany is very sensitive to demand conditions there, and the positive impact of foreign demand is supplemented by the inflow of FDI.[32] In general, this vector provides a good fit for Germany *(Figure 4.6)*. However, in the first two years (1992–1993) the modelled exports moved opposite the actual ones. Regarding the poor fit in the first two years, one could argue that it must be due to transition-related disturbances. What is puzzling is not merely the existence of the gap between the two series, but the fact that the volume of exports was actually decreasing in 1993. We mentioned earlier that at the very beginning of transition the size of exports remained more or less constant. It is well known that such behaviour is quite unique after large trade liberalisations.[33] Usually, the volume of exports and of imports reacts almost immediately with an increase. Here, instead of an increase, we see that exports are constant, and what is more, there was even a fall in 1993.

[32] Because Germany is far the largest trading partner, the patterns we discovered crucially influence the elasticities of the aggregate exports of Hungary. Germany alone accounts for about 40 per cent of Hungary's total exports and imports.
[33] Trade liberalisation took place between 1989 and 1991 (Djankov-Hoekman, 1996; Freudenberg-Lemoine, 1999).

However, it must be borne in mind that a collapse in exports had been expected. At the time, the constancy of exports was viewed as a success by most experts (e.g. Portes, 1993). It was thought that the quality of the goods these countries produced was so low that they simply could not be sold in the west. By 1993 it became obvious that this expectation was flawed, and this is why the decline of exports in that year came as a surprise.

Two principal explanations were common. One suggested that the fall was due to the new private owners having exhausted the large inventories inherited from state-owned enterprises. The early period transition was marked by a drastic credit crunch, and this was a fairly common way of financing the activities of the firm. Proponents of this view presumed that in the first few years the new owners financed their activities by selling the inventory cheaply in the west. After the stocks had been sold, exports fell.

According to the other view, the drop in exports in 1993 was due to a drastic new bankruptcy law.[34] The law forced firms to declare themselves bankrupt if they had any obligation that had not been paid for eight days. It was believed that many exporting firms went out of business as a result. However, empirical surveys showed that most of the firms were still in operation in 1995, and there had not been a large wave of liquidations.[35]

In our view the explanations given for the peculiar behaviour of the series in the first two years suggest reasons for abandoning the co-integrating results in *Table 4.4* completely.

4.1.3 The quest for co-integrating vectors in the shorter sample

The co-integrating vector we presented should be looked at with scepticism. It must be obvious that the sample period covered includes a period of large structural breaks. Even if we managed to find a linear combination of the input series that would produce equilibrium errors in the whole period, this only means that the series themselves contain information that captures the structural breaks. Given the time period covered by the estimation, it is puzzling that we have found a co-integrating vector in the German case at all. The vector found shows good statistical

[34] This view can be supported by Schaffer's (1998) findings.
[35] Some argued that other factors also contributed to falling exports in 1992 (Kovács, 1999). These included excess public spending, the poor credibility of monetary policy, and the recession in the main export markets.

properties, but we know that the sample is far from homogeneous. As already mentioned, at the beginning of transition the series was still affected by the sweeping institutional changes. This was the "shock" period of transition. During that time, behavioural relations could not be stable. The assumption of constant export elasticities over time is simply wrong.

Visual inspection of the series we worked with suggests that it was not only the behaviour of exports that was unusual at the beginning of the period. For instance, we observe a steep real appreciation of the currency. This is something that was observed across all transition countries. The most commonly accepted explanation for this was related to the restructuring in the firm sector, and the resulting Balassa-Samuelson effect (Halpern and Wyplosz, 1996).

The other interesting pattern of the series was that the real exchange rate showed huge and idiosyncratic variation. One reason for this was that a series of devaluations took place. These devaluations reflected the large initial macroeconomic imbalances associated with transition.[36] The last such steep devaluation took place in February 1995, as part of a short-term macroeconomic stabilisation package. Some argued that the relative stability of the real exchange rate in the second part of the series reflects a new equilibrium (Kovács, 1999). Nonetheless, it is clear that the beginning of the series is burdened with structural breaks.

However, it is not only the Hungarian side that is problematic. In the early 1990s there was a long recession in the EU, and it was also the time when German re-unification took place. The recession shows up in slow growth in industrial production. The exit of the Italian lira from the ERM also happened in this period, with dramatic consequences for the Italian real exchange rate. All these factors make it impossible to treat the dataset homogeneously. The problems of homogeneity on the foreign side and on the Hungarian side suggest that the first few years should be treated with great caution. More specifically, one should ask how a line might be drawn to separate the part of the series that is flawed as a result of transition behaviour and recession abroad from the part that is not affected to such an extent.

In practice, it seems sensible to treat time series data as one series from 1995 on. By that year some time had elapsed since the most important microeconomic reforms were implemented, and a macroeconomic stabilisation package had also been put in place. As we have seen, from 1995

[36] Widening of the government budget deficit was discernible from the very start of transition. From 1993, the balance of payments started to worsen quickly as well. The aim of the 1995 stabilisation package was to set these imbalances at a sustainable level.

on most of the input series behave much less idiosyncratically. This choice also has the additional advantage that the time span of the analysis exactly covers the period when Hungary operated a crawling peg exchange regime, so we do not have to control for changes in the exchange regime.

There is also some microeconomic evidence that supports the choice. Two empirical micro-econometric studies show that there were drastic behavioural changes taking place in the early 1990s (Halpern and Kőrösi, 2000; Szanyi, 2001). However, they also show that, from 1993-94, rapid changes in the microeconometric parameters are no longer characteristic. They suggest that the most drastic shocks associated with restructuring and transition must have been over by 1995. At the same time, we cannot think of the series from 1995 to 2000 as completely homogeneous either. For instance, in *Figure 4.3* we witnessed jumps in the real exchange rate due to the Asian and the Russian crises. Nonetheless, these were minor shocks compared to the changes in the first half of the 1990s. We therefore used the second part of the data as a single series.

Table 4.5. The results of Box-Jenkins identification for the input series starting in 1995

	Partner country			
		Germany	Austria	Italy
Data series	Export	ARIMA(2,1,1)	ARIMA(2,1,1)	ARIMA(1,1,0)
	Real exchange	ARIMA(1,1,0)	ARIMA(1,1,0)	ARIMA(1,1,0)
	Ind. production	ARIMA(2,1,0)	ARIMA(1,1,0)	ARIMA(3,1,0)
	FDI stock	ARIMA(1,1,0)	ARIMA(1,1,0)	ARIMA(1,1,0)

There has been some discussion concerning how structural breaks should be modelled in transition countries. The question was whether it was sufficient to allow the constant and the slope parameters in the model to shift after 1995. In this study we opted for a more radical solution. In order to eliminate as much noise from the pre-1995 period as possible, we dropped all observations from the first half of the series, and ran separate regressions with the second half of the series. Another justification for choosing this time span was presented by the results of the ARIMA procedure with the new sample. It should be recalled that the AR part of some of the variables seemed to be unusually long (*Table 4.1*). We reran the Box-Jenkins procedure with the shorter samples. What we now found was that, in the more homogeneous sample, the structure of the ARIMA model became more normal than before (*Table 4.5*). Only for the Italian industrial production did the length of the AR remain high. When the period associated with structural shocks was omitted, therefore, many of the series became better behaved.[37]

With the ARIMA identification process, we implicitly tested again for unit roots using the correlograms. As before, we carried out the ADF and the Phillips-Perron test for the series as well. The relevant p-values for the Phillips-Perron tests appear in *Table 4.6*. They show that even after omitting the period fraught with idiosyncratic behaviour, one obtains a unit root in each of the series. This means that a search for co-integrating relations among the variables in the shorter subsample is justified. The Johansen method suggested the presence of co-integrating relations.

In *Table 4.7* we present the results of the Johansen rank test for the cases where co-integrating relations were found. Based on Hendry (1995), it was assumed that there is an autonomous part of export growth that is not dependent on the observed explanatory variables used, so that there must be an unexplained drift in the exports. This is reasonable as there may be many more determinants of exports than those we were able to account for. Hence, we considered only the version of the test that corresponds to this specification.

Table 4.7 suggests that there is a co-integrating relation in the exports to Germany and Austria, but none for Italy.[38] The short sample results of the Johansen rank test indicate the presence of co-integrating relations for both Austria and Germany. According to *Table 4.7* there should be one co-integrating vector in each of these cases. There is no suggestion of such a vector for the Italian data, so we omitted those results. In the original long sample we had similar findings. However, there is Monte Carlo evidence that the Johansen test tends to overestimate the true number of co-integrating vectors. Therefore, the testing of the residuals had to be carried out from the co-integration test (Enders, 1995; Hendry, 1995).[39] We summarised the test results in *Table 4.8*. These were the tests that made us discard the co-integration vector obtained using the whole sample for Austria.

[37] We have shaded all the entries where there was a change in the identified ARIMA process with the new sample.
[38] A critical point of our methodology was how to choose the right lag length. This was important, as co-integration techniques include lags for the variables. However, the choice of lags can greatly influence the outcome of the exercise. Because the adjusted R^2 tends to exaggerate the optimal lag length, researchers nowadays tend to avoid it. Instead, they either use likelihood-ratio-tests, or simply minimise the Schwartz criterion, which punishes the inclusion of new variables more strictly than adjusted R^2. In our examples we chose to use the Schwartz criterion. It identified the specification with one lag as optimal for the long samples and two lags in the short samples.
[39] It must be remarked that the Johansen test is an estimation of a vector error correction model.

Table 4.6. The p-values of Phillips-Perron tests for various specifications of the regression equation in the series starting from 1995:1

	LEXPORTS	LFDISA	LRARFMOD	LINDPRMO
DEM CT	0.12888	0.14002	0.63653	0.24564
DEM C	0.783663	0.67656	0.57884	0.77897
DEM	0.65868	0.59789	0.38994	0.39787
DEMDIFI CT	1.27989D-13	1.39473D-09	2.86452D-08	2.34628D-13
DEMDIFI C	1.29878D-15	4.4325D-10	1.32658D-09	3.64929D-15
DEMDIFI	2.73642D-15	1.33824D-08	1.32568D-9	2.32678D-15
AUT CT	0.067917	0.76843	0.45798	0.08625
AUT C	0.78768	0.67263	0.52534	0.78761
AUT	0.67813	0.67678	0.48689	0.87879
AUTDIFI CT	1.24628D-10	1.34799D-09	4.76328D-08	3.78436D-08
AUTDIFI C	2.324679D-13	5.32423D-11	2.76346D-10	4.32643D-11
AUTDIFI	1.326483D-13	1.18327D-08	1.32742D-11	7.32462D-11
ITA CT	0.033834	0.89977	0.28179	0.06023
ITA C	0.66588	0.71861	0.83276	0.45682
ITA	0.68172	0.73917	0.26128	0.62545
ITADIFI CT	7.32846D-12	3.32786D-08	1.23461D-06	2.23649D-11
ITADIFI C	1.98732D-13	4.38648D-08	3.45629D-06	2.28366D-12
ITADIFI	1.23463D-14	3.32203D-08	3.21009D-07	3.21374D-14

Note: DEM, AUT and ITA in the equation names indicate German, Austrian, and Italian input data respectively. The suffix DIFI at the end of the equation name denotes test statistics from a differenced, short-term equation (with error-correction specification). The others are long-term equations. Explanation of the signs after the name of the equation: CT = there was both a constant and a trend in the equation; C = there was only a constant in the equation; ς = neither a constant nor a trend was present in the equation.

Table 4.7. The Johansen trace test results of the co-integrating vectors

	Austria		Germany	
	1992-2000	1995-2000	1992-2000	1995-2000
H0: r=0	57.11859	41.51617	40.29956	31.56045
p-value	2.78E-06	0.000298	0.00042837	0.005839
H0:r<=1	17.31278	19.34365	18.19729	13.20839
p-value	0.284553	0.177255	0.23278	0.599539
H0:r<=2	4.012195	6.990809	8.16443	6.059519
p-value	0.716943	0.327684	0.22173	0.427369
H0:r<=3	0.207054	1.830368	1.27929	0.214887
p-value	0.741759	0.19871	0.31393	0.737491
Number of obs.	94	58	94	58
Number of lags	1	2	1	2
LogL	-910	-527	-875	-627

If we consider the tests carried out, it is interesting to see that while we could not find evidence for normality, in every case the residuals proved homoskedastic, and the lack of first-order autocorrelation could not be rejected. We considered the results on the grounds that, in the literature, it is common practice to work with small samples like ours. In such a small sample, it is very unusual not to reject the normality of the residuals at the conventional levels of significance. Also, there is some evidence that procedures working under the assumptions of normality can perform quite well even when the error distribution is non-normal. We now summarise the results of the co-integration tests.

We can now state that co-integration was established for Germany with both the long and the short sample, and for the Austrian subsample after 1995. These vectors are presented in *Table 4.4* and in *Table 4.9*.

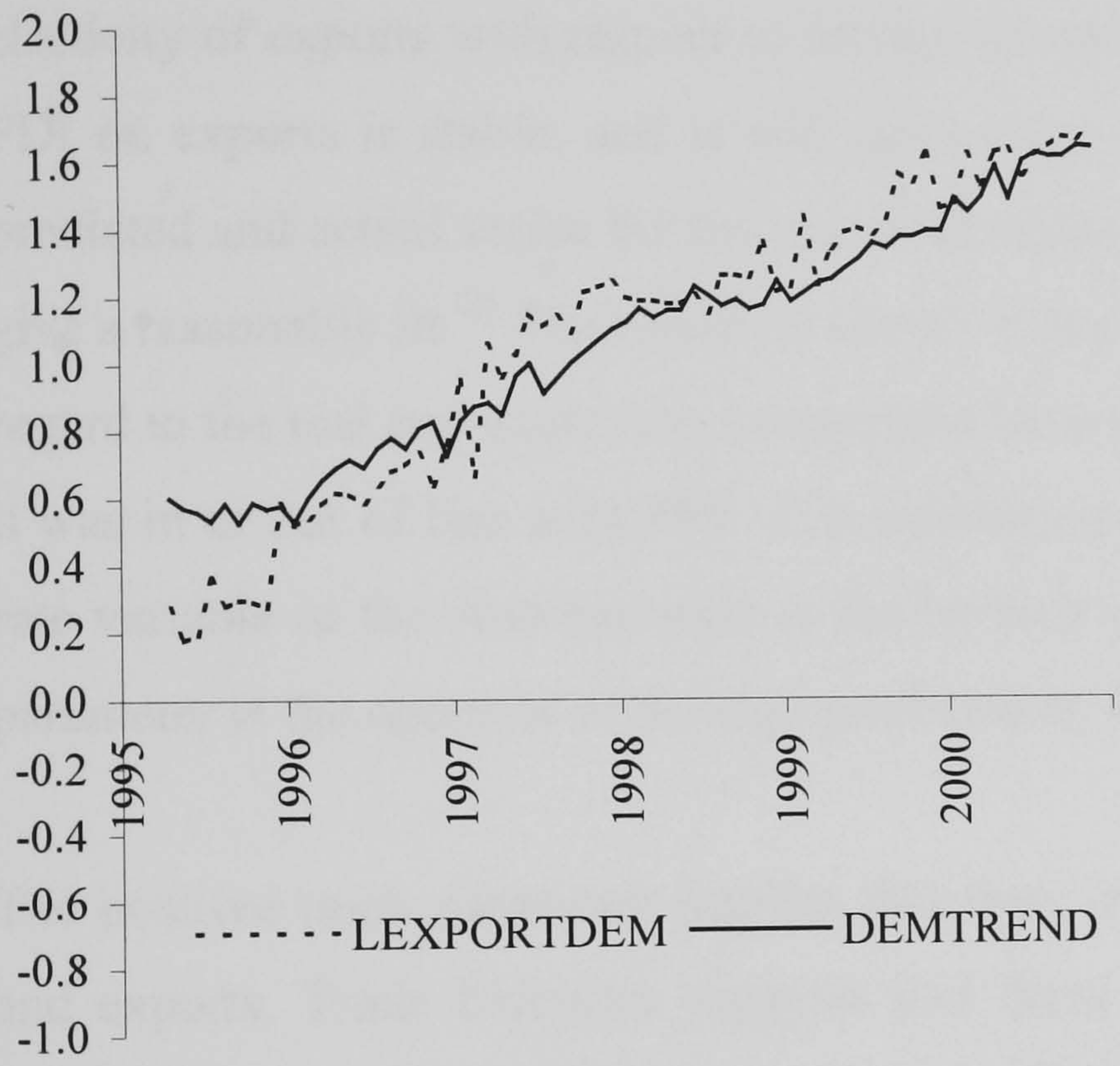
Table 4.8. Summary of the tests for the residuals of the optimal VECM

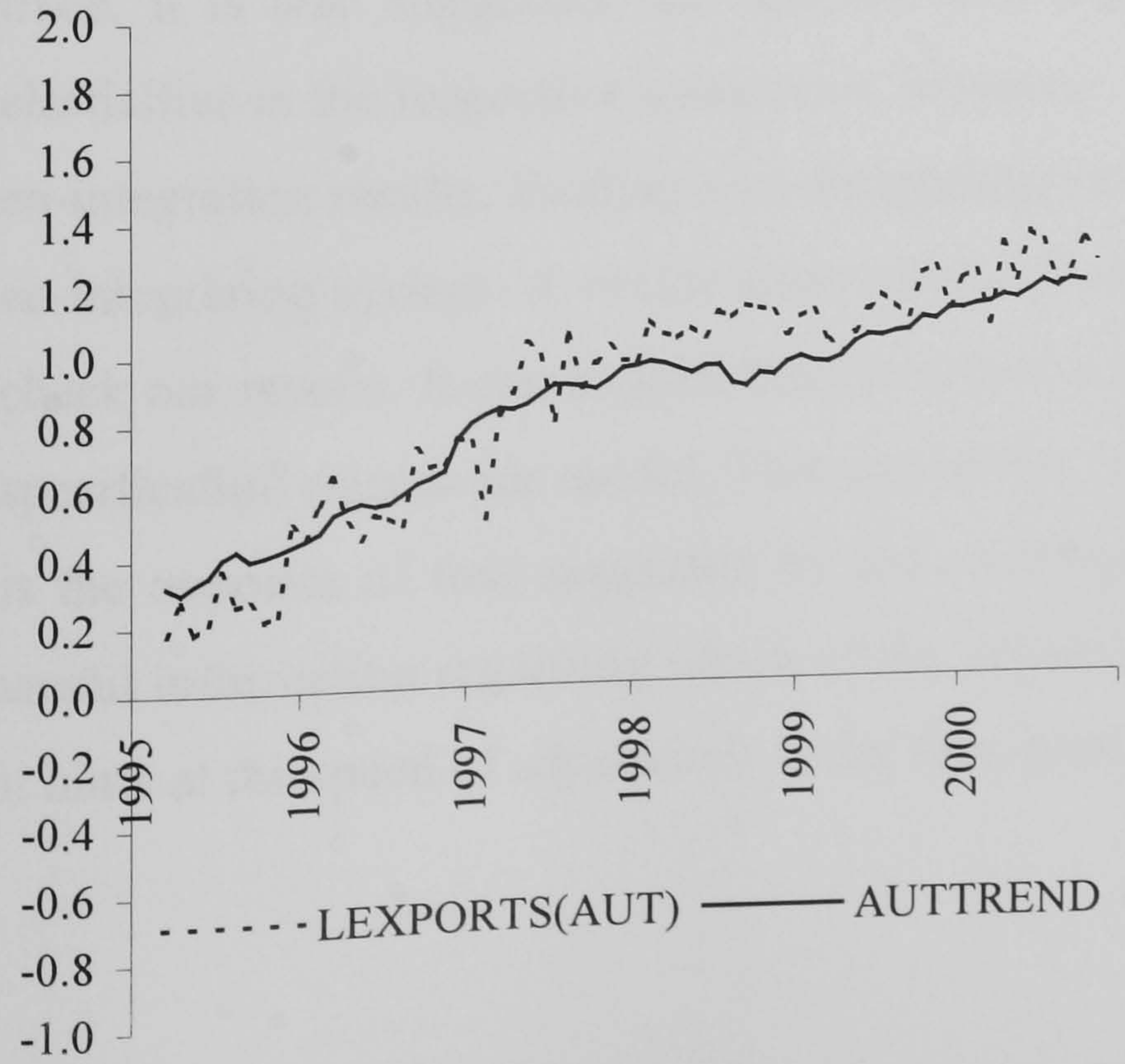
Austria	**1995:4-2000:12**			
	Export equation	FDI equation	Real exch. Eq.	Foreign demand eq.
LM heterosk. test	+	+	+	+
D-W h-test	+	+	+	+
Normality (J-B)	+	Failed	Failed	+
ADF	+	+	+	+
Phillips-Perron	+	+	+	+
ECM	Zero	Negative	Zero	Zero
Germany	**1992:4-2000:12**			
	Export equation	FDI equation	Real exch. Eq.	Foreign demand eq.
LM heterosk. test	+	+	+	+
D-W h-test	+	+	+	+
Normality (J-B)	Failed	Failed	Failed	+
ADF	+	+	+	+
Phillips-Perron	+	+(marg)	+	+
ECM	Neg.	Zero	Zero	Neg.(marg)
Germany	**1995:4-2000:12**			
	Export equation	FDI equation	Real exch. Eq.	Foreign demand eq.
LM heterosk. test	+	+	+	+
D-W h-test	+	+	+	+
Normality (J-B)	+	Failed	Failed	+
ADF	+	+	+	+
Phillips-Perron	+	+	+	+
ECM	Zero	Negative	Failed	Zero

Table 4.9. Co-integrating vectors in Hungary's two main trade relations with the sample omitting 1992, 1993 and 1994 observations

	Germany	Austria
LEXPORTS	1,00000	1,00000
LFDISA	-0,8779	-0,6191
LRARFMOD	-2,7127	1,8032
LINDPRMO	-2,7406	-0,1699

Figure 4.8.
The stochastic trend and the log of exports for Germany and Austria obtained with the co-integrating vectors in Table 4.9.





It is interesting to discuss the co-integration vectors we identified in the more homogeneous, shorter sample. There was a sign change compared to the long-term elasticities we obtained with the longer sample. Omitting the first half of the series resulted in the long-term price elasticity changing from a large negative number to a large positive one. As for the other elasticities, it may be said that the one related to FDI remained quite stable, while the foreign demand elasticity declined considerably.

It may now also be said that, in a more homogeneous sample, German exports react sensitively to relative prices. This behaviour is not in line with PPP. At the same time, we see that the elasticity of exports with respect to foreign demand remains very high. The long-term impact of FDI on exports is stable, and is still quite close to one-to-one. We present the graph with the predicted and actual series for the two trade relations in *Figure 4.7*. One can see that the vectors give a reasonable fit.[40] The elasticity literature has debated how large export elasticities are. With regard to the real exchange rate, researchers have usually found it satisfactory to observe whether it was in or out of line with PPP. It is interesting to note here that the sign of the real exchange rate variable in the Austrian case is the reverse of that in the German case. The German price parameter is the opposite of the sign predicted by PPP.

The positive price parameter implies that there can be factors that break the link between PPP and exports. Trade literature suggests that these can be related to nominal rigidities, whereas some FDI theories would suggest that it can also be the result of transfer pricing in within-firm trade. It is also suggested that this can also happen under certain combinations of structural elasticities in the respective economies. However, we cannot yet be sure about the validity of our co-integration results. Finding a co-integrating vector leads to an extra test for the validity of the co-integrating system. A vector error correction specification must be set up in order to double-check our results. It can happen that, despite the results of other co-integration tests, the VECM specification rejects our model. This can be the case when adjustment towards the long-run path is the opposite of that suggested by the co-integrating vector. This specification also gives us useful information regarding which of the variables carries out the adjustment of the system, and it hints at the speed of adjustment to the long-term path.

[40] It must be noted that, unlike the Engle-Granger method, the Johansen method does not necessarily give a zero mean for the difference of the two series.

Table 4.10. Short-term regression (VECM) results with differenced variables in the German system

Export equation	Lag = 2	R**=0.587 LM het. test=1.1(0.31)	Durbin's h a=1.05(0.29) J-B test=4.7(0.11)
Explanatory variables	Coefficient	t-value	p-value
C	0.013	2.619	0.01
ECM	-0.081	-1.485	0.143
DEXPORTS(-1)	-0.751	-6.301	0.000
DEXPORTS(-2)	-0.385	-3.377	0.001
DFDISA(-1)	0.939	2.74	0.008
DFDISA(-2)	0.387	1.186	0.24
DRARFMOD(-1)	-1.761	-2.793	0.007
DRARFMOD(-2)	1.885	2.911	0.005
DINDPRMO(-1)	-0.287	-.391	0.697
DINDPRMO(-2)	0.1062	1.713	0.092
FDI equation	Lag = 2	R**=0.058 LM het. test=1.59(0.2)	Durbin's h=0.69(0.49) J-B test=4.7(0.10)
Explanatory variables	Coefficient	t-value	p-value
C	0.0108	3.558	0.001
ECM	-0.048	-2.065	0.008
DEXPORTS(-1)	0.035	0.713	0.712
DEXPORTS(-2)	0.098	0.206	0.628
DFDISA(-1)	0.152	1.169	0.277
DFDISA(-2)	-0.0095	0.0536	0.945
DRARFMOD(-1)	-0.078	-0.295	0.820
DRARFMOD(-2)	-0.002	-0.007	0.661
DINDPRMO(-1)	0.112	0.036	0.602
DINDPRMO(-2)	0.238	2.818	0.007
Real exchange rate equation	Lag = 2	R**=0.217 LM het. test=0.3(0.58)	Durbin's h=-0.39(0.69) J-B test=5.72(0.07)
Explanatory variables	Coefficient	t-value	p-value
C	0.0009	-0.212	0.832
ECM	-0.009	1.140	0.259
DEXPORTS(-1)	0.035	0.684	0.496
DEXPORTS(-2)	-0.050	-1.018	0.313
DFDISA(-1)	0.0035	0.194	0.846
DFDISA(-2)	-0.0017	-0.100	0.92
DRARFMOD(-1)	0.337	3.496	0.001
DRARFMOD(-2)	-0.103	-1.058	0.294
DINDPRMO(-1)	-0.0884	-0.798	0.428
DINDPRMO(-2)	0.138	1.169	0.247
Foreign demand equation	Lag = 2	R**=0.392 LM het. test=0.06(0.8)	Durbin's h=-0.09(0.92) J-B test=2.63(0.27)
Explanatory variables	Coefficient	t-value	p-value
C	0.007	1.701	0.094
ECM	0.012	0.780	0.175
DEXPORTS(-1)	-0.031	-0.155	0.877
DEXPORTS(-2)	0.013	0.994	0.324
DFDISA(-1)	-0.043	0.780	0.438
DFDISA(-2)	-0.02	1.169	0.247
DRARFMOD(-1)	0.014	0.407	0.685
DRARFMOD(-2)	-0.134	-0.841	0.404
DINDPRMO(-1)	-0.463	-3.953	0.000
DINDPRMO(-2)	-0.317	-2.823	0.006

We therefore ran the VECM regressions derived from the co-integration vector. However, it should be noted that the differences between the actual and the predicted export series in the graphs (*Figure 4.7*) shed light on some practical problems related to the VECMs. For instance, one can see that the co-integrating vector for Germany generates an ECM whose expected value is close to zero (*Table 4.10*). This is because, at the beginning, the series deviated substantially from the long-run path, and it is only later that it starts behaving in a self-correcting way. One observes that the series do not cross each other very often. At the same time, they do not depart from each other very far either. These results suggest that the self-correction is taking place in other variables than in export.

The VECM results suggest that in the German case the adjustment towards equilibrium takes place mainly in the FDI equation. There is quite a high probability that foreign demand is also playing a role, as its ECM parameter estimate has only been marginally rejected. As for the speed of adjustment in the FDI equation (*0.047*), one can say that it is not rapid. The interpretation of this number is that if a unit deviation is taking place from the long-term trend, it takes more than twenty months for the system to adjust fully.

Clearly, in almost twenty months the nature and the underlying parameters of a transition country like Hungary can change. However, this finding is only intended to characterise the behaviour of the period analysed. If one considers that a unit increase is supposed to take place in an ECM term that includes logarithmic variables, it is worth noting that twenty months for this adjustment is reasonable. This means that a unit change in the index of exports is equivalent to doubling its level, which is a huge change.

After considering the German case, we contemplate the predicted and actual exports to Austria. One observes *(Figure 4.7)* that the modelled and the actual series move closer to each other. They deviate very rarely and when they do so, the adjustment towards each other is slow.

This is not the usual case of error correction presented in the textbooks, where the series adjust towards each other very rapidly. Although the distance between two series is not large, it declines only slowly. It is therefore not surprising that we have again found an insignificant ECM parameter in the export equation (*Table 4.11*).

Table 4.11. Short-term regression results (VECM) with differenced variables in the Austrian system

Export equation	Lag = 2	R**=0.393 LM het. test=0.33(0.56)	Durbin's h a =-0.99(0.32) J-B test=0.40(0.82)
Explanatory variables	Coefficient	t-value	p-value
C	0.003	0.235	0.815
ECM	-0.022	-0.214	0.831
DEXPORTS(-1)	-0.498	-3.439	0.001
DEXPORTS(-2)	-0.309	-2.607	0.011
DFDISA(-1)	3.369	2.472	0.016
DFDISA(-2)	-1.418	-1.017	0.313
DRARFMOD(-1)	-0.219	-0.273	0.786
DRARFMOD(-2)	0.541	0.678	0.500
DINDPRMO(-1)	0.095	1.45	0.152
DINDPRMO(-2)	0.122	2.175	0.034
FDI equation	Lag = 2	R**=0.038 LM het. test=0.26(0.65)	Durbin's h a=-1.39(0.16) J-B test=5.1(0.07)
Explanatory variables	Coefficient	t-value	p-value
C	0.015	4.553	0.000
ECM	-0.04	-4.181	0.000
DEXPORTS(-1)	0.022	1.635	0.107
DEXPORTS(-2)	0.023	2.110	0.039
DFDISA(-1)	0.104	0.807	0.423
DFDISA(-2)	0.153	1.162	0.250
DRARFMOD(-1)	-0.009	0.121	0.904
DRARFMOD(-2)	-0.009	-0.124	0.901
DINDPRMO(-1)	0.146	2.446	0.017
DINDPRMO(-2)	0.134	2.705	0.009
Real exchange rate equation	Lag = 2	R**=0.218 LM het. test=0.3(0.58)	Durbin's h a =.039(0.97) J-B test=4.82(0.09)
Explanatory variables	Coefficient	t-value	p-value
C	0.0053	1.01	0.317
ECM	-0.001	-0.080	0.936
DEXPORTS(-1)	0.014	0.721	0.473
DEXPORTS(-2)	0.014	0.843	0.402
DFDISA(-1)	0.028	0.149	0.882
DFDISA(-2)	-0.123	-0.631	0.531
DRARFMOD(-1)	0.406	3.607	0.001
DRARFMOD(-2)	-0.132	-1.189	0.239
DINDPRMO(-1)	-0.022	-0.256	0.798
DINDPRMO(-2)	0.006	0.086	0.932
Foreign demand equation	Lag = 2	R**=0.235 LM het. test=0.81(0.775)	Durbin's h =1.59(0.11) J-B test=1.03(0.59)
Explanatory variables	Coefficient	t-value	p-value
C	0.008	0.827	0.412
ECM	0.035	0.156	0.123
DEXPORTS(-1)	-0.069	-2.116	0.039
DEXPORTS(-2)	-0.053	-1.969	0.053
DFDISA(-1)	0.530	1.726	0.089
DFDISA(-2)	0.410	1.306	0.196
DRARFMOD(-1)	0.187	1.034	0.305
DRARFMOD(-2)	-0.165	-0.921	0.361
DINDPRMO(-1)	-0.423	-2.985	0.004
DINDPRMO(-2)	-0.104	-0.884	0.380

According to results it is again the FDI equation that carries the brunt of adjustment of the system. The interpretation of the ECM parameter (*0.04*) is quite similar to that of the German case. Here, a doubling of exports would take twenty-five months for the system to adjust, which is slightly longer than in the German case. The vector error correction modelling exercise established the validity of our co-integrating vectors, as no contradictory signs emerged in the parameter of the ECM for either the German or the Austrian case.

In this section we presented both the long-term co-integrating results and the structural VECM. We found that the long-term elasticities for Hungary's trade with Germany and Austria are very different. We saw that the co-integrating results for both countries suggested that FDI plays a crucial role in the long-term behaviour of exports and in short-term adjustment as well. However, we do not yet know the structural implications of our findings. The question now is how to interpret the co-integrating vectors we uncovered. The simplest solution is to treat them as long-term export elasticities of an export demand equation. In this case one can indicate the size and sign of the long-term demand elasticities. Although this is a valid approach, we would not learn much about the structure of the links between the respective countries.

If the model is more complicated than a simple demand equation, then the long-term parameters represent both the direct and the indirect impacts of the variables on exports. The co-integrating vectors give a joint estimate of these impacts. However, we would like to know more about the structural (direct) impacts. In *Chapter 3* we offered a comparative static model to widen the range of interpretations, and we would like to see how the long-term elasticities we uncovered fit that framework.

The other way of capturing these structural effects is to use VECM and to study the Granger causal relations between the variables of the system. Interestingly, even when researchers obtained and presented the structural results, they did not say anything about the implications (Muscatelli, Stevenson and Montana, 1995).

First of all, therefore, we turn our attention to discussing the co-integrating vectors with regard to the comparative static results. Then, we analyse the structural implication of the VECMs.

4.2 Evaluation of the co-integrating vectors

We will now examine what happens if we consider the long-term export elasticities of the extended export model. The question is whether there exists a meaningful set of structural elasticities in the comparative static model we proposed earlier that allows the observed long-term elasticities to prevail. However, if we found that such a system exists, this would not satisfy us, as we would like to infer something important about the structural elasticities.

Assuming the comparative static model is valid, we may draw some conclusions regarding the structural parameters of the model from the estimated long-term multipliers in the co-integrating vector. In the comparative static model, we extended the usual trade models by allowing increasing returns to scale in the production function, and by permitting FDI inflows to depend on income conditions abroad. Can we infer anything with regard to these important aspects of trade?

In order to answer this, let us recall the comparative static result for exports under a decreasing returns to scale production function:

$$\frac{dX}{dp}=-\frac{\overset{?}{A}}{\overset{+}{G}_{23}\overset{+}{G}_{12}\overset{+}{G}_{44}}=?$$

$$\frac{dX}{d\Pi}=\frac{\overset{?}{A}}{\overset{+}{G}_{23}\overset{-}{G}_{11}\overset{+}{G}_{44}}=?$$

$$\frac{dX}{dK_Z}=-\frac{\overset{?}{A}}{\overset{+}{G}_{23}\overset{-}{G}_{11}\overset{?}{G}_{42}}=?$$

Let us consider the long-term multiplier of the German sample first, followed by the Austrian case (see *Table 4.9*).

It is obvious that the term in the nominator ($G_{12}G_{21}G_{44}+G_{11}G_{42}G_{24}$) is difficult to analyse. We denoted it as A in *Chapter 3*. As the real exchange elasticity was estimated to be the opposite of

PPP[41], it follows that *A>0*. Under the condition *A>0* the long-term demand multiplier of export should be negative, which is clearly contradictory to the empirical finding. Therefore the comparative static model under decreasing returns to scale cannot explain the observed co-integrating vector for Germany.

The Austrian case proved to be more fruitful. Here, the price elasticity implied that *A<0*. Under *A<0* the empirical long-term elasticity of foreign demand elasticity was expected to be positive, which is in line with the empirical multiplier. One can see that the empirical elasticities can only match the model under the condition that $G_{42}<0$. This particular elasticity implies that FDI flows to Hungary are complementary to investments abroad (see *Appendix 3.1*).

Under increasing returns to scale we had the following the long-term multipliers for exports:

$$\frac{dX}{dp} = -\frac{\overset{?}{A}}{\overset{+}{G}_{23}\overset{+}{G}_{12}\overset{+}{G}_{44}} = ?$$

$$\frac{dX}{d\Pi} = \frac{\overset{?}{A}}{\overset{+}{G}_{23}\overset{?}{G}_{11}\overset{+}{G}_{44}} = ?$$

$$\frac{dX}{dK_Z} = -\frac{\overset{?}{A}}{\overset{+}{G}_{23}\overset{?}{G}_{11}\overset{?}{G}_{42}} = ?$$

.

Let us proceed similarly to the case of decreasing returns to scale. We know that in the German trade the long-term price elasticity does not correspond to PPP. Assuming the model is valid, this means that *A<0*. Under *A<0* we can only find that the long-term multiplier for income and FDI stock are jointly positive if $G_{11}<0$ and $G_{42}<0$. $G_{11}<0$ signals that the price elasticity of demand for Y is larger than that of supply. At the same time, $G_{42}<0$ indicates that investments abroad are complementary to FDI inflows to the home country.

We have already concluded that for Austria the decreasing return to scale specification of the model was possibly a relevant model. Nonetheless, it is worthwhile to check the Austrian sign combination in the case of increasing returns to scale as well. It may happen that we have potentially more relevant models than one.

[41] In the comparative static model this meant a negative partial.

