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A STRUCTURAL VAR APPROACH ON LABOUR TAXATION POLICIES

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1 Introduction

A huge public debt is a well-known problem for the economic systems. There are at least two main reasons according to which it can not be neglected. First, it can mine the stability of the economies. The second argument is less catastrophic but equally relevant: European Countries must respect the Maastricht Debt/GDP ratio parameter if they wish to stay within the European Monetary Union.

Generally speaking, each economist that suggests a fiscal policy solution to unemployment should take into account public debt implications. There is no doubt that it is completely useless to suggest a policy which could be effective but can not be feasible.

This paper presents a *Structural VAR (*SVAR henceforth) analysis on the employments and output effects of labour taxation policies in Belgium, France, Germany, Italy, Spain and Sweden for the period 1974-1997. As usual, this methodology allows to identify the contemporaneous relations of interest. Furthermore, as suggested by Blanchard and Perotti [2002], the SVAR approach would seem better suited to the study of fiscal policy rather than that of monetary policies. First, budget variables move for many reasons: among them, output stabilization is rarely predominant. In other words, fiscal shocks are exogenous to output. Second, in contrast to monetary policy decision, at high enough frequency, such as a quarter, there is little or no discretionary response of fiscal policy to unexpected movements in activity.

By focusing on the output and employment effects of labour taxation policies, the current paper aims at addressing the question whether or not, following a shock in the labour tax rates, there exists a trade-off between employment and output. Starting with the Malcomson and Sartor [1987] paper, there is a literature which suggests that following a pure increase in tax progressivity wage pressure reduces.[1] Therefore, this should have a positive implication in terms of the level of employment. However, some argue (see for instance Sørensen [1997] among the others), that this might imply a trade-off between employment (equity) and output. All this literature builds on the assumption that inequality (namely less progressivity) affects positively output growth. Recently, Aghion, Caroli and Peñalosa [1999] reviewed all the literature that puts such view into question. They suggest that there could be some good reasons, say capital markets imperfections among the others, according to which more redistribution can lead to output growth.

[1] By "pure increase in tax progressivity" it is meant an increase in the marginal tax rate holding constant the average tax rate.

Further evidence in this respect can be found in Perotti [1996].

The current analysis evaluates the relation of interest in terms of total labour tax revenues, employment and output. Then it moves a step further by taking into account the specific role played by each of the four relevant labour tax parameters (namely the marginal/average personal income/payroll tax rates).

According to our findings, for the majorities of the observed countries a shock in the total personal income tax revenues has a positive effect on employment. The evidence on the output effect is more mixed. However, the impact of these effects appear to be quite small, in particular those related to the output suggesting that if the European governments wish to exploits the advantages, if any, of changes labour taxes, they has to combine this taxation policy to others which are able to accelerate the convergence process towards the parameters established by the European Community.

When we introduce explicitly the relevant labour tax parameters, the effects are not negligible so that for some countries it is possible to conceive labour taxes as policy instruments in favour of more employment and a better economic performance. However, it is important to emphasize a clear evidence of differences across countries. The empirical support on the sign of the output and employment effects is mixed suggesting that the same fiscal policy does not produce the same impact for all the European countries. What can be good for one country, it can be bad for another.

This paper is organized as follows: the second section describes the model and the cointegration properties; the third shows the structural identification of the instantaneous relations; the fourth evaluates the impact of the four labour tax parameters on employment and output and finally some conclusions follows.

2 The model

The choice of the set of the variables is a crucial point for a VAR analysis which aims to identify the transmission mechanisms of a specific shock. This paper aims at evaluating the employment and output effects of changes in total personal income tax revenues[2] in six European Countries (Belgium, France, Germany, Italy, Spain and Sweden) for the period 1974-1995. These countries constitute the bulk of the EU Monetary Union and most of them are experiencing deficit problems. We analyse further the impact of four

[2]For labour tax revenue we mean here tax revenue collected by personal income taxes. This is due to the fact that payroll taxes in Italy are largely made of social security contributions.

labour tax parameters (marginal\average personal income\payroll tax rates) on total personal income tax revenues, employment and output. We will start by taking some results of the literature on the role of labour taxation on employment, as a grant (see for more details Lockwood and Manning [1993] and Sørensen [1997]). In particular, Sørensen [1997] has pointed out that an increase in personal income and payroll tax progressivity may have a positive effect on employment but a detrimental effect on output leading to a trade-off between equity (more employment, lower income inequality) and efficiency. Assume that the European Governments decide to follow this policy advise and change labour taxes. Would we observe substantial employment beneficial gains? What would be the consequences for the public debt? We can provide an answer to these questions if we have a measure of the impact on employment, GDP and total labour tax revenues of changes in our four relevant labour tax rates.

Thus, the current work addresses the empirical question whether it is sensible to advocate a fiscal policy solution to unemployment and as a growth-enhancing device. We could just think about a VAR reduced form model which treats labour tax parameters, total labour tax revenues, employment and output as the endogenous variables. Though the main interest is to provide some empirical evidence, this paper moves a step further from the pure VAR reduced form model by adding some structure. We start by modelling a recursive system according to which changes in labour taxes are exogenous to total labour tax revenue, output and employment. We then allow the data to speak for themselves. Therefore, we introduce some feedback mechanisms following what suggested by the statistical tests on the imposed restrictions. Even under this latter assumption tax rates will be treated as exogenous.

The recursive system is built on the following the three equations model.

$$tr = \lambda + w + n \tag{1}$$

$$y = \phi d \tag{2}$$

$$n = \frac{y}{\alpha} - \theta \tag{3}$$

where tr, y, n denote the logs of the total personal income tax revenues, the real output[3] and employment; θ and d represent shift factors in productivity and an index of government expenditures reflecting basically fiscal policies, respectively.

[3]Prices are taken as given and normalised to one.

In turn the three above equations correspond to the definition of the total personal income tax revenues, aggregate demand and the production function.

We assume that the average personal income tax rate is exogenously determined by the government and its evolution is mainly governed by a stochastic process $\eta \sim i.i.d$ (for simplicity $\lambda = \eta$).

Further, the government expenditures are assume to be equal to the total labour income tax revenues plus a stochastic component (for simplicity $d = tr + \varepsilon$).

Starting from the above equations we can obtain a Cholesky recursive system[4].

$$\mathbf{Y}_{1t} = \begin{bmatrix} tr \\ y \\ n \end{bmatrix} = \begin{bmatrix} c_{11} & 0 & 0 \\ c_{21} & c_{22} & 0 \\ c_{31} & c_{32} & c_{33} \end{bmatrix} \begin{bmatrix} \eta \\ \varepsilon \\ \theta \end{bmatrix} \tag{4}$$

where $c_{11} = 1; c_{21} = c_{22} = \phi; c_{31} = c_{32} = \frac{\phi}{\alpha}; c_{33} = 1$.

To emphasize the role played by each tax rate we need to add a further equation of the above system. That is, now the SVAR model is based on the following vector series:

$$\mathbf{Y}_{2t} = [taxrate, tr_t, y_t, n_t]'$$

where $taxrate = \tau, \lambda, \sigma, s$ (respectively marginal and average personal income tax rate and marginal and average payroll tax rate). Consider, for instance the case of the marginal personal income tax rate corresponding to the tax rate of interest. To our simple model we simply add the following equation:

$$\tau = \chi \tag{5}$$

where $\chi \sim i.i.d$

The Appendix will show that it is possible to obtain a recursive representation as above when now the stochastic components are χ, η, ε and θ.

Under both assumption, starting from a recursive system we allow for some feedback mechanisms[5]. In general, we let the data to speak for themselves. That is for each country the final structure will result to be the one based on the restrictions accepted by the statistical tests. On a priori

[4] The Appendix will report all the details to obtain the reported solution.

[5] The Appendix will describe a possible structure based on some feeback mechanisms.

grounds, it is not obvious to have a common structure for all countries. Nevertheless, how it would be clear in the next sessions, our empirical findings for all countries support the view of exogenous labour tax parameters which affect output and employment.

2.1 Univariate and cointegration properties of the relationship of interest

Before we move on to examine the SVAR model, it is important to look at the univariate properties of the series. The sample period is 1974:1-1997:4 and data are observed quarterly. In particular, we test whether or not the series are difference-stationary (namely $I(1)$).

