Direct vs Indirect Taxation in an Open Economy

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Abstract

We propose an open economy model to assess the gains from a tax reform that shifts the financing of the welfare state from direct to indirect taxation. First, we show the theoretical conditions under which the tax reform can be welfare-improving in a static framework with and without matching frictions (LMF): we show why a government, considered as the leader of a Stackelberg equilibrium, could promote indirect taxation as a protectionist policy. Secondly, we provide a quantitative assessment of the optimal tax reform. Finally, we show the contrasting roles of LMF and the open-economy in shaping the optimal tax scheme.

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1 Introduction

The current euro-zone crisis has spurred a renewed interest in tax reforms as a tool to correct trade balances and boost employment, without reducing the size of the welfare state. One of these reforms consists in shifting the tax burden from the employers’ social contribution towards consumption taxes. Such a reform, that promotes indirect taxation and lowers direct taxation on labor, is expected to reduce labor costs, thus producer prices, while the consumption tax increase would boost import prices without bearing on exports, whose relative price would fall. In this respect, this budget-neutral fiscal devaluation can make exports cheaper and imports more expensive, thereby boosting the demand for domestic goods and reducing trade imbalances. The need for reduced labor costs would be all the more necessary in the case of European labor markets, as they exhibit a substantial degree of rigidity notably attributable to stringent labor market institutions and labor taxation (Blanchard & Wolfers (2000)). But, more than the labor market institutions, it seems that differences in taxes largely explain the gaps in labor market outcomes between European countries and the US. Thus, Prescott (2004) finds that fiscal distortions on the labor supply explain most of the differences at points of time and the big change relative (to US) labor market outcomes over time.¹ Lucas (2003) emphasizes that the welfare consequences for France of adopting American tax rates on labor and consumption “would be equivalent to a 20 per cent increase in consumption with no increase in work effort”. This provides a supplementary argument in favor of implementing, in European countries, tax reform that promotes indirect taxation and reduces direct taxation on labor, if it decreases the tax wedge on labor. Some countries, such as Denmark (in 1987),

¹On this line of research, Rogerson (2006) or Ohanian et al. (2008) suggest that a theory providing a link between the aggregate hours and taxes seems to be sufficient to explain why Europeans work less than Americans. The aggregate hours worked in continental European countries are roughly one third less than in the US.
Germany (in 2007) or France (2012) have already implemented such a tax reform. If some economists have recently called attention to it, little is yet known about its optimal design and its quantitative implications. That is the focus of this paper.

An original feature of our approach is to show that the open-economy dimension of the economy provides a legitimate argument for imposing distortive taxation. Indeed, if goods are imperfect substitutes at the international level, then the planner of a specific country can compute a “fictitious” allocation as if it were a monopoly, by extracting a positive markup. Because it is not possible to control the terms of trade, the government can manipulate the relative price of its home good via the tax system, in particular via indirect taxation, thereby reducing the quantities traded at the equilibrium. By doing so, the home country extracts a part of the surplus of the foreign countries and thus increases the welfare of the agents living in the country, at the price of a welfare decrease for foreign agents. These welfare gains lie at the root of the “pecuniary externality” inherent in the open-economy dimension, which induces a gap between the decentralized equilibrium allocation and the first-rank equilibrium, that the Ramsey government may (or not) correct through tax policy. Finally, in our approach, we take into account the valuation of public expenditures in the welfare of the agents, in order to have, at the equilibrium, a strictly positive optimal government expenditure. This approach gives an additional argument in favor of protectionism, not based on political arguments as in Grossman and Helpman (1994) or (2004). Our approach can be also viewed as complementary to the papers that promote “fiscal devaluation” in frameworks where, in addition, product market imperfections and nominal price rigidities are introduced (see e.g. Correia et al. (2008), Farhi et al. (2011) and Adao et al.

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3Tax reform refers here to a cut in the employers’ social security contribution associated with a rise in consumption tax. We will not consider value-added taxation because, as pointed out by Farhi et al. (2011), consumption tax and value-added tax are equivalent when prices are flexible (complete pass-through of tax changes), which is the case in our model.

4Obviously, a key feature of our reasoning lies in the asymmetry between countries: a markup can be extracted by the strategic country only if an equilibrium à la Stackelberg emerges.

5In a small open economy, private agents do not internalize the effects of the demand choices for the home and foreign goods on the terms of trade.
We propose an open-economy model to assess the potential gains from a tax reform that shifts the financing of the welfare state from direct to indirect taxation. We introduce labor market frictions (hereafter, LMF) through a matching-bargaining process and unemployment insurance system in order to discover if European countries, characterized by more rigid labor markets, have more interest in choosing this policy. Our framework allows us to provide a careful evaluation of the positive and normative implications of this tax reform in an economy with LMF. As shown in the seminal contributions of Diamond (1982), Mortensen (1982) and Pissarides (1985), LMF can lead to an inefficient unemployment level, thereby leaving scope for taxation. In line with Shimer’s view (2009), LMF therefore constitute a promising explanation of the “labor wedge”. Accordingly, they are at the heart of our investigation.

We present our contribution gradually. Firstly, we show the theoretical conditions under which the tax reform can be welfare-improving in a static framework with and without LMF: we show why a government, considered as the leader of a Stackelberg equilibrium, could promote indirect taxation as a protectionist policy, improving welfare. We put key emphasis on the roles of LMF and the openness of the economy. Secondly, we provide a quantitative assessment of the optimal tax reform. Using France as benchmark economy, we show that there is room for a switch from direct labor taxation to indirect consumption taxation, as our model predicts an optimal payroll tax rate of 17% (versus 34% in the benchmark calibration). The robustness analysis shows some key determinants that condition the effectiveness of the tax reform. Precisely, we show the contrasting roles of LMF and the open-economy dimension in shaping the optimal tax scheme. On the one hand, stringent labor market institutions, i.e. generous unemployment benefits in France, call for a large labor tax cut, whereas a calibration which matches the Anglo-Saxon economies does not. On the other hand, this is all the less welcome as agents suffer from a strong relative price effect, such as in European countries, which crucially

\[ \text{Correia et al. (2011) study how fiscal devaluation can be used as an alternative to conventional monetary policy.} \]
depends on the trade balance adjustments. We also show that transition matters in the optimal tax design, the welfare gains in the long run being partially compensated for by losses in the short run, inherent to the saving effort. Finally, we study the sensitivity to different valuations of the public goods and to different budgetary adjustments accompanying the tax reform: it can be implemented by keeping the relative size of the government constant at its observed level, or constant in level as is done in Prescott (2004), or else by shifting its size to its optimal level.

