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Abstract

We investigate the trade-off between employment and labour productivity in a panel of OECD countries in 1970-2003. The endogeneity of employment is shown to matter crucially for assessing its effect on productivity. Estimating a structural model with 3SLS, where employment depends on demographic variables and labour market institutions, we find that employment tends to boost productivity. Literature ignoring the endogeneity of employment, including our own OLS results, incorrectly finds a negative or insignificant effect from employment on productivity. The productivity gain is, however, not a guaranteed by-product of additional employment, as regressions with rolling windows reveal.

Key words: labour productivity, employment

JEL codes: E20, J24, O41

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1 Introduction

The key objective of this paper is to investigate the impact of employment on labour productivity in the long run. The cyclical fluctuations have been extensively investigated, with mixed results. At the other extreme, Kremer (1993) argues that through most of history, pointing at the very long run, the growth rate of world population is positively related to improvements in technology: societies with greater initial population attained higher technology levels and population densities. Our focus is on the time span of decades, rather than quarters or centuries, which we take as the long run. Our main research question is: does an increase in employment, in participation or in hours per worker, affect productivity in the long run?

The relevance of our research is twofold. First, countries can raise production by working more and/or more efficiently. Does one element go at the expense of the other? The United States' record is quite good in both respects: it combines a high participation rate and long working hours with high productivity levels – at least in comparison with the West-European countries. Countries like Ireland, France and the Netherlands outperform the US in terms of hourly productivity, but lag behind in terms of labour effort (Ederveen et al., 2007). Other countries like Japan, Switzerland and many central-European countries work more, but less efficiently than the US.[1] Would these countries be able to increase their productivity by cutting employment? And, will West-European countries be able to raise their labour effort without deteriorating their productivity?

Secondly, our main question is at the heart of the Lisbon agenda, which intends to raise both employment (jobs) and productivity (growth). Clearly, the European Union has the objective (though likely with a long-run vision) of becoming the most competitive economy in the world in 2010, in terms of both productivity and employment. Again, a pressing question is whether there is a trade-off between both objectives in the long run.

Several studies relate the long-run development of productivity (over a period of 10 years or more) to employment. To start with a very long sample, Greasley and Madsen (2006) have a 135-year sample (1870-2005) in which they observe a stable relationship between the levels of employment and productivity, with an elasticity of -0.4. Several studies investigate the post-war period. Beaudry and Collard (2002) use cross-country regressions relating the change in output-per-worker (over 15 of 25 year periods) to the change in employment and the initial level of output-per-worker. Using a panel of 18 OECD countries for the period 1960-1997, they find that the change in employment results

[1] The United States outperforms many other OECD countries in both respects: both productivity per hour and hours worked per capita are higher in the US.

in a large and systematic reduction of labour productivity. They extend their analysis to both developed and developing countries in Beaudry et al. (2004) with similar results. The same estimation methodology is used by Cavelaars (2005), but instead he uses 10-year rolling windows for all OECD countries from 1960 to 2000. He finds a negative impact of employment on labour productivity for the period 1961-1980, but the trade-off disappears in the period 1980-2000. The European Commission (2007) uses the same methodology, but for a sample period of 1960 to 2000 for EU15 Member States. They find a negative relation throughout the whole sample period. However, after 1980 the trade-off is less pronounced, but stable.

A critical weakness of the previous studies is the lack of attention to the endogeneity of employment. Only the study of Beaudry and Collard (2002) explicitly deals with endogeneity by instrumenting employment with active population. However, the broader theoretical and empirical literature clearly points at a bi-causal relationship between employment and productivity – both in the short run and in the long run. In the short run, employment will affect productivity if capital adjusts slowly while higher productivity may make labour temporarily redundant.[2] In the long run, higher productivity will raise wages which likely raises the supply of labour. The opposite causal direction cannot be excluded either. It clearly does not exist in a standard Solow growth model, where total factor productivity is determined exogenously in the long run. However, even in a Solow-context, employment shocks may affect total factor productivity on average if an employment shock affects the composition of the labour force: additional labour might be highly educated, but less experienced; and working more hours per week may only add less productive hours. Moreover, endogenous growth models show that productivity might benefit from economies of scale (Aghion and Howitt, 1998; Bottazzi and Peri, 2007). These arguments show that two-way causality cannot be excluded in advance, not even in

[2]The debate about the short-run impact of employment on productivity is unresolved. First, it is unclear whether employment and productivity are positively (Canova et al., 2007, 2008) or negatively related (Gali, 1999; Dedola and Neri, 2007). Second, it is unresolved whether the causality runs from productivity to employment or vice versa. Both real business cycle (RBC) models and new Keynesian models investigate the impact of exogenous technology shocks on employment. RBC models point at a positive relation, which they explain by standard neoclassical economics. New Keynesian economics explain a negative relation by introducing price rigidities. These literatures do not discuss the reverse effect of employment on productivity. Recently, Denis et al. (2005) apply the structural VAR methodology (similar to Gali, 1999)) to identify employment shocks with long-run identification restrictions. In a sample of Euro area countries in the period 1995-2003 they show that an employment shock has a negative impact on productivity in the short run. By regression productivity growth on employment growth in a panel of 25 OECD countries in 1992-2000, Belorgey et al. (2004) find that employment has an elasticity of about -0.4 on labour productivity. A similar short-run is estimated by Bourlès and Cette (2005).

the long run.

We take the endogeneity of employment into account by including both demographic variables (like Beaudry and Collard, 2002) and labour market institutions as instruments for employment and hours per worker. The single paper which similarly copes with the endogeneity of employment, though in a short-run growth setting, is Dew-Becker and Gordon (2008). This paper shows that employment growth (instrumented with the tax wedge, the degree of corporatism and union density) tends to reduce productivity growth with an elasticity of about -0.6.

We show that the endogeneity of employment matters crucially for the results. Estimating a structural model with 3SLS, where employment depends on demographic variables and labour market institutions, we find that employment tends to boost productivity. This contrasts with the existing literature and with our own OLS results where a negative though insignificant elasticity is estimated. Regressions with rolling windows reveal, however, that the employment-productivity relation is unstable. This relation of productivity to total hours is refined to the intensive and extensive margin of employment. We show that the extensive margin of employment tends to boost productivity. The elasticity to hours per worker cannot, however, be precisely estimated.

In section 2, we setup a structural model on the link between employment and productivity and motivate the choice for demographic variables and labour market institutions to instrument employment. Section 3 regresses labour productivity on total hours and on the intensive and extensive margin separately. Section 4 concludes.

2 Structural approach using a system of equations

2.1 Theoretical framework

We setup the theoretical model which will be estimated with a panel of OECD-countries. We first relate labour productivity to total hours worked, which is subsequently separated/divided into the intensive margin (hours per worker) and the extensive margin (persons employed). Employment, in turn, will be regressed on productivity, labour market institutions and demographic variables.

Consider a production function in labour and capital with constant returns to scale (CRS), which can be written in intensive form as $y = Af(k)$, where $y \equiv \frac{Y}{H}$ denotes production (Y) per hour (H), $k \equiv \frac{K}{H}$ is capital (K) per hour and A measures productivity. This production function can be linearised to:

$$\ln y_{ct} = \ln A_{ct} + \alpha_{ct} \ln k_{ct} \tag{1}$$

where c indexes countries and t indexes years.

There is an endogenous relationship between labour productivity and capital. To avoid this problem in our regressions, we fix the capital-income share α for each country.[3] In addition, we decompose $\ln A_{ct} = \ln \left[A_{c0}(1+g)^t\right] = \ln A_{c0} + g_c t$, where g_c is the country-specific trend rate of TFP growth.[4] We can now rewrite (1) as:

$$\ln y_{ct} = \beta_{c0} + \beta_{c1} t + \widehat{\alpha_c} \ln k_{ct}, \tag{2}$$

where β_{c0} and β_{c1} are the estimated values for $\ln A_{c0}$ and g_c, respectively.

Our empirical strategy consists of including an extra term in equation (2) to account for the possible effect of extra employment (measured as total hours) on labour productivity. Therefore, the equation to be estimated is:

$$\begin{aligned} &\ln y_{ct} = \widehat{\alpha_c} \ln k_{ct} + \beta_{c0} + \beta_{c1} t + \gamma \ln H_{ct} + \varepsilon_{ct} \\ &H_0 : \gamma = 0 \\ &H_1 : \gamma \neq 0 \end{aligned} \tag{3}$$

The null hypothesis is that total hours does not affect capital-adjusted labour productivity ($\ln y_t - \widehat{\alpha} \ln k_t$), as follows from the Solow growth model, while the alternative hypothesis states that hours worked does affect productivity.

