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**Working Paper**

## Explaining Investment Trends in European Union Countries

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**Explaining Investment Trends  
in European Union Countries**

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**Diskussionspapiere**  
*Discussion Papers*

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**Abstract.** In the 1980s and, in particular, in the 1990s the countries of the European Union experienced divergent developments of gross fixed capital formation. Estimating an investment function for a panel of ten countries and analyzing the paths of the determinants of investment in the countries under consideration reveals that differences in final demand are the main driving factors of the divergences in investment. Other factors are disparities in the decline of real interest rates and of relative prices for capital goods.

## 1 Introduction

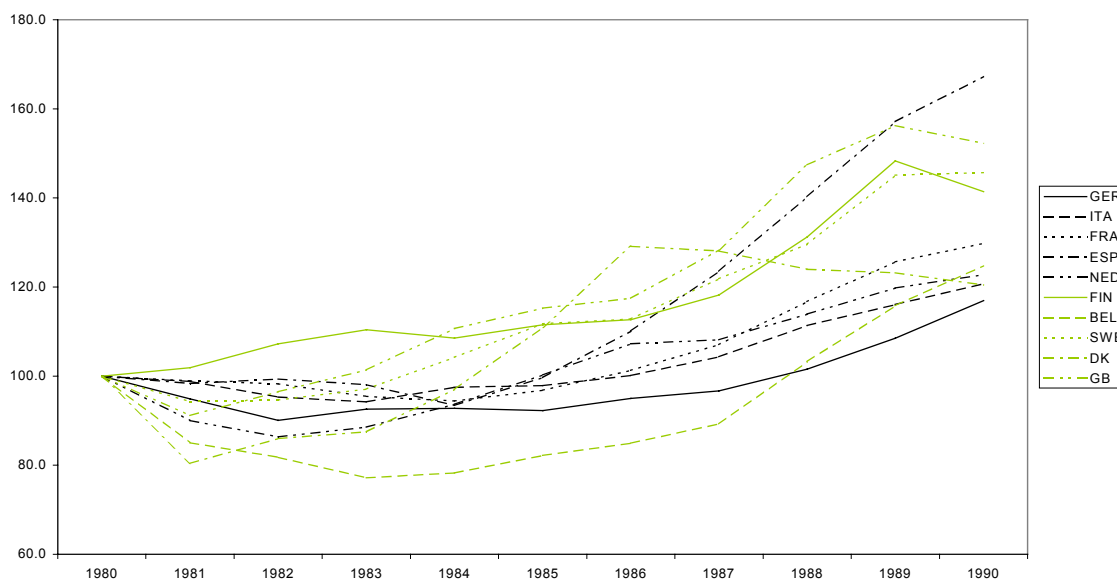
Investment constitutes an important macroeconomic aggregate. Analyzing and explaining business investment is important as capital formation not only exerts a demand effect but also a capacity effect. Therefore, an increase in investment not only raises demand in the same period, but it also enhances the capital stock, thereby creating a foundation for future growth. Countries in which investment remains sluggish over a prolonged period of time face the problem that due to the lack in capital accumulation the future growth potential is endangered. In the short run, gross fixed capital formation determines to a large extent business cycle dynamics. Capital formation exhibits a procyclical behavior, and its volatility is larger than the volatility of total GDP. In the 1980s and, in particular, in the 1990s the countries of the European Union experienced divergent developments of gross fixed capital formation. The aim of this paper is to identify forces behind these deviating investment paths. Possible explanatory factors comprise differences in final demand as well as the convergence of interest rates, in particular among the countries participating in the European Economic and Monetary Union (EMU).

The paper is organized as follows. In section 2 the development of gross fixed capital formation and of investment in machinery and equipment in ten European Union countries over the period 1980 to 2001 is investigated. Section 3 provides an overview of investment theories in order to identify factors relevant for the divergent development of investment in the countries under consideration. In section 4 the results of an econometric estimation of an investment function for the panel of EU countries are presented together with an analysis of the paths of the determinants identified in the section on investment theories and in the econometric estimation. Section 5 concludes.

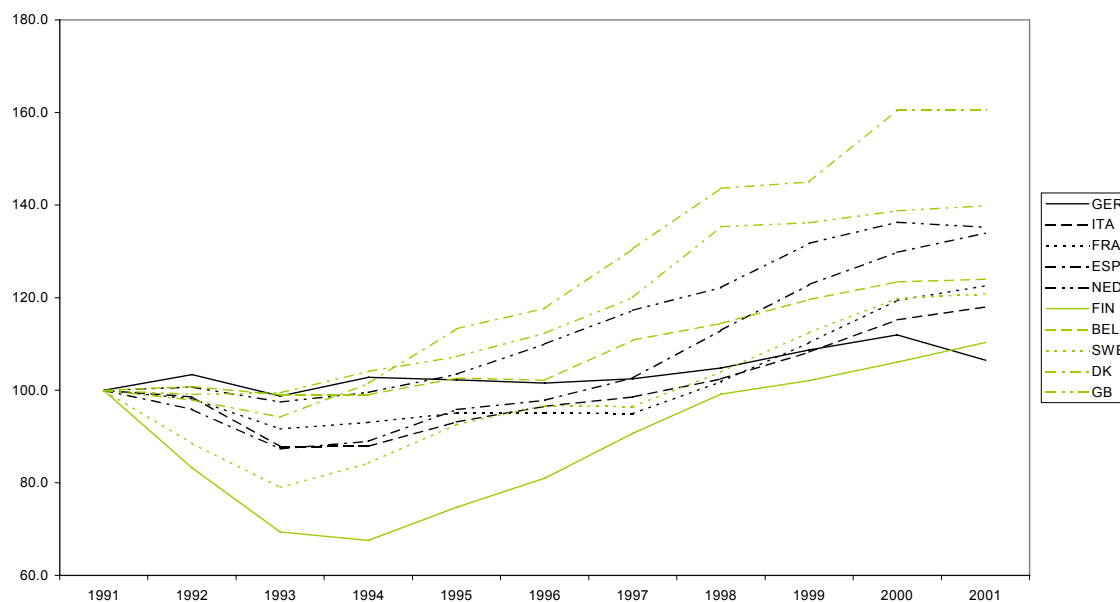
## 2 Development of Investment in EU Countries

In this section the development of total gross fixed capital formation and of investment in machinery and equipment in selected European Union countries is shown. The selected countries are those for which quarterly national accounts data from 1980 onwards are available. These are Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Spain, Sweden, and the United Kingdom. For Germany, data until 1990 are for the western part, while from 1991 onwards they cover the unified Germany. Figures 1 and 2 show the development of total gross fixed capital formation in the EU countries. Both figures depict indices with 1980 and 1991, respectively, as the base years. Figures 3 and 4 show the development of investment in machinery and equipment. All data are measured in constant 1995 prices. Disaggregated investment data are not available for Belgium. For the Netherlands, the data begin in 1987 and were therefore included in figure 4 only. It can be seen that in the 1990s, on average, growth of capital formation in the countries under consideration was lower than in the preceding decade. Exceptions are total investment in Denmark and the Netherlands as well as investment in machinery and equipment in Italy and the UK. In the period 1991 to 2001 the lowest growth rates of fixed capital formation could be observed in Finland and Germany. Germany also exhibited sluggish investment in the 1980s, whereas in Finland capital formation grew at high rates in this decade. In the 1990s, investment expansion was exceptionally high in Denmark. In addition, investment in machinery and equipment increased comparatively fast in Spain and, to a lesser extent, in France.