The paper is organized as follows. Section 2 presents the optimal taxation in a two-country model, where the home country is a Stackelberg leader in the tax competition. We discuss how imperfect fiscal tools allow the government to reach an allocation close to that of the first rank. These results are studied in static models with and without LMF. In Section 3, we extend this analytic framework in order to account for the transition costs: a dynamic general equilibrium model is then presented and a calibrated version is used to quantify the optimal scheme of the tax system in France. We also provide a sensitivity analysis. Section 4 concludes.

2 Optimal labor taxation in an open economy: a theoretical characterization

In this section, using a static\textsuperscript{7} and tractable analytical model\textsuperscript{8}, we aim to shed light on the mechanisms at work that support an allocation which dominates that obtained on competitive markets.

We first characterize the optimal tax scheme in an economy with a Walrasian labor market (Section 2.1), thereby illustrating the impact of i) the pecuniary externality inherent to the open economy dimension, and ii) the optimal level of government-to-output ratio, which we compare to that reached in the presence of LMF (Section 2.2). The results can be summed up as follows. First, in both cases

\textsuperscript{7}We discard capital accumulation, international bond trading and government debt in order to get analytical results. All calculations underlying our analytical results are available in the online technical Appendix from the author’s webpages.

\textsuperscript{8}We thank Jean-Pascal Benassy for helpful input on the functional forms.
the optimal tax policy is able to restore the efficient level of output. However, this is only a second-best situation, as the government cannot reach the first-rank level of terms of trade, simply because we do not introduce a specific tax on imported goods which directly changes the relative prices\textsuperscript{9}. Secondly, comparing the optimal payroll tax rates in economies with or without LMF, we show that, in this last case, the optimal payroll tax has to fall, compared to the case without LMF. The higher the unemployment, the greater the reduction in the optimal Ramsey payroll tax, compared with the economy without matching.

2.1 Labor tax in an open economy without LMF

We focus here on how tax decisions are affected by the open-economy dimension, thereby discarding the modeling of LMF. In order to specify the functions for international trade flows, we consider a two-country world (a home country and a foreign country, representative of the rest of the world). Each country specializes in the production of a national good, respectively denoted $H$ (home good) and $F$ (foreign good).

2.1.1 Foreign country: the optimal demand for goods

The foreign country is assumed to be endowed with a quantity $Y^*$ of a tradable good, none of the home good. Throughout the paper, the foreign variables are denoted with an asterisk ($^*$). In addition, we normalize 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.

The equilibrium market condition for the foreign good is such that foreign private consumption is given by $C^* = Y^* - X^* - G^*$ where $X^*$ and $G^*$ refer, respectively, to exports from the foreign country to the home country and government expenditures. The foreign country also imports a quantity $Z^*$ of the home good, which it consumes totally. The foreign household’s maximization program is then

\textsuperscript{9}We discard this tax because free trade agreements typically forbid import taxes.
such that:

$$U^*(C^*, Z^*, G^*) = \max_{X^*, Z^*, G^*} \left\{ (Y^* - X^* - G^*) + \frac{(Z^*)^{(\sigma^*-1)/\sigma^*}}{(\sigma^*-1)/\sigma^*} + \Phi^* \log(G^*) \right\}$$

s.t. \(\phi X^* = Z^*\) \hspace{1cm} (1)

with \(\sigma^* > 1\), the price elasticity of foreign imports. Foreign households (as well as the domestic ones) derive utility from

1. the consumption of national good,
2. the imports of goods from abroad and
3. the provision of public goods, as in e.g. Barro (1981). Given the absence of international trading of financial assets, both countries are characterized by a zero trade balance (Equation (1)). The FOCs, with respect to \(X^*, Z^*, G^*\), lead to \(Z^* = \phi^* \sigma^*, X^* = \phi^* \sigma^*-1\) and \(G^* = \Phi^*\). This last equation gives the optimal value for the government-to-output ratio. Since, under free trade, exports from one country equals imports from the other, this imposes that: \(Z^* = X\) and \(X^* = Z\), with \(Z\) and \(X\) respectively denoting the volumes of imports and exports of the home country.

2.1.2 Home country: the allocation of the social planner

The home country produces a national good with worked hours \(h\). The production function is such that:

$$Y(h) = Ah^\alpha \hspace{1cm} 0 < \alpha \leq 1$$

(2)

The households’ utility is given by:

$$U(C_H, C_F, G, h) = \xi \log(C_H) + (1 - \xi) \log(C_F) + \Phi \log(G) - \sigma_L \frac{h^{\eta_L+1}}{\eta_L + 1}$$

(3)

with \(0 < \xi < 1\), \(\Phi > 0\), \(\sigma_L > 0\) and \(\eta_L > 0\).\(^{10}\) As a Stackelberg leader, the social planner takes into account the import \((Z^* = \phi^*\sigma^*)\) and export \((X^* = \phi^*\sigma^*-1)\) functions of the foreign country when taking his optimal decisions. Using Equation (2), the resource constraints on the home and foreign goods that the planner takes

\(^{10}\)To maintain 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.
into account are thus respectively given by:

\[ C_H = Y(h) - X(\phi) - G = Ah^\alpha - \phi^{\sigma^*} - G \]  \hspace{1cm} (4)

\[ C_F \equiv Z(\phi) = X^*(\phi) = \phi^{\sigma^*-1} \] \hspace{1cm} (5)

