Taxing capital and labor when both factors are imperfectly mobile internationally

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Abstract

We revisit the standard theoretical model of tax competition to consider imperfect mobility of both capital and labor. We show that the mobility of one factor affects the taxation of both factors, and that the race-to-the-bottom narrative (with burden shifting) applies essentially to capital exporting countries. Our predictions are confirmed base on a panel of 29 OECD countries over 1997-2017. Quantitatively, though, rising capital mobility contributes much less than population ageing to the decline of capital tax rates over the period studied.

Keywords: tax competition, globalization, imperfect factor mobility.

JEL classification: F21, F22, H25.

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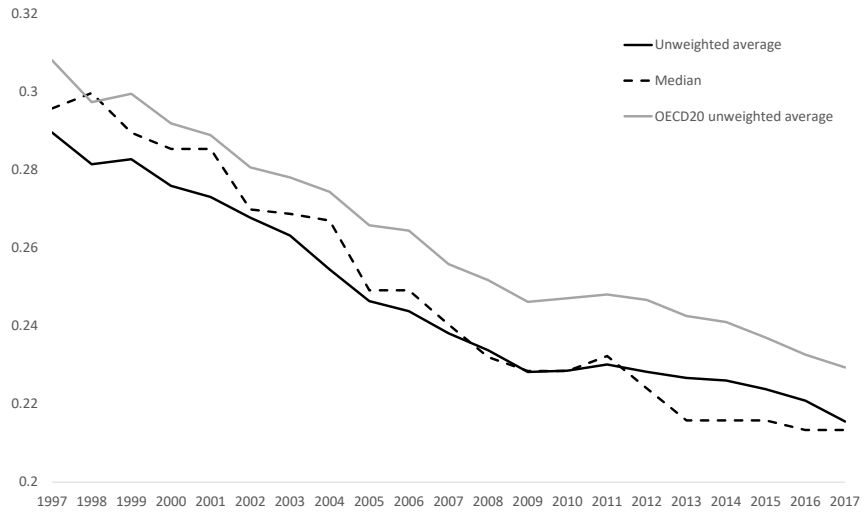
1 Introduction

The theoretical literature on tax competition generally finds that, when capital is mobile whereas land (or labor, or consumption) is not, it is optimal for a benevolent government not to tax capital, hence to finance the provision of public goods only through taxing immobile bases (see Zodrow and Mieszkowski, 1986, Wilson, 1999).[1] As a matter of facts, corporate tax rates have generally decreased in advanced economies since the mid-1990s (see Figure 1), while wealth taxes were hollowing out in most countries.

Figure 1: Effective Average Tax Rate on corporate income, 29 OECD countries*



*Australia, Austria, Belgium, Canada, Chile, Czech Rep., Denmark, Finland, France, Germany, Hungary, Iceland, Ireland, Israel, Italy, Japan, South Korea, Mexico, the Netherlands, Norway, Poland, Portugal, Slovak Rep., Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States. The OECD20 grouping excludes Chile, Czech Rep., Hungary, Israel, South Korea, Mexico, Poland, Slovak Rep., Slovenia. Source: Oxford University Centre for Business Taxation.

Strikingly, though, the empirical literature has remained quite inconclusive on the impact of international capital mobility on the taxation of capital (see the meta analysis of Adam et al., 2013). This surprising non-result may be explained in different ways. First, financial globalization has been concommittant to population ageing: whatever a country's openness, an ageing median voter may favor lower capital taxation.[2] Second, the

[1] Within a general equilibrium model, though, Mendoza and Tesar, 2005 show that capital mobility may not trigger a "race to the bottom" in capital taxation because taxing labor entails inefficiency costs.

[2] Adam and Kammas (2007) find a significant, negative impact of the share of the population over 65

opening up of the economy makes the households more vulnerable to external (terms of trade) shocks; they ask (and get) insurance from the government, which raises the size of the government, resulting in higher taxation (Rodrik, 1998). Third, financial integration has come together with some forms of social and political integration, which may have had opposite effects on capital taxation (Dreher, 2006). Finally, financial globalization, like trade opening up, is a common feature of advanced economies over the 1990s and 2000s. As evidenced e.g. by Slemrod (2004), this makes it it difficult to identify its impact once time fixed effects are introduced.

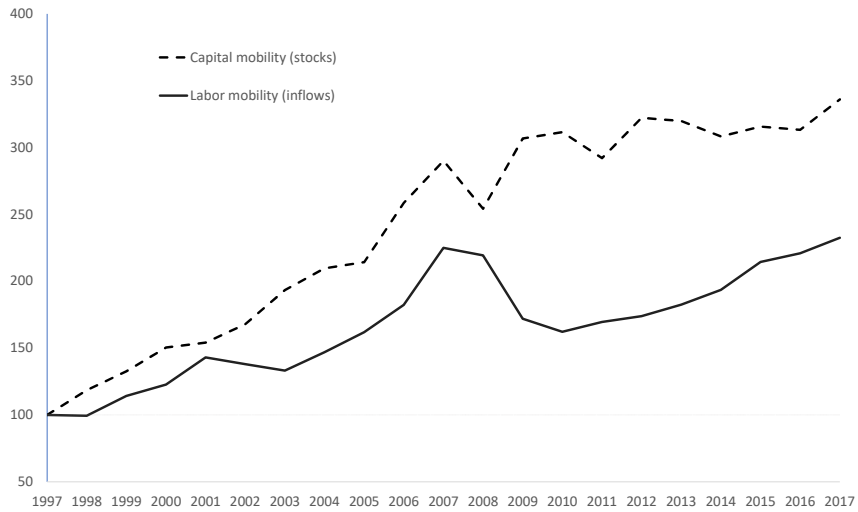
In this paper, we address the above-mentioned pitfalls and further explore two additional explanations for the apparent limited effect of financial globalization on capital taxation. The first one is the simultaneous increase in the mobility of labor. Although in general labor mobility has remained limited over the last three decades, the mobility of at least skilled labor has increased, especially within the European Union where legal barriers to labor mobility have been eliminated. Figure 2 compares a measure of *de facto* capital mobility with a measures of *de facto* labor mobility, for a group of 29 OECD countries (see the definitions in Section 4), both being indexed at 100 in 1997.[3] From 1997 to 2017, labor mobility among OECD countries increased by more than twofold on average, while capital mobility increased by more than threefold.

The literature on tax competition generally enphasizes the burden shifting impact of capital mobility, or equivalently the "compensation effect" of globalization, which both end up in reduced capital taxation and increased labor taxation following financial globalization (see, e.g. Adam and Kammas, 2007). However, labor mobility may alter this result in two ways. First, labor mobility may put downward pressure on labor taxation, at least at relatively high levels of compensation. Liebig et al. (2007), Kleven et al. (2013) and Kleven et al. (2014) find very high elasticities for top-income foreign workers to tax differentials. Since foreign workers are a relatively small proportion of the high-income population, Piketty and Saez (2012) and Lehmann et al. (2014) retain an elasticity of 0.25 for top-income earners. Lehmann et al. (2014) show that, if the semi-elasticity of

years on corporate income tax rates. In general, though, the empirical literature does not control for population ageing.

[3] Labor mobility is measured through migration inflows. Due to the high volatility of capital flows, we measure capital mobility from cross-border assets and liabilities stocks rather than flows.

Figure 2: De facto capital and labor mobility: unweighted averages for 29 OECD countries (100 in 1997)



Note: Capital mobility is the sum of total assets and liabilities in percent of GDP (source: International Monetary Fund). Labor mobility is the ratio of immigration to total population (source: OECD migration database). See the details in Section 4. The country sample is the same as in Figure 1.

migration increases for higher incomes, then it is optimal to reduce the marginal tax rates on top-income earners. Second, to the extent that the skilled workers are in the position to take decisions concerning the location of capital (both at the firm level and as savers), labor and capital mobility are likely to be intertwined. More mechanically, labor and capital mobility interact since the marginal productivity of one factor depends on the quantity of the other factor (see Wilson, 1995).[4]

The second feature we would like to study is the fact that even capital is not perfectly mobile internationally. In particular, a large literature has evidenced a home bias in international portfolio choices.[5] At the macroeconomic level, imperfect capital mobility translates into a wedge between after-tax returns across countries, depending on whether

[4]In Bucovetsky and Wilson (1991) and Razin and Sadka (1991), labor supply is endogenous, which attenuates the standard result of taxation falling on the immobile base. However, to the extent that the elasticity of labor supply is finite, the mobile base stays under-taxed compared to the immobile one. These authors do not consider labor mobility across jurisdictions. Bucovetsky (2003) and Razin and Sadka (2012) do consider labor mobility, but they assume an heterogeneity between local and immigrant workers in terms of productivity or capital endowment.

[5]See the seminal paper by French and Poterba (1991), or the literature review by Lewis (1999).

each country is a net capital exporter or importer.[6] More capital mobility reduces this wedge, with ambiguous impact on tax rates. However, the literature on tax competition generally considers capital to be perfectly mobile, which leads to an equalization of after-tax returns. An exception is Lee (1997) who introduces transaction costs within a two-jurisdictions model. In his setting, tax competition may lead to higher capital tax rates because each jurisdiction disregards the fact that raising its own tax depresses the after-tax return in both jurisdictions. Yet, the transaction cost is given, whereas in the macroeconomic literature, an indebted country will need to offer higher after-tax return than the rest of the world if it wants to keep its foreign capital.

We consider a model of tax competition *à la* Zodrow and Mieszkowski (1986) where the benevolent government of a small open economy maximises the average household's utility that depends of the consumption of both a private good and of a public good. The latter good is financed through two taxes at the source: one on capital and the other one on labor. Both capital and labor are imperfectly mobile internationally. However, there is an asymmetry between capital and labor: while workers must be residents of the same country where they work, capital owners may be residents or non-residents.[7]

We first show that capital and labor taxation generally coexist. We then study the impact of factor mobility on both tax rates, through a full derivation of a simplified model and through simulations of the general model. We find that the government will reduce the tax rate on capital as a result of increased capital mobility (race-to-the-bottom) and increase the tax rate on labor (burden shifting), but mostly for a country that is a net capital exporter. For a net capital importer, the results are more mixed. In contrast, being a net exporter or importer of labor has ambigous effect on the impact of labor mobility because the international position of a country on the labor market needs to be considered in combination with its position on the capital market.

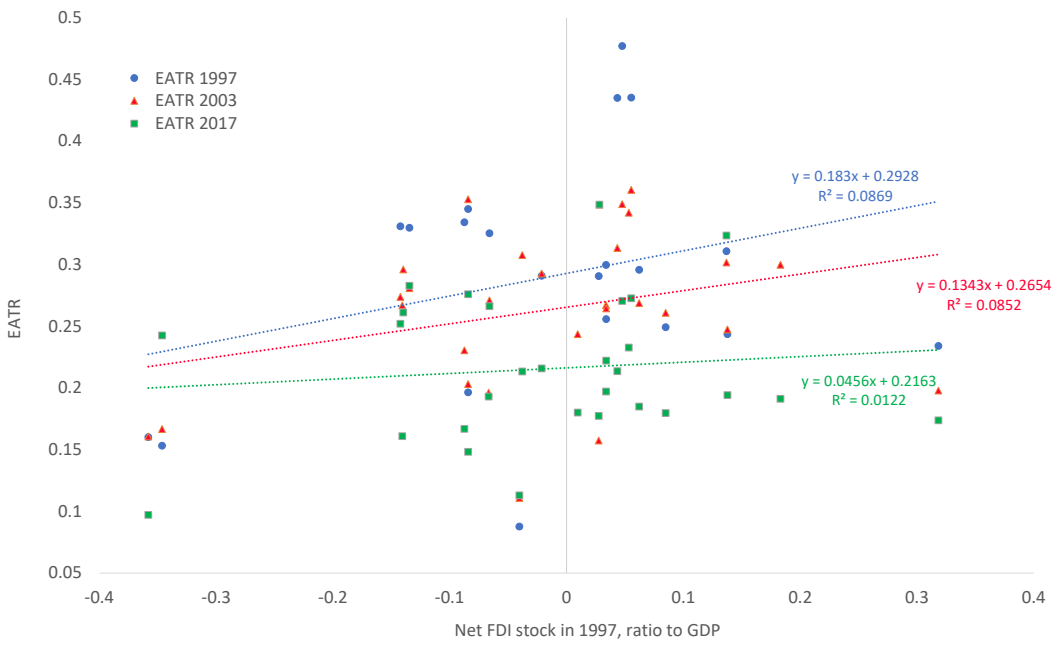
The intuition of our results is the following. In a world of imperfect capital mobility, a capital-importing country needs to offer a higher after-tax return than the rest of the

[6] Horioka and Ford (2017) also explain why return differentials are not eliminated by financial integration.

