Unemployment, Public Spending and International Trade: Challenges for an Optimal Tax Design

François Langot *†
Lise Patureau ‡
Thepthida Sopraseuth §

July 2014

Abstract

The paper characterizes the optimal tax scheme in an open economy with structural inefficiencies on the labor market and on government size. On analytical grounds first, we show that the economy can use fiscal revaluation to exploit the terms of trade externality and to dampen the impact of an excessive public spending. However, if real labor market rigidities are large enough, fiscal devaluation may be desirable. Second, we provide a quantitative assessment of the optimal tax reform using France as the benchmark economy. Our results show that France would benefit more from fiscal devaluation than a economy where the labor market is more flexible, as the US. We also show that the welfare gains from the optimal tax reform crucially depend on the ability of the government to target its optimal size.

Keywords: consumption tax, payroll tax, Ramsey allocation, labor market search, open economy, public spending.
JEL classification: E27, E62, H21, J38

---

*Financial support from the Cepremap is gratefully acknowledged. We thank Etienne Lehmann, Laurence Jacquet and Jean-Pascal Benassy for valuable comments. The paper has also benefited from comments at the T2M Conference (Montreal, 2011), the EALE Congress (Cyprus, 2011), the French Labour Market Workshop (Aussois, 2012), Joint Seminar Lunch at the ECB (Frankfurt, 2012), Search and Matching Annual Conference (Cyprus, 2012), Economics Workshop (Adelaide, 2013), as well as at seminars at the Paris School of Economics, Paris Dauphine University, the University of Lille 1, Cergy-Pontoise and Banque de France. Any omissions and mistakes are our own.

†Université du Mans (GAINS-TEPP), Paris School of Economics, Banque de France & IZA. Email: `flangot@univ-lemans.fr`

‡Université de Lille 1 (EQUIPPE) & CES. Email: `lise.patureau@univ-lille1.fr`

§Corresponding author, Université de Cergy-Pontoise (THEMA) & Cepremap. Email: `thepthida.sopraseuth@u-cergy.fr`. Thepthida Sopraseuth acknowledges the financial support of the *Institut Universitaire de France.*

1 Introduction

Fiscal devaluation has been received a lot of attention in the recent years. This policy is defined in Farhi et al. (2014) as the use of "unilateral fiscal policy to generate the same real outcomes as those following a nominal exchange rate devaluation, while keeping the nominal exchange rate fixed". A particular combination of an increase in value-added taxes along with employment subsidy allows decentralized markets to achieve this objective.[1] As potential tool to raise the country's competitiveness in the short run, fiscal devaluation has been implemented in many European countries in the recent years (Denmark (1988), Sweden (1993), Germany (2006) or France (2012)). The related literature only focuses on the short-run performances of the tax reform in reducing the "Okun gaps" (Farhi et al. (2014), Correia et al. (2008), among others).

This paper supplements these studies by emphasizing the medium-run effects of fiscal devaluation in economies featuring real rigidities. In our view, reducing the gap between European countries and the US indeed requires more than a stabilization policy. More than transitory "Okun gaps", many European countries are faced to severe structural inefficiencies, underlying the existence of persistent and significant "Harberger triangles". Labor market inefficiencies constitute the first summit of the triangle. As underlined by Prescott (2004) or Ljunqvist & Sargent (2008), this calls for structural policies to raise the total number of hours worked, by either acting on hours worked per worker or on (un)employment: Fiscal devaluation, as long as it induces a reduction in total labor costs, can hence be helpful on this issue. The second major inefficiency shared by a large set of European countries comes from excessive government expenditures with respect to their incompressible size, which we view as made of purely collective public spending.[2] This induces a mis-allocation between private and public consumptions, whose consequences on hours worked in Europe have been pointed out by Rogerson (2007) and Ragan (2013). If a reform of the (excessive) government size is hardly implementable in the medium run, then imposing taxes may be desirable, as a signal sent to private agents that a part of their overall consumption is taken in charge through (individual) government expenditures. In contrast to labor market frictions, this rather calls for fiscal revaluation. Third aspect of the Harberger triangle, European countries are small-open economies where the terms of trade externality matters.[3] In this context, optimal

[1] As noted by Farhi et al. (2014), the idea of fiscal devaluation goes back to Keynes (1931), who suggested an uniform ad valorem tariff on import along with an uniform subsidy on exports have the same effect as a nominal devaluation. This tax scheme has the same impact than an increase in value-added taxes accompanied by employment subsidies (see Farhi et al. (2014)).

[2] Public expenditures can be decomposed between "individual" and "collective" spending. This last category (justice, collective facilities, army...) are qualified as such, as they cannot be made by the household herself, even though necessary for her welfare. In France, collective public expenditures represent 6.5% of GDP, whereas the share of the overall government consumption in the GDP is 25%. This shows that a large part of public spending could in fact be achieved through some social transfers. We come back on this point later in Section 3.2.

[3] The terms of trade externality comes from the Home social planner exploiting her monopoly power in the supply of the Home good. The intuition is straightforward. In the decentralized economy, private agents do not internalize the effect of their choices on the terms of trade. Accordingly, the competitive economy works and produces too much,

taxation in international trade theory recommends to use taxes to reduce the terms of trade, so as to exploit the monopoly power in the supply of the home good (see e.g. Costinot et al. (2013)): This argument stands in favor of a fiscal revaluation.[4]

Our paper contributes to the literature by studying the trade-off between fiscal revaluation/ devaluation in the medium run.[5] In accordance with the above identified Harberger triangle, we then assess the desirability of fiscal devaluation using *i)* a small-open economy model with *ii)* labor market search frictions and *iii)* possibly inefficient public spending. Importantly, we show that these dimensions are key in the understanding of the efficiency of fiscal devaluation in the medium run. All results are first derived analytically, using a static version of the model, before turning to a quantitative assessment through a dynamic general equilibrium model (DGE).

In the analytical static matching framework, we characterize the optimal tax policy in the open economy fully specialized in the production of the Home good. We first determine the Home planner's allocation.[6] With respect to this first-best solution, we identify *i)* the optimal overall tax wedge, *ii)* the conditions under which a switch from direct labor taxation to indirect taxes is optimal, *iii)* how the optimal policy depends on the three main market failures, that are *i)* labor market frictions, *ii)* the terms of trade externality and *iii)* the sub-optimal size of the government. With respect to the planner's allocation, labor market frictions induce sub-optimally low levels of quantities (employment, output) and prices (the terms of trade). In contrast, the inability of the competitive economy to internalize the terms of trade externality translates into excessively large quantities worked and produced and an excessively high terms of trade value (everything else equal). Consequences in terms of tax policy are then straightforward. If labor market imperfections are sizeable enough, then optimal taxation must reduce labor costs. We show that this may be achieved through fiscal devaluation, i.e. a switch from direct labor taxation to indirect consumption taxes. As long as this reduces the overall tax wedge, this policy indeed amounts subsidizing employment, therefore bringing the economy closer to the planner's allocation.[7] Compared with Farhi et al.

---

which drives the price of the home good down, thereby making imports too expensive compared to their first-best level.

[4]That is, a fall in consumption tax along with rise in payroll tax. By increasing the overall tax wedge (commonly defined as the conglomerate of the employer and employee's labor tax rates and the indirect tax rate), this policy induces a reduction in employment hence production, thereby driving the home price up (the foreign price down). As such, this brings the terms of trade (i.e., the relative price of imports to exports) closer to those chosen by the Home social planner.

[5]As in Costinot et al. (2013), we neglect the long-run possibility that all countries can use the same tax policy, i.e. we consider the behaviors of the other countries as given.

[6]The Hosios condition and the optimal size of government (the optimal arbitration between private and public goods) holding, this allows the home planner to extract its monopoly rent on foreign demand when selling its goods abroad, thereby fully exploiting the terms of trade externality. Put it differently, this means the the first-best allocation features quantities (total worked hours, production) and prices (the terms of trade) lower than the decentralised walrasian equilibrium.

[7]Strictly speaking, this is the case provided the tax base argument holds, as we prove later in the paper and as empirically relevant.

(2014) who endorse fiscal devaluation in the short run, our result adds another argument in favor of fiscal devaluation, by laying stress on structural labor market imperfections as a rationale to this reform. In contrast, if labor market frictions are low, in which case the the terms of trade externality dominates, then optimal tax policy consists in fiscal revaluation. Finally, if the government size is too big (relative to efficient), tax policy should be designed to induce the households to forgo private consumption, given the excessive provision of public spending. Under the tax base effect argument, this last distortion thereby calls for re-enforcing fiscal revaluation.

These analytical results make clear that the optimal tax policy then depends on the structure of the economy: Countries with rigid labor markets can benefit from fiscal devaluation, whereas countries with flexible labor markets could actually benefit more from fiscal revaluation. This calls for a quantitative assessment of the optimal tax reform, which we provide using a DGE model calibrated to France. Our quantitative results can be summarized in three main points: *i)* The magnitude of labor market frictions in France calls for a fiscal devaluation (the labor tax rate should be reduced to 34% to 0.027%, along with doubling the consumption tax from 0.22 to 0.44). In this respect, our results suggest that France would benefit more from fiscal devaluation than more flexible economies, like the US; *ii)* Yet, if the size of the government does not change, the welfare impact of this tax policy remains small (between 0.2 and 1.5 percent increase in permanent consumption). In contrast, *iii)* if the size of the government is also reduced to its optimal size, then fiscal devaluation leads to much substantial welfare gains (14 percent increase in permanent consumption).

The paper is related to several strands of the literature. First, the paper contributes to the literature devoted to the "European Employment Problem", which refers to the significant decrease in the total number of hours worked in many European countries relative to the US over the recent decades. Two dimensions must be distinguished: *(i)* the persistence of a high unemployment rate, which the literature relates to the role of stringent labor market institutions on the extensive margin of labor (i.e., the number of employees),[8] and *(ii)* a lower amount of hours worked per employee (the intensive labor margin) highly linked to the role of a too heavy labor tax wedge.[9] On this side, Prescott (2004) points out that the welfare gains to French households from adopting American taxes (i.e., reducing the effective tax rate on labour by 20 percentage points) "would be equivalent to a 20 percent increase in consumption, with no increase in work effort" (Lucas (2003)). Such large welfare gains would undoubtedly call for cutting French (and more broadly, European) taxes down to US levels. One contribution of the paper is to put these results into perspective, by adopting a

[8]Let us mention Bertola & Ichino (1995), Blanchard & Wolfers (2000), Daveri & Tabellini (2000), Ljunqvist & Sargent (1998), Ljunqvist & Sargent (2008). The unemployment rate in France e.g. is around 10% since 1980, whereas the job finding rate is two times lower than in the US, implying a large part of long-term unemployed.

[9]See e.g. Prescott (2004), Rogerson (2006) or Ohanian et al. (2008). As reported in Prescott (2004), hours worked in France, and in most European countries, are much lower than in the US, by a ratio equal to around 68% over the 1993-1996 period.

broader framework - which, in our view, is more in accordance with European specificities. These papers use *i)* a closed-economy model *ii)* with a walrasian labor market *iii)* in which households do not value government spending. Unsurprisingly, the first-rank allocation then calls for zero taxes and zero government spending, leading to large welfare gains from the tax reduction. We show that this result is quite restrictive, since it is crucially sensitive to the removal of each of the above assumptions. Our results confirm the importance of modeling both the extensive and the intensive labor market margins in terms of optimal tax policy. We show that the Ramsey tax policy cannot achieve the planner's allocation on both the intensive and extensive margin. This comes from the fact that employment and the hours worked do not have the same elasticities with respect to the tax pressure, due to differentiated impacts of labor market frictions on each margin.

Our focus on the role of public consumption in shaping the optimal tax scheme also relates us to the literature on the role of public spending. Most of the related literature (e.g. Prescott (2004)) considers public spending as a nuisance (by crowding out private spending and giving raise to tax distortion). In this context, higher public spending can only be welfare decreasing. This view omits acknowledging that in all countries, taxes are used to finance public goods that are valuable to private agents – at least to some extent. In the paper, we thus characterize the optimal tax design when taxes are used to finance public expenditures which can provide utility flows to households, in accordance with the empirical results of Ragan (2013) or Rogerson (2007).