Thereby, the Augmented Dickey Fuller test and the Phillips and Perron tests are implemented on this purpose.[6] The lag parameter has been fixed to 5 in all cases. The results of these test are collected in Table $A.1$, reported in the Appendix.[7] As suggested by Dolado *et al.* [1990] we start from the more general model which contains both a deterministic trend and an intercept in order to be sure that the "*true*" generation process of the data is nested within the model. According to results presented in Table $A.1$, the series of total labour tax revenue is $I(1)$ without drift with the sole exception of France where the Φ_2 (joint insignificance of the autoregressive term and the constant) test is rejected even at a 1% size.[8] The same conclusion can be draw for all countries for the series of the employment level. Thereby employment is integrated of order 1 without drift, while the real GDP within this sample period seems to be integrated of order 1 with drift.

We can now start our multivariate analysis on a reduced form VAR model which takes the form:

[6] The econometric package to which we refer is MALCOLM (Maximum Likelihood Cointegration analysis of Linear Models) written by Rocco Mosconi. Tables A1 refer to the tests on the univariate series of the country specific total personal income tax revenue, real GDP and employment. The test on each countries' four labour tax parameters are not reported for space convenience but are available upon request.

[7] As suggested by Dolado *et al.* [1990] we start from the more general model which contains both a deterministic trend and an intercept in order to be sure that the "*true*" generation process of the data is nested within the model.

[8] Note that the Φ_3 (joint insignificance of the trend, the autoregressive term and the constant) is rejected as well. This would imply that one should look at West's result according to which the statistics should be compared to the values of the Normal table. Yet, since the result of the Φ_2 test is quite robust we believe that there are enough elements in favour of our conclusion.

$$
\begin{aligned}
A(L)\mathbf{Y}_t &= \mu + \psi D_t + \varepsilon_t, \varepsilon_t \sim VWN\,(0, \Sigma) \\
A(L) &= I_n - A_1 L - ... - A_p L^p
\end{aligned} \tag{6}
$$

where $\mathbf{Y}_t^1 = [tr_t, n_t, y_t]^{'}$ [9] and D_t is a set of three seasonal dummies variables.

Seasonality can be largely justified from a theoretical ground. As also suggested by Blanchard and Perotti [2002], we can observed seasonal patterns in the response of taxes to economic activity. That is, income taxes, when withheld at the source, are paid with minimal delays relative to the time of transactions. Moreover, both real GDP and employment are those kind of variables that can present some seasonality.

As suggested by Reimers [1993], the Hannan and Quinn information criterion on the choice of the appropriate lag length is the most reliable in presence of cointegration. Then, statistics based on this criterion are reported in Table 1 as follows.

Table 1: Lag Order Determination:Hannan Quinn

Lags	**BEL**	**FRA**	**GER**	**ITA**	**SPA**	**SWE**
1	-27.092	-28.890	-26.378	-28.188	-27.195	-27.570
2	-29.136	-30.534	-27.506	-30.121	-29.415	-29.694
3	-30.270	-31.409	-28.217	-31.091	-30.314	-30.500
4	-30.678	-31.852	-29.143	-31.895	-30.887	-30.880
5	-30.623	-31.804	-29.145	-31.840	-30.915	-30.758

The results give evidence in favour of a model with four lags for all countries[10].

We can now move on to conduct inference on the cointegration rank on the basis of the maximum likelihood approach suggested by Johansen. Since the deterministic components in the VAR model influence the distribution of the rank statistics, it is important to determine jointly the rank and the deterministic polynomial. In our case, given the statistics, for France, Spain and Sweden we introduce within the cointegration relationships a deterministic component of the kind: $\mu = \alpha\beta_0$. This implies the presence of a restricted intercept in the cointegration relationships and the absence of a linear trend

[9] When we evalutaes the role played by each of the four labour tax parameters, the vector of the endogenous variables takes the form of:
$\mathbf{Y}_t^2 = [taxrate_t, tr_t, n_t, y_t]^{'}$

[10] For Germany the test seems to prefer slightly five lags.

in the levels of the series. For Germany, we include an unrestricted constant and for all the other countries we exclude the presence of any deterministic component.

We expect on a priori grounds a cointegration rank equal to 2. That is, we expect two cointegranting vectors: one that describes the relationship between labour taxation revenues and employment and the other one that instead relates labour tax revenues to output. In Table 2 we present Johansen's cointegrating rank statistics on the basis of the trace test, since as shown in Johansen 1992 on the basis of Pantula's [1989], results from the $\lambda-\max$ test could be misleading given that there is not a coherent strategy for the cointegration rank.

Table 2: Johansen/s trace test on the cointegrating rank statistics.

Belgium						*Italy*					
Rank	Cons	Trend	Stat	90%	95%	R	Cons	Trend	Stat	90%	95%
0	0	0	34.51	21.63	24.31	0	0	0	47.06	21.63	24.31
1	0	0	13.34	10.47	12.53	1	0	0	11.62	10.47	12.53
2	0	0	2.51	2.86	3.84	2	0	0	0.37	2.86	3.84
France						*Spain*					
Rank	Cons	Trend	Stat	90%	95%	R	Cons	Trend	Stat	90%	95%
0	$\alpha\beta$	0	56.07	32.00	34.91	0	$\alpha\beta$	0	41.47	32.00	34.91
1	$\alpha\beta$	0	19.34	17.85	19.96	1	$\alpha\beta$	0	21.59	17.85	19.96
2	$\alpha\beta$	0	7.47	7.52	9.24	2	$\alpha\beta$	0	7.31	7.52	9.24
Germany (dummy 1990)						*Sweden*					
Rank	Cons	Trend	Stat	90%	95%	R	Cons	Trend	Stat	90%	95%
0	μ	0	83.61	26.79	29.68	0	$\alpha\beta$	0	57.11	32.00	34.91
1	μ	0	19.02	13.33	15.41	1	$\alpha\beta$	0	18.03	17.85	19.96
2	μ	0	0.06	2.69	3.76	2	$\alpha\beta$	0	3.56	7.52	9.24

Our findings suggest the presence of two cointegrating vectors for all countries, as expected[11].

Figure $A.1$ in the Appendix shows the stability of this cointegration rank supporting the view that the rank is equal to 2. The stability of the cointegration rank is tested by an iterative procedure suggested by Hansen and Johansen [1993]. What is called "model Z" (see the graph on the right hand

[11] For the case of Germany, because of the presence of an intervention dummy which accounts for the 1989 German re-unification the quantilies reported in the Table are not appropriate. However, it seems that the findings of a cointegration rank equal to 2 might be robust to the critical values correction.

side in Figure $A.1$) implies recursive estimation of all the parameters in the model while the so called "model R" (see the graph on the left hand side in Figure $A.1$) estimates only the parameters that lye in the span of the loadings matrix. Thereby Figure $A.1$ describes the cointegrating rank statistics, rescaled by their critical values, relative to the second part of the sample period. Hence, the test has to be interpreted in the following way. The unity line represents the threshold above which one obtains the outcome of the rank test evaluated for any partial sample period. When both the two cointegrating vectors are above the threshold line, as it appears to hold true for almost all countries' analyses, we conclude that the rank is equal to 2.

Further, Figure $A.2$, plots for all countries the residuals of the three equations. The aim is to verify whether there are some normality problems. Then, Table $A.2$ illustrates further the normality test. Table $A.2$ shows that for almost all countries there are some kurtosis problems within the equations. These kurtosis problems drive some normality problem into the system. However, by looking at the graphs of Figure $A.2$, it is clear from where this kurtosis comes from. It derives from some peaks within the sample and to some residuals persistence. Since the introduction of others dummies variables would have a too high cost in terms of the cointegration properties of the model, we consider this specification quite appropriate.

We can now move on to identify the cointegrating relationships. We start from our a priori according to which the two stationary relations regard total labour tax revenues and output first and then total tax revenue and employment. This hypothesis can be tested by specifying the following set of homogenous linear constraints on the two columns of the cointegrating vector β. In the Appendix we illustrate in details for each country the set of homogenous linear constraints imposed on the cointegrating vectors.

Then the Johansen's [1995b] theorem is used to verify whether or not these constraints identify the long run relationships of the model. Note further that when we introduce the restricted constant within the cointegrating relationship, on the basis of the order condition the model is overidentified since we have three constraints for each of the two cointegrating vectors. A likelihood ratio test, distributed as a $\chi^2(2)$, checks whether or not we can accept these constraints. Table 3 reports the estimated cointegration vectors.