[7] This assumption, sometimes labeled "regional model" is standard in the literature, especially for international tax competition (see Wilson, 1999). However the literature on local tax competition has sometimes studied "metropolitan" models where individuals commute between home and work, see Braid (1996). In Richter and Wellisch (1996), households work in their country of residence while holding capital in other jurisdictions. However their capital (land) is in fixed supply in each jurisdiction.

world, hence a lower tax rate, in order to attract foreign capital. Conversely, a country with high capital endowment may enjoy a higher tax rate than the rest of the world.[8] Along financial globalization, differentials in after-tax returns diminish: the net capital importing country may raise its tax rate whereas the net capital exporter has to reduce its own tax rate. Considering the net position of each country in terms of Foreign Direct Investment (FDI) in 1997 (with a positive sign for a net capital exporter), Figure 3 shows a positive relationship with the Effective Average Tax Rate (EATR) on corporate income in 1997, but this relationship weakens in 2003 and vanishes in 2017.[9]

Figure 3: Net FDI position in 1997 and EATR in 1997, 2003 and 2017



Note: A positive Net FDI position points to a net capital exporter. Same sample of 29 OECD countries as in Figure 1.
Sources: Oxford University Centre for Business Taxation and International Monetary Fund (see Section 4).

We test our theoretical predictions on a panel of 29 OECD countries over the period

[8] Peralta and van Ypersele (2005) also highlight the importance of capital endowments in a two-country framework where labor is not mobile.

[9] The slopes are significant at 20% in 1997, 12% in 2003 and 5% in 2017.

1997-2017. More specifically, we study the impact of factor mobility on the EATR and on the tax wedge on relatively high wages (gross income representing 167% of average earnings), while paying careful attention to several other variables that may also have affected tax rates over our sample period, namely trade openness, ageing, government spending and government debt. We also include country and time fixed effects, and we interact factor mobility with proxies of factor importing or exporting status.

We find evidence that capital mobility has a negative impact on capital taxation and a positive impact on labor taxation, but only for capital exporting countries. Conversely, labor mobility has positive impact on capital taxation but no significant effect on labor taxation. Quantitatively, though, we find a much larger contribution of population ageing than of increased capital mobility to the decline of corporate income tax rates over the period. Our results are found robust to a series of robustness checks.

We conclude that the mixed results obtained in the literature concerning the link between international capital mobility and capital taxation may be related to improperly controlling for other factors, notably population ageing and to failing to differentiate net capital exporters and importers.

Our results suggests that a country that opens up to capital inflows may be less vulnerable in its ability to tax capital than a country that opens up to capital outflows. But also that these effects are second order compared to population ageing and to variations in government spending and debt.

The remainder of the paper is organized as follows. In Section 2, we outline the theoretical setting and solve a simplified version. Section 3 presents the calibration and simulation of the complete model. Section 4 introduces the empirical strategy and the data used. The econometric results are presented in Section 5. Section 6 describes three robustness exercises. Section 7 concludes.

2 Theory

We consider a small open economy where production is achieved using two internationally mobile factors - capital and labor. A public good is financed through source taxation of capital and of labor. The government chooses the optimal taxes on factors in order to

maximize a utility function that depends on public spending and on the after-tax national income per inhabitant. The novelty of this model *à la* Zodrow and Mieszkowski, 1986 is to allow for imperfect mobility of both factors and to highlight the cross effects of the mobility of one factor on the taxation of the other factor. Our setting allows us to contrast the impact of factor mobility depending on whether the economy is a net exporter or importer of capital.

2.1 Production and incomes

Production is achieved using two internationally mobile factors, capital and labor, denoted K and L respectively. The production function is written as $F(K, hL)$, where $F(.,.)$ satisfies constant returns-to-scale and is increasing and concave in each argument and where $h > 0$ is an exogenous scaling parameter that represents labor productivity. We assume that capital and labor are taxed at the source at rates τ_K and τ_L, respectively. We denote by r^* and w^* the international remuneration of capital and labor, respectively, and by r and w the domestic after-tax return of each factor such that:

$$r := F'_K(.,.) - \tau_K \text{ and } w := F'_L(.,.) - \tau_L. \tag{1}$$

We assume that two types of agents are living in the considered economy: (mobile) workers, assumed to be equal to the labor force L, and (immobile) pensioners of mass D.[10] Both have the same capital endowment, denoted $\bar{k}$,[11] and thus the total capital available in the economy depends on the total number of residents: $K = (L + D)\bar{k}$. Both workers (who are supposed to live in the same country where they work) an pensioners can invest their capital endowment in a different country. Capital income is the sum of the domestic capital income rK and of the revenue of the net investment position, given by $(L + D)\bar{k} - K$. Importantly, a positive net investment position (*i.e.* when the country is a net exporter of capital) yields the foreign after-tax return r^*, whereas a negative net investment position (net importer of capital) costs the domestic after-tax return r, as

[10] The importance of featuring pensioners in the model will appear clear in the econometric section of the paper. The assumption that they are immobile is made made for computational convenience. Although in reality pensioners are partly mobile, assuming that they are immobile allows us to capture the existence of immobile rentiers in the economy.

[11] We do not study specific results that could arise from heterogenous capital between natives and migrants (Razin and Sadka, 2012) nor from different productivities (Bucovetsky, 2003).

part of the domestic capital income is channeled towards foreign investors. The rest of the earnings is made of an (after-tax) wage w for workers, and of an exogenous pension, denoted by p, for pensioners. Hence, the private (or disposable) income of each worker and pensioner, denoted by y_L and y_D, respectively, is given by:

$$y_L = \left| \begin{array}{l} rk + r^* \left(\bar{k} - k\right) + w \text{ if } \bar{k} \geq k, \\ r\bar{k} + w \text{ if } \bar{k} \leq k, \end{array} \right. \tag{2}$$

and:

$$y_D = \left| \begin{array}{l} rk + r^* \left(\bar{k} - k\right) + p \text{ if } \bar{k} \geq k, \\ r\bar{k} + p \text{ if } \bar{k} \leq k, \end{array} \right. \tag{3}$$

where $k := K/\left(L + D\right)$ is the capital per resident.[12] Notice that, in our model, workers may either relocate with their capital endowment or stay home and invest their endowment overseas. Hence there is an asymmetry between capital and labor: attracting a new worker will automatically attract a new capital endowment, whereas attracting new capital will attract new workers only through the induced rise in the marginal productivity of labor.[13] We now turn to the conditions that provide the wedge between the domestic and the international remunerations of both factors.

2.2 No-arbitrage conditions with imperfect factor mobility

In contrast to the existing literature on tax competition, we assume that both capital and labor are imperfectly mobile, and that the extent of mobility may differ for capital and labor. In macroeconomic models, frictions in the international capital market are typically modelled as departures from the uncovered interest parity depending on the net foreign asset position of the country, these departures relying on utility maximization by the representative household or financial intermediary (see e.g. Lindé and Pescatori, 2017, Itskhoki and Mukhin, 2019). Consistently, we assume that the stock of productive capital in the domestic economy depends on the domestic endowment and on the gap between the domestic after-tax return on capital and the international remuneration of capital, which

[12] If $\bar{k} = k$, then the alternative expressions of y_L and y_D are equivalent since $r = r^*$, see next sub-section.

[13] Such asymmetry could be erased if workers were allowed to work and live in two different countries. Existing models of international tax competition generally disregard this possibility, but things could change with the expansion of cross-border telecommuting (see Baldwin, 2016).

influences the international allocation of capital endowments:[14]

$$K = \left[\bar{k} + \phi_K \left(r - r^*\right)\right] (L + D), \tag{4}$$

where $\phi_K \geq 0$ represents the degree of capital mobility. Hence, a country can enjoy productive capital in excess of its domestic endowment (i.e. $K > (L+D)\bar{k}$) if its after-tax return is greater than the international return.[15] In the limit case such that $\phi_K = 0$, capital is immobile and we have $K = (L + D)\bar{k}$. Conversely, when $\phi_K \to \infty$, an infinitely small excess return is required to attract foreign capital, so at equilibrium the domestic after-tax return is equal to the international return: $r = r^*$. For intermediate values of ϕ_K, the domestic after-tax return satisfies:

$$r = r^* + \frac{k - \bar{k}}{\phi_K}. \tag{5}$$

The literature on international migrations has also modelled the remuneration wedge between host and origin countries as a function of market frictions, here migration costs (see Borjas, 1989). By analogy with capital, we assume that the quantity of labor in the domestic economy depends on an exogenous labor endowment, denoted $\bar{L}$, and on the gap between the after-tax labor return and the international remuneration of labor:

$$L = \bar{L} + \phi_L \left(w - w^*\right) L, \tag{6}$$

where $\phi_L \geq 0$ represents the international mobility of labor. Like for capital mobility, this parameter is scaled by the size of the economy, here L. For $\phi_L = 0$, we have $L = \bar{L}$, while $\phi_L \to \infty$ corresponds to perfect labor mobility that implies $w = w^*$. For intermediate values of ϕ_L, there is a wedge between the domestic after-tax wage and its international remuneration:

$$w = w^* + \frac{1 - \frac{\bar{L}}{L}}{\phi_L}. \tag{7}$$

For given K and L, the absolute size of the wedge in conditions (5) and (7) declines

[14] For simplicity, we consider the depreciation rate of capital to be equal to its price variation over one period, so that the user cost of capital is equal to its gross marginal return.

[15] Symmetrically, $K < (L + D)\bar{k}$ is consistent with $r < r^*$.

for higher factor mobility. For instance, higher capital mobility makes it easier for a net capital importer to attract foreign capital: the premium needed to attract foreign investors is reduced, and the capacity to tax is increased. By replacing r by $F'_K(.,.) - \tau_K$ in (5) we indeed obtain that:

$$\left.\frac{\partial \tau_K}{\partial \phi_K}\right|_{K,L \text{ given}} = \frac{k - \bar{k}}{\phi_K^2}. \tag{8}$$

For a given level of capital and labor, partial derivative (8) suggests that the tax rate on capital should increase with capital mobility for a net capital importer, and decrease for a net capital exporter. The same reasoning applies to labor, except that it is the difference between L and $\bar{L}$ that is relevant. However, capital and labor will adjust to a change in factor mobility, so the model needs to be solved before it is possible to come to a conclusion.

By replacing the no-arbitrage conditions (5) and (7) in the equations that define private incomes, i.e. (2) and (3), we obtain:

$$y_L = \left| \begin{array}{l} w^* + \frac{\left(1-\frac{\bar{L}}{L}\right)}{\phi_L} + r^*\bar{k} + \left(\frac{k-\bar{k}}{\phi_K}\right) k \text{ if } \bar{k} \geq k, \\ w^* + \frac{\left(1-\frac{\bar{L}}{L}\right)}{\phi_L} + r^*\bar{k} + \left(\frac{k-\bar{k}}{\phi_K}\right) \bar{k} \text{ if } \bar{k} \leq k. \end{array} \right. \tag{9}$$

and:

$$y_D = \left| \begin{array}{l} p + r^*\bar{k} + \left(\frac{k-\bar{k}}{\phi_K}\right) k \text{ if } \bar{k} \geq k, \\ p + r^*\bar{k} + \left(\frac{k-\bar{k}}{\phi_K}\right) \bar{k} \text{ if } \bar{k} \leq k. \end{array} \right. \tag{10}$$

For a given L, we see that the income is always larger in a capital importing country than in a capital exporting one. The reason is that the after-tax return on capital is higher and overcompensates for the loss induced by the outflow benefiting to foreign investors. Incomes per capita are independent from L when labor mobility is infinite and from k when capital mobility is infinite.

2.3 Tax rates

The government maximizes a social welfare function that depends on private incomes and on average public spending net of transfers, denoted by G, divided by the size of the

population $L + D$.[16] Private incomes, y_L and y_D, are weighted using the demographic weight of each type of agents, $L/(L+D)$ for workers and $D/(L+D)$ for pensioners, and a parameter $\gamma > 0$ that reflects the relative weight of each pensioner to a worker, which can be justified e.g. by different participation rates to the elections. The social welfare function of the government is given by:

$$U\left(\frac{L}{L+D}y_L + \gamma\frac{D}{L+D}y_D, \frac{G}{L+D}\right) \tag{11}$$

where U is an increasing and concave function in both arguments. Both partial derivatives, denoted $U_Y(.,.)$ and $U_G(.,.)$, are assumed to be infinite when the argument equals zero. Finally, we assume that the budget is balanced and, consequently, that public spending net of transfers is equal to total tax revenues:

$$G = \tau_K K + \tau_L L - pD. \tag{12}$$

The government's problem then is to set τ_K and τ_L so as to maximize its utility function (11) subject to conditions (5), (7), (2), (3), and (12). Hence, tax rates τ_K, τ_L, productive factors k, L and the production of public goods G are all endogenously determined, whereas factor endowments $\bar{k}$, $\bar{L}$, pensioners parameters D, p, and international remunerations r^*, w^* are exogenously given. The derivation of the model is presented in Appendix A. In particular, the optimal tax rate on capital satisfies:

$$\tau_K = \left| \begin{array}{l} \frac{1}{\phi_k}\left[(1-\eta)k + \eta\left(\bar{k}-k\right)\right] \text{ if } \bar{k} \geq k, \\ \frac{1}{\phi_k}\left[(1-\eta)\bar{k} + \left(k-\bar{k}\right)\right] \text{ if } \bar{k} \leq k. \end{array} \right. \quad \text{where: } \eta := \frac{U'_Y(.,.)}{U'_G(.,.)}\frac{L+\gamma D}{L+D}. \tag{13}$$

In the case of an equal weight to each inhabitant in the utility function (i.e. for $\gamma = 1$), it can be shown (see Appendix A) that there is underprovision of public goods, i.e. that partial derivative of the social welfare function satisfy $U'_Y(.,.) < U'_G(.,.)$, which implies that $\eta < 1$. Using the expressions (13), we thus immediately conclude that the tax on capital is positive. It converges to zero for infinite capital mobility. For imperfect capital

[16] Hence, public spending is not subjet to returns to scale. It refers to e.g. education or healthcare rather than to e.g. military spending. By making this assumption, we do not want to introduce an incentive for the government to increase the size of the economy.

mobility, the tax rate depends on the endogenous values of k and η. We first solve the model in the particular case where $D = 0$ before moving to simulations for $D > 0$.

