The determinants of employment in Europe, the USA and Japan

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Abstract

In this report, we investigate whether the determination of employment differs between Europe, Japan and the United States (US) and, for Europe, whether the determination of employment differs between the various sectors of industry. For this purpose, an employment equation is estimated on paneldata of several European countries, Japan and the US for the years 1970-1994. The conclusions are as follows. The output elasticities of Europe, Japan and the US are nearly the same, while for Japan the real wage elasticity at constant output is smaller than for the US and Europe. For the various sectors in Europe, it holds that the output elasticity of the sectors manufacturing, construction, wholesale and retail, finance and business services and community and personal services is bigger than that of the sectors electricity and transport. It is also true that the real wage elasticity at constant output is smaller for the sectors agriculture, construction and transport than for the sectors manufacturing, electricity, wholesale and retail, finance and business services and community and personal services.

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1 Introduction

During the last 25 years, the number of jobs has risen much faster in Japan and the US than in Europe. Particularly in the US, employment has risen at a much higher pace than in Europe (see figure 1). What are the causes for these differences? One possible cause is that in Japan, production has risen much faster than in Europe. However, this cannot be the reason that also the US have created many more jobs than Europe, since the development of production over time has been roughly the same for Europe and the US in the last 25 years (see figure 2). Another possible cause is that in Europe, wages have risen much faster than in the US. Normally, this has a negative effect on labour demand. The wage rise in Europe cannot explain the different growth paces of employment of Japan and Europe, since in Japan the wages have risen even faster than in Europe (see figure 3). In the figures 1, 2 and 3, 'EUR15' indicates the countries of the European Union.

With the help of a dataset with data on production, wages and employment of several European countries, Japan and the US for a number of years, we want to investigate whether we can explain the bigger employment growth in the US and in Japan from a possibly different *structure* of employment determination between the various countries. For example, it might be true that a rise in production in the US has a bigger (positive) effect on employment than a comparable rise in production in a European country. One might also think of a possibly bigger (negative) effect on employment of a wage rise in Europe, in comparison with the US or Japan. Besides possible differences between the European countries and the US and Japan, we are also interested in differences in employment determination between different sectors of industry in Europe. We are able to make this analysis because the data are available on the sectoral level.

In order to investigate the employment determination in different countries, we make use of a theoretical model. This model will be discussed in section 2. From this model we derive an employment equation which will be estimated with the available data. In section 3, the data will be discussed. The employment equation will be estimated for various countries and sectors for the different purposes of analysis. In section 4, the estimation results are reported and interpreted. Section 5, finally, contains a summary.

Figure 1 total employment (1970=100), 1970-1995

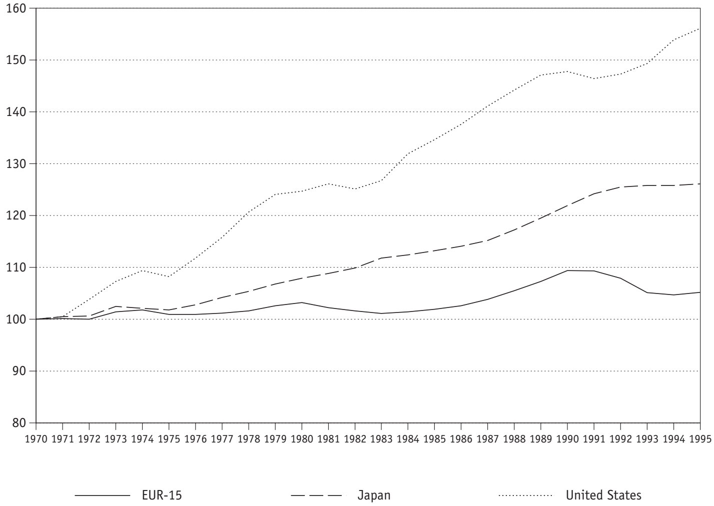


Figure 2 gross domestic product at constant prices, national currencies (1970=100), 1970-1995

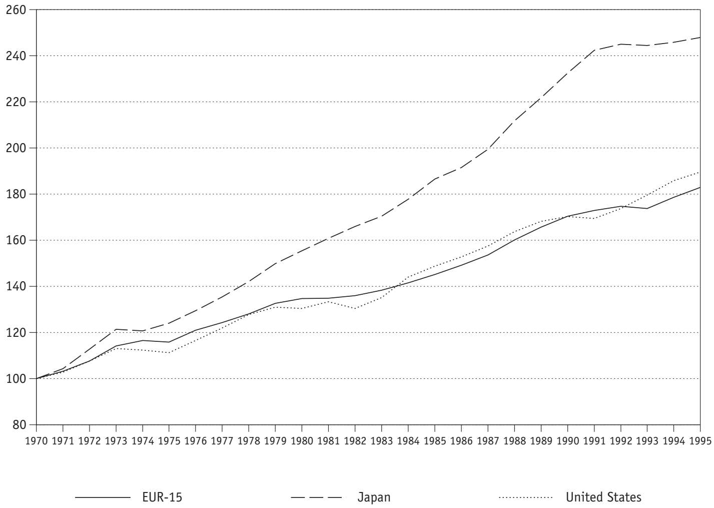
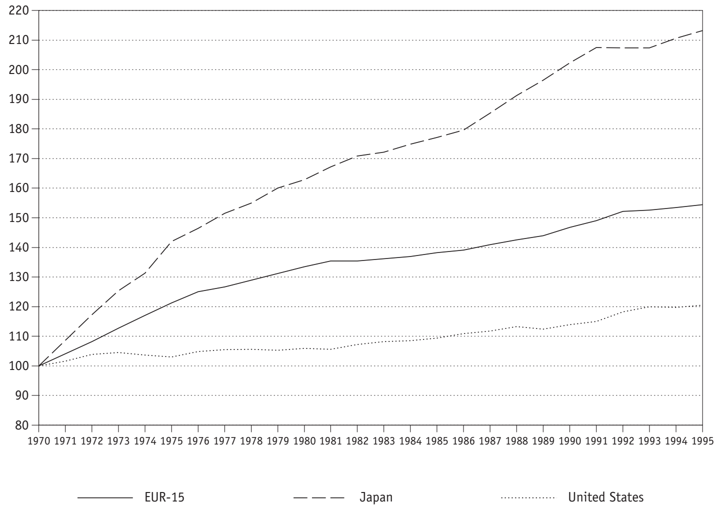


Figure 3 real compensation per employee, deflator GDP, total economy (1970=100), 1970-1995



Source: European Commission, Directorate-General for Economic and Financial Affairs.