Table 3: Cointegrating Vectors

Belgium		Italy	
Vector 1	Vector 2	Vector 1	Vector 2
$tr - y = z_1$	$tr - n = z_2$	$tr - n = z_1$	$tr \underset{(0.004)}{-0.63} y = z_2$
LR:	$\chi^2(2) = \underset{(0.19)}{3.32}$	LR:	$\chi^2(1) = \underset{(0.90)}{0.02}$
France		Spain	
Vector 1	Vector 2	Vector 1	Vector 2
$tr - y = \underset{(0.13)}{-6.35} + z_1$	$y - n = \underset{(0.03)}{4.13} + z_1$	$tr - y = \underset{(0.07)}{11.3} + z_1$	$tr - n = z_2$
LR:	$\chi^2(2) = \underset{(0.01)}{9.35}$	LR:	$\chi^2(3) = \underset{(0.11)}{6.15}$
Germany		Sweden	
Vector 1	Vector 2	Vector 1	Vector 2
$tr - n = z_1$	$n - y = z_2$	$tr - y = \underset{(0.16)}{2.75} + z_1$	$tr - n = \underset{(0.05)}{0.30} + z_2$
LR:	$\chi^2(2) = \underset{(0.00)}{22.6}$	LR:	$\chi^2(2) = \underset{(0.09)}{4.76}$

Note: p−value in Brackets

Results presented in Table 3 are quite satisfactory for almost all countries, then we can conclude that we have identified both the cointegrating vectors. This also provides empirical evidence of a long run relation between the total labour (personal income) tax revenue and output on the one side and employment and the total labour tax revenue on the other side.

3 Structural identification of the instantaneous relations

We chose an "*AB-model*" identification scheme to describe the instantaneous correlations between the variables.[12] That is:

$$AA(L)\mathbf{y}_t = Be_t, e_t \sim VWN(0, I_3) \tag{7}$$

Then we model the interactions among the observables and unobservable shocks. In other words, we try to identify the instantaneous correlations of the observables variables imposing some restriction on the "A matrix" and

[12] For more details on the methodology refer to Amisano and Giannini [1997].

the instantaneous correlations of the unobservables variables through the "B matrix". Hence for each country, we start from an exactly identified model, the lower triangular Choleski decomposition of the variance-covariance matrix Σ which better suits to the scheme of causality. Notice that the data suggest a lower triangular Choleski decomposition of the variance-covariance matrix which corresponds to the recursive structure illustrated by our model presented in Section 2. Then by deleting the non-significant parameters in the A matrix and allowing for the presence of an extradiagonal element in the B matrix, we reach another identified structure. Note that no term which lies in the upper triangular of the A matrix has been found significant at a 5% size. Then the final structure results to be quite close to what we expected on a priori ground and is reported in Table 4.

Table 4 : Estimates of SVAR parameters

BELGIUM

$$\varepsilon_{tr} = \underset{(0.004)}{0.05}\, e_{tr}$$
$$\varepsilon_y = \underset{(0.0002)}{0.0002} e_{tr} + \underset{(0.0001)}{0.001}\, e_y$$
$$\varepsilon_n + \underset{(0.003)}{0.006}\, \varepsilon_{tr} - \underset{(0.10)}{0.41}\, \varepsilon_y = \underset{(0.0001)}{0.001}\, e_n$$

ITALY

$$\varepsilon_{tr} = \underset{(0.004)}{0.05}\, e_{tr}$$
$$\varepsilon_y - \underset{(0.003)}{0.007}\, \varepsilon_{tr} = \underset{(0.0001)}{0.001}\, e_y$$
$$\varepsilon_n - \underset{(0.14)}{0.39}\, \varepsilon_y = \underset{(0.0002)}{0.0001} e_{tr} + \underset{(0.0001)}{0.001}\, e_n$$

FRANCE

$$\varepsilon_{tr} = \underset{(0.003)}{0.04}\, e_{tr}$$
$$\varepsilon_y = \underset{(0.0001)}{0.0001} e_{tr} + \underset{(0.0001)}{0.001}\, e_y$$
$$\varepsilon_n + \underset{(0.003)}{0.005}\, \varepsilon_{tr} - \underset{(0.12)}{0.54}\, \varepsilon_y = \underset{(0.0001)}{0.001}\, e_n$$

SPAIN

$$\varepsilon_{tr} = \underset{(0.002)}{0.02}\, e_{tr}$$
$$\varepsilon_y = -\underset{(0.0001)}{0.0001} e_{tr} + \underset{(0.0001)}{0.001}\, e_y$$
$$\varepsilon_n + \underset{(0.02)}{0.04}\, \varepsilon_{tr} = \underset{(0.0002)}{0.003}\, e_n$$

GERMANY

$$\varepsilon_{tr} = \underset{(0.001)}{0.01}\, e_{tr}$$
$$\varepsilon_y = \underset{(0.0002)}{0.00003} e_{tr} + \underset{(0.0001)}{0.002}\, e_y$$
$$\varepsilon_n - \underset{(0.07)}{0.12}\, \varepsilon_{tr} - \underset{(0.54)}{1.56}\, \varepsilon_y = \underset{(0.0006)}{0.008}\, e_n$$

SWEDEN

$$\varepsilon_{tr} = \underset{(0.0001)}{0.002}\, e_{tr}$$
$$\varepsilon_y - \underset{(0.14)}{0.61}\, \varepsilon_{tr} = \underset{(0.0002)}{0.002}\, e_y$$
$$\varepsilon_n - \underset{(1.77)}{3.21}\, \varepsilon_{tr} - \underset{(1.21)}{2.40}\, \varepsilon_y = \underset{(0.02)}{0.03} e_n$$

Note: Standard Errors in Brackets.

Many of the estimated coefficient are significant at the 5% size. The causal relations among the instantaneous correlations of the errors might be the following: shocks of the total labour tax revenues affect more employment than output[13] with negative coefficients for almost all countries[14].

[13] Labour tax revenues shocks affect positively output in Italy and Sweden.

[14] A positive coefficient has been found in the case of Germany and Sweden.

Then, in the long-run a fiscal policy which increases the total labour tax revenues is detrimental for the performance of the labour market. However, this does not necessarily mean that there is not any hope in favour of a fiscal policy solution to unemployment. Let's consider again the model structure presented in Section 2 (three equations model). Under this view, changes in total labour tax revenues are mainly driven by unexpected changes in the average personal income tax rate. Therefore, let's consider the case of a average tax cut. This should have a negative effect on the total tax revenues and thus a positive impact on employment. Under such circumstances the labour market might benefit of a higher tax progressivity achieved through a cut in the average personal income tax rate. The next section, by relating the changes in total tax revenue and the changes in each of the four labour tax parameters, will discuss more extensively how to relate the total labour tax revenue to tax progressivity.

In contrast to other empirical evidence, most notably that provided by Easterly and Rebelo [1993] who examine the impact of fiscal policy on growth for a large cross-section of developed and developing countries, our findings seem to suggest a weak relationship between tax revenues policy shocks and output.

We conclude the SVAR estimation by presenting the impulse response functions and the Forecast Error Variance Decomposition (FEVD henceforth).

Let's start with the impulse response functions. The model so far described will be simulated for 28 periods (7 years). The following Figure 1 presents the responses to shocks with the 80% confidence bounds based on the asymptotic distributions of the structured impulse responses. The Figure must be read in the following way. The graph on the left (right) presents the (cumulative) impulse response functions. For both graphs, the first column reports the impulse response functions of the total labour tax revenues (first row), of the output (second row) and of the level of the employment (third row) to a shock in the total labour tax revenues. Holding constant the order of the variables with respect to the rows, the second and third columns illustrate the impulse response functions to shocks in the output and employment respectively.

On the basis of Figure 1 we find for many countries a positive significant effect on the employment and output of shocks in the labour taxation revenues. For Belgium and Germany the impact is initially negative but then it turns out to be positive, significant and persistent. In contrast the effect is not statistically significant in Italy and France. Further, for all countries the total labour tax revenues are affected positively, though at a decreasing rate, by their own shocks. With regard to the other structuralised shock, we can observe that for all countries the effect of an output's shocks on employment is positive and significant. Both the impulse response functions of output and employment to their own shocks are positive and significant[15].

The same results can be also viewed by looking at the cumulative impulse response functions contained in the same figure on the right hand side. Notice that in this case the shocks are permanent.