Last, our stress on the terms of trade externality relates the paper to the international trade literature that follows the seminal contribution of Corben (1984).[10] Unlike most related papers in the trade literature, such as Costinot et al. (2013), our originality lies in studying how domestic taxes, rather than tariffs, can be used as a protectionist tool. In doing so, we develop a second-best policy analysis. Since the terms of trade externality distorts the relative price of foreign vs home goods, only a tariff can correct it. We yet preclude the possibility of fully correcting for the terms of trade externality by assuming that government tools only consist in labour and indirect consumption taxes. This choice is rationalized on empirical grounds, as such trade taxes are typically forbidden by international trade agreements, at the worldwide level and in particular among countries within the European Union.

The paper is organized as follows. In Section 2, we shed light on the key mechanisms underlying the optimal labor tax rate using a tractable analytical model. We abstract in particular from dynamics by adopting a pure static framework. In Section 3, we extend this analytic framework to a dynamic general equilibrium model which we calibrate to quantify the optimal scheme of the tax system in France. Section 4 concludes.

[10] As recalled by Costinot et al. (2013), the idea of exploiting the terms of trade externality is an old one in the international trade literature, notably going back to Mill (1844). Its implications in the analysis of optimal tariffs and challenges for the World Trade Organization have been studied in recent theoretical and empirical papers such as Bagwell & Staiger (1990), Bagwell & Staiger (1999) or Broda et al. (2008).

2 Optimal Labor Taxation in an Open Economy: a Theoretical Characterisation

In this section, we develop a static and tractable analytical model which accounts for the main characteristics of the French economy: the open economy dimension and its inherent terms of trade externality, the government spending and the implied (in)efficient government-to-output ratio, and labor market frictions, inducing distortions (unemployment benefits and bargaining power) and bias in the substitution between the intensive and extensive margin.[11, 12] After obtaining the equilibrium allocations in the decentralised and centralised cases respectively, we restrict our analysis to a second-best Ramsey tax scheme where the number of tax instruments is lower than the number of distortions. We then show that, if the economy initially features too low a level of labor (and output), increasing indirect taxation in exchange for reduced labor taxation is welfare enhancing up to a certain limit.

2.1 Main Assumptions

Following Hungerbuhler et al. (2006), we capture labor market frictions (LMF hereafter) in a static setting. Unlike Hungerbuhler et al. (2006), our framework incorporates both the intensive (hours worked) and the extensive margin (the number of employees) of labor. Modeling both margins indeed turns out to have important implications in the design of the Ramsey tax scheme.

Matching frictions on the labor market. Each firm opens a vacancy that can be filled by a searching worker. Matching workers with vacancies is a costly process, with $\overline{\omega}$ the cost of posting one vacancy. Hirings evolve according to a constant return to scale matching function: $M = \chi V^{\psi} U^{1-\psi}$ with V the total number of new jobs made available by firms, U the number of searching workers, $\chi > 0$ a scale parameter measuring the efficiency of the matching function and $0 < \psi < 1$ the weight of vacant jobs in the matching process.

The job finding rate p, defined by $p\left(\frac{V}{U}\right) \equiv \frac{M}{U} = \chi\left(\frac{V}{U}\right)^{\psi}$, is a function of labor market tightness $\frac{V}{U}$. The vacancy filling rate q is given by $q\left(\frac{V}{U}\right) \equiv \frac{M}{U} = \chi\left(\frac{V}{U}\right)^{\psi-1}$. The size of the population is normalised to 1. At the beginning of the period, all workers are looking for a job, $U = 1$. Therefore, with a static matching, we have $M = N = p$. Hence, the matching process in the economy is summarised by:

$$N = \chi V^{\psi} \tag{1}$$

[11] We thank Jean-Pascal Benassy for helpful input on the functional forms.

[12] We discard capital accumulation, international bond trading and government debt in order to get analytical results. More details underlying our analytical results are available in the online technical Appendix from the authors' web pages. Physical capital is included in the dynamic general equilibrium model (Section 3).

The open economy dimension We model a small open economy which trades goods with the rest of the world (also referred to as the foreign country). The home country is specialised in the production of a homogenous good consumed domestically and abroad (Y, C_H and X respectively denoting the volumes of home production, domestic consumption of the home good, and home exports). The economy also consumes the homogenous good produced abroad, in quantity C_F, equal to domestic imports Z. Given that home exports (denoted by X) necessarily constitute the imports of the rest of the world Z^*, it comes that: $X = Z^*$. Symmetrically, we have: $Z = X^*$. In addition, we normalise prices by considering the home good as numéraire. The relative price of the foreign good $\phi \equiv P_F/P_H$ is also interpreted as terms of trade. Throughout the paper, we assume the following functional forms for foreign exports X^* and imports Z^*:

$$X^* = \phi^{\sigma^*-1} \tag{2}$$

$$Z^* = \phi^{\sigma^*} \tag{3}$$

with $\sigma^* > 1$ the price elasticity of foreign imports.[13] In the absence of international trading of financial assets, the home country (as well as the rest of the world) is featured by a zero trade balance $Z = X^* \quad \Leftrightarrow \quad Z = \phi^{\sigma^*-1}$.

Preferences. In each period, employed agents (N) work, while unemployed agents ($1-N$) spend their time enjoying leisure. Hence, after assuming separability between consumption and leisure, the representative household's programme is to maximise:

$$\mathcal{U} = \xi \log(C_H) + (1-\xi)\log(C_F) + \Phi \log(G) - N\sigma_L \frac{h^{1+\eta}}{1+\eta} \tag{4}$$

with $\eta > 0, \sigma_L > 0$ and $0 < \xi < 1$. The consumption bundle is made of home good (C_H) and foreign good (C_F) with respective weights in the expenditure function ξ and $1-\xi$ respectively. Besides, we allow for public spending G providing utility flows, as scaled by the parameter $\Phi \geq 0$. We choose separable preferences. We are aware that it is a debated issue. However, with separability, marginal rates of substitutions and decision rules are not affected by G, which makes the model's first order conditions and results directly comparable with those prevailing in the existing literature.[14]

Technology. Each occupied job yields production using a decreasing production function Ah^α with $0 < \alpha < 1$ and h denoting the number of hours worked by an individual. As a result, at the aggregate level, with N the number of workers (i.e., of firms), the aggregate output Y is given by

[13] In the online appendix (section A.1), we derive the microfoundations of such trade flows.

[14] To maintain the analytical simplicity of the model, we assume that public expenditures are only made in domestic goods. We consider the more general case of G made of both domestic and foreign varieties in Section 3.

the following function:[15]

$$Y = ANh^{\alpha}, \qquad 0 < \alpha < 1 \tag{5}$$

2.2 The Decentralised Economy

Firms. Firms are in perfect competition in the production of the home good. They are subject to direct labor taxation, with τ_f denoting the payroll tax rate. Firms freely enter the goods market and, due to matching frictions, post vacancies as long as the return on vacancy posting exceeds its cost. The free entry condition then equalises the cost of posting one vacancy to its after-tax return. Using the definition of the vacancy filling rate $q = \chi V^{\psi-1}$, we obtain:

$$\frac{\overline{\omega}}{q} = (Ah^{\alpha} - (1+\tau_f)wh) \quad \Rightarrow \quad V = \left(\frac{\overline{\omega}/\chi}{Ah^{\alpha} - (1+\tau_f)wh}\right)^{\frac{1}{\psi-1}} \tag{6}$$

Notice that this condition can also be interpreted as the zero-profit condition, with profits being given by $\pi = Ah^{\alpha}N - \overline{\omega}V - (1+\tau_f)whN$.

Workers. The household maximises its utility function (4) with respect to C_H, C_F subject to its budget constraint:

$$(1+\tau_c)(C_H + \phi C_F) = (1-\tau_w)[wNh + \widetilde{b}(1-N)] + \pi - T \tag{7}$$

with $\widetilde{b}$ the unemployment benefits net of social contributions $\widetilde{b} = b/(1+\tau_f)$,[16] π the firms' profit (equal to zero given the zero-profit condition) and T lump-sum taxes. Labor revenues are taxed at the employee tax rate τ_w, while consumption expenditures are subject to indirect taxation, with τ_c the indirect tax rate. The first-order conditions relative to home and foreign goods consumptions lead to the following arbitrage condition:

$$\frac{U'_{C_F}}{U'_{C_H}} = \phi \;\Leftrightarrow\; \frac{1-\xi}{\xi}\frac{C_H}{C_F} = \phi \tag{8}$$

[15] The aggregate production function thus exhibits increasing returns to scale. This does not jeopardise our assumption of perfect competition on the goods market though, as each firm is modeled as atomistic and does not internalise the effect of its job opening decision on aggregate employment. Also note that, even with a linear production function in N, the share of wages in the GDP wNh/Y is smaller than 1 in the presence of a non-zero vacancy cost (see the online appendix (section A.2.1)).

[16] If we do not make this assumption, a distortion is introduced in the taxation of work w versus non-work b. Discussing the impact of this distortion is beyond the focus of this paper. Furthermore, this hypothesis is consistent with the view that, in France for instance, unemployed workers pay a low social security contribution from their unemployment benefits. The Unemployment Agency pays for them. The total cost of unemployment benefits for the government must then include unemployment benefits with social security contributions. This is what appears in the government budget constraint, Equation (12).

which shows that the sharing rule between domestic and foreign consumption is simply driven by the terms of trade.

Nash bargaining. We assume that wages and hours worked are determined via generalised Nash bargaining as follows:

$$\max_{w,h} \left(\frac{1-\tau_w}{1+\tau_c}(wh - \widetilde{b}) - \Gamma(h) \right)^{1-\epsilon} (Ah^\alpha - (1+\tau_f)wh)^\epsilon \tag{9}$$

with $0 < \epsilon < 1$ and $\Gamma(h) = \sigma_L \frac{h^{1+\eta}}{1+\eta}(C_H + \phi C_F)$. $(1-\epsilon)$ represents the workers' bargaining power. Solving this leads to the following negotiated values for w and h in the decentralised economy:

$$wh = \frac{1-\epsilon}{1+\tau_f} Ah^\alpha + \frac{\epsilon}{1-\tau_w}\left[(1-\tau_w)\widetilde{b} + (1+\tau_c)\Gamma(h)\right] \tag{10}$$

$$\sigma_L h^\eta (C_H + \phi C_F) = \frac{1-\tau_w}{(1+\tau_c)(1+\tau_f)} \alpha A h^{\alpha-1} \tag{11}$$

As is standard in matching models (see Pissarides (1990)), the negotiated wage is a weighted average of the worker's outside option and the marginal product of a match, with the relative weights depending on the relative bargaining power of both players (Equation (10)). We also verify that the negotiated amount of hours worked is efficient, in that it equalises the marginal product of hours with the disutility of work given the tax scheme.

Equilibrium. The model is closed by taking the budget constraint of the government into account:

$$G + (1-\tau_w)\widetilde{b}(1-N) = \tau_c(C_H + \phi C_F) + (\tau_w + \tau_f)wNh + T \tag{12}$$

given the rule for public expenditures $G = \rho_g(Y - \overline{\omega}V)$ and lump-sum taxes $T = \rho_T(Y - \overline{\omega}V)$. We will also assume that unemployment benefits are proportional to the wage bill, i.e.: $\widetilde{b} = \rho_b wh$, with $0 < \rho_b < 1$. The home good equilibrium condition and the zero-trade balance equation are still given by Equations (18) and (19) respectively.