2 Model

In this section, the employment equation which we have estimated will be derived from a theoretical model.

The model is based on the neoclassical theory of the demand for production factors. The derivation of the employment equation starts from assuming that the individual firm sets the employment level such that profits are maximized. Furthermore, we assume that the production technology can be described by a CES production function with constant returns to scale:

$$(2.1)\quad Y_{i,t} = [A_i(1+\alpha)^{\rho t}K_{i,t}^{\rho} + B_i(1+\beta)^{\rho t}N_{i,t}^{\rho}]^{1/\rho},$$
$$0 \neq \rho < 1, \qquad A_i, B_i > 0 \qquad \alpha, \beta \geq 0.$$

In (2.1) $Y_{i,t}$, $K_{i,t}$ en $N_{i,t}$ denote production, capital goods and the number of workers of a representative firm in industry i at time t, respectively. Capital-augmenting and labour-augmenting technical progress are captured by $(1+\alpha)^t$ en $(1+\beta)^t$, respectively, where t is a time index. Finally, we have the parameters A_i en B_i: these are scale parameters.

The firm considers the wage rate of employees and the capital stock exogenous. The firm faces a constant-elasticity demand curve for its products. Let η_i denote the absolute elasticity of demand. If $\eta_i \to \infty$, perfect competition prevails; if η_i is finite, the firm has monopoly power in the product market. The firm's maximization problem is (without time subscript):

$$(2.2)\quad \max_{N_i} \quad \pi_i(N_i) = P_i Y_i - W_i N_i$$
$$\text{s.t.} \quad Y_i = [A_i(1+\alpha)^{\rho t}K_i^{\rho} + B_i(1+\beta)^{\rho t}N_i^{\rho}]^{1/\rho},$$
$$Y_i = C_i\left(\frac{P_i}{P}\right)^{-\eta_i} Y.$$

In (2.2) π_i denotes profits of the representative firm in industry i, P_i the price level in industry i, and W_i the nominal wage rate. In the second restriction, C_i denotes a constant, and P and Y denote aggregate price level and aggregate demand, respectively. This is a quite common specification for demand in industry i; however, other specifications are possible.

By solving (2.2) and writing the variables in natural logarithms, we find:

$$(2.3) \quad n_{i,t} = \sigma\left[b_i + \ln\left(1 - \frac{1}{\eta_i}\right)\right] - \beta(1-\sigma)t - \sigma(w_{i,t} - p_{i,t}) + y_{i,t}$$

$$\beta, \sigma \geq 0.$$

In (2.3) we make use of the relation $\sigma = 1/(1 - \rho)$. The variables in logarithms are denoted by lower case letters. Of course, this does not hold for the variable t (the time index). Furthermore, the expression $\ln(1 + \beta)$, which we find in the original solution of (2.2), is approximated by β and $\ln B_i$ is denoted by b_i.

We are not so much interested in the estimated coefficients themselves, but more in a number of long-run employment elasticities which can be derived from the estimated parameters. It concerns the following elasticities:

- the *elasticity of factor substitution between capital and labour* (symbol σ). This is defined as the change in the proportion of the used amounts of input as a result of a change in the proportion of the (real) prices of the production factors.

  Formally: $\sigma = \dfrac{d\ln(K/L)}{d\ln(w/r)} \geq 0$,

  where K, L, w en r stand for the amounts of capital and labour and the real prices of labour and capital, respectively. One can prove that for the CES-technology it holds that: $\sigma = 1/(1 - \rho)$. We made use of this expression in (2.3).

- the *real wage elasticity at constant output* (symbol η_{LL}). This measures the response of labour demand on an exogenous rise in real wages while output and the price of capital remain constant. We can also write this elasticity as $\eta_{LL} = -(1 - s_N)\sigma < 0$, where s_N denotes the share of labour in value added (see Allen 1938, pp. 372–73).

- the *output elasticity* (symbol η_Y). This elasticity says something about the number of jobs that is created in the long run when a small change in output takes place. For example, when η_Y equals 1.1, it means that a 1% change in output results in a 1.1% change in the number of employees (in the same direction as the output change).

Besides these elasticities, we are also interested in the rate of labour-augmenting technical progress. This is the parameter β from the production function (2.1).

When estimating (2.3), what we actually estimate is this:

$$(2.4) \qquad n_{i,t} = \gamma_{0,i} + \gamma_1 t + \gamma_2(w_{i,t} - p_{i,t}) + \gamma_3 y_{i,t} + \varepsilon_{i,t}.$$

In (2.4) $\varepsilon_{i,t}$ is an error term. This is assumed to be a white noise process. If we compare (2.3) and (2.4), we can find the following relations between the parameters which we actually estimate ($\gamma_{0,i}$ up to γ_3) and the theoretical parameters β, σ, b_i and η_i from (2.3):

$$\gamma_{0,i} = \sigma\,(b_i + \ln\,(1 - 1/\eta_i)), \qquad \gamma_1 = -\beta\,(1 - \sigma),$$
$$\gamma_2 = -\sigma, \qquad \gamma_3 = 1.$$

Now we can derive the long-run employment elasticities from the estimated parameters. The elasticity of substitution equals $\sigma = -\gamma_2$, the real wage elasticity at constant output equals $\eta_N = -(1 - s_N)\sigma = (1 - s_N)\gamma_2$ and the output elasticity can be obtained as $\eta_Y = \gamma_3$. The rate of labour augmenting technical progress, finally, follows from the estimated parameters as $\beta = -\gamma_1/(1 + \gamma_2)$.