The home country’s planner chooses \( C_H, C_F, G, h \) to maximize (3) under good market equilibria (4) and (5). By replacing private consumptions (4) and (5) into the utility function (3), this is equivalent to choosing \( \{\phi, G, h\} \) to maximize \( \max_{\phi, G, h} \{U(Y(h) - X(\phi) - G, Z(\phi), G, h)\} \). The FOCs with respect to \( h, G \) and \( \phi \), respectively, are

\[ -\frac{U_C'}{U_h'} = Y'(h) \hspace{1cm} \Leftrightarrow \hspace{1cm} \sigma_L h^{1+\eta_L} = \frac{Y}{C_H} \] \hspace{1cm} (6)

\[ U_C' = U_G' \hspace{1cm} \Leftrightarrow \hspace{1cm} G = \frac{\Phi}{\xi} C_H \] \hspace{1cm} (7)

\[ \frac{U_F'}{U_C'} = \frac{\epsilon_{Z^*/\phi} Z^*}{\epsilon_{X^*/\phi} X^*} \hspace{1cm} \Leftrightarrow \hspace{1cm} \frac{1 - \xi}{\xi} \frac{C_H}{C_F} = \frac{\sigma^*}{\sigma^*-1} \phi \] \hspace{1cm} (8)

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 \( \phi \). Equation (6) equalizes the marginal rate of substitution between hours and consumption of the home good with the marginal product of labor. The optimal level of government expenditures equalizes the marginal gain to the marginal cost (Equation (7)). Finally, Equation (8) determines the optimal arbitrage between home and foreign goods. Importantly, in this decision, the planner takes into account the endogenous responses of foreign export and import decisions to the terms of trade, by considering the ratio of export and import elasticities to terms of trade weighted by a measure of openness \( \left( \frac{X}{Z} = \frac{Z^*}{X^*} \right) \). In other words, the social planner, in choosing the terms of trade, acts as a monopolist who is able to take into account the impact of his price setting on the relative demand for goods coming from abroad.

To illustrate this point further, assume for simplicity that there is no government spending in the utility function (\( \Phi \to 0 \)): the gap between this solution and the
allocation in a perfect competitive market is then fully governed by $\sigma^*$. When $\sigma^* \to \infty$, i.e. when national goods are perfect substitutes, the centralized allocation converges to that in a perfect competitive market.\textsuperscript{11} In contrast, when $\sigma^* \to 1$, the markup is maximum, and the traded quantities are at their lowest values.\textsuperscript{12} Thus, $\sigma^*$ governs the gap between the perfect competitive market allocation and the one chosen by the planner: in choosing the terms of trade, the home country’s social planner takes advantage of the inelastic demand for exchange coming for the foreign country ($\sigma^* < \infty$).

2.1.3 Home country: the decentralized economy

In this section, we model a decentralized economy in a fully-flexible price environment with distortive taxes and government expenditures.

Competitive equilibrium. The firm is subject to direct labor taxation, with $\tau_f$ denoting the payroll tax rate. The firm’s maximization problem leads to the first-order condition $Y'(h) = (1 + \tau_f)w$. Labor revenues are taxed at the employee tax rate $\tau_w$. Consumption expenditures are subject to indirect taxation with $\tau_c$ the consumption tax rate. The domestic household chooses consumption levels and hours to maximize (3) subject to the following budget constraint: $(C_H + \phi C_F)(1 + \tau_c) = (1 - \tau_w)wh - T + \pi$, with $T$ government lump-sum taxes and $\pi$ firm’s profits. Lastly, we assume that public spending and lump-sum transfers are set so as to remain proportional to GDP, according to the following rules:

$$G = \rho_g Y \quad \text{and} \quad T = \rho_T Y \quad (9)$$

\textsuperscript{11}This can be inferred from the comparison between the equilibrium values of $h^{sp}$ (equation (19)) and $h^{dec}$ (equation (15)) in the case where $\Phi = \rho_g = 0$.

\textsuperscript{12}Since the terms of trade are positive, we must have $\sigma^* > 1$. If $\sigma^* < 1$, the social planner can only choose the corner solution of $\phi = 0$, which is reminiscent of the standard result in monopoly theory whereby a demand curve elasticity smaller than 1 leads to an infinite markup, here $\phi = 0$. We thank Jean-Pascal Benassy for pointing this out.
with \( \rho_g \) and \( \rho_T \) exogenously chosen by the government. The FOCs of the firm and the households lead to\(^\text{13}\)

\[
- \frac{U'_{C_H}}{U'_h} = \frac{1 - \tau_w}{(1 + \tau_c)(1 + \tau_f)} Y''(h) \quad \Leftrightarrow \quad \sigma_L h^{1+\eta_L} = \frac{1}{TW} \alpha \frac{Y}{C_H} \quad \text{(10)}
\]

\[
\frac{U'_{C_F}}{U'_C} = \phi \quad \Leftrightarrow \quad \frac{1 - \xi}{\xi} \frac{C_H}{C_F} = \phi \quad \text{(11)}
\]

with the overall tax wedge \( TW \) defined as: \( TW = \frac{(1 + \tau_c)(1 + \tau_f)}{1 - \tau_w} \). The higher the tax rates, the greater \( TW > 1 \). Comparing the set of first-order conditions of the decentralized economy (Equations (10)-(11) as well as Equation (9)) versus the centralized case (Equations (6) to (8)) sheds light on the three sources of discrepancy at the root of the gap between the decentralized equilibrium and the first-best solution. First, as indicated in Equation (10), the tax system introduces a wedge between the marginal product of labor and the marginal rate of substitution between home consumption and worked hours. Secondly, the arbitrage between home and foreign goods (Equation (11)) in the decentralized economy differs from the social planner’s first order condition (equation (8)). Indeed, the household does not internalize the effect of her relative demand for national goods on terms of trade. This is the source of the pecuniary externality inherent to the open economy dimension. Finally, notice that equation (11) does not depend on tax rates. Indeed, the consumption tax affects the consumption of both goods, the tax system cannot restore the first best share of home versus foreign good.\(^\text{14}\) Finally, Equation (9) recalls that the decentralized economy differs from the first-best allocation to the extent that the government to GDP ratio \( \rho_g \) is \textit{a priori} not optimum, the optimal behavior of \( G \) being given by Equation (7).

