The Unemployment Puzzle of Corporate Taxation

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Abstract

Using annual data on 19 industrial countries for the period 1979 to 2005 and a large number of controls, this paper is the first to empirically study the impact of corporate taxes on the unemployment rate. In contrast to previous empirical research on the labor demand, investment and growth effects of corporate taxation, which consistently finds adverse effects, our regression results suggest that higher corporate taxes may have a favorable impact, lowering the unemployment rate. The magnitude of the estimated effect is substantial. Our results are robust to both endogeneity and numerous variations in specification.

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1. Introduction

To the best of our knowledge, there are no empirical studies to date analyzing the impact of corporate taxation on unemployment.[1] This is surprising because, from a theoretical point of view, corporate taxes may affect unemployment via various transmission channels. It is also surprising because previous empirical studies have found corporate taxes to substantially affect wages, investment and economic growth, which is likely to have knock-on effects on unemployment.

Using annual data on 19 industrial countries for the period 1979 to 2005, this paper empirically studies the impact of corporate taxes on the unemployment rate.[2] Our result is not quite what one would expect. Specifically, whereas previous empirical studies find higher corporate taxes to reduce labor demand, investment and growth, we find that they cause a fall in the unemployment rate. Thus our result contrasts with the generally negative view of corporate taxes. Note that we account for endogeneity and that our result holds up through a myriad of specifications.

The following section briefly discusses the theoretical background. Section 3 summarizes the results from those previous empirical studies that are relevant for this paper. Section 4 describes our corporate taxation variables. Section 5 explains the control variables used. Section 6 describes our sample and estimation method. Section 7 presents and discusses the regression results. Section 8 concludes.

2. Theoretical background

From a theoretical point of view, it is not clear that higher corporate taxes should increase unemployment. Rather, there may be opposing effects at work. On the one hand, as higher corporate taxes reduce net profits, they are likely to lead to fewer business start-ups, lower domestic investment by incumbent firms, a relocation of jobs abroad and lower foreign direct investment (FDI) inflows. This would cause labor demand to fall, raising unemployment if wages are sticky downwards. On the other hand, because they lower the return on capital, higher corporate taxes may result in a substitution of labor for capital, which could lower unemployment. The unemployment

[1] We performed an extensive literature search using, inter alia, EconLit and Google Scholar and were unable to find any study.

[2] Following the literature on corporate taxation, we use the term "corporate taxes" as a short for "corporate income taxes". For a detailed description of our corporate taxation variables, see section 4 and Table 1.

effect could also be favorable if workers and their trade unions reduced their wage demands to overcompensate for the job losses that would otherwise occur as a result of higher corporate taxes, e.g., to avoid a relocation of jobs to foreign countries. A further explanation for a favorable effect could be that the government might use the additional revenue from higher corporate taxes for more labor-intensive activities than do firms.

There are only a few theoretical studies analyzing the labor market effects of corporate taxes, with each of them doing so under different assumptions:

- Wang (1993) uses duality theory for a two-sector general equilibrium model in which the economy experiences sector-specific unemployment and perfect capital mobility with a sector-specific rigid wage in the corporate sector. Examining the incidence of a corporate income tax, he demonstrates that unemployment unambiguously declines.
- Smith (1994) analyzes the effects of wage and profit taxation in a search and bargaining model. He finds that, in the short run with a fixed number of jobs (filled jobs plus vacancies), a profit tax reduces unemployment. In the long run, however, it increases unemployment.
- Parai (1999) develops a model of international duopoly to examine the effects of both a tariff and a corporate profit tax. He finds that the latter could lower domestic output and employment.
- Halko (2005) examines the case where a monopoly union runs an unemployment insurance fund to which employed members pay insurance premiums. Part of the fund's income stems from taxes. She demonstrates that if the government imposes a profit tax to finance some of its contribution to the fund, the higher profit tax reduces the union's wage demands, decreasing the agreed wage and thus increasing employment.
- Kilponen and Sinko (2005) study the implications of centralized wage setting for the relationship between taxation, wages and employment, allowing for endogenous adjustment in working hours. They find that when a publicly provided good is financed by a profit tax, a centralized union's optimal response to an increased profit tax is to set wages lower, raising employment. By contrast, the effect of a profit tax is neutral in case of decentralized wage setting.
- Bettendorf et al. (2009) use an applied general equilibrium model that is calibrated for the European Union. They find that corporate taxes raise unemployment. The magnitude of the effect is larger in countries that host a large share of multinational companies. The effect is smaller if the substitution elasticity between labor and capital is large.
- Proposing a model of search unemployment and discrete location choice, Keuschnigg (2009) analyzes the effects on unemployment of both corporate taxation and social insurance. He

demonstrates that, in his model, a corporate tax increases unemployment due to a decline in domestic investment and job creation. Furthermore, he shows that corporate taxation and social insurance have equivalent effects on unemployment and outbound FDI.

As our general considerations and the brief overview of theoretical studies indicate, the effects of corporate taxation on labor market performance are ambiguous from a theoretical point of view. Thus their direction and magnitude need to be resolved empirically.

3. Previous empirical studies

While there is no empirical study to date on the unemployment effect of corporate taxation, there is one analyzing its impact on labor demand. Using data from surveys of Chilean manufacturing firms over 1981 to 1996, Cerda and Larrain (2010) find that higher corporate taxes reduce not only demand for capital but also demand for labor due to complementarities between both inputs. They also find the impact on labor demand to be significantly higher in large corporations than in small enterprises.