Model in first differences

In reality employment adjustments do not take place immediately because of search times for new employees, terms of notice etcetera. Therefore it is often necessary to include one or more lagged dependent variables in the model (in this case we would thus have a lagged employment term). In such cases the dependent variable can not be entirely explained from the explanatory variables (other than the lagged dependent variable). A model with a lagged dependent variable as explanatory variable is called a *partial adjustment model*. In such a model the endogenous variable is written as a weighted average of the lagged dependent variables and the 'real' explanatory variables. In the case of one lagged dependent variable, we can write the partial adjustment model as follows:

$$(2.5) \qquad y_{i,t} = \lambda y_{i,t-1} + (1 - \lambda)\boldsymbol{X}_{\mathbf{i,t}}$$

In (2.5) the parameter λ is the adjustment parameter and $\boldsymbol{X}_{\mathbf{it}}$ is the matrix with explanatory variables (other than the lagged dependent). Now we can write the partial adjustment model for (2.3) as follows:

$$(2.6)\qquad n_{i,t} = \lambda n_{i,t-1} + (1-\lambda)\sigma\left[b_i + \ln\left(1-\frac{1}{\eta_i}\right)\right] - (1-\lambda)\beta(1-\sigma)t$$
$$-(1-\lambda)\sigma(w-p)_{i,t} + (1-\lambda)y_{i,t}$$

The original theoretical model (2.3) is now a special case of (2.6): set λ equal to zero.

Because the estimation of (2.6) with OLS would yield inconsistent parameter estimates (the transformation which takes place with OLS to eliminate the sector-specific constants is not allowed when there is a lagged dependent variable as a regressor), we write the model in first differences:

$$(2.7)\qquad \Delta n_{i,t} = \lambda\Delta n_{i,t-1} - (1-\lambda)\beta(1-\sigma) - (1-\lambda)\sigma\Delta(w-p)_{i,t}$$
$$+ (1-\lambda)\Delta y_{i,t}.$$

The model that is actually estimated (not with OLS, by the way) looks as follows:

$$(2.8)\qquad \Delta n_{i,t} = \vartheta_0 + \vartheta_1\Delta n_{i,t-1} + \vartheta_2\Delta(w-p)_{i,t} + \vartheta_3\Delta y_{i,t} + \Delta\varepsilon_{i,t}.$$

In (2.8) $\varepsilon_{i,t}$ is the error term of (2.6). By comparing (2.7) and (2.8), we can find the following relations between the parameters which we actually estimate (ϑ_0 up to ϑ_3) and the theoretical parameters λ, β and σ from (2.7):

$$\vartheta_0 = -(1-\lambda)\beta(1-\sigma) \qquad \vartheta_1 = \lambda$$
$$\vartheta_2 = -(1-\lambda)\sigma \qquad \vartheta_3 = (1-\lambda)$$

Again, we can derive the long-run employment elasticities from the estimated parameters. The substitution elasticity equals $\sigma = -\vartheta_2/(1-\vartheta_1)$, the real wage elasticity at constant output equals $\eta_N = -(1-s_N)\sigma = (1-s_N)\vartheta_2/(1-\vartheta_1)$ and the output elasticity can be calculated as $\eta_Y = \vartheta_3/(1-\vartheta_1)$. The parameter β finally, follows from the estimated parameters as $\beta = -\vartheta_0/(1-\vartheta_1+\vartheta_2)$.

With the lagged dependent variable in the model, we are able to compute yet another characteristic which may be of interest: this is the *speed of employment adjustment*. This measures the speed with which actual employment can be adjusted to a new desired level of employment. The speed of employment adjustment can be obtained as $(1-\vartheta_1)$. A high value of the speed of employment adjustment means that employment is determined for a big part by the 'real' explanatory variables wage and production and for a small part by the lagged dependent variable. When the speed of employment adjustment is low, this is the other way around.

3 Data

In this section the data with which the equations (2.4) and (2.8) are estimated, are discussed. Also, we name the countries and sectors for which the equations are estimated.
The data come from the Organisation for Economic Co-operation and Development (OECD)[1]. The data are aggregated on the sectoral level and are available for several countries and for several years.

The dataset contains the following variables which are used to estimate the equations (2.4) and (2.8):

C.GDP: this is *gross domestic product at current prices* (measured in market prices).
K.GDP: this is *gross domestic product at constant prices.*
COM: this is *compensation of employees* (labour costs for the employer).
TE: this is *total employment* (employees as well as self-employed).
EE: this is *employment of employees.*
MHE: this is *total manhours worked by employees.*

Now we will describe how the variables from the equations (2.4) and (2.8) are measured in terms of the above mentioned variables from the dataset. Also, we describe how the share of labour in value added s_N, which we need to calculate the output elasticity η_Y, is constructed out of the available data.

The variable n_i from the model is measured as the variable ln (TE) from the dataset.

The variable $(w_i - p_i)$ (the real wage) from the model is measured as ((ln (COM) – ln (EE)) – (ln (C.GDP) – ln (K.GDP))). The first part of the theoretical variable $(w_i - p_i)$, w_i, or ln (W_i), is thus measured as (ln (COM) – ln (EE)). This part represents the nominal wage rate and is computed as the compensation of employees divided by the number of employees (apart from the log-transformation). Because the theoretical variable represents the wage rate of *all* workers (including the self-employed), and since self-employed persons do not get wages, we can not measure this part of the variable entirely accurate. However, by using (ln (COM) – ln (EE)) for the nominal wage rate, we assume that the (imputed) wage rate of self-employed persons is equal to the average wage rate of employees. This is standard statistical practice. The

1 OECD, National accounts (1970-1994).

second part of the theoretical variable $(w_i - p_i)$, p_i, or ln (P_i), is measured as (ln (C.GDP) - ln (K.GDP)).

For the variable y_i we use ln (K.GDP).

Finally, the time index t is constructed as a variable which runs from zero until the number of available years minus one (for example, when we have data for some country or sector for the years 1977 until 1993, then t runs from 0 until 16).

The share of labour in value added is defined as s_N = WL/PY, that is, the compensation of all workers divided by total yields of a firm. The symbol L stands for 'labour services'. In our model we have measured this as the number of workers, denoted by the symbol N. Because we estimate the equations on the level of countries or sectors, we also use the total compensation and the total yields of an entire country or sector. The denominator of the above stated expression (PY) is easily measured as C.GDP, the gross domestic product at current prices. The nominator WL, however, must be approximated, because we have data only on the compensation of employees (variable COM), whereas WL represents the compensation of *all* workers. Now, the compensation of all workers is approximated by multiplying the variable COM by TE/EE. Again, we implicitly assume that the 'wage rate' of an average self-employed person is equal to the wage rate of an average employee. The approximation becomes less reliable according as there are relatively more self-employed persons in a country or sector. Between countries, there are no big differences in the relative number of self-employed. For the different sectors of industry, however, it holds that in the sector agriculture there are much more self-employed persons than in the other sectors. The approximation of the share of labour in value added is therefore less reliable for agriculture than for the other sectors.