We see that the price multiplier is in line with PPP *(see Table 4.9)*, so it follows that $A<0$ holds. The foreign demand multiplier and the multiplier of the FDI can be jointly positive only if $G_{11}>0$ and $G_{42}<0$ at the same time. This means that, for Austria, the comparative static model can be in line with the empirical findings under both the decreasing returns (DRS) and increasing returns (IRS) production functions.

Table 4.12. Implications of the empirical long-term elasticities with regard to the structural parameters under decreasing (DRS) and increasing (IRS) returns to scale

	Austria	**Germany**
DRS	$A<0,\ G_{42}<0$	*Contradictory signs*
IRS	$A<0,\ G_{11}>0,\ G_{42}<0$	$A<0,\ G_{11}<0,\ G_{42}<0$

We summarised the implications of the signs of the long-run elasticities with regard to the structural parameters in *Table 4.12*. What we gained from this exercise is relevant from a policy point of view. The analysis suggests that in all those versions of the model that can possibly correspond to the empirical long-term elasticities, FDI inflows to Hungary are complementary to investment abroad, and not substituting it. This is interesting as it is a finding that is not in line with other empirical results (Hatzius, 2000; Pfaffmayr, 2001).

The reader may be interested to know whether or not A holds any information for the analyst. Unfortunately, there are too many ambiguous signs in it to obtain a robust interpretation for it. We present the result of its analysis in *Appendix 4.3*.

In the exercise we managed to show that some versions of the comparative static model are consistent with the long-term multipliers we estimated earlier. The fact that we allowed increasing returns to scale did not simplify our job, as in the Austrian case it led to more than one potentially relevant models. In the German case, it was only the IRS specification that was in line with the co-integrating vector. This is puzzling. While there is some evidence of a dynamic traded sector in Austria, this is not the case in Germany (*Figure 4.4*). German industrial production has been sluggish throughout the 1990s, which weakens the validity of our findings. However, it may still be said that increasing returns to scale can be valid in the part of German industry with which Hungary is mainly trading. It should be pointed out that, despite the long recession, some parts of German industry remained dynamic. These industries are concentrated in exactly the kinds of activities Hungary's export industry supplies, such as car production and electronics.[42]

The validity of the assumption of increasing returns to scale in Hungarian manufacturing may be questioned. It should, however, be pointed out that there is robust microeconometric evidence in support of increasing returns to scale in manufacturing in Hungary (Halpern and Kőrösi, 1998).[43] In sum, one can say that, despite the long recession in Germany, the assumption of increasing returns to scale in our comparative static model is realistic. As we have seen, whichever specification was considered, there was one thing that seemed to be certain: this was that investments in the two regions should be complementary. This is a result that is relevant from a policy point of view as well.

Nonetheless, there are other ways of obtaining information about the structure of international economic relations, and we should utilise them. We already hinted at the possibility of extracting information from VECMs.[44] So we now turn our attention to the analysis of the structural relations in a vector error correction model. The advantage of this approach is that, unlike the comparative static framework, it does not impose a theoretical model on the data. Instead, it unfolds the relations that can actually be observed in the data (e.g., Favero, 2001; Hendry, 1995). This is a key aspect that plays a crucial role in the rest of this chapter.

Whichever VECM strategy is followed, the model can be written in the following format (Hendry, 1995):

$$X_t = A(L)\, X_t + B(L)\, M_t + \varepsilon_t \tag{4.1}$$

This is the format in which the results are presented in *Table 4.10* and *4.11*, where X_t is the vector of endogenous variables and M_t is the vector of exogenous variables. A(L) and B(L) are polynomials containing lag operators (ones) and parameters. Our VECMs are similar, except that the set of M_t is empty. Under the Johansen methodology every variable was treated as endogenous.

42 OECD Monthly Indicators of Industrial Activities (1995-2000).

43 In fact, this is something we shall also show in *Chapter 7*.

44 As mentioned in *Section 4.1.1*, there are two ways of dealing with this problem. Our VECM estimates in *Table 4.10* and *4.11* are based on the approach that there are no current variables on the right hand side.

We summarise the structure of Granger causalities in *Table 4.13*.[45] We will now contemplate its economic content. The points we make on the variables of the systems follow the order of the equations in the VECMs.[46]

Table 4.13. Summary table for Granger causality within the VECMs

			Explanatory variables			
Explained variables	Germany		Exports	FDI	Real exchange rate	Foreign demand
		Exports	-	G	G	0
		FDI	0	-	0	G
		Real exchange rate	0	0	-	0
		Foreign demand	0	0	0	-
	Austria		Exports	FDI	Real exchange rate	Foreign demand
		Exports	-	G	0	G
		FDI	G	-	0	G
		Real exchange rate	0	0	-	0
		Foreign demand	G	0	0	-

1. It seems to be the case that, in the short term, foreign demand does not influence *exports* either to Germany or to Austria. In contrast to this, the co-integrating vector suggested that foreign demand plays an important role in determining the trend of exports. This means that the long-term impact of foreign demand on exports evolves through indirect channels by influencing exports through other variables. One can suggest a reason why this might happen. It is probably due to the fact that non-final products play a crucial role in the exports of Hungary.

It was also interesting to observe that the short-term price elasticity of exports in the German case was close to zero (with the expected sign), while in the Austrian case it was insignificant. As mentioned before, inertia in reacting prices in such a short term can have many reasons. One could mention nominal rigidities, and the possibility that it is costly for exporters to change

[45] There is some controversy about whether the number of variables in the model should be reduced. Often it is suggested that LR or F tests should be used individually and jointly to obtain a more parsimonious representation. Others suggest that this would amount to data mining. Using LR tests, we tried to achieve substantial reductions, but these attempts were rejected when it came to testing the joint validity of restrictions. We therefore kept the findings in the format given in *Table 4.10* and *Table 4.11*.

[46] It can be seen in *Table 4.10* and *4.11* that some of the sign expectations of the comparative static models could be justified by the Granger causal structure of the VECM, while others could not.

prices. The role of transfer prices in within-firm trade should not be downplayed either. This may apply to Hungary, as it is a country with low corporate tax rates, although there is no direct evidence to justify the relevance of this type of pricing behaviour.[47] In sum, there can be many reasons why one would not observe a negative relation.

In both the German and the Austrian case, FDI flows tend to have a significant short-term impact on the volume of exports. As reasons one can mention increased solvency of the firms due to an inflow of funds, which can have a short-run supply effect on exports. For instance, one can remark that banks could improve the finances of exporting firms immediately if they know the firm has (or will have) a new owner in the form of foreign direct investment.

2. The second equation in the VECM relates *foreign direct investment* to the rest of the variables. The short-term elasticities in the VECM suggest a positive relation between foreign demand and FDI inflows into Hungary. An obvious interpretation of this observation would be that foreign direct investment in the host country is complementary to investments in the foreign country. This means that increasing foreign capital inflow to Hungary should be associated with "good times" in Germany. It could happen that in bad times the cost sensitivity of firms increases, and they would tend to shift production abroad. In this case we would observe a negative link between FDI inflows to Hungary and foreign demand, which would reduce capital stock in Germany. This finding therefore weakens the argument that direct capital flows from Germany to Hungary would reduce German capital stock and contribute to the recession there. However, this interpretation may be criticised by pointing out that a positive relation can be only the result of the fact that more demand abroad benefits both regions in general, not just via the investment behaviour in the foreign country.

In the Austrian example there is also an indication of exports contributing to the increase in FDI inflows. One can say that abrupt increases in foreign demand may necessitate more finance from abroad to enable firms to match it with the appropriate supply. This would mean that the parent company increases the supply of funds for the subsidiary, if the subsidiary has increased its exports too much and has become short of funds.

[47] Transfer pricing implies that they tend to increase the price level when production at the parent company increases. The point of this price policy is to reduce the profits of the parent company in the high-tax country, and increase it in the low-tax country where the subsidiary is. Therefore, increasing prices and exports can be positively

3. In the third equation of the VECM, we found the *real exchange rate* to be exogenous. The fact that the other variables of the system do not Granger-cause real exchange rate movements might seem peculiar, but there may be good reasons for it. Although it is true that the real exchange rate can be influenced by such important determinants of the balance of payments like exports or changes in FDI, it may be that these effects simply show up too slowly. One reason for this could be the pre-announced crawling peg exchange rate regime that was in operation in Hungary exactly in the sample period. At the beginning of the year, the path of devaluation for the future was announced, and the paths of devaluation were then changed only very rarely. There was thus little scope for the exchange rate to react to variation in exports or FDI flows. We know that there exist other determinants of the real exchange rate, but we only consider the impact of those that the model contains.

4. It is not only the real exchange rate that does not depend on any of the other variables. In the German case, *foreign demand* is also exogenous: it only depends on its own past values. This is not surprising, as Germany's industrial output is simply too large for any Hungarian-related real variable to have any palpable impact on it.

However, the case of Austria is quite different. We observe that Hungarian exports Granger-cause Austrian industrial production. In order to interpret this, it is helpful to recall that exports Granger-caused FDI inflows to Hungary in the second equation. It is possible to link the two observations. In expectation of increasing demand, the foreign parent company increases its imports of inputs from Hungary. However, if, as a result, the subsidiary runs low on cash, funds must be supplied from abroad to sustain the level of exports. So, an increase in exports will predict an increase in FDI. At the same time an increase in expected foreign demand can have another impact on the subsidiary in Hungary. It also reduces the stock of the Hungarian firms as production at the parent firm increases. The negative sign of the parameters can be explained on the grounds that the increase in the exports of Hungarian firms does reduce the output of Austrian firms that produce similar products. This means that growing exports from Hungary can force Austrian firms to restructure. This negative impact feeds back into FDI and reduces its flow to Hungary. So, due to this feedback the sign of the impact of an increased foreign demand is not clear. However, one can conclude, that unlike the German case, the Austrian economy is probably significantly influenced by the behaviour of the Hungarian economy. There is therefore

correlated.

some proof that, in the short term, Austria is adversely influenced by increases in Hungarian exports.

We managed to reveal important structural relations between some of the countries of the EU and Hungary. The VECM framework helped us identify relations that we could not uncover from the co-integrating vectors. However, it emerged that some of these relations are implied by the comparative static model as well. This is something that adds to the credibility of the results. Next, we are going to consider the implications of the links we have discovered.

4.3 Conclusions and the implications of the findings

The purpose of this chapter was to show the role FDI has played in the behaviour of exports in the new era. We recalled that one of the major problems faced by policy-makers under central planning was that exports remained stagnant throughout the 1980s. Furthermore, whenever the economy started to grow, the balance of payments collapsed. Despite initial imbalances and massive foreign debt, Hungary did not default in the early 1990s when a transition-related economic shock occurred. What is more, from 1995 onwards one can observe very steep growth in the volume of exports, without major devaluations.

In this chapter we attempted to evaluate export behaviour and the role of FDI in it. This can be important for at least two reasons. First, in a period in which exports play an increasing role in the world economy, stagnant exports are a clear sign that an economy is performing poorly relative to its competitors. Second, exports and trade are a crucial channel for the real integration of Hungary (and CEECs in general) into the EU. It only makes sense for the EU to take on a new member if the applicant country is sufficiently closely linked to the economies of the EU in terms of both foreign trade and investment.

Establishing Hungary's links through exports is not a straightforward task. The problem is that the usual export models behind the empirical equations are too simple. Although this makes it easier to interpret the findings, at the same time it increases the likelihood of the interpretation being wrong. In order to ease the problem of interpretation, we set up a comparative static model that accounted for aspects of exports that are uncommon in empirical export modelling. Our purpose was to see if we could find out about at least some of the structural parameters of the model using long-term multipliers of exports. We try to obtain such results using different means as well. We discarded all our assumptions about the relations between Hungary and her trading partners in the EU, and used the Granger-causal structure of a vector error correction model to uncover the structural relations between them.

To establish the presence of such relations, we used macroeconomic time series. In order to achieve our first goal we set out to perform a co-integration analysis on a relevant set of variables. Due to problems relating to structural breaks, we had to drop observations from the beginning of our sample and proceed using only data from 1995 onwards. The results obtained suggested that real exchange rate, foreign demand conditions and FDI inflows jointly explain the *long-term* behaviour of exports to Hungary's two most important trading partners (Germany and Austria) quite well. All three variables need to be present in the export model in order to obtain this result. Despite suggestions in the literature (Buch and Döpke, 1998), foreign demand plays a very important and positive role in the long-term volume of exports. This is supplemented by the impact of the FDI inflows. However, the behaviour of prices is ambiguous. In the German case, it has a large impact that is the opposite of PPP, whilst in the Austrian case it is in line with it.

First these results were interpreted with the help of the comparative static model. We extended the model in a way that would allow us to incorporate increasing returns, trade in immediate goods, and the possibility that foreign demand conditions influence FDI flows to Hungary. This model proved helpful in drawing some conclusions about the *short-term*, structural characteristics of the economic relations between Hungary and her important trading partners. It should be emphasised here that there was one aspect of the structural model that appeared in every relevant model specification. This was the positive relationship between investment behaviour in the foreign country and FDI inflows to Hungary. We then took another route to obtain information about the structural patterns of trade, and utilised the vector error correction models constructed from the co-integration vectors. In this way we managed to uncover more information than with the previous method. However, one result reappeared. It was again suggested that foreign demand conditions are positively related to investment flows to the host countries.

This positive relation may be interpreted in two ways: it may be a sign that buoyant economic activity in Germany is beneficial to both countries. The reason for this may be that there are more resources available for investment. At the same time, it may also be said that investments in the two regions may be complementary rather than substitutes for each other, and both regions benefit from better times in Germany. Under both interpretations Hungary benefits from good times in Germany, while bad times do not do her any good. Clearly this result is contrary to the literature, which mostly argues (Hatzius, 2000; Pfaffmayr, 2001) that some EU countries suffer considerably from the effects of FDI outflows to transition countries.

These are not the only important implications of the Granger causal structure. It seems to be the case that real variables related to Hungary do not influence traded sector performance in Germany. This is not surprising, considering the relative size of the two economies. However, this is quite different for Austria. This means that German policy-makers need not pay much attention to fluctuations in real variables in Hungary, whereas Austrians do. During the decades of isolation under the socialist system, Hungary's economy naturally had no significant impact on Austria. The results suggest that this may have changed. Given that the two countries are neighbours, and are of similar size, this should be a natural development. However, the negative impact of growing Hungarian exports on Austrian industrial output hints at the fact that there is less likelihood of mutual short-term benefits than in the German case. Nonetheless, the outstanding performance of Austrian industry *(Figure 4.4)* makes it improbable that the negative effects of the increased import competition from Hungary on local producers would be great. We described a possible interpretation of the Granger causal structure for Austria that emphasised the role of the activities of foreign-owned firms in this process.

We observed that FDI was crucial in the long-term behaviour of exports. One cannot establish a satisfactory long-term model of exports without it. However, it turns out that FDI plays a crucial role not only in the long-term, but also in the short-term behaviour of exports. We found that if there is a deviation from the long-term path of exports, the brunt of the adjustment of actual exports towards those predicted by the model takes place mainly through FDI inflows to Hungary. So if exports are too small, FDI inflows and their subsequent positive impact on exports will drive exports up again towards their long-term path.

Now, we can safely conclude that FDI is crucial in driving exports both in the short and the long-term, and that it has greatly contributed to making exports grow dynamically in the new era. It is also clear that the long-term relation (co-integration) between the German and Austrian variables and those of Hungary indicates close relations between these economies, so a lack of satisfactory integration cannot be a valid argument against EU enlargement. The pattern of FDI inflows suggests that foreign investments in Hungary are supplementary to investments in the EU countries, and this reduces the probability of negative effects of these flows on current members. However, in the Austrian case there may be measurable short-term costs in terms of industrial output due to increasing exports from Hungary.

So far we have concentrated on the impact of invested direct capital on Hungary's exports and its possible repercussions in the foreign country. We were interested in the domestic influence of FDI only inasmuch as it added to the local capital stock and increased export supply. Its role in the domestic economy has hardly been considered. In the next chapter, we explore the domestic impact of FDI. We deal with the relationship between technological change and the role of the foreign investor in the Hungarian economy.

Chapter 5: The Behaviour of Hungarian TFP

The failure of technological progress was a major factor in the collapse of the socialist system. Analysis of technological change is therefore crucial to see if Hungary has managed to break away from this legacy. What we would like know more about is the role that foreign direct investment (FDI) may have played in this regard.

The questions we explore go to the very heart of transition economics. The collapse of the socialist system was often blamed on poor technological progress and inefficient use of resources. A great deal of empirical research was initiated that examined the determinants of productive performance and the restructuring of state-owned enterprises (SOEs). Our work in this chapter adds to this literature. We pursue the following line of discussion.

First, in *Section 5.1*, we present the findings of recent international debate relating to the experiences of transition countries. Technological progress has attracted great interest not only among transition economists, however. We discuss some of the details of a recent dispute concerning technological change and estimates of total factor productivity for Asian countries. A remarkable controversy evolved in connection with this issue, and it has emerged that the implications of the experiences in Asian countries are of relevance in terms of how we view developments in transition countries. We will review this literature and put the findings that have emerged so far in proper perspective.

In *Section 5.2*, the problems of calculating total factor productivity (TFP) by means of a simple growth accounting exercise are discussed. First, we pursue this issue in a general context, and then we focus on the problems that are peculiar to transition countries. The purpose of these first steps is to define the data limitations and to point out the potential problems of the exercise we carry out.

In *Section 5.3*, we present the results of a growth accounting calculation prior to the start of transition (1980-1989) and for a few years after it (1990-1996). We shall carry out our own calculations of TFP based on industry data and will present evidence about its newly evolving patterns in Hungary. The behaviour of TFP is interesting in its own right, but we attempt to relate it to variables thought to be important in determining it. These variables include FDI and R&D.

In *Section 5.4*, we consider the implications of our findings and point out ways of extending the work. To ease the data-related problems of the analysis we decided to turn our attention to a firm-level analysis.

5.1 TFP growth in dynamic countries and in countries in transition

Many have pointed out that the economic failure of the pre-transition socialist system was due to meagre TFP performance (Kornai, 1992, Easterly and Fischer, 1995, Krugman, 1994). It is not only the transition literature that attributes great importance to TFP growth; neo-classical growth theory also suggests that deep parameters including technological change should determine long-run growth. Some endogenous theories place even more emphasis on this. Hence, its behaviour could be crucial for Hungary not only in the transitory period from the socialist system to a functioning market economy. Below, we treat TFP as an empirical concept, first as part of a growth accounting exercise at industry level, then as a regression parameter using firm-level data.

Before we start our calculations, it might be useful to outline the results of recent debates on this issue; this will provide references with which to compare our results. Recently, intense debate has been taking place on the nature of Asian growth and its similarities to the growth of socialist economies. The newly industrialised countries of East Asia achieved a prolonged period of GDP growth, unmatched by developing countries in other parts of the world. Since few other countries have managed an equivalent performance, the experiences of the Asian NICs may be instructive for those lagging behind them. Policy examples from Asia were often recommended by international organisations to CEE countries, where growth collapsed very sharply in the early 1990s. Although many successful policies cannot be imported mechanically, for policy-makers it is crucial to have some idea of how high the TFP growth rate really was in East Asia. Finding high TFP growth would prompt policy-makers elsewhere to favour policies that improve technology, while low TFP growth would tend to support policies aimed at factor accumulation.

The Asian part of the debate arose out of an article by Young (1992), presenting TFP calculations for Singapore and Hong Kong. As the former was more interventionist than the latter, the fact that negative TFP growth was found for Singapore and positive for Hong Kong was interpreted as a sign of wasteful government activity. Krugman (1994) placed the results in historical perspective. He argued that low TFP growth rates did not bode well for future growth in East Asian countries, which could be expected to stall. He argued that rapid factor accumulation was the main reason behind the growth successes so far and, due to the rule that the marginal product of capital is bound to decline as capital accumulation proceeds, these countries would face a slowdown in their economies. Furthermore, in his paper, a historical parallel was drawn between East Asian growth experiences and those of state-socialist eastern Europe. In both regions, enormous factor accumulation took place in capital and in labour.

The lack of TFP growth prevented the socialist countries of Eastern Europe from sustaining their economic growth rates in the 1980s. A credit constraint posed by the debt crisis of the early 1980s, and the fact that the participation of women in the labour market was already high, thwarted growth based on accumulation. Most of these societies, including Hungary, were no longer rural, so drawing in more labour from the rural sector was no longer an option. At the same time, TFP growth collapsed. This could be due to a failure of incentives in the socialist system, weak economic co-ordination, or failure to improve the level of technology as a whole. The mildly liberalising economic reforms of the early 1980s did not bring about the expected improvements in performance and an economic decline in terms of real GDP set in from the mid-1980s. Therefore, so the argument goes, sustained low TFP growth should predict the breakdown of growth in some East Asian countries, as happened in former socialist countries. It was Krugman (1994) who argued along these lines and, for some countries, the results given by Young (1995), Crafts (1998) and Bosworth and Collins (1997) appeared to corroborate the underlying pattern of poor TFP performance in Asian NICs.

However, many economists did not agree. In the ensuing debate, contributors concentrated solely on the Asian side of the argument, neglecting the Eastern European end. One could argue that the low TFP found in Eastern European countries was inherent in the socialist system. Microeconomic studies have shown that the primary concern of firms is the natural quantity of output. Socialist firms were interested in stockpiling as many factors of production as possible.[48] No matter how inefficiently they used resources with the given technology, unless total production rose steeply.[49] The other source of low TFP growth was that in the socialist system there was very little interest in improving the technology of production at all (Kornai, 1992).

Forced accumulation under the socialist system may not be the only reason for low TFP growth. The two-sector Lewis model (1954) of structural transformation in developing countries suggests that rapid accumulation (and low TFP growth) may occur under market conditions (wages are paid at the marginal product of labour in the model), provided there is a large surplus of labour in the economy. This model has commonly been used to describe the structural transformation of a surplus labour economy in developing countries. Kornai (1992) drew parallels between the factor accumulation in the socialist countries and the structural behaviour in the Lewis model. He suggested that the early stages of the socialist economy, with rapid accumulation of factors of production in the industrial (urban) sector, could also be

[48] However, it should be noted that, while modelling the foreign trade of pre-transition Hungary, Halpern and Székely (1993) argued that state-owned enterprises proved to be very price-sensitive in international trade.

[49] On this issue see for more details the paper of Bai, Li and Wang (1997). They argue that the TFP of state-owned enterprises can be a misleading measure of their true performance.

described quite well by the Lewis model. Hence, there could be a common cause for the observed low TFP growth in socialist countries and in East Asia.

However, while the eastern European side of the debate on TFP was virtually inexistent, the literature interpreting the East Asian observations is abundant. One type of criticism is based on the assumption that the production function used in the standard estimates is neutral for technological change. Rodrik (1997) recommended a different specification for the production function: a labour-augmenting component of technological advance should be included in the production function; otherwise the estimates of TFP growth will be biased. Hsieh (1999) used the price-base of a trans-log production function, and came up with TFP estimates from a price-based accounting identity for the total income of an economy. Both articles suggested that TFP growth rates in these countries have not been out of line with the findings in OECD countries. Therefore, parallels with the factor accumulation in the socialist system are probably unwarranted.

Low TFP growth in successful East Asia would suggest that adoption of policies increasing the amount of available factors could be helpful in catching up. However, the finding of TFP growth rates comparable to the experience of OECD countries would suggests that policy-makers should instead favour policies improving technology. There is probably no need to pose the question in this form. The most careful empirical findings suggest that there is nothing unusual about TFP growth rates in the countries of East Asia. This suggests that rapid growth and catching up can happen without accumulation-centred policies. Successful CEE countries, therefore, should not expect TFP growth rates to become unusually low after the impact of passive restructuring (the shedding of idle resources inherited from the socialist system) levels out.

In the case of Hungary, Darvas and Simon (2000) demonstrate that TFP growth was indeed very dynamic in the initial phase of transition, but later started to level out. However, the growth rates of the late 1990s were still significantly above the rates measured in the OECD countries. At the same time, it is worthy of note that in the traded sector (mostly manufacturing) there was little, if any, decline in the growth rate of TFP compared with the shock period. In the initial phase of transition, a high TFP growth rate could only be the result of the passive restructuring of socialist firms. However, from the mid-1990s, there is more evidence that improving performance was becoming associated with rapid growth in investment. Now two questions emerge for our inquiry. Was the TFP growth rate of Hungary prior to transition really so meagre as suggested in the literature? Was there a change in the behaviour of the TFP growth rate in Hungary after transition started?

5.2 The problems of calculating TFP in transition countries

In the growth accounting framework, improvement in technology has various synonyms in the empirical analysis of growth. It is most often called the Solow residual. When technological progress is neutral and production factors are assumed to be exogenous, TFP growth can be estimated using regressions or with simple growth accounting. In simple growth accounting one observes the price of each factor[50] and, using price shares as weights, one calculates the level of (neutral) technology for every observation using the observable data of the production function. This is an index method of calculating TFP.[51] Alternatively, one can obtain the factor elasticities and the level of technology as parameter estimates from a simple regression.

There are two ways to approach TFP using regressions. For instance, it is possible to obtain an estimate of the level of TFP by using a linear regression in the log-linear form of the Cobb-Douglas production function assuming a neutral technological change. In this simple case we assume that observations fall on both sides of the production surface with a zero mean. Modifying this method by assuming that firms tend to produce within their production frontier, one can come up with more realistic results (Lovell, 1993; Grosskopf, 1993). These frontier techniques can be useful, as they account for the shift in the level of technology (a shift in the production surface)

[50] Under unitary Cobb-Douglas it equals the factor elasticity.

and the firms getting nearer or further away from it (technical efficiency) at the same time. However, we would like to analyse the determinants of the shift in the production function, and we are not interested in the technical efficiency term. So, what can we do?

1. One may assume technical efficiency to be unimportant. This is typical in the transition literature and is a usual procedure, irrespective of whether econometric or non-econometric methods are used (see, e.g., Darvas and Simon, 2000; Djankov and Hoekman, 1998, 2000a, 2000b; Dmijan, Knell and Rojec, 2000). This is an assumption we will adopt in this chapter.

2. One may change the interpretation of TFP. From a purely performance point of view it is not important whether improving TFP is due to efficiency or technology. Both are good news for a firm. We have not considered the separation of these two components, so we will bear this point in mind when evaluating our results.

3. When one tries to draw policy-relevant conclusions concerning the role of FDI in technology transfer, the distinction between technical efficiency and technology improvement becomes important. If the efficiency component is ignored, the level of technology in the production function is overestimated. In this case, one can either use frontier techniques or use external information.[52] We shall choose this latter route in *Chapter 7*. Empirical evidence for Hungary has shown that the *level* of technical efficiency (frontier efficiency, capacity utilisation) is quite stable from 1993 onwards (Halpern and Kőrösi, 2000). This implies that an analysis of TFP *growth rates* without frontier techniques is valid, and it can be interpreted as pure technological improvement (an outward shift in the production function).

In this chapter we will carry out a growth accounting exercise, beginning with a discussion of its shortcomings.

[51] We used the Divisia index formula (Good, Nadiri and Sickles, 1999).

[52] There are index number decompositions available as well, but we did not have sufficient data to

Growth accounting requires a great deal of data, which raises a number of serious problems. These can be placed in two groups: (1) those that restrict all total growth-accounting exercises, and (2) those specific to the pre-transition period and the transition process.

(1) These include:

(a) Estimating the growth rate of capital stock. Official estimates of capital stock may be used, but their unreliability means they are scarcely usable in growth-accounting exercises. It is believed that in most countries, investment statistics are superior to the data for capital stock. This is because of the popular way of calculating capital stock by simply adding up a sufficiently long series of investments, after accounting for inflation and depreciation of capital. In practice, the investment series available is often not long enough, so that for want of anything better, statisticians frequently extrapolate backwards.

(b) Another problem concerns weightings. These should be equal to the marginal product of the factor concerned. Anything that causes a deviation from the marginal product undermines the estimate. Examples of such factors include monopsonic input markets, externalities, or informal activities. The last may be extremely important in developing countries and in transition economies.[53]

(c) The most important general problem in measuring total factor productivity is that of interpretation. Since it is a residual concept, it can include anything – from the impact of education, to research and development, innovation, discovery of new tastes, market structure, and constraints on the optimising behaviour of firms. There have been numerous attempts to identify the contributions made by the factors recommended by theory, but with little success so far.

make use of these.

[53] Sarel (1997) adjusted for the informal sector and the difficulty of obtaining reliable income data for it

(2) The data problems specific to the transition economies may prove to be even more severe.

(a) It is not really known how much of the capital stock was lost after the transition started. The highest estimates for Hungary suggest that a third of the initial national stock disappeared. However, it can be argued that this process was not a capital loss (a 'sudden' scrapping), but a more realistic revaluation of the existing capital. It may be assumed that, in the socialist period, firms were prevented from writing off equipment, which meant that they attached very high book values to their assets. The liberalisation of trade brought immediate competition from imports, which squeezed the profits of Hungarian firms and depreciated the value of their capital stock very rapidly. However, it is not easy to adjudicate here, so that alternative calculations for capital stock are still possible. One might also regard the huge, 'sudden' scrapping of capacity in the early 1990s as an abrupt realisation of many years' postponed scrapping. The rate of depreciation varies widely across types of capital stock. However, if the capital stock is treated as a single factor, researchers estimating TFP usually take 7–10 per cent a year as a mean rate.

(b) Another complicating factor is the question of prices. These were set artificially low under the socialist system. Furthermore, price levels were understated in the official statistics. However, these price data are the only ones available for deflating investment and value-added data. Consequently, the calculated growth rate of capital stock is overestimated and the growth rate of efficiency will actually have been higher than the result obtained for the pre-transition period. If more than one factors of production are included in the calculations, the estimate for the TFP growth rate will be higher if the price indices for the factors are such that they would on average be higher than the price index for output. However, there is no reason to believe that, under socialism, prices on the input side *per se* departed in general from prices on the

by using industry-specific weightings.

output side. If they had, the deviation would have shown up by definition as shifts in TFP growth rate and biased calculations.

(c) All the categories in the statistical aggregation have changed radically. In 1992-3, the statistics for labour, investment and the national accounts were all modified, so that there is no complete consistency over time for any sector. At higher aggregation levels consistency is easier to obtain, and so we set up broad industry categories to deal with the problem. Three pre-transition industries where consistency could not be achieved were excluded from the sample. The categories we used are pre-transition industries and we tried to match the post-transition data from the new classification with them. Value-added data have been based on the national accounts, using data collected by the Hungarian CSO (Central Statistical Office), which cover only the larger firms (with more than 20 employees). Capital stock data were constructed by accumulating past investments. At the CSO they constructed and checked a key that bridges the difference between the two classification systems. They found that this key managed to place firms in the correct pre-transition industry category with at least 70 per cent probability.

The first stage of our work was to set up a data set covering 1980–97, including three sub-periods to be accounted for in the calculation procedure: a *socialist/pre-transition period* (1980–89), a *shock period* (1990–92), and a *consolidation/post-shock period* (1993–7). We collected data on employment, income shares of capital, and value-added. In absence of industry price data, national averages are utilised for price indices. Then we calculate TFP growth rates.

The second stage is to relate the TFP growth to variables that are regarded as important for explaining its dynamics. These include the flow of foreign direct investment and spending on R&D. Great importance is ascribed to the former in the literature on technological advance both during transition (Djankov and Hoekman, 1996, 1998, 2000a; Freudenberg and Lemoine, 1999) and in a more general context

(Caves, 1971; Dunning, 1992). R&D is thought to be crucial in some of the new growth theories (reviewed for example in Solow, 2000).

We will calculate TFP growth rates using simple growth accounting, and analyse the pattern thus obtained. Then, some simple statistics are calculated to compare the patterns in the pre-transition and the post-shock period. The pre-transition period should be treated separately from the post-shock period and we completely ignore the observations from the shock-period. However, complete separation of the two periods is impossible. Despite the attempt to separate the two periods, the fact that we have used cumulated investments as capital stock means that, unfortunately, there are errors in measurement in the pre-transition period that appear in the post-shock subsample.

5.3 A non-econometric calculation of TFP growth

We now turn our attention to the behaviour of the actual series we work with. The patterns we observe give us insights into the workings of the socialist system and its collapse. These data constitute the input to our index number calculation of TFP.

Regarding investment, the most conspicuous change is the differentiation of investment behaviour across industries (see *Appendix 5.1* for details). In some industries – e.g., machinery, chemicals – there has been a dramatic increase in investment, while in others the decline is spectacular. Investment activity in the service sector, in trade (including business services), transport and-telecommunications has been particularly strong in the new era, while mining, steel and agriculture have lagged behind in terms of investment. The former group of industries was typically neglected in the pre-transition period at the cost of promoting the latter group. It is remarkable how rigid the sectoral structure of investment under the socialist system was. There were no important changes in the ratios between the branches until the end of the 1980s. The decades of neglect of services show up in an immediate surge of investment once capital was allowed to flow there.

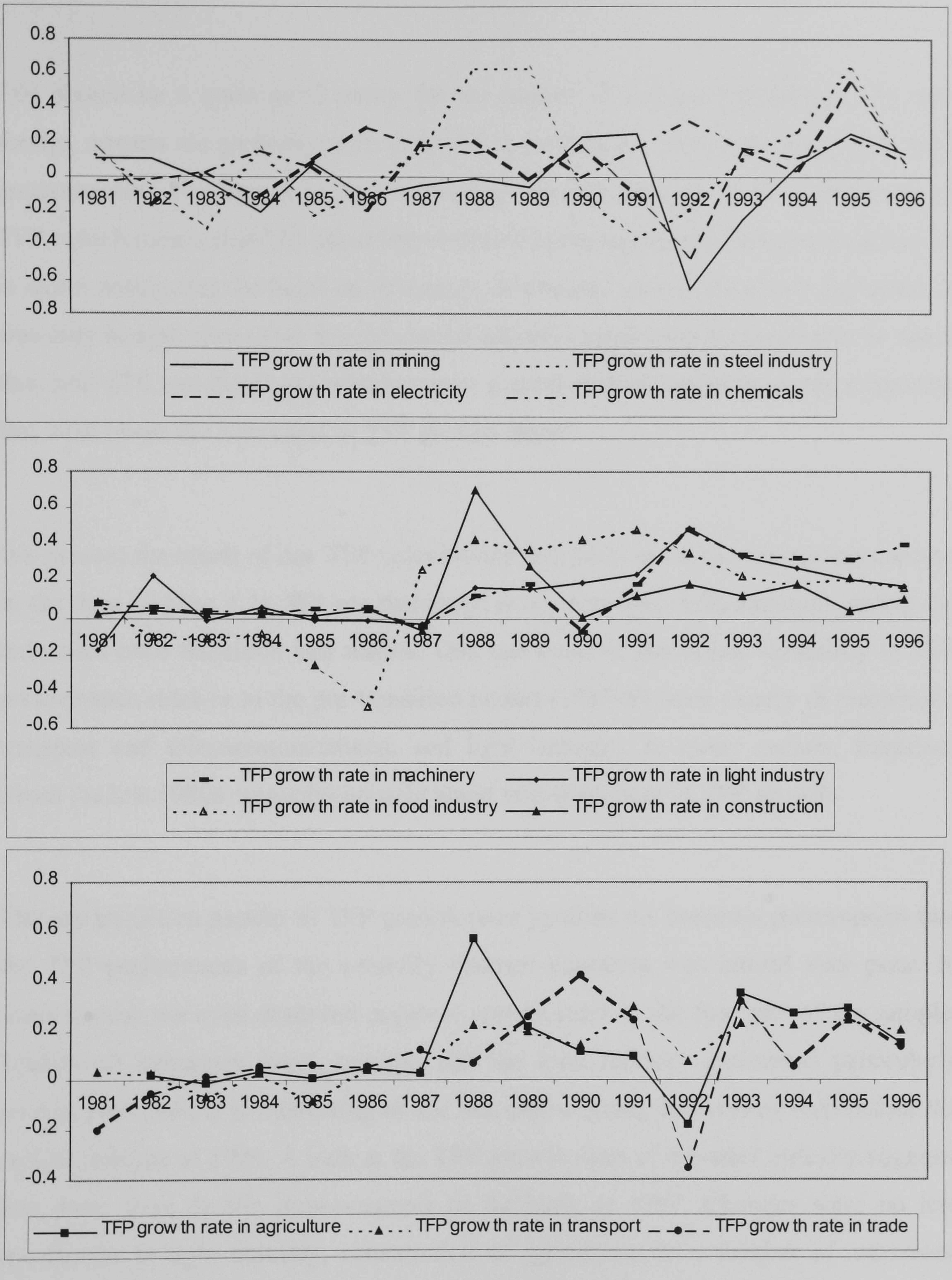
There is also noticeable differentiation in the trends in capital stock. First, it was assumed that there had been no loss of capital relative to book values at the end of 1980s, and then that one-third of each sector's stock at the end of 1989 was lost over the next three years. The loss was distributed as a geometric series across these years. The assumption of a capital loss enhances the differentiation of the capital-growth paths for each sector once the transition started, by modifying the initial values, but essentially the same sectors remain 'winners' and 'losers'.