Furthermore, there is a growing empirical literature according to which a substantial part of the burden of corporate taxes is passed on to workers in the form of lower wages (for a survey, see Gentry 2007). For example, using data on 55,082 companies in nine European countries over 1996 to 2003, Arulampalam et al. (2010) find that an exogenous rise of $1 in the corporate income tax tends to reduce the wage bill by 49 cents.

Whereas there are only few studies on the labor market effects of corporate taxation, there is a vast literature analyzing its effect on domestic investment. Although the estimated magnitude of the effect varies across studies, this research generally finds corporate income taxes to have an adverse impact (for surveys, see Auerbach 2002, Gordon and Hines 2002, Hassett and Hubbard 2002).

Furthermore, over the past twenty years a substantial body of literature has developed empirically analyzing the effect of corporate taxes on FDI. The OECD (2007a) performed a meta-analysis of 31 empirical studies in this area, finding that a 1 percentage point increase in the host country tax rate lowers FDI in that country by around 3.7%. Generally speaking, the OECD's survey reveals

considerable evidence of a negative relationship between host country taxation and FDI. A traditional literature review by Devereux (2007) confirms this general finding.

A recent study analyzes the impact of various taxes on economic growth in OECD countries (Johansson et al. 2009). It finds corporate taxes to be the most harmful, followed by personal income taxes, then consumption taxes and, finally, recurrent taxes on immovable property. It also finds that reduced rates of corporate tax for small firms do not seem to enhance growth.

In sum, the results from previous empirical studies suggest that higher corporate taxes have an adverse impact on economic performance. Given these findings, one would expect the impact on the unemployment rate to be adverse as well. Specifically, if higher corporate taxes reduce labor demand, if they are only partly passed on to workers in the form of lower wages and if they lower domestic investment, FDI inflows and economic growth, they should increase the unemployment rate.

4. Corporate taxation variables

Following much of the recent empirical literature on the effects of corporate taxation, we use indicators developed by Devereux et al. (2002). Specifically, we use an updated version of the data, which was published by the Institute for Fiscal Studies in 2005 (for definitions and descriptive statistics, see Table 1).

Most of the corporate taxation variables are so-called effective tax rates, meaning that they are based on the taxation of income from a hypothetical investment project. In the base case, the assumptions are that the investment is in plant and machinery; that it is financed by equity or retained earnings;[3] that the depreciation rate for plant and machinery is 12.25%; that there is a common fixed inflation rate of 3.5%; that the real rate of interest is 10%; and that the expected rate of profits earned is 10% (implying a financial return of 20%).

To check whether changes in assumptions make a difference, we also use the following variations on this base case:

[3] As taxation at the shareholder level is not included, there is no distinction between investment financed by new equity or retained earnings.

- the hypothetical investment project is financed by debt instead of equity or retained earnings;
- the investment is in buildings rather than in plant and machinery (depreciation rate: 3.61%);
- the calculations are based on actual (i.e., country- and time-specific) inflation rates rather than on a common fixed inflation rate of 3.5%;
- the expected rate of economic profits earned is 20% (30%/40%) instead of 10%, implying a financial return of 30% (40%/50%);
- the hypothetical investment just breaks even, thus earning no economic rent.

Effective tax rates have the advantage of taking into account not only the statutory tax rate but also other aspects of the tax code such as depreciation allowances. Furthermore, they incorporate the tax payments due over the lifetime of an investment, along with all other cash flows of the project. Thus they are forward-looking and likely to be relevant for firms' behavior. By contrast, indicators that relate actual tax paid during a period to some measure of profit are backward-looking, i.e., they reflect the performance and taxation of firms during that past period.

Because they are forward-looking, effective tax rates have the additional advantage of avoiding the endogeneity bias that backward-looking measures introduce when used in regression analysis. This is important because, in countries with high unemployment, governments might set the corporate tax rate at a low level in order to stimulate business activity and thus the creation of jobs. In this case, there would be a negative correlation between unemployment and corporate tax rates but the direction of causation would be opposite of what we aim to investigate. That is, instead of causation running from corporate taxation to unemployment, it would run in the opposite direction.

Effective tax rates have one disadvantage though. As they are computed for a specific type of investment, they rely on simplifying assumptions and are unable to capture all elements of the tax code. Thus it is decisive that the hypothetical investment project is as representative as possible and that variations are used alongside the base case.

Our final indicator of corporate taxation is the statutory corporate tax rate. This is the most basic and widely-known measure. It may have an important function as a signal of business friendliness and thus may affect FDI inflows, in particular. However, as it does not take into account the many rules and regulations defining the corporate tax base (e.g., valuation of assets, deductibility of contributions to pension reserves), it is unlikely to be the most important corporate taxation variable determining firms' behavior. Therefore, we do not use it as our main variable of interest.

5. Control variables

We control for the impact of all other major factors that have been found to determine the unemployment rate. As this is an important aspect of our paper, this section explains the rationale for each of our control variables in some detail (for definitions, descriptive statistics and sources, see Table 1).

Our first control is the labor tax wedge variable. From a theoretical point of view, labor taxes reduce employment because they raise employers' wage cost and lower workers' net wages (e.g., Boeri and van Ours 2008). Most previous empirical studies find a high tax burden on labor to adversely affect labor market performance (e.g., Daveri and Tabellini 2000, Prescott 2004).

