FISCAL POLICY, EMPLOYMENT AND GROWTH: WHY IS CONTINENTAL EUROPE LAGGING BEHIND? °

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Paper presented at the EcoMod 2005 Conference, Istanbul.

Abstract

In this paper we analyse the impact of distortionary taxes, transfers related to structural non-employment and productive government expenditures on employment and long-run growth. Our theoretical model builds on Barro (JPE, 1990) which we extend by endogenizing the decision to work and by allowing two kinds of government expenditures. The model explains what we observe in the data: (i) higher growth and employment in the US (low taxes and low transfers) and in Scandinavia (high taxes, but high productive expenditures and low transfers) and (ii) lower growth and poor employment in continental Europe (high taxes, high transfers, lower productive expenditures).

JEL classification : E24, E62, J22, O41

Keywords: fiscal policy, taxes, transfers, government spending, employment, unemployment, endogenous growth

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° We thank David de la Croix, Geert Dhaene, Paul De Grauwe, Niko Gobbin and Glenn Rayp for valuable suggestions and comments on an earlier draft of this paper. We are grateful also to Jørgen Elmeskov for providing OECD data on gross benefit replacement rates for different employment durations. Furthermore, we wish to acknowledge support from the Belgian Program on Interuniversity Poles of Attraction, initiated by the Belgian State, Federal Office for Scientific, technical and cultural affairs, contract UAP No. P 5/21. Any remaining errors are ours.

1. Introduction

The last three decades show a remarkable change of macroeconomic performance at both sides of the Atlantic. Whereas in the early 1970s real per capita GDP growth and employment were higher in continental Europe than in the US, the opposite situation has emerged since the 1990s. According to a popular view, the level and the evolution of taxes and labour market flexibility are major determinants of this change of fortune. The US show low taxes and high labour market flexibility, whereas countries like Germany, France and Belgium show exactly the opposite (see e.g. Wyplosz, 2001; Young, 2003). The policy implication of this view is obvious. Continental Europe should reduce taxes and reform the labour market.

Although this view undoubtedly contains relevant elements to explain differences between Europe and the US, it is clearly incomplete. It cannot explain macroeconomic developments in Scandinavia. Countries like Sweden, Norway and Denmark also had high and increasing taxes during the last decades. They also combine many of the continental European labour market "rigidities". Yet, the evolution of employment and growth in these countries has been remarkably better than in many continental European countries. We see it as a major goal of this paper to explain this paradox.

In section 2 we illustrate the change of macroeconomic fortune in the US, continental Europe and Scandinavia described above. We also present data on several fiscal policy variables which we believe are crucial for an explanation of changing macroeconomic performance. In section 3 we present a brief overview of the main literature relevant to our study. In section 4 we build a theoretical model to explain the evolution of employment and long-run per capita growth, in which fiscal policy plays a crucial role. More specifically we analyse the impact of distortionary taxes, transfers (in case of structural non-employment) and productive government expenditures. The introduction of transfers related to structural non-employment in a model with endogenous growth and employment is a first contribution of this paper. In section 5 we simulate the effects of changes in the distortionary tax rate and the transfer replacement rate on employment and growth. We find that our model is able to explain what we basically observe in the data: (i) higher growth and employment in the US (low taxes and low transfers related to structural non-employment), (ii) higher growth and employment in Scandinavia (high taxes, but high productive expenditures and low transfers related to structural non-employment) and (iii) lower growth and poor employment in continental Europe (high taxes, high transfers, lower productive government expenditures). Correlation is remarkably strong between actual employment differences across countries and our model's predictions. Our focus on differences within Europe, i.e. differences between continental Europe and Scandinavia, is a second contribution of this paper. Almost all existing literature considers Europe as a whole, to be distinguished from the US. Section 6 discusses welfare implications. Section 7 concludes the paper.

2. Employment, growth and fiscal policy in Europe and the US: A look at the data

Tables 1 and 2 describe a number of stylized facts concerning employment, growth and fiscal policy in Europe and the US. We consider the period 1969-2003. As to Europe, we will in our discussion basically focus on averages for two relatively homogeneous country groups: continental Europe (including Belgium, France, Germany, the Netherlands and Italy) and Scandinavia (including Denmark, Finland, Norway and Sweden). Furthermore, tables 1 and 2 also contain data for the UK. This country often takes positions between Europe and the US. Finally, note that we do not consider countries like Ireland, Spain and Portugal. The major influence of European integration and conditional convergence effects on these countries' growth performance goes beyond the framework developed here.

TABLE 1 Employment and growth: Europe and the US

	employment rate (in %)			average annual hours worked per person 15-64			real per capita potential GDP growth (in %)		
	level 69-73	level 94-03	Δ^a	level 70-73	Level 94-03	$\Delta\%^b$	level 61-73	level 94-03	Δ^c
Belgium	61.08	58.11	-2.97	1134.9	911.4	-19.7	4.47	1.99	-2.48
France	65.86	61.27	-4.59	1273.7	966.9	-24.1	4.26	1.73	-2.53
Germany	68.80	65.30	-3.50	1285.5	978.8	-23.9	3.89	1.51	-2.38
Netherlands	57.74	69.53	6.29*	1015.2	945.8	-14.5*	3.25	2.39	-0.86
Italy	55.96	54.02	-1.94	1026.8	876.5	-14.6	4.59	1.74	-2.85
Average	**61.89**	**61.65**	**-1.34**	**1147.2**	**935.9**	**-19.4**	**4.09**	**1.87**	**-2.22**
Finland	69.96	65.72	-4.24	1311.1	1143.3	-12.8	3.85	2.29	-1.56
Denmark	74.58	75.26	0.68	1384.3	1132.7	-18.2	3.42	2.12	-1.32
Norway	67.56	76.48	8.92	1181.8	1062.7	-10.1	3.51	2.04	-1.46
Sweden	73.06	71.56	-1.50	1220.5	1156.7	-5.2	3.54	1.84	-1.70
Average	**71.29**	**72.26**	**0.97**	**1274.4**	**1123.8**	**-11.6**	**3.49**	**2.00**	**-1.49**
US	**64.52**	**73.74**	**9.22**	**1224.8**	**1354.6**	**10.6**	**2.49**	**1.91**	**-0.58**
UK	70.62	70.31	-0.31	1345.4	1211.0	-10.0	2.93	2.10	-0.83

a: *change 1994-2003 versus 1969-1973;* ***b****: percentage change;* ***c****: change 1994-2003 versus 1961-73.*

Notes: *Employment rate is the ratio of total employment to population of age 15 to 64; Average annual hours worked have been calculated as the employment rate times average annual hours per worker; Due to lack of data, we use average actual real per capita GDP growth in 1961-1973 as a proxy for real per capita potential GDP growth; Per capita GDP is GDP per person of age 15 to 64; n.a.: data are not available; * After correction for a break in series in 1986.*

Sources: *OECD, 2004, Quarterly labour force statistics – Indicators; OECD, 2004, Economic Outlook; Data for the employment rate have been taken from the labour force statistics provided on the OECD website (www.oecd.org). For a few countries however (Belgium, Italy) some data are missing. To complete the series we have then calculated employment rates ourselves using data on total employment and population of age 15-64 from OECD (2004, Economic Outlook).*

Table 1 reports the employment rate, average annual hours worked per person and real per capita potential GDP growth. In the early 1970s the employment rate in Europe, with the exception of Belgium, Italy and the Netherlands, was higher than in the US. After the first oil shock this pattern changed. In the US the employment rate increased, while a majority of European countries suffered from decreasing employment. The employment rate fell in all included continental European countries, except the Netherlands. The evolution in Scandinavia was more balanced, with a rising employment rate in Denmark and Norway, and a falling one in Sweden and Finland[1]. In 1994-2003, the average employment rate was about 72 to 73% in Scandinavia and the US. Continental European employment was more than 10 percentage points lower. Another observation concerns average annual hours worked per person of age 15 to 64. In the US hours worked per person increased over the years, while they decreased in all European countries. Again, there exists a striking difference between continental Europe and Scandinavia. The decrease in hours worked per person was much stronger in the continental European countries, this time including the Netherlands.

In the 1960s and early 1970s per capita potential economic growth in continental Europe was higher than in the Nordic countries and the US. Also this pattern changed after the first oil shock. Per capita potential GDP growth fell markedly in both the US and the whole of Europe, but the growth slowdown in the continental European countries was clearly more pronounced. Only the Netherlands performed better. The Scandinavian countries also experienced a relatively small growth slowdown. In the second period, per capita potential growth in Scandinavia was higher on average than in the US and continental Europe[2]. Relative growth performance was also strong in the UK.