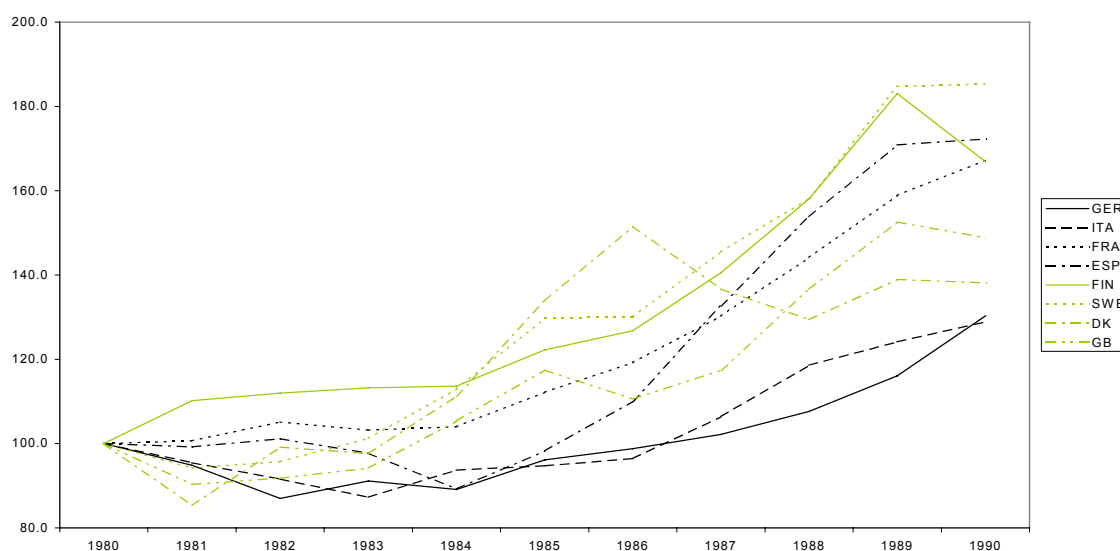
**Figure 1** Gross fixed capital formation in selected EU countries in the period 1980 to 1990 (index; 1980 = 100)



**Figure 2** Gross fixed capital formation in selected EU countries in the period 1991 to 2001 (index; 1991 = 100)



**Figure 3** Investment in machinery and equipment in selected EU countries in the period 1980 to 1990 (index; 1980 = 100)



**Figure 4** Investment in machinery and equipment in selected EU countries in the period 1991 to 2001 (index; 1991 = 100)



Over the period 1980 to 1990, total gross fixed capital formation increased by 72 percent in Spain, but only by 17 percent in Germany. The growth rates of investment in machinery and equipment varied between 85 percent in Sweden and 30 percent in Germany and Italy. In the period 1991 to 2001, total fixed capital formation was expanded by 61 percent in Denmark, compared to 6 percent in Finland. The highest total growth rate of investment in machinery and equipment was 84 percent in the UK, while the lowest growth rate of 8 percent was recorded in Germany.

As the intention of this paper is to explain the differences in the development of fixed capital formation in the European Union the determinants of investment have to be known. Therefore, in the following section investment theories are reviewed in order to identify the factors relevant for firm's investment decisions.

### 3 Investment Theories

An overview of investment theories and their empirical applications may be found in Chirinko (1993). In this section, the accelerator hypothesis, theories focusing on the profitability of investment projects, and the neoclassical model of investment are discussed.

The accelerator hypothesis states a monocausal relationship between investment and the change in demand. The optimal capital stock is proportional to output:

$$(1) \quad K_t^* = \alpha Y_t$$

In (1),  $K^*$  denotes the optimal capital stock, and  $Y$  denotes total demand, both in period  $t$ . Net investment  $I_t$  is equal to the change in the capital stock. It is undertaken to adjust the actual to the optimal capital stock. If in period  $t$  only a fraction  $w$  of the difference between the actual and the optimal capital stock is eliminated, this gives rise to the following expression:

$$(2) \quad I_t = K_t - K_{t-1} = w (K_t^* - K_{t-1})$$

Combining (1) and (2) gives:

$$(3) \quad K_t = w\alpha Y_t + (1-w) K_{t-1}$$

Lagging expression (3) by one period results in:

$$(4) \quad K_{t-1} = w\alpha Y_{t-1} + (1-w) K_{t-2}$$

Taking the definition of net investment as the change in the capital stock into account, the difference between (3) and (4) gives an expression of a flexible form of the accelerator (Koyck, 1954):

$$(5) \quad I_t = w\alpha \Delta Y_t + (1-w) I_{t-1}.$$

According to (5), investment in Period  $t$  depends on the change in total demand and on lagged investment. When estimating this equation empirically it has to be decided which variable should be used to approximate demand  $Y$ . When using GDP the problem arises that investment is part of GDP, thus investment is partly explained by itself.

Contrary to the accelerator theory, Keynes (1936) and Lund (1971), among others, state that the profitability of investment projects is relevant. According to this theory, the



value of the capital stock equals the discounted future income that can be generated by employing the capital stock. Therefore, the interest rate which is used to discount future income is crucial for the profitability of an investment project. The market interest rate is formed on the basis of the time preferences of the individual investors. According to this strand of theories, investment is only a function of the real interest rate  $r$ :

$$(6) \quad I_t = f(r_t)$$

The relation between the present value of the discounted future revenues that can be generated by an additional unit of the capital stock and the price for this additional unit of capital is called marginal  $q$ . This theory was introduced by Keynes (1936) and further elaborated by Brainard and Tobin (1968) and by Tobin (1969, 1978). In empirical studies the problem arises that the marginal  $q$  is unobservable and has to be approximated by observable variables. A possible variable that can be used to approximate the present value of future revenues of a selected number of firms is the stock index. However, this is only justified under the condition that the stock market correctly reflects economic fundamentals of the firms and is not biased by speculative bubbles or over-pessimistic expectations.