Our next three controls – trade union density, collective bargaining coverage and wage bargaining coordination – cover important characteristics of the wage bargaining system. Trade unions are likely to wield substantial bargaining power if a large share of workers are union members. Monopoly models of unions suggest that powerful trade unions will attempt to set aggregate wages at a level that is too high relative to overall productivity, raising equilibrium unemployment. Additionally, for equity reasons unions often bargain for above-average increases in the bottom range of the wage distribution. The resulting reduction in wage dispersion can also lead to an increase in unemployment, particularly in low-productivity regions and among low-skilled workers (for a survey of unions and their effects, see Aidt and Tzannatos 2002). Many previous empirical studies find higher union density to be associated with higher unemployment (e.g., Scarpetta 1996, Blanchard and Wolfers 2000, IMF 2003, Baccaro and Rei 2007).

We include a measure of collective bargaining coverage because a high degree of collective bargaining coverage may strengthen trade union power, adversely affecting labor market performance. Conversely, it may induce trade unions to take the adverse effects of excessive wage hikes into account, prompting them to moderate their wage claims, lowering unemployment. Previous empirical studies have not yet come up with conclusive evidence for the effects of collective bargaining coverage (Aidt and Tzannatos 2002).

Soskice (1990) argues that a coordinated system of sectoral bargaining facilitates implicit or explicit "social pacts" under which trade unions agree to restrain wage demands in exchange for policy concessions from the government, leading to comparatively low unemployment. Indeed, several

empirical studies find a high degree of wage bargaining coordination to be associated with comparatively low unemployment (e.g., Nickell et al. 2005).

In one of our robustness checks, we substitute wage bargaining centralization for coordination. Decentralized wage bargaining at the firm level is likely to prevent excessive wage claims because this would lead to a loss of market shares to competitors with detrimental effects on employment (Siebert 1997). By contrast, a high degree of centralization may strengthen union power, leading to excessive wage hikes and a compressed wage structure, increasing unemployment (Calmfors 1993, McHugh 2002). Alternatively, very centralized bargaining systems may lead to wage moderation if they induce unions to internalize the detrimental effects of excessive wage hikes (Bruno and Sachs 1985). Several empirical studies indicate that higher bargaining centralization is correlated with lower unemployment (e.g., Di Tella and MacCulloch 2005, Feldmann 2011). We do not use the wage bargaining centralization variable in our baseline specification because it is highly correlated with the wage bargaining coordination variable.

We also control for the impact of employment protection legislation. Theory predicts that stricter employment protection legislation leads firms to reduce both dismissal and hiring rates, increasing the length of unemployment spells. The net effect on the unemployment rate is ambiguous though (e.g., Bertola 1990). Most empirical studies find a positive effect on the share of long-term unemployed in the total number of unemployed but no robust evidence for a significant effect on the unemployment rate (e.g., Scarpetta 1996, OECD 2004, Nickell et al. 2005, Bassanini and Duval 2006, Baccaro and Rei 2007).

Furthermore, we control for the impact of unemployment benefit schemes. Many empirical studies find that generous unemployment benefits tend to raise unemployment (e.g., Scarpetta 1996, Elmeskov et al. 1998, Bertola et al. 2002, Nickell et al. 2005, Bassanini and Duval 2006). These studies corroborate standard labor economics theory, according to which such benefits reduce the job-search intensity of the unemployed and their willingness to accept job offers. By lowering the economic cost of unemployment, they may also put upward pressure on workers' wage claims, further increasing unemployment. Conversely, one may argue that generous unemployment benefits may lower unemployment levels by encouraging workers to look for more suitable jobs, thus reducing the likelihood of subsequent job separations.[4]

[4] Acemoglu and Shimer (2000) and Chetty (2008), among others, argue that generous unemployment benefits allow workers to find better matches. They do not, however, argue that this leads to lower unemployment.

Additionally, we control for the impact of product market regulation. Theoretical studies argue that anticompetitive product market regulations (e.g., entry restrictions, price controls) will generally reduce equilibrium output and thus labor demand and employment, increasing unemployment (e.g., Blanchard and Giavazzi 2003, Pissarides 2003). According to these studies, they lead to fewer entries of new firms, lower competitive pressures and more inefficiencies. Furthermore, the lack of competition increases the price mark-up that firms are able to enforce. Insofar as employees are able to appropriate part of these rents via wage premia, firms will produce more capital intensively and less labor intensively than in a competitive situation. This will cause employment to fall and unemployment to rise even further. Indeed, several empirical studies find that anti-competitive product market regulation is likely to adversely affect labor market performance (e.g., Nicoletti and Scarpetta 2005, Bassanini and Duval 2006).

Furthermore, we use the output gap to control for the state of the business cycle and GDP per capita to control for the level of economic development. We also control for openness. As industrial economies have become more open over our sample period, growing international competition for capital has induced them to lower their corporate tax rates (Devereux et al. 2002). At the same time, globalization has adversely affected low-skilled workers in industrial countries (OECD 2007b). To ensure that our corporate taxation variables do not proxy for openness, we include the latter variable.

In one robustness check, we additionally control for the impact of FDI, both net inflows and net outflows. Whereas net inflows are generally expected to reduce unemployment, net outflows can have various effects (e.g., Blomström et al. 1997, Lipsey 1999, 2002, Lipsey et al. 2010).

In a further robustness check, we control for the impact of technological change, using the ratio of triadic patent families to GDP as a proxy. While technological progress may trigger the birth of entirely new industries, creating millions of jobs, some theoretical studies argue that it may increase unemployment under specific circumstances (e.g., Aghion and Howitt 1994, Mortensen and Pissarides 1998).

Finally, in one robustness check we control for the impact of a common time trend. We do not include the respective variable in our baseline specification because this would alter the purpose of

the exercise from explaining how corporate taxation and all the other factors affect unemployment to explaining how they affect fluctuations in unemployment around a time trend.[5]

6. Sample and estimation method

Our estimation sample includes 19 industrial countries: Australia, Austria, Belgium, Canada, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States. Our sample period is 1979 to 2005. This means that we use data on all countries and years covered by the Institute for Fiscal Studies (2005) data set.