Figure 1 : Impulse and Cumulative Impulse Response Functions

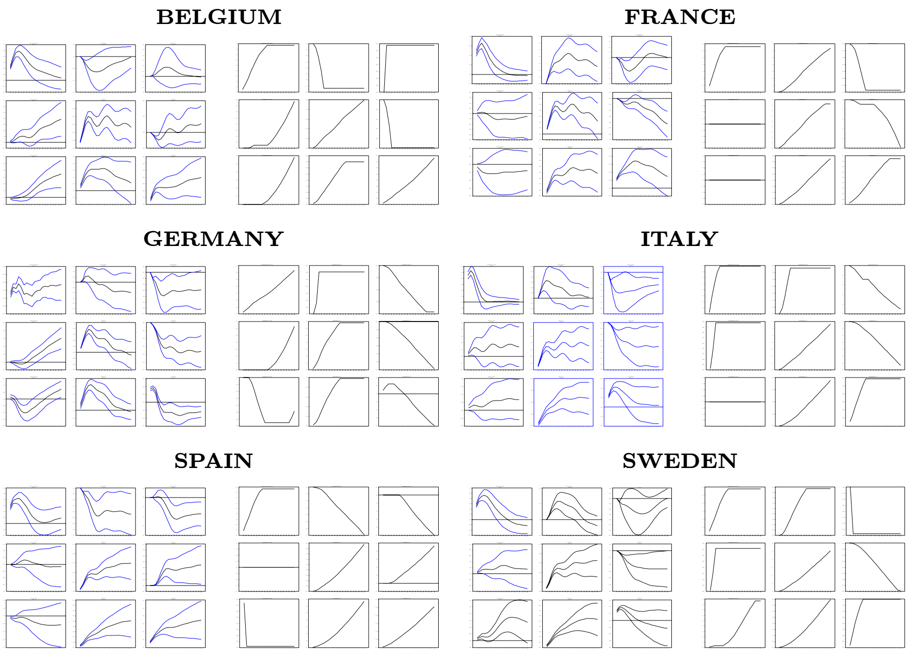


Table $A.3$ illustrates now the coefficient of the impact matrix that generates the impulse response functions observed for 16 periods (four years) for space constraints. We report only the coefficient of the structuralised shocks.

Consider for instance the Sweden case, the more reactive from an output and employment point of view. As described also by the structure of the contemporaneous relation between the errors, the tax revenue effect on employment is higher (on average) than on output. The employment level and the output continue to react until they reach a peak of 1.00 and 0.40 respectively, 8 and 10 periods after the shock occurred. Thereby the mean lag coefficient over the respective period corresponds to 0.30 and 0.18. Finally, the total labour tax revenue reacts hugely and positively to its own

[15] In some cases, like for instance Germany, the effect turns out to be negative at the end of the observed period.

shocks and reaches the largest effect in the third quarter. From then on, tax revenues decrease steadily to trend and the impact ends up to be negative. Following a shock in labour tax revenues, France is the only country whose level of the employment immediately (in the second quarter) tends to move back to trend. As in the Spanish case, this impact on the employment level is negative. Generally speaking for all countries, by looking at Table $A.3$, when positive, the coefficients' size appears to be quite small giving little hope to a public finance solution to unemployment.

At this point we just have to look at the FEVD. We report in Table $A.4$ the percentage of the variance of each series explained by the different structural shocks. Indeed, the Table reports the percentage of the variance of each series explained by the structural innovations in the total labour tax revenues. The coefficient are calculated for 15 horizons.

It is quite clear that the total tax revenues innovations account for much of their FEVD but play a quite minor role in the FEVD functions of the other variables. That is, for all countries almost all the variance in the total labour tax revenue is explained by its own structural innovations. Considering for instance the Swedish case, the structural innovations of the total labour tax revenues account for only 4% of the variance in the output. The effect on the employment starts from a 9% but increases to 24% after 4 years and this effect seems to be quite persistent. Notice that as previously observed for the impulse response functions, the employment effect is more responsive than the output effect, the former keeps increasing until it reaches a peak after 4 years while the output effect is decreasing since the first quarter. Another important point is the absence of large feedbacks from the other variables to the total labour tax revenues[16]. This is quite consistent with our identification scheme.

4 Evaluating the impact of the four labour tax parameters on employment and output.

We can now move on to evaluate the impact of the four labour tax parameters on the employment and output. These effects are measured by the following

[16]Table $A.4$ does not report for space constraints the percentage of the variance of the total labour tax revenues explained by the structural innovations in employment and output. This variance is the relevant indicator for evaluating the feedback effects and as expected results to be very small. For those interested, a Table containing these results is available upon request by the author.

differentials.

$$\frac{d\log(n)}{d\log(\tau)} = \frac{d\log(n)}{d\log(taxrate)} \tag{8}$$

$$\frac{d\log(y)}{d\log(\tau)} = \frac{d\log(y)}{d\log(taxrate)} \tag{9}$$

where $taxrate = \lambda, \tau, s, \sigma$.

Then, we aim at measuring the elasticity of the total labour tax revenues (measured considering only the personal income taxes as in the previous analysis) to the four tax parameters of interest. We take this measure from the SVAR estimates of the four equation model described in Section 2 and in the Appendix.

Table 5 summarises for each country the effect on the employment and output of changes in each of the four relevant labour tax parameters[17]. The values correspond to the mean lag of the impulse response function coefficient calculated up to the point where the effect reaches the peak.

Table 5 : **Employment and Output Effects**(**IRF**)

Effect	BEL	FRA	GER	ITA	SPA	SWE
$\frac{d\log(n)}{d\log(\tau)}$	-0.30	0.20	-0.10	-0.10	-0.90	0.60
$\frac{d\log(n)}{d\log(t)}$	0.30	1.00	0.02	0.10	0.10	0.70
$\frac{d\log(n)}{d\log(\delta)}$	0.01	n.a.	-0.20	0.30	-1.00	0.10
$\frac{d\log(n)}{d\log(d)}$	0.10	-0.20	-0.10	0.30	1.00	0.08
$\frac{d\log(y)}{d\log(\tau)}$	-0.20	0.50	-0.40	-0.10	-0.40	0.30
$\frac{d\log(y)}{d\log(t)}$	0.03	0.60	0.10	0.04	0.30	0.60
$\frac{d\log(y)}{d\log(\delta)}$	-0.04	n.a.	0.30	0.30	-0.50	0.06
$\frac{d\log(y)}{d\log(d)}$	-0.10	-0.40	0.20	0.20	0.40	0.04

Then, for instance in Spain, the more reactive country with respect to changes in personal income taxes the employment effect of a change in the marginal personal income tax rate is equal to 0.9%. Then, this effect is negative and quite strong.

[17]For ease of exposition we not report all the cointegration analyses and the identification of the structural shocks for the four equations model. These results are available upon request.

These estimates are smaller than those presented by Giorno et al [1995]. Notice however that our personal income tax parameters differ from theirs in several respect. Most notably, in contrast to them, we consider average and marginal tax rate separately, we focus on a specific income tax bracket then we do not impose any specific restriction on the income distribution[18], our measure includes social security contributions paid by the employees whereas those burdened over the employers define our payroll tax rate indicators.

In general, our evidence is mixed suggesting that the same fiscal policy does not produce the same effects for all European countries. What can be good for one country, it can be bad for another. In contrast, to results presented in the previous section, when we introduce explicitly the relevant labour tax parameters the effects are not negligible so that for some countries it is possible to conceive labour taxes as policy instruments in favour of more employment and a better economic performance.

In particular a higher marginal personal income tax rate increases employment (0.20 and 0.60) and output (0.50 and 0.30) in France and Sweden respectively.

5 Conclusions

This paper has presented a SVAR approach on the employment and output effects of changes in labour taxes in six European Countries. Generally speaking, according to our findings, a shock in the total personal income tax revenues has a positive impact on the employment. However, the impact of these effects appear to be quite small, in particular those related to the output suggesting that if the European governments wish to exploits the advantages, if any, of changes labour taxes, they has to combine this taxation policy to others which are able to accelerate the convergence process towards the parameters established by the European Community.

When we introduce explicitly the relevant labour tax parameters the effects are not negligible so that for some countries it is possible to conceive labour taxes as policy instruments in favour of more employment and a better economic performance. However, our empirical support on the sign of the output and employment effects is mixed clearly suggesting that the same fiscal policy does not produce the same impact for all the European countries.

