

# Cahiers Papers

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Employment in Europe



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# The employment effects of investment projects



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## 1. Introduction

With some 19 million people out of work, unemployment has become one of the biggest problems facing the EU today. Over the last decade, job creation has been unable to keep up with the increasing size of the active population, leading to a trend of rising unemployment rates for many EU member states. The causes of unemployment in Europe are complex and manifold, but proposals for tackling the problem have so far mainly focused on the supply-side with the aim of making labour markets more flexible. However, the problem may also lie with the demand for labour. Taking into account the fact that investment rates in the EU have declined over the last decade, a focused attempt to stimulate labour demand through investment should also be considered.

The relationship between investment and employment creation raises two key questions. First, how much does investment - in the form of an additional ECU one billion, say - actually increase the demand for labour? Second, is it possible to define the kind of investment required to obtain the maximum effect?

Answering these two questions requires quantitative analysis, and the relationship between investment and employment creation has been addressed in this paper on the basis of three different models, which are differentiated by the uses to which they can be put: The first concerns the construction phase of investment projects; the second looks at the effect of productive capital in the operational phase of investment projects; while the third analyses the structural equilibrium effects combining construction and operational effects for the particular case of public investment spending in Spain. The models are further differentiated by their underlying methodologies: The construction phase is assessed by an input-output model (IO); the operational phase by a vintage capital model (VCM); and the equilibrium effects by a so-called structural vector autoregression (SVAR) (1).

In attempting to see what can be said regarding the additional employment generated by investment, the paper is organised as follows. The next section assesses the employment creation potential during the construction phase of investment projects in different sectors of the EU-12 aggregate with the IO model. Section 3 then considers employment generated over the lifetime of capital in the manufacturing sector of five countries.

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*This paper draws on work carried out in the Chief Economist's Department of the EIB for the IO and VCM models. It also summarises research with SVAR models by Professor Charles Bean of the London School of Economics on behalf of the European Commission. This work (see Bean, 1997, for details) was presented at the conference on "Employment in Europe", 15 January 1998, at the EIB. The authors would like to thank Joseph Heuschling at EUROSTAT and Professor Jörg Beutel at the Fachhochschule Konstanz for their help and assistance.*

*1) All the data used in the IO and VCM calculations were provided by Eurostat. For the IO model, these were 1985 and 1991 IO tables for ten EU member states and the EU-12 aggregate. Greece and Luxembourg were not looked at on an individual basis due to data problems with the former and the small size of the latter. For the VCM, Eurostat data on the capital stock and gross fixed capital formation for three capital goods (machinery, transport equipment and building) in five representative EU countries were used.*

Section 4 looks at the SVAR methodology, which has recently been used to evaluate the impact of public investment projects in Spain. The fifth section offers a summary of the key findings and provides a few policy conclusions.

## 2. Employment effects in the construction phase: an input-output (IO) analysis

First comes a look at a simple demand shock with the help of the IO methodology (2). The IO model - involving large matrices that give a snapshot of all the goods and services flowing through the economy - is a standard technique for analysing the effects of such shocks. A technical description of the model can be found in Box 1. It is worth bearing in mind that the IO model assumes that there are no capacity constraints and that labour and capital are complementary in fixed proportions.

In the IO approach, increased investment augments the demand for labour during the construction phase. The magnitude of this employment creation on the basis of 1997 figures was estimated for the EU, with the economy divided into 25 sectors, encompassing, among others, metal products, agricultural and industrial machinery, office machines, electrical goods, building and construction and inland transport services. These are the sectors most affected during the installation of the great majority of investment projects.

**Table 1.** Employment effects of an ECU one billion final demand shock by sector (in 1,000 person-years)

Sector	Direct effect	Indirect effect	Total effect
Metal products	11.1	9.2	20.3
Agricultural and industrial machinery	8.7	9.9	18.5
Office machines	11.0	9.8	20.8
Electrical goods	9.5	8.8	18.2
Building and construction	11.7	8.7	20.5
Inland transport services	15.0	6.7	21.7

**An investment of ECU one billion creates about 18,000 to 22,000 person-years of jobs in the construction phase.**

As can be seen from Table 1, an investment of ECU one billion in the EU-12 in 1997 created approximately 18,000 to 22,000 person-years (3) of jobs in the construction phase (4). Up to half of the employment effect is indirect, i.e. it accrues due to an increase in demand for intermediate goods and services.