In most cases, we run two-stage least squares regressions of the following form:

Second stage:

$$Y_{i,t} = \beta_1 C_{i,t} + \beta_2 \boldsymbol{X}_{i,t} + \alpha_i + \varepsilon_{i,t}$$

First stage:

$$C_{i,t} = \sum_{s=1}^{3} \beta_3 \left(C_{i,t-s} - C_{i,t-s-1} \right) + \beta_4 \boldsymbol{X}_{i,t} + \gamma_i + \eta_{i,t}$$

$Y_{i,t}$ is the unemployment rate of country i at year t, C denotes a corporate taxation variable and $\boldsymbol{X}$ is a vector of our control variables. Country fixed effects in the second- and first-stage regressions are α_i and γ_i respectively. The error terms in the second- and first-stage regressions are $\varepsilon_{i,t}$ and $\eta_{i,t}$ respectively. Country fixed effects are included to control for the impact of unobserved country-specific characteristics such as cultural norms concerning female labor force participation. We report robust standard errors that are adjusted for clusters at the country level.

We instrument our corporate taxation variables to extract their exogenous components. This is a further device to avoid endogeneity bias, in addition to using forward-looking measures of

[5] We would have preferred to use year dummies or country-specific time trends rather than a common time trend because they more fully control for unobserved time effects. However, when using either year dummies or country-specific time trends, the estimated covariance matrix of moment conditions is not of full rank so that the standard errors should be interpreted with caution. Also, the over-identification statistic is not calculated. With these caveats in mind, when using year dummies or country-specific time trends the estimates for our corporate taxation variables are very similar to the ones from the regressions presented in this paper (results not reported here).

corporate taxation (section 4). Our instruments are lagged differences of the respective instrumented variable covering the previous four years. Lagged differences of the instrumented variable have been shown to be appropriate instruments, provided they pass a test for over-identifying restrictions and are sufficiently strong.[6] To test for over-identifying restrictions, we use Hansen's *J*-test. We also report the first-stage *F*-statistic as Staiger and Stock (1997) propose the rule of thumb that this statistic should take on a value of at least ten, otherwise the instruments are weak. According to the results from Hansen's *J*-test and the first-stage *F*-statistic, our instruments are both exogenous and relevant, and thus valid. This is true for our main regressions, reported in Table 2, as well as for our regressions using alternative corporate taxation indicators, reported in Table 3. Note, however, that in Table 3 only the estimates for the corporate taxation variables are reported. For brevity, neither the test statistic nor the estimates for the controls are reported in this table.

To check whether random effects yield similar point estimates, we perform a further robustness check using random rather than fixed country effects. Random effects estimates have the advantage of exploiting both the cross-country and the time-series variation within the sample. By contrast, fixed effects estimates only use the time-series variation. We do not use the random effects estimator in our baseline specification because only "conventional" standard errors are available for this estimator in two-stage least-squares panel data estimation. Thus, in contrast to our fixed effects regressions, the standard errors for our random effects regressions are neither robust nor adjusted for clusters at the country level.

For comparison, we also report the results from fixed effects regressions that do not use instruments. Additionally, in two further robustness checks we lag the corporate taxation variables by one year and two years, respectively, the rationale here being that the effects of changes in corporate taxation may take several years to fully materialize.[7]

7. Results

Before we discuss the results from the multivariate regressions, let us briefly take a look at the bivariate association between the effective average corporate tax rate (base case) and the

[6] This insight comes from, inter alia, research into GMM estimation (Arellano and Bover 1995, Blundell and Bond 1998). The latter is not an option in our case because it requires the number of cross sections to be much larger than the number of time periods as otherwise the estimates can be severely biased and imprecise (Roodman 2009a, 2009b). Thus we follow Roodman's (2009b) advice to use a fixed effects estimator instead.

[7] In these robustness checks, the lags on the instruments are increased accordingly.

unemployment rate. Intriguingly, Figure 1 indicates that there is a negative correlation, i.e., higher corporate tax rates are generally associated with lower unemployment rates.

Tables 2 and 3 present the results from our regression analysis. In both tables, column 1 reports the results from our baseline specifications while columns 2 to 9 report the results from our various robustness checks. While Table 2 presents regressions using our main corporate taxation indicator, Table 3 reports the estimates for the various alternative indicators. Each cell of Table 3 shows the estimate for the corporate taxation variable mentioned in the first column, with each of these estimates resulting from a separate multivariate regression, i.e., the corporate taxation variables were included one at a time, not simultaneously. In each of these regressions, the respective corporate taxation variable was entered together with the same control variables as in the respective regression using the main corporate taxation variable (Table 2).

Almost all coefficients on our corporate taxation variables are statistically significant.[8] Surprisingly, higher corporate taxes exert a favorable impact on unemployment. Our regression results suggest that the magnitude of the effect is substantial. Specifically, according to regression 1 of Table 2, a 10 percentage point increase in the effective average corporate tax rate (base case) is associated with a 2.1 percentage point fall in the unemployment rate, ceteris paribus. The magnitude of the effect is very similar in most of our robustness checks.

Our finding of a favorable unemployment effect of higher corporate taxes is surprising because previous empirical studies find higher taxes to reduce labor demand, domestic investment, FDI inflows and economic growth. It is also surprising because, according to previous empirical research, the burden of corporate taxes is only partly passed on to workers in the form of lower wages.