In the extension of the model, we distinguish the extensive and intensive margins of employment, namely persons employed (L) and hours per worker (h), such that $H = hL$. Substituting in (3) and allowing for the productivity effects of h and L to be different, i.e. $\gamma_1 \neq \gamma_2$, then we estimate:[5]

$$\begin{aligned} &\ln y_{ct} = \widehat{\alpha_c} \ln k_{ct} + \beta_{c0} + \beta_{c1} t + \gamma_1 \ln h_{ct} + \gamma_2 \ln L_{ct} + \varepsilon_{ct} \\ &H_0 : \gamma_1 = 0 \text{ and } \gamma_2 = 0 \\ &H_1 : \gamma_1 \neq 0 \text{ or } \gamma_2 \neq 0 \end{aligned} \tag{4}$$

2.2 Key determinants of employment

To control for the endogeneity of total hours, we include also a labour market equation. We assume that labour hours are determined not only by labour productivity, but also by

[3] These country-specific capital shares are taken from Bernanke and Gürkaynak (2001). The interpretation of α as capital share strictly holds for a Cobb-Douglas production function only. Sensitivity analysis shows, however, that the assumption about the capital shares does not drive the results.

[4] We found that the estimated coefficients for g_c have significant country variation. Moreover, there are serial correlation problems when not including country-specific time trends.

[5] If indeed $\gamma_1 \neq \gamma_2$ then (3) is unnecessarily restricting the effects of h and L on labour productivity.

labour market institutions, demography and labour taxes.

$$\ln H_{ct} = a_{c0} + b_{c1} \ln y_{ct} + \boldsymbol{\rho}\mathbf{LM} + \boldsymbol{\lambda}\mathbf{D} + \varepsilon_{ct} \tag{5}$$

where **LM** is a matrix of labour taxes and labour market institution variables (i.e. union density, employment protection, unemployment benefit duration, average replacement rate, collective bargaining coverage). **D** is a matrix of demographic variables (i.e. the population share for two age groups: 15-49 and 50-64, and the dependency ratio). The corresponding coefficients are vectors $\boldsymbol{\rho}$ and $\boldsymbol{\lambda}$.

There is no need to argue that employment depends on demographic variables. In the context of the employment-productivity relation, few papers take this dependence into account. In a series of papers, Beaudry and Collard (2002) and Beaudry et al. (2004, 2005) use population growth to avoid the endogeneity problem. Their empirical strategy is based on a technological change being present. Beaudry et al. (2005) argue that around 1995 structural change took place. Thus, the relationship they found could be time-specific and may have changed after 1995. These papers show a strong co-movement between output-per-worker and labour variables (population, labour force and employment), suggesting that demographics variables have both a strong effect on employment and productivity.

Other studies incorporate demographic variables into the analyses of the employment-productivity relationship. Feyrer (2007) argues that demographic differences explain much of the cross-country variation in economic performance between rich and poor countries. He estimates the impact of demographics on productivity in a panel for 87 countries in the period 1960-1990. Arguing that people at mid-ages have the highest productivity levels, he finds that a 5% increase in the size of the cohort of 40 to 49 years, over a ten-year period, results in an increase in productivity growth between 1% to 2% in each year of the decade. Since demographic variables directly affect labour supply, these studies provide an indirect channel between employment and productivity.

Labour market reforms can affect the employment-productivity link in several ways. These reforms are aimed at increasing employment, but can also affect labour productivity. The effect can run indirectly through the expected increase in employment, but also directly (i.e., better functioning labour markets may induce productivity improvements). Given the diversity of labour market institutions that can be reformed (e.g. EPL, labour taxes, unemployment benefits, minimum wages, collective wage bargaining), there are several complex channels through which the reforms can affect the relationship between employment and labour productivity.

The European Commission (2007) details the theoretical functioning of several of these mechanisms through which labour (and product) market reforms interact with the employment and productivity relationship. There are many empirical papers that analyse the

effect of labour market institutions on employment[6], but only a subset of this literature also deals with the effects on productivity. Allard and Lindert (2006), Bassanini and Venn (2007) and OECD (2007) estimate the effect of several labour market policies on labour productivity: policies like minimum wages and parental leave tend to raise productivity, labour taxes and protectionist labour market institutions tend to be harmful, but several other labour market policies do not have a significant effect. The effect of employment protection is supported by Autor et al. (2007), who find tentative evidence that employment protection legislation (EPL) increases labour productivity but reduces TFP in the US. For a panel of OECD countries, Belot et al. (2007) show that there exists an inverse U-shape relationship between employment protection and economic growth.[7]

There is no way to summarize briefly such a complex and rich literature. However, it is clear that the possible trade-off between employment and productivity is highly dependent on the country-specific labour market institutions.

3 Empirical results

3.1 Data

We use a sample of 15 countries: Austria (AUT), Belgium (BEL), Germany (DEU), Denmark, (DNK), Spain (ESP), Finland (FIN), France (FRA), United Kingdom (GBR), Ireland (IRL), Italy (ITA), Japan (JPN), the Netherlands (NLD), Portugal (PRT), Sweden (SWE), and the United States (USA) for the period 1970-2003. Annual data on employment, capital stocks and labour market indicators are taken from the OECD, while demographic values are from United Nations.[8]

In Appendix A we plot the series of labour productivity, total hours, employed workers and hours per worker. It is interesting to note that for all countries labour productivity is increasing in our sample period, while hours per worker is decreasing. The trend in persons employed differs over countries and it is not monotonic, and thus, total hours has also a country-specific trend.

We estimate the system of equations for total hours given by equations (3) and (5). We deliberately choose to estimate both equations in levels, as first-differencing would remove

[6] For instance, Bassanini and Duval (2006) assess the impact of several labour market indicators for OECD countries in the last decade. They find robust relations between different labour market policies and employment.

[7] Cahuc and Koeniger (2007) summarize the articles of the Economic Journal issue that deals with EPL. Also see the OECD (2004) for an overview of the effects of EPL on labour market performance.

[8] See Appendix B for the definition of the variables and the specific sources.

Table 1: Average growth rates of main variables for two sample periods

		Labour productivity		Total hours		Employment		Hours per worker	
		70-86	87-03	70-86	87-03	70-86	87-03	70-86	87-03
Austria	AUT	3.4%	2.0%	0.4%	0.5%	1.1%	0.9%	–0.2%	–0.2%
Belgium	BEL	3.9%	1.5%	–1.1%	0.6%	0.0%	0.8%	–1.1%	–0.1%
Germany	DEU	3.0%	2.2%	–0.4%	–0.3%	0.7%	0.6%	–1.1%	–0.8%
Denmark	DNK	3.3%	1.8%	0.0%	0.1%	0.9%	0.3%	–0.9%	–0.2%
Spain	ESP	3.3%	1.2%	–0.1%	2.7%	0.1%	3.0%	–0.3%	–0.3%
Finland	FIN	3.6%	2.7%	0.6%	–0.1%	1.1%	0.0%	–0.7%	–0.2%
France	FRA	3.8%	2.0%	–0.2%	0.6%	0.9%	1.1%	–1.2%	–0.7%
United Kingdom	GBR	1.7%	2.1%	–0.7%	0.5%	–0.4%	0.8%	–0.2%	–0.3%
Ireland	IRL	3.6%	4.2%	0.1%	2.7%	0.9%	3.4%	–0.8%	–0.7%
Italy	ITA	2.4%	1.6%	0.7%	0.6%	0.6%	0.8%	0.1%	–0.4%
Japan	JPN	4.4%	2.6%	1.3%	0.1%	1.7%	0.9%	–0.4%	–0.7%
Netherlands	NLD	3.4%	1.1%	–0.5%	1.6%	0.8%	2.0%	–1.3%	–0.4%
Portugal	PRT	3.4%	3.3%	–0.1%	0.1%	0.4%	0.6%	–0.4%	–0.5%
Sweden	SWE	1.5%	2.0%	0.9%	0.0%	0.9%	–0.1%	0.0%	0.1%
United States	USA	1.5%	1.5%	1.6%	1.3%	1.9%	1.4%	–0.4%	–0.1%
mean[a]		3.1%	2.1%	0.2%	0.7%	0.8%	1.1%	–0.6%	–0.4%

[a] Mean is the unweighted average of the growth rates of each variable.

the information on long-run behaviour which we are interested in.[9]

To cope with the endogeneity of employment, we apply three stage least squares (3SLS).[10] This method allows for endogenous variables to be among the explanatory variables in some of the structural equations. It also corrects for the correlation between the disturbance terms and the endogenous variables, as well as for the correlation between the disturbances among equations. We will compare these system estimates with OLS, which given the endogeneity problem will likely produce biased coefficient estimates.