For $D = 0$, it can be shown (see Appendix A) that marginal utilities of public and private goods are equal, i.e. $U'_Y(.,.) = U'_G(.,.)$, which allows to conclude that $\eta = 1$. Using (13), the optimal tax on capital is thus:

$$\tau_K|_{D=0} = \left| \begin{array}{l} \frac{(\bar{k}-k)}{\phi_k} \text{ if } \bar{k} \geq k, \\ \frac{(k-\bar{k})}{\phi_k} \text{ if } \bar{k} \leq k, \end{array} \right. \tag{14}$$

where k is obtained, using (5), as the solution of the following equations:

$$\begin{array}{l} F'_K(k,h) = r^* \text{ if } \bar{k} \geq k, \\ F'_K(k,h) = r^* + \frac{2(k-\bar{k})}{\phi_K} \text{ if } \bar{k} \leq k. \end{array} \tag{15}$$

Equations (15) state that the level of capital per worker k is obtained by equalizing the marginal productivity to the world's capital return r^* if the country is a net exporter of capital ($\bar{k} > k$). Conversely, we see that the marginal productivity is larger than r^* if the country is a net importer of capital ($\bar{k} < k$). This asymmetry, which is a direct consequence on the assumption made on the differential remunerations of the net investment position, creates a rationale for different taxation depending on the net investment position of the country. Computing the effect of a change in the degree of mobility on the tax rate is then straightforward and yields:

$$\frac{\partial \tau_K|_{D=0}}{\partial \phi_K} = \left| \begin{array}{l} -\frac{(\bar{k}-k)}{\phi_k^2} \text{ if } \bar{k} \geq k, \\ -\frac{1}{\phi_K^2}(k-\bar{k})\left[\frac{F''_{KK}(k,h)}{F''_{KK}(k,h)-\frac{2}{\phi_K}}\right] \text{ if } \bar{k} \leq k. \end{array} \right. \tag{16}$$

In both cases, an increase in capital mobility reduces the tax rate on capital (it triggers a "race to the bottom"), but the derivative (in absolute value) is larger for a capital exporting country than for a capital importing one. In the latter case, capital mobility increases the capital per worker, hence increases the tax base and reduces the after-tax return premium: more capital mobility raises the taxation space of the capital importing country. This key theoretical result is supported by the empirical analysis we present in Section 5. Concerning the effect of the capital mobility on the tax rate on labor, we have

(provided that the social welfare function is additively separable, see the Appendix A):

$$\frac{\partial \tau_L|_{D=0}}{\partial \phi_K} = \frac{k\left(\bar{k}-k\right)}{\phi_K^2} \text{ if } \bar{k} \geq k. \tag{17}$$

For a capital exporting country, capital mobility increases the tax rate on labor. This "burden shifting" effect can be explained by the fact that the additional capital outflow triggered by higher capital mobility will come along with an outflow of labor, since capital per worker (determined by r^*, see Equation (15)) stays constant *ex post*. Hence the labor tax base is reduced, and public spending requires a higher tax rate. For a capital importing country, higher capital mobility triggers an inflow of capital that exceeds the inflow of labor (since capital per worker k increases, see Equation (15)). The net impact on labor taxation is ambiguous as it depends on how k reacts to higher capital mobility. We conclude that the burden shifting effect should be less apparent in capital importing countries than in capital exporting ones.

3 Model simulations

Now we come back to the complete model with $D > 0$, that we calibrate in order to simulate the impact of capital and labor mobility on tax rates. We first need to choose functional forms for the production and utility functions. We rely on a standard Cobb-Douglas production function:

$$Y = F(K, hL) = K^{\alpha}(hL)^{1-\alpha}, \tag{18}$$

where $0 \leq \alpha \leq 1$ and $h > 0$. In turn, we assume a log-linear utility function:

$$U = ln\left((1-\delta)y_L + \gamma\delta y_D\right) + \theta ln(g), \tag{19}$$

where $\delta = \frac{D}{D+L}$, γ is the weight of a pensioner relative to a worker in the social utility function, $g = \frac{G}{L+D}$ and $\theta > 0$ represents the relative weight of the public good in social preferences.

3.1 Calibration

We calibrate the model on the four largest economies of the euro area: Germany, France, Italy and Spain, over 1997-2017. All four countries have fully liberalized capital flows in the early 1990s and their euro membership means that the frictions on capital markets related to exchange-rate volatility are similar. Furthermore, they have liberalized intra-EU labor flows over the 2000s, although not the flows with the rest of the world. For each variable, we take the country average over 1997-2017 and then the average over the four countries, weighted by GDP.

The old dependency ratio ($d = D/L$) is taken from the World Bank, Health Nutrition and Population Statistics. It is set to 27%. Hence, the share of the pensioners in the population is $\delta = \frac{D}{L+D} = 0.21$.[17]

Gross disposable income of households (when aggregating workers and pensioners) is calibrated at 65% of GDP, based on the Ameco database of the European Commission. From the same database, we calculate that public pensions represent 13% of GDP whereas public expenditure other than inter-personnal transfers represents 35% of GDP: $\frac{pD}{Y} = 0.13$, $\frac{G}{Y} = 0.35$, where Y denotes GDP.

Exogenous foreign factor returns r^* and w^* are calibrated based on the returns observed over the period for the four countries. According to Jordà et al. (2019), p. 1293, the post-1980 real return on wealth averaged 6.29% in Germany, 4.72% in France, 5.01% in Italy and 5.34% in Spain. We set $r^* = 0.05$. From Ameco, we get a net worth per household of around 160,000 euros. We divide by 10,000 and set $\bar{k} = 16$. We then recover w^* based on the 0.7 labor share we get from Ameco and using: $\frac{r^*\bar{k}(1+d)}{w^*} = \frac{0.3}{0.7}$, which gives $w^* = 2.4$.

From Ameco, the ratio of public pensions to labor compensations is 0.27, i.e. $\frac{pD}{wL} = 0.27$. Since $D/L = 0.27$, we get $p = w$: our simulation should yield a similar value for unit pension and unit wage.

Implicit tax rates are recovered from the European Commission's Taxation Trends database. Labor taxes represent 21% of GDP whereas the share of corporate tax revenues is 2.7% of GDP. In our model, there are no other taxes. Since the budget constraint imposes that $\frac{\tau_K K + \tau_L L}{Y} = \frac{G+pD}{Y} = 0.48$, we target $\frac{\tau_K K}{Y} = 0.055$ and $\frac{\tau_L L}{Y} = 0.425$.

[17] Since L is endogenous, we set d and δ in terms of the labor endowment $\bar{L}$.

Finally, the size of the workforce can be set at any level since it will just determine the size of the economy. We set $\bar{L} = 100$.

The first line of Table 1 provides the values of the exogenous variables $\bar{L}$, $D = d\bar{L}$, r^*, w^*. In the second line, we report the target ratios that are used to calibrate the parameters of the model, the parameters being α, h, γ, p, θ, ϕ_K, ϕ_L. The third line provides two parameters that can be set without model simulations: α and γ. As already mentioned, the labor share is 0.7 in our sample, hence we have $\alpha = 0.3$. In our benchmark calibration, we also assume that the weight of the pensioners in the utility function is no higher than their share in the population of households: $\gamma = 1$. The next line reports the other parameters that are set so as the model solution is close to our five target ratios.

The second part of Table 1 reports the results of the simulated model in two different cases: the benchmark case, which corresponds to high capital endowment ($\bar{k} = 16$), and a variant with lower capital endowment ($\bar{k} = 13$). The endogenous ratios are close to their targets. The ratio of pensions to GDP is a bit small, but rising p would make the unit pension exceed the unit wage. As for labor taxation, it is slightly too small, but rising it would make G/Y exceed its target.

Table 1: Calibration

	(1)	(2)	(3)	(4)	(5)
Exogenous variables	$\bar{L} = 100$	$D = 27$	$r^* = 0.05$	$w^* = 2.4$	
Targets ratios	$\frac{p}{w} = 1$	$\frac{G}{Y} = 0.35$	$\frac{pD}{Y} = 0.13$	$\frac{\tau_K K}{Y} = 0.055$	$\frac{\tau_L L}{Y} = 0.425$
Preset parameters	$\alpha = 0.3$	$\gamma = 1$			
Calibrated parameters	$h = 2$	$p = 1.3$	$\theta = 0.57$	$\phi_K = 100$	$\phi_L = 0.1$
Benchmark: high capital endowment ($\bar{k} = 16$)					
Endogenous ratios	$\frac{p}{w} = 1.04$	$\frac{G}{Y} = 0.3510$	$\frac{pD}{Y} = 0.010$	$\frac{\tau_K K}{Y} = 0.061$	$\frac{\tau_L L}{Y} = 0.387$
Production factors	$k = 15.7$	$L = 89.7$			
Variant: low capital endowment ($\bar{k} = 13$)					
Endogenous ratios	$\frac{p}{w} = 1.12$	$\frac{G}{Y} = 0.3472$	$\frac{pD}{Y} = 0.1029$	$\frac{\tau_K K}{Y} = 0.0524$	$\frac{\tau_L L}{Y} = 0.3976$
Production factors	$k = 13.4$	$L = 89.0$			

Source: Simulations with matlab.

In this benchmark, high endowment case, we get $k < \bar{k}$, hence we are in the case of a net capital exporting country. Conversely, the low endowment case yields $k > \bar{k}$, hence we are in the case of a net capital importer.

3.2 The impact of factor mobility on tax rates

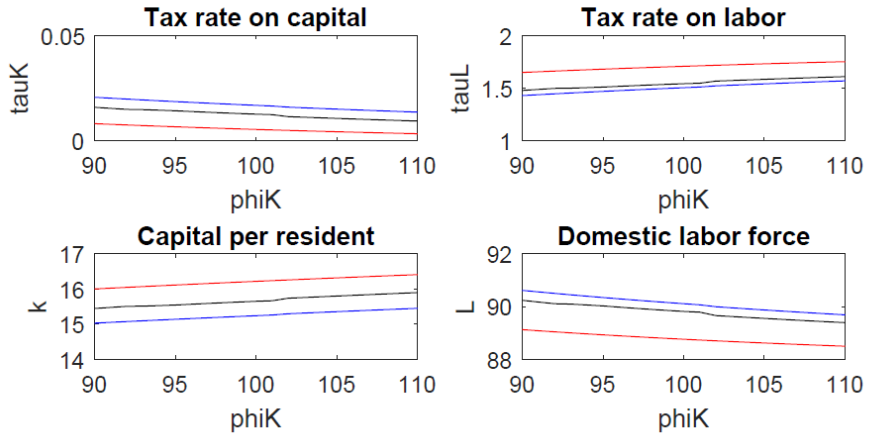
We can now simulate the model with different coefficients of capital mobility, ϕ_K and labor mobility, ϕ_L. In each case, we successively simulate the model with $D = 27$ and $\gamma = 1$ (their calibrated values) and with a higher weight of pensioners either demographically (D) or politically (γ).

Capital mobility

In this first group of simulations, we keep the exogenous variables and parameters of Table 1 except for ϕ_K that is allowed to change by $\pm 10\%$. We then study how population ageing affects the results through a variant where $D = 30$ instead of 27. We also study how the results are affected when pensioners have more say than the workers in public decisions (we set $\gamma = 1.05$ instead of 1 in this case). The results are presented in Figure 4 in the case of a net capital exporter ($\bar{k} = 16$) and in Figure 5 for the case of a net capital importer ($\bar{k} = 13$). In each case, we plot the evolution of the tax rates τ_K, τ_L, and of the production factors k, L as a function of capital mobility ϕ_K.