As indicated in section 2, possible explanations for our finding are that higher corporate taxes trigger a substitution of labor for capital, that trade unions reduce their wage demands in order avoid job losses and that the government uses the additional revenue for more labor-intensive activities than firms. However, for these effects to prevail, they would need to overcompensate any adverse unemployment impact resulting from fewer business start-ups, lower domestic investment by incumbent firms, a relocation of jobs abroad and lower FDI inflows. As the recent research on

[8] The only exceptions are two cases in which the respective corporate taxation variable is lagged by two years (Table 3). This is probably due to insufficient within-country variation in the data because the time lag implies a substantially reduced sample period.

the incidence of corporate taxes indicates, reduced wages go a long way towards compensating firms but they do not overcompensate them. This suggests that the other two effects – substitution of labor for capital by firms and funding of more labor-intensive activities by the government – may play an important part as well.

Our finding is consistent with some theoretical models, particularly Wang (1993), the short-run analysis of Smith (1994), Halko (2005) and the centralized wage setting case of Kilponen and Sinko (2005). Note, however, that these models are based on different and mostly fairly stringent assumptions (section 2).

Finally, let us briefly comment on our estimates for the control variables (Table 2). Many of them are in line with the previous literature (section 5). For example, we find that an increase in labor taxes is likely to raise the unemployment rate. Higher unionization and more generous unemployment benefits are also likely to raise the unemployment rate. By contrast, both a higher degree of wage bargaining coordination and higher net inflows of FDI are likely to exert a favorable impact on unemployment.

8. Conclusion

Our regression results suggest that higher corporate taxes may have a favorable rather than an adverse impact on the unemployment rate. The magnitude of the estimated effect is substantial. Our results are robust to both endogeneity and variations in specification.

As our paper is the first to empirically analyze the impact of corporate taxation on unemployment and as our finding is hard to reconcile with the results from empirical studies on the labor demand, investment and growth effects of corporate taxation (which indicate adverse effects), more research is clearly warranted. Above all, the transmission channels from corporate taxation to unemployment need to be more closely analyzed, both theoretically and empirically.

In particular, the following questions need to be addressed. How large is the substitution elasticity between labor and capital with respect to corporate taxation? Under which circumstances and by how much do workers and trade unions reduce their wage demands as a result of an increase in corporate taxes? Does the government spend the revenue from higher corporate taxes on more

labor-intensive activities, compared with outlays by private enterprises? How large is the unemployment effect of lower domestic investment resulting from an increase in corporate taxation? Similarly, how large is the unemployment effect of lower net FDI inflows resulting from higher corporate taxes?

As these questions indicate, our paper should be regarded as a starting point rather than a final word on this topic. However, as we control for both endogeneity and the impact of all other major factors that have been found to determine the unemployment rate, as our results are very robust and as they are at odds with the results from empirical studies on the labor demand, investment and growth effects of corporate taxation, there clearly appears to be a phenomenon that could be dubbed "the unemployment puzzle of corporate taxation".

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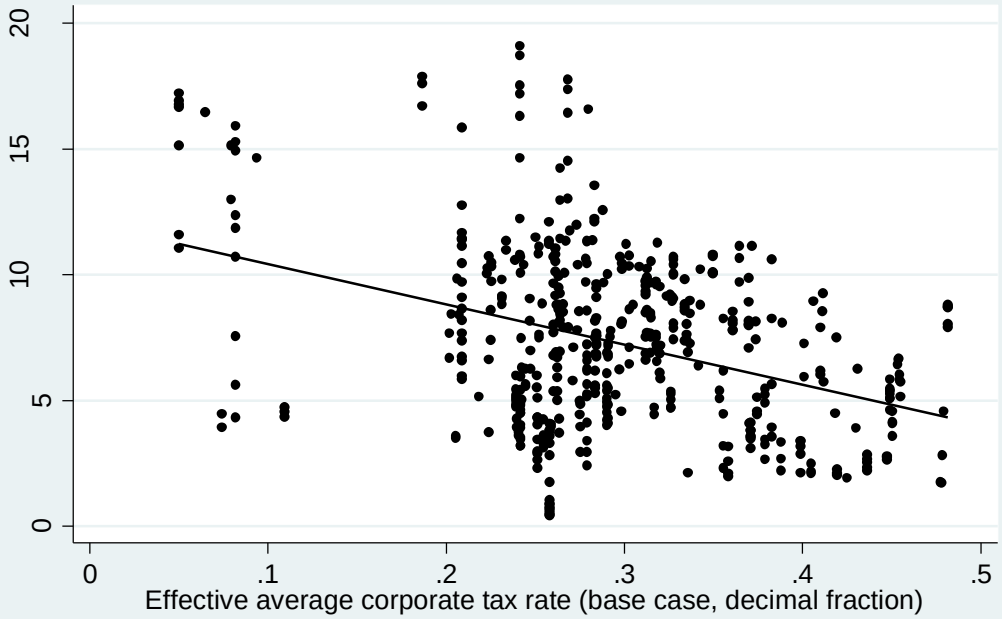
Figure 1. Corporate tax rate and unemployment



Note: Annual data on 19 industrial countries over 1979 to 2005. For definitions and sources, see Table 1.