We test for multicollinearity among the exogenous demographic and institutional variables. We select variables which are sufficiently uncorrelated (with correlation < 0.7). Moreover, we excluded variables with insufficient time variation (like employment protection and union coverage). The instrumental variables used are: the population share of the 50-64 age group (*ag_50_64*), the dependency ratio (*dep_ratio*), trade union density (*undens*), the average unemployment benefit replacement rate (*arr*) and the total labour tax revenue as a proportion of GDP (*totlabtax*).

The sample period is from 1970 to 2003 (34 annual observations in 15 countries), but following the results from the literature we do not expect that the coefficients are stable for the whole sample. For example, Beaudry et al. (2005) and Cavelaars (2005) found a structural change around 1980 in the relationship between employment growth and labour productivity growth. To check the previous results, we use Chow tests for structural breaks in 1980 and 1990, which rejects the hypothesis of stable coefficients.[11] Figure 1 visualises the instability of the elasticity of total hours in equation (3), where we run regressions using a rolling 15-year sample to check the stability of the coefficients. An increase in total hours tend to raise productivity, but the elasticity fluctuates between 0.05 and 0.7 and is not always significant.

The positive coefficient from employment in the productivity equation rejects a clear

[9] The stationarity of the residuals indicates whether or not the estimated relation between employment and productivity is stable. However, the instability of the regressions result makes these cointegration tests redundant.

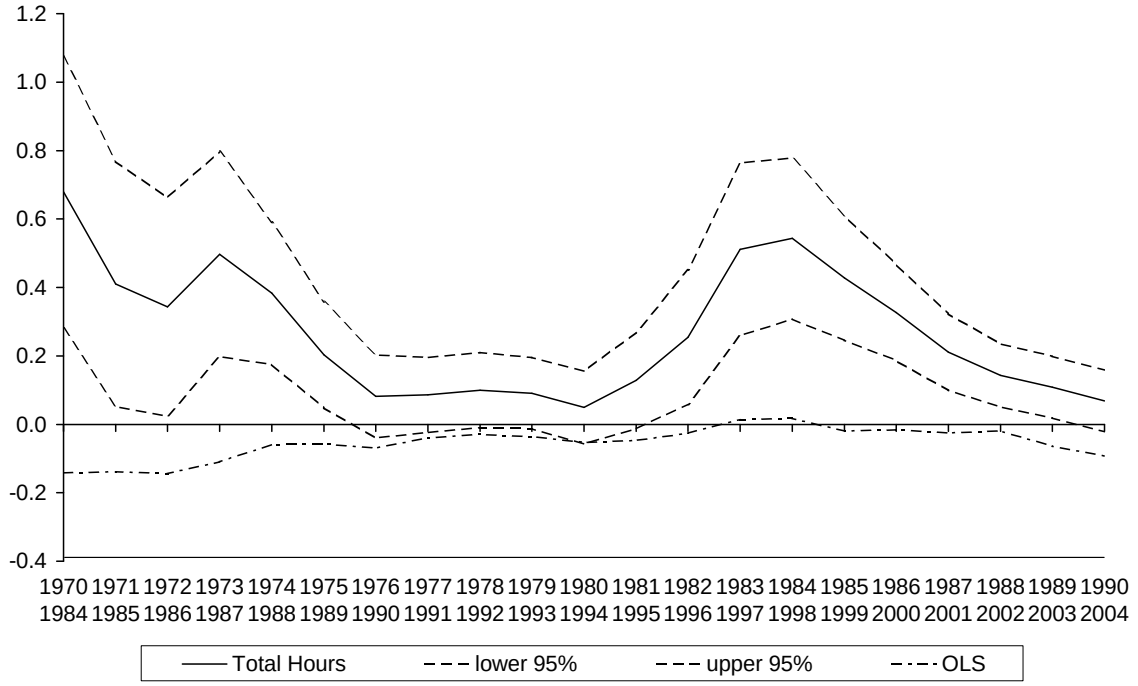
[10] See StataCorp (2007) for the application of 3SLS in Stata. Given the short samples we deal with in the rolling windows, we apply 3SLS with small-sample statistics correction as standard 3SLS would produce too small standard errors.

[11] To compute the Chow statistic we use the residual sum of squares (rss) of equation (3) for each sub-sample, and rss_c from the full sample. The Chow statistic is given by:

$$Ch = \left|\frac{\frac{rss_c-(rss_1+rss_2)}{k}}{\frac{rss_1+rss_2}{N_1+N_2-2k}}\right| \tag{6}$$

where k is the number of parameters in equation (3), N_1 and N_2, are the number of observations in each sub-sample. Ch is distributed as $F(k, N_1 + N_2 - 2k)$.

Figure 1: Elasticity of productivity to total hours (parameter and 10% confidence interval, with 15-years rolling regression)



trade-off between employment and productivity. For the whole period employment and productivity go hand in hand, which we explain from changes in the composition of the labour force. An expansion of employment will stimulate productivity if additional workers are more productive than those leaving the labour market. The introduction of the new general purpose technology (ICT) in the eighties might have temporarily diminished the productivity margin of new workers, who had to spend time in learning and adoption rather than in productive work, as is also suggested by Beaudry et al. (2005). A likely explanation for the declining coefficient in recent years is the EU-wide reliance on policies to stimulate participation, such that less productive workers left the labour market at lower rates and inexperienced workers entered. More research is needed to support these somewhat speculative explanations for the variation in the employment-productivity relation of Figure 1.

In our setup, we deliberately take the endogeneity of total hours into account. The OLS-line in Figure 1 shows the empirical relevance of this approach: we would seriously underestimate the elasticity of total hours on productivity would we ignore this endogeneity by estimating with ordinary least squares. In fact, the OLS estimate is generally negative, but insignificant.

Table 2: System estimate of productivity and total hours

	1970-1984	1975-1989	1980-1994	1985-1999	1990-2003
Productivity					
$\ln H$	0.679***	0.203**	0.049	0.428***	0.068
	[0.203]	[0.079]	[0.054]	[0.093]	[0.046]
Total hours					
$\ln y$	-0.066**	0.028	0.054	0.276***	0.204**
	[0.032]	[0.038]	[0.050]	[0.061]	[0.086]
ag_50_64	0.001	–0.001	–0.002	–0.006	0.007
	[0.005]	[0.004]	[0.005]	[0.006]	[0.006]
dep_ratio	2.636***	2.399***	2.045***	0.091	-0.796***
	[0.350]	[0.301]	[0.381]	[0.352]	[0.274]
undens	-0.006***	0.001	0.000	–0.000	-0.009***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]
arr	0.003***	-0.003***	-0.005***	–0.001	0.002
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
totlabtax	–0.286	0.823**	-1.368***	-3.114***	-2.101***
	[0.296]	[0.394]	[0.408]	[0.383]	[0.410]
Observations	200	215	222	223	208

The productivity equation (3) includes country fixed effects, country specific time trends and corrects for capital adjustment by fixing country-specific values for $\widehat{\alpha_c}$. Standard errors are given in brackets.

Table 2 shows for a selection of windows the estimate of both equations in the system. Clearly, the instability is not only present in the productivity equation, but also in the total-hours equation. Higher productivity encourages employment in recent decades, but has tempered it in the seventies and early eighties. In early years, households may have substituted employment for leisure (by working less hours) in response to higher income. In recent years, higher productivity may have encouraged participation. The table also shows that both demographic variables and labour market institutions significantly affect total hours.