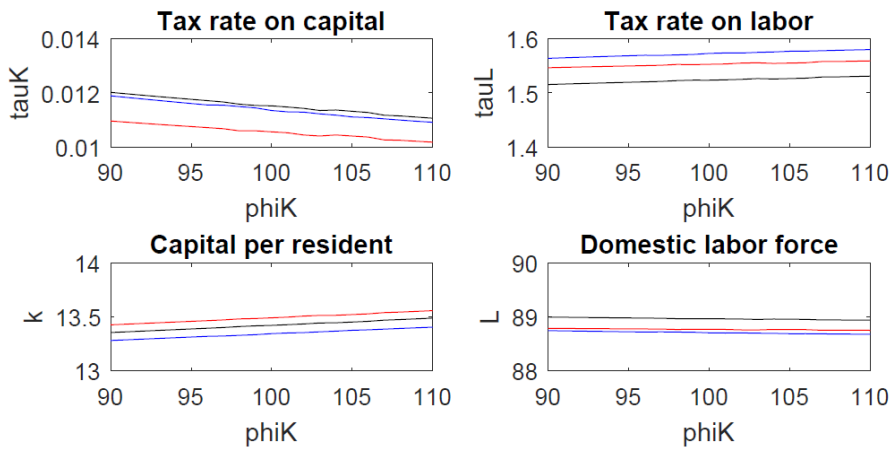
The case with $D = 27$ and $\gamma = 1$ is depicted through black lines. Figure 4 (capital exporter) illustrates the standard result where higher capital mobility triggers a reduction in capital taxation and a shift of the tax burden on to labor. Consistently, the labor force falls when the labor tax is raised, whereas the capital per resident increases. In the case of a net capital importer (Figure 5), more capital mobility also triggers a reduction in capital taxation and a rise in labor taxation, but to a much lesser extent. When ϕ_K rises from 90 to 100, capital taxation falls from 7.97% of GDP to 6.4% in the case of a capital exporter but only from 5.47 to 5.26% in the case of a capital importer. Simultaneously, the share of labor taxation rises from 37% to 38.4% in the former case, but only from 39.6 to 39.75% in the latter case.

Figure 4: Impact of capital mobility on taxation: net capital exporter ($\bar{k} = 16$)



Notes: black lines are for $D = 27$, $\gamma = 1$; blue lines for higher dependence ($D = 30$, $\gamma = 1$), red lines for higher political weight of pensioners ($D = 27$, $\gamma = 1.05$).

Figure 5: Impact of capital mobility on taxation: net capital importer ($\bar{k} = 13$)



Notes: black lines are for $D = 27$, $\gamma = 1$; blue lines for higher dependence ($D = 30$, $\gamma = 1$), red lines for higher political weight of pensioners ($D = 27$, $\gamma = 1.05$).

Interestingly, the two types of countries differ in their reaction to ageing (blue lines). A capital importing country reacts to a higher dependence ratio by increasing the tax rate on labor, whereas a capital exporting country reacts by slightly lowering the taxation of labor (and increasing the tax rate on capital). In both cases, the rising number of pensioners requires additional tax revenues. It also reduces the share of workers in the

utility function of the government. In a capital importing country, though, the return on capital is higher than in the rest of the world, so the capital outflow following an increase in the tax rate on capital is relatively costly: it is better not to increase capital taxation. For a capital exporter, the cost of increasing capital taxation is less.

The result is different when ageing comes along increased political weight of the pensioners. This is shown by the red lines in in Figures 4 and 5, where D is kept at its baseline level of 27 but γ is raised to 1.05: in both types of countries, more powerful pensioners will put downward pressure in capital taxation, at the expense of the workers. Importzantly, the effect is much more sizeable for a capital exporting country than for a capital importing one. Hence, in our model, it is the political economy rather than just the demography that explains while ageing countries tend to cut capital taxation and shift the tax burden on to labor, and we expect the effect to be more visible in a capital exporting country.[18]

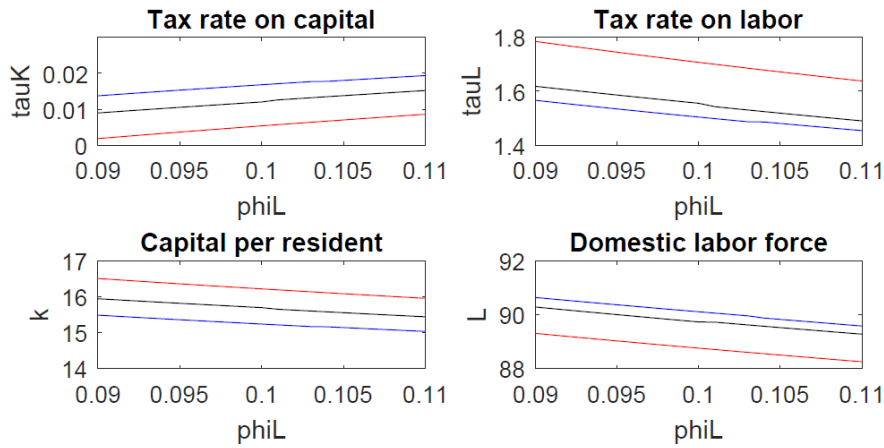
Labor mobility

We now study the impact of labor mobility by varying ϕ_L by $\pm 10\%$. The results are reported in Figure 6 for a capital exporter and Figure 7 for a capital importer. In both cases, more labor mobility puts downward pressure on labor taxation while shifting the tax burden on to capital. Like for capital mobility, though, the reaction of tax rates is much less in a capital importing country than in a capital exporting one. In the former case, the private revenue loss related to an increase in capital taxation is more important than in the latter case.

Again, population ageing leads the capital exporter to lower labor taxation and increase capital taxation, while more political weight of the pensioners has the reverse impact.

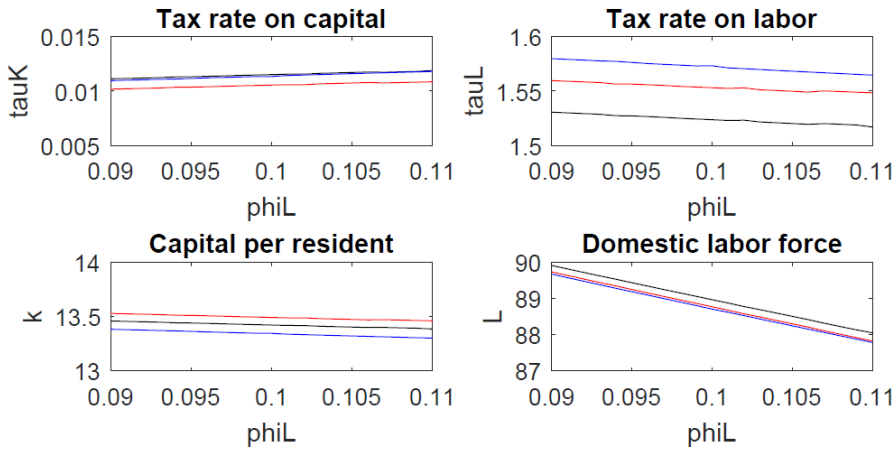
[18] In our model, workers and pensioners have the same capital endowment. Alternatively, with higher capital endowment for the pensioners, population ageing could change the status of the country from capital importer to capital exporter.

Figure 6: Impact of labor mobility on taxation: net capital exporter ($\bar{k} = 16$)



Notes: black lines are for $D = 27$, $\gamma = 1$; blue lines for higher dependence ($D = 30$, $\gamma = 1$), red lines for higher political weight of pensioners ($D = 27$, $\gamma = 1.05$).

Figure 7: Impact of labor mobility on taxation: net capital importer ($\bar{k} = 13$)



Notes: black lines are for $D = 27$, $\gamma = 1$; blue lines for higher dependence ($D = 30$, $\gamma = 1$), red lines for higher political weight of pensioners ($D = 27$, $\gamma = 1.05$).

In all the simulations presented here, we have considered a net labor exporting country ($L < \bar{L}$). For a net labor importing country, we also find that increasing labor mobility puts downward pressure on labor taxation, with a burden shifting on to capital.[19] Hence we do not find the same asymmetry between labor exporters and labor importers as for

[19] We calibrate this case by assuming $w^* = 1$ instead of 2.4. The economy is then close to balance in terms of capital. The figures can be found in Appendix B.

capital exporters and capital importers. The reason is that labor cannot move without its capital endowment whereas capital can move without its labor endowment: when labor becomes more mobile, it is extremely important for the country to keep its labor force (through cutting the labor tax) whatever the net position in terms of labor, because capital will move together with labor.

4 Empirical strategy

Our empirical methodology is close to Adam and Kammas (2007) who estimate the impact of globalization on effective tax rates on capital and on labor, for 17 OECD countries over 1970-1997. They find trade openness to have a negative impact on capital taxation ("efficiency effect") but a positive impact on labor taxation ("compensation effect"). However, they only study the impact of trade openness, not capital nor labor mobility, and their sample stops before the steep increase in capital mobility.[20] We nevertheless follow their general methodology consisting in panel estimations with country and time fixed effects, and a range of control variables that includes ageing, public spending and government debt. Contrasting with Adam and Kammas (2007), though, we consider trade openness as a control rather than a variable of interest, and we rely on specific proxies for capital and labor mobility.

Our panel covers 29 OECD countries[21] over the period 1997-2017. The empirical specification is the following:

$$KTAX_{it} = a_1 KMOB_{it} + a_2 LMOB_{it} + a_3 X_{it} + FE_i + FE_t + u_{it}, \tag{20}$$

$$LTAX_{it} = b_1 LMOB_{it} + b_2 KMOB_{it} + b_3 X_{it} + FE_i + FE_t + v_{it}, \tag{21}$$

where $KTAX_{it}$ is the tax rate on capital for country i in year t, $LTAX_{it}$ the tax rate on labor, $KMOB_{it}$ is the mobility of capital, $LMOB_{it}$ is the mobility of labor, X_{it} is a vector of control variables, FE_i, FE_t are country and time fixed effects, respectively, and

[20] The time sample is especially important in our case. Indeed, Adam et al. (2013) show that studies incorporating more recent years tend to find more negative impact of globalization on capital taxation.

[21] Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Finland, France, Germany, Hungary, Iceland, Ireland, Israel, Italy, Japan, South Korea, Mexico, the Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, the United Kingdom, the United States.

u_{it}, v_{it} are the residuals. Based on the existing theoretical literature, we expect $a_1, b_1 < 0$ ("race-to-the-bottom" effect for capital and labor taxation, respectively) and $a_2, b_2 > 0$ (compensation, or burden-shifting effect). However, we have shown theoretically that these effects may be influenced by the net international position of a country. Subsequently, we interact capital mobility and labor mobility with proxies of factor endowments.

We now briefly describe the data sources used in the analysis, with special attention to tax rates and to the variables used to capture factor mobility.[22]

4.1 Tax rates

Consistent with theoretical models of tax competition that focus on source taxes, the empirical literature on international tax competition has generally focused on the corporate income tax and relied on the Effective Average Tax Rate (EATR) which accounts for tax allowances differing across countries (see Devereux and Griffith, 1998). Adam et al. (2013) note that studies based on implicit tax rates (e.g. corporate income tax revenues divided by GDP or gross operating surplus) tend to find a positive relationship with globalization, but they are plagued with endogeneity problems.

We use EATRs from the 2018 update of the Oxford University Centre for Business Taxation Tax Database developed by Bilicka and Devereux (2012). The EATR is calculated as the ratio of post-tax to pre-tax net present value of a composite investment yielding a 20% pre-tax return financed through a combination of debt, equity and auto-financing.

As for the taxation of labor, we use the average tax wedge for a single individual with no children, and earning a gross income representing 167% of average earnings. The tax wedge includes both the income tax and social security contributions paid, and therefore offers a more complete picture of labour taxation than the statutory personal income tax rate. We choose to work on the tax rate applied on relatively high wages because labor mobility concerns mainly skilled labor across OECD countries. In the robustness checks section, we also study the determinants of the tax wedge at the median wage and at the minimum wage. The data are taken from the comparative tables of the OECD taxing wages database.

[22] The list of variables and of data sources is provided in Appendix C.

4.2 Measures of factor mobility

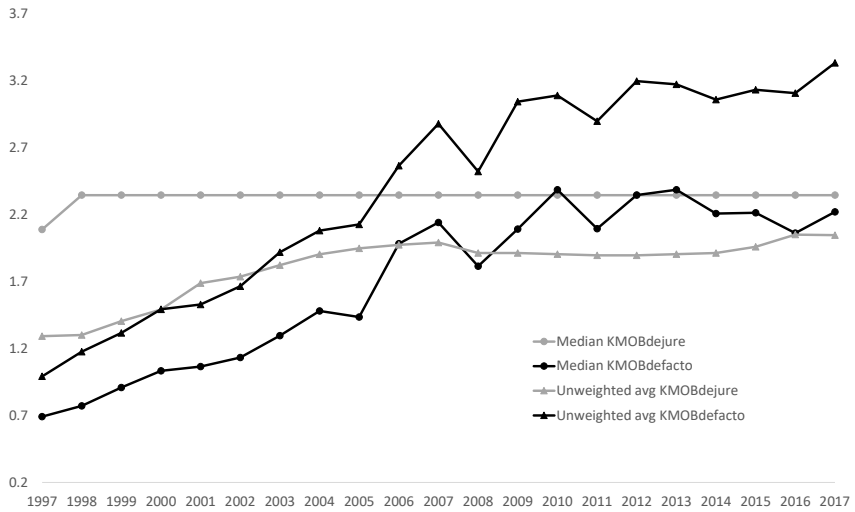
In their meta-analysis, Adam et al. (2013) highlight the importance of how globalization is measured for the estimation of its impact on capital taxation. Some studies have used trade openness or broader measures of globalization that also cover political and social aspects (Dreher, 2006). Other studies have focused specifically on international capital mobility. In the latter case, two categories of measures have been used: *de jure* (based on existing restrictions to capital flows as reported by the International Monetary Fund), or *de facto* (based on actual cross-border capital flows or stocks).