Table 2 describes the facts about fiscal policy. As is clear from this table, both the continental European and the Scandinavian countries have higher effective tax rates than the US. All countries, except the UK, experienced a tax increase over the years, but the European increase was clearly much more pronounced[3]. Even more interesting is the average level of the transfer replacement rate, which is split into two categories: long-term unemployment benefits and early leave incentives. Note that we only look at unemployment benefits during the fourth and fifth year. Our goal is precisely to measure the replacement income of individuals who have de facto turned to structural non-employment. The 'early leave incentive' variable (ELI) tries

[1] The data for Finland should however be interpreted with caution. Much more than any other country, Finland suffered from an extreme fall in aggregate demand in the first half of the 1990s. This obviously fed through in reported employment rates, but reveals little about the structural determinants that we focus on in this paper. In 1997-2003 the average employment rate in Finland was 67.2%, which would reduce the reported decline to about 2.8 percentage points.

[2] Differences are much more pronounced if one considers average actual growth over 1994-2003 as an indicator for potential growth. In the four Scandinavian countries average actual growth was 2.64% in this period. In the five continental European countries it was only 1.86%, in the US 1.89%.

[3] Alternative data sources show a highly similar pattern. For example, correlation between the change in the distortionary tax rate that we report in table 2 and the change between 1970 and 1998 in the total tax wedge on labour presented by Martinez-Mongay (2000, table 6) amounts to 90.3.

to capture the net effect of all incentive systems for workers to leave the labour force early (e.g. early retirement benefits, invalidity benefits). We consider early leave as an important other form of structural non-employment. ELI is calculated as the labour force participation rate of people aged 25 to 54 to the labour force participation rate of people aged 55 to 64. The higher this ratio, the higher we consider to be the incentive to leave early. Absence of special incentives for older workers to leave, would imply an ELI-ratio equal to one.

If we look at the data, the difference between the continental European countries and the Nordic countries is striking. Both the long-term unemployment benefit and the ELI-ratio are much higher in the continental European countries. Although the unemployment benefit data may suggest differently, Finland is the only real exception to the rule. Italy and Denmark are not. Reyneri (1994) has shown that the gap between Italy and the other continental European countries is much smaller than it seems[4]. As to Denmark, if one also takes eligibility criteria and conditions of entitlement into account, Danish policy is in line with Norway and Sweden[5]. To finish, we take a look at productive government expenditures, divided into four categories. As is clear from table 2, Scandinavia has relatively high education and active labour market expenditures, expenditures which have a direct impact on the level of employment. Expenditures for government investment and government financed R&D are comparable with continental Europe. Quite remarkable is that within Europe each component of productive expenditures shows the best evolution in Scandinavia. The US have average, but strongly decreasing education expenditures and poorly developed active labour market policies. Government investment, on the other hand, is relatively high and increasing in the US, whereas Europe experienced a decline.

[4] Unemployment benefits barely exist in Italy. This does not imply a zero fall-back position, though. Reyneri (1994) points to the importance of family support as an alternative to unemployment benefits. Furthermore, he emphasizes the existence of invalidity benefits as an additional mechanism of public transfers that the unemployed could receive.

[5] Although the benefit replacement rate in Denmark is higher than in Sweden and Norway, Danish eligibility criteria make the payment of unemployment benefits strictly conditional upon active job search. Moreover, unemployed workers who refuse participation in active labour market programmes after 12 months of unemployment are excluded from benefits. In recent years this period of 12 months has been reduced (Danish Economic Council, 2002).

TABLE 2 Fiscal policy: Europe and the US (1969-1999)

			Transfer Replacement Rate				Productive Government Expenditures							
	Distortionary tax rate [a]		Long-term unemployment benefit replacement rate [b]		Early leave Incentive [c]		Education expenditure [d]		Active labour market policy [e]		Government investment [f]		Government-financed R&D [g]	
	level 69-99	Δ^{α}	level 69-99	Δ^{α}	level 79-99	$\Delta\%^{\beta}$	level 70-96	Δ^{γ}	level 85-99	Δ^{δ}	level 71-99	Δ^{ε}	level 81-99	Δ^{η}
Belgium	30.58	10.08	39.48	-5.44	3.24	39.1	5.43	-2.27^{θ}	1.31	-0.03	1.22	-0.69	0.46	-0.10
France	26.98	10.44	12.27	8.36	2.11	48.1	5.43	1.08	1.06	0.63	2.65	-1.30	1.04	-0.18
Germany	26.49	3.51	23.13	-1.71	1.83	23.2	4.78^{∞}	/	1.26	0.36	1.71	-1.51	0.91	-0.20
Netherlands	30.98	2.35	22.34	26.65	2.24	51.5	6.87	-2.29	1.46	0.42	1.95	-1.24	0.88	-0.09
Italy	24.26	13.87	0	0	2.42	11.5	4.37	1.01	0.98	0.4	1.4	-0.56	0.56	0.07
Average	**27.86**	**8.05**	**19.44**	**5.57**	**2.37**	**34.7**	**5.53**	**-0.62**	**1.21**	**0.36**	**1.79**	**-1.06**	**0.77**	**-0.10**
Finland	26.60	11.95	18.23	9.91	1.96	20.0	6.09	1.48	1.53	0.60	1.36^{λ}	-0.30	0.64	0.12
Denmark	29.57	9.09	30.46	45.94	1.63	-1.3	7.32	0.9	1.75	0.76	1.08	-1.60	0.75	0.33
Norway	25.59	4.33	5.00	5.33	1.29	9.7	6.64	2.25	1.1	0.52	3.02	0.39	0.74	0.05
Sweden	35.63	10.6	0	0	1.30	3.1	7.83	0.71	2.29	0.15	1.54	-0.45	0.97	-0.01
Average	**29.35**	**8.99**	**13.42**	**15.30**	**1.54**	**7.9**	**6.97**	**1.34**	**1.67**	**0.51**	**1.75**	**-0.49**	**0.77**	**0.12**
US	**22.05**	**1.75**	**4.94**	**1.44**	**1.45**	**7.0**	**6.41**	**-2.07**	**0.19**	**-0.01**	**2.98**	**0.2**	**1.06**	**-0.34**
UK	24.54	-1.58	17.86	-4.56	1.60	4.4	5.47	-0.31	0.4	-0.39	0.8	-0.9	0.76	-0.52

$^{\alpha}$ 1994-1999 versus 1969-1973; $^{\beta}$ 1994-1999 versus 1979-1983, average of available data; $^{\gamma}$ 1994-1996 versus 1970-1973; $^{\delta}$ 1994-1999 versus 1985; $^{\varepsilon}$ 1994-1999 versus 1971-1973; $^{\eta}$ 1994-1999 versus 1981-1983, average of available data; change in percentage points; $^{\theta}$ 1994-96 versus 1975; $^{\infty}$1993-1996; $^{\lambda}$ 1975-1999

Notes: ***[a]*** *The distortionary tax rate is constructed following the methodology suggested by Kneller et al. (1999). Income and property taxes, social security contributions and taxes on payroll and manpower are treated as distortionary taxes. In percentage of GDP;* ***[b]*** *The long-term unemployment benefit replacement rate is the ratio of gross unemployment benefits of workers in their fourth and fifth year of unemployment in percent of gross earnings; [c] Early leave incentive is the ratio of the labour force participation rate of people aged 25 to 54 to the labour force participation rate of people aged 55 to 64;* ***[d]*** *Public expenditures on education in percent of GDP;* ***[e]*** *Public expenditures on active labour market policy in percent of GDP. Active expenditures include labour market training, youth measures, subsidized employment, employment measures for disabled and employment service and administration;* ***[f]*** *Real government investment in percent of the real physical capital stock in the business sector;* ***[g]*** *Government-financed gross expenditures on R&D. In percentage of GDP; n.a.: data are not available*

Sources: *OECD Financial and Fiscal Affairs, Revenue Statistics of OECD Member Countries, OECD (2004), OECD Database on Benefit Entitlements and Gross Replacement Rates; OECD Social Expenditure Database, 1980-1991, 2001 edition; UNESCO, www.uis.unesco.org, Institute for statistics; OECD Main Science and Technology Indicators; OECD, Employment Outlook, 1990-2002*

Summarizing, our data for Europe in the last three decades suggest relatively strong employment and growth performance in Scandinavia, and weak performance in continental Europe, except maybe the Netherlands. Performance was relatively strong also in the US. The data for fiscal policy reveal high and rising distortionary taxes across the whole of Europe (except the UK). In comparative terms, in Scandinavia these taxes have resulted in high and rising productive government expenditures. In continental Europe the level and evolution of productive expenditures has been much less convincing. Transfers related to structural non-employment (including early retirement) tend to show the opposite picture, with more resources being allocated to them in continental Europe. In the US, distortionary taxes have always remained much lower than in Europe. By consequence, government expenditures are also lower, especially transfers. The general level and evolution of productive expenditures in the US have been moderate.

Our aim in the next sections is to develop a model with endogenous growth and employment which can rationalize the above observations. First, however, we put our contribution within the perspective of existing literature.