3.2 Productivity, employment and hours per worker

We investigate whether the link between employment and productivity can be contributed to the intensive or extensive margin. A first indication of the results is already provided by the raw data analysis (see Table 4), which point at the fact that total hours is highly positively correlated with the number of persons employed, but less with hours per worker. We therefore run the 3SLS for the system of equations for separated persons employed and hours per worker, as presented in Table 3.[12]

The ambiguity in the total-hours estimates, on the causality from productivity to employment, is partly resolved in Table 3. The table confirms that productivity stimulates participation, but depresses hours per worker (in favour of leisure). The table cannot prove that the latter effect dominates in the seventies whereas the participation effect drives the elasticities in more recent decades.

The intensive and extensive margin of employment affect productivity differently, i.e. $\gamma_1 \neq \gamma_2$ in equation (4). Figure 2 shows that the elasticity of productivity to total hours is closely related to the employment elasticity. Implausible, however, are the size and the fluctuation of the elasticity of the intensive margin, which fluctuates between -2 and $+2$. For example, an elasticity of -2 would imply that total production declines by 1% if hours per worker expands by 1%. Moreover, a reduction in the estimated elasticity of 4 percentage points, by rolling the window with 2 years is implausible.[13]

[12] The labour market equation is split into:

$$\ln h_{ct} = a_{hc} + b_{hc} \ln y + \boldsymbol{\rho}_h \mathbf{LM} + \boldsymbol{\lambda}_h \mathbf{D} + \varepsilon_{hct} \quad (7)$$

$$\ln L_{ct} = a_{Lc} + b_{Lc} \ln y + \boldsymbol{\rho}_L \mathbf{LM} + \boldsymbol{\lambda}_L \mathbf{D} + \varepsilon_{Lct} \quad (8)$$

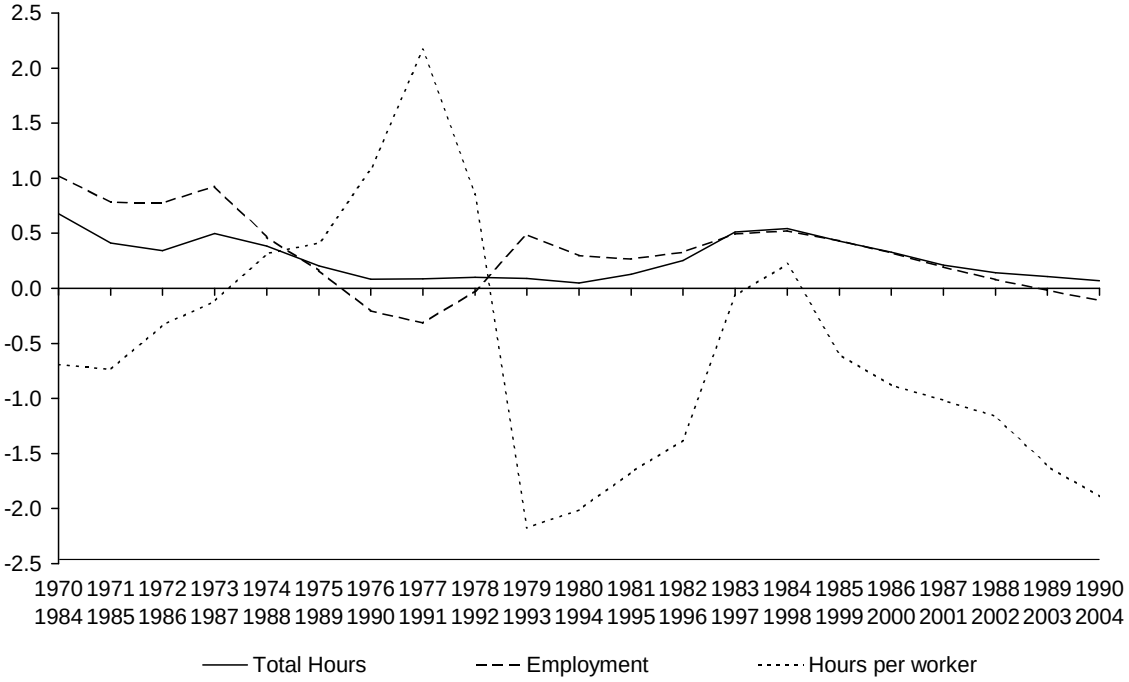
The system of equations is now given by (4), (7) and (8).

[13] We checked whether this result is due to an outlier (or data problem) in a single country, by eliminating each country from the system (one by one, such that we repeatedly regress the rolling window for fourteen countries). This does not resolve the fluctuation in the elasticity of productivity to hours per worker.

Table 3: System estimate of productivity, employment and hours per worker

	1970-1984	1975-1989	1980-1994	1985-1999	1990-2003
Productivity					
ln_emp	1.022***	0.162	0.299***	0.433***	-0.112*
	[0.162]	[0.136]	[0.086]	[0.148]	[0.060]
ln_h_worker	-0.690*	0.411	-2.011***	–0.598	-1.887***
	[0.377]	[0.351]	[0.512]	[0.755]	[0.331]
Employment (persons)					
ln_labpty	0.202***	0.193***	0.192***	0.322***	0.300***
	[0.026]	[0.037]	[0.053]	[0.063]	[0.087]
ag_50_64	-0.008*	–0.001	0.009*	–0.000	0.002
	[0.004]	[0.004]	[0.005]	[0.006]	[0.006]
dep_ratio	1.556***	1.366***	2.065***	0.858**	–0.168
	[0.281]	[0.296]	[0.402]	[0.365]	[0.277]
undens	-0.006***	0.001	0.000	–0.002	-0.012***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]
arr	0.003***	-0.002**	-0.006***	-0.002*	0.000
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
totlabtax	–0.147	1.246***	-1.077**	-3.103***	-2.517***
	[0.236]	[0.386]	[0.427]	[0.396]	[0.417]
Hours per worker					
ln_labpty	-0.279***	-0.168***	-0.120***	-0.038**	-0.103***
	[0.014]	[0.015]	[0.017]	[0.017]	[0.023]
ag_50_64	0.011***	0.000	-0.010***	–0.002	0.004***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.001]
dep_ratio	1.025***	0.940***	–0.110	-0.804***	-0.480***
	[0.147]	[0.121]	[0.131]	[0.097]	[0.073]
undens	0.000	–0.000	0.000	0.002***	0.003***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]
arr	–0.000	-0.001***	0.000	0.000	–0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
totlabtax	–0.140	-0.531***	-0.285**	0.071	0.365***
	[0.124]	[0.159]	[0.136]	[0.108]	[0.104]
Observations	200	215	222	223	208

Figure 2: Elasticity of productivity to total hours, employment and hours per worker



The key findings of this empirical analysis are that one should take the endogeneity of employment seriously and that the relation between employment and productivity is quite unstable, but tends to be positive.

Both findings do not critically depend on the country-sample, as the exclusion of one or another country in our sample does not qualitatively affect our conclusions. Even splitting the sample in two sub samples, for example by taking the Anglo-Saxon countries out, does not change our results: total hours and employment tend to raise productivity to a varying and sometimes insignificant degree, and the elasticity to hours per worker is highly unstable. Moreover, the results are robust to a change in the selection of demographic and institutional variables as well as to estimations where the capital-elasticity is uniform instead of country-specific.

4 Conclusion

Labour productivity and employment are interrelated: productivity depends on employment which in turn is influenced by productivity. The regression analysis shows that this two-way relationship matters significantly for the estimation of the impact of employment on productivity per hour. When a system of equations is estimated, we find that em-

ployment tends to boost productivity, which contrasts the OLS results where a negative though insignificant elasticity is estimated. This finding seriously questions the existing literature on the trade-off between employment and productivity, which generally ignores the endogeneity of employment.

Our estimates confirm the finding in the literature that the relation between employment and productivity is unstable. Using 15-year rolling windows, the estimated elasticity varies between 0.7 in the 1970-1984 window and 0.1 (and insignificant) in the 1990-2003 window. This may be contributed to the dependency ratio, which is rising in all countries. The source of (young and) highly educated starters on the labour market, which initially has contributed to both employment and productivity, is gradually drying up.

Finally, the impact from total hours worked cannot be meaningfully split into the influence of more persons or more hours per worker. The employment elasticity is reasonable and largely in line with the total-hours elasticity, but the elasticity to hours per worker cannot be precisely estimated.