A huge fall in employment took place across the board. The sharpest declines took place in machinery, light industry and agriculture.[54] A dip and then a recovery in the volume of value added accompanied the decline and subsequently the low level of employment in industry. This already suggests a very high rate of TFP growth. However, it is the share of labour in total income that determines the contribution of employment to TFP growth. As *Appendix 5.1* shows, these shares in the socialist period were very low, and then became very high in the early 1990s. Then the share fell back to the range of 60–70 per cent commonly found internationally.

One component of TFP must be the improvement of technology, which can be imported or developed locally. Since the impact of locally developed technology must contribute to TFP, R&D spending must correlate with TFP growth. We assume that the other source of technology improvement is technology import, and that it can be proxied by FDI. Therefore, to obtain the partial effect of these factors, TFP growth should be regressed on R&D spending and on the flow of FDI jointly with a suitably chosen lag structure. Before such an exercise can be executed we need to consider the behaviour of these variables.

[54] The apparent increase in employment in the electricity sector in 1991 results only from a change in sectoral definitions.

Figure 5.1. TFP growth rates in various highly aggregated industries



Spending on R&D shows a dramatic decline in all sectors. In some, it completely disappeared. There is nothing surprising about this if the sector itself has almost vanished (as is the case with mining). R&D spending that is close to zero can also be observed in agriculture, electricity, machinery and light industry. The only sector where significant R&D spending remained is chemicals.

FDI should be a quite good proxy for the import of foreign technology. The new foreign owners are probably more inclined to introduce a new technology than local entrepreneurs. The impact of new technology should show up in the growth rate of TFP, which means that FDI should be included in the regression framework as well. It is worth noting that the build-up of foreign investment took place across the board. It was only in agriculture that foreign capital played a small role. It should also be noted that both FDI and R&D expenditure show a great deal of variation across industries. But what about the behaviour of TFP growth rates?

We present the result of our TFP calculations and point out some interesting patterns in the data *(Figure 5.1)*. We see that there is an increased differentiation among the industries once transition had started. One can observe increasing variability in TFP performance relative to the pre-transition period (1981–9) most clearly in machinery, transport and telecommunications, and light industry. In many sectors, transition (from the late 1980s onwards) brought about two-digit rates of TFP growth.

The pre-transition pattern of TFP growth rates justifies the common presumption that the TFP performance of the centrally planned countries was indeed very poor. In some sectors we even observed negative growth rates in the first part of the sample. Traditional industries (steel, mining) and the food industry performed particularly poorly. However, it is interesting to see that restructuring had started well before the radical reforms of 1990. A look at the TFP growth rates of the steel industry suggests that there were drastic improvements as far back as 1987. Changes were no less spectacular in light industry, construction or agriculture. In a number of industries, therefore, we see a large improvement in technology even before transition, a decline in the shock period, and a rise once again in the post-shock period.

Initially, the improved TFP performance was not due to better value added performance with given labour, but to the fact that heavily subsidised industries like steel and agriculture could no longer sustain their level of employment. As resources for investment dried up, employment in the construction industry also had to adjust. The bottom line is that the performance of the economy did not improve after the enterprise reforms of the early 1980s. Some industries, however, started to adjust radically years before the collapse of the system.

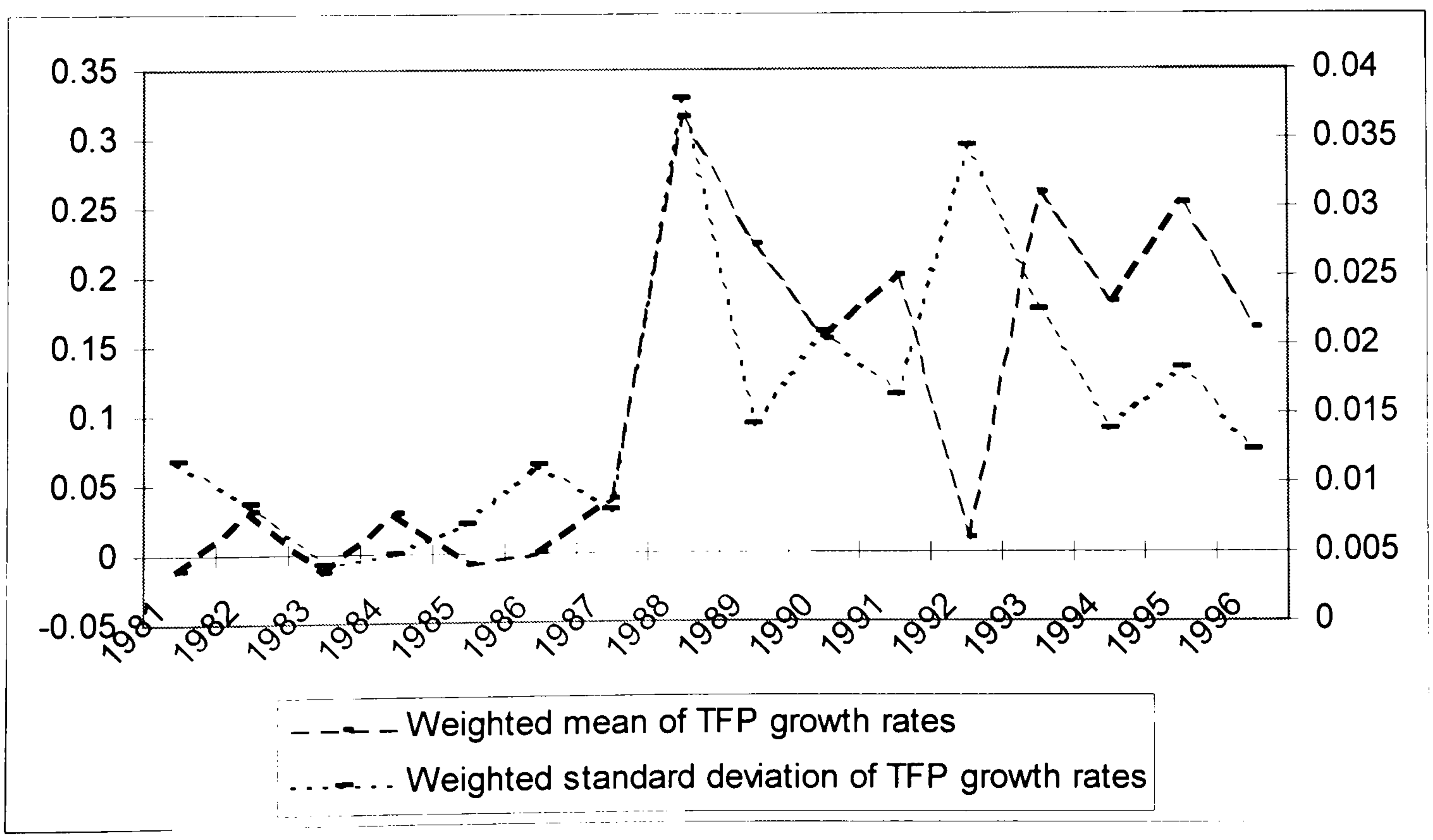
Why do we observe a sharp decline in TFP growth rates in many industries in 1992? 1992 was the trough-point of the well-known U-shaped adjustment process (Repkine and Walsh, 1997) observed in many transition countries, and it was also the year of the change in the system of accounting. Two competing explanations could be considered. One could say that the decline is simply an anomaly caused by inconsistency resulting from the change in the industry classification system in 1992. This would suggest that our attempt to match the old classification to the new proved unsuccessful. The other possibility is that the anomaly is not the result of errors in the data, but that the collapse of demand and output took place a little before the adjustment of the use of factors. However, it must be noted that the industry inconsistency explanation of this anomaly is probably less valid, as the large decline in TFP growth rates took place in industries where the classification had been the least ambiguous over time (transport, mining).

In the period after the shock, TFP growth rates across various industries behave much more similarly to each other than during the shock period. All are positive and higher than suggested by the aggregate estimates of Darvas and Simon (2000). A reason for this, other than methodology, could be that the service sector dominated by the government (education, health, armed forces, administration) is omitted from the whole of our exercise while results based on aggregate data originate from calculations containing them.

In *Figure 5.1* one can also see that the machinery industry shows the highest growth rate after the shock period. This is important as this industry has realised most of the growth in trade (exports and imports) and took the bulk of investments from abroad in the traded sector (e.g. Djankov-Hoekman, 1996; Freudenberg-Lemoine, 1999). This hints at the fact that FDI and trade probably play an important role in firm performance, an issue we will pursue in more detail in *Chapter 7*.

To correct for the changes in the relative importance of different industries we calculated the weighted mean and the weighted standard deviation of TFP growth rates across industries for each year. The labour force was used as weighting. The results are summarised in *Figure 5.2*. As mentioned before, we can see that adjustment had started on a huge scale before transition. However, transition brought about a massive increase in both the variation and the mean in the growth of productivity. Until the end of the sample period these indicators did not show an obvious decline. However, it should be remarked that the mean is far too high to be sustainable in the long run. A sustained two-digit growth rate of TFP would be unprecedented in economic history.

Figure 5.2. The mean and the standard deviation of TFP growth rates across industries



The phenomenal TFP growth rates in machinery or transport and telecommunications, for example, indicate that different sources of growth (e.g., technology imports via FDI) must have taken over from the simple shedding of labour (passive restructuring) that fuelled it in the early 1990s. These are precisely the industries where investment in physical capital was concentrated. The increase in the TFP growth rate after the shock period was no longer the result of labour shedding. Passive restructuring was soon replaced by expanding output fuelled by investment.

High TFP growth rates are commonly associated positively with both R&D and FDI in the literature (Link, 1981; Good, Nadiri and Sickles, 1999; Griliches, 1986). Prior to transition there was no FDI, and research alone could not compensate for other factors that brought about poor performance in terms of technical change. So we observed a very low TFP growth rate. However, in the post-shock period we observe that a massively improved TFP performance goes together with a very low and sluggish R&D. This means that other factors must have compensated for the decline in R&D. A spectacular rise in FDI would therefore be a natural candidate to explain high TFP performance in the period - once passive restructuring was over. Now we turn our attention to checking the joint impact of FDI and R&D on performance in a regression framework.

The assumption that FDI is beneficial for TFP rests on the expectation that the appearance of new technology takes place in the form of knowledge transfer by the foreign owner. These firms possess superior management and firm-specific knowledge than locally owned firms, which can compensate for lesser familiarity with domestic conditions. Technology and skills are supposed to spread locally, and domestic firms are expected to benefit from the presence of foreign firms as well. However, in the regressions where TFP growth is an explained variable regressed on FDI and R&D, two sources of bias may arise. A capital investment by the foreign owner at first worsens TFP by abruptly increasing the growth rate of capital, and it is only later that it brings a piecemeal rise in the growth rate of TFP through the modelled relation. Therefore, there is another relation present between FDI and TFP that is often not accounted for in the regression. A further source of bias is that both FDI and R&D expenses are simultaneously dependent on performance as well.

However, the problems of a TFP regression do not end here. As we saw, there was considerable TFP growth after transition started. Therefore, the large positive impact of FDI probably overwhelmed the positive, small effect of R&D. However, from a methodological point of view we cannot perform this exercise soundly. In the post-shock period we have very few observations and there is no point in pooling data with the pre-transition period. This is because, even if one applied a flexible specification for the regression, some noise from the first period carries over into the post-shock period. To prevent this, one would have to analyse the two sets of observations in the two periods completely separately. This may be either in two separate sets of SUR regressions or in two pools. The problem remains, however, that the length of the time series is very short. One would need lags in any regression specification to obtain meaningful results on the impact of R&D. Particularly in the post-shock period, the sample is very short. We are therefore unable to use it to estimate the partial effects of these factors. Accordingly, we had to completely abandon our plans to carry out regressions with this dataset. Nonetheless, the TFP growth rates we calculated on the basis of the data set are worthy of note and clearly give us important insights into a crucial aspect of Hungary's economic transition. Although a regression exercise could not be undertaken, the observations with regard to the TFP behaviour of Hungary are valuable, as this kind of research at the aggregated level has barely started.

5.4 Comparative considerations regarding the results

The question that naturally arises now is, how do the TFP growth rates compare with those in the OECD or East Asian NICs? The calculations confirmed that the TFP performance of Hungary in the period prior to transition was indeed very low. We saw that massive restructuring started as early as 1988. In some years prior to transition, the industry average of TFP growth rates was similar to those common in OECD countries and probably in East Asian countries: it fell between zero and 5 per cent.

However, in the majority of years it was negative, which is something that characterised the countries of the socialist system.

In the period of the most drastic restructuring, TFP has grown at a phenomenal rate. This was not surprising, considering the massive within-firm over-employment at state-owned enterprises prior to transition. The growth rate of TFP seemed to remain extremely high and did not reduce by the end of the sample period. Its mean remained well above the estimates that are usual in OECD and dynamic Asian countries. This probably implies that it is going to take a long time for the TFP growth rate to converge to the rates found to be common in international comparisons. However, in our judgement the quality of input data was quite poor, so we cannot be certain about the validity of our results.

Others (Darvas and Simon, 2000) also suggest that the TFP growth rate was unusually high even after passive restructuring was over. They also obtained two-digit growth rates in the traded sector, although their results showed that the growth rate slowly declines. Their method of calculating TFP was quite similar to ours, except that in order to obtain an initial stock of capital they assumed a constant growth rate for capital stock for a long enough period before transition.

Another source (EBRD, 1997) published calculations that went contrary to the former results. They found that the TFP growth rate in the period after transition has started to be about 2 per cent. This is probably because they overvalued the stock of capital these countries had. Furthermore, they also managed to account for the quality of labour input, which probably greatly reduced the unexplained part of growth. Unfortunately, we did not have wages available for the 1980s, so we could not account for the quality of labour in our TFP calculations.

However, we do not know exactly what role foreign direct investment plays in improving TFP. Our findings on TFP growth rates encompass better capacity utilisation, improving technology and increasing returns to scale, and we did not separate these effects. Although the positive role of FDI is taken for granted in the literature, a systematic empirical demonstration of this for Hungary is absent. We expect to observe a more positive contribution to TFP growth rates from foreign investors than from domestic players. However, we did not have the chance to demonstrate this using the industry-level dataset we set up.

In order to be able to test the importance of FDI in TFP performance we had to obtain firm-level data. Fortunately, such a dataset became available to us, and a much better grounded analysis became possible than originally anticipated. However, before we make our own estimates, we must familiarise ourselves with the microeconometric literature that deals with the issue.

Chapter 6: TFP and FDI: A Survey of the Literature

In the previous chapter we observed that total factor productivity (TFP) and the weight of foreign direct investment (FDI) in the economy increased together in the 1990s. However, the amount and the quality of the data were not satisfactory to enable us to establish a reliable empirical relation between these two variables. Nevertheless, we believe that there must be a link and this relation should be demonstrated using the appropriate econometric methods. This would help us to evaluate the contribution of foreign investment to the performance of the country more precisely. We will now pursue this issue using firm-level data. The first objective of our investigation is to measure the difference in the performance of foreign and domestically owned firms. Our second purpose is to calculate what part of the difference in performance is due to the impact of the foreign owners. However, before we carry out this exercise, we need to contemplate the issue more carefully and consider the results and the methodologies used in the existing literature. This is the task that we will concentrate on in this chapter.

In *Section 6.1*, we review the most important arguments of the literature dealing with the impact of FDI. We present the arguments that are behind the presumed positive or negative impact of FDI on the domestic economy.

In *Section 6.2*, we focus on one impact in particular. We discuss the literature pertaining to the impact of foreign direct investment on the performance of firms and then summarise the relevant research results obtained in microeconometric studies.

Section 6.3 moves on to review the methodology of those microeconometric papers that had the most influence on the subsequent empirical literature. Latterly, research on the issue has been buoyant, with a great deal of effort going into research on the subject. However, the methodologies used were often unsound. We try to point out the errors in the empirical literature and propose procedures that are correct.

In *Section 6.4*, we summarise the techniques and the implications of the literature that deals with the Hungarian experience. There has been a great deal of non-systematic empirical work in the area, but here we only consider in more detail papers that use econometric techniques to underscore their arguments.

Finally, in *Section 6.5* we present a comparative analysis of those articles that most influence the methodology of our work in the following chapter.

6.1 The impacts of FDI in general

The purpose of our investigation is to identify patterns of differential performance of foreign and domestically owned firms, and the potential impact of FDI on the domestic economy through various channels. We will pursue the following question: does FDI really increase productive potential? Can we identify channels that enhance or weaken its effect?

Based on *Chapter 5*, it would seem natural to reply in the affirmative to both questions. However, the literature is divided on the issue. Before going into the details of the various impacts of FDI, the problem first of all needs to be put in perspective, by presenting the general context of the question. So we will now summarise both the positive and the negative impacts that are most often mentioned in the literature.

Five reasons are usually given for the positive impacts of FDI. *First*, many argue that an inflow of FDI can result in capital accumulation for the country at the macro level. However, if the profits remitted abroad exceed the capital invested, there would be no capital accumulation (Dixit and Norman, 1980). This means a reverse flow from the host countries to the countries from which the investments originate. It is often argued that this is not typical, but happens only under extreme circumstances, and in general FDI inflows lead to improvements in domestic income conditions (Borensztein, De Gregario and Lee, 1999). *Second*, if productivity increases take place due to a higher level of capital stock, they will translate themselves into wage increases and, by and large, the whole of society benefits. This is something one should actually able to measure (Firebaugh, 1992; Firebaugh, 1996). *Third*, there are strong empirical grounds for believing that FDI inflows are an important channel of technology transfer from more developed to less developed countries (Caves, 1971, 1974). This should take place either by trade or by technology transfers from the parent company to the local subsidiary. As a result of these exchanges, we should observe higher total factor productivity associated with higher FDI penetration in the local economy (Hymer, 1976). The weight of the foreign-owned sector, which is more productive, is increasing in the domestic economy, and this naturally raises the average level of productivity. However, the new technology is also expected to 'spill over' to domestically owned firms (Blomstrom and Kokko, 1998). This approach to technological upgrading in poorer countries is similar to the idea of technology in the Solow model, where technology is readily and freely available (Solow, 2000), and a rapid spillover takes place across countries. However, microeconometric studies suggest that the picture is more complicated than this. The transfer of technology and spillover is not as automatic as suggested by the Solow framework, and improvements in domestic technology hinge on a great many factors. *Fourth*, in economic models based on monopolistic competition, it is increasing variety that increases income. Research suggests that FDI contributed importantly to this source of growth in transition countries (Freudenberg and Lemoine, 1999). *Fifth*, FDI inflows should imply more competition, and therefore, as a result we should observe more efficient production. The presence of foreign firms increases efforts by management in the rest of the firms to try to avoid bankruptcy by improving their efficiency (Lovell, 1993; Nickell, 1996).

What could be the negative side of an increasing role of FDI in an economy? *First*, many development economists consider the inflow of FDI as unambiguously harmful (e.g., Chase and Dunn, 1975), because they think the investments are not large enough to absorb all surplus labour, and because instead of reinvesting, foreign investors remit profits abroad. According to this story, foreign direct investment (FDI) is harmful because it is foreign. These firms are more likely than their rivals to remit abroad the profit that they capture from domestically owned producers in the domestic market. The early theories of development economics often emphasise this aspect of FDI. They argue that although FDI probably leads to an increase in productivity and employment, the increase in welfare can be very small, if any (e.g., Singer, 1950). They also suggest that the presence of foreign-owned firms is harmful, as it results in declining prices of the export products (mainly thought to be primary commodities at the time) of the poor country. When this phenomenon is coupled with low price elasticities of demand, the positive welfare effect becomes minuscule. Researchers identified other conditions under which the welfare effect of FDI flows and the subsequent remittances abroad can be harmful. Some suggest that markets protected by tariff walls increase the probability of FDI being welfare-destroying (Neary and Frances, 1988). Others add factors like high export tariffs and the prevalence of export processing zones to the list (Devereux and Roberts, 1997). In the transition literature, too, FDI is often regarded with ambiguity. Particularly in the early stages of transition, FDI was regarded as harmful for similar reasons as in traditional development economics (Farkas, 1996).[55] *Second*, more intense competition as a result of FDI cannot be regarded as unambiguously beneficial. It can be the case that superior performers from abroad raise the average costs for domestic producers by reducing demand for the production of the rest of the firms. This market-stealing effect is welfare-destroying as it reduces the profits of domestically owned firms.[56] This problem is believed to be important for policy-makers, as foreign-owned firms are more prone to remit their profits abroad than domestic firms, thereby reducing the level of domestic spending. At the micro level, FDI can reduce the survival chances of domestic firms. Foreign-owned firms can have a negative effect on their domestic competitors not just by being an extra competitor, but by being a more efficient

[55] Interestingly, we find many articles following this line of argument, despite the fact that, among the transition countries, it was only in Hungary that official policies promoted foreign investors in the privatisation process. The rest of the countries started to take a more positive attitude only in the second half of the 1990s.

[56] In line with the literature, we will call this a spillover. However, this is not what is usually called externality (or spillover). For instance, when the negative influence of the behaviour of one economic agent on another is not offset by monetary compensation, we face a standard externality situation. But if a negative influence is communicated through the market system, the effect is still often called an externality. These kinds of externalities are called *pecuniary externalities*. This happens, for instance, when a new competitor reduces the market share of the others in a market. This is what is called a

producer and therefore grabbing an even bigger share of the market than if they were just another extra competitor. Furthermore, if the foreign firms tend to favour the foreign or local affiliates of the other foreign-owned firms as suppliers (because their parent firm supplies them at home), this can further decrease the survival chances of domestically owned firms. In such a case, the increasing general presence of FDI has a negative impact on the performance of domestically owned firms. *Third*, some have argued, in the context of Hungary for example, that FDI inflows can be harmful to productivity by reducing spending on R&D (Farkas, 1997; 1999).

6.2 FDI and productivity – an overview of the empirics

We have touched upon many of the positive and negative impacts of FDI on the domestic economy. However, we are especially interested in one of them in particular. The question we raise is how FDI influences productivity and whether spillover effects related to FDI can be identified. A distinction should be made between direct and indirect effects. The former occurs when the foreign owner transfers to the local subsidiary a technology superior to that which preceded it. Indirect effects relate to the presence of spillovers. The technology of firms may improve due to increases in the general presence of FDI if there is labour movement and knowledge flow from the foreign firm, and if the rest of the firms manage rapidly to copy the key elements of the foreign-owned high performer (product or marketing). This is a positive spillover. However, as discussed, the indirect impact of a foreign-owned newcomer with a better technology can be harmful to the rest of the firms because of the market-stealing effect. For example, Aitken and Harrison (1999) evaluated the net of these two effects. It is a common observation that firms investing abroad have a technology superior to that of the domestically owned firms. It can be argued that this is to compensate for the lack of domestic knowledge (Hymer, 1976; Dunning, 1992). Therefore, we should observe improvements in their technology taking place more rapidly than in the case of domestically owned firms. However, there is no reason to believe why the spillover related to foreign ownership should be positive.

business or market-stealing effect.

At the firm level, the combination of inputs and the output can be interpreted as a result of decisions by managers. One can argue that managers who decide on the use of resources are interested either in the level of technology or its growth rate, or both (Nickell, Nicolitsas and Dryden, 1997). The existence of a large gap in TFP levels between foreign and domestic firms would not be surprising, but the question is whether we can find any sign that the gap is closing. If the two groups of firms sell on the same market, some sort of adjustment in the performance gap should be observed after some time, as the domestically owned firms progressively learn the techniques and behaviour of the new era. One can approach this issue by estimating production function either in levels or in differences.

Early studies in this field emphasised the positive side of the story, and the benefits associated with the presence of foreign-owned firms. Caves (1971, 1974) showed that the positive effects of the presence of foreign firms are predominant. He argues that these are effects based on the superior technology and firm-specific knowledge. The empirical back-up for his argument is based on the estimated parameter of the FDI-dummy. It indicates superior production performance of the foreign firms in simple cross-section regressions (Caves, 1974).

An early article by Liebenstein (1966) provided the foundation for the early optimism of Caves (1971) about large positive spillovers from the more efficient firms to the less efficient ones. Liebenstein's work (1966) also coined the phrase 'X-efficiency'. It subsumes factors that explain why firms operate within their technical maximum.[57] Liebenstein also emphasises the crucial role of the technologically most advanced firm in spreading knowledge in an industry and thereby improving the technology of the rest. Both X-efficiency (in the language of frontier analysis it is technical efficiency) and technological change should show up as improving TFP.

The massive increase in direct investment abroad from the 1980s onwards considerably increased the relevance of this area of research. In addition, more FDI data have become available for analysis than before. As a result, a great number of

[57] In fact, X-efficiency was found to be much more important in practice than allocative efficiency.

new studies have been published that discuss the importance of foreign ownership for firm performance. What is more, they try to identify the channels of technology transfer. They attempt to modify the unambiguous picture based on the empirical results of Caves (1971, 1974). Typically, these new studies do not find strong grounds to support the old optimism.

Initially, the observed positive link between efficiency and the presence of FDI at firm level (Caves, 1974) was interpreted as a positive impact. However, this reasoning can be flawed if selection is involved and foreign investors tend to choose firms that are already more productive. In the literature, there have been two ways of tackling this problem. One uses panel models, introducing firm specific heterogeneity into the analysis, while the other method prefers to estimate some kind of selection model to obtain interpretable results. A further problem with the early literature is that of omitted variable bias. One should not only account for firm-level foreign ownership, but also consider the impact of foreign presence in the industry in general. The presence of foreign firms in an industry can be harmful for domestically owned firms, because the former simply take away some of the latter's markets, and this might result in differential growth of TFP between the two groups. Hence, the general presence of foreign firms should also be controlled for. Furthermore, it may happen that the general presence of foreign firms in an industry harms domestic firms more than other foreign firms. For instance, this may be due to foreign firms knowing each other's behaviour better than the domestic firms, and so they tend to subcontract out to each other, instead of to domestic firms. If this impact is important, it leads to different paths of TFP growth in the two groups. This impact should therefore also be taken into account, as foreign firms may benefit more from the presence of other foreign firms than their domestic rivals.

One should also try to control for channels of technology improvements other than the impact of foreign ownership. Such sources of good performance might include firm-level research and development, importing input and investment goods of higher quality, or learning how to export and becoming successful abroad. These are channels available for domestically owned firms to compensate for a market loss due to competition from foreign-owned firms. In order to avoid the omitted variable bias these should be accounted for jointly with the ownership spillovers described above. Latterly, other researchers have also addressed these problems (Dmijan, Knell and Rojec, 2000; Djankov and Hoekman, 1998, 2000a, 2000b).

Some of the earlier theoretical work emphasised the ambiguity of more competition from the foreign-owned firm on the domestic economy (Corden, 1989; Norman and Dixit, 1980; Horstmann and Markusen, 1989). Aitken and Harrison (1999) also recommended a simple analytical framework where the spillover related to foreign ownership is also ambiguous. Their analysis suggests that the appearance of foreign firms in a market reduces the production of domestically owned firms, and that these are forced to move back on the decreasing returns part of their average cost curve. Due to fixed costs, smaller production goes together with higher average costs and lower TFP. At the same time, there can be a positive impact on TFP. If the superior technology of the foreign firms improves the technology of the domestically owned firms through some channels, then the average cost curve shifts downwards. Consequently, the net impact of FDI on the TFP of the domestically owned firms is ambiguous. Horstmann and Markusen (1989) propose a model that explains firm performance using firm-specific factors. Their model argues that the performance of the multinational firms is firm-specific, be it the legacy of the founder of the firm, work ethics, attitude to new knowledge, or ability to devise inventions. Their study also gives the theoretical grounding for using panel models to try to measure the impact foreign ownership on performance.

The above authors emphasised the role of ownership and firm-specific effects on a firm's performance. Another important line of literature analyses the relationship between firm performance and ownership under financial pressure. On the empirical side, Nickell (1996) and Nickel, Nicolitsas and Dryden (1997) introduced a new set of spillover variables in their analysis of British firms, which they call internal and external controls. The spillover channels we have mentioned so far fall into the category of external controls for the firms. They regard internal controls to be the structure of ownership and the kind of owners a firm has (e.g., managerial). In these two papers, dominant non-managerial owners were found to have a positive impact on performance.[58] The message of these papers is that financial pressure and the presence of an external dominant owner improve performance. However, they found a trade-off between increasing competition and these two factors. This means that if the firm captures less rent due to more competition, then financial pressure would have a negative impact. Similarly, if it is found that competition increases, the presence of external owners has a negative impact on performance.[59] Consequently, this is another reason why FDI and the resulting increase in competition could reduce the TFP performance of the rest of the firms.

As far as the impact of FDI on technology is concerned, the new empirical work emphasises the costs of foreign penetration for domestic firms (Djankov-Hoekman, 1998, 2000a, 2000b; Aitken-Harrison, 1999). More specifically they suggest that the presence of foreign firms has an adverse impact on the performance of domestic firms, and that no significant technology spillover could be revealed. In fact, this literature is quite pessimistic. Only Djankov and Hoekman (1998) and Kokko, Zejan and Tansini (2001) have suggested that there may be some channels via which the measured negative impact may be compensated for.[60]

6.3 The econometric methods used in the literature

We study the link between FDI and firm performance at the micro level. So we will now look at the methodology of the microeconometric literature in detail, as we would like to avoid the potential pitfalls associated with relatively new estimation

[58] They measure competition with the rent the firm reaps (measured as profits minus the cost of capital).

[59] This suggests that financial pressure and external owners act similarly and that, under these circumstances, increasing competition reduces firm performance. Ideally, we must account for these factors in our empirical analysis as well.

[60] Estimations that try to measure the impact of foreign direct investment in the world using aggregate data produce mixed results. On the one hand, for instance, Borensztein, De Gregario and Lee (1999) present results that are in favour of FDI to achieve better performance at the macro level. They propose a model that shows how increasing variety due to increasing FDI leads to rising demand and to increasing TFP. On the other hand, Kentor (1999) and Dixon and Boswell (1996) cast some doubt on this explanation and presents a panel estimation that shows the negative impact to be dominant.

methods in the field. This methodology considerably influenced the line of research we are engaged in.

The questions we seek to answer are closest to the work by Djankov and Hoekman (hereafter DH, 1998, 2000a, 2000b) and Aitken and Harrison (hereafter AH, 1999). The former authors used a Czech and a Bulgarian dataset to estimate the role of foreign ownership on performance. The latter had access to a very large Venezuelan sample of firms.[61] There have been two basic studies analysing the impact of FDI on productivity (DH, 1998; AH, 1999). One controlled for endogenous choice of ownership and the probable overestimation of the impact of FDI in separate regressions. The other did so by using a fixed-effects framework.

First, in tackling the issue we consider the most popular selection model. In the Heckman-type of selection model (1979) the sample is censored, and thus OLS estimates become biased and inconsistent. The modelled relationship must be corrected with the help of a second equation that describes how the censoring of the sample is taking place. We thereby control for the selection bias that is caused by some firms being fully observed, while others are not. The Heckman model can be estimated consistently in two steps. In the first, the selection equation is estimated, and the predicted values are used to calculate an inverse Mills-ratio that should be included in the equation we are ultimately interested in (the production function or performance equation). In this way we transform the selection bias into an omitted variable problem.[62] In this Heckman model the selection equation describes a mechanism explaining why some individuals do not appear in the sample of the equation of interest. In our application this would be like saying that the FDI equation (the selection equation) describes why some firms become foreign-owned, so that we observe them fully in the performance equation.

[61] We have not considered the article by Kokko, Zejan and Tansini (2001), as their methodology does not even attempt to tackle the most problematic methodological issues.

[62] This method critically depends on the joint normality of the error terms of the two equations. If the error terms in the two equations are uncorrelated, the model reduces to a classical regression model and can be estimated with OLS. This can happen when the unobserved factors of FDI do not depend on the unobservable determinants if firm performance. Alternatively, an efficient maximum likelihood estimator can also be used.

DH (1998) suggests that it is this model they use. However, according to the model there should be firms whose production is not observed, and these should all be domestically owned firms. They should only possess observations on their individual characteristics and not on their production, which is clearly not the case.[63] Therefore, their chosen econometric model does not match the patterns of their dataset. What is more, they included the predicted values of the selection equation into the performance equation jointly with the Heckman correction-term. This is clearly unnecessary and is hard to interpret as both terms use the predicted values from the same equation.

The models we discuss here fall into the general category of treatment models. The name of these models was borrowed from the situations they analyse. These situations are called social or natural experiments. In these experiments a treated and an untreated group of observations are generated, and researchers try to measure the effect of the treatment. Such models are commonly used not only in econometrics, but in medical and behavioural sciences as well. In econometric applications, these models try to ascertain the impact of a policy (a treatment) on some performance variable. In our application, the performance variable is output and the treatment is foreign ownership. We have a full set of observations in the performance equation for firms both with and without foreign ownership. But the problem now is that the treated and untreated groups are not randomly generated, and this causes bias. So far it has been thought that only the good firms have any influence over how they are distributed between the group that is 'treated' with foreign ownership and the group that is not. To arrive at a correct estimate of the 'treatment' of Hungarian firms with foreign ownership, one should account for self-selection not only for the 'treated' firms (similarly to the Heckman model with an inverse Mills ratio), *but also for the 'untreated'*. It is not enough, therefore, to model the behaviour of the foreign-owned firms; the behaviour of the domestically owned firms also has to be taken into account. The model we apply should assume that both groups are fully observed in the performance equation.

[63] DH (1998) obtain their inverse Mills ratio from the predicted values of the selection equation, and put it in the performance equation to see whether it plays a significant role. The problem with this is that inverse Mills-ratio is a proper bias correction only if one group of individuals is observed and the other is not. Again, in our application, this would mean that we would only observe the production function of foreign firms but not that of domestic firms.

Models that satisfy these conditions are not uncommon in the econometric literature and one can usually find them as treatment models or as models of self-selection (Maddala, 1983; Greene, 1997; Stata 7.0 Manual, 2001). Accordingly, the inverse Mills-ratio is not sufficient to arrive at a correct estimate of the treatment effect. The key is that in order to obtain an estimate for the 'treatment' effect of FDI, one should put the inverse Mills-ratios in the correction variable when the firm is foreign-owned, but a modified version of it when it is not.

The above considerations hint at the possibility that if the self-selection of the firms is not accounted for, simple regressions are biased and inconsistent. But why would our sample be self-selected in the first place? It can happen that the positive relation between TFP growth and foreign owner may merely be a result of the fact that the company already achieved rapid technology improvements before the foreign investor became an owner. Firms may self-select themselves to become foreign-owned, as managers who have demonstrated their skills expect better rewards under a foreign owner than under the socialist system. This could happen as, in practice, managers have considerable say in choosing the new owner of the firm in the privatisation process in Hungary. In turn, foreign investors probably look for firms that have already showed good performance. This has the implication that the firms do not randomly become part of the sample, as their past performance influences which subsample they appear in. Similarly, managers of poorly performing firms can be expected to avoid foreign (more performance-oriented) owners, as they are afraid of being sacked. Hence, they tended to end up as domestically owned firms in the sample.[64] The estimation of these self-selected samples can be biased, as they result in good firms ending up as foreign-owned firms and the bad firms as domestically owned ones. Therefore, in order to obtain the true impact of FDI on firms' performance one must use models that account for this, and estimation techniques that clear these effects from estimates. The treatment models are one way of controlling for this problem.

[64] This kind of selection should be distinguished from selection in the unbalanced panel models (Baltagi, 1995; Wooldridge, 2002) where selection is similar to the selection in Heckman's (1979) sense. In these models they assume that some observations are not observed, as they disappear from the

DH (2001a) corrected their estimation results in a subsequent paper. They gave the "generalised two-step Heckman procedure for correcting sample selection bias developed by Amemiya" as their method of estimation. In this earlier Heckman model the observation of output in the performance equation did not depend on the selection equation (unlike in Heckman, 1979). It is set up as a special simultaneous equation where some variables are latent (Amemiya, 1978). The model uses censored or binary ownership variable and is estimated with a two-step estimator recommended by Amemiya (1978, 1979, and 1984) and by Nelson and Olson (1978).

Amemiya's two-step method involves an estimation of a simple tobit/probit reduced form equation first, and then a transformed equation in the second step.[65] Therefore, it is not clear why DH (2000a) includes a correction term, i.e., an 'additional variable' to eliminate the bias due to self-selection. In Amemiya's two-step estimator there is no such step. Therefore, the improved estimation by DH (2000a) is also questionable. Unlike the Heckman two-step procedure (1979) or the treatment model mentioned above, in Amemiya's two-step method, no explicit correction term for selection bias is involved. It works with a transformed set of equations instead. The key is to regress a set of estimated reduced-form parameters on another set of estimated reduced form parameters and a pre-defined matrix of zeros and ones (Amemiya, 1978; 1979). Therefore, we do not really know what kind of estimation procedure Djankov and Hoekman followed either in DH (1998) or in DH (2000a).[66]

A further complication is that many of the estimators used by DH (1998, 2001a) in their articles are applied in panels. However, the application of the above (cross-section) estimation methods in a panel is not natural. It is only quite recently that panel versions of Heckman's selection model (1979) have appeared, and they cannot easily be generalised from the cross-section methods (Baltagi, 1995; Wooldridge 2002). The panel versions of the Amemiya two-step models or the self-selection

sample over time, and that this is the result of a non-random selection process.