\textbf{Restrictions.} In order to focus on theoretical implications which characterize the European case (low levels of employment and competitiveness, with high levels of taxes and government spending) we identify the restrictions on the parameters

\(^\text{13}\)All solutions are given in Appendix A.

\(^\text{14}\)It is trivial to show that a tax on imports would do so. We discard this tax because free trade agreements typically forbid import taxes.
which ensure that \( h^\text{dec}_{\tau_i=0} > h^{sp} > h^\text{dec}_{\tau_i>0} \) and \( \phi^\text{dec}_{\tau_i>0} < \phi^{sp} \), where superscript \( sp \) (\( dec \) respectively) denotes the social planner’s (decentralized respectively) allocation, and subscript \( \tau_i \) refers to the case of all tax rates being zero \( \tau_i = 0 \) or positive \( \tau_i > 0 \).

If this condition holds, reducing taxes will be optimal in order to reach the first-rank allocation. However, it is optimal to maintain non-zero distortive tax rates, as it is not desirable to reduce them until the economy reaches \( h^\text{dec}_{\tau_i=0} \) and \( \phi^\text{dec}_{\tau_i=0} \). Defining \( \rho_g^{sp} \equiv G^{sp}/Y^{sp} \), these restrictions for \( h \) are

\[
\text{If } \frac{1}{1-\rho_g} > \frac{\Phi}{\rho_g^{sp}} \text{ then, } h^\text{dec}_{\tau_i=0} > h^{sp} \tag{12}
\]

\[
\text{If } TW \equiv \frac{(1+\tau_c)(1+\tau_f)}{1-\tau_w} > \frac{\rho_g^{sp}}{\Phi} \frac{1}{1-\rho_g} \text{ then, } h^\text{dec}_{\tau_i>0} < h^{sp} \tag{13}
\]

This means that the benchmark scenario we consider is such as \( \check{\varepsilon} \) the exogenous public spending-to-GDP ratio \( \rho_g \) is large enough such that, in the absence of distortive taxation, this would lead to a higher level of worked hours and output than required in the first-best case (Condition (12) holds, thereby offering a rationale for distortive taxation), but \( \check{\omega} \) in parallel, distortive tax rates levels (\( \tau_c, \tau_w \) or \( \tau_f \)) are set at an excessive level (Condition (13) holds), leading to insufficient levels of worked hours and output in the decentralized equilibrium. Concerning \( \phi \), if \( \frac{\Phi}{\rho_g^{sp}}(1-\rho_g) < \frac{\sigma^*-1}{\sigma^*} \), we have \( \phi^\text{dec}_{\tau_i>0} < \phi^{sp} \): terms of trade are lower in the decentralized economy relative to their first-best level. That is, the home economy suffers from being insufficiently competitive. In what follows, we will assume that these restrictions are satisfied.

### 2.1.4 The Ramsey problem

The Ramsey problem consists in choosing the payroll tax \( \tau_f \) so as to maximize the welfare function (3), subject to optimal behaviors of the agents, summarized by the relations between \( h \) and \( \tau_f \) as given by Equation (15), knowing that the FOC
on consumption goods can be expressed as functions of $h$, using (2).

$$
\tilde{U} = \max_{\tau_f} \left\{ \alpha \left[ \xi + (1 - \xi) \frac{\sigma^* - 1}{\sigma^*} + \Phi \right] \log(h) - \sigma_L h^{1+\eta_L} \right\}
$$

with

$$
h = \left( \frac{\alpha}{\sigma_L} \frac{1 - \tau_w}{[1 + \tau_c][1 + \tau_f][1 - \rho_g]} \right)^{\frac{1}{1+\eta_L}}
$$

$$
\rho_g = \tau_c \frac{C_H + \phi C_F}{Y} + (\tau_w + \tau_f \frac{wh}{Y} + \rho_T
$$

Equation (16) dictates how $\tau_c$ adjusts to balance the government budget, given the chosen $\tau_f$ and exogenous values of $\rho_g - \rho_T$ and $\tau_w$. This government budget constraint mimics the constraint faced by industrial economies nowadays: choosing a tax scheme without reducing the government budget while keeping constant the net government expenditures to GDP ratio under control, and the size of the welfare state. Given our definition of the tax wedge $TW$, the FOC on $\tau_f$ is:

$$
nh TW \left[ \frac{\partial TW}{\partial \tau_f} + \frac{\partial TW}{\partial \tau_c} \frac{\partial \tau_c}{\partial \tau_f} \right] \left[ \alpha \left( \xi + (1 - \xi) \frac{\sigma^* - 1}{\sigma^*} + \Phi \right) \frac{1}{h} - \sigma_L h^{\eta_L} \right] = 0
$$

Two cases should therefore be considered. Firstly, if $\left[ \frac{\partial TW}{\partial \tau_f} + \frac{\partial TW}{\partial \tau_c} \frac{\partial \tau_c}{\partial \tau_f} \right] = 0$. 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. In that case, changing the payroll tax rate has no impact on worked hours and more broadly on the decentralized 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 decentralized allocation.