Using the definition of firms' profits and the budget constraint of the government, the budget constraint of the household becomes: $(1+\tau_c)(C_H + \phi C_F) = (1-\rho_g)(Y - \overline{\omega}V) + \tau_c(C_H + \phi C_F)$. The FOC relative to C_H and C_F can then be written as:

$$C_H = \xi(1-\rho_g)(Y - \overline{\omega}V) \tag{13}$$

$$\phi C_F = (1-\xi)(1-\rho_g)(Y - \overline{\omega}V) \tag{14}$$

The labor market equilibrium can be summarised by the system in $\{V, h\}$:

$$\frac{\overline{\omega}}{\chi}V^{1-\psi} = \epsilon\left[Ah^{\alpha} - b - \sigma_L\frac{h^{1+\eta}}{1+\eta}\frac{(1+\tau_c)(1+\tau_f)}{1-\tau_w}(1-\rho_g)(Y-\overline{\omega}V)\right] \quad (15)$$

$$\Leftrightarrow V^{dec} = \left[\frac{\epsilon\chi}{\overline{\omega}}\left(\frac{(1+\eta)(1-\rho_b)-\alpha}{(1+\eta)(1-\rho_b\epsilon)}\right)A(h^{dec})^{\alpha}\right]^{\frac{1}{1-\psi}} \quad (16)$$

$$h^{dec} = \left[\frac{\alpha A}{\sigma_L}\left(\frac{1-\tau_w}{(1+\tau_c)(1+\tau_f)}\frac{1}{1-\rho_g}\right)\frac{1}{\Theta}\right]^{\nu} \quad (17)$$

with the subscript ^{dec} referring to the decentralised allocation, $\nu \equiv \frac{1-\psi}{(1-\psi)(1+\eta)+\alpha\psi}$ and:

$$\Theta = \left(\frac{A\chi}{(1+\eta)(1-\rho_b\epsilon)}\right)^{\frac{1}{1-\psi}}\left[\frac{\epsilon}{\overline{\omega}}((1-\rho_b)(1+\eta)-\alpha)\right]^{\frac{\psi}{1-\psi}}[(1-\epsilon)(1+\eta)+\epsilon\alpha]$$

recalling ρ_b being the exogenous unemployment benefit ratio.

2.3 The Centralised Economy

The planner's program As goods are imperfect substitutes at the international level, the planner of the home country can compute a "fictitious" allocation by acting as a monopoly vis-à-vis the foreign country. That is, the Home planner uses information about the import and export functions coming from Equations (2) and (3) to extract a positive markup. In this respect, we adopt a similar modeling of the centralised small open economy allocation as in related trade papers (Costinot et al. (2013)).

Using the production function (5), the resource constraint on the home good and the trade balance equilibrium condition that the planner takes into account are respectively given by:

$$C_H = ANh^{\alpha} - \phi^{\sigma^*} - G - \overline{\omega}V \quad (18)$$

$$C_F = \phi^{\sigma^*-1} \quad (19)$$

The programme of the social planner is to maximise the utility function (4) with respect to C_H, C_F, G, h, V and V, subject to the resource constraints (18) and (19), as well as the matching process equation (1). By replacing private consumptions (18) and (19) in the objective function (4), this is equivalent to choosing $\{\phi, G, h, V\}$ so as to maximise:

$$\max_{\phi,G,V,h}\mathcal{U} = \max\left\{\begin{array}{l}\xi\log(A\chi V^{\psi}h^{\alpha} - X(\phi) - G - \overline{\omega}V) \\ +(1-\xi)\log(Z(\phi)) + \Phi\log(G) - \chi V^{\psi}\sigma_L\frac{h^{1+\eta}}{1+\eta}\end{array}\right\}$$

given the foreign import and export functions (2) and (3). The first-order conditions with respect to ϕ, G, h and V are respectively:

$$\frac{U'_{C_F}}{U'_{C_H}} = \frac{\epsilon_{Z^*/\phi}}{\epsilon_{X^*/\phi}} \frac{Z^*}{X^*} \quad \Leftrightarrow \quad \frac{1-\xi}{\xi} \frac{C_H}{C_F} = \mu^* \phi \tag{20}$$

$$U'_{C_H} = U'_G \quad \Leftrightarrow \quad G = \frac{\Phi}{\xi} C_H \tag{21}$$

$$-\frac{U'_{C_H}}{U'_h} = Y'_h \quad \Leftrightarrow \quad \sigma_L h^{1+\eta} = \alpha \frac{Y}{C_H} \tag{22}$$

$$U'_{C_H} \left[Y'_V - \overline{\omega} \right] = N'_V \sigma_L \frac{h^{1+\eta}}{1+\eta} \quad \Leftrightarrow \quad \psi \left[Ah^\alpha - \frac{\sigma_L \frac{h^{1+\eta}}{1+\eta}}{U'_{C_H}} \right] = \frac{\overline{\omega}}{\chi} V^{1-\psi} \tag{23}$$

with $\epsilon_{Z^*/\phi}$ the elasticity of foreign imports (i.e., home exports $X = Z^*$) and $\epsilon_{X^*/\phi}$ the elasticity of foreign exports (i.e., home imports) with respect to terms of trade ϕ.

Equation (20) determines the optimal arbitrage between home and foreign goods. The social planner, in choosing the terms of trade, acts as a monopolist who is able to take the impact of her price setting on the relative demand for goods coming from abroad into account. By doing so, she extracts a part of the surplus of the foreign agents, whose magnitude is scaled by the foreign demand price elasticity. Using our functional forms, this markup is equal to $\mu^* = \frac{\sigma^*}{\sigma^*-1} > 1$, decreasing with the price elasticity of foreign demand σ^*. The optimal level of government expenditures equalises the marginal gain to the marginal cost (Equation (21)). Equation (22) equalises the marginal rate of substitution between hours and consumption of the home good to the marginal product of labor, while Equation (23) determines the optimal value of job vacancies.

Solving the model Using functional forms and given the resource constraints (18) and (19), we obtain:

$$\begin{aligned} C_H &= \frac{\xi}{\xi + (1-\xi)/\mu^*} (1 - \rho_g^{sp}) (Y - \overline{\omega} V) \\ \mu^* \phi C_F &= \frac{(1-\xi)}{\xi + (1-\xi)/\mu^*} (1 - \rho_g^{sp}) (Y - \overline{\omega} V) \\ G &= \rho_g^{sp} (Y - \overline{\omega} V) \end{aligned}$$

where superscript ^{sp} refers to the social planer's allocation. The markup μ^* reduces the share of foreign goods in the total basket, which is $(1-\xi)/\mu^*$ for the planner, vs $(1-\xi)$ at the decentralised equilibrium. The optimal size of the government, denoted by ρ_g^{sp}, and measured by the ratio of public spending to output (net of the cost of vacancies), is:

$$\rho_g^{sp} \equiv \frac{\Phi}{\xi + \Phi + (1-\xi)/\mu^*}$$

Notice that, the greater the market power of the planner μ^*, the larger the optimal size of the government. As public spending is domestic goods, its optimal provision is positively affected by the markup involved in the process of reallocating expenditures towards domestic products. This result is in line with Epifani & Gancia (2009), who also underline the link between trade externality and government size.

For the labor market aggregates, the planner's allocation is summarized by:

$$\frac{\overline{\omega}}{\chi}V^{1-\psi} = \psi\left[Ah^{\alpha} - \sigma_L\frac{h^{1+\eta}}{1+\eta}\left(\frac{1}{\xi+(1-\xi)/\mu^*}\right)(1-\rho_g^{sp})(Y-\overline{\omega}V)\right] \tag{24}$$

$$\Rightarrow V^{sp} = \left[\frac{\psi\chi}{\overline{\omega}}\left(\frac{1+\eta-\alpha}{1+\eta}\right)A(h^{sp})^{\alpha}\right]^{\frac{1}{1-\psi}} \tag{25}$$

$$h^{sp} = \left[\frac{\alpha A}{\sigma_L}\left([\xi+(1-\xi)/\mu^*]\frac{1}{1-\rho_g^{sp}}\right)\frac{1}{\Psi}\right]^{\nu} \tag{26}$$

with:

$$\Psi = \left(\frac{\chi A}{1+\eta}\right)^{\frac{1}{1-\psi}}\left(\frac{\psi}{\overline{\omega}}(1+\eta-\alpha)\right)^{\frac{\psi}{1-\psi}}[(1-\psi)(1+\eta)+\psi\alpha]$$

2.4 Implementing the Ramsey Policy

This section aims at characterising the optimal tax scheme that may be implemented by the government in the decentralised economy. To this aim, we analyze *i°)* the gap between the decentralised allocation and the first-best solution and *ii°)* evaluate to what extent this can be offset by the Ramsey tax policy. We assume here that the objective is to find the optimal mix of distortive tax rates τ_c, τ_f for given values of the ratios of public expenditures and lump-sum taxes (or transfers) ρ_g and ρ_T, as well as the unemployment benefit ratio ρ_b (with $\widetilde{b} = \rho_b wh$), and the employee's tax rate τ_w. Contemplating the whole set of equations characterising the decentralised economy, it must be noted that the three tax rates (τ_c, τ_f, τ_w) affect the decentralised equilibrium only in a joint manner through the tax wedge $TW = \frac{(1+\tau_c)(1+\tau_f)}{1-\tau_w}$, with $TW = 1$ for $\tau_f = \tau_c = \tau_w = 0$, and increasing above 1 with each (positive) tax rate.

2.4.1 Inefficiencies and Second-Best Policy

Given that the fiscal tools available to the government (i.e., the tax wedge) have a direct effect on quantities (more precisely, hours) but not on prices (ϕ), we can infer that the Ramsey tax policy is likely to fail in offsetting the trade externality, measured by the discrepancy between the decentralised and the planner's sharing rules between home and foreign goods. This is formally stated in Proposition 1.

Proposition 1. *$\forall\tau_i$, $i = c, f, w$, and as long as $\sigma^* < \infty$, the share of foreign goods is too large in the decentralised economy. Everything else equal, this induces an excessive price of imports in* *the decentralised economy ($\phi^{dec} > \phi^{sp}$). The magnitude of the gap is inversely related to the price elasticity of foreign imports (σ^*).*

Proof. Recalling here Equations (8) and (20), and with $\mu^* = \frac{\sigma^*-1}{\sigma^*} \in [0,1]$, it comes that:

$$\frac{C_H}{\phi C_F} = \begin{cases} \frac{\xi}{1-\xi} & \text{if decentralised economy} \\ \frac{\xi}{(1-\xi)/\mu^*} & \text{if planner} \end{cases}$$

implying that $\frac{C_H^{dec}}{\phi^{dec} C_F^{dec}} < \frac{C_H^{sp}}{\phi^{sp} C_F^{sp}}$, by noticing that $\mu^* > 1$ as long as domestic and foreign goods are imperfect substitutes ($\sigma^* < \infty$). Given that $C_F = \phi^{\sigma^*-1}$, we deduce that:

$$\phi = \begin{cases} [(1-\xi)(1-\rho_g)(Y - \varpi V)]^{\frac{1}{\sigma^*}} & \text{if decentralised economy} \\ \left[\frac{1-\xi}{\mu^*\xi + (1-\xi)}(1-\rho_g^{sp})(Y - \varpi V)\right]^{\frac{1}{\sigma^*}} & \text{if planner} \end{cases}$$

implying, assuming that everything else equal quantities are at their first-best values, that $\phi^{dec} > \phi^{sp}$ as $\frac{1-\xi}{\mu^*\xi+(1-\xi)}$ is decreasing in μ^*. □

The consequences of a terms of trade externality, arising in an open economy facing a less-than-infinite price elasticity of foreign demand, is well documented in the trade literature, as discussed by Corben (1984) and debated in the context of the World Trade Organization (Bagwell & Staiger (1990), among others). We differentiate ourselves from these papers (see e.g. Costinot et al. (2013)) by studying the implications of the terms of trade externality for tax policy in a general equilibrium setting, in connection with other distortions such as labor market imperfections. Moreover, our originality is to study how "domestic" fiscal tools, rather that trade taxes, can be used as protectionist tool. Proposition 1 has thus important implications regarding tax policy, stated in the following corollary.