2) For IO calculations of the employment impact of Trans-European Transport Networks, see Commission of the European Communities (1997).

3) The person-year unit of employment stands for the amount of labour that one worker provides during one year. A temporary increase in construction investment by ECU one billion spread over one year would need roughly 20,000 additional workers over the same period (i.e. 20,000 person-years).

4) The 1997 IO table was calculated by the authors by extrapolating the changes between the 1985 and the 1991 IO table into the future. The technological changes in the six years between 1985 and 1991 were assumed to continue in the six years from 1991 to 1997. Estimates for the 1997 IO table were produced by both exponential and linear extrapolation. As only minor differences were found between these two approaches, the 1997 projection appears rather robust.

The IO model presents a snapshot of the flow of goods and services throughout the economy at a particular point in time. Comparing the 1985, the 1991 and the forecasted 1997 IO table, employment creation was found to decrease by about 1.5 to 2 percent annually. An ECU one billion final demand shock in the construction sector generated 25,100 person-years of employment in 1985, 22,900 person-years in 1991, and 20,500 person-years in 1997.

**The sector where the investment project occurs does not really matter very much.**

Due to the existence of important sectoral spillovers, all sectors show similar total employment effects, and the sector where the investment project occurs does not really matter very much at this level of aggregation. An industrial project may thus generate as much employment in the construction phase as does investment in infrastructure.

### Box 1. A description of the IO model

The IO method represents the economy as a set of  $n$  sectors, each of which has a linear production function with complementary factors of production. The production system is written as

$$\begin{aligned} a_{11}X_1 + a_{12}X_2 + \dots + a_{1n}X_n + F_1 &= X_1 \\ &\vdots \\ a_{n1}X_1 + a_{n2}X_2 + \dots + a_{nn}X_n + F_n &= X_n \end{aligned}$$

where the  $X_i$  represent the output of the  $i$ th sector of the economy,  $a_{ij}$  represents the amount of the  $i$ th commodity used in the production of one unit of the  $j$ th commodity and  $F_i$  represents the final demand for the  $i$ th commodity ( $i, j = 1, \dots, n$ ). The total output of the  $i$ th sector is thus split into the amounts which are used in the production of all the other commodities (known as intermediate demand) and that which is finally consumed (known as final demand). The model is thus able to capture the interrelationship between sectors.

In matrix algebra, the system can be written as

$$AX + F = X$$

where  $A$  is the matrix of input-output coefficients,  $a_{ij}$ ,  $X$  is the vector of outputs of commodities,  $AX$  is the vector of intermediate demands and  $F$  is the vector of final demands.

The impact of a final demand shock,  $\Delta F$ , on total output,  $X$ , is given by

$$\Delta X = (I - A)^{-1} \Delta F$$

where  $I$  is the  $(n \times n)$  identity matrix. The final demand shock is met by additional output,  $\Delta X$ , which in turn implies an employment effect of

$$\Delta L = \ell \Delta X = \ell (I - A)^{-1} \Delta F$$

where  $\Delta L$  is the additional employment created and  $\ell$  is the vector of labour coefficients for the economy.

This employment effect can be decomposed into a direct and indirect effect, equal to

$$\Delta L_{\text{direct}} = \ell \Delta F \quad \text{and} \quad \Delta L_{\text{indirect}} = \ell ((I - A)^{-1} - I) \Delta F$$

The drawback of the IO model is that since it assumes that the  $a_{ij}$  are fixed, the same linear relationships must exist over time. In addition, labour and capital are assumed complementary in fixed proportion. It must also be the case that there are no capacity constraints in the economy. This makes the IO model totally demand driven and - as supply is fully elastic - what is demanded will be supplied.

**At least a quarter of the employment effect is in services, chiefly due to increased intermediate demand.**

The IO model also allows examination of other aspects of employment creation, including the sector in which the jobs are created and how employment creation varies across EU member states.