Table 1. List of variables

	Definition	Mean	Std. Dev.	Min.	Max.	Source
Collective bargaining coverage	Employees covered by collective wage bargaining agreements as a decimal fraction of all wage and salary earners in employment with the right to bargaining.	0.68	0.24	0.14	0.99	Visser (2011)
Effective average corporate tax rate (actual inflation)	Effective corporate tax rate (decimal fraction), calculations based on actual (i.e., country- and time-specific) inflation rates rather than on a common fixed inflation rate of 3.5%. All other assumptions and calculations are as for the effective average corporate tax rate (base case) variable.	0.30	0.09	0.05	0.65	Institute for Fiscal Studies (2005)
Effective average corporate tax rate (base case)	Effective corporate tax rate (decimal fraction) on a hypothetical investment for one period in plant and machinery, financed by equity or retained earnings. Taxation at the shareholder level is not included. The expected rate of economic profits earned is 10% (implying a financial return of 20%). Other assumptions – real discount rate: 10%, inflation rate: 3.5%, depreciation rate: 12.25%. The approach takes into account both the statutory corporate tax rate and the tax base, including all relevant aspects of the tax code such as depreciation allowances.	0.29	0.08	0.05	0.48	Institute for Fiscal Studies (2005)
Effective average corporate tax rate (debt finance)	Effective corporate tax rate (decimal fraction) on a hypothetical investment financed by debt instead of equity or retained earnings. All other assumptions and calculations are as for the effective average corporate tax rate (base case) variable.	0.06	0.03	-0.01	0.14	Institute for Fiscal Studies (2005)
Effective average corporate tax rate (investment in buildings)	Effective corporate tax rate (decimal fraction) on a hypothetical investment in industrial buildings instead of plant and machinery. The economic depreciation rate is 3.61%. All other assumptions and calculations are as for the effective average corporate tax rate (base case) variable.	0.36	0.11	0.05	0.60	Institute for Fiscal Studies (2005)
Effective average corporate tax rate (20% profit rate)	Effective corporate tax rate (decimal fraction) assuming an expected rate of economic profits earned of 20% (implying a financial return of 30%) instead of 10%. All other assumptions and calculations are as for the effective average corporate tax rate (base case) variable.	0.33	0.09	0.07	0.53	Institute for Fiscal Studies (2005)
Effective average corporate tax rate (30% profit rate)	Effective corporate tax rate (decimal fraction) assuming an expected rate of economic profits earned of 30% (implying a financial return of 40%) instead of 10%. All other assumptions and calculations are as for the effective average corporate tax rate (base case) variable.	0.34	0.10	0.08	0.55	Institute for Fiscal Studies (2005)
Effective average corporate tax rate (40% profit rate)	Effective corporate tax rate (decimal fraction) assuming an expected rate of economic profits earned of 40% (implying a financial return of 50%) instead of 10%. All other assumptions and calculations are as for the effective average corporate tax rate (base case) variable.	0.35	0.10	0.08	0.57	Institute for Fiscal Studies (2005)
Effective marginal corporate tax rate	Effective corporate tax rate (decimal fraction) on a project that is expected to break even, i.e., there is no economic rent. All other assumptions and calculations are as for the effective average corporate tax rate (base case) variable.	0.24	0.10	0.00	0.48	Institute for Fiscal Studies (2005)

Table 1. List of variables (cont.)

	Definition	Mean	Std. Dev.	Min.	Max.	Source
Employment protection legislation	Indicator of the stringency of employment protection legislation. Unweighted average of measures for regular and temporary contracts. The ratings are scaled to range from 0 (least restrictive) to 1 (most restrictive).	0.36	0.19	0.04	0.70	OECD (2011a)
Foreign direct investment net inflows	Foreign direct investment net inflows (new investment inflows less disinvestment) as a decimal fraction of GDP.	0.02	0.06	-0.15	0.92	World Bank (2011)
Foreign direct investment net outflows	Foreign direct investment net outflows as a decimal fraction of GDP.	0.02	0.03	-0.05	0.27	World Bank (2011)
GDP per capita	Gross domestic product per capita, in thousands of US dollars, constant prices and purchasing power parity rates.	22.61	5.60	9.65	39.17	OECD (2011b)
Labor tax wedge	Personal income tax plus employees' and employers' social security contributions less cash benefits as decimal fraction of total labor costs (gross wage earnings plus employers' social security contributions). Average production worker in the manufacturing sector. One-earner married couple at 100% of average earnings, 2 children.	0.29	0.09	0.06	0.46	OECD (2011c)
Openness	Ratio of exports and imports of goods and services to GDP.	0.64	0.32	0.16	1.85	World Bank (2011)
Output gap	The gap between actual and potential output as a decimal fraction of potential output.	-0.00	0.02	-0.09	0.07	OECD (2011d)
Product market regulation	Indicator of regulatory impediments to product market competition in the following seven non-manufacturing industries: gas, electricity, post, telecoms (mobile and fixed services), passenger air transport, railways (passenger and freight services) and road freight. The ratings are scaled to range from 0 (least restrictive) to 1 (most restrictive).	0.66	0.22	0.16	1.00	OECD (2011b)
Statutory corporate tax rate	Statutory corporate tax rate as a decimal fraction of corporate income. For countries using different tax rates, the manufacturing rate is chosen. Local taxes (or the average across regions) are included where they exist. Any supplementary taxes are included only if they apply generally, rather than only under particular circumstances.	0.39	0.11	0.10	0.63	Institute for Fiscal Studies (2005)
Trade union density	Decimal fraction of wage and salary earners that are trade union members.	0.38	0.19	0.08	0.87	Visser (2011)

Table 1. List of variables (cont.)