Corollary 1.1. *Given the absence of any fiscal tool that directly affects the relative price of imports (such as trade taxes and tariffs), the optimal sharing rule between home and foreign goods, and consequently the first-best value of the terms of trade, cannot be reached. Accordingly, the optimal Ramsey taxation can only achieve a second-best allocation where the sharing rule between foreign and home goods is biased in favour of foreign goods.*

2.4.2 Characterizing the Ramsey Tax Wedge

We now turn to characterizing the (second-best) Ramsey tax policy. To do so, we adopt a two-step reasoning. We first determine the Ramsey tax wedge TW. We then use this result to derive the optimal payroll tax rate τ_f given the exogenous values of the employee's tax rate (τ_w) as well as ρ_g, ρ_T and ρ_b, and given the government's budget constraint that determines the endogenous required adjustment of the indirect tax rate τ_c.

Consider first the Ramsey problem relative to the overall tax wedge TW. The Ramsey problem consists in choosing the tax wedge TW so as to maximize the welfare function (4), subject to technological constraints (Equations (1) and (5)), the optimal behaviors of the agents and market equilibria, as summarized by the two key relations: *i°)* between hours worked h and TW as given by Equation (17), and *ii°)* the relation between vacancies and hours worked as given by Equation (16):[17]

$$
\begin{aligned}
&\widetilde{\mathcal{U}} = \max_{TW} \left\{ \left[\xi + (1-\xi)\frac{1}{\mu^*} + \Phi \right] \log(Ah^\alpha \chi V^\psi - \overline{\omega} V) - \chi V^\psi \sigma_L \frac{h^{1+\eta}}{1+\eta} \right\} && (27)\\
\text{s.t.}\quad &\frac{\overline{\omega}}{\chi} V^{1-\psi} = \epsilon \left[\frac{1+\eta-\alpha}{1+\eta} A h^\alpha - b \right] && (28)\\
&\sigma_L \frac{h^{1+\eta}}{1+\eta} (1-\rho_g) TW (Ah^\alpha \chi V^\psi - \overline{\omega} V) = \frac{\alpha}{1+\eta} A h^\alpha && (29)
\end{aligned}
$$

The first constraint (28) implicitly defines $V = \mathcal{V}(h)$, whereas the second constraint (29) is such that $h = \widetilde{\mathcal{H}}(TW, \mathcal{V}(h))$ which implicitly define a relation between h and TW, denoted by $h = \mathcal{H}(TW)$. The Ramsey problem is then:

$$
\max_{TW} \widetilde{\mathcal{U}}(\mathcal{V}(\mathcal{H}(TW)), \mathcal{H}(TW))
$$

where $TW = TW(\tau_f, \tau_c)$. Given the previous notations, the FOC of the Ramsey problem can be reformulated as:

$$
\mathcal{H}'(TW^R) \times \left[\mathcal{V}'(h) \widetilde{\mathcal{U}}'_V + \widetilde{\mathcal{U}}'_h \right] = 0 \qquad (30)
$$

where:

$$
\begin{aligned}
\widetilde{\mathcal{U}}'_V &= \psi \left(Ah^\alpha - \sigma_L \frac{h^{1+\eta}}{1+\eta} \frac{1}{\xi + (1-\xi)/\mu^*} (1-\rho_g^{sp})(Y - \overline{\omega} V) \right) - \frac{\overline{\omega}}{\chi} V^{1-\psi} && (31)\\
\widetilde{\mathcal{U}}'_h &= \alpha A h^{\alpha-1} - \sigma_L h^\eta \frac{1}{\xi + (1-\xi)/\mu^*} (1-\rho_g^{sp})(Y - \overline{\omega} V) && (32)
\end{aligned}
$$

These two components of the FOC (30) are identical to the FOC of the planner problem (Equations (24) and (26)). But, for the planner, they are simultaneously equal to zero, whereas for the Ramsey problem, a linear combination of them is a sufficient condition for the optimality.

Proposition 2. *The optimal tax scheme lies between the fiscal policy that reduces the gap with respect to the intensive margin of labor (hours worked, $\widetilde{\mathcal{U}}'_h = 0$) and the one that reduces the gap with respect to employment (through vacancies, $\widetilde{\mathcal{U}}'_V = 0$).*

[17] Notice that this expression is not the welfare function strictly speaking, as terms that are independent of TW, V and h have been omitted.

Proof. Recall that constraints (28) and (29) of the Ramsey problem can be rewritten as follows:

$$\begin{aligned} 0 &= \epsilon\left[Ah^{\alpha} - b - \sigma_L \frac{h^{1+\eta}}{1+\eta} TW^R(1-\rho_g)(Y-\overline{\omega}V)\right] - \frac{\overline{\omega}}{\chi}V^{1-\psi} \\ 0 &= \alpha A h^{\alpha-1} - \sigma_L h^{\eta} TW^R (1-\rho_g)(Y-\overline{\omega}V) \end{aligned}$$

As the Ramsey tax wedge TW^R is such that these two constraints and (30) are simultaneously verified, it is not possible to also satisfy $\widetilde{\mathcal{U}}'_h = 0$ or/and $\widetilde{\mathcal{U}}'_V = 0$. These constitute two additional restrictions which cannot be simultaneously handled by a single fiscal tool. □

Hence, in the general case with labor market distortions, the Ramsey tax scheme cannot simultaneously eliminate the two biases on the extensive and the intensive margin of labor. Beyond its inability to manage the terms of trade externality, the government can thus only reduce the employment and hour gaps, without being able to eliminate them both.

These results have important implications for tax policy. Given that distortive taxation simultaneously affects hours worked and vacancies (by decreasing them both), it may indeed be optimal to manipulate taxes to correct for labor market inefficiencies. Things are not so clear-cut though, as labor market frictions do not affect the extensive and the intensive margin of labor in a similar direction. From Equation (17), it can be shown that labor market frictions, either through unemployment benefits ($\rho_b > 0$) or too strong a bargaining power for workers ($\epsilon < \psi$), increase the equilibrium value of hours worked relative to their first-best level (i.e., $h^{dec} > h^{sp}$):[18] When the number of employees is restricted by labor market frictions, the market allocation compensates for this inefficiency by an over-adjustment of hours per worker. If we assume the government only focuses on the intensive margin of labor, it calls for an increase in the tax wedge. In contrast, it is clear from Equation (16) that either $\rho_b > 0$ or $\epsilon < \psi$ have a dampening effect on vacancies (everything else equal for a given h), thereby calling for a reduced tax wedge. Given the contradictory effect of labor market frictions on the intensive and extensive margin of labor, this suggests that an optimal tax scheme may exist.

When Hosios conditions hold on the labor market. This constitutes a special case of interest, as it allows us to isolate the intensive margin on the labor market. Assuming that $\rho_b = 0$ and $\epsilon = \psi$, the optimal Ramsey tax, denoted TW^H, can indeed be devoted to one objective, restoring the efficiency of the hours worked. This is formally stated in Proposition 3.

Proposition 3. *In the absence of labor market distortions ($\epsilon = \psi$ and $b = 0$), the optimal policy allowing the government to reach the first best with respect to the aggregates ($h^{dec} = h^{sp}$, $V^{dec} = V^{sp}$,*

[18] Elements of demonstration are provided in the online Appendix (Section A.4).

$N^{dec} = N^{sp}$ and $Y^{dec} = Y^{sp}$) is:

$$\begin{aligned} & TW^H = \frac{1-\rho_g^{sp}}{1-\rho_g} \frac{1}{\xi + (1-\xi)/\mu^*} > 1 \qquad (33) \\ \Rightarrow \quad & \tau_c + \tau_f + \tau_w \approx \rho_g - \rho_g^{sp} + t^* \qquad \textit{with} \;\; 1 + t^* = \frac{1}{\xi + (1-\xi)/\mu^*} \end{aligned}$$

Proof. If $\epsilon = \psi$ and $b = 0$, then $\Theta = \Psi$. Using this result and Equations (26) and (17), we deduce (33) insuring $h^{dec} = h^{sp}$. From Equation (16), we then deduce that $V^{dec} = V^{sp}$ and from Equations (1) and (5), that $N^{dec} = N^{sp}$ and $Y^{dec} = Y^{sp}$. □

Corollary 3.1. *In the absence of labor market distortions ($\epsilon = \psi$ and $b = 0$), fiscal revaluation is optimal in order to exploit the terms of trade externality and to correct for an excessive size of the government. From Equation (33), we indeed deduce that:*

$$TW^H > 1 \quad \textit{as long as} \quad \mu^* > 1 \; (\leftrightarrow \;\; t^* > 0) \quad \textit{and/or} \quad \rho_g > \rho_g^{sp}$$

This can be interpreted as fiscal revaluation, as increasing TW also implies a reduction in the terms of trade ϕ.

Proof. The decreasing link between TW and ϕ is straightforward to establish, starting from Equation (17), which indicates that hours worked are decreasing with the tax wedge. Manipulating the model's equations[19], we can infer that net output is also decreasing with the tax wedge: $Y - \varpi V = \Theta h^{\frac{\alpha}{1-\psi}}$. As shown in Proposition 1, terms of trade ϕ are monotonically increasing with $Y - \varpi V$. Accordingly, increasing the tax wedge induces a reduction in the terms of trade: This justifies our interpretation of such policy as fiscal revaluation. □

These results drive the following interpretation. First, when public spending is efficient ($\rho_g^{sp} = \rho_g$), $TW^H > 1$ as the trade externality ($t^* > 0$) requires positive distortive tax rates: Taxes are used to reduce the quantities exchanged.[20] As made in clear in Corollary 3.1, this a fiscal revaluation.[21]

Second, if $\rho_g > \rho_g^{sp}$, then $TW^H > 1$: It is optimal to compensate the effects of an excessive of public spending by a high tax burden. The underlying mechanism is straightforward: The high tax burden induces the households to forgo private consumption. As such, this policy (indirectly)

[19]See the web Appendix for details.

[20]This theoretical result finds some empirical support in the data. Epifani & Gancia (2009) thus document that trade openness is associated with a larger government size. However, this is only indirect evidence as the direct link between trade and taxation *per se* is not studied.

[21]Note that we refer to fiscal devaluation/revaluation (which by nature refers to a *change* in tax rates, hence in terms of trade ϕ) by analysing the *level* of the overall tax wedge (i.e., $TW \gtrless 1$). This slight abuse of terminology in fact amounts considering as "benchmark" situation the decentralized economy with no distortive taxation (ie, $TW = 1$).

indicates to households that part of total spending (entering in their utility function) is already provided for by the government, thereby allowing to internalize the externality of public spending.[22] Hence, because there is no conflicting arbitrage between the extensive and the intensive margin when the Hosios condition is satisfied, increasing the overall tax wedge (i.e., fiscal revaluation) allows to remove the trade externality and the inefficient government size, so as to reach the first-best value of the hours worked, thus vacancies, employment and aggregate output.

With exogenous hours worked. This constitutes a second special case of interest, as this allows us to isolate the extensive margin of labor. In this case, the optimal Ramsey tax, denoted TW^V, can indeed be devoted to restore the efficiency of employment.

Proposition 4. *If hours worked are fixed at an exogenous level $\overline{h}$, then $\widetilde{\mathcal{U}}'_h$ does not exist. In this case, the optimal taxation scheme is:*

$$TW^V = \frac{1-\rho_g^{sp}}{1-\rho_g}(1+t^*) - \frac{\left(\frac{1}{\epsilon}-\frac{1}{\psi}\right)\omega(V^{sp}|_{\overline{h}})^{1-\psi}+b}{\sigma_L\frac{\overline{h}^{1+\eta}}{1+\eta}(1-\rho_g)(Y^{sp}|_{\overline{h}}-\omega V^{sp}|_{\overline{h}})} \tag{34}$$

with $Y^{sp}|_{\overline{h}}$ and $V^{sp}|_{\overline{h}}$ the (known) first-best values of output and vacancies for given hours worked $\overline{h}$.