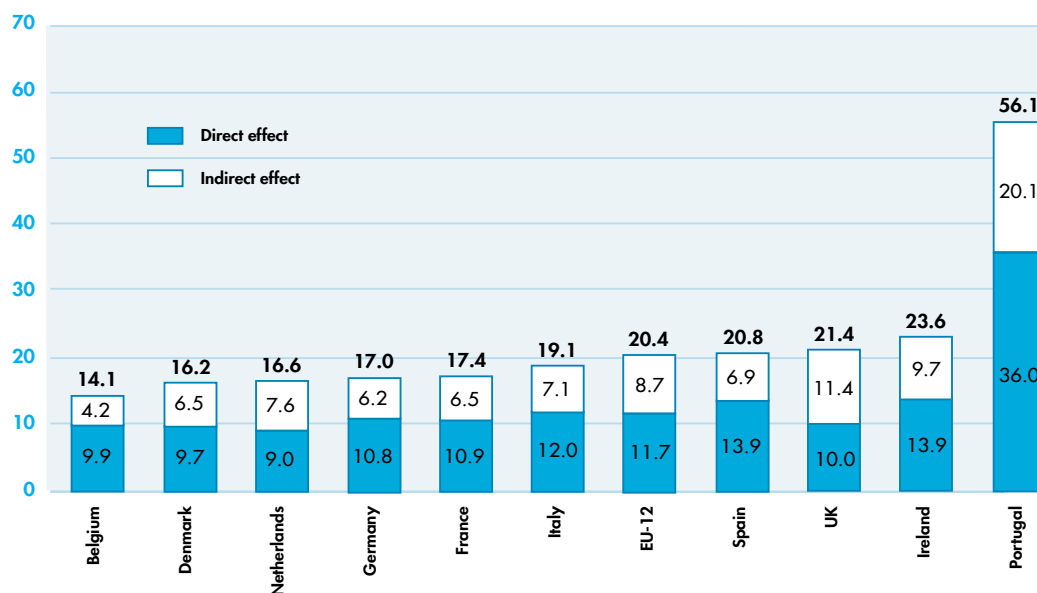
Starting with the sectoral distribution of jobs, the secondary "multiplier" effects are illustrated in Table 2. While the biggest benefits accrue in the sectors where the direct demand shock occurs, at least a quarter of the employment effect is in services, chiefly due to increased intermediate demand.

**Table 2.** Employment effects of an ECU one billion final demand shock in selected sectors, decomposed into four sector groups, 1997 (in 1,000 person-years)

Sector	Agriculture	Industry	Construction	Services	Total
Metal products	0.2	14.8	0.1	5.2	20.3
Agricultural and industrial machinery	0.1	13.3	0.1	5.0	18.5
Office machines	0.1	14.9	0.1	5.6	20.8
Electrical goods	0.1	13.5	0.1	4.7	18.2
Building and construction	0.1	3.4	12.5	4.5	20.5
Inland transport services	0.1	1.5	0.2	19.9	21.7

The analysis of the EU-12 aggregate can be extended to the national level. The country results are shown in Figure 1. Not surprisingly, given differing wage rates, capital structures and international leakages (i.e. purchases of intermediate goods and services from other countries), employment effects in the home country vary significantly across countries. In most of the EU, the domestic employment generated by ECU one billion falls within the relatively narrow range of 16,000 person-years in Denmark to 24,000 person-years in Ireland. Non-domestic employment effects for highly developed countries with high import-to-GDP ratios are likely to be large for small countries. This is the case for Belgium, where only 14,000 Belgian person-years of employment are created for each ECU billion. Portugal, with a less capital intensive production structure lies at the other end of the employment spectrum. This result may partially be due to the sectoral averages used by the model. In the past, typical investment in Portugal may have been relatively smaller-scale and more labour intensive than elsewhere.

**Figure 1.** Domestic employment effects of an ECU one billion final demand shock in the building and construction sector, 1997 (1,000 person-years)



The question of what happens to the investment project after its completion is addressed in the next section with a look at the linkages between sustained employment and the capital base in the economy.

### 3. Employment effects in the operational phase: a vintage capital model (VCM)

Another way of calculating employment multipliers takes as its point of departure the ratio of the capital stock in (a sector of) the economy to the (sectoral) labour force (5). However, calculating the capital stock - an unobservable variable - is a difficult endeavour. Instead, flows of investment, together with assumptions about capital retirements, are used to determine the amount of capital in the economy. The VCM provides a method of calculating the capital stock of an economy, a technical description of which can be found in Box 2.