The neoclassical theory of investment combines the investment determinants according to the accelerator hypothesis and profitability considerations. The following derivations rest on Jorgensen (1963). The investment function is derived from profit maximization of companies, based on a neoclassical production function with the input factor capital and a positive but diminishing marginal product:

$$(7) \quad Y_t = f(K_t)$$

The objective of the firm is to maximize the sum  $V$  of the discounted future revenues:

$$(8) \quad V = \int e^{-rt} [p_t Y(K_t) - p_t^K I_t] dt \rightarrow \max$$

$p$  and  $p^K$  denote the output price and the price for capital goods, respectively. (8) is maximized subject to the constraint given by the definition of investment, taking into account net investment, i.e. the change in the capital stock, and depreciation:

$$(9) \quad I_t = \frac{dK_t}{dt} + \delta K_t,$$

where  $\delta$  represents the depreciation rate. The necessary condition for a maximum is given by the following Euler equation:

$$(10) \quad \frac{\partial f}{\partial K_t} - \frac{d}{dt} \left( \frac{\partial f}{\partial \dot{K}_t} \right) = 0$$

with

$$(11) \quad \dot{K}_t = \frac{d K_t}{d t}$$

and

$$(12) \quad f = e^{-\pi} [p_t Y(K_t) - p_t^K (\dot{K}_t + \delta K_t)]$$

Calculating the Euler equation (10) gives the following expressions:

$$(13) \quad \frac{\partial f}{\partial K_t} = e^{-\pi} [p_t Y'(K_t) - p_t^K \delta]$$

$$(14) \quad \frac{\partial f}{\partial \dot{K}_t} = -e^{-\pi} p_t^K$$

$$(15) \quad \frac{d}{dt} \frac{\partial f}{\partial \dot{K}_t} = -(-re^{-\pi} p_t^K + e^{-\pi} \dot{p}_t^K) = e^{-\pi} (rp_t^K - \dot{p}_t^K) \quad \text{with } \dot{p}_t^K = \frac{dp_t^K}{dt}$$

Combining (13), (14) and (15) results in:

$$(16) \quad e^{-\pi} [p_t Y'(K_t) - p_t^K \delta - p_t^K r + \dot{p}_t^K] = 0,$$

which can be rewritten to get an optimality condition for the capital stock:

$$(17) \quad p_t Y'(K_t) = p_t^K \left( \delta + r - \frac{\dot{p}_t^K}{p_t^K} \right)$$

The optimal capital stock equalizes the marginal revenue product of capital and the user cost of capital. The latter consist of the depreciation rate, the real interest rate, and the growth rate of the prices for capital goods. If the price for capital goods rises this

diminishes the user cost of capital as in this case it is more profitable to invest in the current period instead of postponing investment to the following period.

Besides the variables just mentioned, the user cost of capital are influenced by taxation (e.g. Hassett, Glenn, 2002 and Hall, Jorgenson, 1967). Tax allowances lower the user cost of capital whereas taxation of profits reduces the profitability of investment projects. In empirical estimations, however, the inclusion of these variables is limited by data availability, in particular in international comparisons.

The aforementioned models can be extended by considering uncertainty (e.g. Abel, 1983, and Hartman, 1972). Investment decision have to be taken under uncertainty as future price and demand developments are unknown *ex ante*. The same is true for future costs. Empirical studies show a negative influence of revenue and cost uncertainties on investment (Deutsche Bundesbank, 2001).

## 4 Explaining Business Investment in European Union Countries

### 4.1 Panel Estimation

According to the theories discussed in the previous chapter, the determinants of investment comprise total demand, the real interest rate, the inflation rate of capital goods, and the relative price of capital goods. In this section the relevance of these factors for explaining investment in ten countries of the European Union<sup>1</sup> is analyzed by a panel estimation with fixed country effects. The panel estimation technique combines time series and cross country information. Differences between countries are captured by the constant. The influences of the other explanatory variables, i.e. the change in demand and the user cost of capital, are assumed to be equal across countries.

The user cost of capital UCC are defined in the following way:

$$(18) \quad UCC_{i,t} = \left( r_{i,t} - \frac{p_{i,t}^K}{p_{i,t}^K} \right) \frac{p_{i,t}^K}{p_{i,t}^K}$$

The user cost of capital of country  $i$  in period  $t$  consist of the real interest rate  $r$  minus the growth rate of the investment deflator  $p^K$ , multiplied by the ratio of the deflator for gross fixed capital formation  $p^K$  to the GDP deflator  $p$ . The real interest rate is calculated as the nominal three months interest rate minus the growth rate of the GDP deflator. Due to lack of internationally comparable capital stock data the depreciation rates are not included in the definition of the user cost of capital. For the same reason, tax rates are also not considered.

The estimation results can be found in table 1 below. Separate equations are estimated for total gross fixed capital formation (equations 1 to 4 in the upper panel of the table) and for investment in machinery and equipment (equations 5 to 8 in the lower panel). In the latter case, capital goods prices are approximated by the deflator for investment in machinery and equipment instead of the deflator for total gross fixed capital formation. Due to the limited availability of disaggregated investment data, in this case the panel does not include Belgium.

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<sup>1</sup> Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Spain, Sweden, and the United Kingdom.; data for Germany are for West Germany until 1990 and for the unified Germany from 1991 onwards; growth rates for 1991 are also for West Germany; data were extracted from the Eurostat database.

Besides the user cost of capital, the growth rate of total demand is included as an explanatory variable. In equations 1 and 5, total demand is approximated by GDP. As in this case investment is in part explained by itself, in equations 4 and 8 total demand is defined as GDP minus investment. In addition, it may be argued that capital formation depends on final demand. Therefore, in the remaining specifications imports are excluded. Thus, in equations 2 and 6 final demand is calculated as the sum of private and public consumption, exports, and investment. Finally, in equations 3 and 7 from the latter definition of demand investment is subtracted so as to avoid the problem of endogeneity mentioned above. The residuals seem to exhibit an autocorrelation structure. Therefore, the equations are re-estimated with an AR(1) process. The results of this set of estimations are summarized in table 2.

The accelerator is larger if investment is included in total demand. In addition, the adjusted coefficient of determination is higher when an AR(1) process for the residuals is included. On the other hand, in this case the significance of the explanatory variables is lower. If the AR(1) process is not considered both the accelerator and the user cost of capital are significant on the 1 percent level for all definitions of demand. If, on the other hand, the AR(1) process is included the growth rate in total demand is not significant if demand is defined as GDP minus total fixed capital formation. Furthermore, the user cost of capital are not significant if demand is approximated by the sum of private and public consumption, exports, and investment.

As it is desirable not to explain the development of investment by itself, when investigating the causes of the different paths of capital formation in the countries under consideration in the following sub-section, the definition of total final demand as the sum of private and public consumption and exports is considered (demand2 in equations 3 and 7, 3a and 7a in tables 1 and 2, respectively).