[65] In the case of the probit version of the model, one must correct the estimate of the dummy by normalising it with the estimated standard deviation of the error term (Maddala, 1983). Alternatively, the error variance of the probit equation can be restricted to one (Amemiya, 1978).

[66] A series of papers are published using these methods. For instance, referring to the unidentifiable methodology used in the papers by DH (1998), Dmijan-Knoll-Rojec (2000) follow an incorrect procedure in estimating the impact of foreign ownership with a sample of Slovenian, Estonian, and Slovakian firms.

model have not yet been derived. Using them in panel regressions, therefore, is not well founded.

DH (1998, 2001a) estimated all their equations as a random-effects model. They argued that a fixed-effect model would be wrong as it assumes the constancy of the firm-specific component in the regression equation. This is an outdated interpretation of the model (Greene, 1997; Wooldridge, 2002). The key assumption of the fixed-effects model is not constancy of the firm-specific effect (it can be stochastic), but that it is allowed to be correlated with the regressors. The use of a random-effects model in the performance equation amounts to assuming that a firm-specific asset is uncorrelated with input use and the ownership of the firm. This is very improbable. As in AH (1999), it is more reasonable to use a fixed-effects framework. However, none of these papers carry out specifications to test whether the use of panel regressions, or the version of panel they assume, is justified at all.

We now consider the other route for treating self-selection. Fixed-effect estimations on the impact of FDI were first published using a Moroccan dataset (Haddad and Harrison, 1993). In the specific article that we are considering in more detail (AH, 1999), the authors included a foreign ownership dummy in the equation, and they were interested in whether it shifted the production function. The list of control variables in the regression are quite different from the ones used by DH (1998, 2001a), and throughout the article single-equation estimation techniques were used: OLS, with and without robust errors, weighted least squares, and within-group least squares were the methods applied.[67]

One might ask why a fixed-effects model is an appropriate way of handling this problem? First of all, it is important that we allow some regressors (FDI in particular) to be correlated with the individual, specific part of the performance equation. In our case, this means that there exists firm-specific 'talent' (Dunning, 1992). It may include good inherited management, better company culture, attitude to customer

[67] AH (1999) do not explicitly state that they were using a fixed-effects framework. They assume a fixed-effects model implicitly by using within-group estimator. Also, they remark that the model they apply makes it possible to control for endogeneity due to selection. Wooldridge (2002) remarks that this type of problem can be accounted for in a single equation fixed-effects framework quite simply. Therefore, one can safely conclude that the model AH (1999) had in mind is a fixed-effects model.

relations, and to new knowledge, and possibly a great many other things. These are important factors in the performance of the firm, but they are difficult to quantify (Ruffin, 1985), and they do not change easily. The firms that possess more of these unobservable and firm-specific determinants of performance tend to be chosen by foreign investors, and poor performers tend to remain domestically owned. This means that we should allow correlation between individual, specific, unobservable determinants and (at least) one of the regressors, which in our case is the foreign ownership variable. So now we have a fixed-effect framework that takes into account the endogenous choice of foreign ownership. This was something impossible under simple classical or random-effects assumptions. In this more flexible model, it is easy to correct for endogenous choice using a within-group estimator.

Now that we have discussed the methods of research, we will consider the work that has actually been done on Hungary. This is useful as it enables us to place our planned research in the existing literature more precisely.

6.4 Microeconometric work related to Hungary's experience

Recently, using a small cross-section database of Hungarian firms, Schoors and van der Tol (2001) found a very large positive direct impact of foreign ownership on firms' performance, and they also argued the presence of very large and positive ownership spillovers. The problem with this finding is that they have used a probit version of a simultaneous equation system (Amemiya, 1978; Maddala, 1983). They estimated it as a usual simultaneous model with predicted values from the probit reduced equation. However, they have not corrected their parameters with the estimated standard deviation of the error in the probit equation (Maddala, 1983). Therefore, the parameter estimates they obtained are correct in their signs, but their magnitude is probably overstated. However, theirs is not the only paper that deals with the relation between firm performance and ownership in Hungary.

Based on firm data with double-entry bookkeeping, Major, Vezzoni and Szalavetz (1999) found that the unit profit is higher with foreign-owned firms than with domestically owned ones, and both of these are higher than the unit profit of state-owned firms. However, when they make comparisons, they only use simple performance ratios, and no regression framework is utilised.

Lücke and Szalavetz (1997) analyse another aspect of ownership and performance. Based on a sample of Hungarian manufacturing firms, they find that successful export performance is not necessarily related to foreign ownership of the exporting firm. After controlling for the firm having good managers and for using modern marketing techniques, it turns out that domestically owned firms can be just as successful as their foreign-owned counterparts. This means that they are able to more than compensate for the fixed costs that would otherwise prevent them from entering markets abroad.

In a small sample, Szanyi (2001) looks at an interesting aspect of the role of foreign ownership. He considers how well domestic firms utilise assets obtained from liquidation procedures compared with foreign-owned firms. He finds that there is a higher probability that foreign-owned firms manage the newly acquired assets successfully than the domestically owned firms. The above suggests that foreign-owned firms can be expected to perform better. However, the Lücke and Szalavetz (1997) article suggests that caution should be exercised in this regard. There can be conditions under which the performance of local firms is not inferior to foreign firms. They identify factors that compensate firms for the disadvantage of having a domestic owner. The factors (managers and marketing knowledge) identified by Lücke and Szalavetz (1997) are specific to the firm and are usually found to be more important in practice than allocative efficiency studied by Szanyi (2001).[68] Unfortunately, we are not going to be able to observe these factors in our data set. Therefore, the best way to account for them is to use the fixed-effects framework.

Halpern and Kőrösi (1998, 2000) applied another popular way of analysing firm performance, carrying out a production frontier analysis with a large firm data set. Their model assumes that the production function (commonly assumed to be a Cobb-Douglas function) determines the production possibilities. The simple regression techniques assume symmetric errors around the production surface, and it is presumed

[68] Liebenstein (1966) was first to study the role of the manager on firm performance in detail. Knowledge specific to the firm was found to be important and one can assume that it changes little and slowly over time.

that there is no systematic inefficiency. Unlike the usual estimation procedures, in the frontier analysis the mean inefficiency is positive, and firms tend to perform below their technical maximum. There are two basic approaches to frontier analysis. The first uses the estimated elasticities of a production function and shifts its constant (the technology component) upward by some rule, so that deviations from the production function can be treated as inefficiencies (Lovell, 1993).

The second assumes that the production frontier is stochastic. Using a truncated error term and distributional assumptions about the random error term around the frontier, one can separate the two components for each firm (e.g., Jondrow, Lovell, Materov and Schmidt, 1982). The main benefit of this second method is that not only can the mean inefficiency be calculated, but the inefficiency of individual firms can also be identified. The stochastic production frontier analysis first identifies a stochastic frontier and then separates the error around the frontier from the inefficiency for every firm. It is a useful exercise to relate the estimated individual inefficiency to other observables of the firm.[69]

In their earlier paper, Halpern and Kőrösi (1998) used static and dynamic cross-section regressions in a large sample of firms they observed between 1986 and 1996. They assumed deterministic production frontiers. They claim that the level of inefficiency for foreign firms was very low; in fact, it was below 1 per cent in 1993. However, we do not learn about the relative efficiency, or its dynamics between the foreign firms and the rest of the sample. Halpern and Kőrösi (1998, 2000) restricted themselves to applying a deterministic frontier method.

The second paper of Halpern and Kőrösi (2000) contains a much richer analysis. Their efforts fall into the line of the research initiated by Nickell (1996), who tried to demonstrate the ambiguous impact of competition. The paper again uses a traditional, deterministic frontier analysis with panel data. They assume market share (the proxy for competition) to be endogenous and set up a separate equation to control for it.

[69] For instance, Jondrow, Lovell, Materov and Schmidt (1982) carried out this procedure for a stochastic version of the model and showed that in their sample the technically most efficient producers could be characterised by relatively high outputs, low capital stocks, and a high level of fuel

However, our main interest lies in FDI and its impact on the technology of the firms, and not how far the firms are from technically efficient production at a given point in time. Their research is related to ours, but has no direct bearing on it. Nonetheless, there are some 'by-products' of their work that are of interest to us. One such by-product is the observation that foreign-owned firms are the most efficient throughout the whole sample. In their paper they also infer that the gap between foreign firms and other categories of ownership in the early 1990s has stopped narrowing, and from 1993 onwards it seems to have been more or less stable. One would expect the difference in efficiency growth between foreign-owned firms and the rest of the firms to stop widening, and after some time the gap should start to decline. However, according to their results, the decline in the gap has not yet started.

It is crucial to see that the performance measure of frontier efficiency in the articles of Halpern and Kőrösi (1998, 2000) is not comparable to ours. They were interested in the mean residuals after shifting the production function up by the frontier principle. We, meanwhile, are *estimating the behaviour of the technology parameter* of the production function across time and the two firm categories. We are interested in the shifts in the typical relative position of the production function and not in the typical distance of the firms from it. In order to avoid bias in the shift term, we can ignore these deviations from the frontier and assume them to be random. Alternatively, we may assume that the level of inefficiency is stable over our sample period, and so if our equation is in differences, this source of bias disappears. As we have already mentioned, this was actually something found by Halpern and Kőrösi (2000) in their analysis. Therefore, the production function in differences may allow us to ignore inefficiency in the TFP estimation. So we can proceed likewise to the methods that are commonly found in the literature (AH, 1999; DH 1998, 2000a, 2000b; Nickell, 1996, Nickel, Nicolitsas and Dryden, 1997), which also ignore inefficiency in production.

consumption and labour usage.

6.5 A resume

Next, we will summarise the methodological problems and the main results of the literature we surveyed. Only the most important articles are considered. We present our summary as follows:

1. In their article, AH (1999) controlled for individual effects in the single equation panel framework. DH (1998, 2000a) also used a panel model; however, they chose an incorrect estimator. Nickell (1996) applied a dynamic panel framework and eliminated the individual effect by differencing as part of the Arellano-Bond procedure (Arellano and Bond, 1991). These articles do not adopt the frontier principle. Halpern and Kőrösi (1998) used cross-section regressions and later (Halpern and Kőrösi, 2000) a fixed-effects panel to control for heterogeneity in a frontier analysis.

2. DH (1998, 2000a) tried to avoid the endogenous selection of firms by modelling the selection process in a separate equation. Unfortunately, their method of estimation could not be identified from the information given in the papers. In turn, AH (1999) used a simple fixed-effects model to control for the same problem. Halpern and Kőrösi (1998, 2000) did not concern themselves with endogeneity of ownership, and their attention was focused only on the endogeneity of market share of the firm. Nickell (1996) and Nickell, Nicolitsas and Dryden (1997) used lagged values of the endogenous variables to reduce this problem.

3. DH (1998, 2000a) controlled for the presence of a foreign owner using a dummy. This can be a useful measure when trying to measure threshold effects. From a performance point of view, moving a stake of just over 50 per cent can be more important than changes in ownership at the lower or higher end of ownership distribution. In the article by AH (1999), the share of ownership was observed as a

'continuous' variable. Hence, threshold effects were not measured, and the interpretation of the marginal impact of ownership can be misleading.[70]

4. AH (1999) supplemented the impact of the FDI dummy with two other factors. First, they included a measure of foreign ownership at industry level. They expected to find positive technology spillovers from industry-level FDI that were of benefit to all the firms. According to AH (1999), this should happen because it would be wrong to attribute all benefits to firm-level foreign investment transfers. Thus, it was assumed that not all FDI-related improvement in performance is firm-specific, but at least some can be attributed the presence of other firms in the industry. Equivalently, DH (1998) regress industry-level foreign ownership on the performance of domestic firms to see if there are any positive spillovers from the industry level to individual domestically owned firms.

5. AH (1999) also include an interaction term between FDI ownership at sector level and at firm level. What this variable tries to measure is whether or not individual foreign-owned firms derive significant benefits from the presence of other foreigners in an industry. To put this another way, one might ask 'do foreign firms benefit significantly more from the presence of other foreign firms than from the presence of domestic ones'? DH (1998), on the other hand, do not analyse whether foreign firms benefit more from the presence of other foreign firms.

6. It is important that both DH (1998, 2001a) and AH (1999) argue that there are measurable short-term costs for domestically owned firms associated with the increasing presence of foreign-owned firms. AH (1999) find that these costs do not disappear in time and seem to influence the performance of domestically owned firms for a long time. In fact, their article is quite pessimistic about the performance-related benefits associated with foreign firms in an economy. These are estimated to be rather small. However, the costs associated with the general foreign presence at industry level seem to be much higher.

[70] Also, with a data set analysed by AH (1999), one could have used a set of cross-section models (Nelson and Olson, 1978; Amemiya, 1979).

7. DH (1998) show that the spillover associated with FDI at industry level is negative. However, they also show that there could be other spillover-effects that can compensate for the negative ownership spillover.[71] They suggest that domestic firms try to compensate for the negative impact of the direct technology import of foreign-owned firms in the same industry by importing better-quality investment goods, and materials from abroad. So in addition to the FDI variable at the industry level, they include a variable that measures the imports of the firms. They find that the magnitude of the positive impact from imports on performance was quite similar in size to the negative impact associated with the general presence of FDI. Hence they conclude that, on aggregate, the two spillover effects neutralise each other.

In this chapter, we presented the problems of the methodology and the main points of the recent literature that has tried to tackle the issue of the relation between FDI and performance. Despite the methodological shortcomings of the research we reviewed, one cannot help but notice the richness of the recent work in the field. However, there still remains a great deal of work to be done. Systematic analysis of the technology performance of firms and its determinants requires more carefully chosen econometric models that has been the case so far. Thorough research of the Hungarian case can be of particular interest, as FDI plays an exceptionally important role in the domestic economy in international comparison.

In the following chapter, we carry out our own estimations on the impact of FDI on the technology performance of manufacturing firms. The purpose of our research is to make a contribution that helps to evaluate the role of FDI in the Hungarian economy. To this end, we would like to come up with concrete numbers.

[71] This result is obtained independently from the incorrect procedure with which they tried to control for self-selection.

Chapter 7: TFP and FDI: Estimation Results

In the previous chapter we summarised the main points of the literature dealing with the impact of foreign direct investment (FDI) on the domestic economy. In the discussion we emphasised one particular type of effect: the repercussions of FDI on production technology. In the present chapter we attempt to carry out calculations of our own, which, we believe, will yield results that are more reliable than those put forward in many of the articles we have reviewed.

Bearing in mind the methods used by previous researchers, we begin by summarising the methodology used in this chapter (*Section 7.1*). Our work has two objectives. The first is to estimate the importance of a foreign owner for the individual firm compared with domestically owned firms with similar observable characteristics. Next, we will try to estimate what kind of spillover effects can result from a larger weight of foreign ownership in the economy, and what channels are available to and used by firms in the industry to tackle the possible adverse effects of increasing FDI. However, foreign direct investment can also have a number of positive impacts. We would like to know more about the relative costs and benefits of an increased general foreign presence in the economy, and also how these costs and benefits are distributed among domestically owned and foreign-owned firms. The framework we are going use will allow us to test for the relevance of other potential spillovers that could also improve firm performance. In a nutshell, we shall want to capture the technology associated with FDI and the spillovers from FDI, while we control for other determinants of performance. We will proceed in the following manner.

In *Section 7.1.1*, we explain and summarise the basic patterns of our dataset and the corrections we had to make to it. Then, in *Section 7.1.2*, we discuss the simple cross-section results that back up the hypothesis of increasing returns in Hungarian manufacturing. We also show that this occurs predominantly in the foreign-owned part of the manufacturing sector.

Then we investigate the direct link between the foreign owner and the performance of the firm in *Section 7.2*, and we apply a type of cross-section procedure that has not so far been used in the literature. The purpose of this method is to correct for the endogeneity of foreign ownership and the production factors. While some attention has been paid to the problem of endogeneity of the ownership variable, researchers have completely ignored the problem of endogeneity of the production factors.

In *Section 7.3*, the role of spillovers on performance is investigated. Our main interest lies in the spillover (indirect effect) related to foreign ownership. However, in order to uncover other potential spillovers to performance, we also took account of learning-by-exporting and imports of capital goods. We carry out these estimations in a panel framework, and we compare our results to those in the existing literature.

Section 7.4 summarises the implications of the panel estimations. We organise the results in such a way as to make it clear how the spillovers evolved and which of these were relevant.

Finally, in *Section 7.5*, we evaluate the implications of our results and discuss who the winners and losers of the increasing general foreign presence were, and how the costs and benefits of increasing foreign presence are distributed over time and across producers in the manufacturing sector.

7.1 Econometric models used

We have seen that there were important developments taking place not only in relation to the theoretical literature on FDI (summarised in *Chapter 2*), but also in the econometric methodology used. Up until the 1970s, it was case studies that dominated the empirical analysis in the field, and very little systematic work was done on the impact of FDI. When researchers investigated its impact at all, it was only in the form of simple cross-section regression models. It has only been quite recently that panel models have become popular. These models are superior as they can get rid of an important source of bias by assuming heterogeneity in the unobservables. This kind of bias may arise when the behaviour of different individuals can have unobservable individual specific determinants (like 'talent'). If this is not taken into account, the estimate may not reflect the true behaviour of agents. Inferences from these estimates lead to wrong and misguided policies. The issue of a heterogeneous sample has already been taken up and its importance has been demonstrated in regressions explaining the impact of FDI. This has mostly been done assuming a fixed-effects model. A useful characteristic of the fixed-effects version of the panel model is that it allows correlation between regressors and the individual-specific part of the error term. As mentioned before, the estimation of this model is one way of correcting for the endogeneity of ownership choice in the performance equation (AH, 1999).

Along with the panel model, we will also use more flexible cross-section methods in our work. In order to mitigate endogeneity, we treat our cross-section model as a simultaneous equation system, and we estimate the effect of FDI on performance with two-stage least squares (2SLS) (Wooldridge, 2002). The other cross-section method we apply to correct for self-selection is the treatment regression. It was DH (1998) who attempted to utilise this approach. The correction they calculated accounts for the non-random selection of observations in the sample based on inverse Mills-ratio only. This is unsatisfactory because, given that we observe both foreign and non-foreign firms fully, a different bias correction would be needed to obtain a consistent result (Maddala, 1983; Greene, 1997). In the problem we face, a treatment model can be applied.

Under the 2SLS procedure, we will apply a set of instruments to reduce endogeneity. However, a model is found satisfactory only if its instruments are valid. We do not want exogenously behaving variables to be treated as endogenous. How can we achieve this? First, we will assume that all our variables are endogenous and then test for this assumption individually as well as jointly. This means we assume that every variable in the performance equation is endogenous and try to find an acceptable set of instruments under this null. Then, the endogeneity assumption is tested for each explanatory variable individually and jointly. If there is a need to change the set of endogenous variables under the set of instruments, we do this. Then, we check the validity of the instruments again with the new set of instruments. We carry out this procedure until we obtain a model in which there is no need for further change.

The problem that the practitioner faces is that better firms can themselves decide to become foreign-owned, while bad performers will tend to avoid foreign owners. In turn, foreign investors will tend to search for and buy firms that have demonstrated good performance, and they will keep clear of bad performers. If one has a panel data set, one may control for this problem by assuming a fixed-effects model.[72] The foreign-owned firms are 'treated' with foreign ownership, and we expect a beneficial impact on the performance of the firm. The main advantage of estimating this model is that it accounts for the possibility that firms with certain observable characteristics tend to become foreign-owned, while others remain domestically owned.[73] This problem can be simply modelled with a treatment model and also with a simultaneous equation model. Therefore, in cross-section we shall use 2SLS regressions together with treatment regressions.

We have pointed out that the simultaneous-equation model, the treatment model, and the fixed-effects panel models can be useful in our work. However, it should be noted that in addition to estimating the simplest versions of panel models (like DH, 1998; AH, 1999), we will also estimate a dynamic panel model using the Arellano-Bond technique (Arellano-Bond, 1991). This model is useful, as it allows the partial adjustment of production, which must be closer to reality than the assumption of full and immediate adjustment. The introduction of dynamic considerations causes complications in the estimation procedure, as some explanatory variables will now be correlated with past errors, which renders the simple panel estimators biased and inconsistent. However, the Arellano-Bond technique (a GMM estimator) gives a consistent and a more efficient estimation method than the panel version of 2SLS.[74]

[72] The self-selection models can also be studied in the panel framework (Baltagi, 1995; Woolridge, 2002). There have been attempts to introduce selection in panel estimations (DH, 1998; 2000a), but these were using either wrong techniques or techniques we could not identify. Furthermore, the panel estimations investigating this problem did not have enough cross-section observations to regard the sample as large. Therefore, they could not make use of the asymptotic properties of some of the estimators they used. Our sample size allows this. The possibility of tackling self-selection of FDI is an extra attraction of using a fixed-effects model.

[73] This method does not account for possibility of foreigners enticed to buy bad firms for probably cheaper than good firms. At the initial stage of transition foreigners could acquire firms cheaply across the board. Their main motivation to invest was not price, but the existing market share (*Chapter 2*) of the firm to be privatised.

[74] The idea behind this method is that it weights the instruments of the model optimally, while panel 2SLS simply gives them equal weight.

7.1.1 Description of the data set

The data we use were collected from the balance-sheet reports and profit-and-loss statements that every Hungarian firm has to submit to the Hungarian tax authorities at the end of each year. We only had access to data with double-entry bookkeeping. Firms have to operate double-entry bookkeeping above a certain level of annual turnover – set at a fairly low level. We confined our attention to manufacturing firms. This is because we expect their technological parameters to be better behaved than those of the firms in the rest of the economy.

We had access to data for all firms in the manufacturing sector between 1992 and 1998. The point of the exercise was to measure the determinants of firm performance. This involves the estimation of production functions. Hence, measures of factors of production, output, and other variables that help to construct the other determinants of performance had to be collected. Unfortunately, not all the variables we requested were made available to us. Sensible analysis is nonetheless possible using the kinds of variables we managed to obtain.

Originally, we intended to work with a production function that contains energy as a production factor. However, there is no energy or electricity consumption data in the data set, so we have to resort to a simple Cobb-Douglas function with three production factors. These are capital stock, labour input and material input. In fact, this is the usual set-up of variables in the literature we have reviewed. The capital stock data were constructed by adding up the stock of physical capital in buildings, machinery and other physical capital stock. Unfortunately, these reflect end-of-period data, while the labour stock represents an average over the year. Labour stock could not be corrected for the hours worked either. We cannot do much about this, and we have to accept the limitations of our labour data. Material input is made up of five input categories on the balance sheet. New enterprises tend to borrow physical assets and machinery, some even labour, and consequently the stock of labour and capital may be understated for these firms. This introduces some bias into our estimates. What is probably a more serious problem is that we did not have measures on capacity utilisation and it cannot be proxied either, as we lack the data for it. This is why we are compelled to utilise the findings of Halpern and Kőrösi (2000) that frontier efficiency is fairly constant after 1993. Therefore, estimating a production function in differences eliminates most of this source of bias.

We have access to industry identifiers at the NACE two-digit level. This is useful, as we can control for the differences in technology across industries in the regressions. The importance of this correction is that there may exist considerable industry-specific differences in the level of technology.[75] In theory we have twenty-two industries in the sample. However, in 1995 we have no observations for NACE-2 industry number 15, which is 'food and beverages'. The reason for this is that in 1995 another government body became responsible for collecting data on the industry. The data, if they were ever collected, never made it to the data set of the tax authorities. The other change we have to make is to drop the most heavily concentrated industry with NACE-2 industry number 23.[76]

We measure the output of the firm using net sales. Another natural choice would be to use value added instead. In order to obtain the value added variable, we have to subtract material input from the net sales. One could argue that if material input cannot be deflated properly, then value added is a better measure of output, as one may end up having a large measurement error in the input variable. Therefore, the use of simple industry-specific deflators may not be correct. Why is this?

The use of simple industry-specific deflators (say, PPI) for deflating material input can be unsatisfactory, as the composition of the material input use of firms is very much dependent on the technology of the specific industry. Some industries tend to use more of the output of certain industries than other industries, and this should be reflected in the deflating procedure. Investment goods (and capital stock) can be also affected by this problem, but for material input it is probably more acute.

[75] We have seen this in *Chapter 5*.

We are also interested in the output elasticity of material input, so eliminating it from among the regressors in the production function by using value added as an output measure is not a good idea. In order to keep material input in the production function, we opted to use a more sophisticated deflating procedure than for the other variables.

Table 7.1. Simple PPI indices and the weighted PPI used for deflating material input

		Food	Light	Chemical	Mineral	Metal	Machine	Other	Mean deviation
		D15-16	D17-22	D23-25	D26	D27-28	D29-35	D36-37	
Simple PPI	1992	114.3	105.7	107.0	106.6	105.8	105.7	106.6	-
	1993	115.4	110.4	109.8	109.2	109.7	110.2	110.7	
	1994	126.0	129.2	130.1	128.8	129.7	127.9	128.8	
	1995	127.0	122.0	124.2	122.3	117.9	119.5	116.8	
	1996	112.6	113.8	117.1	116.3	111.2	111.9	111.6	
	1997	103.7	108.6	107.4	106.1	100.8	103.5	107.8	
	1998	103.3	103.9	104.3	103.8	102.3	101.9	102.9	
Weighted PPI	1992	113.0	108.6	111.9	110.0	108.0	116.0	106.7	3.78
	1993	118.5	115.9	118.7	114.5	111.7	112	107.7	3.36
	1994	127.1	141.2	148.1	127.4	132.9	126.7	121.5	3.47
	1995	123.o	113.1	130.3	117.3	110.1	116.2	116.1	-3.35
	1996	127.1	116.7	127.7	117.5	114.7	114.0	114.3	5.36
	1997	113.1	117.0	113.1	106.9	117.5	110.2	111.3	7.30
	1998	97.9	108.8	118.3	108.2	99.4	107.4	110.1	3.95

In order to construct the deflator for material input we used the input-output tables for Hungary between 1992 and 1998. With the help of the input-output coefficients we created a vector of weights for the material use of each industry. For some two-digit industries we observed these coefficients easily, while for others they had to be added together with the figures of some other industries. This was not good news for us, but the correction with these less detailed figures was still a marked improvement on using simple industry-specific price indices (PPI). Hence, with the help of the input coefficients, we created a new deflator for each industry. The results of this calculation are summarised in *Table 7.1.* It is immediately apparent that there are substantial differences between the simple industry-specific PPI commonly used in other studies, and the price indices weighted with the input-output coefficients. In the last column we present the geometric mean of the differences between the two measures in percentages. They indicate quite a substantial deviation between the two

[76] This is oil refining - a monopoly of a single firm.

sets of deflators, so our correction probably makes a significant difference. For the other variables we used the relevant industry-specific deflator from price figures of the Hungarian Central Statistical Office (e.g., export price indices for exports) in a straightforward manner.

We had access to a few auxiliary variables that were not part of the balance sheet or the profit and loss statement of the firm. Such items were the labour force, and the value of exports, imports and ownership data. Export data were based on balance-sheet reports, but imports were not. We obtained import data by matching the firm identifiers of the balance-sheet statistics with those of the trade statistics. Ownership data are particularly important, as they can be used to identify firms with foreign direct investment. The providers of the data included a dummy in our dataset that only signals whether or not foreign owners have a share of more than 50 per cent in the subscribed capital of the firm.

Why could the 50 per cent cut-off point be relevant for us? The literature on FDI is somewhat divided with regard to the precise point at which the presence of foreign owners becomes important in influencing the input and output decisions of the firm. International organisations suggest that foreigner owners start to exert an influence on management decisions even at around 10 per cent. However, our measure is stricter than this. It makes sure that our measure contains all cases where foreign owners make the important management decisions. This can certainly be assumed where their ownership stake is more than 50 per cent; below this, however, it may hinge on a number of other factors.[77]

The data set has an increasing number of observations in every cross-section. Some firms disappear, while many new firms appear. Typically, we can observe a firm in more than one year. In the first half of the data set in particular, many firms disappear. While the number of observations increases each year, the number of disappearing firms progressively declines.

[77] Most of the firm in the sample had no change in the status of their ownership throughout the sample. Only in a case of a small portion of firms one could observe a change.

This kind of data set can be utilised for cross-section exercises, and it helps characterise the behaviour of the firms in each year. However, after merging the data of individual years into a panel, the disappearing firms can make our regression results inconsistent. In balanced panels we observe every firm each year, while in unbalanced panels this is not the case. This is a problem if the firms go missing non-randomly. This can be a valid problem where there is a pattern in the disappearance of the firms, and it can be related to the observable characteristics of the firms and the error term in the performance equation (Wooldridge, 2002). This is something that must be particularly acute with transition data sets that include data from the early 1990s, when a great deal of restructuring took place, and there were many bankruptcies and liquidations. As a result, a large number of firms disappeared, and it is hard to imagine that the determinants of firm performance were unrelated to their disappearance. In the literature, however, none of the papers that used panel data gave any consideration to this issue. Using a simple test recommended in Baltagi (1995) we found some evidence for selection bias in the first half of the sample period, but not for the second.

Table 7.2. Means of some input variables at 1996 prices (thousands local currency, 1 GBP=290 units of local currency in 1996)

	1992	1993	1994	1995	1996	1997	1998
Nr of observations	9758	11896	13267	12341	14758	18014	19470
Net Sales	175.372	172.548	204.868	232.620	326.293	362.413	419.075
Exports	39.980	42.310	52.899	82.275	113. 523	148.428	191.099
Imports	33.147	35.382	49.289	73.311	107.027	133.425	178.805
Investments	45.681	47.377	54.387	66.489	81.758	90.048	97.963
Employment	93	69	60	52	56	45	43
Capital stock	103.555	98.339	94.720	91.593	110.192	107.880	124.115
Material input	120.520	118.549	141.731	156.820	231.105	258.978	302.332

In *Table 7.2* we summarise the most important input data. In each row we indicate the average of the variable. It is interesting to see that in 1993 net sales were still falling.

Hence, the trough point of transition in this sample seems to be a year later than in the published aggregate data. The mean of exports, imports and investments were increasing throughout the whole sample, while material input, wage bill and capital stock were declining in 1993, and they were on the increase in the rest of the years.[78]

7.1.2 Is the performance gap between foreign and domestic firms declining?

Empirical results show that, in general, the output-labour ratio moves very closely together with TFP (Good, Nadiri and Sickles, 1999). This is not surprising, as usually labour input carries a large weight in total input use. Consequently, knowing that foreign firms have a higher output-labour ratio than their domestically owned counterparts, one can safely assume that there exists a gap in total factor productivity between the two groups of firms. Direct estimation of the gap in levels with the help of an FDI dummy reinforces our presumption of a considerable performance gap. However, we are interested in the changes in the gap. Our calculations seem to suggest that the gap in TFP between the two groups of firms did not diminish. This is an observation that can be justified by the estimation results in *Table 7.3*.

We would like to identify the determinants of the gap in our sample, and see what role is played by FDI in this regard. As a starting point for this analysis we run regressions with a Cobb-Douglas production function in log differences containing the FDI dummy to measure the shift of the constant between the two groups. We were also interested in the sums of estimated elasticities of the production functions as this gives us another performance measure in addition to TFP: the economies of scales of production. The production function or *performance equation* we estimate in cross-section is:

$$y_i = c + \alpha * Owndum_i + \sum_{j-1} \mu_j + \beta_j * k_i + \gamma_j * m_i + \delta_j * l_i + \varepsilon_i \qquad (7.1)$$

[78] We also made comparisons between the capital-labour ratio, the output-labour ratio, per capita investments, export, and material input of majority foreign-owned firms and the rest. Unsurprisingly, it was found that the foreign-owned firms have higher capital-labour and output-labour ratios, and per capita investment, exports, and material input use. This is in line with earlier findings by other researchers (Hamar, 2001; Éltető, 2001).

where index i indicates the firm, and j stands for 21 manufacturing industries. y_i, k_i, m_i, l_i, are the log differences of net sales, capital stock, material input, and employment. β_j γ_j δ_j μ_j are the corresponding industry-specific parameters and c is the constant of the regressions. When a firm is majority foreign-owned, $Owndum_i$ takes the value of 1, otherwise it is 0. The parameter that belongs to the dummy (α) is our parameter of interest. Later we set up a *selection equation* that explains *Owndum*. However, we do not describe its specification here, as it will depend heavily on the results of a testing procedure on the instruments of the model.

There are many ways of measuring the performance of firms, and estimation of the technology component of a production function is one. It is also not uncommon in the literature to use returns to scale as a measure for this purpose. Usually, researchers use the sum of Cobb-Douglas factor elasticities to calculate the returns to scale of the estimated production function. In *Table 7.3* we summarise the results of the exercise.

The results with the sample for *small firms* suggest that in the first year there are decreasing returns to scale that initially rise above unity and then decline again.[79] Surprisingly, *large firms* (with more than 100 employees) seem to operate under smaller returns to scale than the total sample. What is more, in most of the years we observe that it is smaller than one. This suggests that smaller firms probably performed better. At the beginning of the sample, the relatively poor performance of larger firms could probably be attributed to transition-related factors. There must have been a considerable restructuring effort still ahead of these firms, and in the second half of the sample some already improve their performance by investing and expansion. At this point one must emphasise that foreign-owned firms have performed far better than either the typical small ore large firms.

In sum, large firms did not seem to reap many of the benefits associated with scale of production. Instead, foreign firms did this. In their case, in three years out of six the returns to scale exceeded unity by more than ten per cent. This suggests that the

[79] It is interesting to note that returns to scale were the highest in the year of a macroeconomic stabilisation package (1995).

performance of the foreign firms was far superior to the rest of the firms, and it is hard to imagine that the performance gap vis-à-vis domestic firms could decline, or even remain stable between the two groups in the short term. Interestingly, the best performing foreign-owned firms were concentrated among the small firms. At the same time, the returns-to-scale performance of large foreign-owned firms is similar to their domestic counterparts.

Table 7.3. Cross-section OLS regression results on the impact of FDI

		1993	1994	1995	1996	1997	1998
Smaller firms (employees <100)	No. of observations	4398	5780	5949	6634	9772	11148
	Constant	Yes	Yes	Yes	Yes	Yes	Yes
	Production factors	Yes	Yes	Yes	Yes	Yes	Yes
	Sum of factor Elasticities	0.972	1.027	1.063	1.01	1.022	1.013
	Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
	R^2	0.72	0.75	0.71	0.72	0.73	0.72
	Owndum	0.09	0.092	0.062	0.041	0.033	0.031
	p-value	0.000	0.000	0.000	0.000	0.000	0.000
Larger firms (employees >100)	No. of observations	890	1106	943	933	1184	1286
	Constant	Yes	Yes	Yes	Yes	Yes	Yes
	Production factors	Yes	Yes	Yes	Yes	Yes	Yes
	Sum of factor Elasticities	0.971	0.967	1.01	0.978	0.988	0.989
	Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
	R^2	0.85	0.82	0.82	0.83	0.83	0.83
	Owndum	0.013	0.031	0.030	0.045	0.032	0.032
	p-value	0.497	0.103	0.048	0.014	0.005	0.001
Majority foreign-owned firms	No. of observations	851	1175	1262	1402	1697	1946
	Constant	Yes	Yes	Yes	Yes	Yes	Yes
	Production factors	Yes	Yes	Yes	Yes	Yes	Yes
	Sum of factor Elasticities	1.023	1.179	1.072	1.215	1.012	1.101
	Industry dummies	No	No	No	No	No	No
	R^2	0.76	0.76	0.73	0.75	0.64	0.69

In order to see how their relative performance might have changed over time, we also estimated the mean difference in the TFP growth rate between the two groups with a sample of large firms (Refer to *Owndum* in *Table 7.3*).[80] What we observe is quite surprising. At the beginning the difference in TFP growth rates between foreign and domestic firms was much smaller among large firms than among small firms. This difference fades away over time and the estimated parameters obtained with small and large firms become closer.

However, according to this measure the performance gap between foreign and domestic firms is still increasing (the parameter of *Owndum* is positive). At the beginning, the gap grew faster among small firms, but later the growth rate of the gap became similar among small and large firms.

These regression results on *Owndum* cannot be interpreted automatically as impacts of foreign ownership on technology. More sophisticated methods are required to control for the various sources of bias. The OLS results can only be useful to describe the technological differences between the two groups and the dynamics of the gap.

The significant positive FDI dummy does not necessarily mean a positive impact on performance. It may only be a result of the endogenous choice (self-selection) of ownership in the regression. There are two strategies to handle this problem, and there will be two corresponding parts of analysis. First, we use cross-section methods and then a panel specification. Our main variable of interest will be the parameter of the FDI dummy. Compared with the simple OLS cross-section estimates, we introduce a new element: to try to eliminate the endogeneity of the variables in the performance equation. Then, in the remainder of the chapter, we will assess what difference it makes if we introduce firm-specific effects into the econometric model, and how the

[80] In obtaining the results in *Table 7.3* we used robust OLS that accounts for a flexible form of heteroskedasticity in the error term. The large decline in the number of observations compared with the earlier summary table (*Table 7.2*) should be noted. This is due to the fact that many firms were not observed in the previous year, and in these cases we see that differencing creates a large number of missing values.

results change, assuming dynamic adjustment of production in the presence of various spillover variables.