In the subsequent analysis, the emphasis is placed on the manufacturing sector in five EU member states (France, Germany, Italy, the Netherlands and the UK) during the period from 1960 to 1995. With a share of the total capital stock of around 15 percent for all countries, manufacturing represents not only an important sector in the economy, but is also a "classic" sector for investment.

Figure 2 presents an overview of employment, the capital stock and their ratio (the average labour-to-capital ratio) in the manufacturing sector of the five countries.

**The average labour-to-capital ratio has been falling over the last three decades.**

With roughly unchanged employment levels and an increasing capital stock, it is not surprising that the average labour-to-capital ratio has been falling over the last three decades (from an average of 20,000 jobs in 1960 to 10,000 jobs per ECU one billion in 1995). The drop in employment in the manufacturing sector has been especially marked for the UK, where - in contrast to the other European countries - labour shedding has taken place. As a result, the average 1995 labour-to-capital ratio for the UK is almost 1.4 times as high as the European average. This higher labour intensity could also be due in part to more flexible labour markets in the UK. The Italian capital stock in 1995 ECU, on the other hand, has remained almost unchanged since the late 1960s, so that the decline of the average labour-to-capital ratio has been less than in the other countries (6).

A first glimpse of employment creation can be provided by the average labour-to-capital ratio, indicating the average amount of labour per unit of capital. Looking simply at the ratio of employment to the capital stock, it can be seen that a capital stock of ECU one billion in the manufacturing sector in 1995 is associated with an average of about 10,000 jobs. This is equivalent to a cost of ECU 100,000 per job. Interestingly, there has been a strong convergence between countries over time (7).

However, it has to be said that the average labour-to-capital ratio is a relatively simple step in the direction of quantifying employment creation. New investments do not necessarily mirror the average labour intensity in the economy and there are general equilibrium effects that are ignored. One way to proceed a little further is to calculate the marginal labour-to-capital ratio with the VCM. At least this will provide some idea of the actual employment multiplier for investment projects in a particular year.

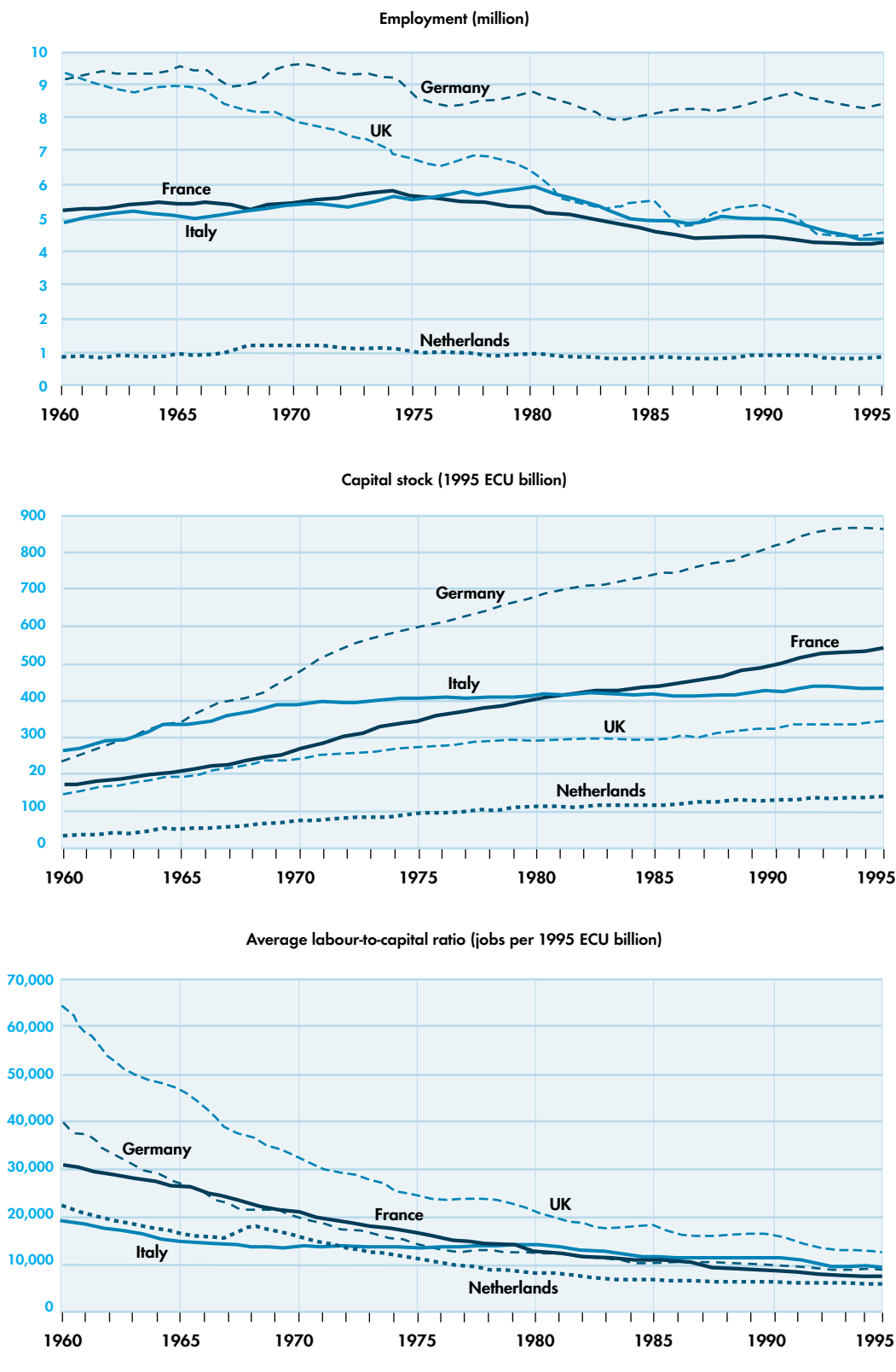
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5) For a table of the historical development of the EU-12 real gross capital stock per occupied person for six aggregate sectors of the economy, see Eurostat (1997, p. 29).