**Table 1** Estimation results

<b>Dependent variable: <math>\Delta</math>(gross fixed capital formation)</b>							
<b>1</b>		<b>2</b>		<b>3</b>		<b>4</b>	
$\Delta$ GDP	2.50** (33.73)	$\Delta$ demand1	0.62** (17.33)	$\Delta$ demand2	0.64** (13.04)	$\Delta$ demand3	0.39** (5.45)
UCC	-0.08** (5.98)	UCC	-0.06** (3.29)	UCC	-0.09** (4.73)	UCC	-0.16** (7.88)
R <sup>2</sup> adj.	0.60	R <sup>2</sup> adj.	0.36	R <sup>2</sup> adj.	0.28	R <sup>2</sup> adj.	0.15
DW	0.84	DW	0.58	DW	0.57	DW	0.50
<b>Dependent variable: <math>\Delta</math>(investment in machinery and equipment)</b>							
<b>5</b>		<b>6</b>		<b>7</b>		<b>8</b>	
$\Delta$ GDP	3.37** (23.09)	$\Delta$ demand1	0.68** (10.15)	$\Delta$ demand2	0.80** (8.94)	$\Delta$ demand3	0.38** (3.06)
UCC	-0.11** (4.19)	UCC	-0.14** (3.71)	UCC	-0.15** (4.03)	UCC	-0.24** (6.09)
R <sup>2</sup> adj.	0.44	R <sup>2</sup> adj.	0.19	R <sup>2</sup> adj.	0.16	R <sup>2</sup> adj.	0.08
DW	0.98	DW	0.62	DW	0.64	DW	0.58

fixed country effects are included ; (\*), \*, \*\*: significant on the 10, 5, 1 percent level

demand1: private consumption + public consumption + gross fixed capital formation + exports;  
demand2: private consumption + public consumption + exports; demand3: GDP minus gross fixed capital formation;  
 $\Delta$ : growth rate over the same quarter in the previous year; R<sup>2</sup> adj.: adjusted coefficient of determination; DW: Durbin Watson statistic; t-statistics in parentheses;

the estimations were performed using the software package EViews 3.1

**Table 2** Estimation results with AR(1) process

<b>Dependent variable: <math>\Delta(\text{gross fixed capital formation})</math></b>							
<b>1a</b>		<b>2a</b>		<b>3a</b>		<b>4a</b>	
$\Delta\text{GDP}$	1.71** (16.01)	$\Delta\text{demand1}$	0.50** (8.03)	$\Delta\text{demand2}$	0.26** (3.68)	$\Delta\text{demand3}$	-0.09 (1.01)
UCC	-0.08** (2.26)	UCC	-0.02 (0.86)	UCC	-0.04(*) (1.74)	UCC	-0.06* (2.42)
$\rho(1)$	0.66** (22.41)	$\rho(1)$	0.74** (26.93)	$\rho(1)$	0.79** (31.68)	$\rho(1)$	0.82** (36.82)
$R^2$ adj.	0.77	$R^2$ adj.	0.72	$R^2$ adj.	0.70	$R^2$ adj.	0.70
DW	2.15	DW	2.11	DW	2.16	DW	2.18
<b>Dependent variable: <math>\Delta(\text{investment in machinery and equipment})</math></b>							
<b>5a</b>		<b>6a</b>		<b>7a</b>		<b>8a</b>	
$\Delta\text{GDP}$	2.33** (10.15)	$\Delta\text{demand1}$	0.58* (4.76)	$\Delta\text{demand2}$	0.36* (2.54)	$\Delta\text{demand3}$	-0.24 (1.61)
UCC	-0.13** (2.79)	UCC	-0.07 (1.33)	UCC	-0.10(*) (1.86)	UCC	-0.12* (2.37)
$\rho(1)$	0.62** (18.17)	$\rho(1)$	0.73** (23.88)	$\rho(1)$	0.74** (25.32)	$\rho(1)$	0.77** (28.00)
$R^2$ adj.	0.65	$R^2$ adj.	0.62	$R^2$ adj.	0.60	$R^2$ adj.	0.60
DW	2.08	DW	2.06	DW	2.08	DW	2.10

fixed country effects are included; (\*), \*, \*\*: significant on the 10, 5, 1 percent level

demand1: private consumption + public consumption + gross fixed capital formation + exports; demand2: private consumption + public consumption + exports; demand3: GDP minus gross fixed capital formation;  $\Delta$ : growth rate over the same quarter in the previous year;  $R^2$  adj.: adjusted coefficient of determination; DW: Durbin Watson statistic; t-statistics in parentheses;  $\rho(1)$ : AR(1) term;

the estimations were performed using the software package EViews 3.1

## 4.2 Development of Investment Determinants

In this section, the trajectories of the explanatory variables of investment identified in the previous sections are analyzed. The aim is to identify the determinants of the divergent development of capital formation in the EU countries as described in section 2 above. Two sets of explanatory variables could be identified: the change in final demand and the user cost of capital. According to equation 18, the latter consist of the real interest rate, the growth rate of capital goods prices, and the relation between prices for capital goods and output prices. The following sub-sections therefore focus on the trajectories of total demand, nominal and real interest rates as well as the deflators for gross fixed capital formation and for investment in machinery and equipment, normalized by the GDP deflators, in the ten European Union countries under consideration.

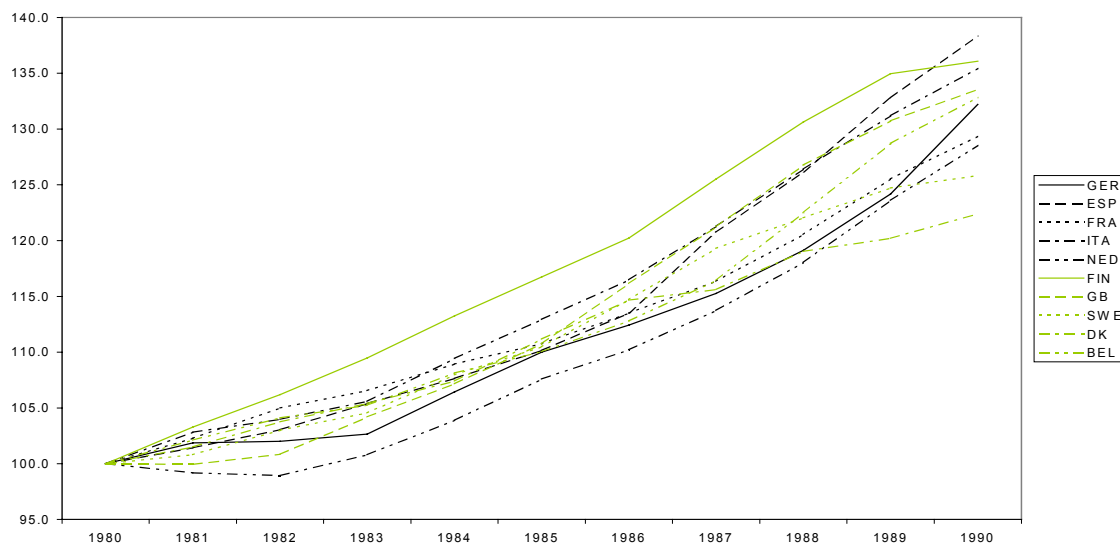
### *Demand*

The analysis starts with the inspection of total demand. Figures 5 and 6 show the development of demand in the countries under consideration in the 1980s and in the 1990s.