**The tax base argument.** It is the government budget constraint that determines the condition under which changes in direct taxation are/are not offset by the opposite change in indirect taxation. Using the good market equilibrium $C_H + \phi C_F = (1 - \rho_g)Y$, and the FOC of the firm’s problem leading to

\[\text{Notice that this expression is not the welfare function strictly speaking, as terms that are independent of } \tau_f \text{ and } h \text{ have been omitted.}\]
\((1 + \tau_f)wh = \alpha Y\), Equation (16) rewrites as:

\[
\rho_g - \rho_T = \tau_c(1 - \rho_g) + (\tau_f + \tau_w) \frac{\alpha}{1 + \tau_f} \Rightarrow \quad d\tau_c = -\frac{\alpha}{1 - \rho_g} \frac{1 - \tau_w}{(1 + \tau_f)^2} d\tau_f \quad (17)
\]

Equation (17) indicates the change in indirect taxation for a given variation of payroll taxation. We deduce, for \(\tau_w \geq 0\):

\[
\left|\frac{d\tau_c}{d\tau_f}\right| < 1 \quad \text{iff} \quad \alpha < 1 - \rho_g \Leftrightarrow (1 + \tau_f) \frac{wh}{Y} < \frac{C_H + \phi C_F Y}{Y} \quad (18)
\]

For a non-negative labor tax rate \((\tau_w > 0)\), Equation (18) indicates that, as long as the tax base for labor taxation (left-hand-side of Equation (18)) is lower than that of indirect taxation (right-hand-side of Equation (18)), the reduction in \(\tau_f\) can be offset by a less-than-proportional increase in \(\tau_c\). Note that the required change in \(\tau_c\) for a given variation in \(\tau_f\) depends on the public spending-to-GDP ratio \(\rho_g\): with a lot of public spending in the decentralized economy, the share of output devoted to private consumption is lower, hence the tax base for indirect taxation. Simple calculus indicates that this condition is also sufficient to ensure a reduction in the overall tax burden \(TW\). Indeed, differentiating \(TW\) in \(\tau_c, \tau_f\) using Equation (17), we obtain \(dTW = \frac{1}{1 + \tau_f} \left[\frac{-\alpha}{1 - \rho_g} + \frac{(1 + \tau_c)(1 + \tau_f)}{1 - \tau_w}\right] d\tau_f\). If \(\alpha < 1 - \rho_g\), we always have \(\frac{-\alpha}{1 - \rho_g} < \frac{(1 + \tau_c)(1 + \tau_f)}{1 - \tau_w}\). Thus, the tax-base condition (17) is a sufficient condition for a reduction in \(\tau_f\) to be compensated for by a less than proportional increase in \(\tau_c\), in which case the overall size of tax distortion \(TW\) falls\(^\text{16}\). Given that the tax base argument is satisfied empirically, we assume that this restriction is satisfied in the following.

**The Ramsey allocation.** Because \(\left[\frac{\partial TW}{\partial \tau_f} + \frac{\partial TW}{\partial \tau_c} \frac{\partial \tau_c}{\partial \tau_f}\right] \neq 0\), the Ramsey first-order condition is such that:

\[
\mathbf{h}^R = \left[\frac{\alpha}{\sigma_L} \left(\xi + (1 - \xi) \frac{\sigma^* - 1}{\sigma^*} + \Phi\right)\right]^{1+\eta_L} \equiv \mathbf{h}^{sp} \quad (19)
\]

\(^{16}\)Alternatively, if \(\frac{\alpha}{1 - \rho_g} = TW\), then \(\left[\frac{\partial TW}{\partial \tau_f} + \frac{\partial TW}{\partial \tau_c} \frac{\partial \tau_c}{\partial \tau_f}\right] = 0\), in which case the government cannot affect the overall tax burden by manipulating specific tax rates.
In this case, under the Ramsey allocation, the government is able to manipulate the payroll tax rate such that it can restore the first-best level of worked hours \((h^R = h^{sp})\), and thus of output\(^{17}\). This result is achieved for a tax wedge \(TW^R\) such that:

\[
TW^R = \left[\frac{(1 + \tau_c)(1 + \tau_f)}{1 - \tau_w}\right]^R = \frac{1}{1 - \rho_g \xi + (1 - \xi)\cdot\frac{\sigma^* - 1}{\sigma^*}} + \Phi
\]  

\[\Rightarrow 1 + \tau_f^R = \frac{1}{(1 - \tau_w)}\cdot\frac{1 - \alpha}{1 - \rho_T - \alpha}\cdot\left[\xi + (1 - \xi)\cdot\frac{\sigma^* - 1}{\sigma^*} + \Phi\right]
\]

The Ramsey tax wedge \(20\) implies all tax rates are equal to 0 (i.e. \(TW = 1\)) if and only if \(i\) consider a closed economy framework \((\xi \to 1)\) and \(ii\) without government spending \((\Phi = \rho_g = 0)\). The open-economy pecuniary externality and the presence of a (too large) provision for public goods (relative to GDP) make it optimal for the government to rely on distortive taxation, with an optimal tax wedge level as given by Equation \(20\). Indeed, the Ramsey solution is such that the FOCs relative to consumption and leisure in the decentralized versus the centralized economies are similar, implying:

\[
(C^{sp}_H + \phi C^{sp}_F) \cdot \left[\frac{1 + \tau_f(1 + \tau_c)}{1 - \tau_w}\right] = (C^{R}_H + \phi C^{R}_F)
\]

This shows that taxes allow the government to reach the optimal sharing between aggregate consumption and leisure, given that the aggregate consumption in the Ramsey allocation is the same as in the planner’s\(^{18}\). However, implementing the Ramsey tax wedge only constitutes a second-best policy. If able to correct for distortions with respect to quantities (worked hours, output, aggregate consumption), the decentralized government cannot reach the first-rank level of terms of trade. Indeed, we have \(\phi^R < \phi^{sp}\) if \((1 - \rho_g)\frac{\phi}{\rho_{gt}^*} < \frac{\sigma^* - 1}{\sigma^*}\). We recognize here the condition ensuring \(\phi^R_{\tau_i > 0} < \phi^{sp}\). In the absence of a specific tax on home versus foreign

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\(^{17}\)In the online Appendix, we show that this is indeed an optimum, as it corresponds to the peak of the welfare curve. The demonstration relies on checking that the second-order condition on welfare holds.