7.2 Results from the simultaneous and the treatment model

The procedure we follow first is a simple, two-stage least squares (2SLS) estimation. If one is only interested in the parameters of a single equation, one obtains the reduced form equations for the endogenous variables of that equation. Then the predicted values are substituted in place of the endogenous variables of the equation of interest, before running an OLS that is now clear of endogeneity. Care must be taken to ensure that the equation of interest is not underindentified. The only occasion when this problem does not emerge is when the number of exogenous and predetermined variables outside the equation are larger than the number of endogenous variables in it. In this case, the parameters of the equation of interest can all be identified, and the equation becomes overidentified. In short, it is advisable to keep the number of instruments above the number of endogenous variables in the equation.

Initially, we assume a specification that allows all variables (growth rate of capital, labour, material input and ownership dummy) of the performance equation to be endogenous, and we also assume that there is a large number of valid instruments. After a testing procedure described below, we would like to obtain a valid empirical model. In theory, the large number of instruments improves the estimates. However, this is only so if the instruments themselves are valid. There are two testable criteria that a valid instrument must satisfy. First, it must be correlated with the variable it instruments. Second, it must be uncorrelated with the error term of the equation of interest. However, if the correlation with the instrumented variable is too low, this can greatly increase the standard error of the parameter estimates. If the instrument is correlated with the error term, the estimate we obtain will be biased. Therefore, when we use instruments in our regressions, we must check the validity of these two criteria.

One can observe the validity of the first criterion in the reduced form equations where the endogenous variable is regressed on the set of all valid instruments. However, checking the other criterion is not quite so easy. To this end we use both the joint and individual variable version of the Sargan test (or a test of overidentifying restrictions). This test is an χ^2-test, and it has the null that a single instrument (or set of instruments) is uncorrelated with the residuals from the performance equation.

What is the exact procedure we apply? After a valid set of instruments is identified with the help of the Sargan tests, we test the endogeneity of the variables in the performance equation. We carry out an F-test, as recommended by Davidson and MacKinnon (1993), under the null that a variable (or a set of variables) can be treated as exogenous. If the test suggests that some variables of the equation are not endogenous, we will assign them to the set of instruments we are using. Then the Sargan test is reiterated. If, as a result of the testing procedure, the set of instruments changes, we again apply the Davidson-McKinnon test(s). We continue the process until both the Sargan test(s) and the Davidson-McKinnon test(s) are jointly satisfied. In our data set, we usually obtained an acceptable model after only two rounds of the testing procedure. In some cases just one round was enough, while others required three. A remark needs to be made regarding this procedure. This is that we also utilised the traditional Hausman test to validate the chosen model.[81] However, it did not cause major changes in our findings. This is a testing procedure that has not been used in the literature we reviewed before. With the help of this method, we managed to purge most of the endogeneity from our cross-section model.[82]

[81]We compared OLS and 2SLS parameter estimates. The null of the Hausman test assumes that OLS estimates of the performance equation do not differ significantly from the 2SLS estimates, and hence there is no need for the instrumental variables procedure. Except for one example, the test always rejected the null of OLS being a valid estimator. However, in some of these cases, the Davidson-McKinnon test(s) found the opposite. This suggests that the Hausman test is stricter. This is in line with the findings of Monte Carlo studies that argued that the Hausman test over-rejects the null (Wooldridge, 2002).

[82] Based on economic theory, one would expect that capital stock is the least likely to be endogenous, as it is thought to be fixed in the short run. In turn, labour, material input and ownership were expected to be endogenous. Instead, we found that, except for the first year of the sample, it was the ownership dummy that was always exogenous. For all the other variables, there is considerable variation as

We are interested in the impact of FDI on the domestic economy, on the condition that the endogeneity of the regressors in the performance equation is taken account of. If FDI proves to be endogenous and we have a valid set of instruments for it, one may apply the treatment model we discussed earlier. The problem is that it may happen that FDI is endogenous in the performance equation, and it is also very probable that all the other variables of the performance equation are endogenous. If they are, one should instrument them and replace them with their predicted values. It is only when this correction is carried out that one obtains consistent estimates of the impact of FDI in a treatment regression. However, there still remains a problem with regard to this procedure. This is that the standard errors of the treatment model with endogenous controls are not known, so one cannot draw proper inferences. Nonetheless, the magnitudes of the parameter estimates for the FDI dummy are helpful for providing clues about the possible size of the effect of foreign ownership on TFP performance.

To make the results easier to compare with the results obtained with 2SLS, we instrument the endogenous variables in the performance equation of the treatment model with the same set of instruments as with the 2SLS estimation of the model. Consequently, in all cases where we find FDI to be endogenous, we are going to present parameter estimates obtained with the treatment regression and the 2SLS together. We now turn to the discussion of the actual regression results.

We ran regressions with samples of large firms (firms with over 100 employees), and then with the small ones (firms with fewer than 100 employees). The results obtained with the whole sample are in *Appendix 7.1*. For the initial set of instruments we used lagged endogenous variables and some other variables that capture the initial conditions of the firm. These initial conditions included the share of labour costs in the total cost, the initial market share of the firm and their interactions.[83]

regards when they turn up as exogenous.

[83] It turns out that these initial variables predicted the future foreign ownership of the firm very well. Foreign ownership was typically positively and significantly related to initial cost efficiency and initial market share. However, they added much less to the explanation of other endogenous variables. The other group of instruments was the lagged values of the performance equation and, naturally, they predicted their own forward values best.

Table 7.4. 2SLS and treatment regression results with the sample of small firms

2SLS	1994	1995	1996	1997	1998
Number of observations	4436	4389	3672	3332	3194
Constant	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
R^2	0.54	0.72	0.70	0.69	0.68
Capital.(DM test)	Endog.	Endog.	Endog.	Exog.	Endog.
Labour (DM test)	Endog.	Endog.	Exog.	Exog.	Exog
Material.(DM test)	Endog.	Endog.	Exog.	Endog.	Exog.
Ownership dummy (DM test)	Endog.	Exog.	Exog.	Exog.	Exog.
Hausman test	Rejected	Rejected	Rejected	Rejected	Rejected
Joint exogeneity test (Sargan test)	Rejected	Rejected	Rejected	Rejected	Rejected
Foreign ownership dummy	0.401	0.068	0.021	0.021	0.020
St. error	0.146	0.015	0.018	0.015	0.014
p-value	0.006	0.000	0.152	0.167	0.056
Treatment					
Constant	Yes	-	-	-	-
Industry dummies	Yes				
Hazard (λ)	-0.114				
Standard error	0.048				
p-value	0.018				
Foreign ownership dummy	0.355				
Standard error	0.072				
p-value	0.000				

We carried out the model selection procedure described before with two initial specifications. First we included one-lagged values of the variables from the performance equation in the initial set of instruments; then we also included the second lag. The results we obtained with the initial set of instruments with one-lagged variables are given in the text, while the tables with the twice-lagged instruments can be found in *Appendix 7.1.*[84]

[84] In *Appendix 7.2* we present results with an initial set of instruments that contains twice-lagged variables as well. How do they compare to the estimates obtained above using one-lagged instruments? FDI is similarly endogenous in the sample of large firms in 1995, although the estimates involved are much higher. This time the estimate of the hazard does not contradict the conclusions of the 2SLS procedure. The rest of the results are almost identical to those obtained before.

We estimate the equations with a sample of small firms, and then with large firms separately. Because lagging the instruments twice means dropping an extra year from the sample, we observe estimates with this specification from 1995 only. Now we discuss the results of the estimation procedure with the set of instruments containing one-lagged variables.

Table 7.5. 2SLS and treatment regression results with the sample of large firms

2SLS	**1994**	**1995**	**1996**	**1997**	**1998**
Number of observations	734	550	504	500	571
Constant	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
R^2	0.43	0.67	0.66	0.70	0.69
Capital.(DM test)	Exog.	Exog.	Exog.	Exog.	Exog.
Labour (DM test)	Exog.	Exog.	Exog	Endog.	Exog.
Material.(DM test)	Endog.	Exog.	Exog	Exog.	Exog.
Ownership dummy (DM test)	Exog.	Endog.	Exog	Exog.	Exog.
Hausman test	Rejected	Rejected	Rejected	Rejected	Rejected
Joint exogeneity test (Sargan test)	Not Rejected	Not Rejected	Not Rejected	Not Rejected	Not Rejected
Foreign ownership dummy	0.025	0.017	0.046(OLS!)	-0.010	0.028(OLS!)
St. error	0.279	0.032	0.018	0.159	0.013
p-value	0.373	0.585	0.013	0.523	0.017
Treatment					
Constant	-	Yes	-	-	-
Industry dummies		Yes			
Hazard (λ)		-0.006			
Standard error		0.037			
p-value		0.859			
Foreign ownership dummy		0.037			
Standard error		0.062			
p-value		0.554			

The 2SLS estimates obtained with the sample of small firms (*Table 7.4*) indicate a very high initial impact of FDI on performance, while at the end of the sample the impact becomes small, although it is still significant. One should also notice that it is only in the first year of the sample that FDI is endogenous. Therefore, this is the year when the magnitude of the estimate can be double-checked with the treatment model. The parameter estimate of hazard is highly significant. Therefore the treatment regression also indicates the endogeneity of FDI. Again, we find a similarly high estimate for the FDI dummy as with the 2SLS. It is only the last year when the estimates obtained with both estimators become comparable to the simple OLS results we found earlier (Refer to *Table 7.2*).

For the sub-sample with large firms (*Table 7.5*) the results are somewhat different. Except for the last year of the sample, there is no indication of a significant impact of FDI on the performance of large firms. The FDI dummy turns out to be endogenous in 1995, but it is exogenous in the remaining years.

In 1995, when we observe endogenous ownership, we double-check the results using the treatment regression. On the one hand, we find that the FDI dummy has a similar magnitude as before. On the other, the parameter estimate of the correction term for self-selection signalled no significant endogeneity of ownership choice. This contradicts the result of the model selection procedure of the simultaneous model.

We now summarise our cross-section results. After controlling for endogeneity of ownership choice we found that the impact of FDI on performance was probably very considerable at the beginning the sample. It was insignificant in the middle of the sample period and significant, although small, in the final year of the sample. The models we used explained performance better in the second half of the sample than in the first. Except for one subsample, the treatment regressions gave very similar results to those obtained using 2SLS. Overall, there is an indication that ownership had a large impact in the early stages of transition, but that it has progressively become much less important. The exception to this conclusion is the sample of large firms. In their case, we could not observe significant positive impact of ownership on performance.

This may imply that larger domestic firms managed to compete well with their foreign-owned rivals in terms of TFP. This could be due to a number of factors. Large firms have more opportunities than small firms to learn by exporting, and a better knowledge of high-quality inputs and investment goods produced abroad. Now, the question is whether we manage to estimate any of the crucial channels through which these knowledge spillovers might take place. More specifically, we would also like to ascertain whether these knowledge spillovers could offset the negative spillover (market-stealing effect) often attributed to the increasing presence of foreign firms.

7.3 Results from pooled, fixed-effects panel and dynamic panel models

Before discussing the regression results, we present *Table 7.6*, which contains the notation of the variables we included in the subsequent regressions.

Table 7.6 New variables used in the panel estimations

Variable name	Definition
Owndum	*Owndum=1*, the share of foreign investors in the subscribed capital is more than 50%, otherwise *Owndum=0*
Forsh1	The share of majority foreign-owned firms in the net sales of an industry
Ownown1	*Owndum* multiplied with the ratio of net sales of a majority foreign-owned firm in the net sales of an industry
Impsh2	The share of firm-level imports as a ratio of total imports of the industry
Impow	The firm-level import interacted with *Owndum*
Expo	The export orientation of the firm: share of exports in net sales
Exow	The export orientation interacted with *Owndum*

We carried out our estimations in two sub-periods. For reasons mentioned in *Chapter 4*, we chose 1995 as the cut-off point. For each sub-period we present two sets of regressions. One is obtained with large and the other with small firms in the sample. In each set of regressions we carry out robust OLS, within-group (WG) and Arellano-Bond estimations (AB).

When the within-group estimator (WG) is used, we perform three specification tests. First we check the presence of stochastic individual effects. Then we use the Hausman test to see if an estimation of a fixed-effects model is the right choice.[85] In every case

[85] We want to know if the within-group estimation on a fixed-effects model results in significantly

the testing procedure has justified this specification. As explained before, this makes economic sense as the unobservable individual specific talent (management, marketing, company culture) of the firm can be correlated with input use and ownership. When estimating the fixed-effects model, we also carry out an F-test that tells us if our model is poolable, so that it can be estimated with OLS. However, this hypothesis is always rejected, which suggests that the assumption of a fixed-effects regression specification is more justifiable than either the classical or the random-effects specification.

In the AB procedure we applied two tests. The model assumes a dynamic adjustment process, so we have a lagged dependent variable on the right side. The procedure uses instruments, and so they should be tested using the Sargan test. Also, according to the model, one should observe first-order autocorrelation and no second-order autocorrelation in the residuals. These are also testable implications and both aspects are investigated.

At the beginning we obtain results for the subsample of large firms in the early period of the sample (1993-1995), and then we rerun the same regressions with small firms. Afterwards we carry out the whole exercise again for the second half of the sample period (1995-1998).

First, we present the results obtained for the sample of large firms between 1993 and 1995 in *Table 7.7.* We find marginally significant and low estimates on the impact of FDI with simple OLS. However, when we estimate the fixed-effects model with within-group (WG) regressions, the positive impact of FDI disappears. Consequently, it may be concluded that when we account for self-selection with a fixed-effects panel, it casts doubt on the positive role of FDI among large firms.

different parameter estimates than those obtained using the random-effects model (which is GLS). The idea behind this test is, that both WG and GLS estimate the random-effects model consistently, while the fixed-effects model is only estimated consistently with the within-group estimator. Therefore, if the two sets of estimated parameters are significantly different, we should proceed assuming a fixed-effects model.

Table 7.7. Regression results with the sample of large firms between 1993 and 1995

	Simple spec.		D-H spec. (dom. firms)		D-H spec. (foreign firms)		A-H spec.		Dynamic spec.	
	OLS	WG	OLS	WG	OLS	WG	OLS	WG	AB	AB
Nobs	2932	2932	2173	2173	758	758	2927	2927	1208	870
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ind. dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prod. Factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged dep. Vars	No	No	No	No	No	No	No	No	Yes	Yes
R^2	0.83	0.74	0.84	0.68	0.77	0.73	0.83	0.61	-	-
Robust error	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Yes
LM test	-	Rej.	-	Rej.	-	Rej.	No	Rej.	-	-
Hausman test	-	Rej.	-	Rej.	-	Rej.	-	Rej.	-	-
F-test on I-effect	-	Rej.	-	Rej.	-	Rej.	-	Rej.	-	-
Test of overid. Restrictions (Sargan test)	-	-	-	-	-	-	-	-	N Rej	N Rej
AR tests	-	-	-	-	-	-	-	-	N Rej	N Rej
Foreign dummy	0.022	-0.04	-	-	-	-	0.019	-0.10	-0.08	-0.04
p-value	0.046	0.43					0.548	0.201	0.020	0.740
Ownown1	-	-	-	-	-	-	0.004	0.175	0.147	0.286
p-value							0.953	0.317	0.037	0.334
Forsh1	-	-	-0.03	0.250	-0.14	0.086	0.995	0.145	0.205	**0.501**
p-value		-	0.955	0.015	0.431	0.745	0.370	0.945	0.079	**0.050**
Impsh2	-	-	-0.02	-0.69	0.104	0.159	-	-	-	-0.76
p-value			0.92	0.508	0.567	0.891				0.265
Impow	-	-	-	-	-	-	-	-	-	0.577
p-value										0.377
Expo	-	-	-	-	-	-	-	-	-	-0.07
p-value										0.353
Exow	-	-	-	-	-	-	-	-	-	-0.25
p-value										0.150

Then, we test the model recommended in DH (1998, 2000a). Their results suggest that the general presence of foreign-owned firms in an industry has a negative effect on performance, which domestic firms can counteract by increasing imports. They argue that imported inputs are of better quality and they improve the TFP performance of domestic firms. We check this assumption in two specifications: first, ignoring firm-specific talent, and then taking it into account. Surprisingly, imports play no role, while the share of foreign ownership in an industry has a positive impact on the performance of domestic firms.

However, it is not only the domestic firms that can be influenced by the presence other foreign firms. Some of the foreign firms themselves may be adversely or positively affected by spillovers due to the presence of other, more productive, foreign firms. Although DH (1998) ignores this, the analysis should not be confined to domestic firms only. Nonetheless, the results show that neither of these spillovers significantly influences the performance of large foreign-owned firms.

We now try to identify some of the channels through which technology transfers can take place. The channels we try to test are ownership, importing, and learning-by-exporting. Ownership was measured as the weight of foreign-owned firms in net sales at industry level, learning-by-exporting was proxied by the past export-orientation of the firm, and imports were observed in our data set directly. First, we use a specification recommended in AH (1999); then we assume a more complete model. Out of these three sources, only AH (1999) account for ownership. They estimate the performance equation assuming direct technology transfer by the owner at firm level, the impact of foreign ownership at industry level, and the interaction of these two factors. They argue that the interaction term measures the differential impact of ownership spillover on foreign firms. It indicates whether foreign firms benefit significantly more than domestic firms from the presence of other foreign firms. We found no role for ownership, either in OLS or in the within-group (WG) regression.

When we assumed a dynamic adjustment process, the lagged dependent variable turns out to be insignificant and the point estimate is very close to zero. This implies that the long-term elasticities of the regression are not very different from the short-term ones appearing in *Table. 7.7.* However, under the AB procedure we found ownership at industry level to be significantly positive. This signals that, unlike the results by AH (1999) and DH (1998), there has been a large positive technology spillover to the local firms (both foreign and domestically owned) due to the general presence of foreign owners. The estimate *(0.501)* suggests that a 10 per cent level in the industry-level share of foreign-owned firms in production would increase the TFP growth rate by about 5 per cent. However, the true impact for the period of observation is much larger than this. The mean of the spillover variable[86] was 28 per cent in 1993. In 1994 and 1995, it was 33 and 39 per cent respectively. This implies that, in reality, in these years the impact of the spillover was about three times larger than our 5 per cent guess based on a mere 10 per cent weight of foreign ownership. Interestingly, the rest of the channels do not turn out to be significant.[87]

We now consider the estimation results obtained from the sample of small firms observed between 1993 and 1995, and these are summarised in *Table 7.8.* For the subsample of small firms, we carried out a similar set of regressions to the one we have just performed with the large firms. As expected, simple pool OLS results in high and significant estimates for the FDI dummy. As before, this completely disappears when individual effects and self-selection are allowed for. All the regressions with the DH-specification again result in insignificant spillover effects.

When we assumed the AH specification, we found more indications of a possible technology spillover. In a fixed-effects framework, the technology spillovers to domestic firms from the general presence of foreign firms were significantly positive. However, the impact of the presence of more foreign ownership in an industry has a large negative impact on the performance of foreign-owned firms. So domestic firms benefit and foreign firms are harmed by increased foreign presence. How can this happen? When small domestic firms have a low level of technology, the benefits from technology spillovers from foreign firms can be so great that this can easily compensate for the negative market-stealing effect. In turn, foreign firms in the local market possess a high level of technology. If their international rivals, also in possession of high-level technology, appear in the local market, there is little technology difference that can spill over. Consequently, in their case, the market-stealing effect can easily outweigh the technology benefits. This is an interpretation of the results obtained from a model that corresponds to the recommendations of AH (1999). However, these results may not be very reliable.

[86] This spillover variable was created as the share of sales of foreign-owned firms in the total sales of an industry (*Table 7.6*).

[87] Another explanation of the positive ownership spillover could be that firms within an industry are not rivals to each other, but complementary producers. In this case, there would be foreign firms in an industry producing inputs for each other.

Table 7.8. Regression results with the sample of small firms between 1993 and 1995

	Simple spec.		**D-H spec. (dom. Firms)**		**D-H spec (foreign firms)**		**A-H spec.**		**Dynamic spec.**	
	OLS	**WG**	**OLS**	**WG**	**OLS**	**WG**	**OLS**	**WG**	**AB**	**AB**
Nobs	19024	19024	11887	18717	2499	3288	18978	18978	7757	7196
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ind. dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prod. Factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged dep. Vars	No	No	No	No	No	No	No	No	Yes	Yes
R^2	0.74	0.66	0.74	0.68	0.74	0.73	0.74	0.68	-	-
Robust error	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Yes
LM test	-	Rej.	-	Rej.	-	Rej.	No	Rej.	-	-
Hausman test	-	Rej.	-	Rej.	-	Rej.	-	Rej.	-	-
F-test on I-effect	-	Rej.	-	Rej.	-	Rej.	-	Rej.	-	-
Test of overid. Restrictions (Sargan test)	-	-	-	-	-	-	-	-	N Rej	N Rej
AR tests	-	-	-	-	-	-	-	-	N Rej	N Rej
Foreign dummy	0.092	-0.01	-	-	-	-	0.110	0.222	-0.01	-0.23
p-value	0.000	0.76					0.001	0.004	0.971	0.214
Ownown1	-	-	-	-	-	-	-0.05	-0.69	-0.06	0.817
p-value							0.534	0.000	0.488	0.102
Forsh1	-	-	-0.03	0.250	-0.03	0.086	0.05	0.304	0.217	**-0.49**
p-value		-	0.804	0.015	0.885	0.745	0.534	0.005	0.072	**0.053**
Impsh2	-	-	0.361	-0.69	0.309	0.159	-	-	-	-1.14
p-value			0.646	0.508	0.569	0.891				0.16
Impow	-	-	-	-	-	-	-	-	-	-4.03
p-value										0.486
Expo	-	-	-	-	-	-	-	-	-	-0.03
p-value										0.756
Exow	-	-	-	-	-	-	-	-	-	-0.32
p-value										0.23

Endogeneity may still be present in the regressions, and the dynamic response of production may not be immediate either. We therefore apply an AB procedure. Now, almost all significant technology effects related to ownership disappear. Then, we try to account for other possible channels of technology. It turns out that neither learning-by-exporting nor imports have a significant impact on performance. The ownership spillover, however, does seem to matter, but with the opposite sign to that of the large firms: it is now negative.

One can argue that small firms are adversely influenced by the increased general presence of foreign firms. A level of 10 per cent for the mean industry share of foreign-owned firms reduces TFP growth by about 5 per cent. However, the level of the spillover variable is much higher than 10 per cent. Its mean is again around three times higher. Therefore, the decline in the TFP growth rate due to the spillover is about 15 per cent per annum. This phenomenon can occur if small firms do not benefit sufficiently from the new technology used by foreign firms, and the business-stealing effect they suffer due to the general foreign presence dominates.

We now turn our attention to the second half of the period to see how the patterns we observed in the first period might change. So, we next consider the results obtained with large firms between 1996 and 1998. These are presented in *Table 7.9.*

Again we see that, assuming self-selection with a fixed-effects model, the impact of foreign owners on firm performance ceases. None of the regressions following the specification by DH (1999) signal significant spillovers from foreign-owned firms, or any impact from imports.

The estimation of the fixed-effects specification recommended by AH (1999) shows that large domestic firms are adversely affected by the increasing general presence of foreign-owned firms. However, if the specification that accounts for more possible channels of technology is estimated with an AB procedure, the results again show a large positive ownership spillover. Although the rest of the channels do not influence firm performance, the share of foreign ownership at industry level does. It has a positive impact on performance, which means that there are significant benefits due to their increased presence.

As mentioned before, this can be due to technology spillovers that more than compensate for the business-stealing effect, but complementarity of production is another possibility that should not be ignored. The former explanation looks more plausible, however. Case studies show that foreign-owned firms in Hungary tend to stick to foreign-owned suppliers (Hamar, 2001). If this is true, individual foreign firms should benefit significantly more from the increased general foreign presence than their domestically owned counterparts. This did not seem to be the case, as the interaction term between the ownership dummy and the measure of general foreign presence (*Ownown1*) was insignificant.

Table 7.9. Regression results with the sample of large firms between 1996 and 1998

	Simple spec.		D-H spec. (dom. Firms)		D-H spec (foreign firms)		A-H spec.		Dynamic spec.	
	OLS	WG	OLS	WG	OLS	WG	OLS	WG	AB	AB
Nobs	3152	3152	2111	28136	985	5045	3145	3145	2167	1596
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ind. dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prod. Factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged dep. Vars	No	No	No	No	No	No	No	No	Yes	Yes
R^2	0.80	0.49	0.78	0.72	0.82	0.64	0.80	0.56	-	-
Robust error	Yes	No	Yes	No	Yes	No	No	No	Yes	Yes
LM test	No	Rej.	-	Rej.	No	Rej.	Rej.	Rej.	-	-
Hausman test	-	Rej.	-	Rej.	-	Rej.	Rej.	Rej.	-	-
F-test on i-effect	-	Rej.	-	Rej.	-	Rej.	Rej.	Rej.	-	-
Test of overid. Restrictions (Sargan test)	-	-	-	-	-	-	-	-	N Rej	N Rej
AR tests	-	-	-	-	-	-	-	-	N Rej	N Rej
Foreign dummy	0.014	-0.02	-	-	-	-	0.038	-0.02	0.021	-0.03
p-value	0.065	0.542					0.254	0.776	0.316	0.623
Ownown1	-	-	-	-	-	-	-0.04	0.01	-0.04	0.035
p-value							0.447	0.944	0.278	0.77
Forsh1	-	-	0.033	0.020	-0.10	0.017	-0.13	-0.14	-0.04	**0.137**
p-value			0.534	0.63	0.172	0.15	0.042	0.044	0.612	**0.023**
Impsh2	-	-	-0.05	0.128	- 0.045	-0.15	-	-	-	0.081
p-value			0.689	0.92	0.736	0.815				0.775
Impow	-	-	-	-	-	-	-	-	-	0.078
p-value										0.723
Expo	-	-	-	-	-	-	-	-	-	-0.07
p-value										0.142
Exow	-	-	-	-	-	-	-	-	-	-0.04
p-value										0.696

The spillover estimate *(0.137)* implies that a 10 per cent level in the mean industry share of foreign-owned firm increases the TFP growth rate by about 1.4 per cent. However, in the first year of this subsample, the mean of the spillover variable is 45 per cent and this hardly changes in the remaining years. Weighted with the share of large firms in the total, this implies that this impact raises the TFP growth rate by about 4.4 per cent per annum.

Table 7.10. Regression results with the sample of small firms between 1996 and 1998

	Simple spec.		D-H spec. (dom. Firms)		D-H spec (foreign firms)		A-H spec.		Dynamic spec.	
	OLS	**WG**	**OLS**	**WG**	**OLS**	**WG**	**OLS**	**WG**	**AB**	**AB**
Nobs	28967	28967	25504	28136	3152	5045	28873	28873	15353	14434
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ind. dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prod. Factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged dep. Vars	No	No	No	No	No	No	No	No	Yes	Yes
R^2	0.73	0.70	0.74	0.72	0.68	0.64	0.73	0.66	-	-
Robust error	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Yes
LM test	No	Rej.	No	Rej.	No	Rej.	No	Rej.	-	-
Hausman test	-	Rej.	-	Rej.	-	Rej.	-	Rej.	-	-
F-test on i-effect	-	Rej.	-	Rej.	-	Rej.	-	Rej.	-	-
Test of overid. Restrictions (Sargan test)	-	-	-	-	-	-	-	-	N Rej	N Rej
AR tests	-	-	-	-	-	-	-	-	N Rej	N Rej
Foreign dummy	0.032	0.049	-	-	-	-	-0.04	-0.01	-0.04	0.067
p-value	0.000	0.061					0.17	0.859	0.146	0.319
Ownownl	-	-	-	-	-	-	0.156	0.227	-0.08	0.014
p-value							0.012	0.079	0.311	0.927
Forshl	-	-	0.011	0.020	0.215	0.017	-0.03	-0.05	0.042	**0.050**
p-value			0.752	0.63	0.073	0.15	0.449	0.326	0.517	**0.386**
Impsh2	-	-	0.79	0.128	0.129	-0.15	-	-	-	-1.35
p-value			0.291	0.92	0.83	0.815				0.314
Impow	-	-	-	-	-	-	-	-	-	1.407
p-value										0.840
Expo	-	-	-	-	-	-	-	-	-	-0.05
p-value										0.427
Exow	-	-	-	-	-	-	-	-	-	-0.12
p-value										0.328

We now discuss in brief the results we obtained with the sample of small firms in the period between 1996 and 1998. *Table 7.10* contains a summary of these calculations. The OLS estimate of the FDI dummy is smaller than in the first half of the period. This indicates that the difference in the growth rate of the technology gap declines over time. By assuming a fixed-effects model, we allow company-specific skills to exist. This specification shows that if we use OLS, we slightly overestimate the direct impact of foreign ownership. The estimated parameter of the FDI dummy is significant at the 10 per cent level, which suggests that this is not a very robust result. Again, we find that self-selection in the fixed-effects model leads to an overestimation of the role of foreign ownership.

The estimation of the specifications recommended by DH (1998, 2000a) does not indicate significant spillovers caused by general foreign presence, or increasing imports. When we apply the AH (1999) specification, it is only the OLS estimate that shows positive benefits from an increased foreign presence, but these benefits accrue only to foreign-owned firms.

Under the AB procedure, however, when the possibility of endogeneity and other channels of technology transfer are accounted for, all these impacts disappear completely. One must also notice that, as before, in the most flexible specification the interaction terms between the foreign dummy and the spillover variables always become insignificant. This means that foreign firms in the current subsample are typically similarly affected by the spillovers (including the general presence of other foreign firms) as their domestic counterparts.

7.4 Evaluation of the estimation results

We tried to relate technology performance to foreign ownership of the firms. We used performance measures that ignore frontier (technical) efficiency and concentrated only on the shift of the production boundary. Both measures of performance we used, such as the scale of production and the technical parameter of simple OLS regressions, suggested that foreign-owned firms outperform domestically owned ones. In the subsequent analysis we focussed on the determinants of one of these measures: the shift in the level of technology. We saw that in the first part of the sample period the gap increased rapidly, while in the second half this increase almost stopped. At the end of the sample period, the difference in TFP growth rates between the two groups turned out to be only around 3 per cent.

However, we cannot interpret the parameter of the dummy that measures the technological gap as a positive effect of foreign ownership on firm performance. This could merely be the result of a selection process, with better firms tending to become foreign-owned, and firms that fare poorly tending to remain in domestic hands. In order to account for this possibility, we followed two kinds of strategies.

First, in a cross-section framework, we assumed that in the performance equation every factor of production and the ownership dummy are endogenous. Second, we used a panel framework. We will begin by discussing our cross-section work. Using a procedure that combined endogeneity tests and the testing of the instruments of the endogenous variables, we obtained an acceptable specification for each year. The results suggested that in some of the early years of the sample selection was indeed taking place. However, it took place in the opposite direction to that which one would have expected. In those years, instead of overestimating, we have actually underestimated the impact of FDI on performance.

In the treatment regression we see that the unobserved determinants of ownership and the unobserved determinants of performance are negatively correlated (the hazard was negative). This is surprising, as it makes it impossible to interpret the correlation of errors across equations in the usual way. Often, unobservables such as the quality of a firm's management are positively correlated in the two equations. This means that unobserved 'talent', such as good-quality management, cannot explain our case. Improvement of a firm's management makes the firm more desirable to own, and it also increases its TFP performance. Therefore, the error terms in the two equations[88] are positively correlated, which is the opposite of what we found.

[88] These are the performance equation (the production function) and the selection equation (the FDI

How, then, can the negative correlation of the error terms of the two equations be explained? There should exist an important unobserved variable that makes a firm more desirable to own, but at the same time worsens its technological performance. One such unobservable could be the rent the firm captures. Unfortunately, we did not have variables in the data set that could be used to calculate the rent (profit minus the cost of capital). So we could not control for it. Because rent remains among the unobservables in both equations, it may be responsible for this anomaly. The rent is positively related to the motivation of the foreign investor to own a firm, and has a negative impact on the productive performance of the firm. This is something that makes a firm both more desirable and reduces its performance at the same time, so it could explain the observed negative correlation of the error across the equations.

Had we managed to control for rent (which we could not), we would probably have obtained the usual positive correlation of the error terms across the two equations. Instead, we obtained a negative sign. But what could be the economic explanation for this? We observed selection for large firms in 1995 and for small firms in 1994 only. If it was really rent that caused selection, then it is not surprising that selection was only important in the earlier years of the sample. Presumably, as the transition process evolved, competition increased and rent went down. Therefore, the main cause of the selection process gradually disappeared.

We observed another peculiar finding: with the passage of time, more factors of production started to behave exogenously. This means that variation in factors of production became less sensitive to output variation. This may hint at the stabilisation of external conditions, but it is also possible that other reasons behind input use are becoming important. For instance, instead of input use reacting to output variation, the variation of input use might be determined to a greater extent by technological change. Technological progress means that input use is less and less dependent on the production of output (as it means factor saving), so it can be relevant in explaining the increasing exogeneity of input use. However, there are other possible reasons. One might also argue that the input use of firms is less sensitive to market signals than

equation).

before. This is a highly unlikely explanation in view of the market-oriented policies pursued in the period. Another explanation that cannot be ruled out is probably the most down-to-earth one: it could simply be the decline in the errors of the observed variables.

To control for the selection of foreign ownership, one can also use the fixed-effects model. It allows correlation of FDI and the unobserved 'talent' of the firm. We used two sub-periods, and within each sub-period we estimated two subsamples with a variety of estimators. We take account of macroeconomic effects by using time dummies. In the simple specification without spillovers, we tried to see what the effect of self-selection is. The results showed that in both periods and in all subsamples there is self-selection present. This is because the significant impact of FDI turns out to be overestimated. If the model is re-estimated using within-group estimator (WG), then the positive significance of the FDI-dummy again disappears. In sum, with the exception of one year, we observed that simple OLS in the cross-section overestimates of the impact of FDI.[89]

The results obtained from simple panel models without spillovers justify the general pattern suggested by the cross-section 2SLS results. We now summarise these common patterns of the simple estimates:

1. According to 2SLS and the treatment regression with *small firms*, FDI probably had a large positive initial impact on the upgrading of technology. However, this effect declined over time. This coincides with the OLS pattern, but not with the findings of the within-group (WG) estimation.

[89] There is a problem with the interpretation of the impact of FDI. We may interpret it as a business-stealing effect (or the ownership impact on technology). In practice, we can only measure a market at some aggregated industry level, as categorised by industrial statistics, whereas competition takes place at a much less aggregated level, probably at product level. Hence, many of the adverse effects and their determinants can go unmeasured. Unfortunately, we only have firm-level data to tackle the issue. These are not product data, but they are still definitely better than using only industry-level data.

2. The pattern is different with *large firms*. At the beginning of the sample period, OLS results signalled no significant impact of FDI and this finding was also reinforced by 2SLS, the treatment regressions and the WG estimator.

3. By the last year of sample for *both small and large firms*, 2SLS and OLS estimates come very close to each other. They suggest that the impact of foreign ownership is significant, although very low. The within-group (WG) estimates for the second half of the period are insignificant, so this also supports the finding of a low impact.

However, there is some ambiguity between the results obtained with cross-section methods like simple 2SLS, and the treatment regression, and the panel regression (WG). The former two methods indicate underestimation of the effect of FDI due to self-selection in one year, and indicate no self-selection in the remaining years. The within-group method (WG) indicates overestimation and self-selection in both the first and the second half of the sample. However, with the exception of a single year, *both methods suggest that OLS tends to overestimate the impact of FDI.* Therefore, the simple estimates of the early literature are indeed too optimistic.

We can therefore conclude that, except for a single year at the beginning of the sample, there seems to be reason to believe that the positive direct impact of a foreign owner on technology improvement at firm level is very small. However, the main purpose of the exercise was to test the relevance of various (indirect) channels of technology transfer and their impact on firm performance.

We found that foreign ownership of a firm *per se* can hardly explain the differential performance of foreign-owned firms relative to domestically owned firms. For instance, AH (1999) suggest that it is the general presence of foreign firms that matters, and not whether a firm is foreign-owned or not. They argue that domestic firms face negative spillovers caused by the presence of foreign-owned rivals, while foreign firms in turn benefit more than domestic firms from the presence of other foreign-owned firms. Their results suggest that the observed superior performance of foreign-owned firms is not due to the behaviour of the foreign owner of the firm, but to the generally larger presence of FDI. These findings are partly in line with our results. It is true that the TFP growth rate of foreign firms is higher than that of domestic firms, and that the direct role of the foreign owner in this regard is very small. However, the assumption that foreign-owned firms benefit more from the increasing general foreign presence does not seem to hold. Both AH (1999) and DH (1998) argue that this spillover is large and negative. We in turn showed that these spillovers create large benefits for large firms and cause negative effects, or are neutral to the small ones.

When we set up a dynamic panel, it turned out that a key variable of the AH (1999) study plays no role. Foreign firms do not benefit more than domestic firms from the positive spillover. In fact, both groups of firms were similarly affected all the time. We made two important modifications to the original specification. We accounted for the possible positive impact of imports and learning-by-exporting on performance. In addition, we adopted a dynamic panel specification that allows dynamic adjustment and estimated it with the Arellano-Bond (AB) procedure. The appropriate specification tests were applied. The estimation was carried out on the subsample of small and large firms in two sub-periods of the total sample. We summed up the results as follows:

1. the regressions suggest that neither learning-by-exporting (e.g., Clerides, Lach and Tybout, 1998), nor the import of inputs plays a role in firm performance in any of the subsamples.