6) Of course, another explanation could be problems with the survival function for the Italian manufacturing capital stock, such as the simplifying assumption of a constant functional form. Equally, estimates of the capital stock in the UK may be distorted if investment scrapping during the 1980s is not captured.

7) As already mentioned, one exception is the UK.

**Figure 2.** Employment, the capital stock and the average labour-to-capital ratio in the manufacturing sector of five EU member states, 1960-1995





The calculation of the marginal labour-to-capital ratio requires a linkage between labour and capital (see Box 2). This is achieved by making the - very strong - assumption that capital and labour are complements, i.e. one unit of labour sticks to one unit of capital throughout the lifetime of capital in fixed proportions. The assumption of fixed complementarity between inputs is similar to that of the IO analysis. Figure 3 shows the calculated marginal labour-to-capital ratios in manufacturing as well as their trends for the five countries.

## Box 2. A description of the VCM

### 1. Estimating the capital stock

The capital stock of an economy is not directly observable and has to be estimated from annual investment data. As investment represents the acquisition of capital goods at a given point in time, the durable goods acquired at different times can be referred to as different vintages of capital. The gross capital stock is then calculated as the sum of the remaining parts of all previous capital vintages, which is equivalent to cumulating past investment and deducting the cumulated value of investment that has been retired as well as to the cumulative value - at prices as if they were new - of past investment still in use. No weight is given to whether the capital goods are actually used in the production process or stay idle.

### 2. Using the VCM to estimate marginal labour-to-capital ratios

Just as the (gross) capital stock ( $GC$ ) at time  $t$  can be calculated as

$$GC_t = GC_{t-1} + GFCF_t - \text{Retirements},$$

where  $GFCF$  is gross fixed capital formation, i.e. investment, labour can be decomposed into