Figure 8 compares the evolution of *de jure* and *de facto* capital mobility for our sample of 29 OECD countries over 1997-2017. The *de jure* measure is the index constructed by Chinn and Ito (2006), and regularly updated, based on the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions. For *de facto* capital mobility, we calculate the sum of total assets and total liabilities of the international investment position position (International Monetary Fund database) and divide by GDP in current dollar (World Bank database). The graph shows that, on average, our countries reach high *de jure* mobility very soon in our time sample, so the median and average of the *de jure* measure are almost flat. In contrast, the *de facto* measure shows a clear upward trend that only stabilizes after the global financial crisis. Since we intend to estimate the model in the within dimension, we select the *de facto* measure (denoted by KMOB), which offers the additional advantage of being more consistent with our measure of labor mobility, which is also *de facto* (see *infra*).

For labor mobility, there is no available *de jure* measure. The Migrant Integration Policy Index (MIPEX) developed by Huddleston et al. (2015) is a notable exception. Unfortunately, the index covers only a few years for a limited number of OECD countries. Hence, we have to rely on a *de facto* measure based on international migrations. Since bilateral data on international migrations is scanted, and absent a reliable source for population outflows, we have to rely on the yearly inflows of foreign population in percent of the total population of the home country, as reported by the OECD International Migration Database.[23]

[23]For a subset of 10 countries, there is consistent reporting of bilateral inflows over the whole time sample. For this subset, the correlation between total inflows and inflows from other OECD countries

Figure 8: *De jure* and *de facto* capital mobility: unweighted averages, 29 OECD countries



Note: Country sample: see Figure 1.
Source: Chinn and Ito (2006) and International Monetary Fund databases.

The problem with using a unidirectional measure of labor mobility is potential endogeneity, since foreign labor may be attracted by lower tax rates. We address this problem by incorporating country fixed effects in the estimations and by instrumenting labor mobility with its first too lags.[24]

4.3 Control variables

Our first control variable is trade openness, denoted by TRADE, which is the sum of exports and imports of goods and services divided by twice the GDP, all variables being defined in current US dollar (OECD and World Bank databases). The square of TRADE is also introduced in order to capture a possible non-linear impact of trade openness, consistent with the economic geography literature (Baldwin et al, 2003).

In advanced economies, financial integration has been concommittant to population

varies from 74% (Norway) to 97% (Spain). Hence, total inflows can be considered as a good proxy of inflows from other OECD countries.

[24] Clemens and Hunt (2017) argue that lagging the migrant-to-population ratio leads to a "blunt instrument" problem because the denominator of this ratio (total population) is almost constant from one year to the next. This generates spurious correlation between labor mobility and its lagged value. They rather recommend to use the lagged value of the numerator (migrations) as an instrument. In our case, though, instrumenting labor mobility with inward migrations leads to a weak instrument problem.

ageing, which, as highlighted in our theoretical section, may affect capital and labor taxation is an ambiguous way. We control for the share of the population aged 65 and more in total population (65+ variable) using data from OECD population statistics.[25]

In order to account for a possible "compensation effect" of globalization whereby home workers would ask for more public spending in order to insure their income (Rodrik, 1998), we control for general government spending in percent of GDP, GOVSPEND (IMF World Economic Outlook database).[26] We also include the debt-to-GDP ratio, GOVDEBT, in order to capture a debt brake effect, based on OECD and on national data sources. Both government spending and government debt are lagged in order to control for possible reverse causality.

4.4 Factor endowments

Whether a country is a net capital importer or exporter can be observed through its net position in terms of Foreign Direct Investment - FDI (the difference between FDI assets and liabilities, hence a positive figure for a net capital exporter). The data is from the International Monetary Fund.[27] Because net FDI may be endogenous to taxation, we use the net stock in percent of GDP in the first year of the sample, hence at end-1997, and keep the same fixed proxy for the subsequent years. The variable is labelled FDI97. It is positive for a net capital exporting country.

Table 2 reports the list of countries considered as capital exporters or importers according to the sign of FDI97. There are 13 capital exporters and 16 capital importers. Unsurprisingly, the most advanced economies are mostly in the former group.

In the estimations, we either interact capital mobility with FDI97 directly, or we interact it with a dummy variable Kexp that is equal to unity in case FDI97 is positive. The latter strategy allows for a direct interpretation of the coefficient obtained.

Hays (2003) rather rely on the level of capital per worker in a remote year as a proxy for the capital endowment. Consistently, we also use the stock of capital per worker in

[25] We also tried political variables such as a right-wing executive or the share of seats in Parliament held by the government party. These variables did not show up significant.

[26] Adam et al. (2013) show that including a measure of government spending in the regression significantly reduces the coefficient on globalization. Hence it is especially important to control for government spending.

[27] Alternatively, we could use the overall net foreign asset position, but the latter includes sovereign assets and liabilities that do not fit our theoretical model which assumes budget balance.

Table 2: Capital exporters and importers

Net capital exporters (FDI97> 0)	Germany, Denmark, Finland, France, UK, Iceland, Italy, Japan, the Netherlands, Norway, Sweden, Switzerland, USA
Net capital importers (FDI97< 0)	Australia, Austria, Belgium, Canada, Chile, Czech Rep., Spain, Hungary, Ireland, Israel, Korea, Mexico, Poland, Portugal, Slovakia, Slovenia

Source: own calculations.

1990, labelled k90 (Penn World Tables).[28] A country with relatively high capital per worker in 1990 is likely to export capital in subsequent years.

For labor endowments, we rely the 5-year average estimate of *net* migrations between 1983 and 1987 divided by total population in 1990 (based on United Nations data).[29] We use a dummy variable Lexp that is equal to unity when past net migrations are negative (more outflows than inflows, suggesting high labor endowments).[30]

4.5 Summary statistics

Our sample includes 29 OECD countries from 1997 to 2017. However, some variables are missing at the beginning and/or at the end of the period for some countries. Table 3 provides an overview of the sample. The maximum number of observations ($29 \times 21 = 609$) is obtained only for three variables. However, the sample is close to being balanced, with a minimum of 588 observations for the corporate income tax. The bottom of the table reports the statistics for those variables that are constant over time: capital per worker in 1990 (k90), the net FDI position in 1997 (FDI97) and the labor exporter dummy (Lexp). Our sample is well distributed around zero FDI position whereas more countries are net labor importers than net labor exporters.[31]

[28] The data is not available for some of our countries before 1990.

[29] The net inflows are generally calculated based on successive censuses, without disentangling inflows from outflows. Hence unfortunately UN data cannot be used to measure labor mobility which would require data on gross flows rather than the balance between the two.

[30] We also used the ratio of workers to total population in 1990 (from the Penn World Tables) as a proxy for labor endowments, but the results were non-significant.

[31] The labor exporters in our sample are the following: Chile, Spain, Hungary, Ireland, Italy, Japan, Mexico, Poland, Portugal, Slovakia, hence 11 countries out of 29.

Table 3: Summary statistics: 29 OECD countries, 1997-2017

Variable	Obs	Mean	Std. Dev.	Min	Max
KTAX	588	.2452568	.0681861	.086295	.476933
LTAX	594	.4112591	.1151811	.074952	.6261567
TRADE	609	.422904	.1943722	.0920932	1.128186
KMOB	609	2.396152	2.819328	.2786209	19.78285
LMOB	589	.0063036	.0049536	.0000436	.03424
GOVSPEND	602	.4191572	.0934996	.14192	.65052
GOVDEBT	608	.6817297	.3699242	.03900	2.228252
65+	609	.1495787	.0371776	.04678	.27743
k90	29	.2081211	.0842571	.0536248	.336016
FDI97	29	-.0169953	.1400568	-.3580411	.3183823
Lexp	29	.3448276	.4837253	0	1

Source: Authors' database.

5 Econometric results

5.1 Preliminary estimates

As a preliminary exercise, we regress capital and labor tax rates on trade openness (TRADE), squared trade openness (TRADE2), capital mobility (KMOB), labor mobility (LMOB), and on a set of control variables: lagged government spending (L.GOVSPEND), lagged government debt (L.GOVDEBT) and the old dependency ratio (65+). Country and time fixed effects are also included, and the standard errors are robust to heteroskedasticity. The results are reported in Table 4. Columns (1)-(2) are for capital taxation, while (3)-(4) correspond to the labor tax. In each case, we successively perform the estimations without and with instrumentation of labor mobility. In the latter case, the Hansen-J tests suggest that the instruments are valid. In turn, the Kleibergen-Paap rk LM tests reject the nul of underidentification: the instuments are correlated to labor mobility. Finally, the Kleibergen-Paap rk Wald F largely exceeds the value of 10 that is usually considered as the adequate threshold to reject the nul hypothesis of weak instruments. The results with instrumented labor mobility are similar to those without but the coefficients display higher level of significance. In the following, labor mobility will always be instrumented.

As expected, lagged government spending and lagged government debt both have a positive impact on taxation: for a given country, a rise in government spending (or government debt) compared to country and time averages puts upward pressure on both

the corporate income tax and the labor tax wedge. Furthermore, a higher share of the population aged 65+ has opposite effects on capital and on labor taxation, with significant burden shifting from the former to the latter. Finally, capital mobility affects both tax rates negatively, whereas labor mobility has a positive impact on capital taxation and a negative, although non-significant impact on labor taxation.

Comparing Columns (2) and (4), we see that a 1 pp increase in government spending involves and increase in both tax rates by approximately the same amount (0.1 pp). Similarly, a 1 pp increase in government debt raises taxes by 0.04-0.06 pp.[32] In contrast, a 1 pp increase in the old dependency ratio reduces the capital tax by 1.1 pp while increasing the labor tax by 0.3 pp.

As shown in Table 3, the standard deviation of capital mobility (2.82) is much higher than that of labor mobility (0.005). Hence, we need to be cautious when comparing the coefficients on both variables. According to Table 4, an increase in capital mobility by 1 standard deviation reduces both tax rates by around $2.8 \times 0.002 = 0.06$, hence 6 pp. In turn, an increase in labor mobility by 1 standard deviation increases the capital tax by $0.005 \times 1.8 = 0.009$, hence 0.9 pp.

Trade openness is found to affect both tax rates negatively, but its impact declines for higher openness ratios and it becomes even positive in the case of capital taxation when trade openness exceeds 85% (according to Column (2)). This result is consistent with the economic geography literature: for low levels of openness (hence high transaction costs), production needs to be located close to the demand. Then, when the economy opens up, multinational firms start taking relative costs into account when locating their production, which puts downward pressure on taxation. However, for high levels of openness (hence low transaction costs), agglomeration forces become prominent and production becomes less sensitive to relative costs.

5.2 The impact of factor endowments

We now study whether the reaction of tax rates to factor mobility depends on factor endowments. To do so, we interact capital mobility sucessively with three measures of international capital status: capital per worker in 1990 (k90), a dummy for a positive net

[32] In both cases, though, the impact on the capital tax is slightly lower than that on the labor tax.

Table 4: Preliminary results

	KTAX		LTAX	
	(1)	(2)	(3)	(4)
		IV		IV
TRADE	-0.231	-0.147*	-0.160	-0.103**
	(0.189)	(0.0809)	(0.120)	(0.0498)
TRADE2	0.236*	0.177***	0.103	0.0660*
	(0.132)	(0.0573)	(0.101)	(0.0400)
KMOB	-0.00270	-0.00217*	-0.00188	-0.00212**
	(0.00318)	(0.00127)	(0.00169)	(0.000894)
LMOB	1.559**	1.789***	0.186	-0.282
	(0.582)	(0.490)	(0.419)	(0.401)
L.GOVSPEND	0.0786	0.0947**	0.155**	0.154***
	(0.0799)	(0.0378)	(0.0594)	(0.0387)
L.GOVDEBT	0.0357**	0.0412***	0.0626***	0.0590***
	(0.0166)	(0.00821)	(0.0164)	(0.00667)
65+	-1.122**	-1.139***	0.435	0.322**
	(0.416)	(0.180)	(0.266)	(0.128)
Observations	564	534	572	542
R-squared	0.531	0.522	0.368	0.367
Number of countries	29	29	29	29
Country FE	yes	yes	yes	yes
Time FE	yes	yes	yes	yes
Hansen J		2.042		3.611*
K-Paap rk LM		47.889***		49.308***
K-Paap rk Wald F		48.046		49.825

Notes: Dependent variable: EATR (columns (1)-(2)); tax wedge on high labor income (columns (3)-(4)). Estimation period: 1997-2017. Robust std errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Columns (2) and (4): LMOB is instrumented by its first two lags.

FDI position in 1997 (Kexp), and the net FDI position in 1997 (FDI97). We also interact labor mobility with a dummy for net labor exporter status, Lexp. In all the regressions, labor mobility is instrumented in the same way as in the previous subsection. Country and time fixed effects are also introduced, and the reported standard errors are corrected for heteroscedasticity.

The results are reported in Table 5. Columns (1) to (4) refer to capital taxation while columns (5) to (8) concern labor taxation.[33] Like in the preliminary estimations, lagged government spending and lagged government debt have a positive and significant impact on both tax rates, whereas the proportion of the 65+ has opposite effect on capital and labor taxation (burden shifting). We also find similar, non-linear effect of trade openness as in the preliminary estimations, although the coefficient is not always significant.