2. Nonetheless, foreign ownership does play a significant role. However, it is the general level of foreign ownership that seems to matter in technology improvement, and not direct technology transfer by the owner. The results indicate that in the first half of the sample the increase in the general presence of foreign firms has a large positive impact among large firms. This shows that taking over technology from the newcomers compensated for the market-

stealing effect of the foreign-owned firms. To explain the large negative spillover observed among small firms, one could reason the other way round: in the early period of transition they seem to be more heavily hit by the presence of foreign rivals, and the technological benefits did not bring enough benefits for them.

3. In the second sub-period the negative impact of the general presence of foreign-owned firms on small firms disappears. One can also observe that large firms still benefit from foreign presence, although these benefits are much smaller than before.

4. It turns out that both the foreign-owned and the domestically owned firms are similarly influenced by the spillovers. Hence, for instance, foreign-owned firms do not benefit more from the increasing general foreign presence in the economy. This hints at the possibility that the production networks of foreign firms may not be as closed to domestically owned firms as is often suggested in the literature. The benefits and costs of the increasing foreign presence influence the performance of both groups of firms similarly.

7.5 Summary of the chapter

The questions we set out to answer in this chapter were related to identifying the sources of improving firm performance in Hungarian manufacturing. There are many such potential channels. We chose TFP as a performance measure and hypothesised that foreign owners contributed considerably to its growth. The choice of TFP was not arbitrary, as it plays a crucial role in the catch-up process. It does so by directly increasing productivity and by impinging on the real appreciation of the Hungarian currency. The importance of the variable was also underscored by its crucial role in the economic problems of Hungary under the socialist system. The choice of FDI was not arbitrary either. As has been shown, it plays a crucial role in the Hungarian economy. Its contribution to TFP should be large and positive, but our results only partly justify this presumption.

A large data set of Hungarian manufacturing firms became available to us. Using this data source, we tried to analyse the link between TFP and foreign direct investment. What we were interested in was not the (unsurprising) finding that rapid improvement of technology was taking place after transition. We were concerned with two other issues:

1. Can we demonstrate the connection between the rapidly improving technology and the increasing presence of foreign-owned firms in Hungary? Considering the crucial role foreign-owned firms play in the economy, this is a question that obviously requires investigation. The key problem to tackle in the regression framework was how to reduce endogeneity of the production factors, and how to correct for the possibility that firms become foreign-owned non-randomly.

2. Can we say something new that is empirically well founded about the relevance of foreign ownership and other important channels of technology transfer? The early literature was unambiguously optimistic about the impact of foreign ownership, whereas more recent studies that have already controlled for selection indicated the ambiguity of the net impact of foreign ownership in the domestic economy. Apart from the data set, what is new in our work is that we try to address the issue of endogeneity of the other regressors in the performance equation and introduce more potential channels of international technology transfer than is common in the empirical literature to date.

We now summarise the findings as follows:

1. First, we estimated a log-differenced production function with a dummy for the presence of FDI. In this, we assumed that technology improvements are the result of the different behaviour of the two kinds of owner. The simple

OLS estimations indicated that the presence of foreign owners improves the technology of the firm. This effect was found to be large at the beginning of the sample period, and it subsequently declined over time among small firms. For large firms it was insignificant at the beginning, and it became very small and significant in the later part of the sample. However, except for one year, accounting for self-selection and endogeneity of the factors of production further reduced the estimated impact of ownership on performance. Panel estimates also indicated an overestimation with OLS.

2. We also accounted for other possible determinants of firm performance. We allowed for the general presence of foreign firms, the impact of using better quality inputs from abroad, and export-orientation as other (indirect) sources of technology improvement. It was found that only the general presence of foreign firms matters and the positive impact of foreign ownership at firm level completely disappeared. In the initial phase of transition, the increase in the general presence of foreign firms had a large adverse impact on small firms, whereas large firms greatly benefited from it. We also found that foreign and domestic firms benefited equally or were equally harmed by the general foreign presence.

3. Small firms produced only a small share of production. Their share was a little above 20 per cent throughout the sample period. Consequently, it was essentially the large firms that determined the sign of the net impact of the general foreign presence on production and TFP (other factors held constant). Among large firms this impact was positive, so the net impact also turned out to be positive. We estimated the net impact around the mean. Although small firms suffered a large adverse impact in the early period of the sample (1993-1995), their weight in production was small. In this part of the panel sample, the calculations implied an addition of about 8.4 per cent to the growth rate of TFP. Therefore, the impact of FDI on them was more than compensated for by the beneficial impact on large firms.

4. In the second half of the sample (1995-1998), large firms still benefited from increased technology transfer, and the adverse impact on small firms disappeared. We interpreted these effects as a joint result of a negative market-stealing effect and a positive technology transfer effect. We found that there was only one relevant spillover impact among the large firms and none among the small firms. The spillover variable had a much smaller estimated parameter than in the first half of the sample. Because we failed to find any significant role for it, the net spillover was itself the one observed among large firms. So we came to the conclusion that the spillover from the general presence of foreign firms added about 4.3 per cent to TFP growth in manufacturing in the later part of transition. Although this was still a considerable addition to the performance variable, it was also a noticeable decline compared with the 8.4 per cent observed in the early period of transition. In the early period of transition, the large addition to TFP performance was achieved with a relatively low level of FDI in the economy. However, in the latter part of the sample, the large addition to performance took place in the presence of a very large weight of FDI in the economy. This suggests that this 'easy way' of improving TFP may be coming to an end. Policy-makers must therefore find alternative ways of enhancing TFP performance other than promoting FDI inflows.[90] In the case of Hungary, the share of foreign ownership in manufacturing production is already very high. Increasing this share still further by policy measures is no longer a feasible option.

In sum, we can say that despite the observation that foreign-owned firms improve their performance more rapidly than their domestically owned counterparts, we find little evidence for a large direct impact of foreign owners on technology performance. However, when it is assumed that it is not only direct technology transfer by the owner that matters, it turns out that the general foreign presence is a key determinant of performance. It has a very large positive impact on large firms. In the initial period of the sample, it also had a large negative impact on small firms, but this seems to

[90] The standard recommendation would be to put more emphasis on the improvement of education, infrastructure and research and development.

disappear later. This implies that the technology improvements of small firms probably take place through a channel that is no longer dependent on FDI behaviour. Presumably, they utilise other channels of technology transfer that we were unable to observe. However, one can also suggest an alternative explanation for this. It may simply happen that it takes a longer time interval for spillovers to appear at firm level than we could account for.

These results support the hypothesis that FDI plays a considerable role in improving the performance of firms in Hungary. However, the channel through which its impact is taking place is quite unexpected. It is not due to the direct transfer of technology by the owners of foreign firms, but to the beneficial impact of the very high general foreign presence in the economy.

Our sample period covered the years subsequent to the trade and investment liberalisation. These steps were often heavily criticised for contributing to the economic malaise of the economy in the early 1990s, and for worsening the decline of domestic manufacturing. The arguments countering this view mostly emphasised the beneficial effects of liberalisation on consumer welfare and on the technology of producers. In this chapter we concentrated on the latter issue.

We know that the radical liberalisation of trade and investment increased the level of exports, imports and foreign direct investment in the economy. This is a common observation after such liberalisation measures were taken in Hungary. We expected that these steps contributed considerably to the technology performance of firms operating in Hungary. It turned out that in this regard trade was unimportant. To our surprise, it was the increase in the general presence of foreign direct investment that proved crucial in improving the technology of the typical firm – be it foreign or domestically owned. This conclusion was the opposite of the conclusions arrived at in most of the empirical literature on the issue: according to our findings, foreign-owned and domestically owned firms benefited or suffered equally.

In sum, one could say that, by and large, the policy of rapidly increasing the role of FDI in the domestic economy was successful from a performance point of view. However, a cautious researcher must also concede that this policy has probably reached its limits.

Chapter 8: Conclusions

This study focussed on the impact of foreign direct investment (FDI) on the performance of the Hungarian economy. The reasons for this choice are rooted in the past. Before 1989, in the socialist system, the presence of foreign investors (and private investors in general) was restricted. At the same time, this was also a period when the country's economy performed very poorly. This pattern changed when the old system was abandoned. The task we set ourselves was to investigate the extent to which FDI managed to contribute to the improving performance of the economy after transition started. We picked out two areas for analysis where the weaknesses had been particularly obvious: exports and technological progress. Both variables showed essentially zero growth under the old system in the 1980s. Their behaviour was an indication of the sorry state of the Hungarian economy at the time.

Such poor performance was common in the former socialist countries. In order to resolve the economic deadlock faced by many governments in the region, they initiated drastic reforms. To avoid the total collapse of the economy, policy-makers had to move rapidly with these reforms. Mild reforms under the old system did not bring about any palpable positive impact to relieve the huge economic problems that had accumulated. Consequently, any reforms in the new era had to be rapid and radical in comparison with those of the past.

The key aspect of transformation was how to transfer the assets of the country into private hands in a relatively short period of time. To achieve this, Hungary adopted a privatisation policy that was quite unusual among the former socialist countries: the sale of firms for cash. This method favoured foreign investors and, mainly as a result of the policy, the foreign-owned sector of the economy grew to a considerable size in less than half a decade.

Despite the great initial loss of GDP and industrial output, major improvement in the basic performance measures of the economy was observed in the new era. The technology improvements that took place were massive. In the initial phase, this was due to mainly to the reduction of overemployment in firms, which had been inherited from the old system. Later on, investment started to play a dominant role. As a result, TFP (total factor productivity) grew at a very high rate by international comparison. Exports, the other measures of performance we analysed, also grew spectacularly. In contrast to the collapse predicted by experts at the time, there was no collapse of exports after the liberalisation of foreign trade.

Both of the performance variables we selected for analysis improved considerably in this period and became crucial to the Hungarian economy. Consequently, it was perfectly natural to ask what contribution FDI made to this improving performance. We therefore tried to link the rapidly increasing FDI with our two performance indicators.

The close integration of the EU member countries through exports is important, as it constitutes the basis of the common behaviour of these economies. This behaviour is the foundation of many common EU policies. Consequently, close trade links between Hungary and her main trading partners in the EU increase the likelihood that the process of integrating the Hungarian economy with those of the EU will take place smoothly. The question was whether we could demonstrate the presence of a long-term structural link between the Hungarian economy and her leading trading partners in the EU, and whether it was possible to identify the role FDI plays in this. We found that there was indeed a long-term structural link between the Hungarian economy and her key trading partners (Germany, Austria). We identified this link by estimating export equations, and it turned out that FDI was crucial in the relation.

To assist in the interpretation of the long-term export elasticities we uncovered, we set up a simple comparative static model that corresponds well to the nature of the link between the leading countries of EU and Hungary. This model was more flexible than the usual export models, as it allowed the presence of increasing returns and also assumed that FDI flows to Hungary depend on the income conditions in the countries of the EU. We expected that in bad times, due to the increased cost-sensitivity in the

EU, firms in the EU would tend to shift production capacities to applicant countries like Hungary. In this case, income conditions abroad should be negatively related to the FDI flows to Hungary. However, we found that the signs of the long-term export elasticities were not in line with this hypothesis. Instead, they suggested that investment in the EU countries is complementary to investing in the economy of Hungary. This implies that both regions benefit from good times in the EU countries, and that the increase in capital stock in Hungary is not at the expense of a decrease in capital stock in her trading partners in the EU.

We double-checked this finding using another method as well. We set up a vector error correction (VECM) model. This is an approach that has no theoretical priors, so we could jointly consider all the possible Granger-causal relations between the variables of this system. The complementary behaviour of FDI in Hungary and investments in the main partner countries was shown again. Another important aspect of the model's results was that while Hungary's economy had no impact on the industrial performance of Germany, it did have a significant impact on the industrial performance of Austria. It would thus appear that while German policy-makers have no need to pay much attention to what is happening in Hungary, their Austrian counterparts do.

Next we tried to establish the role of FDI in the TFP performance of the country. We first looked at industry data. While this provided us with a number of insights, the limitations of the industry data meant that we had to resort to the analysis of large firm data set. We had to abandon this approach due to data limitations, so we then turned our attention to the analysis of a large firm data set. This allowed us to obtain more reliable results. In order to avoid the mistakes common in the literature, we discussed the methodological problems at length. We had two main concerns. The first was how to uncover the true impact of FDI on the TFP performance of the firm. The second was whether we could identify the relevant channels of technology transfer.

The first problem involved the selection bias of the sample and the endogeneity of the factors of production. In cross-section regressions, FDI was commonly found to be positively associated with the performance of the firm. This is often cited as the justification of a popular theory on FDI by Hymer (1976). However, the empirical part of this kind of literature has hardly controlled for the possibility that the observed positive relations could be a consequence of a selection bias. In our case, this would mean that foreign investors pick firms that are good performers anyway, while they try to avoid poor performers. This behaviour introduces an upward bias in the estimation of the impact of FDI.

Simple OLS regressions suggested that the impact of FDI on the gap between foreign-owned and domestically owned firms was significantly positive, and that it declined progressively over time. However, when we controlled for selection bias and the endogeneity of the factors of production, the results changed considerably. With the exception of the beginning of the period of analysis (1993), it was found that the impact of foreign owner qua foreign ownership on technology was insignificant among both small and large firms. We also observed that simple regressions did indeed overestimate the impact of FDI. Moreover, the results demonstrated that the presence of selection could be a problem in the early stages of transition, and that it disappears later.

In the second part of the firm analysis, we considered the channels of technology transfer that are commonly regarded as important in a country's advancement. We considered the presence of three such "spillovers": learning-by-exporting, importing capital goods and inputs, and the general presence of foreign firms. These are determinants of technology that are different from direct technology transfer by the owner of a firm. We expected the signs of the first two channels to be positive. However, we attached no sign expectation to the impact of the general presence of the FDI. This is because, although it might contribute to the improvement of technology in a firm, it could also increase its unit cost (and reduce TFP) by increasing competition and thereby curtailing the market share of the firms already in the market. In the recent panel literature it was common to find a significant negative impact of an increased presence of foreign firms the performance of the other firms. We found exactly the opposite for large firms in our sample. The large firms seem to benefit greatly from the increasing general presence of foreign firms. In the initial phase of transition (1993-1995), however, small firms suffered. In the latter phase (1996-1998) this impact seemed to have disappeared. Due to the considerable weight of large firms in the production of manufactures, the overall impact turns out to be positive in both periods. The increasing general presence of the foreign firms enhanced the growth rate of TFP by approximately 8 per cent in the first period, and by about 4 per cent in the second period. However, to our surprise, neither of the other two indirect channels of technology transfer proved to have any significant impact on firm performance.

We may therefore conclude that FDI has indeed made an important favourable contribution to the performance of Hungarian economy. It has added considerably to the long-term export performance and was also crucial in the short-term adjustment process. It appears that the contribution of FDI was such that it benefited both the country of the parent firms and the host country. And while the direct impact of FDI on technology transfer by the owner of individual firms was not large, the analysis of indirect channels of technology transfer demonstrated that it was the general presence of foreign firms that was crucial here.

This result can also be regarded as a warning for Hungarian policy-makers. If it is really the general presence of FDI that is the crucial source of technology improvement, then the policy of increasing foreign presence in the economy can no longer be effective for very long. Despite the fact that this policy has been largely beneficial, the weight of the foreign-owned sector cannot really be raised significantly above the already high level where it stands now. Consequently, a careful policy-maker should now search for other methods of improving technology performance in the firm sector, and give more emphasis to alternative policies in the future rather than relying mainly on increasing the role of foreign ownership.

Appendix 3.1: The Partials of the Comparative Static Framework

Under the *first equation* there is no excess demand in the final good-producing sector *(Y)*. It says that supply is matched by demand from the home country and the foreign country. We derived the partials of the normalised equation in the following fashion:

$$G_1 = Y_D + Y_Z^D(P) - Y_Z^S(P, K_{Y0}) = 0$$

$$\frac{\partial Y_Z^D(P)}{\partial P} < 0; \frac{\partial Y_Z^S(P)}{\partial P} > 0 \rightarrow (\text{under decreasing returns});$$
$$\frac{\partial Y_Z^S(P)}{\partial P} < 0 \rightarrow (\text{under increasing returns});$$

$$G_{11} = \frac{\partial G_1(Y_D, P, K_{Y0})}{\partial P} = \frac{\partial Y_Z^D(P)}{\partial P} - \frac{\partial Y_Z^S(P)}{\partial P} < 0 \rightarrow (\text{under decreasing returns})$$

$$G_{11} = \frac{\partial Y_Z^D(P)}{\partial P} - \frac{\partial Y_Z^S(P)}{\partial P} = ? \rightarrow (\text{under increasing returns})$$

$$G_{12} = \frac{\partial G_1(Y_D, P, K_{Y0})}{\partial Y_D} = \frac{\partial Y_Z^S(P)}{\partial P} > 0$$

$$G_{13} = \frac{\partial G_1(Y_D, P, K_{Y0})}{\partial X} = 0$$

$$G_{14} = \frac{\partial G_1(Y_D, P, K_{Y0})}{\partial K_Z} = 0$$

$$G_{15} = \frac{\partial G_1(Y_D, P, K_{Y0})}{\partial \Pi} = 0$$

Explanation of the first equation:

We would like to obtain the partials of the normalised equation with respect to each variable of the model. The final good *(Y)* sector is supplied with immediate input *(Z)* from the home country and it has some capital stock (K_{Y0}). The foreign part of demand for (Y_D) enters the equation with an obvious positive partial with regard to the price ratio *P*. This is because the home country demand for the final good is a negative function of the final product price, and it is a positive function of the price of the product of the home country.

The partials of the supply function of the final good with regard to the input prices should be negative, and they should be positive with regard to own price. The positive relation between own price and supply hinges on decreasing returns to scale. However, when the unit cost is decreasing due to the expansion of production, so do competitive prices. Therefore, if increasing returns are allowed, this makes the supply curve downward-sloping.

It is not only the price of the final good (*Y*), but also the price of the immediate good (*Z*) that plays a role. Demand for the final good is influenced by the profitability of the immediate good-producing sector. We leave consumer considerations out of the system. This is because research shows that it is intermediate products that make up most of Hungary's export growth, and not consumer goods (Éltető, 2001; Freudenberg and Lemoine, 1999). This is quite a common observation around the world (Balassa, 1979).

We treated capital stock in the final good-producing sector of the foreign country as constant (K_{Y0}). The German economy, and German industry in particular, showed very sluggish performance in the sample period covered in the empirical study. This poor performance naturally went together with weak inward investment. We therefore assumed that the stock of capital could not change a great deal and regarded it as constant. Strictly speaking, the cost of capital should appear in every supply function in which input prices play a role. Despite this, one does not observe it in empirical trade equations. In time series there is an obvious reason for this. Its usual proxy, the real interest rate, is mostly stationary, so it cannot be very helpful in explaining the behaviour of a trending series like volume of exports. At this point we introduced a single function G_1 to summarise the relation of the two terms (an excess demand function) and indicated the sign of the partials we assumed for the model.

Under the *second equation*, there is no excess demand in the immediate good-producing sector *(Z)*. This equation represents the demand for exports of the immediate input from the home country by the final good sector in the foreign country. The demand for exports is matched by export supply. It should be recalled that the price of the immediate good is in the denominator of price ratio *P*.

$$Z_D(P\ ) - Z_S(P\ , \mathrm{K}_Z) = 0$$

$$\frac{\partial Z_Z^D(P)}{\partial P} > 0; \frac{\partial Z_Z^S(P)}{\partial P} < 0 \rightarrow (\text{under decreasing returns});$$

$$\frac{\partial Y_Z^S(P)}{\partial P} > 0 \rightarrow (\text{under increasing returns})$$

$$X\ = Z_D(P) = Z_S(P, \mathrm{K}_Z)$$

$$X\ = \frac{1}{2}(Z_D(P) + Z_S(P, \mathrm{K}_Z))$$

$$G_2 = X\ - \frac{1}{2}(Z_D(P) + Z_S(P, \mathrm{K}_Z)) = 0$$

$$G_{21} = \frac{\partial G_2(P, X, K_Z)}{\partial P} = \frac{\partial X}{\partial P} - \frac{\partial \frac{1}{2}(Z_D(P) + Z_S(P, \mathrm{K}_Z))}{\partial P} = ?$$

$$G_{22} = \frac{\partial G_1(P, X, K_Z)}{\partial Y_D} = G_{25} = \frac{\partial G_1(P, X, K_Z)}{\partial \Pi} = 0$$

$$G_{23} = \frac{\partial G_2(P, X, K_Z)}{\partial X} = 1$$

$$G_{24} = \frac{\partial G_1(P, X, K_Z)}{\partial K_Z} < 0$$

Explanation of the second equation:

We now discuss the assumptions of this equation in detail in order to obtain the partials of its normalised equation *(G_2)*. In the normalised equation, the partial of the price of the final good turns out to be ambiguous. This is because price enters the demand function (Z_D) with a positive sign and the supply function (Z_S) with a negative sign. This may seem peculiar at first, but one must be reminded that P is a price ratio, and hence we are now analysing the impact of a price decline in the immediate good (P_Z) or a price rise in the final good (P_Y). Supply is a positive function of the price of the immediate good (in the denominator of P), while it is negative in demand. Hence, in the normalised equation, the partial becomes ambiguous.

Again, we allow the own-price elasticity of supply to be negative and follow a pattern derived from increasing returns to scale. If the price elasticity of the supply of the immediate good *(Z)* is negative, then the partial of G_2 with respect to the price ratio *(P)* becomes ambiguous. If the price elasticity of supply is positive (there are decreasing returns to scale) then the partial becomes negative. Consequently, we did not restrict the sign of this partial.

Total profits in the foreign country *(Π)* will influence the total level of capital in use there *(K)*. Ultimately, the use of capital stock in the home country *(K_Z)* will be determined by the income and profit conditions in the foreign country only *(Π)*. In this context, we assume that the home country firms are capital constrained, which is not an unrealistic assumption (EBRD Report, 1999). Firms in the home country are keen to take in capital inflow at the current cost. Consequently, the amount of capital we observe is a result of flows from abroad and is supply-driven, so the factor demand function does not play a role in determining its level.

We also assumed away taxes, infrastructure bottlenecks, distance, and the costs of transport as determinants of supply and demand. As in the *first equation*, the cost of capital was omitted from the home country. It was assumed that producers of the immediate product are capital constrained.

Under the *third equation*, the total of profits in the foreign country is assumed to be equal to the demand of the economy there.

$$\Pi = Y^D$$

$$G_3 = \Pi - Y^D = 0$$

$$G_{31} = \frac{\partial G_3(Y_D, \Pi)}{\partial P} = G_{33} = \frac{\partial G_3(Y_D, \Pi)}{\partial X} = G_{34} = \frac{\partial G_3(Y_D, \Pi)}{\partial K_Z} = 0$$

$$G_{32} = \frac{\partial G_3(Y_D, \Pi)}{\partial Y_D} = -1$$

$$G_{35} = \frac{\partial G_3(Y_D, \Pi)}{\partial \Pi} = 1$$

Explanation of the third equation:

Our purpose is to obtain the partials of the normalised G_3. We set the demand for the final good *(Y)* in the foreign country to be determined by profits *(Π)*. However, it is safe to assume that Hungarian profits and income make no impact on large economies like Germany, and the variation in the price ratio in trade with Hungary *(P)* is not going to influence the overall profitability of production in Germany *(Π)*.

By assuming away the rest of the economy in the home country (Hungary), we simply indicate that the export sector is not well embedded in the local economy. This is because the most dynamic part of exports is produced with very little domestic value added content.

Under the *fourth equation*, foreign direct investment is driven by income conditions abroad. We have not restricted the partial of the home country capital *(K_Z)* to being positive or negative with regard to foreign profits *(Π)*.

$K_Z = f(\Pi)$

$$\frac{\partial f(\Pi)}{\partial \Pi} = ?$$

$$G_4 = K_Z - f(\Pi) = 0$$

$$G_{41} = \frac{\partial G_4(\Pi)}{\partial P} = G_{42} = \frac{\partial G_4(\Pi)}{\partial Y_D} = G_{43} = \frac{\partial G_4(\Pi)}{\partial X} = G_{44} = \frac{\partial G_4(\Pi)}{\partial K_Z} = 0$$

$$G_{45} = \frac{\partial G_4(\Pi)}{\partial \Pi} = ?$$

Explanation of the fourth equation:

Capital in the two countries can be negatively related. This can happen when some foreign producers substitute away from domestic capital *(K)* and replace it with more of the immediate inputs from the home country *(Z)*. More production in the home country, however, may require more capital, so the level of capital in the two countries may turn out to be negatively related. This problem is important for German and other EU policy-makers, who often believe that the low wage level of the CEE countries is one of the main reasons behind the weak performance of manufacturing in Germany in the past decade. Given the size of the German capital stock and the level of FDI in Hungary, we can safely assume that Hungary cannot influence capital stock and profit conditions in Germany (*K* and *Π*, respectively). This is why we did not make income conditions in Germany dependent on the sector with which Hungary trades.

Nonetheless, it can also happen that large foreign multinationals in the foreign country take investment decisions that increase capital stock in both countries. However, capital stock in the home country *(K_Z)* may increase simply because, *ceteris paribus*, there is more of it available in the foreign country *(K)*. Therefore, the positive relationship can materialise if production in the two countries is linked. More production in the home country means more capital (*K*) in the foreign country, and we also expect it to stimulate larger capacities (K_Z) in the home country. It may be that more FDI flows to Hungary are only the result of more income abroad, but they may also be due to the fact that investments in the two countries are more complementary, rather than substitutes for each other. Nonetheless, there are other reasons why foreign and home investments can be complementary. One might be that investors tend to spread risk across countries.

We should now assume that the partial of the G_4 function with regard to foreign total profit (Π) is ambiguous, and that it is positive with regard to the capital stock in the home country (K_Z). One should also remark that total foreign capital stock is dependent on foreign total profits, but profits do not depend on prices. This is because it was assumed that the part of the income-generating sector with which Hungarian firms are trading is small compared to the total. In addition, it is the supply of and not the demand for capital stock in the home country that determines the capital stock in use.

Appendix 3.2: The Derivation of the Comparative Static Results

One can write up for instance the long-term elasticity of exports with regards to real exchange rate using Cramer's rule as:

$$\frac{dX}{dP} = -\frac{|J_j|}{|J|}$$

where,

$$|J| = \begin{vmatrix} G_{12} & 0 & 0 \\ 0 & G_{23} & G_{24} \\ G_{32} & 0 & G_{34} \end{vmatrix}$$

$$|J_j| = \begin{vmatrix} G_{12} & G_{11} & 0 \\ 0 & G_{21} & G_{24} \\ G_{32} & 0 & G_{34} \end{vmatrix}$$

.

A/ The case of decreasing returns to scale (DRS)

The first determinant can be obtained from the reordering (2.5) and the second by substituting the right vector in it. The starting point was the following:

$$\begin{bmatrix} G_{12} & 0 & 0 \\ 0 & G_{23} & G_{24} \\ G_{32} & 0 & G_{34} \end{bmatrix} \begin{bmatrix} d\Pi \\ dX \\ dK_Z \end{bmatrix} = -\begin{bmatrix} G_{12} \\ G_{21} \\ 0 \end{bmatrix} dP$$

.

In $|J_j|$ the column of the right hand side of the reordered system replaced the column corresponding to the endogenous variables whose comparative static behaviour we are interested in.

Imposing sign restrictions on the results we found that:

$$\frac{dX}{dP} = -\frac{\overset{+}{G}_{12}\overset{?}{G}_{21}\overset{-}{G}_{44} + \overset{-}{G}_{11}\overset{?}{G}_{42}\overset{-}{G}_{24}}{\overset{+}{G}_{23}\overset{+}{G}_{12}\overset{+}{G}_{44}} = ?$$

.

To find the comparative static result for the impact of foreign income on export, we reorganise the system again in the following manner:

$$\begin{bmatrix} G_{11} & 0 & 0 \\ G_{21} & G_{23} & G_{24} \\ 0 & 0 & G_{34} \end{bmatrix} \begin{bmatrix} dP \\ dX \\ dK_Z \end{bmatrix} = -\begin{bmatrix} G_{12} \\ 0 \\ G_{32} \end{bmatrix} d\Pi$$

.

Now the sign becomes:

$$\frac{dX}{d\Pi} = \frac{\overset{+}{G}_{12}\overset{?}{G}_{21}\overset{-}{G}_{44} + \overset{-}{G}_{11}\overset{?}{G}_{42}\overset{-}{G}_{24}}{\overset{+}{G}_{23}\overset{-}{G}_{11}\overset{+}{G}_{44}} = ?$$

.

In order to see how export depends on the capital stock in the export sector of the home country, one should again reorder the system of total differentials:

$$\begin{bmatrix} G_{11} & G_{12} & 0 \\ G_{21} & 0 & G_{23} \\ 0 & G_{32} & 0 \end{bmatrix} \begin{bmatrix} dP \\ d\Pi \\ dX \end{bmatrix} = -\begin{bmatrix} 0 \\ G_{24} \\ G_{34} \end{bmatrix} dK_Z$$

.

Then we find the comparative static to be

$$\frac{dX}{dK_Z} = -\frac{\overset{+}{G}_{12}\overset{?}{G}_{21}\overset{-}{G}_{44} + \overset{-}{G}_{11}\overset{?}{G}_{42}\overset{-}{G}_{24}}{\overset{+}{G}_{23}\overset{-}{G}_{11}\overset{+}{G}_{42}} = ?$$

.

If we reorder the system of total differentials we get:

$$\begin{bmatrix} G_{12} & 0 & 0 \\ 0 & G_{23} & G_{24} \\ G_{32} & 0 & G_{34} \end{bmatrix} \begin{bmatrix} d\Pi \\ dX \\ dK_Z \end{bmatrix} = - \begin{bmatrix} G_{11} \\ G_{21} \\ 0 \end{bmatrix} dP$$

.

and then,

$$\frac{dK_Z}{dP} = \frac{\overset{-}{G_{11}}\overset{+}{G_{44}}}{\overset{+}{G_{12}}\overset{?}{G_{42}}} = ?$$

.

The partial of home capital with respect to total profit in the foreign country can be calculated from:

$$\begin{bmatrix} G_{11} & 0 & 0 \\ G_{21} & G_{23} & G_{24} \\ 0 & 0 & G_{34} \end{bmatrix} \begin{bmatrix} dP \\ dX \\ dK_Z \end{bmatrix} = - \begin{bmatrix} G_{12} \\ 0 \\ G_{32} \end{bmatrix} d\Pi$$

.

Then,

$$\frac{dK_Z}{d\Pi} = - \frac{\overset{?}{G_{42}}}{\overset{+}{G_{44}}} = ?$$

.

To express the link between home country capital and total profit/income in the foreign country one needs to set up (2.5) like this:

$$\begin{bmatrix} G_{12} & 0 & 0 \\ 0 & G_{23} & G_{24} \\ G_{32} & 0 & G_{34} \end{bmatrix} \begin{bmatrix} d\Pi \\ dX \\ dK_Z \end{bmatrix} = - \begin{bmatrix} G_{11} \\ G_{21} \\ 0 \end{bmatrix} dP$$

.

Hence,

$$\frac{d\Pi}{dP} = - \frac{\overset{+}{G_{12}}}{\overset{-}{G_{11}}} > 0$$

.

All the other comparative static results remaining can be obtained as a reciprocal of some of the above results.

A/ The case for decreasing returns to scale (IRS)

Starting form similar system of total differentials as above, which modified to account for IRS, one obtains another set of long term multipliers.

Imposing sign restrictions on the results we found that:

$$\frac{dX}{dP} = -\frac{G_{12}^{+} G_{21}^{?} G_{44}^{-} + G_{11}^{?} G_{42}^{?} G_{24}^{-}}{G_{23}^{+} G_{12}^{+} G_{44}^{+}} = ?$$

$$\frac{dX}{d\Pi} = \frac{G_{12}^{+} G_{21}^{?} G_{44}^{-} + G_{11}^{-} G_{42}^{?} G_{24}^{-}}{G_{23}^{+} G_{11}^{?} G_{44}^{+}} = ?$$

$$\frac{dX}{dK_Z} = -\frac{G_{12}^{+} G_{21}^{?} G_{44}^{-} + G_{11}^{-} G_{42}^{?} G_{24}^{-}}{G_{23}^{+} G_{11}^{?} G_{42}^{+}} = ?$$

$$\frac{dK_Z}{dP} = \frac{G_{11}^{?} G_{44}^{+}}{G_{12}^{+} G_{42}^{?}} = ?$$

$$\frac{dK_Z}{d\Pi_Y} = -\frac{G_{42}^{?}}{G_{44}^{+}} = ?$$

$$\frac{d\Pi_Y}{dP} = -\frac{G_{12}^{+}}{G_{11}^{?}} = ?$$

.

All the other comparative static results remaining can be obtained as a reciprocal of some of the above results.

Appendix 4.1: Summary of the VECM Methodology

Writing an export equation using the set of variables we planned to use would mean the following regression:

$$X = \alpha^* p + \beta^* Y_{D+} \gamma^* K_Z + \varepsilon$$

ε should be a stationary error term if the co-integrating vector (1 -α -β -γ) has been chosen appropriately. This is the single-equation Engle-Granger co-integration approach (Engle and Granger, 1987). This implies that the set of variables in the systematic part provides a proper approach to the economic problem. If the errors are not satisfactory, the system is not co-integrated and the underlying theory may be a flawed description of the economic relation under analysis.

It is possible to choose the wrong set of non-stationary variables to explain the behaviour of a non-stationary variable. A single-equation co-integration means that the variables on the right hand side are the 'cause' and hence the possibility of a spurious regression diminishes. In this case, simple OLS provides true parameter values in what is known as super-consistency. This implies that the parameters in a simple OLS regression converge to the true value of the underlying equilibrium parameters much faster than with stationary data. However, there has to be sufficient evidence that the system is co-integrated. It can be argued that the variables of the system are driven by other unobserved variables in such a way that they remain in equilibrium, and the equation should not be regarded as a causal relationship, but merely as a stable one. Hence, it is useful to check the causality of the variables of the co-integrating relation by VAR before interpreting the parameters. In order to interpret the co-integrating regression as regression, there has to be evidence that right-hand-side variables are causing the dependent variable. The intuition for the VAR to check this is simple: past values of the cause must predict the current values of the consequence well, and the reverse should not be true.

Granger causality makes use of the fact that variation in the cause should precede variation in the result. Hence, it is sensible to use it in combination with the Engle-Granger method. There has been some controversy as to whether the Granger causality tests should be used in levels or differences (Enders, 1995), and specification in differences became the common practice of applied work.

Therefore, the Granger causality test is a VAR with a suitably chosen lag length k, where $W' = (X_P\ Y_D\ K_Z)$ *is:*

$$W_t = A_0 * W_t + A_1 * W_{t-1} + \ldots + A_k * W_{t-k} + \varepsilon_t$$

A variable *m* Granger-causes variable *n* if at least one of *m*'s lagged parameter values is significant in the equation explaining *n*. If no significant lagged parameter value can be found, then this questions the validity of interpreting the co-integrating vector as regression elasticities.

VAR was a starting point to another co-integrating test. Subtracting W_{t-1} on both sides and adding and subtracting $(A_0\text{-}I)*W_{t-2}$ (and this is likewise done with every lag) on the right side, one can write the VAR in a different way that is helpful in explaining the Johansen test of co-integration:

$$dW_t = (A_0 - I) * W_t + A_1 * dW_{t-1} + \ldots + A_k * dW_{t-k} + u_t$$

In a more sophisticated multi-equation version of estimating a co-integrating relation, one can use the Johansen test. What the Johansen test recommends is nothing other than an estimate of a VAR model. After algebraic transformation of an original VAR model, one tests for the singularity of matrix $(A_0\text{-}I)$. This matrix is crucial in determining whether one should regard the error structure of the original VAR as a stationary equilibrium error or not. On both sides of the VAR we have differenced variables, so dW_t can only be stationary if $(A_0\text{-}I)*W_t$ is stationary. Because W_t is a vector of non-stationary variables, this can only happen if the $(A_0\text{-}I)$ has reduced rank.

$(A_0\text{-}I)$ can be written up as a product of the set of error correction parameters and the set of co-integrating vectors. The former shows how fast the variable in question returns to the trend. The rank of that matrix can be determined using its trace or the eigenvalues, and both tests are implemented in time series packages. The appeal of the Johansen test lies in the fact that it assumes that all variables are endogenous, and this makes the Granger causality test superfluous. It also eliminates the possibility of finding co-integrating vectors from different equations that do not match. When a set of variables is co-integrated, their VAR representation must include a set of error correction components that correspond to matrix $(A_0\text{-}I)$ in the Johansen specification. If we already know that the system is co-integrated, the use of vector error correction should be preferred over VARs. In practice, adding a residual series that is probably white noise (or at least stationary) to the VAR may not appear to be a drastic change, but in some cases it can change some of the parameter estimates. (Enders, 1995; Favero, 2001; Hendry, 1995; Alogoskoufis and Smith, 1995).