\(^{18}\)Interestingly, we will find a similar condition in the matching economy (Section 2.2).
consumption (such as a tax on imports), the tax schedule can, at best, bring the competitive equilibrium closer to the first rank allocation with respect to the level of worked hours, output and aggregate consumption. In doing so, the terms of trade chosen by the social planner and the one prevailing under the Ramsey allocation remain different (in Appendix A, $\phi^{sp} \neq \phi^{dec}$), thereby suggesting that the pecuniary externality inherent to the open economy dimension still prevails (the baskets of goods do not have the same composition).

This completes the spectrum of our results. If, as assumed, the benchmark economy features both too little output and lower terms of trade due to a too heavy tax burden (i.e. the economy is on the right-hand side of the welfare curve), then the second-best policy consists in reducing tax rates such as to reach the Ramsey tax wedge (Equation (20)) where aggregates are the same as in the first rank allocations. In doing so, the government makes the terms of trade move closer to their first-best values, but they still remain too low, such that we obtain the following ranking $\phi^{dec}_{\tau_i > 0} < \phi^R < \phi^{sp}$. Moreover, provided the tax base for consumption is larger than the one for wages, a shift from direct taxation to indirect taxation (a fall in $\tau_f$ with a less-than-proportional increase of $\tau_c$) enables the government to reduce the tax wedge, thereby bringing the economy to the Ramsey allocation and increasing welfare.

2.2 Optimal taxation with labor market frictions

This section is devoted to show that LMF can amplify the magnitude of the tax reform. Appendix A.2 provides a full characterization of the equilibrium in the decentralized and centralized economies.

2.2.1 Main assumptions

Matching frictions on the labor market. Following Hungerbuhler et al. (2006), we capture LMF in a static setting with the extensive margin of labor.\textsuperscript{19}

\textsuperscript{19}Note that we eliminate here the intensive margin of labor, i.e. the amount of worked hours per worker, following so Hungerbuhler et al. (2006). In some respects, we view this modeling choice as complementary to the previous analysis of Section 2.1. In the Walrasian model, we
Each firm opens a vacancy, that can be filled with a searching worker. Matching workers with vacancies is a costly process, with \( \omega \) the cost of posting one vacancy. Hirings evolve according to a constant returns 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 normalized to 1. At the beginning of the period, all workers look for a job, \( U = 1 \). With a static matching, we have \( M = N = p \). Hence, equation \( N = \chi V^\psi \) summarizes the matching process in the economy.

Preferences. Each period, an agent can engage in only one of two activities, working or enjoying leisure. Employed agents \( (N) \) work, while unemployed agents \( (1 - N) \) spend their time searching for a job. Individual idiosyncratic risks faced by each agent in his job match are smoothed by using employment lotteries. Hence, after assuming separability between consumption and leisure, the representative household’s program is to maximize:

\[
U = \xi \log(C_H) + (1 - \xi) \log(C_F) + \Phi \log(G) - N\bar{\Gamma} \tag{23}
\]

with \( \bar{\Gamma} = \Gamma^e - \Gamma^u > 0 \) the net disutility from labor market participation, measured by the gap between the disutilities associated with work and search activities.

We now focus on the way labor taxation may (or not) restore the first-rank allocation with respect to the extensive margin of labor. We include both dimensions simultaneously when developing the dynamic general equilibrium version of the model in Section 3.
Technology. For the sake of simplicity, we consider in this section a linear production function with $A$ the exogenous worker productivity, such that

$$Y = AN$$

(24)

2.2.2 The centralized economy

The social planner chooses \{\(C_H, C_F, G, \phi, V, N\)\} so as to maximize (23) subject to

$$C_H = AN - \phi^{\sigma^*} - G - \bar{\nu}V$$

(25)

$$C_F = \phi^{\sigma^* - 1}$$

(26)

$$N = \chi V^\psi$$

(27)

It is trivial to show that FOCs on $C_H, C_F, G, \phi$ are given by the same equations as (7) and (8). Using these FOCs in the social planner’s choice on $V$ and $N$, and given that $U = 1$, we get the first-best labor market tension (denoted $V^{sp}$) as:

$$V^{sp} = \left[\frac{\psi \chi}{\bar{\omega}} \left( A - \tilde{\Gamma} \left( C_H + \frac{\sigma^*}{\sigma^* - 1} \phi C_F \right) \right) \right]^{\frac{1}{1-\psi}}$$

(28)

$$\Leftrightarrow \frac{\bar{\nu} V^{sp}}{\psi N^{sp}} = A - \tilde{\Gamma} \frac{Y^{sp} - \bar{\nu} V^{sp}}{\xi + \Phi + (1 - \xi) \frac{\sigma^* - 1}{\sigma^*}}$$

(29)

Notice that the optimal ratio of public spending to output is in fact defined relative to output net of vacancy posting costs.

2.2.3 The decentralized economy

Firms. Firms freely enter the goods market and post vacancies as long as the return on vacancy posting exceeds its cost. The free entry condition then equalizes the cost of posting one vacancy to its after-tax return. Thus, using the definition

Even in a linear production function, the share of wages in GDP $wN/Y$ is smaller than 1 in the presence of non zero vacancy cost (see Appendix A.2). In Section 2.1, the economy is also characterized by a share of wages in GDP $wh/Y$ smaller than 1.
of \( q \), we obtain:

\[
\frac{\bar{w}}{q} = (A - (1 + \tau_f)w) \quad \Rightarrow \quad \frac{V}{U} = \left( \frac{\bar{w}/\chi}{A - (1 + \tau_f)w} \right)^{\frac{1}{1-\epsilon}}
\]  

(30)

Notice that this condition can also be interpreted as the zero-profit condition (see Appendix A.2). From the free-entry condition (30), labor demand \( N(w) \), i.e. the number of hirings in the economy, is given by \( pU \), or, with \( U = 1 \) and using Equation (30):

\[
N(w) = p \left( \frac{V}{U} \right) = \chi^{\frac{1}{1-\epsilon}} \left( \frac{A - (1 + \tau_f)w}{\bar{w}} \right)^{\frac{\epsilon}{1-\epsilon}}
\]

Workers. The household maximizes its utility function (23) with respect to \( C_H, C_F \) subject to its budget constraint: \( T + (1 + \tau_c)(C_H + \phi C_F) = (1 - \tau_w)[wN + \bar{b}(1 - N)] + \pi \), with \( \bar{b} \) the unemployment benefits net of social contributions\(^{21}\) \( \bar{b} = b/(1 + \tau_f) \) and \( \pi \) the firms’ profit (equal to zero given the zero-profit condition).