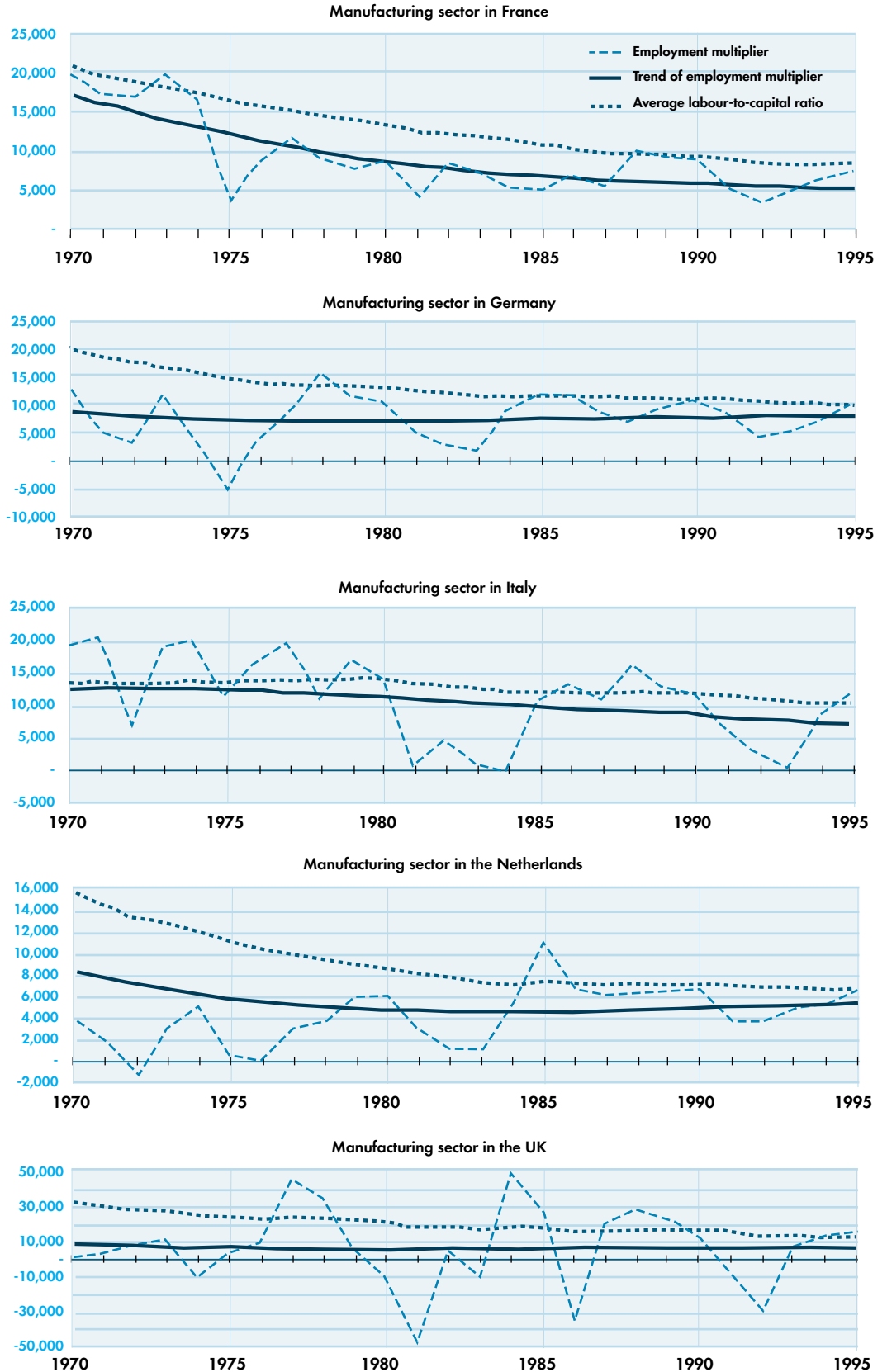
$$L_t = L_{t-1} + \Delta L_t^+ - \Delta L_t^-$$

where  $L_t$  is equal to the stock of labour in year  $t$ . The last entry,  $\Delta L_t^-$ , is equivalent to labour leaving employment, and corresponds - under the stringent complementarity assumption between capital and labour - to capital retirements. The first entry,  $\Delta L_t^+$ , represents labour entering employment and corresponds to  $GFCF_t$ . This is the variable of interest and is calculated as the difference between the two labour stocks in years  $t$  and  $t-1$ , which are given, and labour outflows, which are calculated from the stock of labour and the survival function. The marginal labour-to-capital ratio for year  $t$  is thus equal to:

$$\frac{\Delta L_t^+}{GFCF_t}$$

The weakness of this approach lies with the stringent underlying assumption of complementarity between labour and capital throughout the lifetime of the capital good. The analysis also takes no account of capacity utilisation of the factors of production, the inclusion of which would probably smooth the marginal ratio. The model assumes that capacity is used at a fixed and invariable rate. A drop in demand could, however, also be met by decreasing capital utilisation rates.