[18] Our choice presents the cost of considering only a specific portion of tax revenues from labour income. Giorno et al's analysis refer to the entire income distribution. Their income distribution reflects the assumptions made on its shape and, for lack of data, does not take into account self-employment.

Appendix

Starting from:

$$tr = \lambda + w + n$$

$$y = \phi d$$

$$n = \frac{y}{\alpha} - \theta$$

we assume that our production function (expressed in logs) corresponds to:

$$y = \alpha n$$

then from profit maximisation wages (expressed in levels W) are equal to:

$$W = \alpha N^{\alpha - 1}$$

where N denotes employment in levels

or

$$W = \alpha \frac{Y}{N}$$

where Y defines output in levels

assuming that the ratio $\frac{Y}{N}$ approximates a constant β and by assuming $\lambda = \eta$ we have

$$tr = \eta + \alpha\beta + n \tag{A1}$$

Our further identification hypothesis is that government expenditures are equal to personal income tax revenues plus a stochastic term ($d = tr + \varepsilon$) (government budget constraint balanced in expected values). That is:

$$y = \phi\,(tr + \varepsilon) \tag{A2}$$

$$n = \frac{y}{\alpha} - \theta \tag{A3}$$

To obtain a recursive system our main identification hypothesis is that the effect of the employment level on the labour tax revenues is negligible (i.e. we assume $n = 0$ in equation $A1$). Then, by substituting equation $A1$ into $A2$ and equation $A2$ into $A3$ our system now becomes:

$$tr = \eta + \alpha\beta \tag{A4}$$

$$y = \phi\,(\eta + \alpha\beta + \varepsilon) \tag{A5}$$

$$n = \frac{\phi\,(\eta + \alpha\beta + \varepsilon)}{\alpha} - \theta \tag{A6}$$

Writing the system made of equations $A4$, $A5$ and $A6$ in compact form we obtain expression 4 reported in the main text.

An example of a non recursive system

Starting from:

$$tr = \eta + \alpha\beta + n \tag{A7}$$

$$y = \phi\,(tr + \varepsilon) \tag{A8}$$

$$n = \frac{y}{\alpha} - \theta \tag{A9}$$

By substituting equation $A7$ into $A8$ and equation $A9$ into $A8$ we have:

$$tr = \eta + \alpha\beta + n$$

$$y = \phi\left(\eta + \alpha\beta + \frac{y}{\alpha} - \theta + \varepsilon\right)$$

$$n = \frac{y}{\alpha} - \theta$$

That is:

$$tr = \eta + \alpha\beta + n \tag{A10}$$

$$y = \frac{\phi}{\left(1 - \frac{\phi}{\alpha}\right)}\left(\eta + \alpha\beta - \theta + \varepsilon\right) \tag{A11}$$

$$n = \frac{y}{\alpha} - \theta \tag{A12}$$

Our main identification assumption here is that a productivity shock affects the real output only through a feedback mechanism on the employment level (i.e. $\theta = 0$).

Then our system in compact form now corresponds to:

$$\begin{bmatrix} 1 & 0 & a_{13} \\ 0 & 1 & 0 \\ 0 & a_{32} & 1 \end{bmatrix} \begin{bmatrix} tr \\ y \\ n \end{bmatrix} = \begin{bmatrix} c_{11} & 0 & 0 \\ c_{21} & c_{22} & 0 \\ 0 & 0 & c_{33} \end{bmatrix} \begin{bmatrix} \eta \\ \varepsilon \\ \theta \end{bmatrix}$$

where $a_{13} = 1; a_{32} = \frac{1}{\alpha}; c_{11} = 1; c_{21} = c_{22} = \frac{\phi}{1-\frac{\phi}{\alpha}}; c_{33} = 1.$

Identification of the role played by each of the four labour tax parameters

In this section we report the identification of the role played by each of the four labour tax parameters for the recursive system only. The example of a structure which allows for some feedback mechanism is quite similar to the one reported above for the three equations models[19]. Given that our measure of personal income tax revenues includes the average personal income tax rate λ only, we need to distinguish the case of the average personal income tax rate from all the other tax rates.

The average personal income tax rate case

Starting from the following four equations model:

$$\lambda = \eta \tag{A13}$$

$$tr = \lambda + w + n \tag{A14}$$

$$y = \phi \left(tr + \varepsilon \right) \tag{A15}$$

$$n = \frac{y}{\alpha} - \theta \tag{A16}$$

Assume now that the wage rate is equal to a constant $\alpha\beta$ plus a stochastic component χ ($w = \alpha\beta + \chi$). This stochastic component can also be conceived as a fiscal policy shock due to a variation in other labour tax parameters than the average personal income tax rate.

As above for the three equations model case, to obtain a recursive system our main identification hypothesis is that the effect of the employment level on the labour tax revenues is negligible (i.e. we assume $n = 0$ in equation $A14$). Then, by substituting equation $A13$ into $A14$, equation $A14$ into $A15$ and equation $A15$ into $A16$ we have

$$\lambda = \eta$$

$$tr = \eta + \alpha\beta + \chi$$

[19] Recall, that our empirical findings refer to a model structure which is identified starting from this recursive system and allowing for some feedback mechanism whose restrictions are those accepted by the data.

$$y = \phi\left(\eta + \alpha\beta + \chi + \varepsilon\right)$$

$$n = \frac{\phi\left(\eta + \alpha\beta + \chi + \varepsilon\right)}{\alpha} - \theta$$

Writing the system in compact form we obtain the expression as follows.

$$\mathbf{Y}_{1t} = \begin{bmatrix} \lambda \\ tr \\ y \\ n \end{bmatrix} = \begin{bmatrix} c_{11} & 0 & 0 & 0 \\ c_{21} & c_{22} & 0 & 0 \\ c_{31} & c_{32} & c_{33} & 0 \\ c_{41} & c_{42} & c_{43} & c_{44} \end{bmatrix} \begin{bmatrix} \eta \\ \chi \\ \varepsilon \\ \theta \end{bmatrix}$$

where $c_{11} = c_{21} = c_{22} = 1; c_{31} = c_{32} = c_{33} = \phi;$
$c_{41} = c_{42} = c_{43} = \frac{\phi}{\alpha}; c_{44} = 1.$

All the other tax rates case

Consider now the following model:

$$taxrate = \chi \tag{A17}$$

where $taxrate = \tau, \sigma, s$

$$tr = \lambda + w + n \tag{A18}$$

$$y = \phi\left(tr + \varepsilon\right) \tag{A19}$$

$$n = \frac{y}{\alpha} - \theta \tag{A20}$$

As before assume that the wage rate is now equal to a constant $\alpha\beta$ plus a stochastic component χ $(w = \alpha\beta + \chi)$. Further assume that the evolution of the average personal income tax rate is mainly driven by a stochastic component $(\lambda = \eta)$.

As above, the main identification hypothesis is that the effect of the employment level on the labour tax revenues is negligible (i.e. we assume $n = 0$ in equation $A18$). Then, by substituting $(w = \alpha\beta + \chi)$ and $(\lambda = \eta)$ into equation $A18$, equation $A18$ into $A19$ and equation $A19$ into $A20$ we have

$$taxrate = \chi$$

$$tr = \eta + \alpha\beta + \chi$$

$$y = \phi\left(\eta + \alpha\beta + \chi + \varepsilon\right)$$

$$n = \frac{\phi\left(\eta + \alpha\beta + \chi + \varepsilon\right)}{\alpha} - \theta$$

Writing the system in compact form we obtain the expression as follows.

$$\mathbf{Y}_{1t} = \begin{bmatrix} taxrate \\ tr \\ y \\ n \end{bmatrix} = \begin{bmatrix} c_{11} & 0 & 0 & 0 \\ c_{21} & c_{22} & 0 & 0 \\ c_{31} & c_{32} & c_{33} & 0 \\ c_{41} & c_{42} & c_{43} & c_{44} \end{bmatrix} \begin{bmatrix} \chi \\ \eta \\ \varepsilon \\ \theta \end{bmatrix}$$

where $c_{11} = c_{21} = c_{22} = 1; c_{31} = c_{32} = c_{33} = \phi;$
$c_{41} = c_{42} = c_{43} = \frac{\phi}{\alpha}; c_{44} = 1.$

Table A.1: Augmented Dickey Fuller Integration Test *on* Total Labour Tax Revenues