As detailed in Appendix A.2, the FOCs on home and foreign consumptions can be written as:

\[
C_H = \xi \frac{(1 - \tau_w)[wN + \bar{b}(1 - N)] - T}{1 + \tau_c}
\]  

(31)

\[
C_F = (1 - \xi) \frac{(1 - \tau_w)[wN + \bar{b}(1 - N)] - T}{\phi(1 + \tau_c)}
\]  

(32)

Nash bargaining. In the presence of labor market frictions, the match between a worker and a firm gives rise to a rent, that is shared by both players through a bargaining process. We assume that wages are determined via generalized Nash bargaining according to

\[
\max_w \left( \frac{1 - \tau_w}{1 + \tau_c} (w - \bar{b}) - \Gamma \right)^{1-\epsilon} (A - (1 + \tau_f)w)^\epsilon, \quad 0 < \epsilon < 1 \quad \text{and} \quad \Gamma = \tilde{\Gamma}(C_H + \phi C_F), \quad (1 - \epsilon) \text{being the workers’ bargaining power. Solving this}
\]

---

\(^{21}\)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 includes unemployment benefits with social security contributions. This is what appears in the government budget constraint, Equation (37).
leads to the negotiated value of $w$ in the decentralized economy:

$$
\begin{align*}
  w &= \frac{1 - \epsilon}{1 + \tau_f} A + \frac{\epsilon}{1 - \tau_w} \left[ (1 - \tau_w) \tilde{b} + (1 + \tau_c) \Gamma \right] \\
  \text{(33)}
\end{align*}
$$

As 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 powers of both players.

**The labor wedge.** Replacing $w$ by its bargained expression (33) along with the definition of $\Gamma$, we derive the job creation condition in the decentralized economy:

$$
\begin{align*}
  V^{\text{dec}} &= \left( \frac{\epsilon \chi}{\omega} \left( A - \frac{1 + \tau_f}{1 - \tau_w} \left[ (1 - \tau_w) \tilde{b} + (1 + \tau_c) \tilde{\Gamma}(C_H + \phi C_F) \right] \right) \right)^{\frac{1}{1 - \psi}} \\
  \text{(34)}
\end{align*}
$$

Comparing the social planner’s labor market tension (Equation (28)) to the one that prevails in the decentralized economy (34), one can identify that distortions affecting the decentralized economy are twofold: i) the departure from the Hosios condition ($\psi \neq \epsilon$ and $b > 0$ and distortive taxation $\tau_i > 0$, $\forall i = c, f, w$), and ii) the open-economy dimension ($\phi \neq \frac{\epsilon_X/\phi}{\epsilon_Z/\phi} \frac{X}{Z} = \frac{\sigma^*}{\sigma^*-1} \phi$).

Notice that, under the Hosios condition ($b = 0$ and $\epsilon = \psi$), we have in the decentralized economy and the first-rank economy respectively:

$$
\begin{align*}
  V^{\text{dec}} &= \left( \frac{\psi \chi}{\omega} \left( A - \frac{(1 + \tau_f)(1 + \tau_c)}{1 - \tau_w} \tilde{\Gamma}(C_H + \phi C_F) \right) \right)^{\frac{1}{1 - \psi}} \\
  \text{(35)} \\
  V^{\text{sp}} &= \left( \frac{\psi \chi}{\omega} \left( A - \tilde{\Gamma} \left( C_H + \frac{\sigma^*}{\sigma^*-1} \phi C_F \right) \right) \right)^{\frac{1}{1 - \psi}} \\
  \text{(36)}
\end{align*}
$$

Distortive taxation and the pecuniary externality still introduce a gap between the social planner’s labor market tension and the one that prevails in the decentralized economy. Interestingly, we observe that labor market tension (36) and (35) are identical if condition (22) holds. This is the same condition as the one derived in the economy without matching. This illustrates that, with or without matching,
the same distortions on the labor market prevail, associated with proportional taxation and the pecuniary externality inherent to the open-economy dimension.

**Market equilibria and the government’s budget constraint.** The model is closed by taking into account the equilibrium condition for the home good (25), zero trade balance and the government’s budget constraint:

\[
G + (1 - \tau_w) \frac{b}{1 + \tau_f} (1 - L) = \tau_c (C_H + \phi C_F) + (\tau_w + \tau_f) wL + T
\]

where \( G = \rho_g (Y - \bar{\omega} V) \) and \( T = \rho_T (Y - \bar{\omega} V) \).\(^{22}\) As detailed in Appendix A.2, manipulating the model’s equations leads to the following rewriting of the job posting condition (34):

\[
\frac{\bar{\omega} V^{dec}}{\epsilon L^{dec}} = A - \tilde{\Gamma} (AL - \bar{\omega} V) \left[ \frac{b}{\tilde{\Gamma} (AL - \bar{\omega} V)} + (1 - \rho_y) \frac{(1 + \tau_c)(1 + \tau_f)}{1 - \tau_w} \right]
\]

\(^{22}\)These assumptions are mainly made to get tractable analytical solutions. In the dynamic general equilibrium model (Section 3), we adopt the more standard assumption that public expenditures and lump-sum taxes are proportional to aggregate output.