3. Existing literature

Endogenous growth theory and labour market research have paid increasing attention to fiscal policy variables as determinants of long-run growth and labour market performance. In this section we present a brief overview of the main focus and results of this literature relevant to our analysis. This overview will allow us also to clarify the contribution and limitations of this paper.

3.1 Labour market research

Research on the labour market effects of fiscal policy has mainly focused on the influence of taxes, unemployment benefits and active labour market policy expenditures. Although the results of this literature are not unanimous, many authors find that generous unemployment benefit systems contribute to lower employment and higher unemployment. Both the benefit replacement rate and the number of years during which benefits are paid seem to matter. The latter is generally considered to be the most important (e.g. Burda, 1988; Nickell, 1997; Elmeskov et al., 1998; Blanchard and Wolfers, 2000; Wyplosz, 2001; OECD, 2002; European Commission, 2004; Allard and Lindert, 2004). Studies investigating the (un)employment effects of active labour market policy are less numerous. Their empirical results are not always clear-cut (e.g. Blanchard and Wolfers, 2000). Yet, it should be noted that several recent studies do support the idea that active labour market policy contributes to higher employment (Elmeskov et al., 1998; Estevão, 2003; European Commission, 2004)[6]. The literature on the effects of taxes is somewhat more controversial. Research typically reveals negative effects on employment, but the magnitude of this effect is uncertain. Most of the above mentioned authors find a rather weak effect. Daveri and Tabellini (2000), Prescott (2003) and Cardia et al. (2003) however find strong effects. Prescott (2003) and Cardia et al. (2003) build on standard competitive business cycle theory. Prescott concludes from a simple calibration that "virtually all the large differences [since the early 1970s] in the US labour supply and those of Germany and France are due to differences in tax systems" (p. 13). Cardia et al. estimate a structural model for the US, Canada, Germany and Japan, and draw very similar conclusions. Daveri and Tabellini consider imperfectly competitive labour markets and emphasize the influence of wage bargaining institutions. Taxes seem to matter less in highly decentralized and in highly centralized labour markets. The UK and the US represent the former case, Scandinavia the latter. By contrast, Daveri and Tabellini observe very unfavourable tax effects on employment in continental European countries. In most of these countries, labour markets are neither centralized nor decentralized.

These results from the labour market literature are important for our analysis. First, they highlight the crucial role of transfers directly related to non-employment. Second, they suggest alternative explanations for our observations in the previous section. While this paper will demonstrate that the growth and employment effects of taxes depend crucially on the composition of government expenditures, the labour literature emphasizes the influence of wage bargaining institutions. Scandinavia may benefit from favourable characteristics in both respects.

3.2 Fiscal policy and growth

The literature on fiscal policy and endogenous growth has shown an enormous development during the last fifteen years. Initial models typically treated labour supply and employment as exogenous (e.g. Barro, 1990; King and Rebelo, 1990; Rebelo, 1991; Jones et al., 1993; Cashin, 1995; Turnovsky, 1996). More recently, however, models have been developed with endogenous labour supply (e.g. Devereux and Love, 1995; Roeger and De Fiore, 1999; Turnovsky, 2000). Except for a few studies (e.g. Roeger and De Fiore, 1999; Van der Ploeg 2003), this literature generally assumes perfect competition.

It goes far beyond the scope of this paper to review this whole literature. It is worthwhile, however, to summarize some of the main results. Some of these results will be confirmed by our study. *First*, beginning with King and Rebelo (1990) and Rebelo (1991), many authors have shown that – all other things equal – higher income taxes reduce growth.

[6] Allard and Lindert (2004) find negative effects of active labour market policies on employment, but positive ones on labour productivity and real GDP. Arjona et al. (2002) also find positive effects of active labour market expenditures on GDP growth.

Basically, taxes reduce the net return to investment and undermine capital formation. As long as labour supply is exogenous, consumption taxes may have no effect on growth. With endogenous labour however – and again assuming all other things equal – all taxes may undermine growth (see e.g. Roeger and De Fiore, 1999; Turnovsky, 2000). *Second*, the effects of taxes depend crucially on the allocation of government income. Taxes may promote growth when they are allocated to productive expenditures. Elaborating on this assumption, Barro (1990) has shown the existence of an inverted U-shaped relationship between income taxes and growth. Various authors have extended Barro's model by introducing additional categories of government expenditures (e.g. Cashin, 1995; Capolupo, 2000; Weber, 2000). In general, these extended models confirm Barro's inverted U-shape. The level at which it is situated, however, will change as a function of the precise composition of expenditures. Kneller et al. (1999) provide empirical support to these extended Barro models.

A *third* series of relevant findings comes from studies which consider not only alternative taxes and government expenditures, but also endogenous labour. Turnovsky (2000) derives a number of key results. As we have already mentioned, endogenizing labour implies growth effects from all kinds of taxes (i.e. taxes on capital, labour and consumption). A rise in any of these tax rates with revenues rebated in lump-sum fashion, reduces labour supply and employment. The reason is that higher tax rates undermine the relative net marginal utility of working versus leisure. By contrast, higher government expenditures will stimulate employment (and growth) if they are financed by lump-sum taxation. Higher expenditures induce a negative wealth effect, which reduces consumption and leisure. The increase in labour supply further raises the marginal productivity of private capital and the return to investment, which stimulates capital formation and growth. If higher government expenditures are productive, an additional positive effect on the productivity of labour and private capital reinforces favourable employment and growth effects. Finally, as will be obvious from the previous, composite fiscal policy actions involving both changes in tax rates and government expenditures will have ambiguous effects.

Although they assume imperfectly competitive product markets, the approach in Roeger and De Fiore (1999) is basically comparable to Turnovsky's (2000). So are some of their results. As an interesting difference, Roeger and De Fiore pay more explicit attention to the role of transfers. They find that shifting expenditures from government purchases to transfers unambiguously reduces employment and growth. The reason is that an increase in non-labour income makes households supply less labour. Growth will fall because the subsequent reduction in employment also affects the marginal productivity of capital and the return to investment. The effects of social transfers are a key issue also in extensive empirical work on the OECD countries by Arjona et al. (2002) and Lindert (2004). One of Lindert's most interesting findings from the perspective of this paper is that tax-financed social transfers in general have no net negative effect on output and growth, except transfers related to unemployment benefits and early retirement. Arjona et al. (2002) also find negative effects of ‘passive’ labour market expenditures on growth. Interestingly, they find positive effects of social expenditures related to active labour market policies and expenditures that seek to increase labour supply through reducing barriers to participation, e.g. provision of childcare.

Given all the above results, we can now summarize the contribution and limitations of this paper. The main contribution of the paper is double. First, labour market studies have convincingly demonstrated the key role of transfers related to structural non-employment for an explanation of low employment in many European countries. Almost all authors agree on the important negative influence on employment of the length of the period during which benefits are paid. Arjona et al. (2002) and Lindert (2004) have shown negative effects of unemployment and early retirement benefits on output and growth. In our model we take these key elements into account. Government revenue will come from income taxes; it can either be allocated to productive expenditures or to transfers related to structural non-employment. This way of modelling gives us a powerful instrument to explain existing growth and employment differences across countries. The latter brings us to the second contribution of the paper. In contrast to existing literature we will especially focus on differences within Europe, i.e. the differences between continental Europe and Scandinavia that we have highlighted in the previous section. To the best of our knowledge, existing work either considers Europe as one group, to be distinguished from the US (e.g. Roeger and De Fiore, 1999; Allard and Lindert, 2004; Blanchard, 2004), or reduces Europe to Germany and/or France (e.g. Prescott, 2003; Cardia et al., 2003).

In some respects, our approach in this paper is too restrictive. First, we make the assumption of perfect competition. Obviously, Europe is not perfectly competitive. Union power is significant, labour and product markets are often highly regulated, etc.. A first extension of this paper that we have in mind, is to reassess our findings within an imperfectly competitive framework. Second, we only assume one kind of tax in this paper, a flat-rate income tax. Yet, as has been demonstrated theoretically by e.g. Turnovsky (2000) and empirically by Lindert (2004), the precise composition of the tax system may be at least as important as the total tax level. Introducing alternative tax systems provides a second possible extension of this paper. A third limitation of the paper is our assumption that fiscal policy is exogenous. Reality shows distinctive differences in tax rates and transfer replacement rates across countries (see table 2), which would obviously be worth explaining. In line with most of the related literature, however, we take these differences as given and concentrate on studying their effects.

4. Employment, taxes and government expenditures – The model

In this section we investigate the relationship between employment, taxes, government expenditures and growth in a simple endogenous growth framework. Our theoretical model builds on Barro (1990) which we extend by endogenizing the decision to work and by allowing two kinds of government expenditures: productive expenditures and transfers related to structural non-employment. The economy is closed. Population is constant.