Variable	tr			Max Lag				
Country	BEL	FR	GER	IT	SP	SW		
Test Statistics							5%	10%
MODEL C								
$H_0 : \rho = 0$	-4.38	-7.07	-9.80	-5.84	-6.07	-6.49	-20.70	-17.50
$H_0 : \alpha = 0$	-2.00	-4.37	-2.71	-2.25	-2.63	-2.26	-3.45	-3.15
$H_0 : \alpha = \rho = 0\,(\Phi_3)$	2.05	9.69	3.96	2.73	3.53	3.09	6.49	5.47
$H_0 : \alpha = \rho = \mu = 0\,(\Phi_2)$	2.02	6.84	3.78	2.29	2.80	2.08	4.88	4.16
MODEL B								
$H_0 : \rho = 0$	-1.40	-1.74	-0.20	-2.20	-4.27	-6.40	-13.70	-11.00
$H_0 : \mu = 0$	-0.99	-1.78	-0.16	-1.66	-2.29	-2.48	-2.89	-2.58
$H_0 : \rho = \mu = 0\,(\Phi_1)$	1.43	2.07	1.58	2.04	3.28	3.11	4.71	3.86

Table A.1: Phillips and Perron Integration Test *on* Total Labour Tax Revenues

Variable	tr			**Lag truncation parameter**				5
Country	BEL	FR	GER	IT	SP	SW		
Test Statistics							5%	10%
MODEL C								
$Z\left(\tilde{\alpha}\right)$	-8.21	-18.91	-13.03	-22.37	-12.29	-10.59	-20.70	-17.50
$Z\left(t_{\tilde{\alpha}}\right)$	-1.97	-7.81	-3.35	-12.45	-3.68	-2.16	-3.45	-3.15
$Z(\Phi_3)$	2.06	37.77	6.44	98.52	8.13	2.37	6.49	5.47
$Z(\Phi_2)$	1.85	30.86	4.76	72.86	6.79	1.69	4.88	4.16
MODEL B								
$Z(\alpha^*)$	-2.46	-10.73	-0.35	-18.09	-9.84	-10.27	-13.70	-11.00
$Z(t_{\alpha^*})$	-0.90	-6.95	-0.20	-10.12	-3.87	-2.16	-2.89	-2.58
$Z(\Phi_1)$	1.11	31.16	0.63	56.83	9.53	2.51	4.71	3.86

Table A.1cont: Augmented Dickey Fuller Integration Test *on* Output

Variable	y			Max Lag			5	
Country	BEL	FR	GER	IT	SP	SW		
Test Statistics							5%	10%
MODEL C								
$H_0 : \rho = 0$	-1.48	-0.90	-0.69	-0.53	-0.71	-0.98	-20.70	-17.50
$H_0 : \alpha = 0$	-1.60	-1.34	-1.63	-0.86	-1.80	-1.49	-3.45	-3.15
$H_0 : \alpha = \rho = 0\,(\Phi_3)$	1.43	3.18	1.78	1.40	2.67	1.13	6.49	5.47
$H_0 : \alpha = \rho = \mu = 0\,(\Phi_2)$	10.34	9.91	6.47	8.91	7.10	5.20	4.88	4.16
MODEL B								
$H_0 : \rho = 0$	0.04	-0.19	0.05	-0.14	0.09	-0.07	-13.70	-11.00
$H_0 : \mu = 0$	0.35	-2.27	0.55	-1.54	1.02	-0.49	-2.89	-2.58
$H_0 : \rho = \mu = 0\,(\Phi_1)$	13.70	14.11	7.77	13.09	8.11	6.63	4.71	3.86

Table A.1cont: Phillips and Perron Integration Test *on* Output

Variable	y			**Lag truncation parameter**				5
Country	BEL	FR	GER	IT	SP	SW		
Test Statistics							5%	10%
MODEL C								
$Z\left(\tilde{\alpha}\right)$	-9.71	-7.06	-5.89	-8.35	-4.35	-7.02	-20.70	-17.50
$Z\left(t_{\tilde{\alpha}}\right)$	-2.23	-1.97	-1.78	-2.42	-1.56	-1.88	-3.45	-3.15
$Z(\Phi_3)$	2.58	2.78	1.67	4.16	1.93	1.77	6.49	5.47
$Z(\Phi_2)$	14.13	18.50	6.21	17.49	11.47	6.09	4.88	4.16
MODEL B								
$Z(\alpha^*)$	0.10	-0.76	-0.03	-1.06	0.49	-0.35	-13.70	-11.00
$Z(t_{\alpha^*})$	0.17	-1.57	-0.03	-1.92	0.82	-0.40	-2.89	-2.58
$Z(\Phi_1)$	19.29	26.69	7.61	23.61	15.24	7.42	4.71	3.86

Table A.1cont: Augmented Dickey Fuller Integration Test *on* Employment

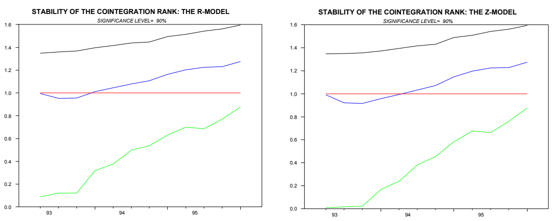
Variable	n			Max Lag			5	
Country	BEL	FR	GER	IT	SP	SW		
Test Statistics							5%	10%
MODEL C								
$H_0 : \rho = 0$	-1.96	-3.11	-3.54	-3.04	-1.30	-1.05	-20.70	-17.50
$H_0 : \alpha = 0$	-2.05	-2.64	-2.23	-2.62	-2.10	-1.33	-3.45	-3.15
$H_0 : \alpha = \rho = 0\,(\Phi_3)$	2.51	3.60	2.56	3.47	3.32	1.88	6.49	5.47
$H_0 : \alpha = \rho = \mu = 0\,(\Phi_2)$	1.68	3.49	2.18	2.42	2.35	1.26	4.88	4.16
MODEL B								
$H_0 : \rho = 0$	-2.04	-0.10	-0.63	-1.21	-0.62	-1.27	-13.70	-11.00
$H_0 : \mu = 0$	-2.23	-0.28	-0.77	-1.70	-1.10	-1.68	-2.89	-2.58
$H_0 : \rho = \mu = 0\,(\Phi_1)$	2.49	1.54	0.97	1.61	0.79	1.42	4.71	3.86

Table A.1: Phillips and Perron Integration Test *on* Employment

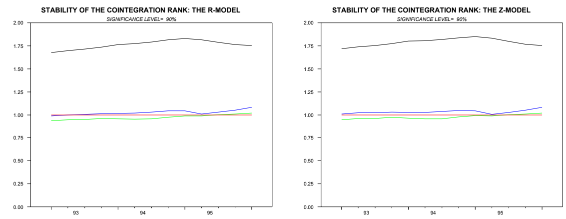
Variable	n			**Lag truncation parameter**				5
Country	BEL	FR	GER	IT	SP	SW		
Test Statistics							5%	10%
MODEL C								
$Z\left(\tilde{\alpha}\right)$	-4.52	-4.93	-6.70	-3.79	-2.50	-2.24	-20.70	-17.50
$Z\left(t_{\tilde{\alpha}}\right)$	-1.60	-1.53	-1.98	-1.27	-1.18	-0.95	-3.45	-3.15
$Z(\Phi_3)$	2.69	1.25	2.19	1.14	2.40	2.82	6.49	5.47
$Z(\Phi_2)$	1.89	5.25	2.00	1.10	1.76	1.88	4.88	4.16
MODEL B								
$Z(\alpha^*)$	-5.80	-0.08	-0.85	-2.88	-0.89	-3.85	-13.70	-11.00
$Z(t_{\alpha^*})$	-2.06	-0.09	-0.47	-1.45	-0.42	-1.48	-2.89	-2.58
$Z(\Phi_1)$	2.25	6.60	0.88	1.55	0.29	1.10	4.71	3.86