After obtaining co-integrating vectors using the Engle-Granger or the Johansen methodology, one must construct an error correction term for the model and include it in a VECM specification. However, it should be noted that there are two VECM specifications in use in the literature (Alogoskoufis-Smith, 1995), and the choice of which to use hinges on the method by which one obtained the long-term elasticities that appear in the ECM term.

One methodology starts by estimating an ADL equation for each variable and sums up the significant short-term elasticities. After reordering, the long-term elasticities for the given parameter are then obtained with regard to each of the other parameters. The point is that here current time values of the explanatory variables appear. This implies that after constructing the VECM formulation, current time variables appear on the right hand side, so there is cross-equation correlation (simultaneity) present among them. Hence, simple estimation methods (OLS, SUR) are not applicable. Before estimating the VECM, however, one should reduce the lag length using criterion functions or other methods. Having done this, the model should be estimated using full information maximum likelihood (FIML), or three-stage least squares (3SLS). Then, the researcher may want to consider whether further simplification can be carried out in the model specification to arrive at a parsimonious representation of the system. Essentially, this is the methodology used in Muscatelli, Srinivasan and Vines (1992) and Muscatelli, Stevenson and Mantagna (1995), and its origin is linked to David Hendry. The advantage about this methodology is that it makes it impossible to arrive at more than one set of long-term elasticities. However, this is also its disadvantage. It does not allow other theoretically relevant combinations of long-term elasticities to appear from the data set.

The Johansen approach (which uses a VECM, or VAR augmented with ECMs), on the other hand, allows this. The advantage of this other method is that it only includes lagged variables on the right-hand side, which means there is no contemporaneous correlation across equations. So, simple methods of estimation (OLS, SUR) can be used to estimate the VECM (Alogoskoufis and Smith, 1995). In practice, the Johansen test uses maximum likelihood to obtain the test statistics on the number of co-integrating vectors. It gives us an indication of how many co-integrating vectors to look for when checking the residuals of the equation of the system. Candidates for co-integrating vector are calculated from data of the system. After identifying the co-integrating vectors, one can construct the ECM terms that appear in the VECM specification. The length of the VECM should correspond to the lag length that was chosen optimally when carrying out the Johansen test (the two are equivalent), and care should be taken to include the constant and/or trend depending on the co-integration specification. Then, one may consider using an LR test again to see whether there is a more parsimonious representation of the system than the VAR. If so, then it should be estimated again using the estimator from either maximum likelihood system. OLS is no longer a proper method here, as the variables have very probably become different across equations. Hendry (1995) Enders (1995) demonstrated the use of this method with non-trade data, and obtained structural parameters of their model.

FIML/3SLS makes use of something that was a drawback in the VAR/VECM methodology: the autocorrelated pattern of the input variables of the system. The two procedures are equivalent (consistent, and have the same asymptotic variance-covariance matrix). VARs consume a great many degrees of freedom and do not make use of the autocorrelated pattern of the input series to reduce the degrees of freedom they require. FIML and 3SLS do just the opposite by plugging in the predicted values for every variable gained from an AR estimate (stage 1), and then estimating the reduced form with these predicted variables (stage 2), and evaluating structural parameters if possible (stage 3). It must be remarked that the idea behind FIML/3SLS is very similar to GMM. They make use of the information present in the autocorrelated nature of the input processes and create an instrument to improve the efficiency of the estimates.

The method that starts out by using ADL, and that based on the Johansen test, both use normality of the error structure, which is the single most important problem in practice considering that macroeconomic time series are finite. It is not surprising, then, that the latest applied works published using the new methodology often ignore the problem completely.

There is a problem present in the Johansen test and the Engle-Granger test alike. With both, one can find more than one co-integrating vector, and hence there is more than one stochastic trend as well. It can be very difficult to choose among them. Usually, researchers impose restrictions proposed by theory in this case. Because there is a great deal of arbitrariness involved here, researchers try to avoid this situation by keeping the number of variables in the system to the minimum. The more variables one has, the more likely one is to find multiple co-integrating vectors.

If we have a system of co-integrated variables, this implies that we have a common long-run trend. The system, then, can be described as a combination of long-run behaviour and behaviour that corrects for short-term deviations from the long-term stochastic trend. This long-term component of the error-correction variable of VECM consists of the deviations of the system from the long-run path, and its parameter value shows the speed of adjustment towards it. In a single-equation framework, it must be negative if the variables are co-integrated. In the multi-equation framework, they should correspond to the signs predicted by the long-term elasticities. The parameters of the differences can be regarded as the structural parameters of the variable with respect to the variable explained in the equation. This is something we will utilise in obtaining information on the underlying structural parameters of the model. The comparative static elasticities are too complicated in the model to be able to make inferences about them, so we shall also be compelled to use VECM for this purpose.

Appendix 4.2: The Box-Jenkins Procedure on the Longer Input Series

1. Variables relating to Germany

Remark: All ARIMA parameters are significant at the 5 percent level

Autocorrelation Function of the series of the *differenced log of export*

```
          -1.00      -0.60      -0.20      0.20       0.60       1.00
          |-+---------+---------+----0----+---------+---------+-|
1         |                R   +    |    +                      | -0.36845
2         |                    + R  |    +                      | -0.10517
3         |                    +    |    +  R                   | 0.30148
4         |                  R+     |     +                     | -0.28182
5         |                   +     |     R                     | 0.22044
6         |                   +    R|     +                     | -0.056107
7         |                   +  R  |     +                     | -0.10594
8         |                   +     | R   +                     | 0.098156
9         |                   +     | R   +                     | 0.076535
10        |                   +    R|     +                     | -0.054289
11        |                   +   R |     +                     | -0.097125
          |                   +     |    R+                     | 0.18631
          |                  +   R  |      +                    | -0.10609
14        |                  +   R  |      +                    | -0.13012
15        |                  +      |     R+                    | 0.23318
16        |                  +R     |      +                    | -0.22640
17        |                  +      | R    +                    | 0.083416
18        |                  +      | R    +                    | 0.083419
19        |                  +  R   |      +                    | -0.17364
20        |                  +      |     R+                    | 0.22578
21        |                  +     R|      +                    | -0.051460
22        |                  +   R  |      +                    | -0.11875
23        |                  +      |     R+                    | 0.22103
24        |                  +    R |      +                    | -0.073599
25        |                 +     R |       +                   | -0.097503
          |-+---------+---------+----0----+---------+---------+-|
          -1.00      -0.60      -0.20      0.20       0.60       1.00
```

Partial Autocorrelation Function of the series of the *differenced log of export*

```
          -1.00      -0.60      -0.20      0.20       0.60       1.00
          |-+---------+---------+----0----+---------+---------+-|
1         |                R   +    |    +                      | -0.36845
2         |                  R +    |    +                      | -0.27877
3         |                    +    |    R                      | 0.18720
4         |                    + R  |    +                      | -0.13856
5         |                    +    |    R                      | 0.18242
6         |                    +   R|    +                      | -0.045957
7         |                    +    R    +                      | 0.0017891
8         |                    +  R |    +                      | -0.094419
9         |                    +    |    R                      | 0.20667
10        |                    +    R    +                      | 0.0057712
          |-+---------+---------+----0----+---------+---------+-|
          -1.00      -0.60      -0.20      0.20       0.60       1.00
```

We found: dlexport=-0.92122*dlogexport(-1)-.466936*dlogexport(-2)-.985224*error(-1)+error

Autocorrelation Function of the series of the *differenced log of FDI*

```
         -1.00     -0.60     -0.20      0.20      0.60      1.00
         |-+---------+---------+----0----+---------+---------+-|
1        |                     +    |    +R                    | 0.25405
2        |                     +    |   R+                     | 0.14706
3        |                     +    | R  +                     | 0.087256
4        |                     +    R    +                     | -0.014041
5        |                     +    R    +                     | -0.014729
6        |                     +    |R   +                     | 0.058446
7        |                     +    R    +                     | -0.0019690
8        |                     +    |  R +                     | 0.11845
9        |                     +    R    +                     | 0.015852
10       |                     +    |  R +                     | 0.11988
11       |                     +    |  R +                     | 0.10148
12       |                     +    | R  +                     | 0.064176
13       |                     +    |  R +                     | 0.11688
14       |                     +    | R  +                     | 0.084387
15       |                     + R  |    +                     | -0.12603
16       |                    +  R  |     +                    | -0.12053
17       |                    +  R  |     +                    | -0.13586
18       |                    + R   |     +                    | -0.17680
19       |                    R     |     +                    | -0.25171
20       |                    +R    |     +                    | -0.18374
21       |                    + R   |     +                    | -0.15815
22       |                    +  R  |     +                    | -0.12132
23       |                    +     |R    +                    | 0.022925
         |                    +     R     +                    | 0.0029929
         |-+---------+---------+----0----+---------+---------+-|
         -1.00     -0.60     -0.20      0.20      0.60      1.00
```

Partial Autocorrelation Function of the series of the *differenced log of FDI*

```
-1.00       -0.60     -0.20     0.20      0.60      1.00
         |-+---------+---------+----0----+---------+---------+-|
1        |                     +    |    +R                    | 0.25405
2        |                     +    | R  +                     | 0.088208
3        |                     +    |R   +                     | 0.033163
4        |                     +   R|    +                     | -0.058528
5        |                     +    R    +                     | -0.011801
6        |                     +    | R  +                     | 0.075870
7        |                     +   R|    +                     | -0.025101
8        |                     +    |  R +                     | 0.12002
9        |                     +   R|    +                     | -0.049421
10       |                     +    |  R +                     | 0.11996
         |-+---------+---------+----0----+---------+---------+-|
         -1.00     -0.60     -0.20      0.20      0.60      1.00
```

We found: dlogfdi=-0.25405*dlogfdi(-1)+error

Autocorrelation Function of the series of the differenced *log of real exchange rate*

```
        -1.00     -0.60     -0.20     0.20      0.60      1.00
        |-+---------+---------+----0----+---------+---------+-|
1       |                     +    |    +R                    | 0.25405
2       |                     +    |   R+                     | 0.14706
3       |                     +    | R  +                     | 0.087256
4       |                     +    R    +                     | -0.014041
5       |                     +    R    +                     | -0.014729
6       |                     +    |R   +                     | 0.058446
7       |                     +    R    +                     | -0.0019690
8       |                     +    |  R +                     | 0.11845
9       |                     +    R    +                     | 0.015852
10      |                     +    |  R +                     | 0.11988
11      |                     +    |  R +                     | 0.10148
12      |                     +    | R  +                     | 0.064176
13      |                     +    |  R +                     | 0.11688
14      |                     +    | R  +                     | 0.084387
15      |                     + R  |    +                     | -0.12603
16      |                    +  R  |     +                    | -0.12053
17      |                    +  R  |     +                    | -0.13586
18      |                    + R   |     +                    | -0.17680
19      |                    R     |     +                    | -0.25171
20      |                    +R    |     +                    | -0.18374
21      |                    + R   |     +                    | -0.15815
22      |                    +  R  |     +                    | -0.12132
23      |                    +     |R    +                    | 0.022925
24      |                    +     |R    +                    | 0.047200
25      |                    +     R     +                    | 0.0029929
        |-+---------+---------+----0----+---------+---------+-|
        -1.00     -0.60     -0.20     0.20      0.60      1.00
```

Partial Autocorrelation Function of the series of the differenced *log of real exchange rate*

```
        -1.00     -0.60     -0.20     0.20      0.60      1.00
        |-+---------+---------+----0----+---------+---------+-|
1       |                     +    |    +R                    | 0.25405
2       |                     +    | R  +                     | 0.088208
3       |                     +    |R   +                     | 0.033163
4       |                     +   R|    +                     | -0.058528
5       |                     +    R    +                     | -0.011801
6       |                     +    | R  +                     | 0.075870
7       |                     +   R|    +                     | -0.025101
8       |                     +    |  R +                     | 0.12002
9       |                     +   R|    +                     | -0.049421
10      |                     +    |  R +                     | 0.11996
        |-+---------+---------+----0----+---------+---------+-|
        -1.00     -0.60     -0.20     0.20      0.60      1.00
```

We found: $dlograrf=-0.2812*dlograrf(-1)+error$

Autocorrelation Function of the series of the *differenced log of industrial production*

```
        -1.00     -0.60     -0.20      0.20      0.60      1.00
        |-+---------+---------+----0----+---------+---------+-|
1       |                   R +    |    +                      | -0.26614
2       |                     +  R |    +                      | -0.066018
3       |                     +    |    R                      | 0.20076
4       |                     +    | R  +                      | 0.075837
5       |                     +   R|    +                      | -0.057215
6       |                     +    |  R +                      | 0.13045
7       |                     +    | R  +                      | 0.092328
8       |                     +   R|    +                      | -0.046662
9       |                     +    |R   +                      | 0.026825
10      |                     +    R    +                      | -0.0090417
11      |                     +    R    +                      | 0.016915
12      |                     +    R    +                      | -0.018077
13      |                     +    |  R +                      | 0.12670
14      |                     R    |    +                      | -0.22036
15      |                    +     | R   +                     | 0.081490
16      |                    +    R|     +                     | -0.022187
17      |                    +R    |     +                     | -0.19476
18      |                    +     |R    +                     | 0.049779
19      |                    +     |  R  +                     | 0.13111
20      |                    +R    |     +                     | -0.18219
21      |                    +     |R    +                     | 0.033171
22      |                    +    R|     +                     | -0.043212
23      |                    +    R|     +                     | -0.023471
24      |                    +    R|     +                     | -0.057313
25      |                    +     |R    +                     | 0.022046
        |-+---------+---------+----0----+---------+---------+-|
        -1.00     -0.60     -0.20      0.20      0.60      1.00
```

Partial Autocorrelation Function of the series of the *differenced log of industrial production*

```
        -1.00     -0.60     -0.20      0.20      0.60      1.00
        |-+---------+---------+----0----+---------+---------+-|
1       |                   R +    |    +                      | -0.26614
2       |                     +R   |    +                      | -0.14728
3       |                     +    |   R+                      | 0.15555
4       |                     +    |    R                      | 0.18866
5       |                     +    |R   +                      | 0.054568
6       |                     +    |  R +                      | 0.12230
7       |                     +    |  R +                      | 0.13032
8       |                     +    |R   +                      | 0.024487
9       |                     +    R    +                      | -0.015495
10      |                     +  R |    +                      | -0.099739
        |-+---------+---------+----0----+---------+---------+-|
        -1.00     -0.60     -0.20      0.20      0.60      1.00
```

We found: dlogindprmo=.208073*dlogindprmo(-1)-.225282*dloginprmo(-3)-.455836* dloginprmo(-4)+error

2. Variables relating to Austria

Autocorrelation Function of the series of the *differenced log of export*

```
         -1.00     -0.60     -0.20     0.20      0.60      1.00
         |-+---------+---------+----0----+---------+---------+-|
1        |                R    +    |    +                     | -0.40483
2        |                     +   R|    +                     | -0.046336
3        |                     +    |    R                     | 0.20850
4        |                   R+     |     +                    | -0.27306
5        |                    +     |  R  +                    | 0.10920
6        |                    +     | R   +                    | 0.069010
7        |                    +   R |     +                    | -0.090446
8        |                    +     |R    +                    | 0.028062
9        |                    +     |  R  +                    | 0.13700
10       |                    + R   |     +                    | -0.16747
11       |                    +     | R   +                    | 0.079439
12       |                    +     R     +                    | -0.017815
13       |                    +  R  |     +                    | -0.11589
14       |                    +     | R   +                    | 0.079045
15       |                    +     | R   +                    | 0.085663
16       |                    + R   |     +                    | -0.14945
17       |                    +     |    R+                    | 0.19260
18       |                   +   R  |      +                   | -0.10338
19       |                   + R    |      +                   | -0.21896
20       |                   +      |      R                   | 0.27449
21       |                   +     R|      +                   | -0.040385
22       |                   +    R |      +                   | -0.089495
23       |                   +      |   R  +                   | 0.14200
24       |                   +   R  |      +                   | -0.13696
25       |                   +    R |      +                   | -0.086335
         |-+---------+---------+----0----+---------+---------+-|
         -1.00     -0.60     -0.20     0.20      0.60      1.00
```

Partial Autocorrelation Function of the series of the *differenced log of export*

```
         -1.00     -0.60     -0.20     0.20      0.60      1.00
         |-+---------+---------+----0----+---------+---------+-|
1        |                R    +    |    +                     | -0.40483
2        |                    R+    |    +                     | -0.25143
3        |                     +    |  R +                     | 0.10628
4        |                     +R   |    +                     | -0.17966
5        |                     +   R|    +                     | -0.053144
6        |                     +    |R   +                     | 0.032710
7        |                     +    |R   +                     | 0.028133
8        |                     +   R|    +                     | -0.045587
9        |                     +    |   R+                     | 0.15814
10       |                     +   R|    +                     | -0.024782
         |-+---------+---------+----0----+---------+---------+-|
         -1.00     -0.60     -0.20     0.20      0.60      1.00
```

We found: dlogexport=-0.938073*dlogexport(-1)-.490984*dlogexport(-2)-.972743* error(-1)+error

Autocorrelation Function of the series of the *differenced log of real exchange rate*

```
    -1.00     -0.60     -0.20     0.20      0.60      1.00
    |-+---------+---------+----0----+---------+---------+-|
1   |                     +    |    +  R                  | 0.31658
2   |                     +    | R  +                     | 0.063021
3   |                     +   R|    +                     | -0.048978
4   |                     R    |    +                     | -0.19469
5   |                     +  R |    +                     | -0.073878
6   |                     +    | R  +                     | 0.068893
7   |                     +    |    +R                    | 0.25692
8   |                    +     |    R+                    | 0.21993
9   |                    +     |    R+                    | 0.18103
10  |                    +     |   R +                    | 0.15896
11  |                    +    R|     +                    | -0.040687
12  |                    R     |     +                    | -0.22039
13  |                    + R   |     +                    | -0.16834
14  |                    +     R     +                    | 0.0018515
15  |                    +     | R   +                    | 0.072850
16  |                    +     | R   +                    | 0.077392
17  |                    +     R     +                    | 0.0049595
18  |                    +    R|     +                    | -0.035639
19  |                    + R   |     +                    | -0.17058
20  |                   +  R   |      +                   | -0.14681
21  |                   +  R   |      +                   | -0.16128
22  |                   +R     |      +                   | -0.23826
23  |                   +     R|      +                   | -0.037334
24  |                   +      R      +                   | -0.016590
25  |                   +      | R    +                   | 0.071125
    |-+---------+---------+----0----+---------+---------+-|
    -1.00     -0.60     -0.20     0.20      0.60      1.00
```

Partial Autocorrelation Function of the series of the *differenced log of real exchange rate*

```
    -1.00     -0.60     -0.20     0.20      0.60      1.00
    |-+---------+---------+----0----+---------+---------+-|
1   |                     +    |    +  R                  | 0.31658
2   |                     +   R|    +                     | -0.041344
3   |                     +  R |    +                     | -0.063085
4   |                     +R   |    +                     | -0.17594
5   |                     +    |R   +                     | 0.049023
6   |                     +    | R  +                     | 0.097761
7   |                     +    |   R+                     | 0.22465
8   |                     +    |R   +                     | 0.047195
9   |                     +    | R  +                     | 0.099780
10  |                     +    |  R +                     | 0.12784
    |-+---------+---------+----0----+---------+---------+-|
    -1.00     -0.60     -0.20     0.20      0.60      1.00
```

We found: dlograrf=-0.39647*dlograrf(-1)-.78431* error(-1)+error

Autocorrelation Function of the series of the *differenced log of industrial output*

```
     -1.00     -0.60     -0.20     0.20      0.60      1.00
     |-+---------+---------+----0----+---------+---------+-|
1    |                  R  +    |    +                     | -0.30134
2    |                     + R  |    +                     | -0.13366
3    |                     +    |  R +                     | 0.13611
4    |                     +   R|    +                     | -0.037635
5    |                     +R   |    +                     | -0.17182
6    |                     +    |    +   R                 | 0.34925
7    |                    R     |     +                    | -0.23383
8    |                    +   R |     +                    | -0.065326
9    |                    +     |  R  +                    | 0.10013
10   |                    +  R  |     +                    | -0.11035
11   |                    +   R |     +                    | -0.086145
12   |                    +     |     +   R                | 0.41678
13   |                   +    R |      +                   | -0.096651
14   |                   +  R   |      +                   | -0.16198
15   |                   +      | R    +                   | 0.068994
16   |                   +      |R     +                   | 0.030168
17   |                   +    R |      +                   | -0.069966
18   |                   +      |  R   +                   | 0.12251
19   |                   +   R  |      +                   | -0.12592
20   |                   +    R |      +                   | -0.096133
21   |                   +      | R    +                   | 0.085827
22   |                   +      R      +                   | 0.016494
23   |                   +     R|      +                   | -0.050835
24   |                   +      |   R  +                   | 0.15098
25   |                   +     R|      +                   | -0.047809
     |-+---------+---------+----0----+---------+---------+-|
     -1.00     -0.60     -0.20     0.20      0.60      1.00
```

Partial Autocorrelation Function of the series of the *differenced log of industrial output*

```
     -1.00     -0.60     -0.20     0.20      0.60      1.00
     |-+---------+---------+----0----+---------+---------+-|
1    |                  R  +    |    +                     | -0.30134
2    |                    R+    |    +                     | -0.24689
3    |                     +    R    +                     | 0.013455
4    |                     +    R    +                     | -0.017826
5    |                     R    |    +                     | -0.18373
6    |                     +    |    +R                    | 0.25937
7    |                     + R  |    +                     | -0.11566
8    |                     +  R |    +                     | -0.065981
9    |                     +   R|    +                     | -0.042908
10   |                     + R  |    +                     | -0.14000
     |-+---------+---------+----0----+---------+---------+-|
     -1.00     -0.60     -0.20     0.20      0.60      1.00
```

We found: dlograrf=-0.480333*dlograrf(-1)-.198347* dlograrf (-2)+error

1. Variables relating to Italy

Autocorrelation Function of the series of the differenced *log of export*

```
        -1.00     -0.60     -0.20     0.20      0.60      1.00
        |-+---------+---------+----0----+---------+---------+-|
1       |                R    +    |    +                     | -0.41360
2       |                    +     |R    +                    | 0.028557
3       |                    +   R |     +                    | -0.064836
4       |                    +     |  R  +                    | 0.11875
5       |                    +   R |     +                    | -0.095438
6       |                    +     |  R  +                    | 0.11206
7       |                    + R   |     +                    | -0.17205
8       |                    +     |  R  +                    | 0.11638
9       |                    +     R     +                    | -0.013473
10      |                    +    R|     +                    | -0.051817
11      |                    +     R     +                    | -0.016314
12      |                    +     |R    +                    | 0.030831
13      |                    +    R|     +                    | -0.045944
14      |                    +     |R    +                    | 0.039554
15      |                    +     R     +                    | -0.0015442
16      |                    +  R  |     +                    | -0.10669
17      |                    +     | R   +                    | 0.083747
18      |                    +  R  |     +                    | -0.11312
19      |                    +     R     +                    | 0.0093123
20      |                    +     |  R  +                    | 0.13590
21      |                    +    R|     +                    | -0.052131
22      |                    +  R  |     +                    | -0.13395
23      |                    +     | R   +                    | 0.069053
24      |                    +     R     +                    | 0.013572
25      |                    +    R|     +                    | -0.036827
        |-+---------+---------+----0----+---------+---------+-|
        -1.00     -0.60     -0.20     0.20      0.60      1.00
```

Partial Autocorrelation Function of the series of the *differenced log of export*

```
        -1.00     -0.60     -0.20     0.20      0.60      1.00
        |-+---------+---------+----0----+---------+---------+-|
1       |                R    +    |    +                     | -0.41360
2       |                    R+    |    +                     | -0.17191
3       |                     +R   |    +                     | -0.15178
4       |                     +    |R   +                     | 0.038008
5       |                     +   R|    +                     | -0.039852
6       |                     +    | R  +                     | 0.084863
7       |                     + R  |    +                     | -0.11092
8       |                     +    R    +                     | -0.0051444
9       |                     +    |R   +                     | 0.031545
10      |                     +  R |    +                     | -0.072355
        |-+---------+---------+----0----+---------+---------+-|
        -1.00     -0.60     -0.20     0.20      0.60      1.00
```

We found: dlogexport=-0.497702*dlogexport(-1)-.207513* dlogexport (-2)+error

Autocorrelation Function of the series of the *differenced log of real exchange rate*

```
      -1.00     -0.60     -0.20     0.20      0.60      1.00
      |-+---------+---------+----0----+---------+---------+-|
1     |                     +    |    +    R                | 0.40148
2     |                    +     |   R +                    | 0.14800
3     |                    +     |R    +                    | 0.059259
4     |                    + R   |     +                    | -0.14703
5     |                    R     |     +                    | -0.23204
6     |                    + R   |     +                    | -0.15932
7     |                    +   R |     +                    | -0.091658
8     |                    +  R  |     +                    | -0.11816
9     |                    +     |  R  +                    | 0.12910
10    |                    +     |    R+                    | 0.19234
11    |                    +     |   R +                    | 0.17102
12    |                   +      | R    +                   | 0.077144
13    |                   +      R      +                   | 0.00077579
14    |                   +    R |      +                   | -0.063387
15    |                   +      |R     +                   | 0.027410
16    |                   +      |R     +                   | 0.022825
17    |                   +  R   |      +                   | -0.16918
18    |                   +    R |      +                   | -0.073581
19    |                   +   R  |      +                   | -0.12578
20    |                   +R     |      +                   | -0.24967
21    |                   +     R|      +                   | -0.042524
22    |                   +      R      +                   | -0.0039071
23    |                   +      |R     +                   | 0.025093
24    |                   +      |   R  +                   | 0.14093
25    |                   +      |   R  +                   | 0.17095
      |-+---------+---------+----0----+---------+---------+-|
      -1.00     -0.60     -0.20     0.20      0.60      1.00
```

Partial Autocorrelation Function of the series of the differenced *log of real exchange rate*

```
      -1.00     -0.60     -0.20     0.20      0.60      1.00
      |-+---------+---------+----0----+---------+---------+-|
1     |                     +    |    +    R                | 0.40148
2     |                     +    R    +                     | -0.015726
3     |                     +    R    +                     | 0.0062242
4     |                     R    |    +                     | -0.20392
5     |                     + R  |    +                     | -0.12684
6     |                     +    R    +                     | -0.0046129
7     |                     +    R    +                     | 0.011189
8     |                     + R  |    +                     | -0.10415
9     |                     +    |   R+                     | 0.20989
10    |                     +    |R   +                     | 0.052124
      |-+---------+---------+----0----+---------+---------+-|
      -1.00     -0.60     -0.20     0.20      0.60      1.00
```

We found: dlograrf=0.437615*dlograrf(-1)-.239753*dlograrf (-4)+error

Autocorrelation Function of the series of the differenced *log of industrial production*

```
        -1.00     -0.60     -0.20     0.20      0.60      1.00
        |-+---------+---------+----0----+---------+---------+-|
1       |                 R   +    |    +                     | -0.36340
2       |                     +  R |    +                     | -0.068676
3       |                    +   R |     +                    | -0.076163
4       |                    +     |     + R                  | 0.30088
5       |                    +  R  |     +                    | -0.12504
6       |                    +     R     +                    | -0.0039973
7       |                    + R   |     +                    | -0.16149
8       |                    +     |     +R                   | 0.27803
9       |                    +   R |     +                    | -0.085711
10      |                    +     R     +                    | -0.012197
11      |                    +    R|     +                    | -0.053612
12      |                    +     R     +                    | 0.0088111
13      |                    +     R     +                    | 0.0063153
14      |                    +   R |     +                    | -0.077442
15      |                    +     |  R  +                    | 0.12145
16      |                    +   R |     +                    | -0.099450
17      |                   +    R |      +                   | -0.061251
18      |                   +      |  R   +                   | 0.10700
19      |                   +     R|      +                   | -0.037495
20      |                   +    R |      +                   | -0.066272
21      |                   +     R|      +                   | -0.032681
22      |                   +     R|      +                   | -0.039250
23      |                   +      |   R  +                   | 0.16160
24      |                   +  R   |      +                   | -0.16937
25      |                   +    R |      +                   | -0.088793
        |-+---------+---------+----0----+---------+---------+-|
        -1.00     -0.60     -0.20     0.20      0.60      1.00
```

Partial Autocorrelation Function of the series of the *differenced log of industrial output*

```
        -1.00     -0.60     -0.20     0.20      0.60      1.00
        |-+---------+---------+----0----+---------+---------+-|
1       |                 R   +    |    +                     | -0.36340
2       |                    R+    |    +                     | -0.23128
3       |                    R+    |    +                     | -0.23243
4       |                     +    |    R                     | 0.19972
5       |                     +    | R  +                     | 0.073510
6       |                     +    | R  +                     | 0.066369
7       |                     +R   |    +                     | -0.15654
8       |                     +    | R  +                     | 0.098147
9       |                     +    |R   +                     | 0.045456
10      |                     +    |R   +                     | 0.036891
        |-+---------+---------+----0----+---------+---------+-|
        -1.00     -0.60     -0.20     0.20      0.60      1.00
```

We found: dlogindprmo=-0.483082*dlogindprmo(-1)-.313697*dlogindprmo(-2)-.216258*dlogindprmo(-3)+error

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Appendix 4.3: The Analysis of the Nominator of the Comparative Static Multipliers

We know from *Appendix 3.1* that *A* has the following form:

$$G_{12}^{+}G_{21}^{?}G_{44}^{+} + G_{11}^{-}G_{42}^{?}G_{24}^{-}$$
$$G_{12}^{+}G_{21}^{?}G_{44}^{+} + G_{11}^{?}G_{42}^{?}G_{24}^{-}$$

under decreasing (DRS) and increasing returns to scale (IRS), respectively.

Table 4.3.1 The implications of the sign of term A

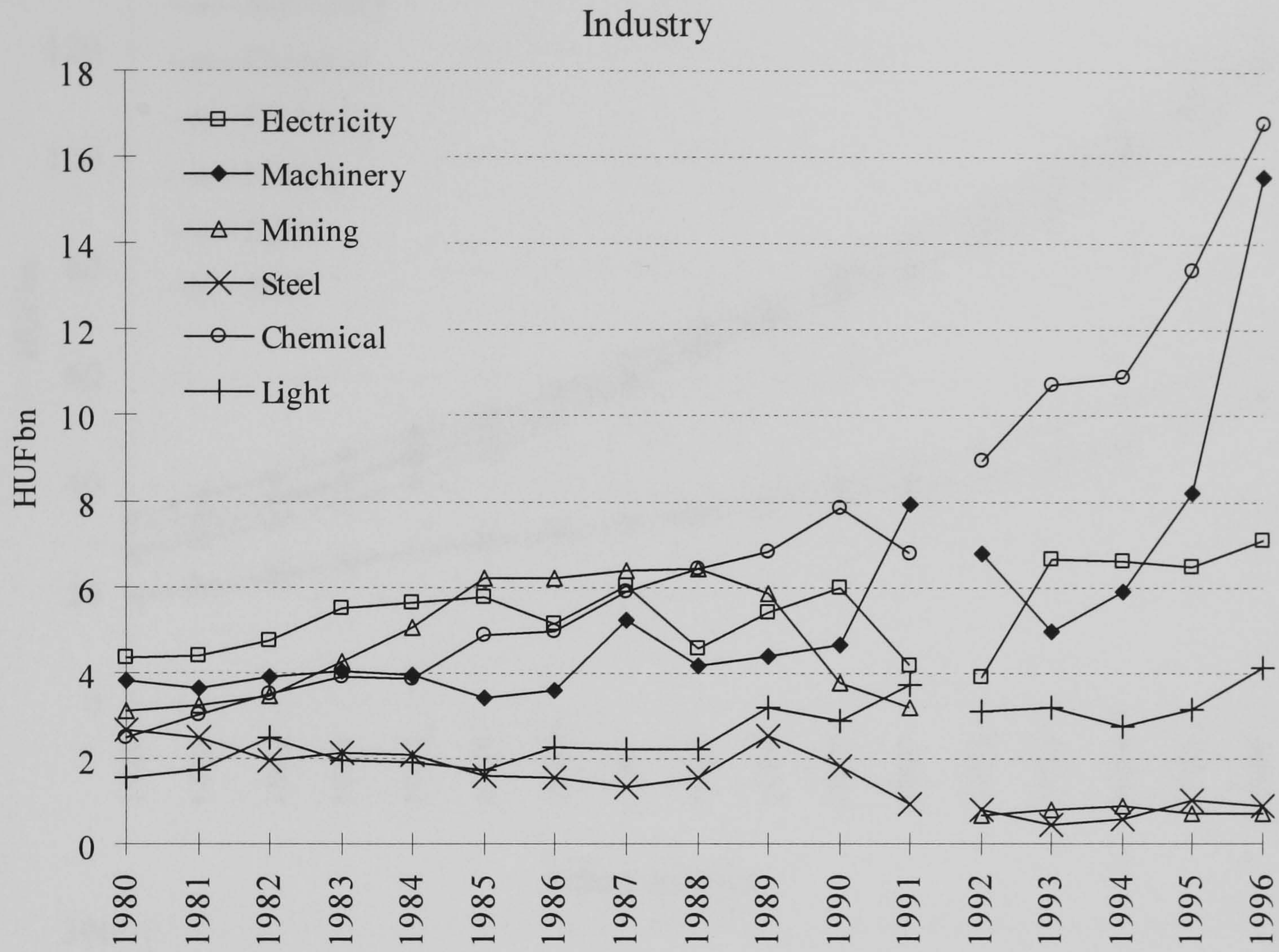
	A>0	**A<0**
DRS	*1. G_{21} <0 (always true)* *2. G_{42}* must be large in the presence of given small G_{11} and G_{42}, or the other way round.	*1. G_{21} <0 (always true)* *2. G_{42}* must be small in the presence of given large G_{11} and G_{42}, or the other way round.
IRS	*1.G_{21} <0* and G_{11}>0 *(always true)* *2.G_{21} <0* and must be *large for given* G_{11}<0, or the other way round *3.G_{21} >0* and *large for given G_{11}*>0, or the other way round	*1.G_{21} >0* and G_{11}<0 *(always true)* *2.G_{21} >0* and must be *large for given* G_{11}>0, or the other way round *3.G_{21} <0* and *large for given G_{11}*<0, or the other way round

Remark: G_{11} - the difference (DRS) or sum (IRS) of supply and demand price elasticities of the foreign final goods production; G_{21} - the difference (IRS) or sum (DRS) of supply and demand price elasticities of the home country's input production; G_{42} - elasticity of FDI flows to with regard to foreign investment and demand conditions;

One could simplify the interpretation of *A* using the empirical findings in *Table 3.12* by making use of information on the sign of G_{11}, and G_{42}. We also know that G_{12}=1 and $G_{44} = 1$. The implication for the elasticities of the model can be summarised in *Table 3.13*. One can see that the analysis of A did not result in any robust conclusions.