4.1. Setup of the model

The economy consists of identical infinitely lived household-producers with perfect foresight. Each household contains N members, from whom a fraction l_t works and produces market goods. A fraction $(1-l_t)$ has no market job. These family members allocate their time to leisure or to useful non-market production activities (e.g. caring time). Each household maximizes an intertemporal utility function:

$$U = \int_0^{\infty} u\left(Nc_t, \phi\left(N\left(1-l_t\right)\right)\right) e^{-\rho t} dt \tag{1}$$

where Nc_t stands for household consumption at time t and $\phi\left(N\left(1-l_t\right)\right)$ is a positive function of the number of household members who enjoy leisure or who engage in useful non-market activities. In what follows we will call l_t the employment rate. $\rho>0$ is the pure rate of time preference.

The representative household-producer faces the following resource constraint

$$Nc_t + N\dot{k}_t = (1-\tau)Ny_t + b_t N(1-l_t), \tag{2}$$

where Ny_t is household output and productive income before taxes, $N\dot{k}_t$ is physical capital accumulation, τ is the income tax rate and b_t is a transfer paid by the government to household members without a market job. Physical capital is assumed not to depreciate.

Each household-producer has access to the following Cobb-Douglas production function:

$$y_t = Ak_t^{1-\beta} g_t^{\beta} l_t, \quad \text{with} \quad 0 < \beta < 1. \tag{3}$$

Per capita output y_t is produced by means of physical capital per capita k_t, productive government expenditures per capita g_t and the employment rate l_t. Technology A is assumed constant. The above production function specifies constant returns to scale in k_t and g_t (both endogenous). The employment rate will be constant in equilibrium.

As to government expenditures, we distinguish productive and non-productive expenditures. Expenditures which are included in the private production function, as g_t is, are treated as productive. Examples are expenditures related to general public services, education and training, transport and communication infrastructure. Like Barro (1990) we assume that productive government expenditures are provided without user charges and are not subject to congestion effects. Transfers are non-productive in our model. They are an unconditional source of income support to household members without a market job. Alternatively, one could call them a 'wage' for non-market household activities. Although it may seem strange to have such transfers in a model without involuntary unemployment, one can analyse their employment and growth effects as a theoretical benchmark case (see also van der Ploeg, 2003). Moreover, there is also clear practical relevance. Unconditional or quasi unconditional benefits to structurally non-employed people are a fact of life in many European countries, as the data for the transfer replacement rate (including ELI) show in table 2.

The government runs a balanced budget in which productive expenditures Ng_t and (non-productive) transfers $b_t N(1-l_t)$ are financed by a flat-rate income tax τ.

$$Ng_t + b_t N(1-l_t) = \tau N y_t, \quad \textit{with } b_t = v y_t \quad \textit{and } g_t > 0 \tag{4}$$

We only consider taxes that affect the production decision. In equation (4) we assume that the government transfer b_t is proportional to output according to the replacement rate, v. Our specification of the government's budget constraint implies a hard trade-off. When for example output falls, the government either has to raise distortionary tax rates, or to cut productive expenditures or transfers. The government cannot take the 'easier' way out of changing lump-sum variables. In our view this assumption may very well reflect reality in many countries in the 1970s to 1990s. Facing bad times, governments typically increased distortionary tax rates and reduced government investment (Alesina and Perotti, 1995; de Haan et al., 1996).

4.2. Optimization

To simplify notation we normalize household size and put N equal to 1. Furthermore, we shall assume the instantaneous utility function $u\left(Nc_t, \phi\left(N(1-l_t)\right)\right)$ to be log-linear in both arguments. For a similar approach, see e.g. Roeger and De Fiore (1999) and Cardia et al. (2003). The optimization problem of the representative household then concerns choosing c_t and l_t to maximize

$$U = \int_0^\infty \left[a \ln(c_t) + (1-a)\ln(1-l_t)\right] e^{-\rho t} dt \tag{5}$$

taking g_t, τ and b_t as given and subject to

$$\dot{k}_t = (1-\tau) A k_t^{1-\beta} g_t^{\beta} l_t + b_t(1-l_t) - c_t \tag{6}$$

The parameter a reflects the relative weight of consumption versus non-market employment in household utility.

The present-value Hamiltonian for this problem is

$$H_t = \left[a \ln(c_t) + (1-a)\ln(1-l_t)\right] e^{-\rho t} + \lambda_t \left[(1-\tau) A k_t^{1-\beta} g_t^{\beta} l_t + b_t(1-l_t) - c_t\right] \tag{7}$$

The first order conditions yield three equations describing the representative household's optimal behaviour and equilibrium, taking g, τ and v as given.

$$\gamma_c = \frac{\dot{c}}{c} = (1-\tau)(1-\beta) A \left(\frac{g}{k}\right)^{\beta} l - \rho \tag{8}$$

$$\gamma_k = \frac{\dot{k}}{k} = (1-\tau) A \left(\frac{g}{k}\right)^{\beta} l + \frac{b}{k}(1-l) - \frac{c}{k} \tag{9}$$

$$\frac{1-a}{1-l} = \left[(1-\tau) A k^{1-\beta} g^{\beta} - b\right] \frac{a}{c} \tag{10}$$

Equation (8) is the usual Euler equation for the optimal growth rate of consumption over time γ_c, which describes intertemporal optimality. Equation (9) follows from the household's resource constraint (6) after dividing both sides by k. Equation (10) describes the intratemporal optimality condition between labour (consumption) and 'leisure'. The left hand side of this equation represents the marginal utility of non-employment, the right hand side is the net marginal utility of working. The latter rises in the marginal utility of consumption (a/c) and in the net marginal after-tax income gain from employment $\left[(1-\tau) A k^{1-\beta} g^{\beta} - b\right]$.

In order to find equilibrium growth and employment rates in terms of the parameters of the model we substitute equation (3) for y in the equations of the public sector (4), also with $N = 1$. This yields expressions for (g/k) and (b/k)

$$\frac{g}{k}=\left[Al\left(\tau-v(1-l)\right)\right]^{\frac{1}{1-\beta}} \tag{11}$$

$$\frac{b}{k}=vA\left(\frac{g}{k}\right)^{\beta}l=vA^{\frac{1}{1-\beta}}l^{\frac{1}{1-\beta}}\left(\tau-v(1-l)\right)^{\frac{\beta}{1-\beta}} \tag{12}$$

Substituting (11) and (12) into (8), (9) and (10), allows us to determine economic growth and employment in the economy, consistent with both household optimization and the government budget constraint.

$$\gamma_c=\frac{\dot{c}}{c}=(1-\tau)(1-\beta)A^{\frac{1}{1-\beta}}\left(\tau-v(1-l)\right)^{\frac{\beta}{1-\beta}}l^{\frac{1}{1-\beta}}-\rho \tag{13}$$

$$\gamma_k=\frac{\dot{k}}{k}=(1-\tau)A^{\frac{1}{1-\beta}}l^{\frac{1}{1-\beta}}\left(\tau-v(1-l)\right)^{\frac{\beta}{1-\beta}}+vA^{\frac{1}{1-\beta}}l^{\frac{1}{1-\beta}}\left(\tau-v(1-l)\right)^{\frac{\beta}{1-\beta}}(1-l)-\frac{c}{k} \tag{14}$$

$$\frac{c}{k}=\frac{a}{1\text{-}a}(1-l)A^{\frac{1}{1\text{-}\beta}}l^{\frac{\beta}{1\text{-}\beta}}\left(\tau\text{-}v(1-l)\right)^{\frac{\beta}{1\text{-}\beta}}\left[(1\text{-}\tau)\text{-}vl\right] \tag{15}$$

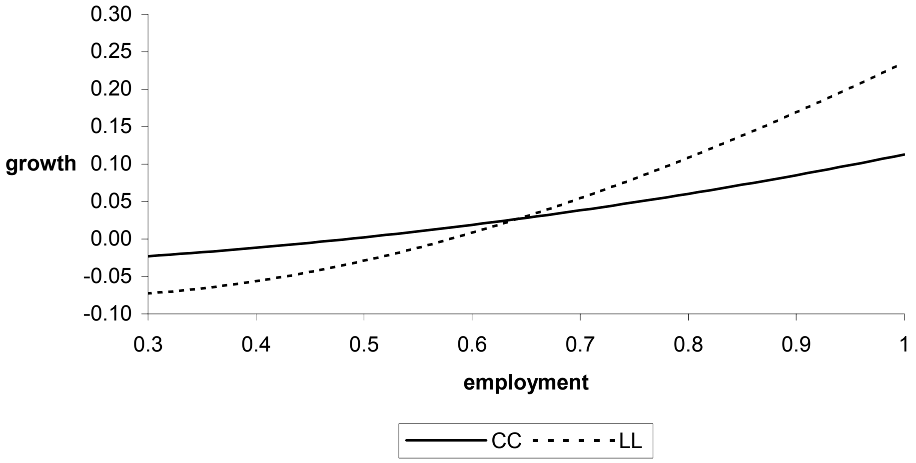
In steady-state these three equations determine the variables $\gamma_c=\gamma_k=\gamma_y$, c/k and l. Note that it is not possible to solve this model analytically. We can however solve it numerically for realistic parameterizations. We discuss the choice of these parameters in the next section.