**Figure 3.** Employment creation per year by additional investment projects in the manufacturing sector (jobs per 1995 ECU billion)



The variability of the estimated marginal labour-to-capital ratio - which can even turn negative - is seen in Figure 3. As the ratio represents the current employment multiplier, economic shocks and business cycle fluctuations enter into the calculation and are strongly reflected in the ratio. Despite the variability, however, a trend emerges for the marginal ratio (8). This lies consistently below the average, which explains the continuous decline of the latter. As the trend of the marginal ratio is still below the average, the average labour-to-capital ratio can be expected to fall further in the future.

A first estimate of the employment creation of a new investment project in manufacturing can be done with the trend value of the marginal labour-to-capital ratio. Based on this value, there are close to 170,000 person-years of employment created over the lifetime of a 1995 investment project of ECU one billion if it depreciates in the standard way (6,300 jobs per ECU billion times an average life of 26 years). Thus, if investment produced truly additive employment and the same labour intensity remained throughout the operational life, then a manufacturing investment generates direct employment equal to about eight times the jobs created economy-wide during installation and construction.

#### **4. Employment effects of an investment project: a structural vector autoregression (SVAR) analysis**

*A general equilibrium model of the impact of investment would be very complex. Instead, we can use a structural vector autoregression.*

The two previous analyses have been partial in the sense that they looked at particular aspects of employment creation. It is thus worthwhile to include more general equilibrium effects within the economy. However, to develop a general equilibrium model of the impact of investment on the economy would be prohibitively complex, and the calibration of such a model would probably reduce the objectivity of many of the results.

Instead, there is recourse to a structural vector autoregression (SVAR), in which historical data is used to infer relationships about investment and its consequences on several variables. The particular example presented below looks at investment in public infrastructure. With hardly any direct operating employment, this sort of investment constitutes an extreme case. As a result, all the long-run employment effects are equilibrium effects, which the previous two models are not capable of capturing. Box 3 gives a technical description of the SVAR methodology.

Bean (1997) has used this methodology to assess the economic consequences of public sector investment in Spain. The Madrid Ring Road, an investment of ECU 300 million, provides an example. From this case study, illustrative employment multipliers can be extracted. For the purposes of the analysis, the total public capital stock is treated as endogenous, i.e. determined within the model. One particular result of the calculation is that public investment crowds in private investment, which in turn generates employment.

The SVAR predicts that public investment in the Madrid region of ECU one billion generates a further private investment of ECU 2.4 billion, for a total investment of ECU 3.4 billion (9). This is paralleled in the model by an employment generation of 770,000 person-years over 22 years (equivalent to 35,000 permanent jobs). From the analysis, the ratio of labour-to-total capital is thus equal to  $35,000/(1 + 2.4) = 10,000$  jobs per ECU billion. Interestingly, this is close to the figure seen in the previous analysis of the manufacturing sector.

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8) This is done by using a Hodrick-Prescott filter.

9) The SVAR analysis can be extended to capture interregional spillovers.

### Box 3. A description of the SVAR

A structural vector autoregression (SVAR) takes as its starting point a vector of variables observed at time  $t$  denoted  $X_t$ . In this example, the vector consists of five variables, namely the logarithm of the private capital stock (k), the logarithm of the public capital stock (g), the logarithm of employment (n), the logarithm of output (y) and the unemployment rate (u). In other words,  $X = \{k, g, u, n, y\}'$ . An SVAR is of the form

$$SX_t = B_0 + B_1X_{t-1} + B_2X_{t-2} + \dots + B_pX_{t-p} + e_t$$

where the  $B_i$  are matrices ( $i = 1, \dots, p$ ),  $B_0$  is a vector of the net effect of any deterministic variables and  $e_t$  is a vector of serially and mutually uncorrelated shocks. The individual components of  $e_t$  are the shocks driving the system. As such,  $e_t = \{e_k, e_g, e_u, e_l, e_d\}'$ . These are, in turn, shocks to private capital formation, public capital formation, the natural rate of unemployment, the labour force and aggregate demand. Unfortunately, due to the correlation between the endogenous regressors on the right-hand side and the error term, which is also manifested in non-zero off-diagonal elements in the matrix  $S$ , an SVAR cannot be directly estimated.