Proof. We have $V_R = V_{sp}$ (conditional on $\overline{h}$) if and only if:

$$(\epsilon-\psi)A\overline{h}^{\alpha} - \epsilon b + \psi\sigma_L\frac{\overline{h}^{1+\eta}}{1+\eta}\frac{Y-\varpi V}{\left[\xi+(1-\xi)\frac{1}{\mu^*}+\Phi\right]} = \epsilon\ TW\ \sigma_L\frac{h^{1+\eta}}{1+\eta}(1-\rho_g)(Y-\varpi V)$$

One can then derive the optimal tax wedge value as stated in Proposition 4. □

Corollary 4.1. *When $\epsilon \neq \psi$ and $b \neq 0$, fiscal devaluation can be optimal (ie. TW^V can be lower than 1) if and only if labor market frictions induce higher distortions than the government size and the trade externality.*

This solution for the optimal taxation in an economy without an intensive margin shows the constraints faced by the government on the extensive margin of labor. On the one hand, the trade externality ($t^* > 0 \Leftrightarrow \sigma^* < \infty$) and excessive public spending ($\rho_g > \rho_g^{sp}$) call for increased taxation. On the other hand, labor market frictions ($b > 0$ or $\epsilon < \psi$) require a lower tax burden.

[22] The above reasoning implicitly assumes an endowment economy, in which tax policy affects the sharing between private and public consumptions. The argument also holds in an economy with production. In this case, raising the overall tax wedge also distorts labor supply and production downwards, again pointing in the same direction as exploiting the terms of trade externality through fiscal revaluation.

From Equation (34), it is clear that the optimal tax burden is strictly positive as long as the first two dimensions dominate the inefficiency induced by labor market frictions.

2.4.3 Indirect Versus Direct Taxation

If we now reformulate the Ramsey problem in terms of optimal labor taxation, the FOC of the Ramsey problem with respect to τ_f is:

$$\mathcal{H}'(TW)\left[\frac{\partial TW}{\partial \tau_f}+\frac{\partial TW}{\partial \tau_c}\frac{\partial \tau_c}{\partial \tau_f}\right]\times\left[\mathcal{V}'(h)\widetilde{\mathcal{U}}'_V+\widetilde{\mathcal{U}}'_h\right]=0 \tag{35}$$

In view of Equation (35), two cases should be considered. First, if $\left[\frac{\partial TW}{\partial \tau_f}+\frac{\partial TW}{\partial \tau_c}\frac{\partial \tau_c}{\partial \tau_f}\right]=0$. In this case, any change in the payroll tax is offset by the opposite change in the indirect tax, such that it does not affect the tax wedge. Consequently, changing the payroll tax rate has no impact on hours worked or vacancies and more broadly on the decentralised equilibrium allocation. Secondly, if $\left[\frac{\partial TW}{\partial \tau_f}+\frac{\partial TW}{\partial \tau_c}\frac{\partial \tau_c}{\partial \tau_f}\right]\neq 0$. In this case, under the Ramsey allocation the government is able to manipulate the payroll tax rate such that it improves the decentralised allocation. It is the government budget constraint that determines the condition under which changes in direct taxation are offset or not by the opposite change in indirect taxation. This leads to Proposition 5, which we refer to as the "tax base" effect.

Proposition 5. *Starting from an initial allocation with an excessive tax burden, it is optimal to switch from direct labor taxation to indirect taxation if the wage share of output is lower than the consumption share of output. Indeed, for non-negative labor tax rates τ_w,τ_f and with $C\equiv C_H+\phi C_F$ aggregate consumption, the condition $\frac{C}{Y-\varpi V}>\frac{wNh}{Y-\varpi V}$ is a sufficient condition for $\frac{dTW}{d\tau_f}>0$ given the required adjustment in τ_c.*

Proof. Using the decision rules, the budgetary constraint of the government is:

$$\tau_c(1-\rho_g)+\frac{\tau_f+\tau_w}{1+\tau_f}+\rho_T=\rho_g+(1-\tau_w)\rho_b\frac{1-N}{N}$$

where we assume that $\frac{b}{1+\tau_f}=\rho_b wh \Rightarrow \frac{b}{1+\tau_f}N=\rho_b(Y-\omega V)$. We thus deduce that a sufficient condition for $\left|\frac{d\tau_c}{d\tau_f}\right|<1$ is

$$\frac{1-\tau_w}{1+\tau_f}\frac{whN}{Y-\omega V}<\frac{C_H+\phi C_F}{Y-\omega V}+\rho_b\varepsilon\frac{\tau_f-\tau_c}{TW}$$

where $\varepsilon\equiv -N'(TW)\frac{TW}{N}$ stands for the elasticity of employment to the tax burden. If $\frac{whN}{Y-\omega V}<\frac{C_H+\phi C_F}{Y-\omega V}$, then $\left|\frac{d\tau_c}{d\tau_f}\right|<1$ because $\frac{1-\tau_w}{1+\tau_f}<1$ and $\rho_b\varepsilon\frac{\tau_f-\tau_c}{TW}>0$.

□

The tax base condition stated in Proposition 5 is a sufficient condition for a decrease in τ_f to be compensated for by a less than proportional increase in τ_c, in which case the overall size of the tax distortion TW decreases. Importantly, one has to note that the tax base condition is satisfied empirically.[23] In this respect, asking the question of direct versus indirect taxation is more than of theoretical interest. If the single source of consumption expenditures came from labor revenues, the question would be pointless. However, in a (realistic) environment where households have other sources of revenues, our results demonstrate the relevance of switching from direct to indirect taxation: as long as the tax base condition holds, which is the case in the data, it is optimal to do so, as long as implementing the Ramsey tax policy requires alleviating the overall tax burden in the economy. In this respect, these analytical results call for a quantitative assessment. This is the purpose of next section.

3 Optimal Labor Taxation: a Quantitative Assessment

The dynamic general equilibrium (DGE) model remains close to our analytical setup in many respects. The open economy dimension in particular is similarly modeled, as we stick to the analytical import and export functions and we still discard foreign debt analysis. As in the analytical setup, we also preserve the assumption of a balanced budget.[24] The main extension consists in including capital dynamics, which enables us to quantify the role of transitional dynamics in shaping the optimal tax scheme. In addition, with the DGE, we can assess the impact of alternative fiscal adjustments, as in Prescott (2004).

3.1 The Model

In what follows, we provide a brief overview of the model, putting particular emphasis on the aspects that differ from the analytical setup. A more detailed presentation of the DGE model is made in the online appendix (Section B).

Labor market modeling Employment is predetermined at each time and changes only gradually as workers separate from jobs, at the exogenous rate s $(0 < s < 1)$, or unemployed agents find jobs. The matching function is identical to that in the previous section, except that we now introduce an endogenous search effort, denoted by e_t. Thus, at each date t, the number of unemployed workers

[23] We have verified that this holds for a large number of countries over the recent decades, using OECD data on national accounts. Results are available upon request.

[24] Public debt introduces an additional instrument for the government that affects the intertemporal trade-off. Foreign debt also introduces an additional externality in the Euler equation, thereby affecting the mechanisms allowing the small open economy to have a saddle path. The study of the impact of tax policies on this dynamic inefficiency is left for future research.

in efficiency units is $e_t(1-N_t)$ and thus employment evolves as follows:

$$N_{t+1} = (1-s)N_t + M_t \quad \text{ with } M_t = \chi V_t^{\psi}\left[e_t(1-N_t)\right]^{1-\psi}, \quad 0 < \psi < 1 \tag{36}$$

The labor force is constant and normalised to one, then $1 - N_t$ is also the unemployment rate.

The household The representative household's preferences are now given by:

$$\mathcal{U} \quad = \quad \sum_{t=0}^{\infty} \beta^t \left[U(C_t, N_t, h_t, e_t) + \Phi \log G_t\right] \tag{37}$$

$$\text{with} \qquad U(C_t, N_t, h_t, e_t) = \log C_t + N_t \Gamma_t^n(h_t) + (1-N_t)\Gamma_t^u(e_t) \tag{38}$$

with $\Gamma_t^n(h_t) \equiv -\sigma_L \frac{h_t^{1+\eta}}{1+\eta}$ and $\Gamma_t^u(e_t) \equiv -\sigma_u \frac{e_t^{1+\eta}}{1+\eta}$ the disutility of working and searching for a job respectively. The aggregate current consumption (C_t) is spread over domestic goods (C_{Ht}) and imports (C_{Ft}), given CES preferences with elasticity of substitution η:

$$C_t = \left[\xi^{\frac{1}{\eta}} C_{Ht}^{\frac{\eta-1}{\eta}} + (1-\xi)^{\frac{1}{\eta}} C_{Ft}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \qquad \eta > 1 \tag{39}$$

As in the analytical setup, the household is subject to lump-sum taxes T and distortive taxation (with a direct labor tax τ_w and an indirect tax τ_c). Unemployed people still receive unemployment benefits b.

Firms There are many identical firms in the economy producing a homogeneous good at price 1. Each firm has access to a Cobb-Douglas production technology to produce output:

$$Y_t = AK_t^{1-\alpha}(N_t h_t)^{\alpha}, \quad 0 < \alpha < 1 \tag{40}$$

A is the global productivity of factors in the economy (assumed to be constant) and K_t the physical capital stock, whose law of motion is:

$$K_{t+1} = (1-\delta)K_t + I_t \tag{41}$$

with $0 < \delta < 1$ the capital depreciation rate and I_t the aggregate investment. To preserve homogeneity in the aggregate demand, the investment is assumed to be a CES aggregator with the same elasticity of substitution as the consumption basket (Equation (39)).[25] Search frictions require firms to post vacant jobs to be matched by unemployed workers. Accordingly, each firm chooses a number V_t of job vacancies, the unit cost of maintaining an open vacancy being $\overline{\omega}$. As in the analytical

[25] For the same reason, we also make this assumption for public spending G_t and the cost of job posting in the search model $\overline{\omega} V_t$.

model, firms are subject to direct labor taxation, scaled by the payroll tax rate τ_f.

Wages, hours and search effort In the presence of labor market search frictions, the match between a worker and a firm gives rise to a rent, which is shared by both players through a bargaining process. We assume that wages and hours are determined via generalised Nash bargaining according to $\max_{w_t,h_t}(\lambda_t \mathcal{V}_t^F)^{\epsilon}(\mathcal{V}_t^H)^{1-\epsilon}$, with $\mathcal{V}_t^F$ the marginal value of a match for a firm and $\mathcal{V}_t^H$ the marginal value of a match for a worker. The negotiated values for hours worked and wages are respectively given by:

$$
\begin{aligned}
\alpha \frac{Y_t}{N_t h_t} &= TW_t \sigma_L h_t^{\eta} P_t C_t && (42)\\
(1+\tau_t^f) w_t h_t &= \epsilon \left[b_t + TW_t \left(\Gamma_t^u - \Gamma_t^n \right) P_t C_t \right] + (1-\epsilon) \left[\alpha \frac{Y_t}{N_t} + SC_t \right] && (43)\\
\text{with} \qquad & SC_t \equiv \overline{\omega} \left[\frac{1-s}{q_t} \left(1 - \frac{1+\tau_t^f}{1+\tau_{t+1}^f} \frac{1-\tau_{t+1}^w}{1-\tau_t^w} \right) + e_t \theta_t \left(\frac{1+\tau_t^f}{1+\tau_{t+1}^f} \frac{1-\tau_{t+1}^w}{1-\tau_t^w} \right) \right]
\end{aligned}
$$

where SC_t refers to search costs and θ_t is the labor market tightness (standardly defined as $\theta_t = V_t/(e_t(1-N_t))$. As shown by Equation (42), with an efficient bargaining process over wages and hours, the optimal choice of hours worked by the employee is close to the Walrasian case (up to payroll tax rates). In contrast, according to Equation (43), the wage contract is a weighted average of the worker's outside option and the marginal product of a match, where the relative weights depend on the relative bargaining power of both players, distorted by the tax rates. Finally, given the sharing rule determined by the Nash programme, the optimal search effort level is given by:

$$
\frac{1-\epsilon}{\epsilon} \overline{\omega} \theta_t = TW_t \sigma_u e_t^{\eta} C_t \qquad (44)
$$

Government budget constraint and market equilibria As in the analytical framework, we assume a balanced budget for each period with $P_t G_t = \rho_g Y_t$ and $P_t T_t = \rho_T Y_t$. In Section 3.2.3, we will measure how our results change if we modify this assumption. The model is closed by taking the equilibrium conditions on the home and foreign good markets into account, as well as the zero-trade balance condition. The functional forms for the export and import functions are identical to the analytical framework (Equations (2) and (3)).