Turning to our variables of interest, the interaction of capital mobility with any of measure of capital endowments (k1990, Kexp and FDI97) has negative, significant impact on the corporate income tax and positive, although not always significant effect on the labor tax. When significant, the non-interacted coefficient on capital mobility is of opposite sign compared to the interacted one. It can be concluded that, for net capital importers, capital mobility exerts positive pressure on capital taxation and negative pressure on labor taxation. For capital exporters, the net effect of capital mobility on the corporate income tax is ambiguous and may be negative (see quantification in Section 5.3). As for labor mobility, it affects capital taxation positively, with no significant effect on labor taxation. Column (4) suggests that the positive impact of labor mobility on capital taxation is more marked for a labor exporting country. However the level of significance is only 10% and the Kleibergen-Paap rk Wald F statistics suggests weak instruments.

Figure 3 in the introduction shows a positive relationship between the net FDI position in 1997 and the corporate income tax in 1997. The relationship is still positive but flatter in 2003 and it vanishes in 2017. In Table 5, Columns (3)-(4), the coefficient on the interaction between capital mobility and the FDI in 1997 (KMOB*FDI97) is -0.03. This means that the same increase in capital mobility has negative impact on the corporate income tax when the initial FDI position is positive, and positive impact in the opposite

[33] The instrumentation strategy is validated by the different tests, although less so for labor taxation especially in Column (7) where the null of valid instruments is rejected at 5%.

case. Between 2003 and 2017, the rise in the unweighted average of capital mobility has been of 1.4. According to our results, such rise would have negligible impact on the capital tax for a country with initial FDI position close to balance (e.g. Austria, Iceland). For a country with a positive FDI position of 14% in 1997 (Sweden), the impact of a 1.4 increase in capital mobility on the capital tax is $-0.03 \times 0.14 \times 1.4 = -0.006$, hence -0.6 pp. For a country with an initial net FDI position of -14% (Mexico), the impact of the same increase in capital mobility on the tax rate is $+0.6$ pp. Hence, our results are consistent with the flattening of the curve on Figure 3. However, the orders or magnitude are limited. In the next section, we compare the contribution of capital mobility to those of the other cariables to the observed evolutions of the different tax rates.

Table 5: Impact of factor mobility on capital and labor taxation: factor endowments

	KTAX				LTAX			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TRADE	-0.160**	-0.0590	-0.0445	-0.0550	-0.0886*	-0.109**	-0.186***	-0.194***
	(0.0805)	(0.0832)	(0.0828)	(0.0826)	(0.0486)	(0.0517)	(0.0519)	(0.0518)
TRADE2	0.170***	0.0995*	0.0836	0.0985	0.0706*	0.0704*	0.140***	0.149***
	(0.0561)	(0.0600)	(0.0598)	(0.0604)	(0.0378)	(0.0428)	(0.0411)	(0.0414)
KMOB	0.0267***	0.00116	0.000148	-0.000407	-0.0354***	-0.00239**	-0.00398***	-0.00430***
	(0.00848)	(0.00120)	(0.00110)	(0.00110)	(0.00680)	(0.00116)	(0.000913)	(0.000960)
KMOB*k90	-0.102***				0.118***			
	(0.0286)				(0.0242)			
KMOB*Kexp		-0.00664***				0.000604		
		(0.00138)				(0.00145)		
KMOB*FDI97			-0.0345***	-0.0307***			0.0290***	0.0313***
			(0.00586)	(0.00602)			(0.00724)	(0.00742)
LMOB	1.572***	1.727***	1.570***	1.037*	-0.0587	-0.282	-0.0949	-0.414
	(0.526)	(0.475)	(0.483)	(0.553)	(0.358)	(0.407)	(0.397)	(0.439)
LMOB*Lexp				1.995**				1.197
				(0.813)				(0.740)
L.GOVSPEND	0.0948**	0.0903**	0.0800**	0.0911**	0.151***	0.154***	0.166***	0.173***
	(0.0406)	(0.0383)	(0.0387)	(0.0396)	(0.0358)	(0.0390)	(0.0391)	(0.0392)
L.GOVDEBT	0.0329***	0.0326***	0.0272***	0.0297***	0.0685***	0.0599***	0.0705***	0.0721***
	(0.00834)	(0.00848)	(0.00850)	(0.00853)	(0.00673)	(0.00685)	(0.00688)	(0.00704)
65+	-1.160***	-1.023***	-0.973***	-1.024***	0.343***	0.306**	0.177	0.148
	(0.181)	(0.183)	(0.184)	(0.187)	(0.129)	(0.129)	(0.127)	(0.128)
Observations	534	534	534	534	540	540	540	540
R-squared	0.542	0.538	0.546	0.550	0.427	0.367	0.403	0.403
N of countries	29	29	29	29	29	29	29	29
Hansen J	0.732	2.805*	1.567	5.354*	7.546*	3.514*	4.167**	9.259*
K-Paap rk LM	46.140***	48.381***	16.011***	20.832***	48.040***	49.738***	49.748***	20.411***
K-Paap rk WaldF	49.149	48.298	47.733	8.356	51.401	50.027	49.393	8.407

Notes: Dependent variable: EATR (columns (1) to (4)); tax wedge on high labor income (columns (5) to (8)).
Estimation period: 1997-2017. All columns include country and time fixed effects. LMOB instrumented by its first two lags .
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5.3 Quantification

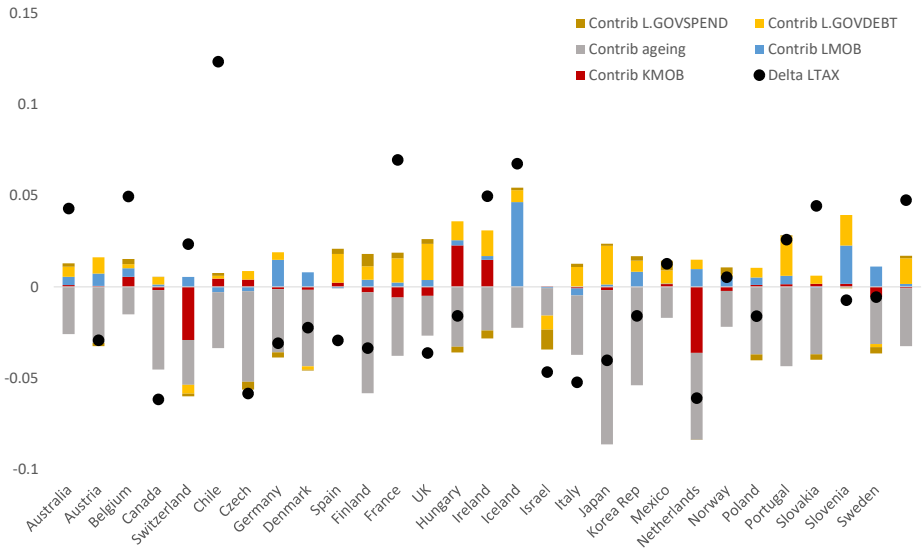
Based on our preferred specifications of Table 5, namely Columns (3) and (7), we can calculate the contribution of each significant variable to the variation of both tax rates between 2003 (first year with complete dataset) and 2017. The results are presented in Figures 9 and 10. The dots represent the variations of each country's tax between 2003 and 2017 relative to the unweighted sample average.[34] In turn, the cumulative bars represent the contributions of the different variables, when they are significant.

Except for some countries (Switzerland, Hungary, Ireland, the Netherlands), the contribution of rising capital mobility to the variation of the corporate income tax (relative to the OECD sample) is negligible. It is negative for Switzerland and the Netherlands, but positive for Hungary and Ireland (these two countries being net capital importers). The contribution of labor mobility is generally positive, sometimes larger (in absolute value) than that of capital mobility, but still relatively limited exept in Iceland and Slovakia. In fact, changes in the corporate income tax rate between 2003 and 2017 seem to be mostly driven by the growing share of the 65+ in the population.

In the case of the labor tax, labor mobility does not appear in the graph since it is not significant in Column (7) of Table 5. Rising capital mobility contributes negatively to the change in the labor tax in Ireland and in Hungary, and positively in Switzerland. In the other countries the effect is minor compared to the contribution of rising government debt and, for some countries, the impact of trade opening up.

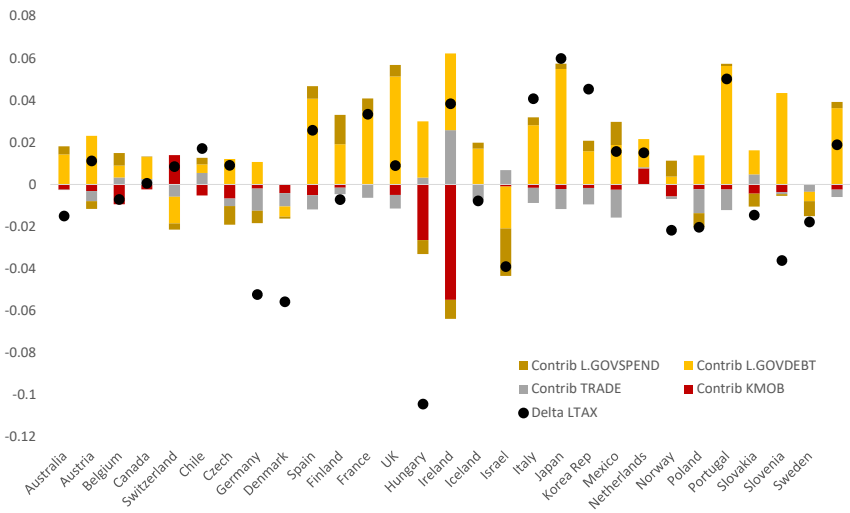
[34] Remember that the estimations are carried out with time fixed effects.

Figure 9: Contributions to changes in capital taxation, 2003-2017



Source: Own calculations based on Table 5, Column (3) .

Figure 10: Contributions to changes in labor taxation, 2003-2017



Source: Own calculations based on Table 5, Column (7) .

6 Robustness

In this section, four robustness tests are presented, successively. First, we check whether our results are robust to excluding some specific countries. Second, we estimate a dynamic specification. Third, we perform similar estimations for labor taxation at lower levels of income and for the value-added tax. Finally, we check whether interacting the old dependency ratio with the international capital status (as suggested by our theoretical estimation) does not affect our results.

6.1 Excluding some countries

We first test whether our results are robust to excluding some countries from the sample. More specifically, we successively remove the following groups of countries:

- Potential tax havens, where our theoretical model may not apply due to a gap between the corporate tax base and the stock of physical capital: Ireland, the Netherlands, Switzerland;
- Countries with citizenship taxation, where our theoretical model may not apply due to a gap between the personal income tax base and the resident population: Hungary, United States.

The results are reported in Table 6. We only report the estimations carried out with the net FDI position in 1997 as a proxy for capital exporting/importing status, and without interacting labor mobility with a measure of labor exporting/importing status. The non-linear impact of capital mobility on both tax rates depending on the net FDI position is confirmed, and capital mobility has opposite signs on the two tax rates. As for labor mobility, it still affects capital taxation positively, without any significant impact on labor taxation.[35]

6.2 Dynamic model

In our theoretical model, imperfect factor mobility translates into wedges between domestic after-tax returns and their world levels. The wedge declines following an increase in factor

[35] However the Hansen J test casts some doubt on the instrumentation in the case of labor taxation.

Table 6: Excluding some countries

	KTAX		LTAX	
	w/o CHE, IRL, NDL	w/o HUN, USA	w/o CHE, IRL, NDL	w/o HUN, USA
	(1)	(2)	(3)	(4)
TRADE	-0.158*	-0.0424	-0.0973	-0.220***
	(0.0943)	(0.0832)	(0.0625)	(0.0441)
TRADE2	0.179**	0.0752	0.0601	0.178***
	(0.0745)	(0.0608)	(0.0528)	(0.0333)
KMOB	-0.00193	0.000230	-0.00972***	-0.00420***
	(0.00250)	(0.00119)	(0.00178)	(0.000832)
KMOB*FDI97	-0.0395***	-0.0265***	0.0330*	0.0174***
	(0.0134)	(0.00645)	(0.0170)	(0.00580)
LMOB	1.610***	1.611***	-0.0126	-0.0891
	(0.505)	(0.475)	(0.380)	(0.386)
L.GOVSPEND	0.106**	0.0842**	0.225***	0.147***
	(0.0496)	(0.0394)	(0.0445)	(0.0361)
L.GOVDEBT	0.0422***	0.0251***	0.0660***	0.0729***
	(0.00955)	(0.00865)	(0.00796)	(0.00670)
65+	-0.931***	-0.962***	0.142	0.180
	(0.182)	(0.188)	(0.121)	(0.125)
Observations	474	498	484	506
R-squared	0.534	0.563	0.446	0.463
N. of countries	26	27	26	27
Hansen J	0.443	2.071	4.184**	4.865**
K-Paap rk LM	33.972***	48.494***	35.886***	49.909***
K-Paap rk WaldF	37.408	48.298	39.657	50.052

Notes: Dependent variable: EATR (col. (1)-(2)); tax wedge on high labor income (col. (3)-(4)). Estimation period: 1997-2017. All columns include country and time fixed effects. LMOB instrumented. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

mobility. Hence, after-tax returns should converge over time to the world level when capital and/or labor mobility increases. Consistently, countries starting with higher tax rates on capital at the beginning of the sample period should see their rate decline more rapidly, especially when they are net capital exporters.