Stimulating employment may or may not conflict with productivity targets. We show in this paper that productivity responses may be expected, but show that these responses are unstable and depend on the intensive and extensive margin of employment. The risk of a productivity slowdown seems to be stronger with stimulating hours per worker than with targeting on participation.

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A Figures of yearly data

Figure 3: Yearly data, United States

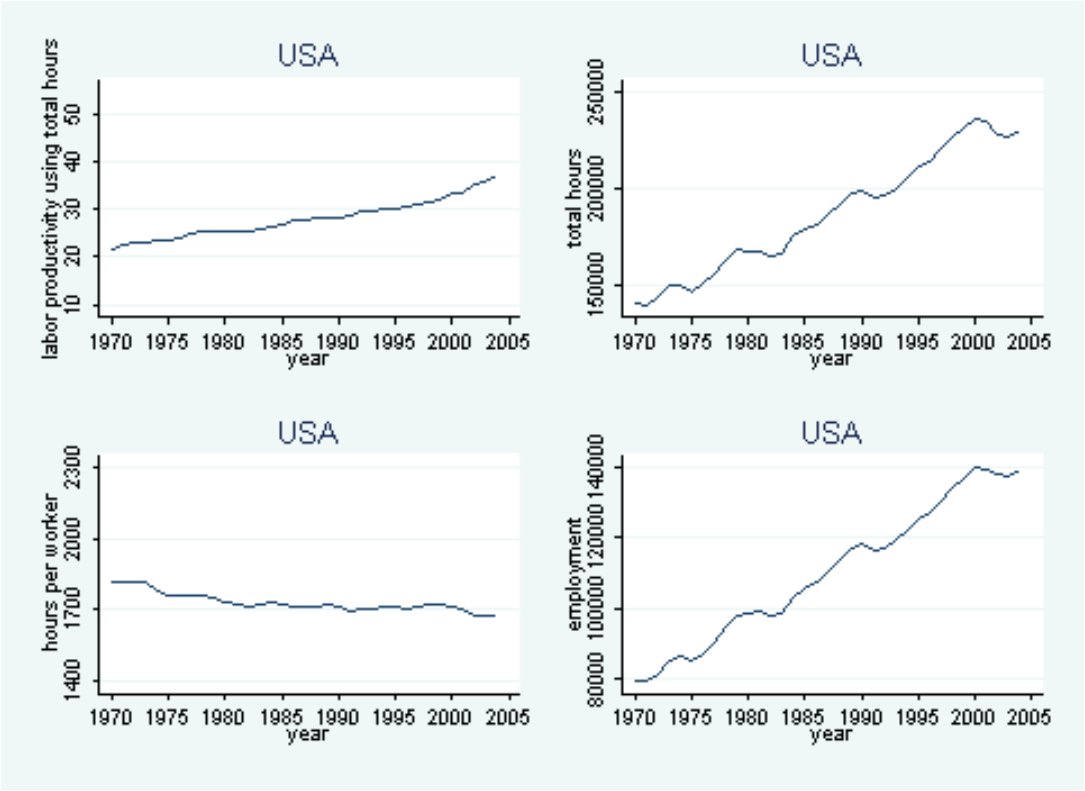

Figure 4: Yearly data, Japan and Italy

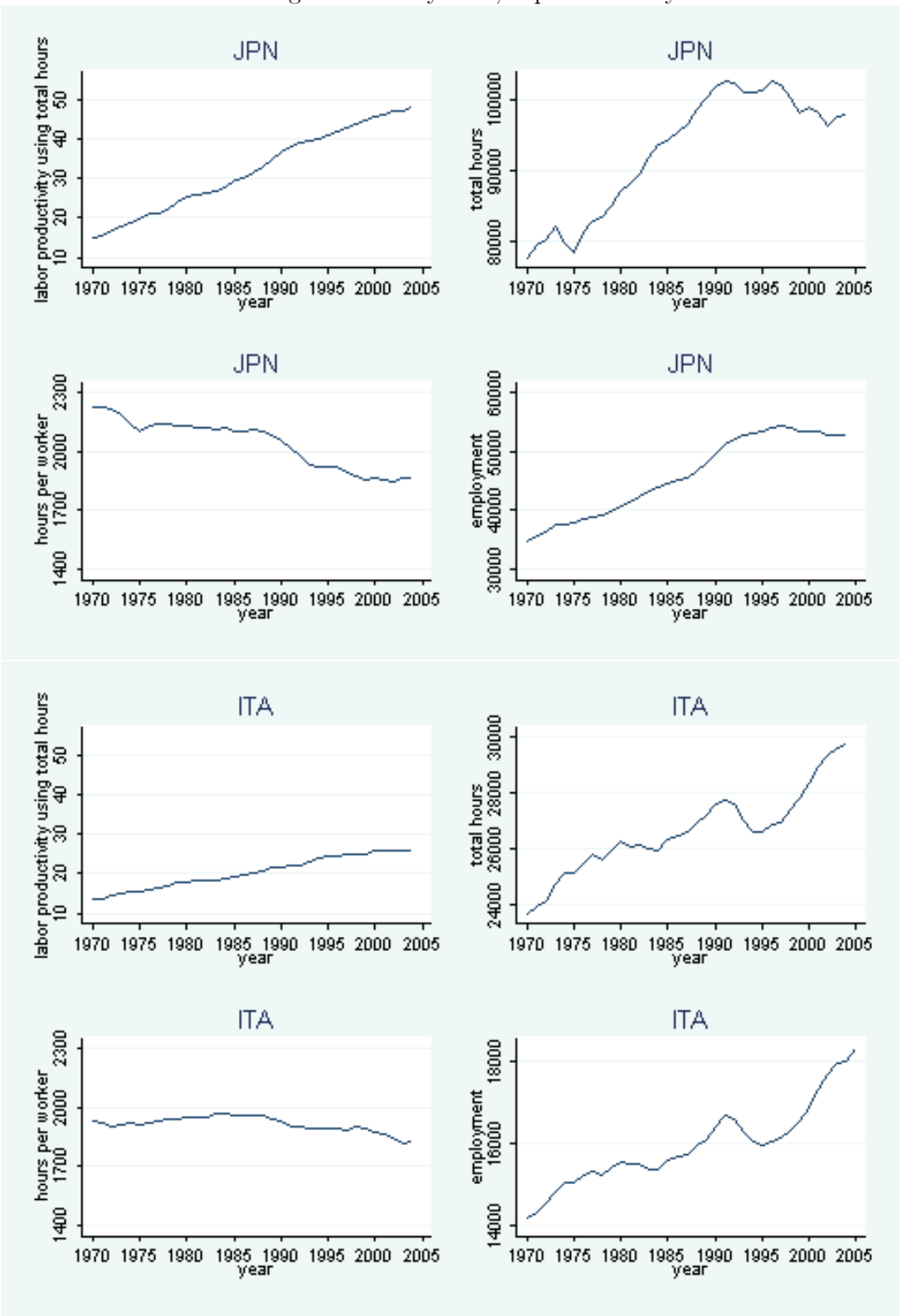

Figure 5: Yearly data, UK and Ireland

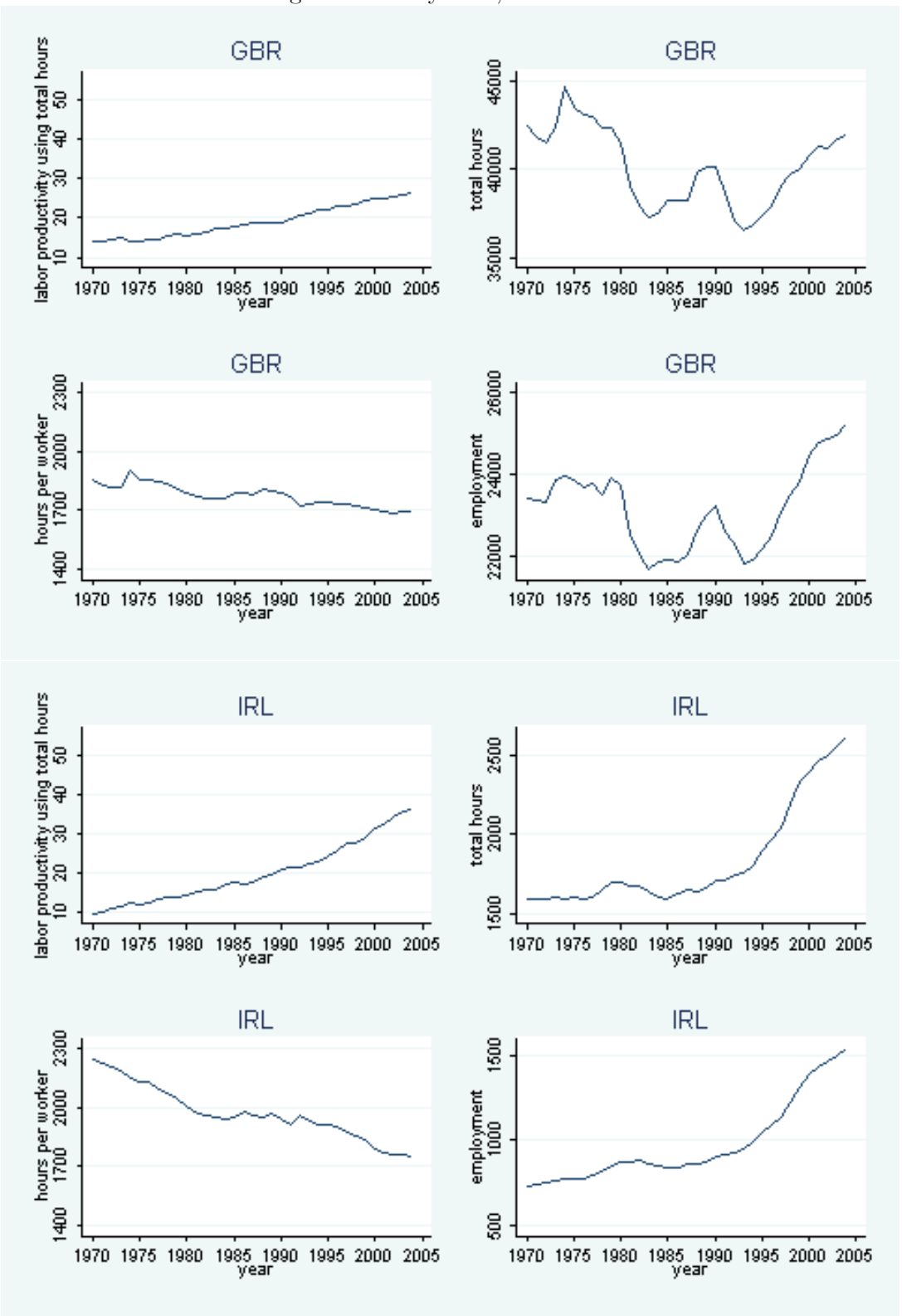

Figure 6: Yearly data, Germany and France

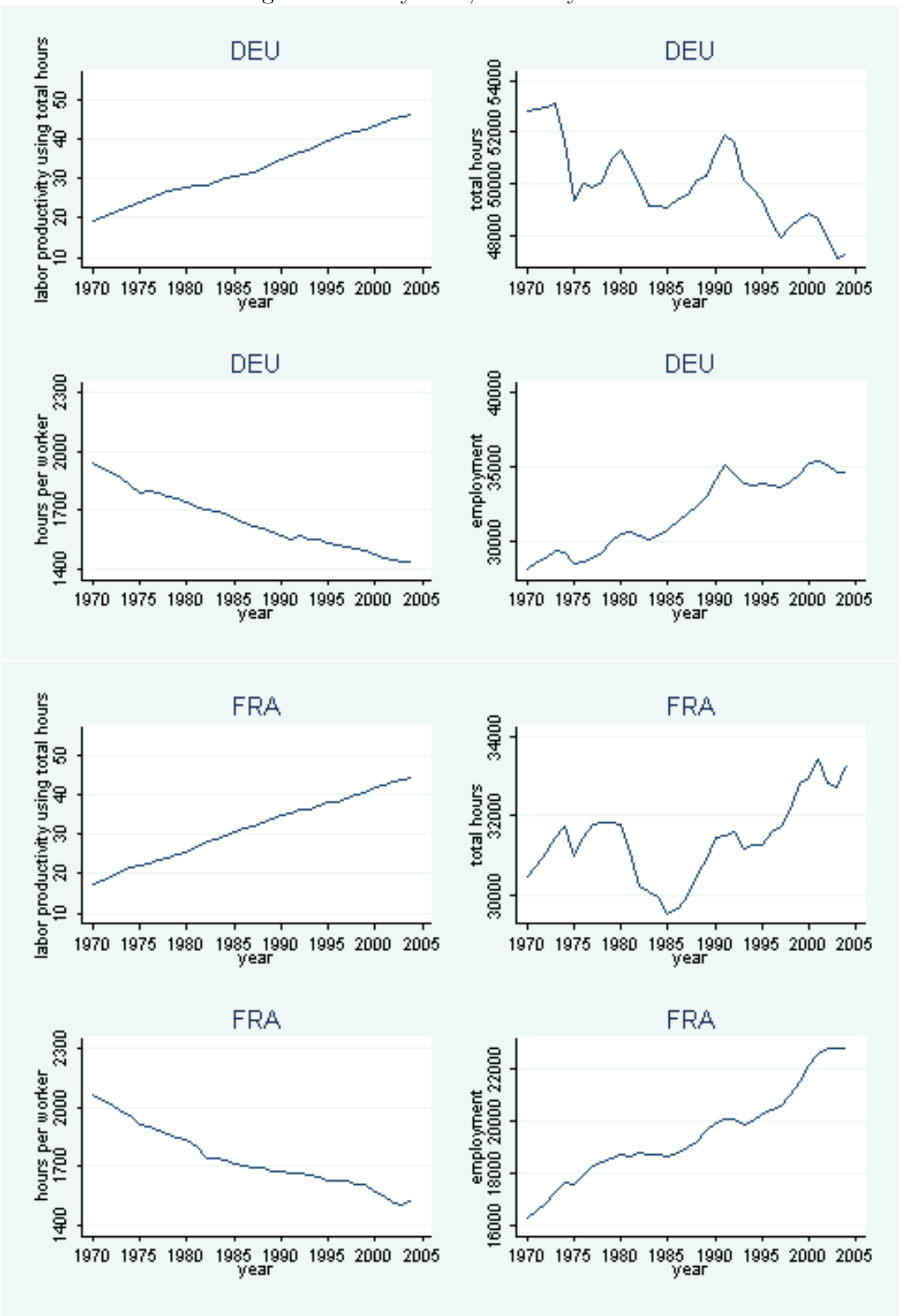

Figure 7: Yearly data, Spain and Portugal

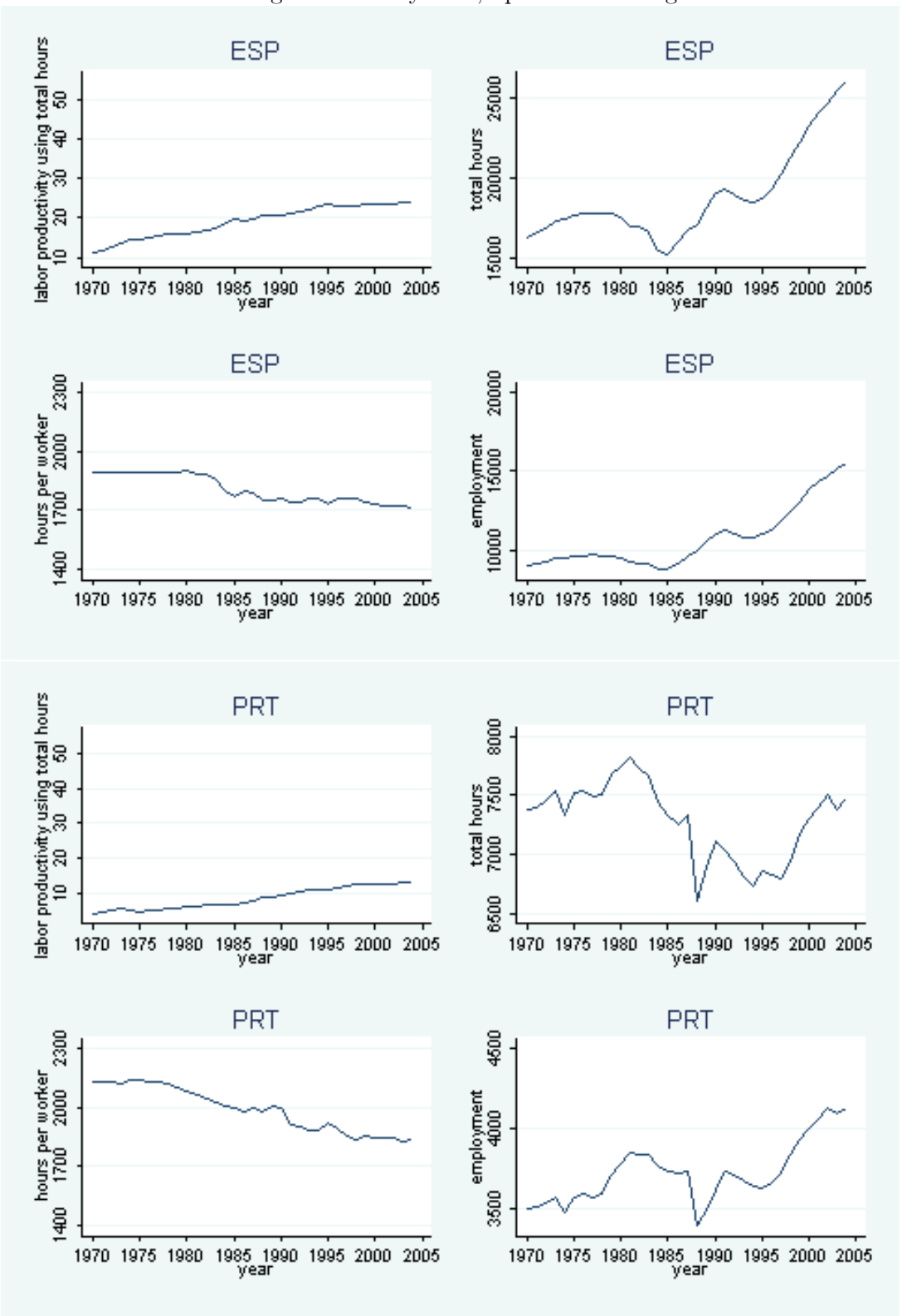

Figure 8: Yearly data, Belgium and the Netherlands

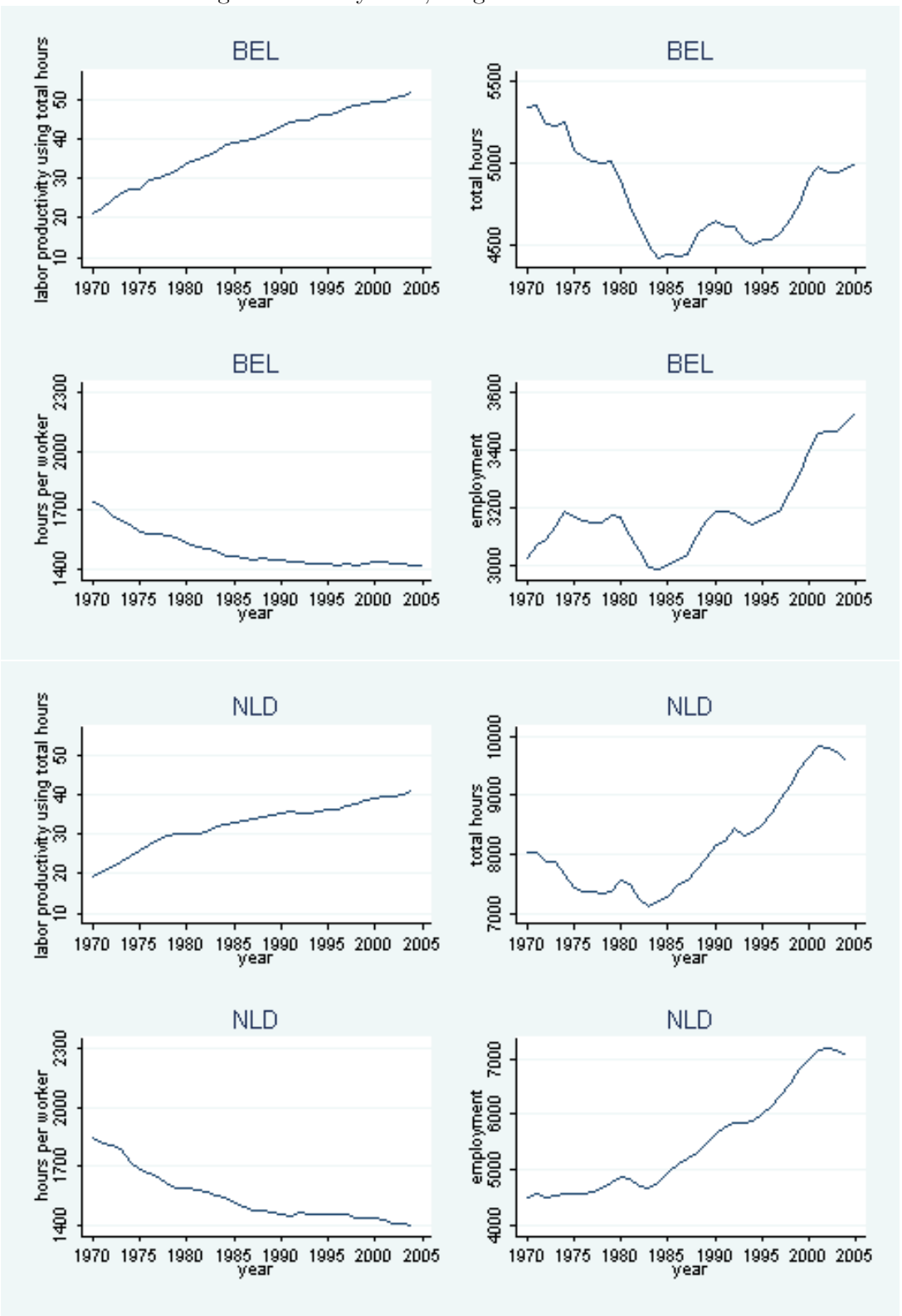

Figure 9: Yearly data, Austria and Denmark