3.2 The Optimal Tax Scheme: a Quantitative Assessment

We consider France as the benchmark economy, as it exemplifies a rigid labor market. We thus proceed to a careful calibration of the deep parameters of the model (full details are provided in Appendix A).

3.2.1 Calibration and Method

Calibration. We briefly detail the calibration of the key parameters here, as highlighted in Section 2. At the benchmark equilibrium, the model matches the tax base difference in consumption and payroll taxes. The initial taxes are $\{\tau^f = 0.34, \tau^c = 0.22, \tau^w = 0.13\}$. The Hosios condition does not hold as $\rho_b = 0.37$, which is consistent with French data over the recent decades. The price elasticity of foreign demand for domestic goods σ^* is set equal to 1.5, as for η, thus following Backus et al. (1995).[26] The calibration for Φ, which captures the valuation of public spending in the utility, is an open question. In contradiction with Prescott (2004) and others, we believe that it is essential to discuss the optimal tax design in an environment where taxes are used to finance valuable public spending. In terms of calibration, this imposes $\Phi > 0$. There is however no clear benchmark value in the related literature. Our calibration for Φ obeys the following reasoning, based on the actual record of public spending in national accounts.[27] Government spending G is separated in two components, "collective" consumption expenditures (defense, justice, police, collective equipments, etc., hereafter denoted G^c) and "individual" consumption expenditures (health, education, etc.). This last category can in fact be considered as representing social transfers "in kind", as they could be directly handled by households provided adequate social monetary transfers from the government. To calibrate Φ, we thus assume that the Home planner limits public spending to items that only fall into "collective" consumption expenditures, as these cannot be bought by single consumers alone (the rest of public expenditure being efficiently allocated by the market). Then we pick the calibration for Φ on the actual ratio between collective consumption expenditures and private consumption in France (thereby assuming that this corresponds to its optimal level), which yields $\Phi = G^c/C = 0.10$.[28]

Method: Welfare cost and the optimal policy. In the spirit of Lucas (1987) and (2003), the welfare gain (or loss) from a given reform is evaluated by the compensation ζ such that:

$$\mathcal{W}\left[\left\{(1+\zeta)C^0, N^0, h^0, G^0\right\}_{t=0}^{\infty}\right] = \mathcal{W}^*\left[\{C_t^*, N_t^*, h_t^*, G_t^*\}_{t=0}^{\infty}\right] \tag{45}$$

A positive (negative) value of ζ means that the reform is welfare improving (welfare deteriorating). To determine the optimal tax policy, we derive the values of ζ associated with various ranges of tax reforms. Following the pioneering contributions of Kydland & Prescott (1977) and Barro & Gordon

[26] This calibration lies within the range of values commonly used in the international macroeconomic literature, typically between 1 and 2.

[27] Precisely, as adopted by the OECD countries and by the French national statistical office, the INSEE, from which we take our data for calibration purposes.

[28] See Appendix A for details. Also note that the same spirit of calibration can be found in Christiano et al. (2011) or Coenen et al. (2013). These authors pick Φ such that the model replicates the observed PG/Y ratio, and thus assume that the actual size of the government is optimal. We share the view that government actually chooses optimally its spending, but only for the "collective" spending. Thus, we diverge from the view that all the government expenditures cannot be made by households (the individual consumption expenditure), leading us to introduce only *collective* consumption expenditure in the utility function.

(1983), the credibility problem associated with optimal policy has stimulated a huge literature. Its central message is the existence of significant gains from "enhancing credibility" through formal commitment to a policy rule or through institutional arrangements. Nevertheless, there are vivid debates in the literature regarding the appropriateness of conducting fully optimal Ramsey-type policies rather than "simple" rules. Proponents of simple rules emphasize both their simplicity and transparency, and their robustness to model-misspecification (see e.g. McCallum (1999) or Taylor & Williams (2011)). We adopt this view by considering the following "simple" tax reform: The government commits *ex-ante* for a new constant payroll tax rate τ^f, adjusting the indirect tax rate τ^c periodically to fulfill its budget constraint during the transition path.The optimal scenario $\{\tau^f, \tau_t^c | \rho_g, \rho_T, \tau^w\}_{t=0}^{\infty}$ is thus chosen such that ζ is maximized, for an initial jump in τ^f, a budgetary adjustment via a time-varying consumption tax τ_t^c, and keeping the other instruments as their previous values.[29]

3.2.2 Steady-State impact of the Tax Reform

In this section, we study the optimal tax reform when we abstract from the transition. One interest of this experiment is to provide a quantitative assessment of our analytical results. In particular, we can evaluate the sensitivity of the optimal tax scheme and the induced welfare gains, to aligning the government size on its efficient value (Proposition 3) and to the magnitude of labor market frictions (Proposition 2). To be more specific, we determine the optimal tax scheme in a steady state economy under here three alternative scenarii: *i°)* for the excessively large government size and stringent labour market institutions (as in the benchmark French case, $\rho_g > \rho_g^{sp}$ and $\rho_b > 0$), *ii°)* when the government also targets the efficient provision of public spending (modifying taxes along with setting $\rho_g = \rho_g^{sp}$), and *iii°)* when it is also able to eliminate labor market frictions (i.e., for $\rho_b = 0$). In this respect, running this experiment goes far beyond simply quantifying the analytical results. In our view, it constitutes an attempt to answer the very naive -but key question: Where is it better to live in? Suppose the agent (in the benchmark French economy) can choose her place to be, where does she get the larger welfare gains? The answer gives an evaluation of the inefficiencies that can be corrected by the taxes in each place, and thus an upper bound of the optimal tax reform, abstracting from the transitional costs which are conditional to the current state of the economy.

In the first scenario, we characterize the optimal tax reform (ie, the optimal tax wedge TW and its articulation $\{\tau_f, \tau_c\}$, for given labour market institutions and government size (as observed in French data). In this case, the optimal tax scheme is reached for $\{\tau_f^R = -0.69, \tau_c^R = 2.63\}$, whereas in the benchmark economy (French tax system) we have $\{\tau^f = 0.34, \tau_c = 0.22\}$. This implies a

[29] Given the budgetary constraint of the government, the change in τ^f can be accompanied by a another tax change than the one of the consumption tax, for example a change in the lump sum transfers (the level T or the share ρ_T) or in the government spending (the level G or the share ρ_g). All these scenarii will be evaluated and discussed.

reduction in the tax wedge TW from 1.88 to 1.29. This fiscal devaluation scenario induces welfare gains equivalent to 2.99% increase in permanent consumption.[30]

One may then wonder, what are the welfare costs of an excessive size of the government? To answer the question, we determine the optimal long-run tax scheme when the government size matches its efficient value (i.e., $\rho_g = \rho_g^{sp}$). In accordance with Proposition 3, this suppresses one motive to impose distortive taxes in the economy. Put it differently, this strengthens the need to subsidize labor, meaning a stronger fiscal devaluation: $\{\tau_f^R = -0.69, \tau_c^R = 1.84\}$, implying a tax wedge equal to 1.01, along with a reduction of the government size from $PG/Y = 24\%$ to $PG/Y = 7.92\%$. This "double reform" scenario induces substantial welfare gains, that now amount to 17.05% increase in permanent consumption. In accordance with Proposition 3, if G/C is equal to Φ, lower taxes are needed to get closer to the optimal allocation. Moreover, the difference in welfare between these two scenarii (14 percentage points in consumption) gives a measure of the crowding out effect by public spending of a fiscal devaluation.

Even if the size of the crowding-out effect is large, this should not lead us to conclude that the most important distortion is linked to a downward rigidity in the size of the State. One can only conclude that the direct choice of public spending is more effective than the indirect manipulation of labor wedges via distortive taxes. To assess the welfare costs of labor market rigidities, it is necessary to measure welfare in their absence. In comparison with the benchmark economy, the welfare gain reached by the Home planner would bring an increase in permanent consumption of 28%. In view of the gain of aligning the government size on its efficient value (17%), this indicates that substantial welfare gains remain to be achieved, would the decentralized government also reform the labor market.[31]

3.2.3 Taking the Dynamics of the Tax Reform into Account

Optimal tax reform and transition dynamics To what extent is the optimal tax scheme modified by taking transition dynamics into account? The quantitative results are very different.[32] Starting from the benchmark current tax policy $\{\tau^f = 0.34, \tau^c = 0.22\}$, the optimal tax reform is reached for $\{\tau_f^R = 0.0275, \tau_c^R = 0.44\}$. This contrasts with the analysis focusing only on the steady

[30]From Equation (45) (adjusted to the long-run situation), we get $\zeta^{LT} = \exp(\mathcal{W}^* - \mathcal{W}^0) - 1 = 0.0299$.

[31]One should pay attention to not put the two reforms (the government size and labour market reforms) on the same level though. First, the government has direct power of changing both taxes and public spending. In contrast, reforming labor market institutions is a much more complex exercise from a political economy point of view, notably implying negotiations with social partners such as trade unions. Second, we start from an economy where the employment rate is high ($N = 0.9$). Due to decreasing returns to scale, labor market reforms only have a moderate impact in terms of employment and production. In our view, this contributes to explain why, in quantitative terms, welfare gains of reforming the labor market may appear modest in comparison with adjusting the government size (A 10 percentage point increase in consumption when moving from Scenario *(ii)* to Scenario *(iii)*).

[32]The hump-shape welfare curve associated to varying tax couples (τ_f, τ_c is reported in Figure 1, Section C.1. of the online Appendix.

state. The difference with the steady-state optimal tax reform comes from the bigger responses of hours worked in the short run. Indeed, workers prefer to smooth their consumption and work more in order to accumulate and then reach the (higher) level of capital which characterizes the final steady state. Even if the decrease in the payroll tax can be welfare improving in the long run, these potential gains are counteracted by the short-run effort necessary for the accumulation process.[33]

The quantitative effects of implementing the optimal tax reform (with transition included) are reported in Table 1, Column (1). The optimal tax reform implies an increase in the terms of trade of 3% (real devaluation), as well as an increase in total worked hours and output. On this side, most adjustment occurs along the intensive margin (as reported in Column (1), employment and hours worked per employee rise by 0.55 pp and 5.32%, respectively): By lowering the elasticity of the extensive margin, stringent labor market institutions lead the reform to favor the insiders. On the normative side, implementing the optimal tax reform results in an increase in lifetime consumption of 0.19 %. The gains from the tax policy are small. One can rationalize this result using our analytical findings: The large labor wedge asking for employment subsidies is counterbalanced by the large oversize of the government and the terms of trade externality which, at the opposite, call for higher taxes. Balancing these effects implies a moderate reduction in the overall tax wedge ($\Delta TW = -9.5\%$) which explains the moderate welfare gains induced by this tax reform. One may yet argue that these welfare gains are surprisingly much lower than those advocated by Prescott (2004), who obtains a 20 percent increase in lifetime consumption for a decrease in the tax burden of 20 percentage points. We thus go further in examining this difference in results, by studying the implications of implementing the optimal tax reform for alternative budgetary adjustments. Results are reported in Table 1.

Assessing the role of alternative budgetary adjustments First, we compare scenarios in which the government size is constant in *level* rather than constant in *relative size* (Columns (2) to (4)). Second, we evaluate a reform which implements the optimal tax scheme *and* the optimal government size simultaneously (Column (5)).

Comparing Column (2) to Column (1) of Table 1, maintaining G and T constant in level rather than relative to the GDP does not significantly increase the welfare gains from the tax reform (which rise from 0.19% to 1.46% only). In contrast, as reported in Columns (3) and (4), the welfare gains are much higher when the payroll tax cut is compensated for by an increase in lump-sum taxation (with no distortive effect, Column (3)) or even more, by reducing the government size (Column (4), scenario (d)).

The significant welfare gains in Columns (3) and (4) are reminiscent of Prescott's (2004) results

[33] In the online appendix (Section C), we present the impulse response functions of the aggregate variables when the optimal tax reform is implemented.