	Definition	Mean	Std. Dev.	Min.	Max.	Source
Triadic patent families	Number of triadic patent families, per one billion of GDP. Triadic patent families are patents filed at the European Patent Office, the US Patent and Trademark Office and the Japanese Patent Office, protecting the same set of inventions. Classification is according to the inventor's country of residence and by priority year (the year of the first international filing of a patent). GDP is in constant 2005 US dollars using purchasing power parity rates.	1.25	1.07	0.00	4.31	OECD (2011d, 2011e), author's calculations
Unemployment benefits replacement rate	Gross unemployment benefits as a decimal fraction of previous gross wage earnings. Averages across two income situations (100% and 67% of average production worker earnings), three family situations (single, with dependent spouse, with spouse in work) and three different unemployment durations (first year, second and third years, fourth and fifth years of unemployment).	0.27	0.12	0.00	0.57	OECD (2011f)
Unemployment rate	Unemployed as a percentage of the civilian labor force (harmonized rates).	7.20	3.61	0.18	19.11	OECD (2011d)
Wage bargaining centralization	The dominant level(s) at which wage bargaining takes place. 5-point classification: 1 = national or central level; 0.75 = national or central level with additional sectoral, local or company bargaining; 0.5 = sectoral or industry level; 0.25 = sectoral or industry level with additional local or company bargaining; 0 = local or company bargaining.	0.43	0.30	0.00	1.00	Visser (2011)
Wage bargaining coordination	Degree of coordination of wage bargaining. 5-point classification: 1 = economy-wide bargaining, based on enforceable agreements between the central organizations of unions and employers affecting the entire economy or the entire private sector, or based on government imposition of a wage schedule, freeze or ceiling; 0.75 = mixed industry and economy-wide bargaining: central organizations negotiate non-enforceable central agreements (guidelines) and/or key unions and employers associations set a pattern for the entire economy; 0.5 = industry bargaining with no or irregular pattern setting, limited involvement of central organizations and limited freedoms for company bargaining; 0.25 = mixed or alternating industry- and firm-level bargaining, with weak enforceability of industry agreements; 0 = none of the above, fragmented bargaining, mostly at company level.	0.55	0.32	0.00	1.00	Visser (2011)

Table 2. Regressions to explain the unemployment rate – main corporate taxation indicator[a)]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Baseline specification	Random effects substituted for fixed effects[b)]	Instrumental variables excluded	Corporate taxation variable lagged by one year	Corporate taxation variable lagged by two years	Time trend added	Wage bargaining centraliza-tion substituted for wage bargaining coordination	Foreign direct investment variables added	Triadic patent families variable added
Effective average corporate tax rate (base case)	-20.64*** (6.73)	-21.03*** (4.21)	-12.37*** (3.49)	-20.28*** (6.24)	-15.41** (7.22)	-19.49*** (6.88)	-20.61*** (6.86)	-22.00*** (6.66)	-20.24*** (5.65)
Labor tax wedge	20.50*** (2.45)	19.10*** (1.97)	23.72*** (2.95)	17.43*** (2.59)	16.43*** (3.40)	18.20*** (2.91)	21.12*** (2.56)	19.89*** (2.45)	17.23*** (2.82)
Trade union density	9.25* (4.98)	4.76** (1.90)	2.51 (6.07)	8.67 (6.57)	6.89 (8.89)	8.76 (5.43)	8.75* (5.05)	9.08* (5.11)	8.76 (5.35)
Collective bargaining coverage	0.48 (1.96)	1.45 (1.35)	3.18 (3.32)	0.32 (2.28)	0.32 (2.93)	0.89 (2.10)	0.37 (1.96)	0.41 (2.01)	0.12 (1.69)
Wage bargaining coordination	-1.12* (0.66)	-1.11*** (0.43)	-1.37** (0.49)	-1.30** (0.57)	-1.30* (0.71)	-1.04 (0.63)		-1.17* (0.66)	-0.94 (0.83)
Employment protection legislation	-2.53 (3.68)	-3.42** (1.54)	-4.62** (1.75)	-1.71 (3.54)	-2.32 (3.43)	-2.77 (3.74)	-2.45 (3.86)	-2.32 (4.41)	-1.46 (3.45)
Unemployment benefits replacement rate	5.17* (2.65)	3.70*** (1.39)	7.05*** (1.70)	4.68* (2.64)	3.92 (2.67)	3.88 (2.72)	5.06* (2.59)	4.92 (3.04)	5.00* (2.83)
Product market regulation	1.77 (1.93)	1.59* (0.93)	1.39 (0.90)	1.60 (1.94)	1.24 (2.12)	2.77 (1.97)	1.46 (2.01)	2.04 (1.90)	1.77 (2.00)
Output gap	-49.39*** (4.59)	-49.06*** (3.13)	-54.13*** (5.37)	-50.39*** (5.15)	-51.12*** (6.12)	-47.13*** (4.82)	-48.84*** (4.50)	-48.49*** (4.73)	-49.21*** (4.75)
Openness	-0.45 (1.96)	-1.20 (0.79)	-2.09* (1.03)	0.44 (2.12)	0.96 (2.60)	-0.39 (1.96)	-0.81 (2.05)	0.20 (1.97)	-0.30 (1.96)
GDP per capita	-0.09 (0.07)	-0.13*** (0.04)	-0.00 (0.06)	-0.13 (0.08)	-0.15 (0.09)	-0.19** (0.09)	-0.10 (0.07)	-0.10 (0.07)	-0.13* (0.07)