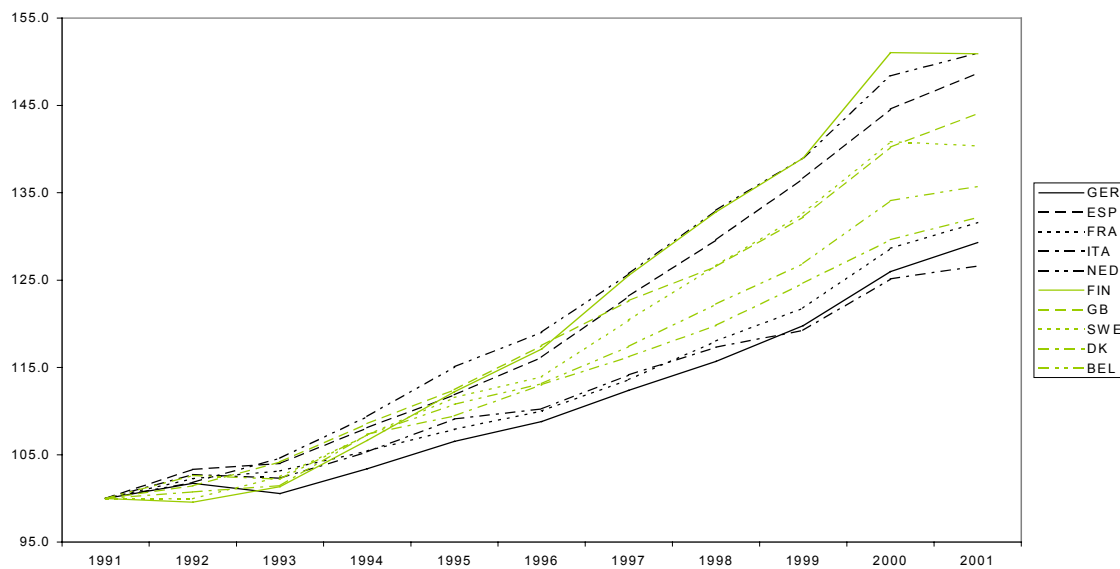
In the 1980s the performance of total demand was more homogenous than in the following decade. From 1980 to 1990 total demand expanded by 22 percent in Denmark, the country with the worst performance, and by 38 percent in Spain which in this period was the country with the most robust demand. Between 1991 and 2001, the lowest total growth rate of 29 percent could be observed in Germany, compared to 51 percent in Finland and the Netherlands. Given the estimated accelerator of 0.64 (equation 3 in table 1) for the definition of demand used in figures 5 and 6 (demand2 in the above equations), the divergent paths of gross fixed capital formation can to a large extent be explained by the differences in demand. As an example, had Germany experienced the same demand performance as the Netherlands, between 1991 and 2001 gross fixed capital formation in Germany would have grown, *ceteris paribus*, by more than  $3\frac{3}{4}$  percent p.a. instead of the actually realized 0.6 percent. The corresponding figure for investment in machinery and equipment is  $4\frac{3}{4}$  percent p.a. instead of the observed  $\frac{1}{4}$  percent p.a.



**Figure 5** Total demand (sum of exports and public and private consumption) in EU countries in the period 1980 to 1990 (index; 1980 = 100)



**Figure 6** Total demand (sum of exports and public and private consumption) in EU countries in the period 1991 to 2001 (index; 1991 = 100)



### *User Cost of Capital*

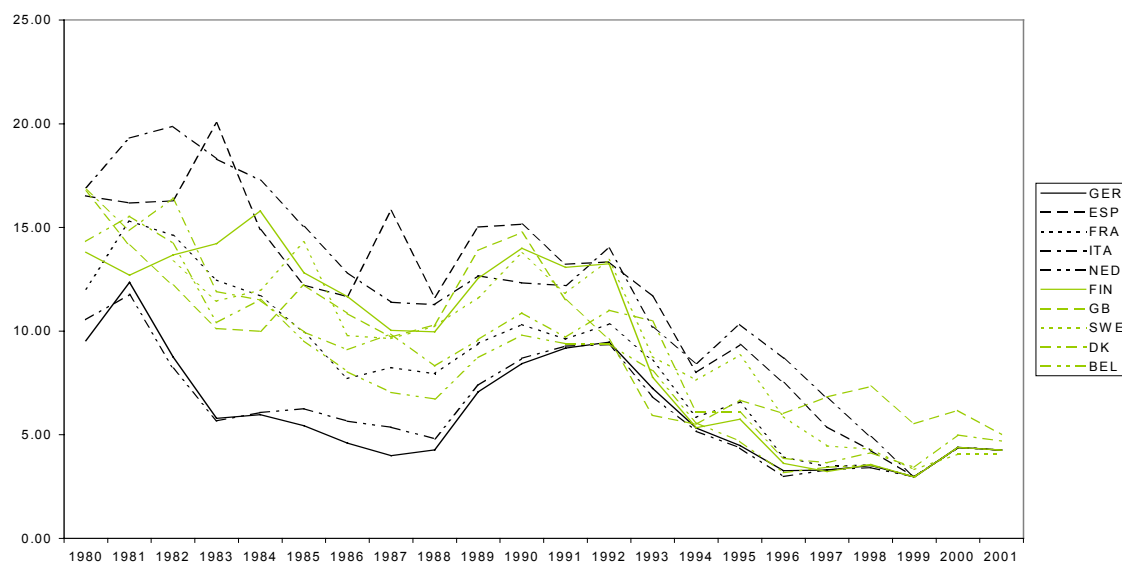
Besides the growth rate of demand, investment is influenced by the user cost of capital. According to equation 18 above, the user cost consist of the real interest rate, the growth rate of capital goods prices, and the relative price of capital goods. Due to the lack of internationally comparable data, the depreciation rate was excluded from the analysis. For the same reason, the impact of taxation on the investment behaviour is not considered. In the following, the developments of interest rates and of capital goods prices in the ten countries of the European Union considered throughout this paper are investigated. The analysis begins with the inspection of interest rates.