In order to test for conditional convergence, we estimate the following dynamic model:

$$\Delta TAX_{it} = \rho TAX_{it-1} + \beta X_{it} + FE_i + FE_t + u_{it}, \tag{22}$$

where TAX stands for either the capital or the labor tax, Δ is the first-difference operator, X_{it} is the vector of control variables and FE_i, FE_t are the country and time fixed effects. We expect $\rho < 0$, meaning that higher tax rates tend to decline faster over time. Equation (22) can be estimated as an auto-regressive equation (estimating $1 + \rho$ instead of ρ). To avoid the bias arising from the correlation between the lagged dependent variable and the fixed effect (Nickell, 1981), Equation (22) could estimated through a GMM panel. However, the extent of the Nickell bias depends on T (number of time periods) relative to N (number of individuals, here countries). In our case, we have a relatively large T (T=21) but a small N (N=29). Estimating Equation (22) through system GMM[36] involves a "proliferation of instruments", even when we keep the number as small as possible and use the orthogonal deviation methodology in order not to lose too many observations due to the lags. This proliferation can be observed through the perfect 1.000 p-value obtained for the Hansen-J test of overidentification. The problem could be solved by dropping the time fixed effects. However, doing so would likely invalidate the autocorrelation tests that rely on the assumption of no correlation across countries.

Hence, we finally decided to run the estimations through panel fixed effects, acknowledging the likely underestimation of the auto-regressive coefficient. The results are reported in Table 7. Columns (1)-(4) concern the capital tax whereas (4)-(8) are for the labor tax. In all cases, the lagged dependent variable is positive, significant and lower than unity. With an autoregressive coefficient of 0.7 to 0.8, the half-life of the adjustment is of 2-3 years, although this is a lower bound due to the possible estimation bias.[37].

The impact of capital mobility is found significantly negative when interacted with the

[36] System GMM is to be preferred to difference GMM when the variables are persistent.
[37] The half-life is $H = \frac{-ln2}{ln(1+\rho)}$), where $(1 + \rho)$ is the auto-regressive coefficient.

net FDI position in 1997: only in net capital exporting countries does capital mobility accelerate the downward convergence of the capital tax. For the labor tax equation, we get similar convergence speed but with no significant effect of factor mobility.

On the whole, despite the very demanding specification that features an auto-regressive term together with both country and time fixed effects, we find some evidence confirming that capital mobility puts more pressure on the corporate income tax in capital exporting countries than in capital importing ones.

Table 7: Dynamic panel estimation

VARIABLES	KTAX			LTAX		
	(1)	(2)	(3)	(4)	(5)	(6)
L.KTAX	0.767***	0.757***	0.763***			
	(0.0431)	(0.0447)	(0.0452)			
L.LTAX				0.754***	0.743***	0.746***
				(0.0555)	(0.0545)	(0.0538)
TRADE	-0.00219	0.0168		-0.00160	-0.0204	
	(0.0395)	(0.0425)		(0.0309)	(0.0318)	
TRADE2	0.0324	0.0153		-0.00103	0.0155	
	(0.0302)	(0.0328)		(0.0232)	(0.0258)	
LMOB	0.523*	0.502*	0.347	-0.316	-0.277	-0.301
	(0.306)	(0.303)	(0.297)	(0.231)	(0.231)	(0.217)
KMOB	-0.000928	-0.000499	0.000202	-8.03e-05	-0.000501	-0.000318
	(0.000676)	(0.000711)	(0.000401)	(0.000824)	(0.000787)	(0.000691)
KMOB*FDI97		-0.00735*	-0.00914**		0.00600	0.00525
		(0.00401)	(0.00379)		(0.00587)	(0.00520)
L.GOVSPEND	0.00207	0.000493	-0.0121	0.0778***	0.0814***	0.0795***
	(0.0230)	(0.0232)	(0.0212)	(0.0216)	(0.0222)	(0.0207)
L.GOVDEBT	0.00960*	0.00725	0.00753	0.00683	0.00997*	0.00901*
	(0.00504)	(0.00499)	(0.00517)	(0.00606)	(0.00536)	(0.00494)
65+	-0.234*	-0.212*	-0.180	-0.0192	-0.0432	-0.0482
	(0.120)	(0.120)	(0.117)	(0.0864)	(0.0805)	(0.0802)
Observations	529	529	529	540	540	540
R-squared	0.828	0.829	0.826	0.760	0.761	0.761
N. of countries	29	29	29	29	29	29
Hansen J	0.891	0.819	0.680	5.094**	5.363**	5.024**
Kleibergen-Paap rk LM	47.135***	47.489***	46.912***	48.974***	49.424***	48.847***
Kleibergen-Paap rk Wald F	46.173	46.180	50.717	49.640	49.033	53.743

Notes: Dependent variable: EATR (col. (1)-(3)); tax wedge on high labor income (col. (4)-(6)). Estimation period: 1997-2017. All columns include country and time fixed effects. LMOB instrumented. Robust std errors in parentheses.*** p<0.01, ** p<0.05, * p<0.1.

6.3 Other taxes

Our third exercise is to test for the impact of capital and labor mobility on the standard rate of the value-added tax (VAT) or of the general sales tax, and on the tax wedge at lower levels of labor income: median wage (LTAX med), minimum wage (LTAX min). The results are presented in Table 8.[38]

Capital mobility is found to put upward pressure on the VAT especially in capital exporting countries. It has no significant impact on the tax wedge at the median wage, and a negative effect on the tax wedge at the minimum wage. While the result for VAT is consistent with burden shifting on to an immobile tax base, in the case of the tax wedge at the minimum wage, the result may come from an indirect channel related to low-skilled workers obtaining a more protective social safety net when globalization makes their income more uncertain (Rodrik, 1998).

In turn, labor mobility has no significant impact except for the tax wedge at the minimum wage. In this case, though, the Hansen J test rejects the validity of the instrumentation. We can conclude that labor mobility has no robust impact on the three tax rates.

6.4 Inspecting ageing

Our final exercise consists in interacting the old dependency ratio with the international capital status of the country. Based on our theoretical simulations (Section 3), we expect net capital exporters to react more to ageing especially when ageing is not just a demographic change but also a change in political balance. We replicate our baseline estimations but now interact the old dependency ratio with the net FDI position in 1997 (dummy and level, successively). The results are reported in Table 9. The results for the non-interacted old dependency ratio are kept unchanged. Once interacted with the international capital status, the dependency ratio has no significant impact, except in the last column where the coefficient is significantly positive: in capital exporting countries, ageing tends to put upward presure on the labor tax. This result is consistent with our theoretical simulations if ageing is not considered as a pure demographic trend but also

[38] The estimation is still run for 29 countries. However, due to data limitations, we had to substitute Turkey for Chile.

Table 8: Impact of factor mobility on VAT and labor taxation of low wages

	VAT		LTAX med		LTAX min	
	(1)	(2)	(3)	(4)	(5)	(6)
TRADE	0.0143	0.0118	0.0607	0.0200	-0.0925	-0.0900
	(0.0289)	(0.0294)	(0.0550)	(0.0536)	(0.0596)	(0.0584)
TRADE2	-0.0445**	-0.0422*	-0.0219	0.0134	0.0912*	0.0883*
	(0.0218)	(0.0221)	(0.0432)	(0.0409)	(0.0474)	(0.0461)
KMOB	0.00144***	0.00164***	-0.000299	-0.00152*	-0.00637***	-0.00677***
	(0.000506)	(0.000490)	(0.00123)	(0.000906)	(0.00189)	(0.00146)
KMOB*Kexp	0.00115**		-0.00105		-0.00218	
	(0.000549)		(0.00147)		(0.00192)	
KMOB*FDI97		0.00587*		0.0102		-0.0106
		(0.00334)		(0.00630)		(0.00744)
LMOB	-0.236	-0.212	-0.0507	-0.00976	0.931**	0.882**
	(0.196)	(0.200)	(0.340)	(0.339)	(0.431)	(0.423)
L.GOVSPEND	-0.0281	-0.0261	0.139***	0.142***	0.161***	0.158***
	(0.0178)	(0.0179)	(0.0384)	(0.0382)	(0.0407)	(0.0406)
L.GOVDEBT	0.0288***	0.0296***	0.0325***	0.0379***	0.0597***	0.0583***
	(0.00360)	(0.00384)	(0.00623)	(0.00624)	(0.00820)	(0.00823)
65+	0.0480	0.0424	0.256**	0.189	0.112	0.125
	(0.0727)	(0.0746)	(0.121)	(0.123)	(0.156)	(0.155)
Observations	526	526	504	504	540	540
R-squared	0.407	0.409	0.296	0.300	0.364	0.365
N. of countries	29	29	29	29	29	29
Hansen J	1.587	1.293	1.282	1.434	6.983***	6.413**
Kleibergen-Paap rk LM	48.995***	48.974***	44.491***	45.073***	49.738***	49.748
Kleibergen-Paap rk WaldF	49.040	48.440	44.029	44.239	50.027	49.393

Notes: Dependent variable: standard VAT rate (Col. (1)-(2)); tax wedge at median wage (col. (3)-(4)); tax wedge at minimum wage (col. (5)-(6)). Estimation period: 1997-2017. Chile excluded, Turkey included. All columns include country and time fixed effects. LMOB instrumented. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

as a change in social preferences. The results for capital mobility, labor mobility and the other control variables are kept unchanged.

Table 9: Ageing in capital exporting countries

	KTAX		LTAX	
	(1)	(2)	(3)	(4)
TRADE	-0.0556	-0.0434	-0.112**	-0.190***
	(0.0821)	(0.0812)	(0.0510)	(0.0509)
TRADE2	0.0897	0.0762	0.0762*	0.151***
	(0.0587)	(0.0585)	(0.0416)	(0.0394)
KMOB	0.00134	0.000598	-0.00250**	-0.00465***
	(0.00120)	(0.00115)	(0.00115)	(0.000906)
KMOB*Kexp	-0.00619***		0.000349	
	(0.00140)		(0.00151)	
KMOB*FDI97		-0.0251***		0.0164**
		(0.00725)		(0.00745)
LMOB	1.767***	1.682***	-0.304	-0.227
	(0.481)	(0.494)	(0.406)	(0.389)
L.GOVSPEND	0.0923**	0.0824**	0.153***	0.165***
	(0.0388)	(0.0389)	(0.0391)	(0.0392)
L.GOVDEBT	0.0309***	0.0256***	0.0610***	0.0731***
	(0.00898)	(0.00868)	(0.00674)	(0.00705)
65+	-0.791***	-0.884***	0.172	0.0541
	(0.290)	(0.196)	(0.184)	(0.135)
65+*Kexp	-0.214		0.124	
	(0.214)		(0.151)	
65+*FDI97		-1.595		2.201**
		(1.096)		(0.904)
Observations	534	534	540	540
R-squared	0.539	0.550	0.368	0.421
N. of countries	29	29	29	29
Hansen J	2.959*	2.012	3.346*	3.199*
K-Paap rk LM	48.710***	47.844***	50.175***	49.488***
K-Paap rk WaldF	48.239	46.621	50.146	48.696

Notes: Dependent variable: EATR (col. (1)-(2)); tax wedge on high wages (col. (3)-(4)). Estimation period: 1997-2017.
All columns include country and time fixed effects. LMOB instrumented.
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

7 Conclusion

By relaxing the assumptions of perfect capital mobility and perfect labor immobility, we have shown theoretically that financial globalization does not necessarily lead to a race-to-the-bottom of capital tax rates, whereas labor mobility does matter for both capital and labor taxation. More specifically, both our simplified model and the simulations of our complete model show that only a net capital exporting country will feel a sharp downward pressure on its (source) capital tax rate and a pressure to shift the burden on to labor

when capital mobility increases. Net capital exporters are also more sensitive to changes in labor mobility.

Our theoretical results are supported by the econometric estimations run on a panel of 29 OECD countries over 1997-2017. We find evidence that capital mobility has a negative impact on capital taxation and a positive impact on labor taxation, but only for net capital exporting countries. Conversely, we find that rising labor mobility increases capital taxation with no robust impact on labor taxation. However the ageing of the population is found to have much more sizeable impact on capital taxation than either capital or labor mobility.

We conclude that the mixed results obtained in the literature concerning the link between international capital mobility and capital taxation may be related to improperly controlling for other factors, notably ageing, failing to account for labor mobility, and especially to the extreme assumption of full capital mobility versus full labor immobility.

This paper may be extended in various ways. In particular, the game between countries could be studied through reaction functions. Additionally, the development of immaterial capital has offered new possibilities of tax optimization, with increased pressure on tax rates; and new technologies may offer new opportunities for households to live and work in different places. Different scenarios of (partial) tax cooperation could also be studied. Finally, it would be interesting to extend the model to incorporate endogenous savings in a dynamic setting following the tradition of optimal taxation models of Judd (1985) and Chamley (1986). These developments are left for future research.