Countries and sectors in the analysis

The data on the variables are available for twelve European countries: Belgium, Denmark, Finland, France, Iceland, Italy, Luxembourg, Netherlands, Norway, Spain, Sweden and West-Germany. Also, there are data for the non-European countries Australia, Japan and the US (we look at Australia out of general interest, this country does not relate to the situation that was described in the introduction of this report). For all these countries, the data on the various variables are available at the sectoral level. The following sectors are distinguished[1]: agriculture, manufacturing, electricity, construction, wholesale and retail, transport, finance and business services and community and personal services. For Italy, the data of the last two mentioned sectors were combined into one sector. This sector is therefore not comparable with the sectors of other countries. We have not used this sector. This implies that for Italy, we have data of only six sectors in stead of eight. The data are available for several years. The number of available years however, differs per country and sometimes also per sector. The maximum period of time for which data can be available for a country is 1970–1994.

Both the equation in levels (2.4) and the equation in first differences (2.8) are estimated for the 15 countries and the 8 sectors from the dataset. The estimations for the sectors concern only the European countries. For the estimations on country-level, we made use of all the available data for the countries concerned, that is, all sectors in all years available for the country are included in the sample. For the estimations on sector-level, we combined the available data for the concerning sectors of the European countries in the dataset.

Calculation of share of labour in value added

The elasticities which are described in section 2 are calculated on the basis of the regression results. For the output elasticity, however, we also need the share of labour in value added. For the different types of estimation, this is calculated in the following ways (with the help of the variables COM, C.GDP, TE and EE, which were described earlier).

For the estimations on *country-level*, we start by computing the share of labour per country per year as follows:

$$s_{k,j} = \frac{\sum_{i=1}^{8} W_{i,j,k} N_{i,j,k}}{\sum_{i=1}^{8} P_{i,j,k} Y_{i,j,k}} \qquad k = 1, \ldots, 15, \qquad j = a_k, \ldots, b_k.$$

The symbols *i, j* and *k* denote sectors, years and countries, respectively and the symbols a_k and b_k denote the first and the last year for which data are available for country *k*. When for a certain year the data were not available for *all* sectors, we made use of another ‘sector’ in the dataset, namely 'Total Industries'. This item gives the data for a certain country for all industries taken together (excluding the government) and approximately equals the sum of the eight sectors used. Now, the share of labour in value added for country *k* becomes:

1 The sectoral classification is according to OECD, National accounts (1970-1994). The sector mining and quarrying is not included in our research.

$$s_{N,k} = \frac{\sum_{j=a_k}^{b_k} s_{k,j}}{b_k - a_k + 1}, \qquad k = 1, \ldots, 15.$$

As can be seen, the share of labour in value added is weighted over the sectors but not over the years. We weighted over the sectors because a bigger sector is more important for a country than a smaller one. We did not weigh over the years because we use a long-term model and we do not know whether possibly different values of the labour share in recent years are of a structural nature. It would then be premature to use only the recent years (or to give them a higher weighting factor).

For the estimations on *sector-level*, we start by computing the share of labour per sector per country:

$$s_{i,k} = \frac{\sum_{j=a_{k,i}}^{b_{k,i}} s_{i,j,k}}{b_{k,i} - a_{k,i} + 1}, \qquad i = 1, \ldots, 8, \qquad j = a_{k,i}, \ldots, b_{k,i}.$$

As before, the symbol k runs only over the European countries. The symbols $a_{k,i}$ and $b_{k,i}$ now stand for the first and the last year per country per sector for which data are available, whereas $s_{i,j,k}$ stands for the share of labour in value added of sector i in year j in country k: $s_{i,j,k} = (W_{i,j,k} N_{i,j,k})/(P_{i,j,k} Y_{i,j,k})$. The share of labour per sector is now calculated by averaging over the European countries:

$$s_{N,i} = \sum s_{i,k}/12, \qquad i = 1, \ldots, 8.$$

Thus, we do not correct for the size of countries. We do not do this because the differences in shares of labour between the different countries are not very big (see table 1a in section 4.1). Therefore, we don't think it is worthwhile to make a complex calculation in order to construct proper weighting factors for the different countries.

4 Results

We have estimated the equations (2.4) and (2.8) for 15 countries and 8 sectors. The equation in levels (2.4) is estimated by instrumental variable estimation (IV). Because we specify the country-specific or sector-specific effects as a fixed effect (as opposed to a random effect), we will indicate the estimations of (2.4) as fixed-effects estimations. The equation in first differences (2.8) is estimated by the *generalized method of moments* (GMM), see Arellano and Bond (1991) and Wansbeek (1997). For both estimation techniques we have used as instruments for the variables real wage and real production a number of lags of these variables. The restriction of constant returns to scale is not imposed during estimation, that is, the restrictions $\gamma_3 = 1$ (model in levels) and $\vartheta_3 = (1 - \vartheta_1)$ (model in first differences) which were derived in section 2, are not imposed during estimation. In this way we reduce the chance on misspecification of the model.

4.1 Country-estimations

In this section we present the results of the estimations for the different countries. We will do this by showing the elasticities which can be derived from the parameter estimates and which were described in section 2. In the tables 1a and 1b, we state the results of the substitution elasticity σ, the real wage elasticity at constant output η_N, the output elasticity η_Y and the rate of labour-augmenting technical progress β. Also, we state the share of labour in value added s_N, the estimation period (first column) and the number of observations. Table 1a provides the results of the equation in levels (2.4), or the results of the fixed-effects-estimator, while table 1b provides the results of the equation in first differences (2.8), or the results of the GMM-estimator. Besides the above mentioned elasticities, table 1b also provides the speed of employment adjustment.