Appendix 5.1: The Input Data of the Growth Accounting Exercise

Figure 5.1.1. Investment by industries, in 1980 terms



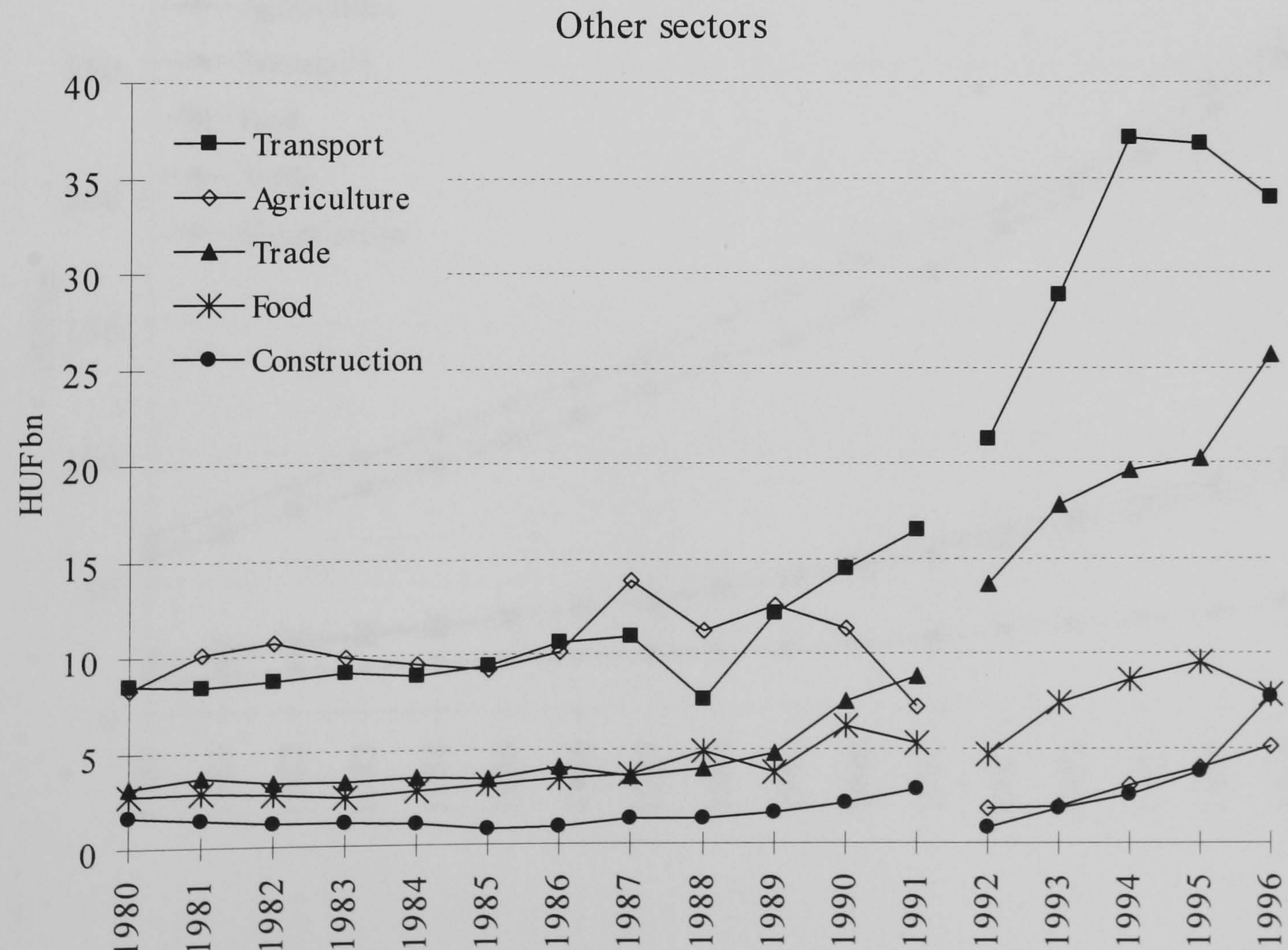


Figure 5.1.2. The stock of fixed capital in 1980 terms assuming no loss of capital

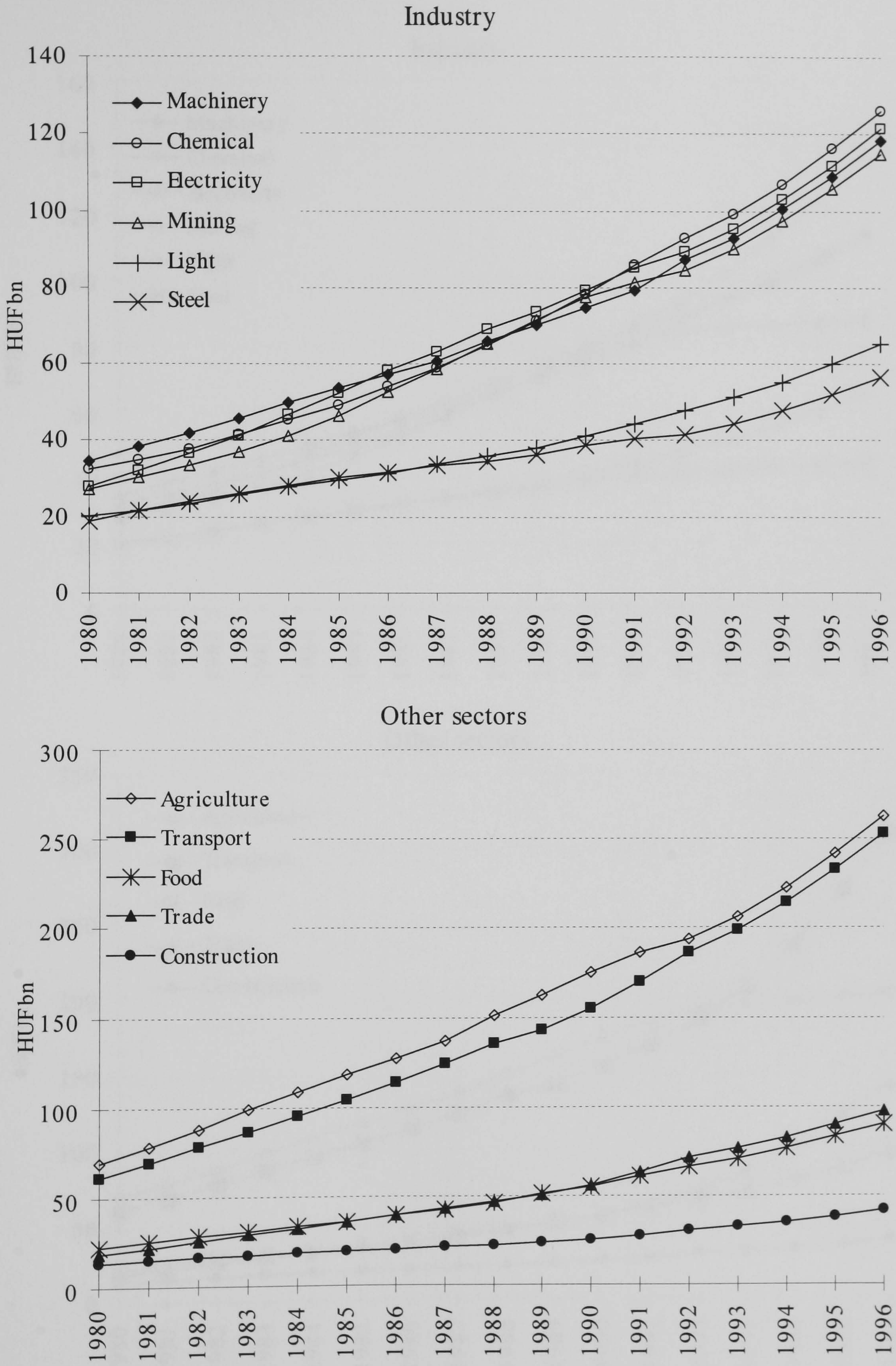
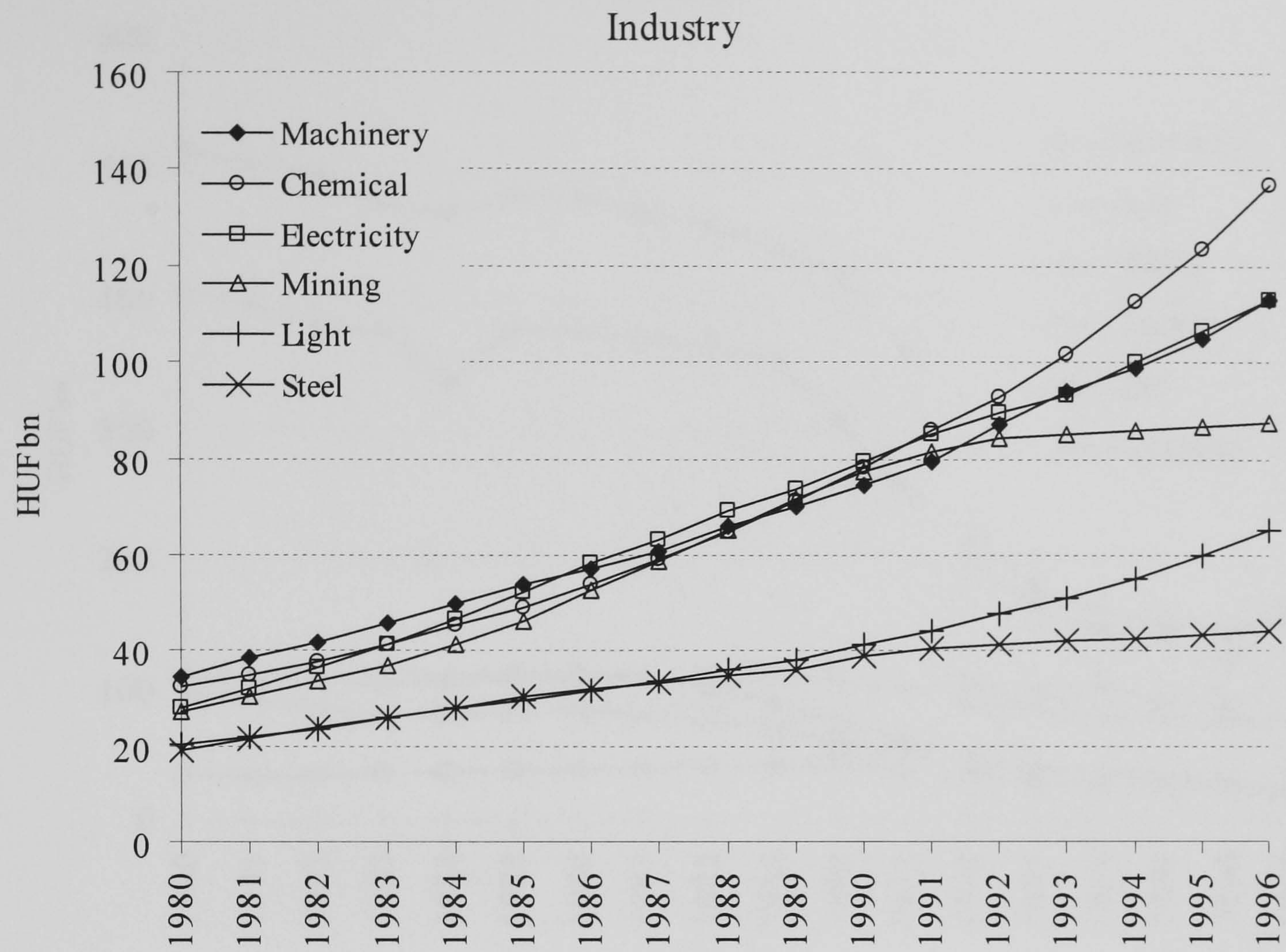


Figure 5.1.3. The stock of fixed capital in 1980 terms assuming a one-third loss over three years from 1989



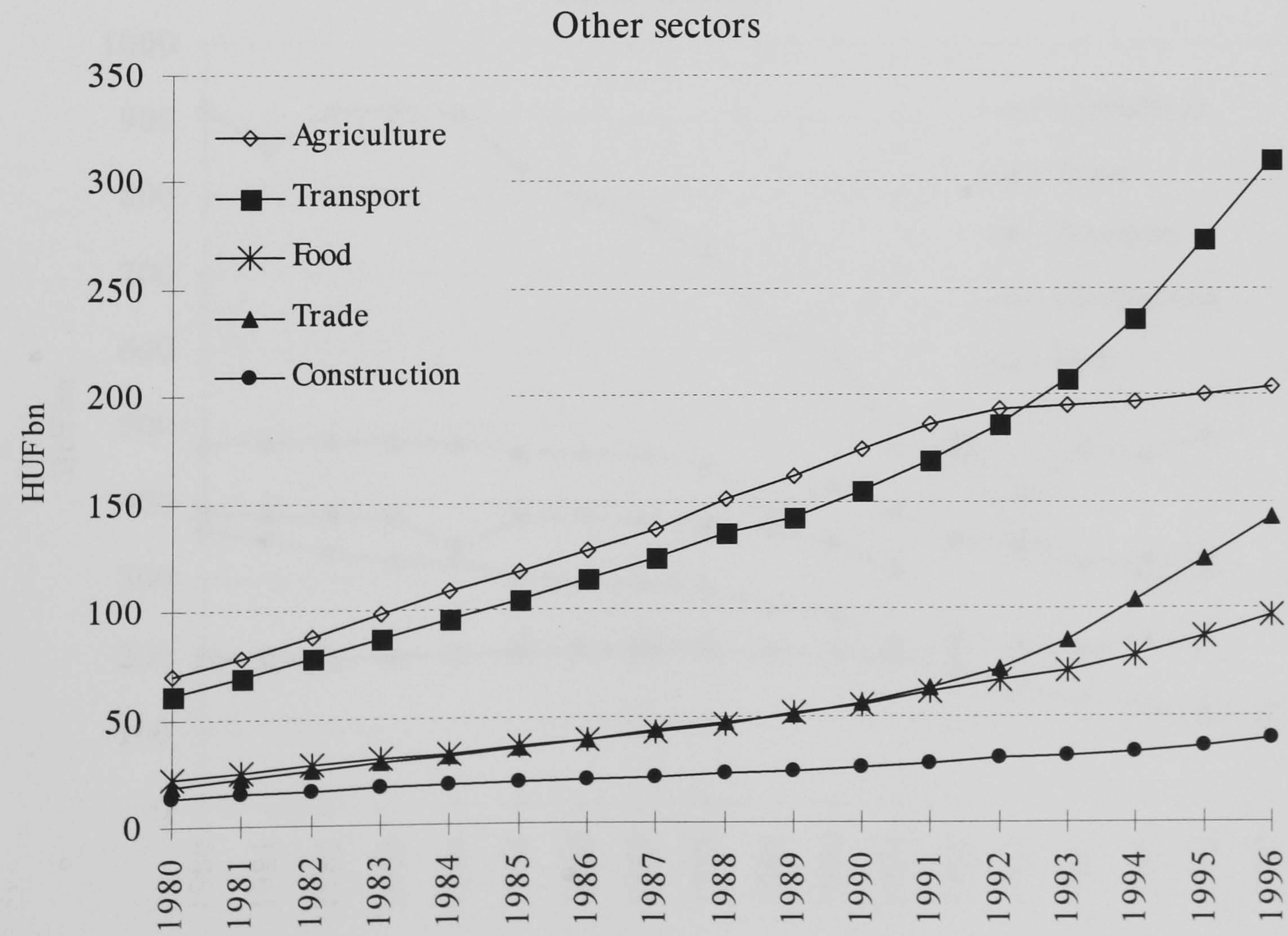


Figure 5.1.4. Number of employed, in thousands

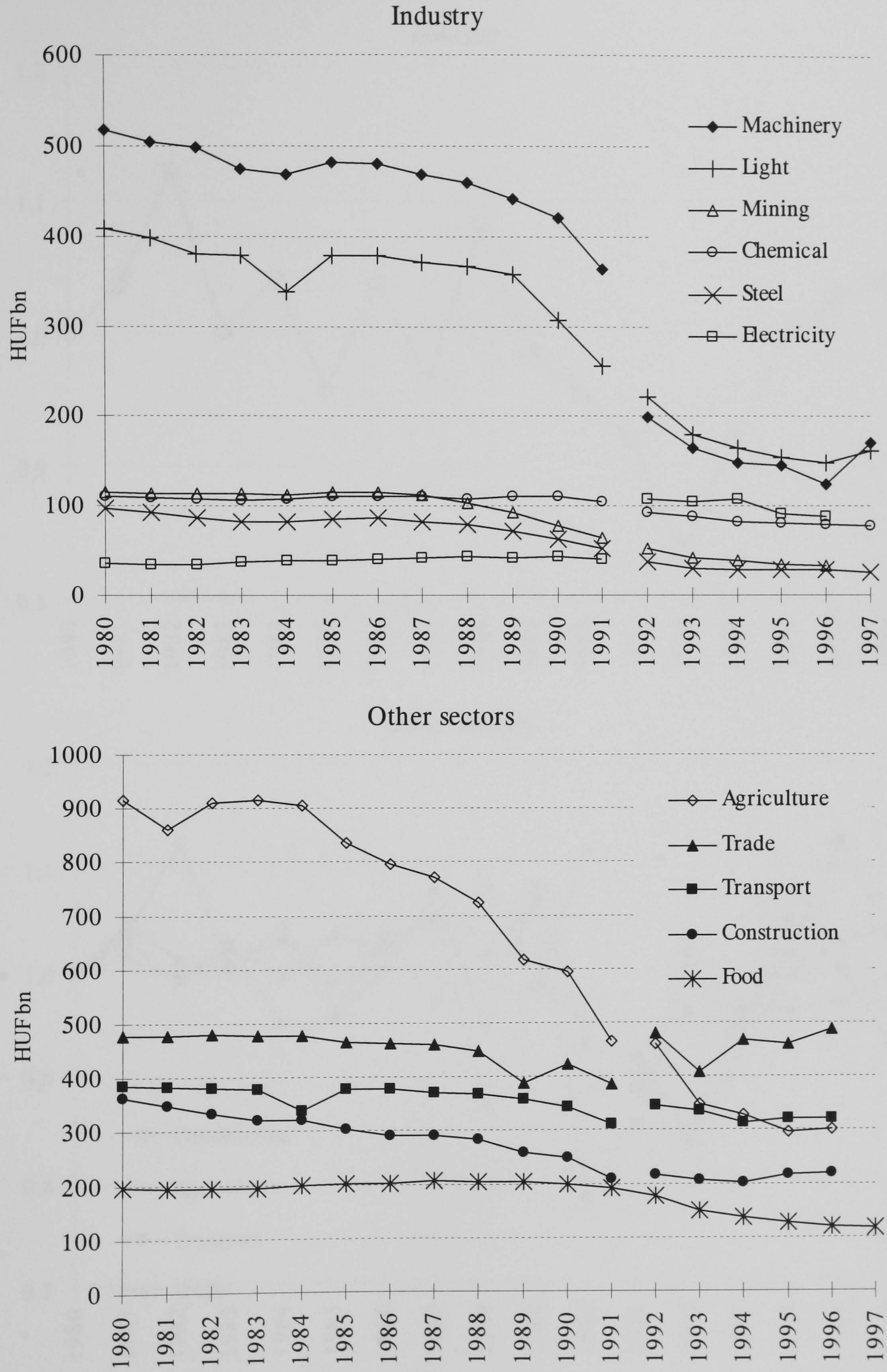


Figure 5.1.5. Volume index of value added, 1980 = 1

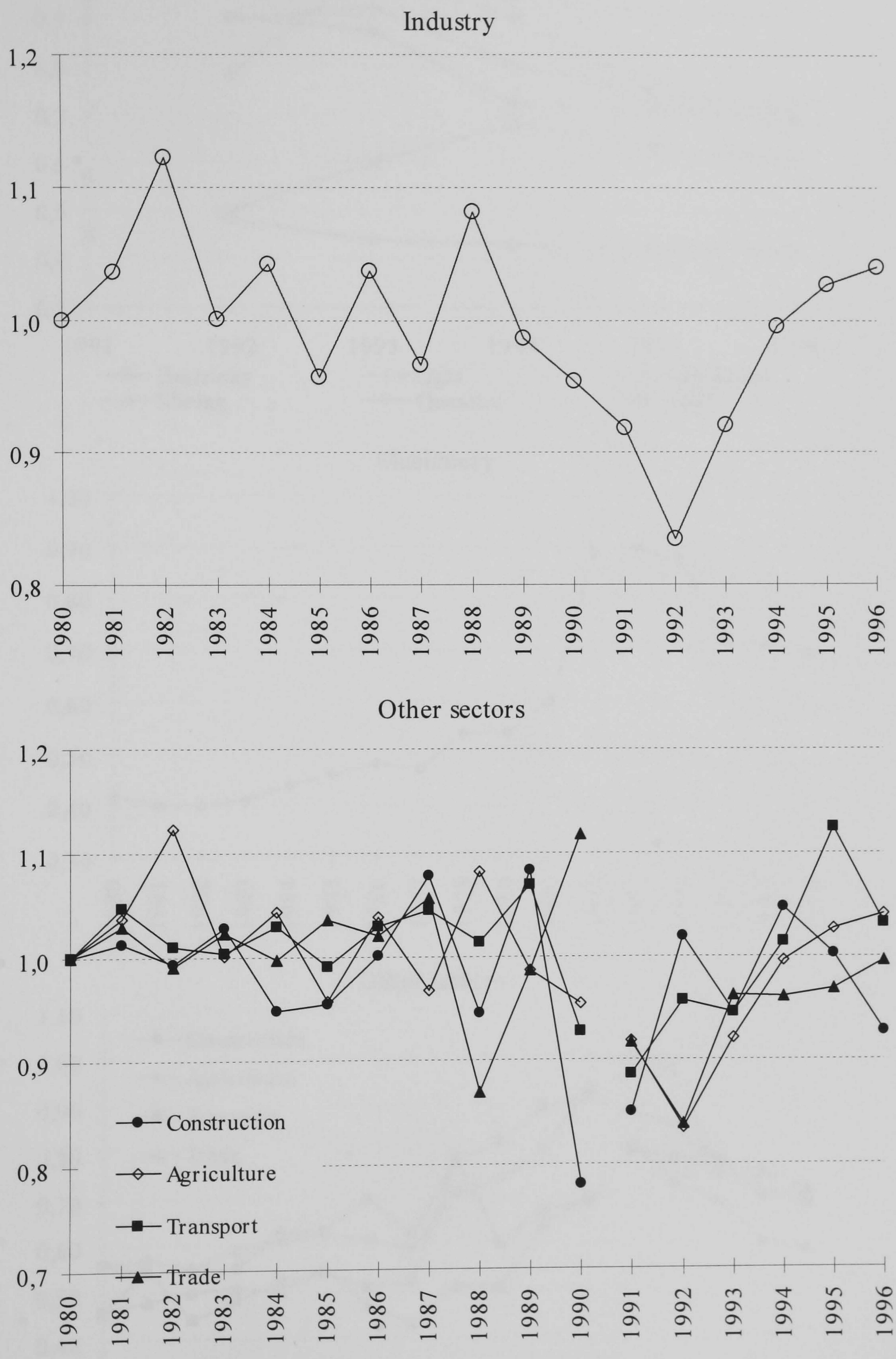


Figure 5.1.6. Share of labour in total income

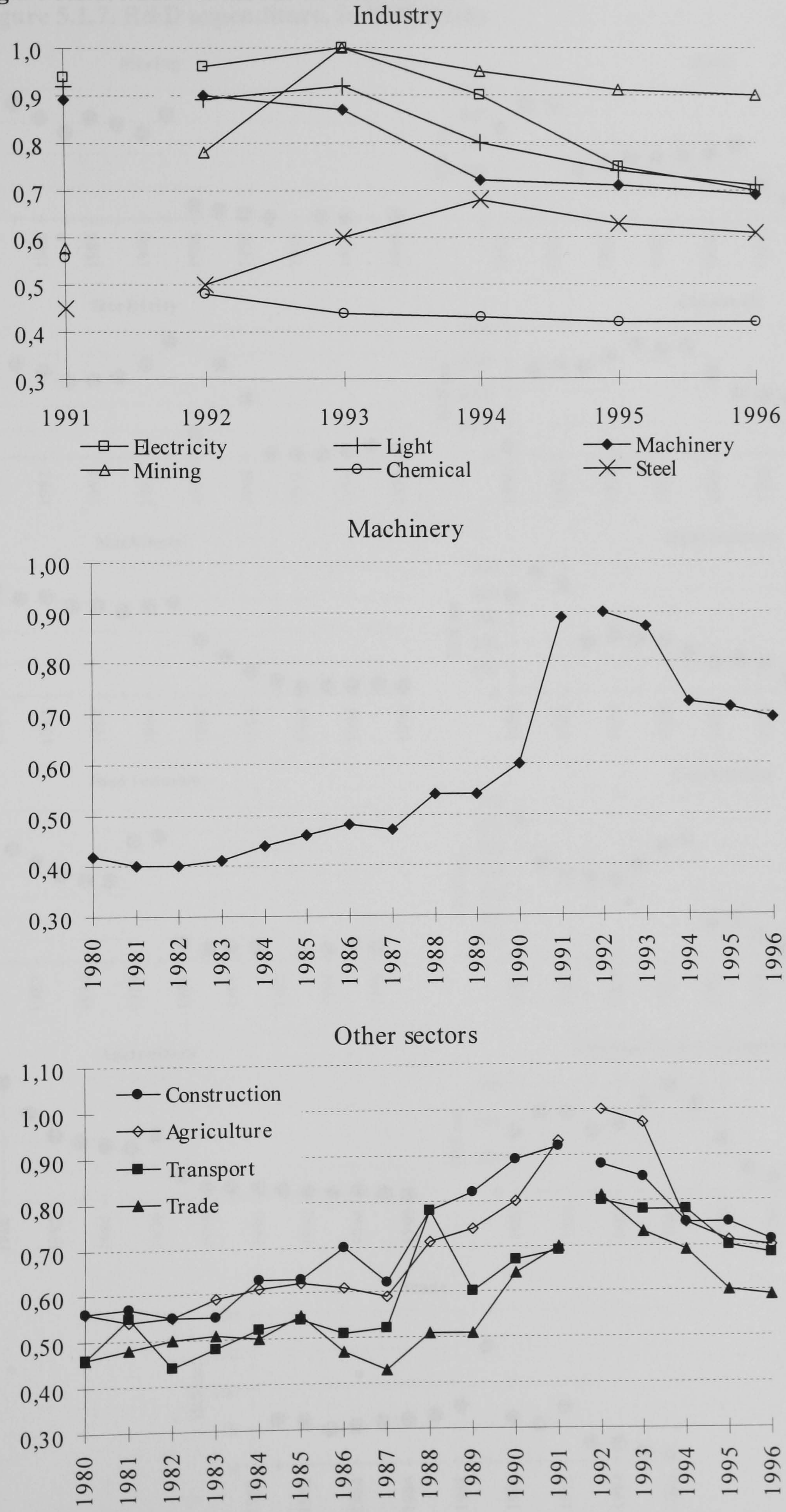


Figure 5.1.7. R&D expenditure, in 1980 terms

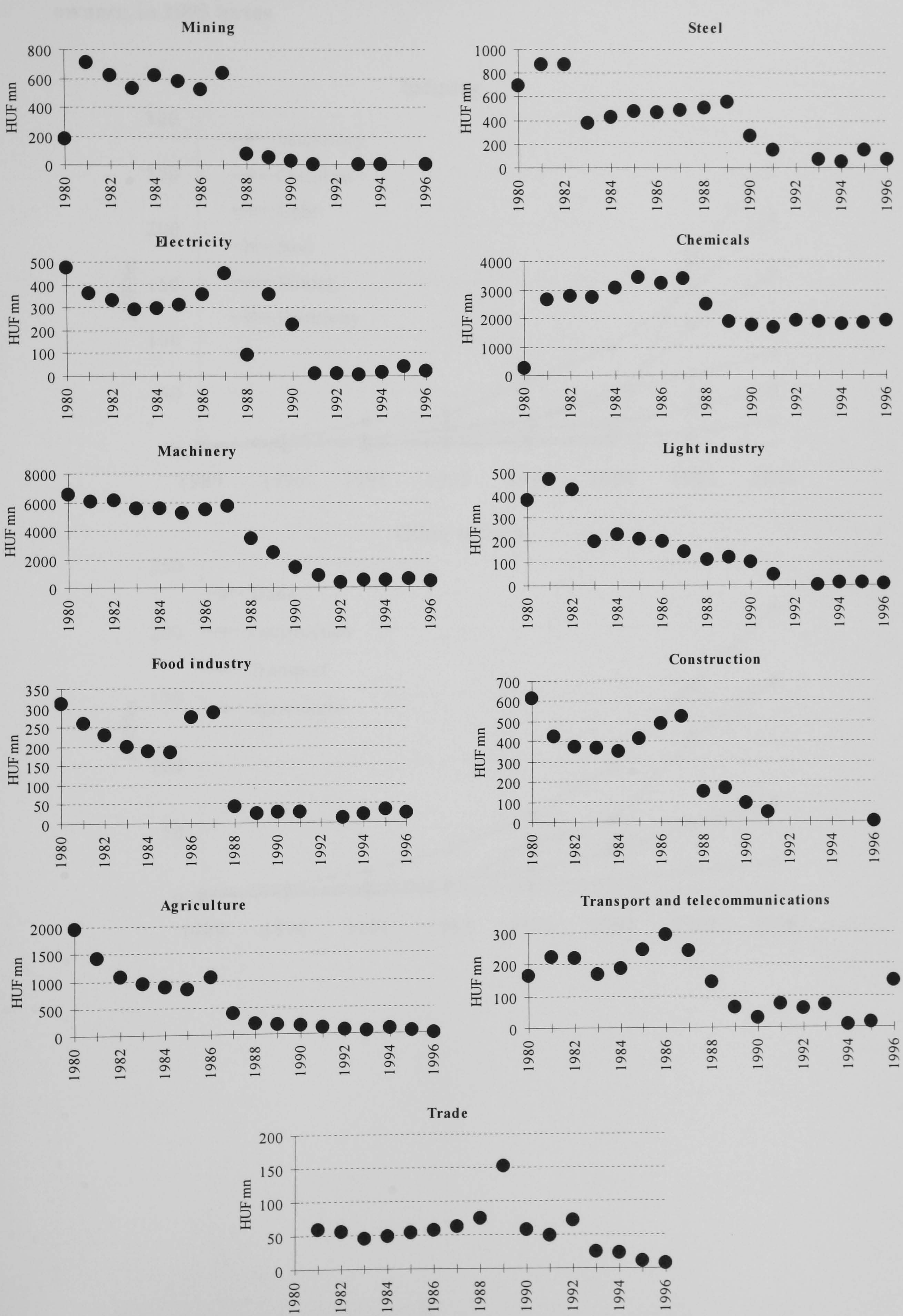
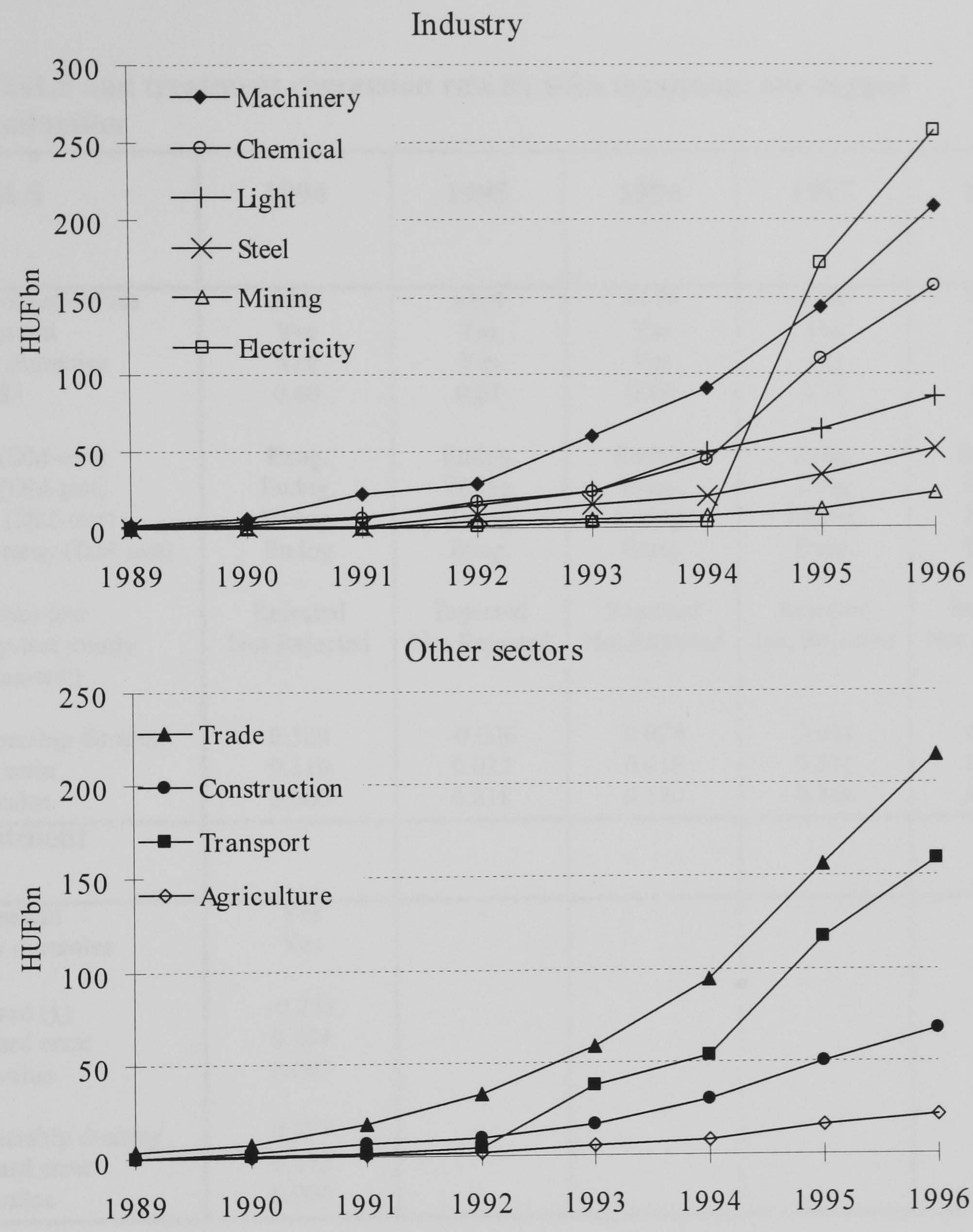


Figure 5.1.8. The stock of foreign capital invested in firms with foreign owners, in 1995 terms



Appendix 7.1: 2SLS and Treatment Results Obtained with Firms of All Sizes

Table 7.1.1. 2SLS and treatment regression results with maximum one-lagged factors of production

2SLS	1994	1995	1996	1997	1998
Number of observations	5444	4354	4176	4076	4002
Constant	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
R^2	0.60	0.61	0.69	0.71	0.69
Capital.(DM-test)	Exog.	Endog.	Endog.	Exog.	Endog.
Labour (DM-test)	Endog.	Endog.	Exog.	Exog	Exog.
Material.(DM-test)	Endog.	Endog.	Endog.	Endog.	Exog.
Ownership dummy (DM-test)	Endog	Exog.	Exog.	Exog.	Exog.
Hausman-test	Rejected	Rejected	Rejected	Rejected	Rejected
Exogeneity-test jointly (Sargan-test)	Not Rejected	Not Rejected	Not Rejected	Not Rejected	Not Rejected
Foreign ownership dummy	0.529	-0.006	0.024	0.014	0.027
St. error	0.119	0.022	0.015	0.012	0.013
p-value	0.000	0.818	0.120	0.246	0.039
Treatment					
Constant	Yes	-	-	-	-
Industry dummies	Yes				
Hazard (λ)	-0.251				
Standard error	0.084				
p-value	0.003				
Foreign ownership dummy	0.577				
Standard error	0.152				
p-value	0.000				

Table 7.1.2. 2SLS results with maximum twice-lagged factors of production

2SLS	1994	1995	1996	1997	1998
Number of observations	-	3923	3823	3818	3667
Constant		Yes	Yes	Yes	Yes
Industry dummies		Yes	Yes	Yes	Yes
R^2		0.63	0.69	0.70	0.69
Capital.(DM-test)		Endog.	Endog.	Exog.	Endog.
Labour (DM-test)		Exog.	Endog.	Exog.	Exog.
Material.(DM-test)		Endog.	Endog.	Endog.	Exog
Ownership dummy (DM-test)		Exog.	Exog.	Exog.	Exog.
Hausman-test		Rejected	Rejected	Rejected	Rejected
Exogeneity-test jointly (Sargan-test)		Rejected	Rejected	Rejected	Rejected
Foreign ownership dummy		0.003	0.023	0.014	0.029
St. error		0.019	0.016	0.011	0.013
p-value		0.881	0.152	0.215	0.048
Treatment					
Constant	-	-	-	-	-
Industry dummies					
Hazard (λ)					
Standard error					
p-value					
Foreign ownership dummy					
Standard error					
p-value					

Appendix 7.2: 2SLS and Treatment Results under an Alternative Specification

This appendix contains results obtained when the initial set of instruments contains twice-lagged variables as potential instruments.

Table 7.2.1. 2SLS and treatment regression results with large firms

2SLS	1994	1995	1996	1997	1998
Number of observations	-	534	490	486	467
Constant		Yes	Yes	Yes	Yes
Industry dummies		Yes	Yes	Yes	Yes
R^2		0.57	0.69	0.70	0.87
Capital.(DM-test)		Endog.	Exog.	Exog.	Exog.
Labour (DM-test)		Exog.	Exog.	Endog.	Exog.
Material.(DM-test)		Exog.	Exog.	Exog.	Exog.
Ownership dummy (DM-test)		Endog.	Exog.	Exog.	Endog.
Hausman-test		Rejected	Rejected	Rejected	Not Rejected
Exogeneity-test jointly (Sargan-test)		Rejected	Not Rejected	Rejected	Not Rejected
Foreign ownership dummy		0.213	0.047(OLS!)	-0.011	0.028 (OLS!)
St. error		0.090	0.018	0.015	0.012
p-value		0.018	0.013	0.510	0.014
Treatment					
Constant	-	Yes	-		
Industry dummies		Yes			
Hazard (λ)		-0.093			
Standard error		0.045			
p-value		0.037			
Foreign ownership dummy		0.178			
Standard error		0.075			
p-value		0.017			

Table 7.2.2. 2SLS results with small firms

2SLS	1994	1995	1996	1997	1998
Number of observations	-	3389	3333	3332	3242
Constant		Yes	Yes	Yes	Yes
Industry dummies		Yes	Yes	Yes	Yes
R^2		0.64	0.72	0.69	0.67
Capital.(DM-test)		Endog.	Endog.	Exog.	Endog.
Labour (DM-test)		Endog.	Endog.	Exog.	Exog.
Material.(DM-test)		Endog	Endog.	Endog.	Exog.
Ownership dummy (DM-test)		Exog.	Exog.	Exog.	Exog.
Hausman-test		Rejected	Rejected	Rejected	Rejected
Exogeneity-test jointly (Sargan-test)		Rejected	Rejected	Rejected	Rejected
Foreign own. dummy		-0.007	0.018	0.169	0.032
St. error		0.025	0.019	0.016	0.016
p-value		0.784	0.349	0.281	0.079
Treatment					
Constant	-	-	-	-	-
Industry dummies					
Hazard (λ)					
Standard error					
p-value					
Ownership dummy					
Standard error					
p-value					

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