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Appendix A: Derivation of the theoretical model

Using the fact that $k := K/(L+D)$, and equations (1), the government's optimization problem can be written as:

$$\max_{\tau_K,\tau_L} U\left(\frac{L}{L+D}y_L + \frac{\gamma D}{L+D}y_D, \frac{G}{L+D}\right)$$
$$s.t. \left|\begin{array}{l} y_L = \left|\begin{array}{l} \left[F'_K\left(k, h\frac{L}{L+D}\right) - \tau_K\right]k + r^*\left(\bar{k}-k\right) + F'_L\left(k, h\frac{L}{L+D}\right) - \tau_L \text{ if } \bar{k} \geq k, \\ \left[F'_K\left(k, h\frac{L}{L+D}\right) - \tau_K\right]\bar{k} + F'_L\left(k, h\frac{L}{L+D}\right) - \tau_L \text{ if } \bar{k} \leq k, \end{array}\right. \\ y_D = \left|\begin{array}{l} \left[F'_K\left(k, h\frac{L}{L+D}\right) - \tau_K\right]k + r^*\left(\bar{k}-k\right) + p \text{ if } \bar{k} \geq k, \\ \left[F'_K\left(k, h\frac{L}{L+D}\right) - \tau_K\right]k + \left[F'_K\left(k, h\frac{L}{L+D}\right) - \tau_K\right]\left(\bar{k}-k\right) + p \text{ if } \bar{k} \leq k, \end{array}\right. \\ F'_K\left(k, h\frac{L}{L+D}\right) - \tau_K = r^* + \frac{k-\bar{k}}{\phi_K}, \\ F'_L\left(k, h\frac{L}{L+D}\right) - \tau_L = w^* + \frac{1-\frac{\bar{L}}{L}}{\phi_L}, \\ G = \tau_K K + \tau_L L - pD. \end{array}\right. \tag{A.1}$$

The endogenous variables of this problem are $\tau_K, \tau_L, L, G, y_L, y_D, k$, while the exogenous parameters are $D, \gamma, r^*, w^*, \bar{k}, p, \phi_K, \phi_L$. The weighted average personal income can then be simplified using (9) and (10). The average spending can be rewritten obtained by replacing the tax rates τ_K and τ_L and rearranging the expression using the homogeneity property of the production function. The problem then rewrites as an optimization problem in (k, L):

$$\max_{k,L} U\left(\frac{L}{L+D}y_L + \frac{\gamma D}{L+D}y_D, \frac{G}{L+D}\right)$$
$$s.t. \left|\begin{array}{l} \frac{L}{L+D}y_L + \frac{\gamma D}{L+D}y_D = \left|\begin{array}{l} \frac{L+\gamma D}{L+D}\left[\frac{k\left(k-\bar{k}\right)}{\phi_K} + r^*\bar{k}\right] + \frac{L}{L+D}\left[w^* + \frac{\left(1-\frac{\bar{L}}{L}\right)}{\phi_L}\right] + \frac{\gamma D}{L+D}p \text{ if } \bar{k} \geq k, \\ \frac{L+\gamma D}{L+D}\left[\frac{\bar{k}\left(k-\bar{k}\right)}{\phi_K} + r^*\bar{k}\right] + \frac{L}{L+D}\left[w^* + \frac{\left(1-\frac{\bar{L}}{L}\right)}{\phi_L}\right] + \frac{\gamma D}{L+D}p \text{ if } \bar{k} \leq k, \end{array}\right. \\ \frac{G}{L+D} = F\left(k, h\frac{L}{L+D}\right) - \left(r^* + \frac{\left(k-\bar{k}\right)}{\phi_K}\right)k - \left(w^* + \frac{\left(1-\frac{\bar{L}}{L}\right)}{\phi_L}\right)\frac{L}{L+D} - p\frac{D}{L+D}. \end{array}\right. \tag{A.2}$$

Moreover, the tax rates satisfy:

$$\begin{aligned}\tau_K &= F'_K\left(k, h\tfrac{L}{L+D}\right) - r^* - \tfrac{\left(k-\bar{k}\right)}{\phi_K},\\ \tau_L &= F'_L\left(k, h\tfrac{L}{L+D}\right) - w^* - \tfrac{\left(1-\frac{\bar{L}}{L}\right)}{\phi_L}.\end{aligned} \tag{A.3}$$

Th first order conditions with respect to (k, L) are:

$$\begin{aligned}&U'_Y(.,.)\left[\tfrac{\left(2k-\bar{k}\right)}{\phi_K}\tfrac{L+\gamma D}{L+D}\right] + U'_G(.,.)\left[F'_K(.,.) - r^* - \tfrac{\left(2k-\bar{k}\right)}{\phi_K}\right] = 0 \text{ if } \bar{k} \geq k,\\ &U'_Y(.,.)\left[\tfrac{\bar{k}}{\phi_K}\tfrac{L+\gamma D}{L+D}\right] + U'_G(.,.)\left[F'_K(.,.) - r^* - \tfrac{\left(2k-\bar{k}\right)}{\phi_K}\right] = 0 \text{ if } \bar{k} \leq k,\end{aligned} \tag{A.4}$$

and:

$$\begin{aligned}&U'_Y(.,.)\left[(1-\gamma)D\left(\frac{\bar{k}\left(k-\bar{k}\right)}{\phi_K} + r^*\bar{k} + p\right) + D\left(w^* + \frac{1}{\phi_L} - p\right) + \frac{\bar{L}}{\phi_L}\right]\\ &+U'_G(.,.)\left[F'_L(.,.)D - D\left(w^* + \frac{1}{\phi_L} - p\right) - \frac{\bar{L}}{\phi_L}\right] = 0.\end{aligned} \tag{A.5}$$

One can rewrite (A.4) as follows:

$$\begin{aligned}&F'_K(.,.) - r^* - \tfrac{\left(k-\bar{k}\right)}{\phi_K} = \tfrac{1}{\phi_k}\left[k - \tfrac{U'_Y(.,.)}{U'_G(.,.)}\tfrac{L+\gamma D}{L+D}\left(2k-\bar{k}\right)\right] \text{ if } \bar{k} \geq k,\\ &F'_K(.,.) - r^* - \tfrac{\left(k-\bar{k}\right)}{\phi_K} = \tfrac{1}{\phi_k}\left[k - \tfrac{U'_Y(.,.)}{U'_G(.,.)}\tfrac{L+\gamma D}{L+D}\bar{k}\right] \text{ if } k \geq \bar{k},\end{aligned} \tag{A.6}$$

Using the expression of τ_K in (A.3), we obtain (13).

One can rewrite (A.5) as follows:

$$\frac{U'_Y(.,.)}{U'_G(.,.)} = \frac{\left[D\left(w^* + \frac{1}{\phi_L} - p\right) + \frac{\bar{L}}{\phi_L} - F'_L(.,.)D\right]}{\left[D\left(w^* + \frac{1}{\phi_L} - p\right) + \frac{\bar{L}}{\phi_L} - (1-\gamma)D\left(\frac{\bar{k}(k-\bar{k})}{\phi_K} + r^*\bar{k} + p\right)\right]} \tag{A.7}$$

which implies:

$$\left.\frac{U'_Y(.,.)}{U'_G(.,.)}\right|_{\gamma=1,D>0} = 1 - \frac{F'_L(.,.)D}{\left[D\left(w^* + \frac{1}{\phi_L} - p\right) + \frac{\bar{L}}{\phi_L}\right]} < 1 \text{ and } \left.\frac{U'_Y(.,.)}{U'_G(.,.)}\right|_{D=0} = 1. \tag{A.8}$$

Note also that when $D = 0$, (A.6) reduces to:

$$\begin{aligned} F'_K(k,h) - r^* &= 0 \text{ if } \bar{k} \geq k, \\ F'_K(k,h) - r^* - \tfrac{2(k-\bar{k})}{\phi_K} &= 0 \text{ if } \bar{k} \leq k, \end{aligned} \tag{A.9}$$

and (A.5) to:

$$U'_Y(.,.) - U'_G(.,.) = 0. \tag{A.10}$$

If the social welfare function is additively separable, and using (A.3), (A.10) can be written as:

$$U'_Y\left(\frac{k\left(k-\bar{k}\right)}{\phi_K} + r^*\bar{k} + F'_L(k,h) - \tau_L\right) - U'_G\left(F(k,h) - \left(r^* + \frac{\left(k-\bar{k}\right)}{\phi_K}\right)k - F'_L(k,h) + \tau_L\right) = 0, \tag{A.11}$$

if $\bar{k} \geq k$. Using the homogeneity property of the production function and (A.9), the latter can be rewritten as:

$$U'_Y\left(\frac{k\left(k-\bar{k}\right)}{\phi_K} + r^*\bar{k} + F'_L(k,h) - \tau_L\right) - U'_G\left(-\frac{k\left(k-\bar{k}\right)}{\phi_K} + \tau_L\right) = 0, \tag{A.12}$$

which used as an implicit function gives Equation (17). Similarly, (A.10) can be written as:

$$U'_Y\left(\frac{\bar{k}\left(k-\bar{k}\right)}{\phi_K} + r^*\bar{k} + F'_L(k,h) - \tau_L\right) - U'_G\left(\frac{k\left(k-\bar{k}\right)}{\phi_K} + \tau_L\right) = 0, \tag{A.13}$$

if $\bar{k} \leq k$. We obtain

$$\frac{\partial \tau_L}{\partial \phi_K} = \frac{-\frac{\bar{k}(k-\bar{k})}{\phi_K^2}U''_{YY} + \frac{k(k-\bar{k})}{\phi_K^2}U''_{GG}}{U''_{YY} + U''_{GG}} + \frac{U''_{YY}\left[\frac{\bar{k}}{\phi_K} + F''_{KL}(k,h)\right] - U''_{GG}\frac{2k-\bar{k}}{\phi_K}}{U''_{YY} + U''_{GG}}\frac{dk}{d\phi_K}, \tag{A.14}$$

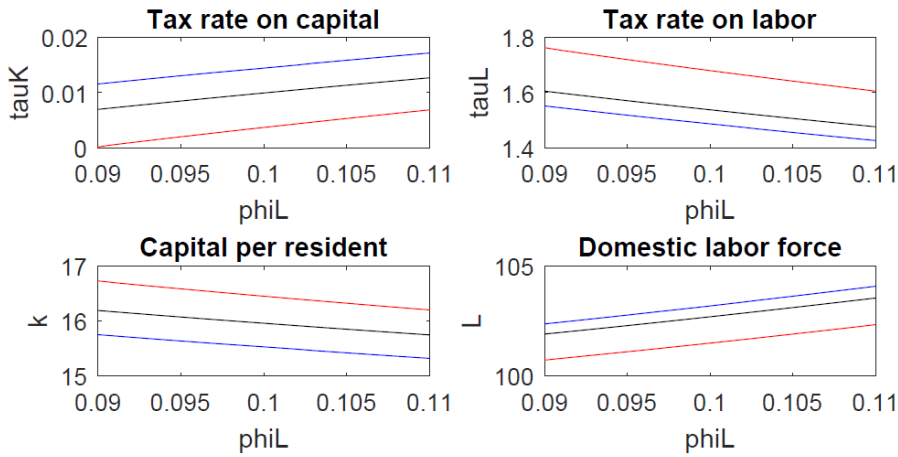
where:

$$\frac{dk}{d\phi_K} = \frac{\frac{2k}{\phi_K^2}}{F''_{KL}(k,h) + \frac{2k}{\phi_K}} > 0. \tag{A.15}$$

The sign of is therefore ambiguous.

Appendix B: Impact of labor mobility on taxation: The case of a net labor importer

Figure 11: Impact of labor mobility on taxation: net labor importer ($w^* = 1$)



Notes: black lines are for $D = 27$, $\gamma = 1$; blue lines for higher dependence ($D = 30$, $\gamma = 1$), red lines for higher political weight of pensioners ($D = 27$, $\gamma = 1.05$).

Appendix C

Table 10: Variables definitions and data sources

Variable	Label	Definition	Source
Capital tax rate	KTAX	Effective average tax rate on corporate income	Oxford University
Labor tax rate	LTAX	Tax wedge on gross income representing 167% of gross earnings (single, no children)	OECD
Labor tax rate med	LTAX med	Tax wedge on gross income at the median wage	OECD
Labor tax rate min	LTAX min	Tax wedge on gross income at the minimum wage	OECD
Capital mobility	KMOB	International investment position assets + liabilities /2GDP	IMF, World Bank
Labor mobility	LMOB	Inflows of non-nationals/total population	OECD
Trade openness	TRADE	Exports + Imports /2*GDP	OECD, World Bank
Trade openness squared	TRADE2	Square of TRADE	OECD, World Bank
Ageing	65+	Share of the population aged 65+	OECD
Government spending	GOVSPEND	General government spending /GDP	IMF
Government debt	GOVDEBT	General government debt /GDP	OECD, nat. sources
Net FDI position	FDI97	(FDI assets - FDI liabilities)/GDP in 1997	IMF
Capital endowment	k1990	Capital per worker in 1990 in USD mn of 2011	Penn World Tables
Net migration	MIGR90	Cumulated net immigration 1983-97/residents	United Nations