Equations (13) – (15) imply two equilibrium loci in an employment-growth framework (see figure 1). The CC locus reflects equation (13) and describes the equilibrium relationship between employment and growth that is consistent with intertemporal optimality. The higher employment, the higher the marginal product of capital and the more interesting it is for the household to substitute future for current consumption. The household will save and invest more, the consumption path will be steeper and γ_c higher. Note that the increase in the marginal product of capital induced by higher employment also follows from higher productive government expenditures. For given τ, the government can raise its productive expenditures since higher employment reduces the need to pay transfers. Substituting equation (15) for (c/k) into equation (14), gives us the LL locus as a second equilibrium condition relating employment to growth:

$$\gamma_k=\frac{\dot{k}}{k}=A^{\frac{1}{1-\beta}}l^{\frac{\beta}{1-\beta}}\left(\tau-v(1-l)\right)^{\frac{\beta}{1-\beta}}\left[\left((1-\tau)+v(1-l)\right)l-\frac{a}{1\text{-}a}(1-l)\left[(1\text{-}\tau)\text{-}vl\right]\right] \tag{16}$$

This equilibrium condition depicts the relationship between employment and capital growth that is consistent with the household's resource constraint and intratemporal optimality. For realistic parameter and employment values the LL locus also has a positive slope, which basically reflects the household's labour-'leisure' choice. To be optimal, high employment requires a high net marginal utility of working, i.e. a low *c/k* (see equation 10). Given the household's resource constraint, $\dot{k}/k$ should then be high.

FIGURE 1 Equilibrium growth and employment



Note: *Underlying parameters: A=0.75, ρ =0.04, (1-β) =0.65, a =0.65, τ =0.3 and ν =0.2*

The intersection of CC and LL determines the balanced growth equilibrium in our model. It describes employment and growth that is consistent with both intertemporal and intratemporal optimality. For realistic parameter values – and thinking about realistic macroeconomic outcomes for growth and employment – this intersection is unique. In appendix 1 we discuss the existence and characteristics of equilibria in our model in general.

5. The impact of fiscal policy on equilibrium employment and growth

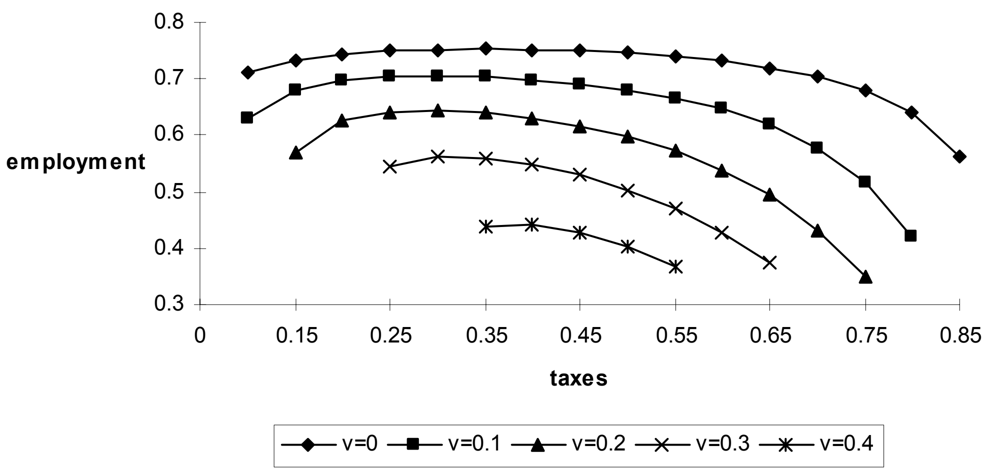
In order to find numerical solutions for our model, we have chosen specific values for the parameters. Following among others Barro (1990), Turnovsky (2000) and Capolupo (2000), the time preference rate ρ has been set equal to 0.04. A is a scaling parameter and has been set equal to 0.75. With respect to capital, we take a broad view. We assume a private capital-share coefficient $(1-\beta)$ equal to 0.65. The implied output elasticity of public expenditures β may be rather high, but its relative size is well within the range of existing empirical results (e.g. Glomm and Ravikumar, 1997). The weight of 'leisure' in the felicity function, $(1-a)$, has been set at 0.35. The literature offers less guidance for this parameter. For example, Turnovsky (2000) assigns a relative weight of 0.23 to leisure, Prescott (2003) however chooses 0.60. Cardia et al. (2003, p. 369) estimate a structural model for several countries and conclude that the weight of leisure in the utility function is comparable to the weight assigned to consumption. Our choice has been inspired by the aim to obtain a realistic macroeconomic outcome, i.e. an employment rate of about 60 to 70%. The higher the value one assigns to the weight of 'leisure', the lower equilibrium employment.

In what follows, we now first derive the theoretical relationships between fiscal policy, employment and growth as predicted by our model. Then we assess the model's empirical relevance and return to the basic question why employment and growth in continental Europe are lagging behind.

5.1 Simulating the model

In this section we compute numerical simulations for the net impact of taxation and the government transfer replacement rate on output growth and employment. Due to the way we have modelled the government budget constraint, a change in either of these two policy variables affects productive government expenditures and implies movements in both the CC and LL locus of figure 1. In what follows we concentrate on net outcomes. Figure 2 describes the relationship between taxes, transfer replacement rates and employment. Note that we only consider combinations of tax rates and transfer replacement rates for which $(1-\tau) > v$, i.e. productive income after tax should be higher than the government transfer. The bottom left corner of figure 2 also illustrates a necessary condition for equilibrium in our model: τ must be higher than *v(1-l)*. In other words, *g* must be positive (see equation 4).

FIGURE 2 Employment and taxes for a varying replacement rate



The higher the transfer replacement rate, the lower the employment rate will be, which is intuitively clear. A higher transfer replacement rate decreases the net marginal utility of working, which induces the representative household to work less. This decrease in net marginal utility of working also follows from the fact that an increase in transfers implies less productive government expenditures. Marginal productive income from working will then fall as well. More interestingly, we see an inverted U-shaped relationship between taxes and employment, especially for the lower transfer replacement rates. The employment rate will at first increase with taxes and only after a while it starts decreasing. Several forces are at work here. On the one hand, higher taxes imply higher productive government expenditures. These productive expenditures have a positive influence on both the net marginal utility of working and on the marginal productivity of physical capital. The former will induce the representative household to work more, while the latter will give an incentive to invest more. As soon as more physical capital has been installed, the marginal utility of working increases again, reinforcing the stimulus to increase employment. On the other hand, higher taxes undermine working and physical capital investment, because the government takes a higher fraction of produced gross returns. At low tax rates, the net effect of higher taxes is positive, since the first effect will be dominant. At low taxes, g will be low, implying that its marginal productivity will be high. Increasing τ and g will then encourage employment and capital formation. At high tax rates the opposite holds.

FIGURE 3 Growth and taxes for a varying transfer replacement rate

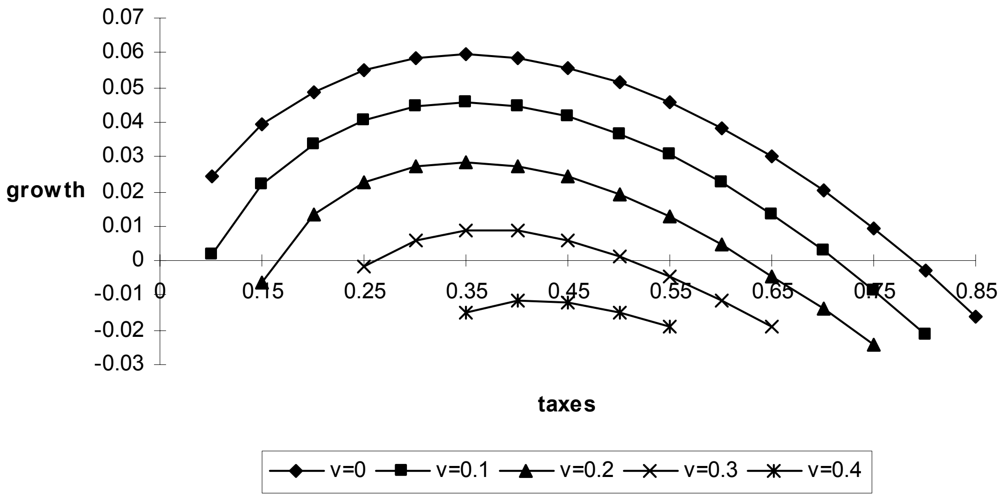


Figure 3 depicts the relationship between taxes, the transfer replacement rate and growth. For given v this figure confirms Barro's (1990) inverted U-shaped relationship between the tax rate and the equilibrium growth rate. The growth maximizing tax rate is higher in our model, mainly due to the assumed higher output elasticity of government expenditures. Calculation reveals some influence of the transfer replacement rate, but this influence is small[7]. By contrast, the replacement rate plays a major role for the level of the equilibrium growth rate.