Table 1a Results country-estimations fixed-effects estimator (model in levels)*

Country	obs.	σ	s_N	η_N	η_y	β
Belgium	124	0.833	0.666	-0.278	0.888	0.049
1977-1992		(0.086)		(0.029)	(0.076)	(0.023)
Denmark	176	0.988	0.652	-0.344	0.724	-0.061**
1973-1994		(0.065)		(0.023)	(0.061)	(0.389)
Finland	168	0.620	0.659	-0.211	1.645	0.074
1974-1994		(0.207)		(0.071)	(0.167)	(0.031)
France	96	0.881	0.602	-0.350	0.941	0.093**
1980-1991		(0.070)		(0.028)	(0.063)	(0.048)
Iceland	72	0.734**	0.680	-0.235**	1.082**	-0.029**
1984-1992		(0.542)		(0.173)	(0.634)	(0.090)
Italy	138	0.492	0.649	-0.173	0.637	0.011
1972-1994		(0.031)		(0.011)	(0.049)	(0.002)
Luxembourg	134	-0.696**	0.588	0.287**	0.761	0.017
1974-1991		(0.448)		(0.185)	(0.215)	(0.003)
Netherlands				X		
Norway	144	0.856	0.651	-0.299	0.792	0.001**
1974-1991		(0.108)		(0.038)	(0.161)	(0.028)
Spain	44	0.571	0.551	-0.256	0.992	0.007**
1988-1994		(0.088)		(0.040)	(0.136)	(0.009)
Sweden	96	0.907	0.658	-0.310	0.708	-0.075**
1983-1994		(0.089)		(0.031)	(0.084)	(0.101)
West-Germany	172	0.870	0.594	-0.353	0.826	0.010**
1973-1994		(0.052)		(0.021)	(0.040)	(0.010)
Australia	112	0.909	0.594	-0.369	0.577	-0.016**
1981-1994		(0.090)		(0.037)	(0.192)	(0.065)
Japan	168	0.638	0.615	-0.246	1.072	0.047
1974-1994		(0.069)		(0.026)	(0.057)	(0.009)
United States	112	0.929	0.607	-0.365	1.130	0.084**
1980-1993		(0.089)		(0.035)	(0.177)	(0.153)

* Standard errors are given in parentheses.

** Not significant at 5% level.

X Estimation not included because of rejection of instruments.

Table 1b Results country-estimations GMM-estimator (model in first differences)*

Country	obs.	σ	s_N	η_N	η_y	β	sp. of adj.
Belgium 1980-1992	100	1.375** (0.707)	0.666	-0.459** (0.236)	1.307 (0.546)	-0.020** (0.036)	0.222** (0.147)
Denmark 1974-1994	168	0.881 (0.179)	0.652	-0.307 (0.062)	0.538 (0.115)	-0.014** (0.041)	0.141 (0.059)
Finland 1974-1994	168	0.655 (0.139)	0.659	-0.224 (0.048)	1.277 (0.165)	0.077 (0.026)	0.181 (0.031)
France 1981-1991	88	0.946 (0.194)	0.602	-0.376 (0.077)	0.856 (0.172)	0.110** (0.320)	0.316 (0.117)
Iceland 1984-1992	72	0.195** (0.181)	0.680	-0.062** (0.058)	1.280 (0.296)	0.037 (0.013)	0.271 (0.071)
Italy 1974-1994	126	0.469 (0.149)	0.649	-0.165 (0.052)	0.483 (0.151)	0.025** (0.018)	0.090 (0.045)
Luxembourg 1974-1991	134	0.213** (0.203)	0.588	-0.088** (0.083)	1.168 (0.416)	0.007** (0.012)	0.094 (0.046)
Netherlands 1981-1994	94	0.585 (0.203)	0.642	-0.209 (0.073)	0.348** (0.184)	-0.006** (0.014)	0.300 (0.082)
Norway 1975-1991	136	0.481 (0.119)	0.651	-0.168 (0.042)	1.351 (0.233)	0.051 (0.012)	0.114 (0.036)
Spain 1990-1994	28	0.552 (0.075)	0.551	-0.248 (0.034)	0.997 (0.146)	0.011** (0.008)	0.699 (0.073)
Sweden 1984-1994	88	0.630 (0.137)	0.658	-0.215 (0.047)	0.819 (0.180)	0.013** (0.014)	0.344 (0.080)
West-Germany 1975-1994	156	0.462 (0.172)	0.594	-0.188 (0.070)	0.731 (0.096)	0.012** (0.007)	0.446 (0.074)
Australia 1984-1994	88	1.504 (0.750)	0.594	-0.610 (0.305)	1.027 (0.410)	-0.013** (0.020)	0.358 (0.180)
Japan 1974-1994	168	0.422 (0.211)	0.615	-0.162 (0.081)	1.027 (0.153)	0.034 (0.011)	0.107 (0.037)
United States 1981-1993	104	0.718 (0.197)	0.607	-0.282 (0.078)	0.590 (0.160)	-0.027** (0.030)	0.725 (0.119)

* Standard errors are given in parentheses.

** Not significant at 5% level.

In the tables 1a and 1b the second column reports the number of observations that is actually used for the respective estimations. This number is reported because not all the data for the reported estimation period are available. By reporting only the estimation period we would give a false impression of the amount of observations that is actually used in the estimations. The reported estimation period is a maximum period. By this we mean the period of the sector for which data for the largest number of years are available (for the country concerned). By looking at the reported estimation period and the number of observations, one can get an impression of the relative amount of data with respect to the reported period. For example, the reported period for the fixed-effects estimation of Belgium is 1977-1992 and the number of observations is 124. If the data for all these years would be available for all eight sectors, we would have $8 \times 16 = 128$ observations. Since the actual number of observations is 124, we conclude that for this estimation, almost all the data for the reported period are indeed available. In this way we can get a picture of the relative amount of data actually used with respect to the reported estimation period for every country.

Differences between fixed-effects and GMM

When we look at the results of the fixed-effects estimations and the GMM-estimations for the various countries, it attracts attention that in a number of cases, the results found differ rather a lot between the two techniques. This means that we have to be very careful when interpreting the results. We have a number of suppositions about the causes of these differences. One possible cause is that the correlation between the instruments used and the disturbances is 'too strong', through which the estimations become inconsistent. We test for this correlation by means of the so-called Sargan-test (see Stewart 1991, pp. 145-46). By 'too strong', one must not think of a large rejection of the null hypothesis of the Sargan-test ('proper instruments') but of a value of the test statistic that is such that the null hypothesis is not rejected at a significance level of 5%, but ìs rejected at a significance level of 10%. Only for the FE-estimation of the Netherlands, the null hypothesis was heavily rejected, indicating a real strong correlation between instruments and disturbances. For this reason, the estimation results for the Netherlands are not reported in table 1a.