However, this is not the case for the following reduced form VAR

$$X_t = A_0 + A_1X_{t-1} + A_2X_{t-2} + \dots + A_pX_{t-p} + u_t$$

with  $A_i = S^{-1}B_i$  ( $i = 0, \dots, p$ ) and  $u_t = S^{-1}e_t$ , which can be estimated by Instrumental Variables.

In order to recover the coefficients of interest,  $B_i$  and  $S$ , certain restrictions are imposed on the elements of  $S$ . These restrictions are derived from either short- or long-run economic theory of the standard neo-classical variety.

There are also problems with the SVAR methodology, however. Based on time series data, this purely statistical technique has often been described as a method for "letting the data speak". In other words, the quality of the data that goes into the model is reflected in the subsequent results. In addition, the results are not only time-dependent, but also prone to false causality. A case in point is that public infrastructure gains cannot be duplicated once they have been reaped. In other words, investment in infrastructure where it has been lacking before may well lead to exaggerated effects. This is also reflected in agglomeration economics. Then there is the question of causality. The SVAR assumes a causal link between investment and employment, and disregards the possibility of investment projects as a result of historical accidents.

The results of the SVAR presented above are subject to the usual caveats concerning modelling exercises, and in particular that the SVAR methodology is a purely statistical technique. The results are time-dependent in the sense that public infrastructure gains cannot be duplicated once they have

been reaped. Investment in infrastructure today, for example, may not be as effective because a larger stock of capital already exists. In addition, the SVAR assumes a direct causal link between investment and employment, which may be either exaggerated or not necessarily true. Other factors omitted from the model, such as agglomeration effects, could also explain part of the increase in output and employment.

## 5. Conclusions

The above analysis has shown that the overall effects of investment on employment creation are difficult to estimate. Existing models, such as the three presented above, can only deal with specific facets of this relationship. However, the studies give some feeling for the size of the employment effects. In the construction phase, around 20,000 person-years of employment are created per ECU one billion spent. This number is roughly similar across different sectors of the economy and is falling at 1.5 to 2 percent per year. In the operational phase of an investment project in the manufacturing sector, around 170,000 person-years of employment over the average lifetime of a project are created. The average labour-to-capital ratio in this sector, roughly equal to 10,000 permanent jobs per ECU billion or ECU 100,000 per job in the first year, has also been falling. The marginal ratio seems to lie between 5,000 and 8,000 jobs per ECU billion, so the average ratio can be expected to fall further. Taking general equilibrium effects into account, similar results can be found in the structural vector autoregressions. This is also true for public investment, since this has the secondary effect of crowding in private investment. Taking all these effects into account, the net result, namely 10,000 person-years per ECU billion per year, is similar to the one found with the vintage capital model of the manufacturing sector.

*The overall effects of investment on employment creation are difficult to estimate.*

While the exact numbers of jobs created is prone to uncertainty, broad-based support for investment makes sense in terms of employment creation. In the construction phase, it may not be necessary to have a focused programme of public works. In fact, the employment benefits of programmes with relatively broad "eligibility" criteria may be equally large. However, an important feature of the European unemployment problem is the regional dimension, with unemployment being high in regions facing industrial restructuring. In this regard, investment is necessarily location specific and may be a particularly appropriate tool. Conversely, investment projects also require skilled labour and other inputs. As unemployment falls disproportionately on the unskilled, supporting investment may be a blunt tool for generating unskilled employment, if that is the only goal. Due to the important spillovers between sectors, it is clear that investment projects must be sound in their own right. Reliable figures on policy measures to boost employment are unlikely to be forthcoming. As a consequence, investment decisions as well as the employment benefits of supporting investment must, to a large degree, be based on economic reasoning.

## References

- Bean, C. (1997). "The Impact of Cohesion Fund Spending on Regional Output and Employment in the Presence of Interregional Spillovers". Modelling Report of the Economic and Social Cohesion Laboratory, The European Institute, London School of Economics and Political Science, for the European Commission, April.
- Commission of the European Communities (1997). "The Likely Macroeconomic and Employment Impact of Investments in Trans-European Transport Networks". Commission Staff Working Paper SEC(97) 10, January.
- Eurostat (1997). "The Capital Stock in the European Union: Structural Diagnosis and Analytical Aspects". Luxembourg: Office for Official Publications of the European Communities.