[7] The introduction of a labour-leisure choice explains this small influence. As we have described above, introducing transfers implies a lower employment rate, which increases total government transfers and leaves less resources for productive government expenditures. Lower productive government expenditures imply a higher marginal productivity of g, which rationalizes higher tax rates.

This result is again not surprising. A higher transfer replacement rate at first decreases the net marginal utility of working, which induces lower employment. Total government transfers rise, leaving fewer resources for productive expenditures g. This decrease in g further has a negative influence on the marginal productivity of physical capital and the propensity to save and invest. The decline in employment and in the propensity to invest undermines growth.

5.2 Predicted versus actual employment and growth in Europe and the US

How well does our model explain the data? Why is continental Europe lagging behind on employment and growth? In this section we try to answer these questions. Let it be clear though that, due to the very simple nature of our model and our calculations below, our answers can at best be tentative.

Table 3 reports actual and predicted employment and growth rates for continental Europe, Scandinavia, the US and the UK. Actual data are averages for 1994-2003. Predictions are based on true values for the tax rate τ and the transfer replacement rate v. The upper part of the table is based on average τ and v over the whole period 1969-99 (see the data in table 2). The lower part is based on average τ and v in 1994-99. These data are reported in appendix 2. As can be seen, we present in each part of the table two predictions for continental Europe and for Scandinavia. Underlying these two predictions are alternative values for the transfer replacement rate. The first prediction is based on the values for v reported in table 2 and appendix 2. However, as we have emphasized in our discussion before, there may be a problem with the raw replacement rates reported for Denmark and Italy (see also footnotes 4 and 5). As a simple alternative we have put the transfer replacement rate in these two countries equal to the average of the other countries in their respective groups.

Despite the very simple nature of our model, our predictions for the employment rate are remarkably close to the actual values. This is especially the case after adjusting the replacements rates for Italy and Denmark. When we adjust, the difference between actual and predicted employment rates in the upper part of the table remains below 1.5 percentage points as well in continental Europe, as in Scandinavia and the US. Only for the UK there remains a gap of almost 5 percentage points.

In the lower part of the table differences are a little larger for continental Europe and the US, but smaller for the UK. Differences between actual and predicted data are also larger when we do not adjust v for Denmark and Italy. In the upper part of the table, however, our model still correctly predicts the relative performance of each country (group). Figure 4 presents the results for the individual countries. We relate actual employment rates in 1994-2003 to our model's predictions using the average values for v and τ in 1994-1999. For Italy and Denmark we again use the adjusted data for v. Correlation is 0.78. If we use average values for v and τ in 1969-99, correlation is 0.68.

TABLE 3 Growth and employment in 1994-2003

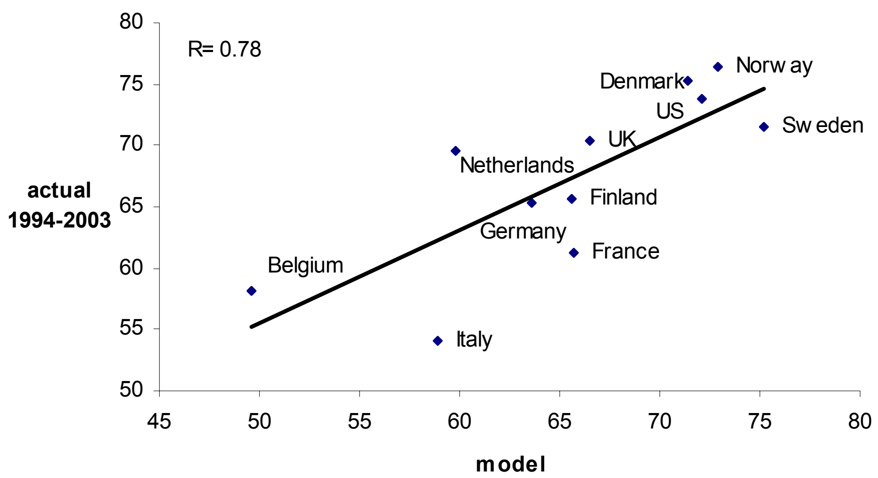
	τ and v 1969-99						
	τ	v	Employment Actual	Employment Model	Growth Actual	Growth Model	Utility Model
Continental Europe 1	0.28	0.19	61.65	65.03	1.87	2.75	-37.89
Continental Europe 2	0.28	0.24	61.65	61.34	1.87	1.75	-41.78
Scandinavia 1	0.29	0.13	72.26	68.78	2.00	3.89	-33.61
Scandinavia 2	0.29	0.08	72.26	71.48	2.00	4.69	-30.86
US	0.22	0.05	73.74	72.41	1.91	4.47	-32.62
UK	0.25	0.18	70.31	65.5	2.10	2.64	-38.73

	τ and v 1994-99						
	τ	v	Employment Reality	Employment Model	Growth Actual	Growth Model	Utility Model
Continental Europe 1	0.30	0.20	61.65	64.35	1.87	2.70	-37.80
Continental Europe 2	0.30	0.26	61.65	59.77	1.87	1.50	-42.48
Scandinavia 1	0.33	0.23	72.26	61.99	2.00	2.25	-39.14
Scandinavia 2	0.33	0.08	72.26	71.46	2.00	4.84	-30.06
US	0.23	0.06	73.74	72.07	1.91	4.45	-32.50
UK	0.23	0.16	70.31	66.54	2.10	2.75	-38.74

Notes: *Continental Europe 1 and Scandinavia 1 are derived from the average data for τ and v reported in table 2 (for 1969-99) and appendix 2 (for 1994-99). Continental Europe 2 and Scandinavia 2 differ in one respect. For reasons put forward in footnotes 4 and 5, the underlying values for v in Italy and Denmark have been changed to the average v of the other countries in their respective groups. The last column reports welfare levels predicted by our model. We discuss these in section 6.*

FIGURE 4 Employment rates in individual countries, 1994-2003 (data in percent)

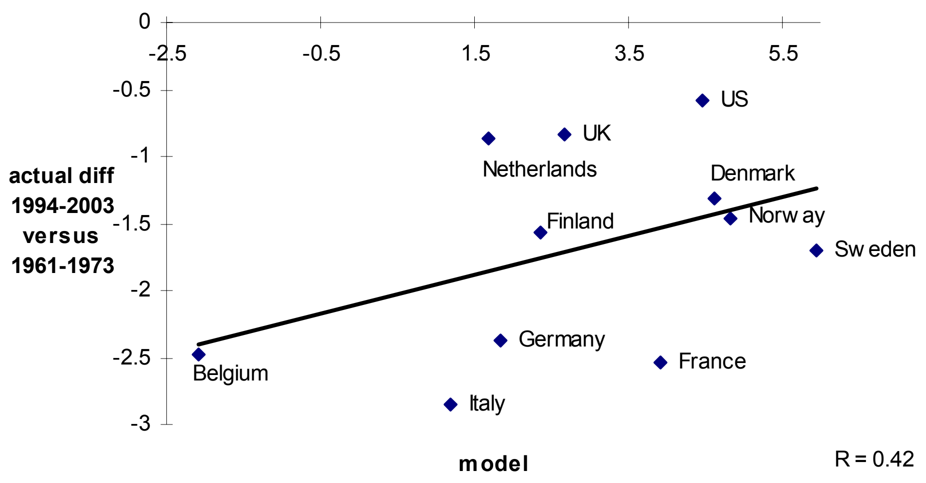
τ and v 1994-99



Our model has somewhat more problems explaining per capita growth. Using the adjusted data for v in Denmark and Italy, it explains relative positions well, except for the UK, but the absolute numbers in table 3 are estimated much less precisely. For Scandinavia and the US the gap between actual and predicted values in table 3 is more than 2 percentage points. In most cases our model overestimates growth. This relatively weak explanatory power can also be observed at the level of the individual countries. Correlation between actual growth in 1994-2003 and predicted growth typically remains below 0.20. Yet, we believe that our model can contribute to an explanation of countries' growth performance[8]. Figure 5 relates the change in actual average per capita growth between 1994-2003 and 1961-73 (see also table 1) to our model's prediction for the level of growth, using average τ and v in 1973-99 and adjusted data for v in Denmark and Italy. Correlation is now much higher (0.42). In this respect our results link up with an extensive literature explaining the growth slowdown in all OECD countries since the early 1970s. Despite the fact that all countries were hit by highly similar shocks during the 1970s and 1980s, it is well-known that some have suffered much more than others (see e.g. OECD, 1989). Our results point to fiscal policy as a relevant determinant of the capacity of countries to deal with adverse macroeconomic shocks.