Figure A.1 : Stability in the Cointegration Rank

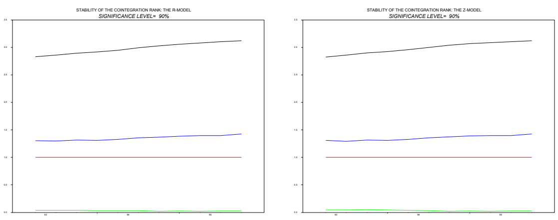
Belgium



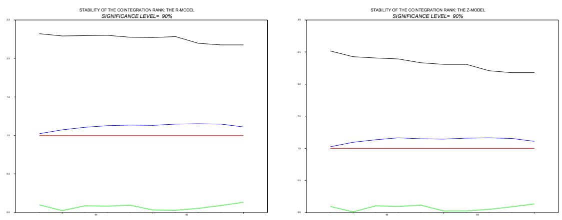
France



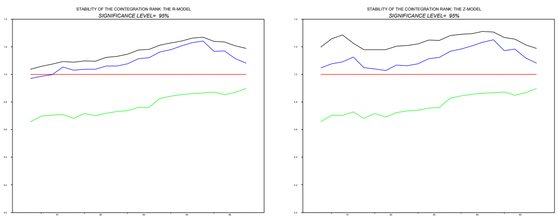
Germany



Italy



Spain



Sweden

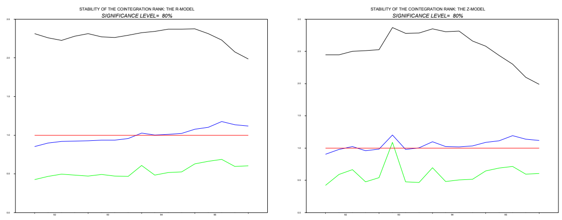
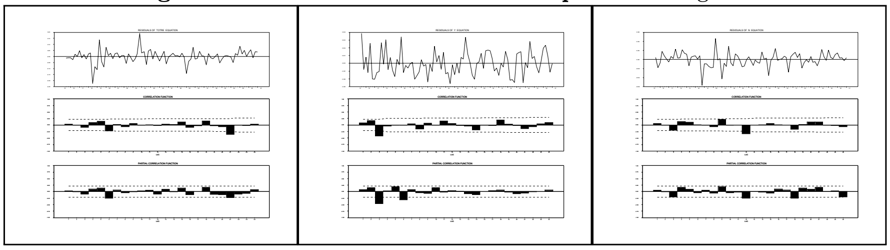
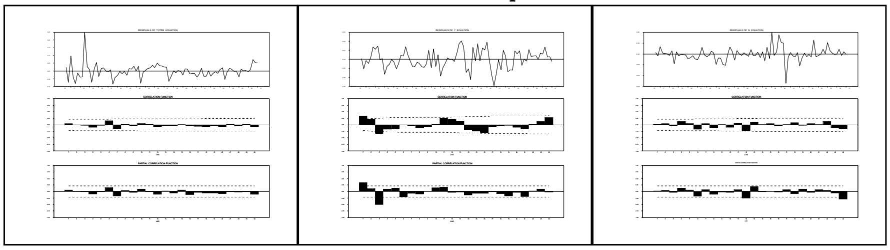


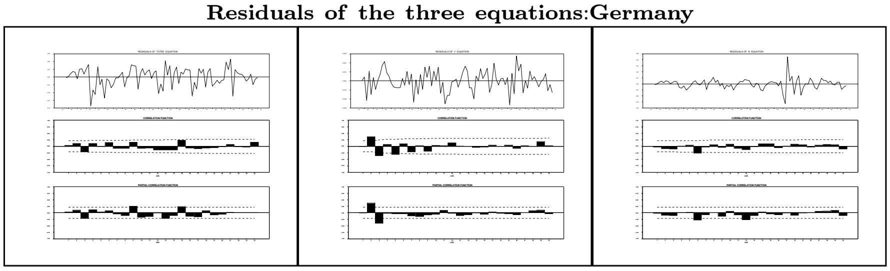
Figure A.2: Residuals of the three equations:Belgium



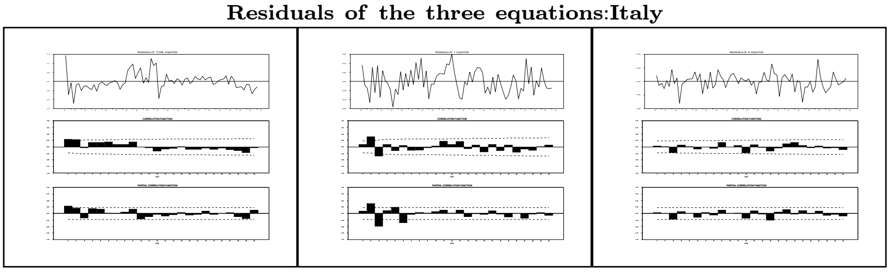
Residuals of the three equations:France



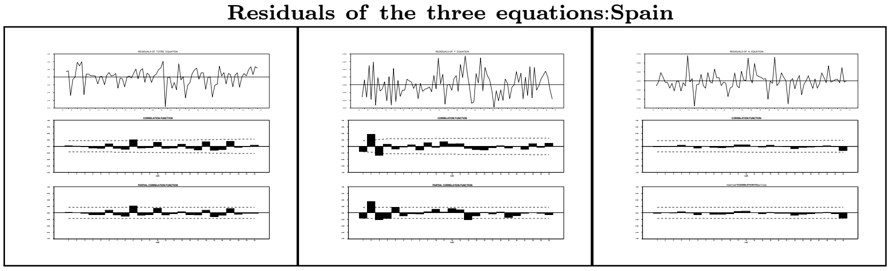
Residuals of the three equations:Germany



Residuals of the three equations:Italy



Residuals of the three equations:Spain



Residuals of the three equations:Sweden

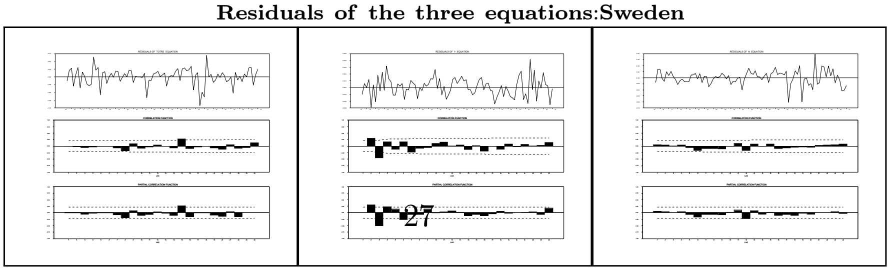


Table A.2: Normality on the three equations residuals

Belgium	**Skweness**	**Kurtosis**	**Skwe.&Kurt.**
tr	2.30 (0.13)	22.3 (0.00)	24.6 (0.00)
y	1.75 (0.19)	4.46 (0.04)	6.21 (0.05)
n	3.45 (0.06)	4.11 (0.04)	7.56 (0.02)
system	7.62 (0.05)	35.2 (0.00)	43.0 (0.00)
France			
tr	31.9 (0.00)	14.4 (0.00)	17.6 (0.00)
y	0.30 (0.59)	4.36 (0.04)	4.66 (0.10)
n	0.32 (0.57)	22.3 (0.00)	22.6 (0.00)
system	34.6 (0.00)	159 (0.00)	194 (0.00)
Germany			
tr	3.05 (0.08)	3.58 (0.06)	6.64 (0.04)
y	0.13 (0.72)	5.98 (0.01)	6.11 (0.05)
n	3.18 (0.08)	61.6 (0.00)	64.8 (0.00)
system	5.06 (0.17)	36.7 (0.00)	41.7 (0.00)
Italy			
tr	3.61 (0.06)	0.08 (0.77)	3.70 (0.16)
y	0.18 (0.67)	6.80 (0.01)	6.98 (0.04)
n	0.38 (0.54)	0.32 (0.57)	0.70 (0.71)
system	3.68 (0.30)	6.67 (0.08)	10.4 (0.11)
Spain			
tr	5.42 (0.02)	0.33 (0.57)	5.76 (0.06)
y	0.48 (0.49)	7.07 (0.01)	7.55 (0.02)
n	0.50 (0.48)	0.14 (0.71)	0.64 (0.73)
System	6.48 (0.10)	7.62 (0.05)	14.1 (0.03)
Sweden			
tr	5.13 (0.02)	0.26 (0.61)	5.39 (0.07)
y	0.33 (0.57)	3.04 (0.08)	3.36 (0.19)
n	2.02 (0.16)	1.76 (0.18)	3.78 (0.15)
System	7.01 (0.07)	2.76 (0.43)	9.77 (0.14)