Table 1: Impact of alternative budget adjustments (with transition)

	1	2	3	4	5
Budget adjustment	(a)(*)	(b)	(c)	(d)	(e)(*)
τ_f^0	0.34	0.34	0.34	0.34	0.34
τ_f^1	0.0275	0.0275	0.0275	0.0275	-0.0875
τ_c^0	0.22	0.22	0.22	0.22	0.22
τ_c^1	0.440	0.407	0.22	0.22	0.222
$\Delta TW \times 100$	-9.52	-11.540	-23.321	-23.321	-31.8
$\Delta PG/Y \times 100$	0	-4.372	-9.275	-43.171	-68.3
$\Delta PT/Y \times 100$	0	-4.372	-102.87	-4.372	0
$\Delta Y \times 100$	5.451	5.739	12.898	5.739	7.679
$\Delta h \times 100$	5.317	5.599	12.627	5.599	7.496
ΔN (pp)	0.555	0.583	1.222	0.583	0.765
$\Delta \phi \times 100$	2.961	3.115	6.893	3.115	4.150
$\zeta \times 100$	0.192	1.464	2.627	11.37	14.123

In all experiments, τ_w maintained constant equal to 0.13.
^{0} and ^{1}: For the pre-reform and post-reform tax rates.
*: Identifies the optimal tax reform in this scenario.
(a) PG/Y and PT/Y kept constant (in ratios);
(b) G and T kept constant (in levels);
(c) G and τ^c constant, T adjusts;
(d) T and τ^c constant, G adjusts;
(e) Reforming both $G/C(= \Phi)$ and τ_f, PT/Y constant and τ^c adjusts.

on the benefits from lowering labor taxation. In his exercise, using a closed economy Walrasian model where public expenditures are wasteful, the decrease in proportional taxes is compensated for by an increase in lump-sum taxation (which has no distortive effect) while maintaining the level of public spending constant.[34] Table 1 contributes to putting these results into perspective. First, in contrast to Prescott's (2004) case, in benchmark scenario (a), the tax scheme is designed to preserve the size of welfare state programmes, i.e. with public spending and transfers both maintained constants (in proportion of GDP). This difference in budgetary adjustment undoubtedly moderates the decrease in tax distortions in comparison with Prescott (2004), hence the welfare gains associated with the tax reform (as may be inferred from Columns (3) and (4), in comparison with Column (1) of Table 1).

Second, the large welfare gains obtained by Prescott (2004) rely on the strong assumption that public spending is wasteful ($\Phi = 0$ in our setting). In our view, this assumption is highly disputable. From the empirical point of view first, Rogerson (2007) and Ragan (2013) show that including public expenditure as an argument in the utility function helps to explain trends in hours worked in the OECD countries. Second, from the theoretical side, Prescott's (2004) conclusion are questionable, as they rely on mixing two distinct elements, the impact of reducing distortive taxation on the one hand, and the alignment of the government size on the efficient one on the other hand.

[34] In this respect, Scenario (c) (reported in Column (3)) is the closest to Prescott's case.

In order to investigate this point, we run the following experiment. Now assuming that the government can manipulate the budget on top of taxes, at the date of the tax reform the government decides to also bring the economy to the optimal ratio of government spending to consumption ($G/C = \Phi \leftrightarrow \rho = \rho^{sp}$), in parallel to reforming labor taxation. In Column (5) of Table 1, we report the effects of the optimal tax reform in this scenario (labeled (e)).[35] In comparison with the benchmark scenario, the optimal labor tax is lower (and even slightly negative, equal to -0.0875). This is consistent with our analytical findings (Propositions 3 and 4): An excessive size of public spending provides a motive for increasing the tax burden ($\tau^{f*} = 0.0275$ in the benchmark scenario (a), Column (1))). Aligning public expenditures on their efficient value suppresses one motive for taxation, thereby enlarging the optimal magnitude of fiscal devaluation (($\tau^{f*} = -0.0875$). When the size of government is optimal, the optimal tax wedge is lower as putting more weight on counteracting labor market frictions. As a consequence, the welfare gains from the reform significantly increase, up to 14.12 % in terms of lifetime consumption.[36] These results somehow provide a better perspective on Prescott's (2004) findings. We show that substantial welfare gains can be obtained when the tax reform comes along a reduction of the government size, provided that it is initially "too" large (Column (5) vs (1)).

3.2.4 Optimal Taxation: Sensitivity Analysis

We study the sensitivity of the optimal tax reform (under benchmark scenario (a)) to the key dimensions identified in Section 2, i.e. the size of the public spending, the open-economy dimension and labor market frictions. They can respectively be captured by *i°)* Φ, which is the weight in the household utility function of the public goods, *ii°)* σ^*, which measures the sensitivity of the trade balance to the terms of trade, and *iii°)* ρ_b and $\epsilon \neq \psi$, which govern labor market frictions. The results are reported in Table 2.[37] For the sake of comparison, Column (1) recalls the benchmark results.

Sensitivity to the valuation of the public goods. In Section 2, we obtained that an excessive government size provides a motive to optimally impose distortive taxation, which amounts running fiscal revaluation ($\Delta\phi < 0$). Results reported in Column (2) of Table 2 are perfectly consistent with the analytical finding. In comparison with the benchmark scenario (Column (1)), setting $\Phi = 0$

[35] More precisely, the deterministic simulation is performed under the following assumptions. Starting from the benchmark initial steady state, the economy benefits from a drop in τ^f *and* a shift in the government spending-to-consumption ratio G/C set to Φ, consistently with the planner's optimal choice of G. The budget adjustments are still insured by the consumption tax.

[36] Welfare gains remain substantial when the payroll tax rate is aligned on its optimal value under the benchmark scenario (i.e., 0.0275), with the compensation ζ equal to 14% in this case.

[37] Note that in all experiments, the indirect tax rate in the initial steady state has been adjusted to the new environment.

Table 2: Sensitivity Analysis

	1		2		3		4		5	
	Benchmark		$\Phi = 0$		High σ^*		Low ρ_b		$\epsilon < \psi$	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
τ^f	0.34	0.0275	0.34	0.368	0.34	-0.1825	0.34	0.1675	0.34	-0.01
τ^c	0.22	0.44	0.22	0.206	0.222	0.684	0.198	0.301	0.227	0.485
TW	1.879	1.70	1.890	1.895	1.882	1.582	1.845	1.747	1.890	1.690
$\Delta TW \times 100$	-9.52		0.84		-15.92		-0.054		-10.60	
$\Delta Y \times 100$	5.45		-0.44		9.89		2.84		6.20	
$\Delta h \times 100$	5.32		-0.43		9.35		3.03		5.88	
ΔN (pp)	0.56		-0.05		1.03		0.07		0.76	
$\Delta \phi \times 100$	2.96		-0.24		4.14		1.55		3.36	
$\zeta \times 100$	0.192		0.001		0.618		0.057		0.244	

Note: In all experiments, τ_w maintained constant equal to 0.13.
Note: In all experiments, the final steady state corresponds to the Ramsey tax policy.

enlarges the gap between the current and the efficient government size. Precisely, it becomes large enough to dominate the incentives to reduce taxation linked to the labor market institutions: It is optimal to increase the tax wedge ($\Delta TW^* > 0$, resulting in reduced terms of trade, $\Delta\phi < 0$).

Sensitivity to the open economy dimension. As shown in Section 2, when foreign demand is strongly sensitive to the terms of trade (high σ^*), the centralized allocation converges to the one in a perfect competitive market. Accordingly, the tax reform can fight more easily the labor market distortions, the opportunity to keep a markup on tradable goods being negligible (Proposition 2). To put it differently, the magnitude of the tax cut rises with σ^*. In this case, labor market inefficiencies are likely to play a dominant role, calling for a reduced labor cost. According to this reasoning, the higher σ^*, the lower the optimal tax rate τ_f^R. The results shown in Table 2, Column (2) confirm the relevance of the previous reasoning. In an economy with labor market frictions and with $\sigma^* = 2$ (versus 1.5 in the benchmark calibration), the optimal tax policy is reached for a negative payroll tax rate ($\tau_f^R = -0.18$). This leads to a larger devaluation and larger increases in both labor market margins than in the benchmark case. Besides, the magnitude of welfare gains is significantly affected, thereby illustrating the importance of the open economy dimension in the evaluation of a tax reform in the French economy. This result is consistent with related papers (De Paoli (2009), Epifani & Gancia (2009)), in which the elasticity of substitution between home and foreign goods scales the terms of trade externality.

Sensitivity to labor market institutions. First, we investigate the sensitivity of the result to the generosity of the unemployment benefit system. In Column 3 of Table 2, we determine the optimal tax scheme for a lower unemployment benefit ratio $\rho_b = 0.15$, which corresponds to the values observed in the United States and the United Kingdom in recent decades (1993-2003).[38]

[38] This calibration is based on OECD data as provided in Nickell's (2006) CEP database.

The optimal tax policy is reached for $\tau_f^R = 0.1675$, vs 0.0275 when $\rho_b = 0.37$. The magnitude of the fiscal devaluation and of the labor market adjustments are smaller than in the benchmark case. That is, the optimal need to reduce the tax burden decreases when the unemployment benefit system is not very generous. This result is fully consistent with our analytical findings (see Equation (34)). The direct effect of the unemployment benefit ratio is to increase labor costs, which reduces labor market tightness below its first-rank level. A large ρ_b also reduces the unemployed search effort. This effect suggests that a large ρ_b must be compensated for by lower fiscal distortions, so as to entice both firms and workers to search more intensively. This is achieved by lowering the payroll tax. On the contrary, with low unemployment benefits, the call for increased taxation attributable to the open economy dimension and the inefficient government size is more likely to dominate, in which case it is optimal to increase the tax pressure, as reported in Column 2 of Table 2. However, for $\rho_b = 0.15$, the magnitude of the change in tax pressure remains modest hence the associated welfare gains.

Our modeling allows for another labor market inefficiency, whenever the firm's bargaining power (ϵ) differs from its contribution to the matching process (ψ). Table 2, Column 4 reports the results in the case where the firm's bargaining power is lower than under Hosios ($\epsilon < \psi$). In this case, the optimal tax reform consists in lowering the payroll tax rate, with a null (and even slightly negative) $\tau_f^R = -0.01$ for $\epsilon = 0.5$ and $\psi = 0.6$. Indeed, the low share of the matching rent attributed to firms (in comparison with their contribution to the matching process) reduces their incentives to search for workers. Thus, the distortion induced by $\epsilon < \psi$ implies that increasing the firm's search effort should be a priority for the tax policy, which is achieved by lowering the payroll tax (See Equation (34)) and results in greater welfare gains than in the benchmark case with $\epsilon = \psi$ (Column (1) of Table 2).

4 Conclusion

In this paper, we propose an re-assessment of welfare gains of fiscal devaluation in an open-economy setting. Supplementing the short-run analysis of Farhi et al. (2014), the paper focuses on the medium run effects of fiscal-devaluation in economies featuring real rigidities. An original contribution of the paper is to thus establish the link between the desirability of fiscal devaluation/revaluation and two key structural inefficiencies, rigidities on the labor market and on the government budget adjustments. Precisely, we identify the role of each of these three dimensions *(i)* open economy, *(ii)* labor market friction with the extensive and intensive margin of employment, and *(iii)* an excessive size of public expenditure in the optimal tax scheme. We also put forward the strong interaction between the three dimensions. Our conclusions draw on both analytical and quantitative results. On the analytical side, we identify the conditions under which *i)* it is optimal to reduce the overall tax wedge, and *ii)* this can be achieved by a switch from direct labor taxation to indirect taxes.