### *Interest Rates*

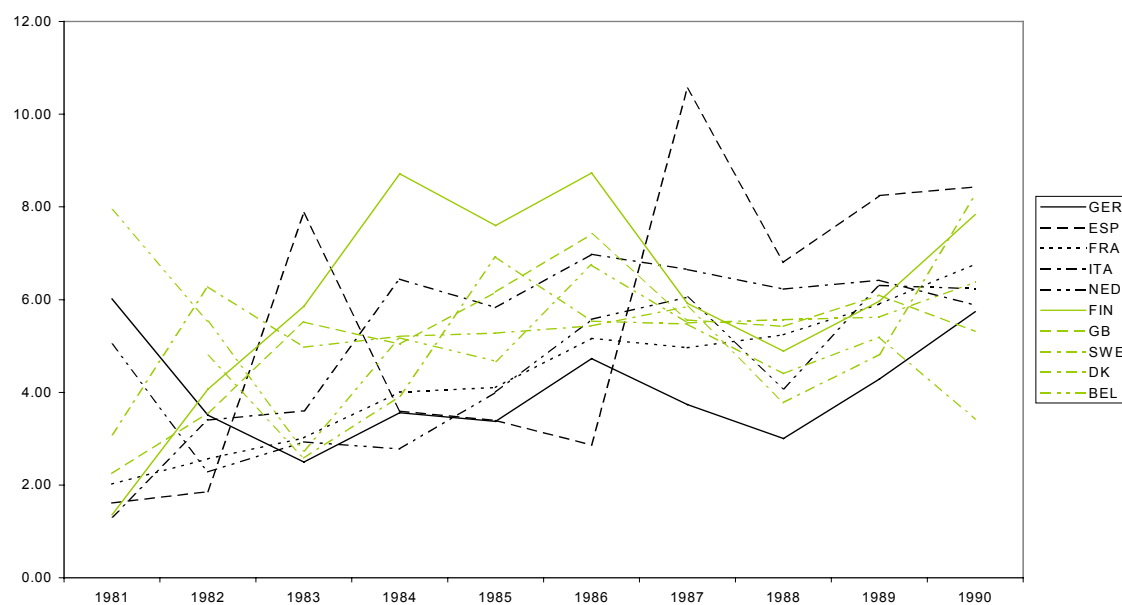
Figure 7 depicts the paths of nominal interest rates between 1980 and 2001 in the countries under consideration. Figures 8 and 9 show real interest rates, separately for the 1980s and the 1990s. The nominal interest rates exhibit a clear downward trend. This is in particular relevant for Italy, Spain, Denmark, and the United Kingdom. The Netherlands and Germany, on the other hand, experienced the lowest interest rates over the entire period. Since the start of the European Economic and Monetary Union in 1999, short-term nominal interest rates are identical in the member countries. In the non-EMU members, interest rates are higher than in the EMU countries.

For investment decisions, the real rather than the nominal interest rate is crucial. In contrast to the nominal interest rates, the real rates did not follow a clear downward trend over the entire period. In the 1980s, some countries, namely Italy, France, Spain, Finland, the UK, and Denmark, experienced quite a sharp increase of real interest rates. In Germany, the Netherlands, Belgium, and Sweden, no clear trend was visible. From the peak in 1991/92 to 2001, real interest rates declined in all countries of the panel, but to different degrees. Over this period, the lowest decline could be observed in the United Kingdom (2.7 percentage points), and in Germany (3.4 percentage points). The largest decrease occurred in Sweden (9.4 percentage points) and in Finland (8.7 percentage points). In the remaining countries, the real interest rates fell between 5 and 7 ¼ percentage points.

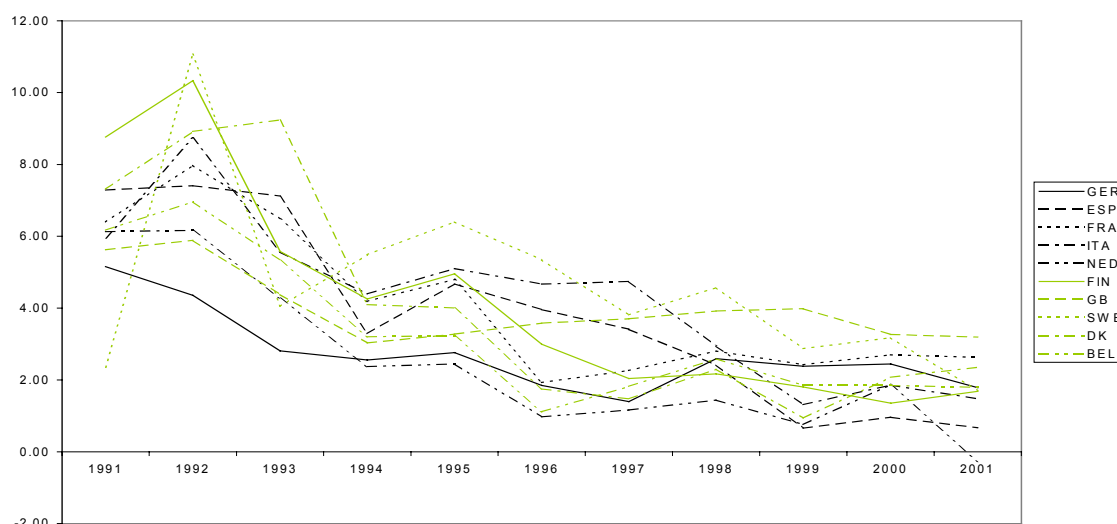
**Figure 7** Nominal three months interest rates in EU countries in the period 1980 to 2001



**Figure 8** Real three months interest rates in EU countries in the period 1980 to 1990 (nominal interest rates minus annual growth rates of GDP deflator)



**Figure 9** Real three months interest rates in EU countries in the period 1991 to 2001 (nominal interest rates minus annual growth rates of GDP deflator)