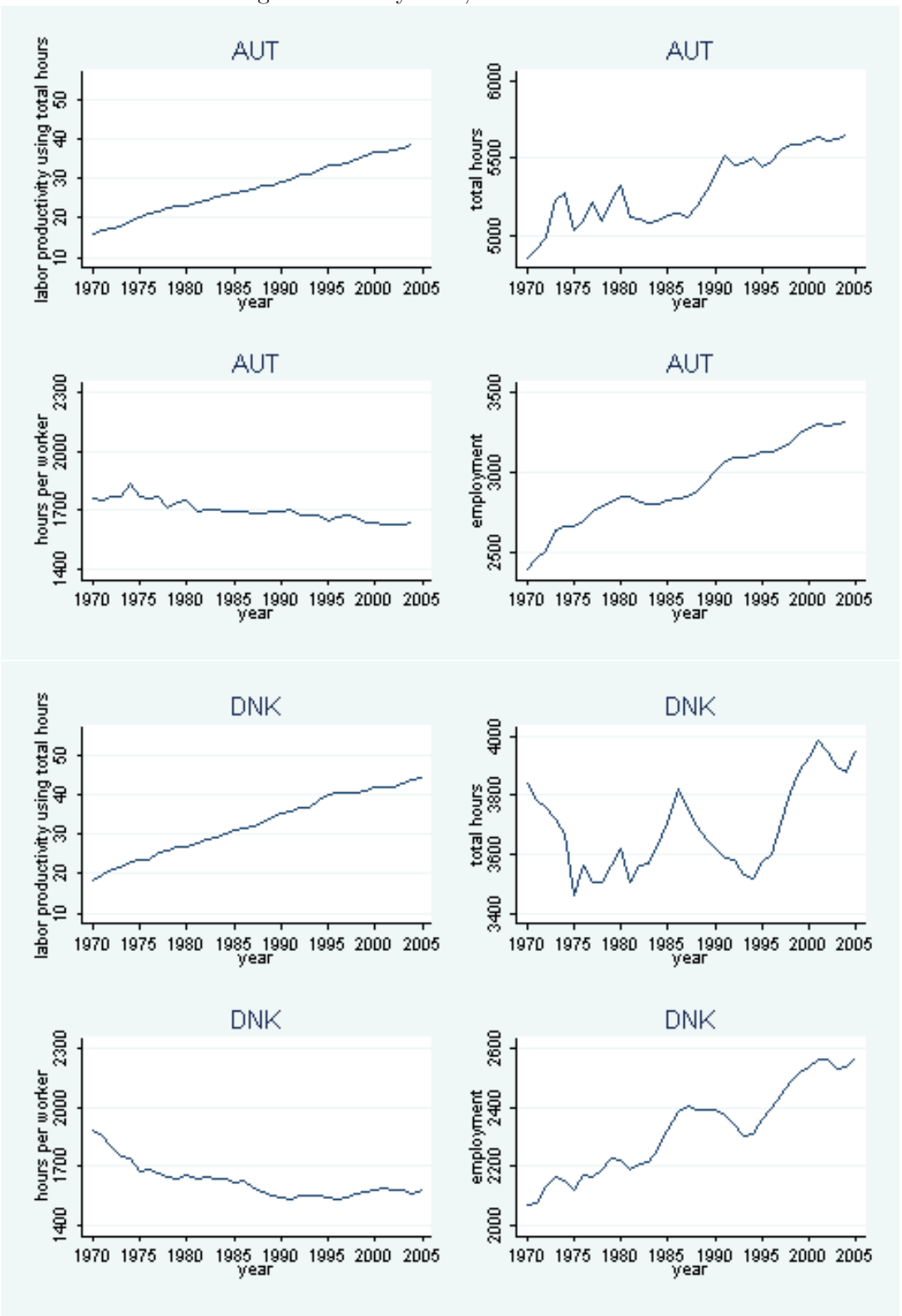

Figure 10: Yearly data, Finland and Sweden

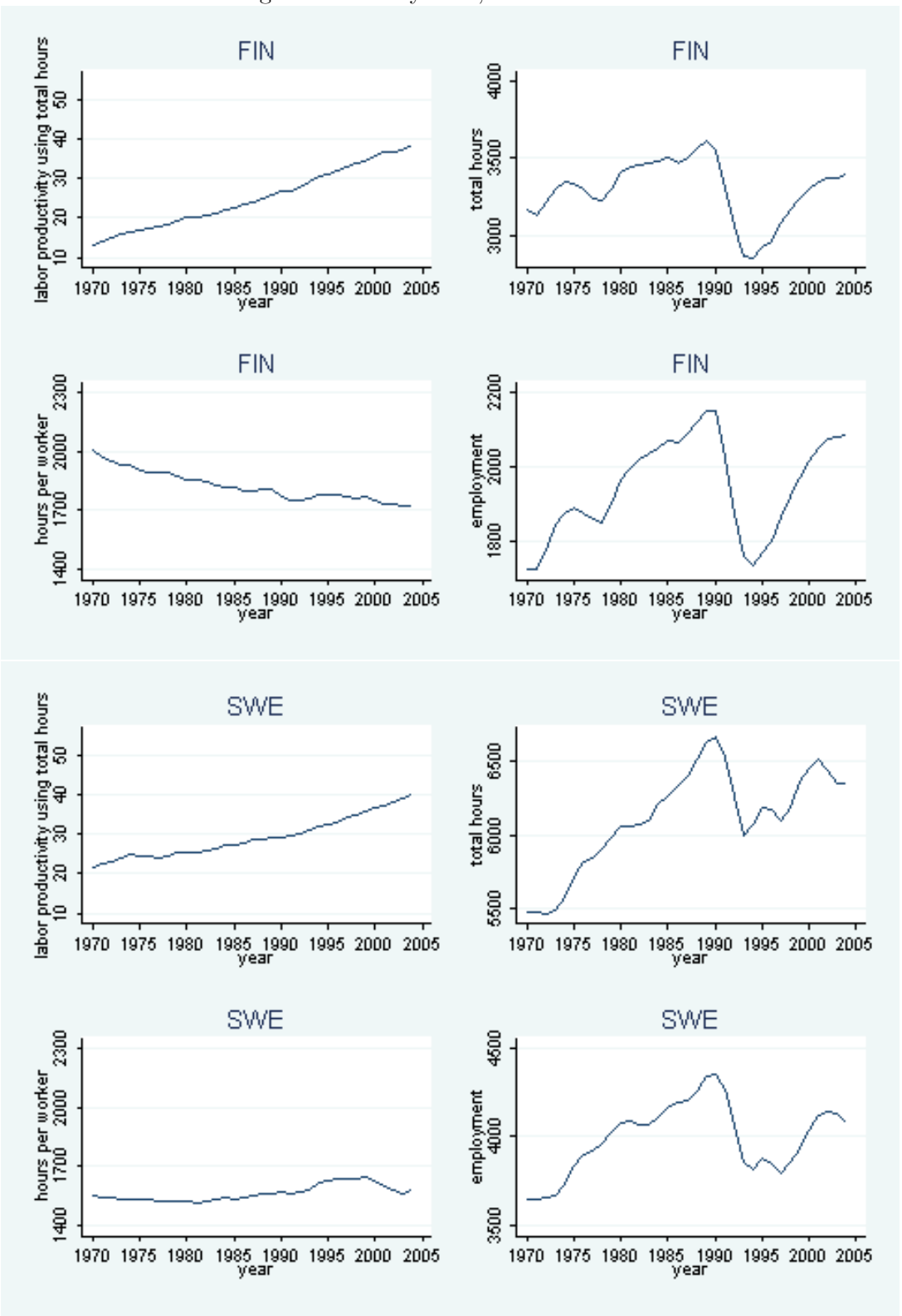

Table 4: Correlation and unit root in productivity and employment-variables

Correlation and unit root				
	$\ln y$	$\ln H$	$\ln L$	$\ln h$
$\ln y$	1.00			
$\ln H$	0.12	1.00		
$\ln L$	0.17	1.00	1.00	
$\ln h$	–0.71	0.15	0.07	1.00
Common unit root process[a]				
levels	–4.61	–0.06	–0.15	–1.93
	(0.00)	(0.48)	(0.44)	(0.03)
first difference	–13.14	–7.47	–9.24	–13.03
	(0.00)	(0.00)	(0.00)	(0.00)
Individual unit root process				
levels	–0.95	–0.82	–0.06	–0.72
	(0.17)	(0.21)	(0.48)	(0.24)
first difference	–12.12	–7.79	–9.79	–13.67
	(0.00)	(0.00)	(0.00)	(0.00)

We applied the panel unit root tests of Im et al. (2003) and Levin et al. (2002).
p-values are in parenthesis.

B Definition of exogenous variables used in the system of equations

- AG_15_49 : Population share of the age group from 15 to 49 years. Source UN (2004).
- AG_50_64 : Population share of the age group from 50 to 64 years. Source UN (2004).