FIGURE 5 Growth changes in individual countries, 1994-2003 versus 1961-73

τ and v 1973-99



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[8] Note that extensive research at the OECD supports our focus on the employment – growth relationship. OECD (2003) points to employment as the top issue on the growth agenda for much of Europe. It should be recognized however that, assuming constant technology in this paper, we have disregarded other important issues that also explain growth differences across countries, e.g. product market characteristics and the pace of ICT diffusion.

6. Welfare implications

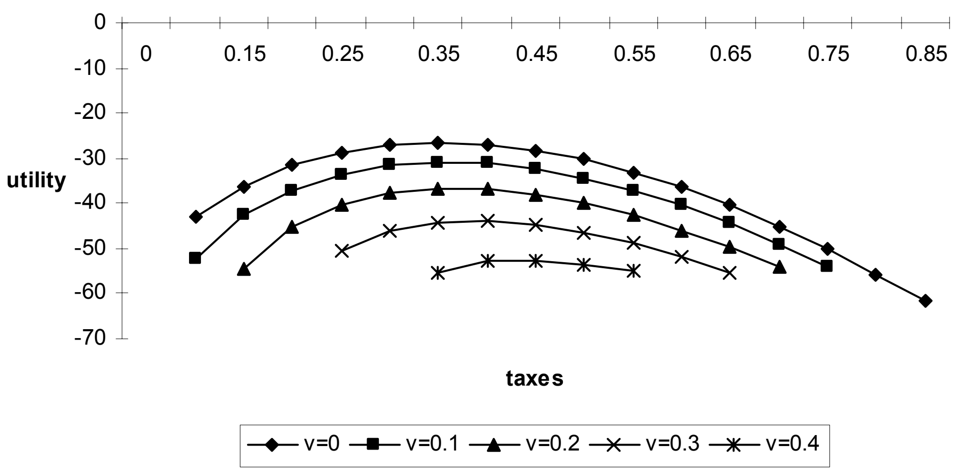
What are the welfare implications of our model? Do higher employment and growth rates in Scandinavia and the US, compared to continental Europe, also imply higher welfare levels? Blanchard (2004) for example points out that continental Europe has done better than is often perceived. In his view, low employment in continental Europe is to an important extent due to larger preferences for leisure. It should therefore not be suboptimal.

Equation (17) describes the representative household-producer's equilibrium welfare level, i.e. his optimized life-time utility. The derivation of this equation is outlined in appendix 3.

$$U = \frac{a\ln(c_0)}{\rho} + \frac{a\,[(1-\tau)(1-\beta)A^{\frac{1}{1-\beta}}\left(\tau - v(1-l_t)\right)^{\frac{\beta}{1-\beta}} l_t^{\frac{1}{1-\beta}} - \rho]}{\rho^2} + \frac{(1-a)\ln(1-l_t)}{\rho} \tag{17}$$

Assuming that initial capital k_0 equals one, figure 6 depicts the relationship between taxes, the transfer replacement rate and welfare. The higher the transfer replacement rate, the lower will be the welfare level of the representative household, whatever the level of the distortionary tax rate. For given v, we see an inverted U-shaped relationship between tax rates and welfare. This result is not straightforward, given the influence of taxes on the equilibrium employment and growth rates as depicted in respectively figures 2 and 3. Both employment and growth will at first increase with taxes (leisure will fall) and only after a while they start decreasing, which implies opposite influences on the welfare level of the representative household. If taxes are low, the positive relationship between taxes and growth will raise consumption and welfare, whereas the positive effect of taxes on employment will reduce welfare (lower leisure). The relationship between taxes and growth seems to be dominant.

FIGURE 6 Welfare and taxes for a varying transfer replacement rate



The last column of table 3 reports predicted welfare levels for continental Europe, Scandinavia, the US and the UK. Using the parameter values discussed before and adjusted data for v and τ in Italy and Denmark, our model predicts a welfare level of about -30 to -33 in Scandinavia and the US. Predicted welfare in continental Europe is only about –42. Our model therefore not only predicts higher employment and growth, but also higher welfare for continental European countries if they were to reduce transfers to structurally non-employed people and to allocate more resources to productive government expenditures. Additional simulations show that this conclusion holds, irrespective of the level of the relative weight of consumption versus leisure in the utility function.

7. Conclusions and policy implications

This paper demonstrates a clear theoretical link between fiscal policy, employment and long-run growth. We find that distortionary taxes may raise long-run growth and employment when taxes are not too high and when they are used to finance productive government expenditures. If taxes are mainly used to finance transfers related to structural non-employment, they will undermine growth and employment. In addition to the potentially positive effect of taxes and productive government expenditures, this paper also finds a strong negative relationship between the transfer replacement rate and employment and long-run growth. The higher the transfer replacement rate, the lower employment and growth will be, whatever the level of the distortionary tax rate.

Empirically, our results may contribute to explaining the important growth and employment differences within Europe and between Europe and the US that have occurred during the last three decades. All European countries, with a few exceptions, have suffered from a decreasing employment and growth rate. Although continental Europe and Scandinavia experienced an equal increase in distortionary tax rates, the employment and growth slowdown in continental Europe was clearly more pronounced. Our results suggest that this difference is to an important extent due to the level of transfers paid to structurally non-employed people. These transfers are much higher in continental Europe. Scandinavian higher taxes fed through into relatively higher productive government expenditures.

The policy implication of our results is important for the continental European welfare states. Our research provides a clear indication that low employment and growth levels in continental Europe are not mainly due to the level of distortionary tax rates, but to high (structural non-employment) transfers, combined with a lack of sufficient productive government expenditures. Thinking about employment and growth promotion, instead of first reducing taxes it might be more necessary in continental Europe to reduce the (structural non-employment) transfer replacement rate, to strengthen the conditions of entitlement and to allocate the resources saved to productive government expenditures. Such a policy may also be welfare improving.

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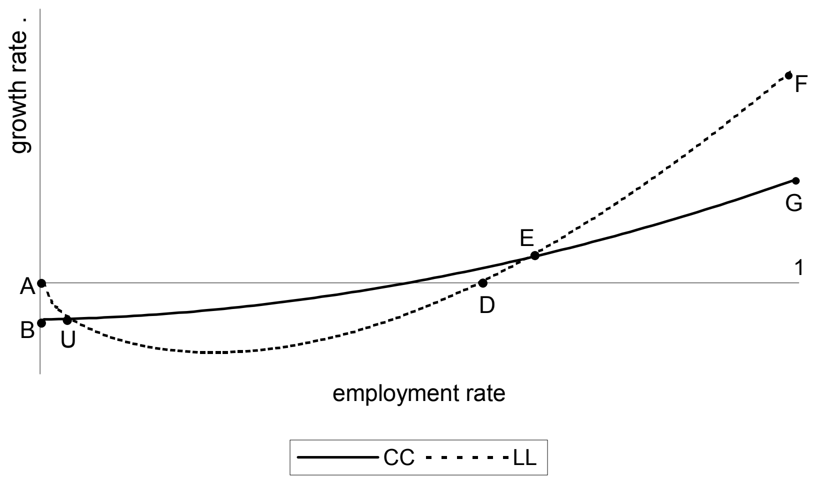
Appendix 1. Existence and stability of equilibrium in the model

In this appendix we discuss the existence of a stable employment-growth equilibrium in our model. Figure 7 guides us through this discussion. It has been drawn with the same parameter values as figure 1, but we now represent the CC and LL loci for the whole range of employment rates between 0 and 1. As can be seen, the LL locus has a negative slope at low employment rates. At higher (and more realistic) employment rates, its slope is positive. In what follows we show that figure 7 is representative for a wide range of equilibria in our model. First of all, we prove that $\gamma_k(l=0) > \gamma_c(l=0)$ (see points A and B), $\gamma_k(l=1) > \gamma_c(l=1)$ (see points F and G), $\left.\frac{\partial \gamma_c}{\partial l}\right|_{l=0} = 0$, $\left.\frac{\partial \gamma_c}{\partial l}\right|_{l>0} > 0$, $\left.\frac{\partial \gamma_k}{\partial l}\right|_{l=0} = -\infty$ and $\left.\frac{\partial \gamma_k}{\partial l}\right|_{l=1} > 0$. These are general results. Then, we discuss the conditions for equilibrium. To have an equilibrium it is also required that the LL locus intersects the CC locus. Given the characteristics of both loci there will in that case be two equilibria. One is unstable (point U), one is stable (point E)[9]. However, intersection is not a general result. Depending on the values of six relevant parameters, three situations can occur : (i) the CC locus intersects the LL locus at positive growth (figure 7), (ii) the CC locus intersects the LL locus at negative growth (point E is south-west of D), (iii) there is no intersection, the LL locus is always above the CC locus. We discuss the likelihood of these situations in a second part of this appendix.