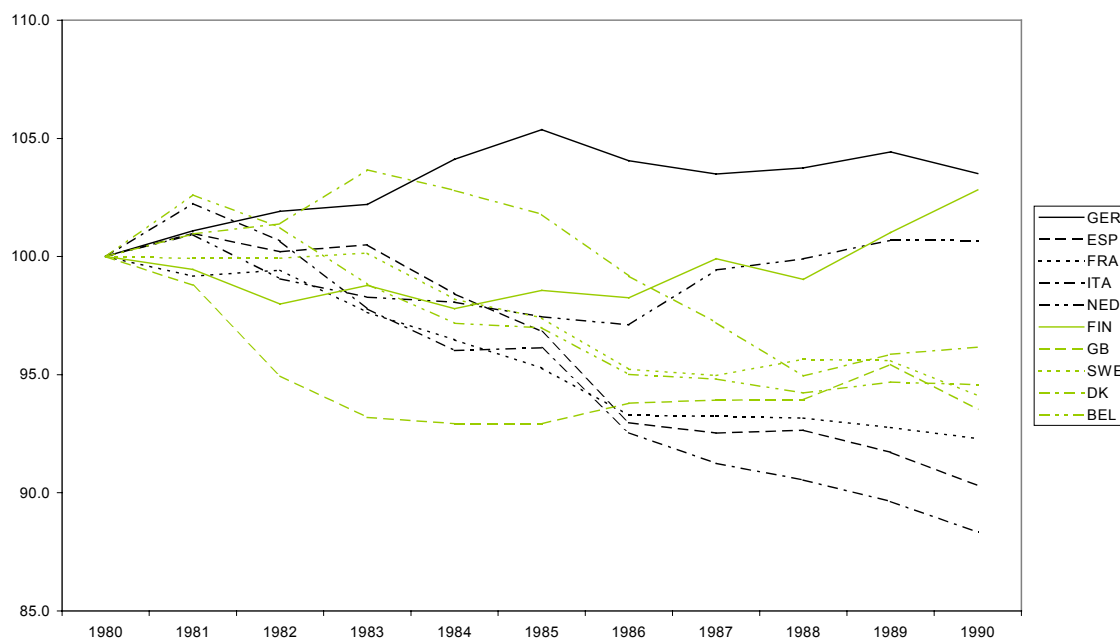
In the 1990s, high growth rates of capital formation could be observed in some countries like Spain and Sweden which experienced a substantial decrease in real interest rates. In Germany real interest rates remained more or less stable in this period, and investment stagnated. On the other hand, real interest rates declined sharply in Finland, while capital formation was sluggish. In the UK, on the contrary, real interest rates moved little, while investment grew at high rates. This underlines the result of the panel estimation according to which the growth in demand is more important for investment decisions than the real interest rate as one part of the user cost of capital. Nevertheless, a counterfactual experiment similar to the case of demand is undertaken here. Specifically, taking the estimation results of equations 3 and 7 in table 1, the paths of total gross fixed capital formation in Spain and of machinery and equipment investment in the Netherlands from 1999 to 2001, i.e. a period in which the real interest rates were exceptionally low in these countries, with the German real interest rates are simulated *ceteris paribus*. The analysis shows that, on average, capital formation would have grown 0.3 percentage points less in Spain (5.6 percent p.a. instead of 5.9 percent p.a.). The negative impact of the higher German interest rates on the growth rate of machinery and equipment investment in the Netherlands would have been 0.4 percentage points p.a. (2.9 percent p.a. instead of 3.3 percent p.a.). This shows that the influence of the real interest rate on investment is rather limited.

### *Relative Prices for Capital Goods*

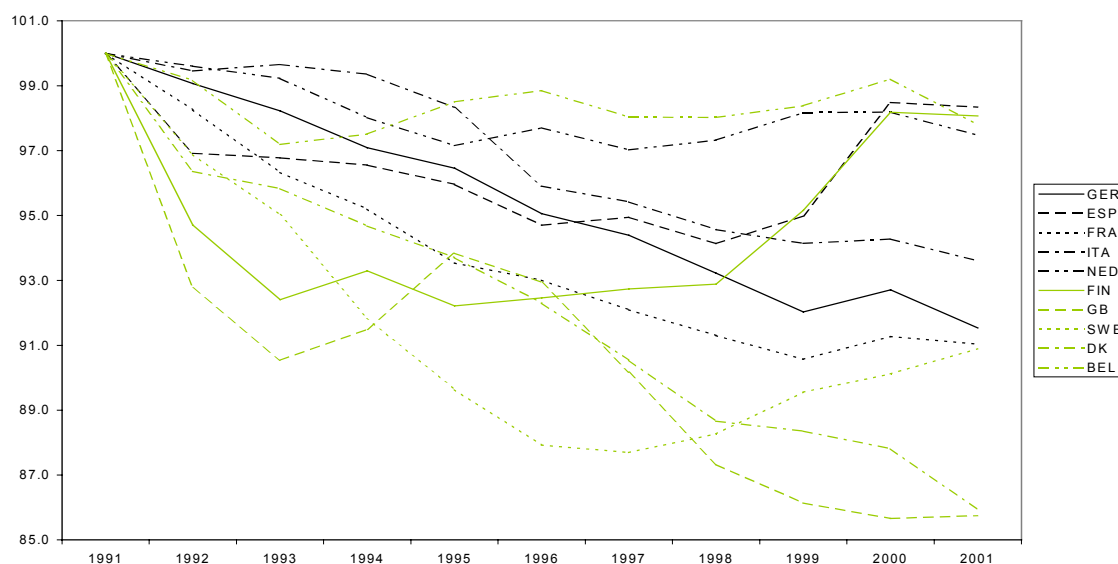
Besides the real interest rate, the user cost of capital consist of the growth rate of capital goods prices. Figures 10 and 11 depict the development of the investment deflator, normalized by the GDP deflator, in the panel of countries between 1980 and 1990 and from 1991 to 2001. Figures 12 and 13 provide corresponding diagrams for the deflators of investment in machinery and equipment.

In the 1980s, the relative price of investment goods remained more or less stable in the Netherlands, Germany, and Finland. In a group of countries consisting of the UK, Belgium, Denmark, and Sweden this relative price declined by a total of about 6 percent over the 11 year period 1980 to 1990. In the remaining countries considered here, the investment deflator decreased by about 10 percent relative to the GDP deflator. In the period 1991 to 2001 the relative price of investment goods more or less stagnated in the Netherlands, Spain, Belgium, and Finland. In France, Italy, Sweden, and Germany it declined by about 10 percent, while it fell by about 15 percent in Denmark and the UK.

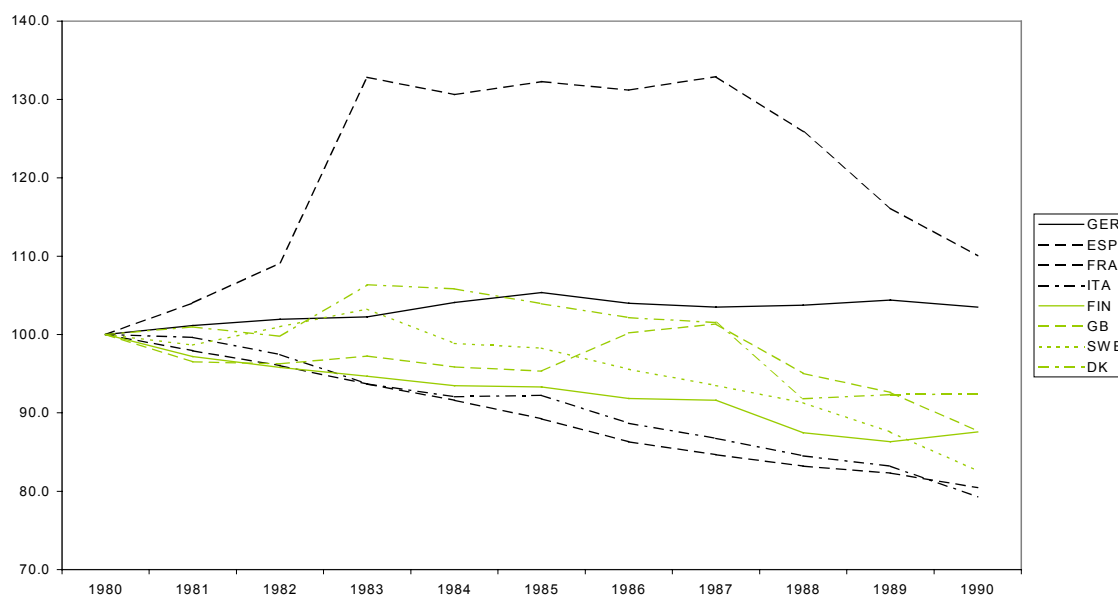
**Figure 10** Deflators of gross fixed capital formation, normalized by GDP deflators, in the period 1980 to 1990 (index; 1980 = 100)