- DEP_RATIO : The ratio of the inactive population (older than 65 years) to the active population (15 to 64 years). Source UN (2004).
- $TOTLABTAX$: Total labour tax revenue as a proportion of GDP. We construct this variable using the revenue for Social Security Contributions and Taxes on Payroll and Workforce as a proportion of GDP taken in local currency. Source: OECDstat.
- $LABWEDGE$: The labour tax wedge, which is defined as the difference between the labour cost paid by the employer and the net take-home pay of the employee. These data is taken for a single-earner couple with two children earning 100% of average production workers earnings. It takes the combined central and sub-central government income tax plus employee and employer social security contribution taxes (also including cash transfers); as a percentage of labour costs defined as gross wage earnings plus employer social security contributions (also including employer payroll taxes). Source: OECD,Taxing Wages.
- EPL : OECD summary indicator of the stringency of Employment Protection Legislation. Source: OECD (2004).
- ARR : Average unemployment benefit replacement rate. Defined as the average unemployment benefit replacement rate across two income situations (100% and 67% of the average production worker APW earnings), three family situations (single, with dependent spouse, with spouse in work) and three different unemployment durations (1st year, 2nd and 3rd years, and 4th and 5th years of unemployment).Source: OECD, Benefits and Wages Database.
- $UBENDUR$: Unemployment benefit duration, which is defined as the ratio of average to initial unemployment benefit replacement rate. Source: OECD (2004).
- $UNDENS$: Trade union density rate, i.e. the share of workers affiliated to a trade union, in percentages. Source: OECD (2004).

- $UNCOVCM$: collective bargaining coverage rate, defined as the share of workers covered by a collective agreement. Source OECD (2004).