FIGURE 7 Equilibrium growth and employment – positive growth



Note: *Underlying parameters: A=0.75, ρ =0.04, (1-β) =0.65, a =0.65, τ =0.3 and ν =0.2*

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[9] The LL-locus is crucial. Below this locus, *c/k* is too high (γ_k too low) for intratemporal optimality. The marginal utility of working will be too low, pushing *l* down. Above the LL-locus the opposite holds. These adjustments turn E into a stable equilibrium, and U into an unstable one.

Proof of general results

(i) $\underline{\gamma_k(l=0) > \gamma_c(l=0)}$ (points A and B)

From (13) and (16) it can immediately be seen that $\gamma_c(l=0) = -\rho < 0$ whereas $\gamma_k(l=0) = 0$.

(ii) $\underline{\gamma_k(l=1) > \gamma_c(l=1)}$ (points F and G)

$$\gamma_c(l=1) = (1-\tau)(1-\beta)A^{\frac{1}{1-\beta}}\tau^{\frac{\beta}{1-\beta}} - \rho$$

$$\gamma_k(l=1) = A^{\frac{1}{1-\beta}}\tau^{\frac{\beta}{1-\beta}}(1-\tau) \;>\; \gamma_c(l=1)$$

Note that our model does not generally imply positive γ_c at l=1. This depends on parameter values. Positive γ_c at l=1 is certain only when the CC locus intersects the LL locus at non-negative growth.

(iii) $\underline{\left.\frac{\partial \gamma_c}{\partial l}\right|_{l=0} = 0}$, $\underline{\left.\frac{\partial \gamma_c}{\partial l}\right|_{l>0} > 0}$

$$\frac{\partial \gamma_c}{\partial l} = (1-\tau)A^{\frac{1}{1-\beta}} l^{\frac{1}{1-\beta}} (\tau - v(1-l))^{\frac{\beta}{1-\beta}} \left[\frac{1}{l} + \frac{v\beta}{(\tau - v(1-l))}\right]$$

Under the realistic condition $(\tau - v(1-l)) > 0$, which comes down to productive government expenditures g being positive, this derivative is positive for $l > 0$. For $l = 0$, this derivative is zero.

(iv) $\underline{\left.\frac{\partial \gamma_k}{\partial l}\right|_{l=0} = -\infty}$, $\underline{\left.\frac{\partial \gamma_k}{\partial l}\right|_{l=1} > 0}$

$$\frac{\partial \gamma_k}{\partial l} = A^{\frac{1}{1-\beta}} l^{\frac{\beta}{1-\beta}} (\tau - v(1-l))^{\frac{\beta}{1-\beta}}$$

$$\left[\frac{\beta}{1-\beta}\left(\frac{1}{l} + \frac{v}{\tau - v(1-l)}\right)\left(\frac{1}{1-a}\big((1-\tau)l + v(1-l)l\big) - \frac{a}{1-a}(1-\tau)\right) + \left(\frac{1}{1-a}\big((1-\tau) + v - 2vl\big)\right)\right]$$

$$\left.\frac{\partial \gamma_k}{\partial l}\right|_{l=0} = A^{\frac{1}{1-\beta}} \frac{\beta}{1-\beta} \tau^{\frac{\beta}{1-\beta}} \left(-\frac{a}{1-a}(1-\tau)\right) l^{\frac{2\beta-1}{1-\beta}} = -\infty$$

For this result to hold, it is required that $\frac{2\beta-1}{1-\beta}<0$. Rewriting, this condition comes down to $\beta<1/2$. Given existing literature on the output elasticity of public capital (e.g. Glomm and Ravikumar, 1997), this condition is clearly satisfied.

$$\left.\frac{\partial\gamma_k}{\partial l}\right|_{l=1} = A^{\frac{1}{1-\beta}}\tau^{\frac{\beta}{1-\beta}}\left(\frac{\beta}{1-\beta}(1+\frac{\tau}{v})(1-\tau)+\frac{1}{1-a}(1-\tau-v)\right)>0$$

This result follows from the condition $(1-\tau)>v$. Working should make economic sense. Net productive income should be higher than the government transfer.

Existence of a stable equilibrium

The above described results do not guarantee a stable equilibrium, let alone an equilibrium with positive growth rates. Given the characteristics of our model and the many parameters involved, we cannot in general derive the conditions for a stable equilibrium. To clarify things, we have extensively simulated the model under a wide range of settings for a, β, A, v, τ and ρ. Our main findings are the following:

(i) For a stable equilibrium to exist, there are two necessary conditions. First, $(\tau-v(1-l))>0$, which comes down to $g > 0$ and which has been mentioned before. Second, $a>\beta$. Both these conditions are reasonable, they fit the empirical facts.

(ii) Stable equilibria exist under a very wide range of parameter choices. Although not always necessary, the likelihood of obtaining an equilibrium rises if $aA>\beta(1+\beta)$ and if $\tau>v$. For example, with a rate of time preference ρ equal to 0.04, the condition $aA>\beta(1+\beta)$ is sufficient for a stable equilibrium as long as $0.4>\tau>v+0.1$. For a stable equilibrium with positive growth, $aA>\beta(1+\beta)$ is sufficient as long as $0.4>\tau>v+0.17$. The higher aA and the lower β, the higher τ can be and the smaller the required gap between τ and v. In this respect, it may make sense to reconsider figure 3. In this figure we have imposed A=0.75, β=0.35 and a =0.65. Equilibria are legion, even with $\tau\leq v$. The likelihood of observing an equilibrium also rises when we assume a lower rate of time preference. With ρ equal to 0.03, for example, the condition $aA>\beta(1+\beta)$ is sufficient for a stable equilibrium as long as $0.4>\tau>v+0.05$.

Appendix 2. Additional data for τ and v

	τ		v	
	1973-99	1994-99	1973-99	1994-99
Belgium	31.74	33.32	39.31	35.67
France	27.96	30.8	12.48	18.33
Germany	27.02	27.03	23.09	21.29
Netherlands	31.59	30.27	25.53	26.66
Italy	25.41	29.73	0	0
Average	**28.74**	**30.23**	**20.08**	**20.39**
Finland	27.62	32.15	20.84	18.25
Denmark	30.37	33.37	31.86	66.83
Norway	26.23	26.13	5.71	5.33
Sweden	36.78	38.52	0	0
Average	**30.25**	**32.54**	**14.60**	**22.60**
US	**22.12**	**23.35**	**5.1**	**5.56**
UK	24.46	23.02	17.43	15.94

Appendix 3. Derivation of equilibrium welfare

The utility function of the representative household depends on consumption and 'leisure'. The optimal amount of 'leisure', $(1-l_t)$ follows from the intersection of the two equilibrium loci CC and LL. Equation (18) describes how consumption will evolve over time, c_t.

$$c_t = c_0\, e^{\frac{\dot{c}}{c}t} \tag{18}$$

Substituting equation (18) into the household's intertemporal utility function allows us to determine equilibrium welfare.

$$U = \int_0^\infty a\ln(c_0)e^{-\rho t}dt + \int_0^\infty a\frac{\dot{c}}{c}\, t\, e^{-\rho t}dt + \int_0^\infty (1-a)\ln(1-l_t)e^{-\rho t}dt \tag{19}$$

Integrating by parts, we have

$$U = \left[a\ln(c_0)\frac{-1}{\rho}e^{-\rho t}\right]_0^\infty + \left[a\frac{\dot{c}}{c}\left(\frac{-1}{\rho}e^{-\rho t}(t+\frac{1}{\rho})\right)\right]_0^\infty + \left[(1-a)\ln(1-l_t)\frac{-1}{\rho}e^{-\rho t}\right]_0^\infty \tag{20}$$

Using l'Hôpital's rule, the welfare level is equal to

$$U = \frac{a\ln(c_0)}{\rho} + \frac{a(\dot{c}/c)}{\rho^2} + \frac{(1-a)\ln(1-l_t)}{\rho} \tag{21}$$

Substituting equation (13) for $(\dot{c}/c)$ yields

$$U = \frac{a\ln(c_0)}{\rho} + \frac{a\,[(1-\tau)(1-\beta)A^{\frac{1}{1-\beta}}\left(\tau - v(1-l_t)\right)^{\frac{\beta}{1-\beta}} l_t^{\frac{1}{1-\beta}} - \rho]}{\rho^2} + \frac{(1-a)\ln(1-l_t)}{\rho} \tag{22}$$

Finally, to compute the equilibrium welfare level, we still need to determine the initial value of consumption, c_0. To do this, we first substitute the balanced growth equilibrium into equation (14), we yields the equilibrium (c/k) value. Then, assuming in all countries an initial value of capital k_0 equal to 1, we obtain c_0.