As for the first point, we demonstrate that, while the terms of trade externality and an excessive government size call for higher taxes (a fiscal revaluation), labor market frictions require rather alleviating taxes (a fiscal devaluation). These opposing forces thus yield to a non-zero optimal tax burden. Regarding the second point, our paper provides an additional argument in favor of implementing tax reform in European countries which promotes indirect taxation and reduces the direct taxation on labor, if it decreases the tax wedge on labor: Beyond a short-run impact on the Okun gap, we show that fiscal devaluation can be welfare-improving in the medium run, provided labor market rigidities are strong enough. Our contribution to the literature is also on quantitative grounds. We indeed evaluate the optimal tax reform in quantitative terms, using France as the benchmark economy. Our calibrated DGE on the French economy indicates that there is room for a lower payroll tax, as our model predicts an optimal payroll tax rate of 0.0275% (versus 34% in the benchmark (current) situation). However, one may expect greater benefits from the tax reform when it comes along, aligning the size of the welfare state to its optimal value.

These results open the route to further research. We somewhat understate the inefficiency associated with the open economy dimension as, in the paper, we preclude any change in the external balance and we assume a balanced government budget. One might also wonder about the fiscal policy response from the foreign country to the change in tax scheme in the home country. All these elements raise interesting questions that are left for future investigation.

References

Andolfatto, D. (1996). Business cycles and labor-market search. *The American Economic Review*, (1), 112–132.

Backus, D., Kehoe, P., & Kydland, F. (1995). International real business cycles: Theory versus evidence. In T. Cooley (Ed.), *Frontiers of Business Cycle Research* (pp. 213–231). Princeton University Press.

Bagwell, K. & Staiger, R. (1990). A theory of managed trade. *American Economic Review*, 80(4), 779–95.

Bagwell, K. & Staiger, R. (1999). An economic theory of gatt. *American Economic Review*, 89, 215–248.

Barro, R. & Gordon, D. (1983). Rules, discretion and reputation in a model of monetary policy. *Journal of Monetary Economics*, 12(1), 101–121.

Bertola, G. & Ichino, A. (1995). Wage inequality and unemployment: United states vs. europe. In E. Besson (Ed.), *NBER Macro Annual* (pp. 13–53).: NBER.

Blanchard, O. & Wolfers, J. (2000). The role of shocks and institutions in the rise of european unemployment: The aggregate evidence. *Economic Journal*, 110.

Broda, C., Limao, N., & Weinstein, D. (2008). Optimal tariffs and market power: The evidence. *American Economic Review*, 98(5), 2032–65.

Christiano, L., Eichenbaum, M., & Rebelo, S. (2011). When is the government spending multiplier large? *Journal of Political Economy*, 119(1), 78–121.

Coenen, G., Straub, R., & Trabandt, M. (2013). Gauging the effects of fiscal stimulus packages in the euro area. *Journal of Economic Dynamics and Control*, 37, 367–386.

Corben, W. (1984). The normative theory of international trade. In R. Jones & P. Kenen (Eds.), *Handbook of International Economics* chapter 2. Elsevier.

Correia, I., Nicolini, J., & Teles, P. (2008). Optimal fiscal and monetary policy: Equivalence results. *Journal of Political Economy*, 116(1), 141–170.

Costinot, A., Donaldson, D., Vogel, J., & Werning, I. (2013). *Comparative Advantage and Optimal Trade Taxes*. Technical report.

Cotis, J.-P. (2009). *Partage de la valeur ajoutée, partage des profits et écarts de rémunérations en France*. Report, INSEE.

Daveri, F. & Tabellini, G. (2000). Unemployment, growth and taxation in industrial countries. *Economic Policy*, 30, 49–90.

De Paoli, B. (2009). Monetary policy and welfare in a small open economy. *Journal of International Economics*, 77, 11–22.

Epifani, P. & Gancia, G. (2009). Openness, government size and the terms of trade. *Review of Economic Studies*, 76(2), 629–668.

Farhi, E., Gopinath, G., & Itskhoki, O. (2014). Fiscal devaluations. *Review of Economic Studies*, Forthcoming.

Fève, P. & Langot, F. (1996). Unemployment and the business cycle in a small open economy: Gmm estimation and testing with french data. *Journal of Economic Dynamics and Control*, 20, 1609–1639.

Hairault, J.-O. (2002). Labor-market search and international business cycles. *Review of Economic Dynamics*, 5, 535–558.

Hungerbuhler, M., Lehmann, E., Parmentier, A., & Van Der Linden, B. (2006). Optimal redistributive taxation in a search equilibrium model. *Review of Economic Studies*, 73(3), 743–767.

Keynes, J. (1931). *Addendum to: Great Britain. Committee on Finance and Industry Report (Macmillan Report).* London: Macmillan and Cambridge: Cambridge Press for the Royal Economic Society, 1981: London:His Majesty´s Stationery Office. Reprinted in Donald Moggridge, The Collected Writings of John Maynard Keynes, vol. 20.

Krause, M. & Lubik, T. A. (2007). The (ir)relevance of real wage rigidity in the new keynesian model with search frictions. *Journal of Monetary Economics*, 54(4), 706–727.

Kydland, F. & Prescott, E. (1977). Rules rather than discretion: The inconsistency of optimal plans. *Journal of Political Economy*, 85, 473–91.

Landais, C., Piketty, T., & Saez, E. (2011). *Pour une révolution fiscale - Un impôt sur le revenu pour le* 21^e *siècle*. Paris: Seuil.

Ljunqvist, L. & Sargent, T. (1998). The european unemployment dilemma. *Journal of Political Economy*, 106(3), 514–550.

Ljunqvist, L. & Sargent, T. (2008). Two questions about european unemployment. *Econometrica*, 76(1), 1–29.

Lucas, R. (1987). *Models of Business Cycles*. Oxford: Blackwell.

Lucas, R. E. (2003). Macroeconomic priorities. *American Economic Review*, 93(1), 1–14.

McCallum, B. T. (1999). *Issues in the Design of Monetary Policy Rules*. Elsevier, taylor, j.b. and woodford, m. edition.

Mill, J. (1844). *Essays on Some Unsettled Questions of Political Economy*. London: Parker.

Nickell, W. (2006). *The CEP - OECD Institutions Dataset (1960-2004)*. Discussion Paper 0759, Centre for Economic Performance.

Ohanian, L., Raffo, A., & Rogerson, R. (2008). Long-term changes in labor supply and taxes: Evidence from oecd countries, 1956-2004. *Journal of Monetary Economics*, 55(8), 1353–1362.

Pissarides, C. (1990). *Equilibrium Unemployment Theory*. Oxford: Basil Blackwell.

Prescott, E. (2004). Why do Americans work so much more than Europeans? *Federal Reserve Bank Of Minneapolis Quarterly Review*.

Ragan, K. (2013). axes and time use: Fiscal policy in a household production model. *American Economic Journal: Macroeconomics*, 5(1), 168–192.

Rogerson, R. (2006). Understanding Differences in Hours Worked. *Review of Economic Dynamics*, 9(3), 365–409.

Rogerson, R. (2007). Taxation and market work: is scandinavia an outlier? *Economic Theory*, 32(1), 59–85.

Taylor, J. & Williams, J. (2011). *Simple and robust rules for monetary policy*, volume 3. Friedman, b. and woodford, m. edition.

A The DGE Model: Calibration

Step 1: The calibrated parameters using external information. We calibrate a first set of parameters using econometric studies. Table 4 gives the references used and the parameter values retained. All these parameters are in the range of the values commonly retained. Without any robust information for the bargaining power on French data, we assume, as usual $\epsilon = \psi$.

Table 3: Calibrated parameters (Step 1)

Parameter		Value	Reference
Label	Notation		
Labor market features			
Firms' weight in match	ψ	0.6	Fève & Langot (1996)
Firms' bargaining power	ϵ	0.6	$\epsilon = \psi$
Open economy dimension			
Home elasticity of subst. between goods	η	1.5	Backus et al. (1995)
Foreign elasticity of subst. between goods	σ^*	1.5	Backus et al. (1995)
Preferences and technology			
TFP level	A	1	Normalisation
Discount rate	β	0.99	Annual real interest rate of 4%, France, 1995-2008([a])

([a]): Authors' calculations, based on OECD data.

Step 2: Calibrated parameters using model and aggregate data. In Table 4, we report the targets of our calibration. Since the consumption tax applies to all consumption expenditures, the consumption aggregate includes non-durables and durables, which implies PC/Y = 62% and PI/Y = 13%. This low value of investment to output ratio will result in a low depreciation rate of capital δ. Secondly, in the French data we observe $(1+\tau^f)wNh/Y$ and wNh/Y, which yields τ^f. We also observe tax revenues from indirect taxation $\tau^c \frac{PC}{Y}$ and employers' social security contributions $\tau^f \frac{wNh}{Y}$ (Landais et al. (2011)), which yields τ^c given τ^f. In addition, National Accounts yield the macroeconomic ratios PC/Y, PI/Y and PG/Y, where the purchases of durable goods by households (purchases by firms) are included in C (in I). Thus, in the data, the tax base for indirect taxation ($PC/Y = 62\%$) is larger than that for payroll taxation ($wNh/Y = 50\%$). Finally, we want our model to be consistent with the main labor market features: the unemployment rate, the vacancy filling probability and the job finding rate observed in France, such that the mean duration of unemployment is 14 months. We also calibrate the parameters of the model so as to match the unemployment benefit ratio observed in France over the recent decades (1995-2003), based on Nickell's (2006) CEP database.[39]

To calibrate Φ, we use data on the sharing of public spending (G) between collective (G^c) and individual public spending, using a detailed presentation of public accounts of the French government (INSEE) (mean value over). This lead us to subtract from the "collective" consumption expenditures as recorded by OECD (8.5% of GDP as mean value over 1995-2008), the expenditures which are targeted to firms which represent 2 percentage points. Combining the ratio $PG^c/Y = 0.065$ to the observed ratio $PC/Y = 0.62$, we obtain $G^c/C = 0.10$.

Table 4: Empirical targets (Step 2)

Empirical Target		Value	Reference
Label	Notation		
Labor market features			
Unemployment rate	$1 - N$	0.1	France, 1995-2008(^{a})
Working time	h	0.33	Andolfatto (1996)
Search effort time	e	$h/2$	Andolfatto (1996)
Job finding rate	$\widetilde{p} = ep$	0.22	France, 1995-2008(^{a})
Search costs	$P\varpi V/Y$	0.01	Hairault (2002)
Vacancy finding rate	q	0.7	Krause & Lubik (2007)
Unemployment benefit ratio	ρ_b	0.38	France, 1995-2003(^{b})
Public expenditure's valuation	Φ	0.1	France, 1995-2008(^{c})
Key ratios (relative to GDP) and fiscal policy			
Consumption ratio	PC/Y	0.62	France, 1995-2008(^{c})
Investment ratio	PI/Y	0.13	France, 1995-2008(^{c})
Public spending ratio	$PG/Y \equiv \rho_g$	0.25	France, 1995-2008(^{c})
Imports-to-output ratio	Z/Y	0.3	France, 1995-2008(^{c})
Labor share	$(1+\tau^f)wNh/Y$	0.67	France, 1995-2007, Cotis (2009)
Gross labor cost	wNh/Y	0.5	France, 1995-2007, Cotis (2009)
Employee's labor tax	τ^w	0.13	France, 1995-2008, OECD data
Payroll tax rate	τ^f	0.34	France, 1995-2008(^{c})
Indirect tax rate	τ^c	0.22	France, 1995-2008(^{c})

(^{a}): Authors' calculations, based on OECD data.
(^{b}): Nickell's (2006) database
(^{c}): Authors' calculations, based on National Accounts (INSEE)

In Table 5, we present the parameter values that allow the model to match these targets.

[39] More precisely, the empirical target is the average across the first five years of unemployment for three family situations and two money levels (*brroecd* in Nickell's database.)

Table 5: Calibration results (Step 2)

Parameters		Value	Parameters		Value
Label	Notation		Label	Notation	
Separation rate	s	0.024	Share of imports	$1-\xi$	0.3
Matching efficiency	χ	0.941	Disutility of work	σ_L	5.698
Cost of job posting	$\overline{\omega}$	0.4558	Disutility of search	σ_u	1.740
Depreciation rate	δ	0.006	Labor supply preference	η	0.8
Technology parameter	$1-\alpha$	0.32	Transfers to GDP ratio	$\rho_T \equiv PT/Y$	-0.103