Table 2. Regressions to explain the unemployment rate – main corporate taxation indicator[a)] (cont.)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Baseline specification	Random effects substituted for fixed effects[b)]	Instrumental variables excluded	Corporate taxation variable lagged by one year	Corporate taxation variable lagged by two years	Time trend added	Wage bargaining centraliza-tion substituted for wage bargaining coordination	Foreign direct investment variables added	Triadic patent families variable added
Wage bargaining centralization							-0.81 (0.59)		
Foreign direct investment net inflows								-4.57** (2.10)	
Foreign direct investment net outflows								3.34 (2.39)	
Triadic patent families									0.75 (0.46)
Number of observations	417	417	483	418	419	417	417	401	393
R^2 (within)	0.79	0.78	0.70	0.77	0.74	0.79	0.78	0.79	0.80
F-statistic	153.72***		183.38***	77.83***	47.90***	419.87***	123.94***	230.62***	180.63***
Hansen *J* statistic (*p*-value)	0.81			0.68	0.49	0.84	0.75	0.85	0.67
First-stage *F*-statistic	31.00***			46.73***	33.74***	43.27***	95.65***	25.04***	25.40***

[a)] Two-stage least squares regressions with country-specific fixed effects, except for regression 2, which uses generalized two-stage least squares with country-specific random effects, and regression 3, which uses pooled least squares with country-specific fixed effects. Except for regression 3, the corporate taxation variable is instrumented. The excluded instruments are lagged differences of the instrumented variable covering the previous four years. The sample consists of 19 industrial countries. Annual data for the years 1979 to 2005. Standard errors are reported in parentheses. Except for regression 2, they are robust and adjusted for clusters at the country level. ***(**/*) denotes statistically significant at the 1%(5%/10%) level.

[b)] R^2 (between) is 0.32. The χ^2 statistic from the Hausman test is 18.57*. The *p*-value from the Sargan statistic is 0.93. The Wald χ^2 statistic is 1,289.32***. The Wald χ^2 statistic from the first-stage regression is 506.97***.

Table 3. Regressions to explain the unemployment rate – coefficients on alternative corporate taxation indicators[a)]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Baseline specification	Random effects substituted for fixed effects	Instrumental variables excluded	Corporate taxation variable lagged by one year	Corporate taxation variable lagged by two years	Time trend added	Wage bargaining centraliza-tion substituted for wage bargaining coordination	Foreign direct investment variables added	Triadic patent families variable added
Effective average corporate tax rate (debt finance)	-44.87*** (16.20)	-46.33*** (9.89)	-29.34*** (5.68)	-40.22*** (15.34)	-20.68 (17.41)	-42.27** (16.41)	-45.39*** (16.07)	-45.60*** (15.93)	-51.65*** (14.32)
Effective average corporate tax rate (investment in buildings)	-12.91** (5.18)	-13.02*** (3.63)	-8.12*** (2.33)	-14.31*** (4.86)	-13.05*** (4.98)	-12.15** (5.00)	-12.74** (5.19)	-13.80** (5.37)	-12.66*** (4.72)
Effective average corporate tax rate (actual inflation)	-25.42*** (6.64)	-26.01*** (5.11)	-12.78*** (2.59)	-25.03*** (7.49)	-16.57** (7.97)	-25.23*** (7.44)	-25.25*** (7.00)	-26.28*** (6.77)	-23.73*** (6.48)
Effective average corporate tax rate (20% profit rate)	-18.33*** (6.36)	-18.70*** (3.93)	-11.46*** (3.01)	-19.31*** (5.87)	-15.74** (6.54)	-17.26*** (6.39)	-18.47*** (6.39)	-19.56*** (6.36)	-18.11*** (5.42)
Effective average corporate tax rate (30% profit rate)	-16.82*** (6.09)	-17.15*** (3.77)	-10.70*** (2.75)	-18.22*** (5.66)	-15.17** (6.17)	-15.80*** (6.07)	-17.03*** (6.09)	-17.91*** (6.13)	-16.72*** (5.26)
Effective average corporate tax rate (40% profit rate)	-15.88*** (5.90)	-16.19*** (3.66)	-10.22*** (2.59)	-17.48*** (5.51)	-14.70** (5.95)	-14.90** (5.86)	-16.14*** (5.88)	-16.89*** (5.96)	-15.85*** (5.15)
Effective marginal corporate tax rate	-13.27** (5.67)	-13.21*** (3.23)	-6.76** (3.07)	-10.16* (5.98)	-6.07 (5.65)	-12.14** (5.84)	-12.81** (5.97)	-14.07** (5.76)	-13.05*** (4.61)
Statutory corporate tax rate	-12.37** (5.09)	-12.57*** (3.24)	-8.32*** (2.04)	-14.40*** (4.81)	-12.44** (5.06)	-11.54** (4.97)	-12.75** (5.03)	-13.06** (5.17)	-12.54*** (4.68)

Table 3. Regressions to explain the unemployment rate – coefficients on alternative corporate taxation indicators[a)] (cont.)

[a)]Results from two-stage least squares regressions with country-specific fixed effects, except for column 2, which reports results from generalized two-stage least squares regressions with country-specific random effects, and column 3, which reports results from pooled least squares regressions with country-specific fixed effects. Each cell shows the estimate for the corporate taxation variable mentioned in the first column, with each of these estimates resulting from a separate multivariate regression (i.e., the corporate taxation variables were included one at a time, not simultaneously). In each of these regressions, the respective corporate taxation variable was entered together with the same control variables as in the respective regression using the main corporate taxation variable (Table 2). Except for the regressions reported in column 3, the corporate taxation variables are instrumented. The excluded instruments are lagged differences of the instrumented variable covering the previous four years. The sample consists of 19 industrial countries. Annual data for the years 1979 to 2005. Standard errors are reported in parentheses. Except for the regressions reported in column 2, they are robust and adjusted for clusters at the country level. ***(**/*) denotes statistically significant at the 1%(5%/10%) level.