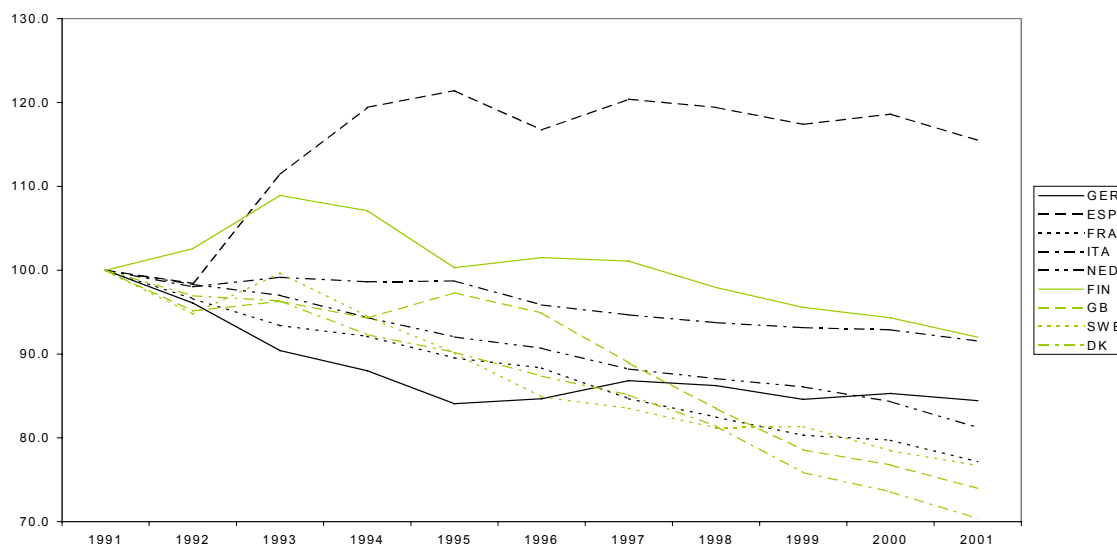
**Figure 11** Deflators of gross fixed capital formation, normalized by GDP deflators, in the period 1991 to 2001 (index; 1991 = 100)



**Figure 12** Deflators of machinery and equipment investment, normalized by GDP deflators, in the period 1980 to 1990 (index; 1980 = 100)



**Figure 13** Deflators of machinery and equipment investment, normalized by GDP deflators, in the period 1991 to 2001 (index; 1991 = 100)



In the following, counterfactual experiments similar to those of the sub-sections on demand and real interest rates are conducted. Specifically, it is investigated how total gross fixed capital formation in Finland and machinery and equipment investment in Germany would have developed between 1991 and 2001, *ceteris paribus*, given the paths of relative capital goods prices observed in the UK. Had the relative price of capital goods, defined as the relation between the investment deflator and the GDP deflator, in Finland declined by the same amount as in the UK, the average annual growth rate of capital formation would have reached, *ceteris paribus*, 0.0 percent instead of the actually observed  $-0.25$  percent. If Germany would have experienced the same decline in the relative price for machinery and equipment as the UK, the average annual growth rate of investment in machinery and equipment would have increased by a negligible 0.1 percentage point.

Summing up the results of the empirical analyses, the growth of final demand is more important for investment decisions of companies than the user cost of capital. Thus, the divergent development of demand in the countries of the European Union is more relevant for the explanation of the different paths of investment than the differences in real interest rates and in the relative prices of capital goods, particularly in the 1990s.

## 5 Conclusion

Investment constitutes an important macroeconomic aggregate. Analyzing and explaining business investment is important as capital formation not only exerts a demand effect but is also crucial for an economy's long-term growth potential. In addition, besides stock variations, fixed capital formation is the most volatile component of GDP. In the 1980s and, in particular, in the 1990s the countries of the European Union experienced divergent developments of gross fixed capital formation. A panel estimation of an investment function reveals that gross fixed capital formation in general and investment in machinery and equipment in particular can be explained by the growth of final demand and by the user cost of capital. Analyzing the determinants of investment reveals that the divergent development of demand in the countries of the European Union has been more relevant for the explanation of the different paths of investment than the differences in real interest rates and in the relative prices of capital goods, particularly in the 1990s. Therefore, it can be concluded that the impact of the convergence of nominal interest rates in the run-up to the European Economic and Monetary Union on the investment performance was negligible. Stated differently, the subdued capital formation in Germany where interest rates had historically been lower than in the other EMU countries cannot be explained by the fact that Germany did not experience a fall in interest rates.



## References

- Abel, A.B. (1983), *Optimal Investment under Uncertainty*, American Economic Review 73, 228-233.
- Brainard, W.C., J. Tobin (1968), *Pitfalls in Financial Model Building*, American Economic Review 58(2), 99-122.
- Chirinko, R.S. (1993), *Business Fixed Investment Spending: Modelling Strategies, Empirical Results, and Policy Implications*, Journal of Economic Literature 31, 1875-1911.
- Deutsche Bundesbank (2001), *Unsicherheit, Handlungsfreiheit und Investitionsverhalten – ein empirischer Befund für Deutschland*, Monatsbericht September 2001, 71-88.
- Hall, R., D. Jorgensen (1967), *Tax Policy and Investment Behaviour*, American Economic Review 57, 391-414.
- Hartman, R. (1972), *The effect of price and cost uncertainty on investment*, Journal of Economic Theory 5, 258-266.
- Hassett, K.A., H.R. Glenn (2002), *Tax Policy and Business Investment*, Handbook of Public Economics 3, 1293-1343.
- Jorgensen, D.W. (1963), *Capital Theory and Investment Behavior*, American Economic Review, Papers and Proceedings 53.
- Keynes, J.M. (1936), *The General Theory of Employment, Interest, and Money*. London.
- Koyck, L.M. (1954), *Distributed Lags and Investment Analysis*. Amsterdam.
- Lund, P.J. (1971), *Investment. The Study of an Economic Aggregate*. Edinburgh.
- Tobin, J. (1969), *A General Equilibrium Approach to Monetary Theory*, Journal of Money, Credit, and Banking 1(1), 15-29.
- Tobin, J. (1978), *Monetary Policies and the Economy: The Transmission Mechanism*, Southern Economic Journal 44(3), 421-431.