Another possible cause for the differences between FE and GMM is that there are too few GMM-restrictions per observation (see Arellano and Bond, 1991) through which we make use of too little information during estimation. When we have only a few GMM-restrictions, this is because in such cases more restrictions turn out to lead to a rejection of the Sargan-test. Still other possible causes are a too low speed of employment adjustment which makes it not sensible to estimate the equation without a lagged employment term and a weak correlation between the instruments used and the explanatory variables for which the instruments are used. An indication that this last reason may be in force is when we must make use of long lags of the variables real wage and real production as instruments (because shorter lags lead to rejection of the Sargan-test).

When one of the above mentioned phenomena coincides with an estimation with high standard errors or inplausible results (like very low output elasticities, for example), then it is likely that the estimation result is due to one (or more) of the above mentioned phenomena. Based on these considerations we 'reject' the GMM-results of Belgium, Denmark, Luxembourg, Australia and the US and the FE-results of Finland, Iceland, Italy and Luxembourg. Note that the arising of these underlying phenomena is not reported here. It can be found in Van Stel (1997).

Technological development

Another thing about the estimation results that attracts attention is this: when we find a very low output elasticity η_y (significantly smaller than one), then it is often the case that we also find an insignificant value of β, the rate of labour-augmenting technical progress. In some cases the estimated value of β is even negative. It seems that in such cases the model does not succeed in assigning the labour-augmenting technical progress to the parameter β, but that this technical progress finds expression by means of increasing returns to scale (an output elasticity smaller than one). The unrealistic low value of β may have to do with a misspecification of the model. The labour-augmenting technical progress is modelled by a trendterm, thus it is assumed that technical progress is the same every year. This does not necessarily have to be true: technical progress might be larger in certain years, for example by new inventions. Also the value of β might differ between different sectors, for instance because in certain sectors there will be worked more with machines that are subject to technological changes than in other sectors. It may then be the case that it is not possible to estimate the value of β well for a country as a whole, because of the different technological developments which the different sectors are facing. However, it is not always true that a (very) low value of β is attended with a (very) low output elasticity η_y. Thus, for some countries it may indeed be true that there are increasing returns to scale. However, when we find increasing returns to scale, we must be very cautious to accept this result; as said before, it may well have to do with a bad estimate of the parameter β. Unfortunately, in these cases (a low β in combination with a low η_y) we can not be sure about the correctness of the estimation results found. The phenomenon of a low output elasticity in combination with an insignificant or even negative value of β arises with Denmark (both GMM- and FE-estimation), Italy (GMM + FE), Netherlands (GMM), Sweden (FE), West-Germany (GMM + FE), Australia (FE) and the US (GMM).

Robustness of results

Before we draw some conclusions about the results found for the country-estimations, we want to check whether our results are robust against a different specification of the model. Particularly, we look at the inclusion of the variable 'hours worked per worker' in the regression equation. This variable may influence employment: when people are working fewer hours per day, it seems logical that a firm engages more people in order to make the same production level. The expected sign of the variable is thus negative.
Now, we want to look whether the inclusion of the variable 'hours worked per worker' influences the values of the elasticities that we found in the tables 1a and 1b. If this turns out to be the case, we will not be able to interpret the results found from the tables 1a and 1b, since the estimation results would then be the consequence of mis-specification.

The inclusion of the variable 'hours worked per worker' can be modelled in the following way. Instead of the variable N_i from the production function (2.1), which represented the number of workers in firm i, we will now use the variable 'labour services' L_i. This is defined as $L_i = N_i H_i^{\gamma}$. The variable H_i stands for the number of hours worked per worker per year. The variable L_i thus represents the total number of hours worked by all workers per year (that is, if $\gamma = 1$). The parameter γ represents the *elasticity of labour services with respect to working hours*. If $\gamma < 1$, it means that an extra hour worked leads to a rise of labour services that is less than proportional: people become tired at the end of the day through which every extra working hour becomes less effective. When we fit in the variable $L_{i,t}$ in the production function, we find:

$$Y_{i,t} = [A_i(1+\alpha)^{\rho t} K_{i,t}^{\rho} + B_i(1+\beta)^{\rho t} N_{i,t}^{\rho} H_{i,t}^{\gamma\rho}]^{1/\rho}, \tag{4.1}$$

$$0 \neq \rho < 1, \qquad A_i, B_i > 0, \qquad \alpha, \beta \geq 0, \qquad 0 \leq \gamma \leq 1.$$

By solving the maximization problem (2.2) for the new production function (4.1) we find the following labour demand equation (see Lever (1996)):

$$(4.2) \quad n_{i,t} = \sigma\left[b_i + \ln\left(1 - \frac{1}{\eta_i}\right)\right] - \beta(1-\sigma)t - \sigma(w_{i,t} - p_{i,t}) + y_{i,t} - \gamma(1-\sigma)h_{i,t}$$

$$\beta, \sigma \geq 0, \qquad 0 \leq \gamma \leq 1.$$

The equation that is actually estimated looks like:

$$(4.3) \quad n_{i,t} = \gamma_{0,i} + \gamma_1 t + \gamma_2(w_{i,t} - p_{i,t}) + \gamma_3 y_{i,t} + \gamma_4 h_{i,t} + \varepsilon_{i,t}.$$

When we compare (4.2) and (4.3) and express the substitution elasticity σ, the real wage elasticity at constant output η_N, the output elasticity η_y and the rate of labour-augmenting technical progress β again as functions of the estimated parameters $\gamma_{0,i}$ up to γ_4, we find the same relations as we found in section 2 with the original model. This is also true for the model in first differences that we use for the GMM-estimations. For completeness, we also write down the estimated equation for the model in first differences:

$$(4.4) \Delta n_{i,t} = \vartheta_0 + \vartheta_1 \Delta n_{i,t-1} + \vartheta_2 \Delta(w-p)_{i,t} + \vartheta_3 \Delta y_{i,t} + \vartheta_4 \Delta h_{i,t} + \Delta\varepsilon_{i,t}.$$

The theoretical variable $h_{i,t}$ is measured as (ln (MHE) – ln (EE)) (see section 3.1). This represents the average number of manhours worked per year per employee. Note that by measuring $h_{i,t}$ in this way we implicitly assume that the average self-employed person works as much as an average employee in a year. Because the number of self-employed persons is relatively small, we do not consider this a big problem. Since the data on the variable MHE (total manhours worked by employees) are only available for the countries Finland, Norway, Sweden and the US, we can only estimate the equations (4.3) and (4.4) for these four countries. The results are reported in the tables 1c and 1d. In these tables, γ_4 en ϑ_4 represent the estimated coefficients of the variable h_i from the equations (4.3) and (4.4), respectively.