Appendix: Linear restrictions imposed on the cointegrating vectors

$$\begin{aligned}\beta^* &= [\beta_1^*, \beta_2^*] = \left[\beta', \beta_0'\right]' \\ \beta_1 &= H_1\phi_1; \beta_2 = H_2\phi_2\end{aligned}$$

BELGIUM

$$H_1 = \begin{bmatrix} -1 \\ 1 \\ 0 \end{bmatrix}; H_2 = \begin{bmatrix} -1 \\ 0 \\ 1 \end{bmatrix}$$

FRANCE

$$H_1 = \begin{bmatrix} -1 & 0 \\ 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}; H_2 = \begin{bmatrix} 0 & 0 \\ -1 & 0 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}$$

GERMANY

$$H_1 = \begin{bmatrix} -1 \\ 0 \\ 1 \end{bmatrix}; H_2 = \begin{bmatrix} 0 \\ -1 \\ 1 \end{bmatrix}$$

ITALY

$$H_1 = \begin{bmatrix} -1 \\ 0 \\ 1 \end{bmatrix}; H_2 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}$$

SPAIN

$$H_1 = \begin{bmatrix} -1 & 0 \\ 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}; H_2 = \begin{bmatrix} 1 \\ 0 \\ -1 \\ 0 \end{bmatrix}$$

SWEDEN

$$H_1 = \begin{bmatrix} -1 & 0 \\ 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}; H_2 = \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ -1 & 0 \\ 0 & 1 \end{bmatrix}$$

Table A.3 : Impulse Response Function Coefficients

	BELGIUM			FRANCE		
	tr_tr	**y_tr**	**n_tr**	**tr_tr**	**y_tr**	**n_tr**
1	8.98	0.10	-0.03	5.89	0.01	-0.03
2	11.6	0.10	-0.03	6.58	0.01	-0.10
3	12.2	0.20	-0.02	5.68	0.01	-0.10
4	11.6	0.20	0.001	4.57	-0.01	-0.10
5	10.3	0.20	0.02	3.36	-0.03	-0.10
6	8.69	0.20	0.1	2.45	-0.04	-0.10
7	7.23	0.20	0.1	1.74	-0.10	-0.10
8	6.02	0.20	0.2	1.23	-0.10	-0.10
9	5.08	0.30	0.3	1.00	-0.10	-0.10
10	4.40	0.40	0.3	1.00	-0.10	-0.10
11	3.88	0.40	0.4	0.2	-0.10	-0.10
12	3.47	1.00	1.00	0.03	-0.10	-0.10
13	3.07	1.00	1.00	-0.1	-0.10	-0.10
14	2.67	1.00	1.00	-0.2	-0.10	-0.10
15	2.25	1.00	1.00	-0.2	-0.10	-0.10
16	1.85	1.00	1.00	-0.2	-0.04	-0.10

	GERMANY			ITALY		
	tr_tr	**y_tr**	**n_tr**	**tr_tr**	**y_tr**	**n_tr**
1	1.68	-0.02	0.10	5.26	0.10	0.04
2	1.61	-0.10	-0.20	4.76	0.10	0.10
3	1.91	-0.10	-1.00	3.34	0.10	0.10
4	1.69	-0.10	-1.00	1.95	0.10	0.04
5	1.24	-0.10	-1.02	1.00	0.10	0.03
6	1.31	-0.03	-1.03	0.30	0.10	0.04
7	1.22	0.10	-1.00	0.10	0.10	0.10
8	1.12	0.20	-1.00	0.10	0.20	0.10
9	1.36	0.40	-1.00	0.10	0.20	0.10
10	1.46	1.00	-1.00	0.10	0.20	0.10
11	1.50	1.00	-0.30	0.10	0.20	0.10
12	1.70	1.00	-0.10	0.10	0.10	0.10
13	1.75	1.00	0.03	0.10	0.10	0.10
14	1.73	1.00	0.20	0.20	0.20	0.10
15	1.81	1.10	0.30	0.20	0.20	0.10
16	1.80	1.21	0.40	0.10	0.20	0.10

	SPAIN			SWEDEN		
	tr_tr	**y_tr**	**n_tr**	**tr_tr**	**y_tr**	**n_tr**
1	3.10	-0.01	-0.20	3.94	0.10	0.10
2	3.28	0.01	-0.20	4.43	0.20	0.20
3	3.40	0.10	-0.10	4.59	0.20	0.10
4	3.18	0.10	-0.10	4.35	0.20	0.10
5	2.15	0.20	-0.10	3.74	0.20	0.20
6	2.74	0.20	-0.10	2.98	0.20	0.30
7	2.23	0.10	-0.30	2.25	0.20	0.40
8	1.61	0.10	-0.30	1.62	0.30	1.00
9	1.05	0.04	-0.40	1.10	0.30	1.00
10	1.00	0.02	-1.00	1.00	0.40	1.00
11	0.40	-0.01	-1.00	0.20	0.30	1.00
12	0.20	-0.04	-1.00	-0.10	0.30	1.00
13	0.10	-0.10	-1.00	-1.00	0.30	1.00
14	0.10	-0.10	-1.00	-1.00	0.20	1.00
15	0.20	-0.10	-1.00	-1.00	0.20	1.00
16	0.40	-0.10	-1.00	-1.00	0.20	1.00

Table A.4 FEVD estimates

	BELGIUM			FRANCE			GERMANY		
	tr	**y**	**n**	**tr**	**y**	**n**	**tr**	**y**	**n**
1	1.00	0.01	0.03	1.00	0.01	0.02	1.00	0.0004	0.03
2	1.00	0.01	0.02	0.97	0.002	0.02	0.99	0.002	0.01
3	0.99	0.02	0.01	0.93	0.001	0.02	0.97	0.004	0.01
4	0.98	0.03	0.01	0.86	0.001	0.02	0.95	0.01	0.06
5	0.97	0.04	0.01	0.80	0.0004	0.02	0.92	0.01	0.11
6	0.95	0.05	0.004	0.75	0.001	0.02	0.89	0.01	0.16
7	0.94	0.06	0.01	0.69	0.002	0.02	0.88	0.01	0.19
8	0.93	0.06	0.02	0.64	0.003	0.02	0.87	0.01	0.21
9	0.92	0.06	0.04	0.59	0.01	0.02	0.86	0.02	0.21
10	0.91	0.07	0.07	0.55	0.01	0.02	0.85	0.03	0.21
11	0.91	0.08	0.12	0.53	0.01	0.02	0.85	0.05	0.21
12	0.91	0.10	0.17	0.51	0.01	0.02	0.85	0.07	0.20
13	0.91	0.13	0.23	0.49	0.01	0.02	0.85	0.10	0.20
14	0.91	0.16	0.28	0.47	0.01	0.02	0.85	0.14	0.19
15	0.91	0.18	0.32	0.46	0.01	0.02	0.85	0.19	0.19

	ITALY			SPAIN			SWEDEN		
	tr	**y**	**n**	**tr**	**y**	**n**	**tr**	**y**	**n**
1	1.00	0.07	0.03	1.00	0.02	0.06	1.00	0.09	0.09
2	0.98	0.06	0.02	0.99	0.002	0.05	0.98	0.05	0.09
3	0.94	0.05	0.02	0.98	0.001	0.04	0.93	0.04	0.09
4	0.89	0.04	0.02	0.96	0.003	0.02	0.87	0.03	0.07
5	0.85	0.03	0.01	0.93	0.01	0.02	0.82	0.03	0.05
6	0.81	0.03	0.01	0.87	0.01	0.01	0.79	0.03	0.05
7	0.78	0.03	0.01	0.81	0.02	0.01	0.76	0.03	0.06
8	0.75	0.03	0.01	0.74	0.01	0.01	0.73	0.03	0.08
9	0.73	0.03	0.01	0.68	0.01	0.02	0.71	0.03	0.11
10	0.71	0.03	0.02	0.62	0.01	0.02	0.69	0.03	0.15
11	0.69	0.03	0.02	0.57	0.01	0.02	0.67	0.04	0.18
12	0.68	0.03	0.02	0.53	0.01	0.03	0.66	0.04	0.20
13	0.67	0.03	0.02	0.49	0.01	0.03	0.66	0.04	0.22
14	0.66	0.03	0.02	0.47	0.01	0.03	0.66	0.04	0.23
15	0.66	0.03	0.02	0.44	0.01	0.03	0.66	0.03	0.24

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