Table 1c Results with 'hours worked' in regression, FE-estimator*

Country	obs.	σ	s_N	η_N	η_y	β	γ_4
Finland	168	0.622	0.659	-0.212	1.714	0.085**	-0.530**
1974-1994		(0.192)		(0.065)	(0.238)	(0.044)	(0.804)
Norway	144	0.667	0.651	-0.233	0.950	-0.005**	0.870**
1974-1991		(0.139)		(0.048)	(0.192)	(0.013)	(0.449)
Sweden	96	0.849	0.658	-0.290	0.626	-0.073**	-0.482
1983-1994		(0.086)		(0.029)	(0.086)	(0.057)	(0.184)
US	112	0.928	0.607	-0.365	0.955	0.036	-0.697
1980-1993		(0.068)		(0.027)	(0.137)	(0.075)	(0.118)

* Standard errors are given in parentheses.

** Not significant at 5% level.

Table 1d Results with 'hours worked' in regression, GMM-estimator*

Country	obs.	σ	s_N	η_N	η_y	β	ϑ_4	sp. of adj.
Finland	168	0.644	0.659	-0.220	1.270	0.073	0.031**	0.181
1974-1994		(0.121)		(0.041)	(0.204)	(0.036)	(0.160)	(0.037)
Norway	136	0.428	0.651	-0.149	1.323	0.041	0.042**	0.113
1975-1991		(0.109)		(0.038)	(0.220)	(0.011)	(0.055)	(0.038)
Sweden	88	0.626	0.658	-0.214	0.745	-0.002**	-0.159**	0.383
1984-1994		(0.136)		(0.047)	(0.194)	(0.015)	(0.101)	(0.062)
US	104	0.722	0.607	-0.284	0.556	-0.027**	-0.290**	0.778
1981-1993		(0.151)		(0.059)	(0.179)	(0.024)	(0.336)	(0.086)

* Standard errors are given in parentheses.

** Not significant at 5% level.

When comparing the results from the tables 1c and 1d with the results of the equations without the variable ‘hours worked’ as a regressor from the tables 1a and 1b, it attracts attention that the GMM-estimations hardly differ between the two specifications. This probably has to do with the fact that the parameter ϑ_4 is not significant (for all four estimations). When we look at the FE-estimations, we see that there *are* some differences between the results of both specifications, particularly in the output elasticity η_y. The estimations with a significant value of γ_4 (Sweden and the US) have output elasticities which are a little smaller in comparison with the original model. This seems plausible: a rise in employment is now for a smaller part explained from the output elasticity, because it is partly explained from a fall in the number of working hours worked by an average worker. However, the differences between both specifications of the model are small, so that we can conclude that the estimations of the original model (2.4) and (2.8) for which the data on the variable MHE are not available, have not been influenced much by the absence of the variable 'hours worked', that is, there is no misspecification of the model. Now, we can indeed draw conclusions from our estimation results.

When we compare the results of Europe with those of the US and Japan, we will form a (rough) picture of the values of the various elasticities for Europe by looking at the estimation results of the regressions of the separate European countries.

Conclusions

With some caution, we can now draw some conclusions about the results of the country estimations. When doing this, we keep in mind the developments of employment, production and wages in Europe, Japan and the US from the figures 1, 2 and 3 of the introduction. Also, we will leave out of consideration the rejected estimation results which were mentioned earlier.

When we look at the estimation results from the tables 1a and 1b, we see that the output elasticity η_y of many European countries approximately lies between 0.7 and 0.9, while the output elasticity of the US equals 1.13 and the output elasticity of Japan equals 1.03 (GMM-estimation). After including the variable 'hours worked' in the regression, η_y equals 0.96 for the US. The real wage elasticity at constant output η_N of Europe approximately lies between –0.2 and –0.4, while for the US, η_N equals –0.37 and for Japan, η_N equals -0.16.

It seems to be the case that the US and Japan benefit somewhat more under a certain level of economic growth (in terms of creating jobs) than Europe: the output elasticity is bigger. The differences are not large, though. The smaller employment growth in Europe in comparison with the US must mainly be imputed to the wage rise in Europe: every percentpoint wage rise causes a loss in employment of between 0.2 and 0.4 percentpoint (this is at a constant output, in reality there will also be a scale effect, through which employment falls down even harder).

The big wage rise in Japan did not have such a large negative effect on employment: η_N equals -0.16 for Japan, this value is smaller than that of Europe (and also than that of the US). Because of the larger production growth and, in a smaller extent, because of the larger value of η_y, Japan too has created more jobs than Europe, in spite of the larger wage rise in Japan.

When we finally take a quick look at Australia, we see that the estimation results of Australia are more or less comparable to those of the European countries: η_N lies between -0.2 and -0.4 and η_y is smaller than one.

4.2 Sector-estimations

In this section the results of the sector estimations are presented. These results will again be stated in terms of the long-run employment elasticities. Table 2a gives the results of the equation in levels (2.4), that is, the results of the fixed-effects-estimator, while table 2b gives the results of the equation in first differences (2.8), that is, the results of the GMM-estimator.

The maximum estimation period is put in the heading of the table. This is now the period of the *country* for which the most years are available. This period is (almost) the same for all sectors because the sector estimations combine the data of the European countries for the sectors concerned. Because there are countries for which all data are available (thus for the years 1970-1994, as mentioned in section 3.1), the maximum estimation period for every sector is 1972-1994 (because of the use of lagged variables as instruments we lose a couple of years). For the GMM-estimations the maximum estimation period is 1974-1994. Now we can look at the relative amount of data used per estimation in the same way as with the country-estimations. For instance, for the GMM-estimation of the sector agriculture, the estimation period is 1974-1994 and the number of observations is 183. If we would indeed have the data on the various variables for all the years 1974-1994 for all twelve European countries that are used for the sector estimations, we would have $12 \times 21 = 252$ observations. However, we have only 183 observations, that is 73% of the data for the estimation period mentioned. In this way, we can calculate for every sector how many percent of the data of the estimation period mentioned is actually used for estimating.

Table 2a Results sector-estimations fixed-effects estimator (max. estimation period 1972-1994)*

Sector	obs.	σ	s_N	η_N	η_y	β
Agriculture	195	0.257 (0.075)	0.792	-0.053 (0.016)	0.852 (0.131)	0.042 (0.003)
Manufacturing	192	0.721 (0.088)	0.693	-0.221 (0.027)	0.936 (0.133)	0.041 (0.014)
Electricity	203	0.222 (0.037)	0.326	-0.149 (0.025)	0.409 (0.054)	0.004 (0.002)
Construction				X		
Wholesale and retail	188	0.689 (0.094)	0.728	-0.188 (0.026)	1.059 (0.086)	0.019 (0.006)
Transport	206	0.232 (0.042)	0.745	-0.059 (0.011)	0.467 (0.056)	0.007 (0.003)
Finance and business services	152	-0.861** (0.552)	0.376	0.537** (0.345)	-0.054** (0.470)	-0.014 (0.004)
Community and personal services	146	0.555 (0.200)	0.646	-0.197 (0.071)	0.910 (0.099)	0.017** (0.009)

* Standard errors are given in parentheses.

** Not significant at 5% level.

X Estimation not included because of rejection of instruments.

Table 2b Results sector estimations GMM-estimator (max. estimation period 1974-1994)*

Sector	obs.	σ	s_N	η_N	η_y	β	sp. of adj.
Agriculture	183	0.313 (0.102)	0.792	-0.065 (0.021)	0.186** (0.136)	0.026 (0.006)	0.249 (0.057)
Manufacturing	180	0.301** (0.165)	0.693	-0.092** (0.051)	0.822 (0.164)	0.029 (0.005)	0.356 (0.048)
Electricity	167	0.261 (0.133)	0.326	-0.176 (0.090)	0.102** (0.276)	0.012** (0.019)	0.173** (0.093)
Construction	172	0.331 (0.114)	0.802	-0.066 (0.022)	0.890 (0.103)	0.010 (0.003)	0.760 (0.062)
Wholesale and retail	164	0.678 (0.140)	0.728	-0.184 (0.038)	0.914 (0.088)	0.015** (0.010)	0.329 (0.064)
Transport	170	0.320 (0.120)	0.745	-0.082 (0.030)	0.430 (0.162)	0.007** (0.009)	0.249 (0.053)
Finance and business services	141	0.284** (0.167)	0.376	-0.177** (0.104)	1.065 (0.266)	0.008** (0.016)	0.227 (0.070)
Community and personal services	135	0.494** (0.441)	0.646	-0.175** (0.156)	0.451** (0.908)	-0.025** (0.098)	0.244** (0.243)

* Standard errors are given in parentheses.

** Not significant at 5% level.

Differences between fixed-effects and GMM

As was the case with the country-estimations, we also find some (big) differences between the fixed-effects estimations (FE) and the GMM-estimations for the various sectors in the European countries. Again we argue that certain 'bad' estimates (big standard errors or implausible results) are due to the problems mentioned in the previous section 4.1. When we look at the values of the Sargan-test statistics and the instruments used for the various estimations (which are not reported in this report, as said before), we reject the GMM-results of the sectors manufacturing, electricity and community and personal services, and the FE-results of the sector finance and business services. Furthermore, it attracts attention that the output elasticity η_y of the sector agriculture is very different for both estimation methods: 0.19 with GMM versus 0.85 with FE. Based on the possible causes of the difference that we have used so far to choose between both methods, we are not able to reject one of the methods for this sector. This means that we are, unfortunately, not able to draw an unambiguous conclusion about the value of the output elasticity of the sector agriculture. We could only say that the value of 0.85 seems more plausible than the extreme low value of 0.19.

Conclusions

When we look at the various estimation results in the tables 2a and 2b (again not considering the rejected estimation results), we find the following. The output elasticity η_y of the sectors manufacturing, construction, wholesale and retail, finance and business services and community and personal services approximately lies between 0.9 and 1.0, while for the sectors electricity and transport, η_y lies between 0.4 and 0.5. As observed before, we cannot draw an unambiguous conclusion about the output elasticity of the sector agriculture. Thus, in the five sectors first mentioned employment benefits more under a certain level of economic growth than in the sectors electricity and transport.

An explanation for the low output elasticity of the sector electricity may be that the production process in this sector is very capital intensive. A rise in production is then, for example, a consequence of a rise in the number of capital goods or of a bigger capital productivity of the present capital goods. The rise in production is then not necessarily attended with a rise in employment, which could explain the low value of η_y. Another explanation may be the fact that in many countries the sector electricity forms part of the public sector. Because of this, there is a smaller incentive to maximize profits, as is assumed in the derivation of our model (see the beginning of section 2). Now, it could be the case that the electricity companies actually employ more people than necessary to work in an efficient way. A rise in production may then be explained by a temporary bigger effort of the employees (because there is a busier period of the year, for example). The rise in production is then not attended with a rise in employment, which leads to a low output elasticity.

The real wage elasticity at constant output η_N of the sectors manufacturing, electricity, wholesale and retail, finance and business services and community and personal services lies between –0.15 and –0.25, while for the sectors agriculture, construction and transport η_N approximately equals –0.06. Employment in these last sectors is thus less sensitive to possible wage rises.

Another striking feature of the estimation results is the very high speed of employment adjustment in the sector construction. This is probably because of the fact that in this sector, many contracts are concluded on a temporary basis, for example contracts for the duration of one project. These contracts can be concluded in a short period of time, such that the desired level of employment can be achieved relatively fast.

5 Summary

In this report we investigated whether the determination of employment differs between Europe on the one hand, and Japan and the United States on the other hand. For Europe, we also investigated whether the determination of employment differs between the various sectors of industry. For this purpose, an employment equation was estimated on paneldata of several European countries, Japan and the US for the years 1970-1994. The conclusions are as follows. The output elasticities of Europe, Japan and the US are nearly the same, while for Japan the real wage elasticity at constant output is smaller than for the US and Europe. That is, given a certain level of economic growth, approximately the same number of jobs is created in Europe, Japan and the US (ceteris paribus) and employment in Japan is less sensitive to possible wage rises than employment in Europe and the US. For the various sectors of Europe, it holds that the output elasticity of the sectors manufacturing, construction, wholesale and retail, finance and business services and community and personal services is bigger than that of the sectors electricity and transport. It is also true that the real wage elasticity at constant output is smaller for the sectors agriculture, construction and transport than for the sectors manufacturing, electricity, wholesale and retail, finance and business services and community and personal services.

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