\(^{23}\)As in Section 2.1, this equation does not give the welfare value, as terms independent of \( \tau_f \) and \( V \) (i.e., constant in the Ramsey problem) have been eliminated.
The government balanced budget is taken into account in the Ramsey problem since $\tau_c$ is a function of $\tau_f$ through equation (37). The FOC with respect to $\tau_f$ is:

$$V_{TW}' \left[ \frac{\partial TW}{\partial \tau_f} + \frac{\partial TW}{\partial \tau_c} \frac{\partial \tau_c}{\partial \tau_f} \right] \left( \xi + (1 - \xi) \frac{\sigma^* - 1}{\sigma^*} + \Phi \right) \frac{A \chi \psi V^{\psi - 1} - c}{A \chi V^{\psi} - \bar{\omega}V^{\psi} - \chi \psi V^{\psi - 1} \bar{\Gamma}} = 0$$

Assuming that $\left[ \frac{\partial TW}{\partial \tau_f} + \frac{\partial TW}{\partial \tau_c} \frac{\partial \tau_c}{\partial \tau_f} \right] \neq 0$ (the tax base argument), we obtain the job creation condition under the Ramsey solution as given by:

$$\bar{\omega}V^R = A - \bar{\Gamma} \frac{Y^R - \bar{\omega}V^R}{\xi + \Phi + (1 - \xi) \frac{\sigma^* - 1}{\sigma^*}} \tag{40}$$

We recognize here the same job creation condition as in the centralized economy (Equation (29)). In other words, under the Ramsey tax policy, we have: $V^R = V^{sp}$. As a corollary, $N^R = N^{sp}$ and $Y^R = Y^{sp}$. As in Section 2.1, the Ramsey government uses the tax policy to reach the same employment level as in the first-best economy.

We then determine the Ramsey optimal payroll tax rate, such that labor market tension under the Ramsey allocation also satisfies the job creation condition chosen by the social planner. Subtracting Equation (38) from Equation (29), we get the optimal tax wedge $TW^R \equiv \left[ \frac{(1 + \tau_f)(1 + \tau_c)}{1 - \tau_w} \right]^R$:

$$TW^R = \frac{1}{(1 - \rho_g)} \left[ \frac{1}{\xi + (1 - \xi) \frac{\sigma^* - 1}{\sigma^*} + \Phi} - \frac{\frac{1}{\epsilon} - \frac{1}{\psi}}{\bar{\Gamma}(AN^R - \bar{\omega}V^R)} \right] \tag{41}$$

Notice that the optimal tax wedge boils down to the expression found without labor

---

24 We check that the second-order conditions hold (see online Appendix), so that the Ramsey problem yields a hump-shaped curve on welfare.

25 Given the relation between $\tau_c$ and $\tau_f$ that fulfills the government’s budget constraint (37) (given the equilibrium values of aggregate variables and the exogenous values of $\tau_w$, $\rho_g$, $\rho_T$ and $b$), it is then possible to uncover the optimal value of the payroll tax at the Ramsey solution. As detailed in Appendix A.2, we cannot derive a tractable analytical expression for this relation in the presence of positive unemployment benefits. For $b = 0$, the relation $\tau_c(\tau_f)$ boils down to:

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

Which we recognize as the same as in the Walrasian model for $\alpha = 1$. 

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21
market frictions (Equation (20)) when the Hosios condition holds ($\psi = \epsilon$ and $b = 0$). Interestingly, with matching frictions, the peak of the welfare curve shifts to the left with respect to the one obtained without matching frictions. Indeed, Equation (41) suggests that the presence of unemployment benefits ($b > 0$) calls for a lower optimal payroll tax than the one that prevails in an economy without matching frictions. In addition, if workers’ bargaining power is too great compared with their contribution to the matching process ($\epsilon < \psi \Rightarrow \frac{1}{\epsilon} - \frac{1}{\psi} > 0$), the decentralized economy is characterized by a low level of employment compared with the social planner’s economy, which gives a strong incentive for the Ramsey government to reduce labor costs by cutting the payroll tax. The greater the departure from the Hosios condition, the lower the optimal level of $\tau_f$, the greater the shift of the welfare curve to the left compared with the Ramsey Laffer curve without matching frictions.

3 Direct vs indirect taxation in a DGE model

The DGE includes capital dynamics and allows us to quantify the role of the 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). We do not introduce public and foreign debts because we want to be as close as possible to our theoretical analysis. Public debt introduces an additional instrument for the government that affects the intertemporal trade-off. Foreign debt also introduces an additional externality, on 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.

\footnote{The DGE also allows us to generalize our results to a setting with more general specifications than in Section 2: The DGE includes a matching model with extensive \textit{and} intensive margins, government expenditures consist of home \textit{and} foreign goods, the government and transfers are a fraction of output, rather than a fraction of output net of the cost of posting vacancies.}
3.1 The home country in the DGE models

3.1.1 Labor market

Without labor market frictions. The employment rate is equal to one at each time ($N_t = 1, \forall t$). Workers can adjust their labor supply only via the intensive margin, the number of hours $h_t$. The labor market equilibrium is such that the wage ensures the equality between the marginal rate of substitution (hours/consumption) and the marginal productivity of an hour worked.

With labor market frictions. 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 of 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 in efficiency units is $e_t (1 - N_t)$ and thus employment evolves as follows:

$$N_{t+1} = (1 - s)N_t + M_t \quad \text{with} \quad M_t = \chi V_t \psi [e_t (1 - N_t)]^{1-\psi}, \quad 0 < \psi < 1 \quad (42)$$

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

Let $e_i$ be the search effort of an individual worker $i$. Worker $i$’s probability of finding a job is equal to $\tilde{p}_i = e_i M(V,N)$. Since all workers are identical, the symmetric equilibrium leads to $e_i = e \forall i$, which implies $\tilde{p}_i = \tilde{p}$, with $\tilde{p}$ the aggregate job finding rate. Defining labor market tightness $\theta$ as $\theta_t = \frac{V_t}{e_t (1 - N_t)}$, the average job finding rate can be rewritten as: $\tilde{p}_t = e_t \chi \theta_t^\psi = e_t p_t$, with $p_t \equiv \frac{M(V_t, N_t)}{e_t (1 - N_t)}$. Alternatively, we have $\theta_t = p_t / q_t$. At the level of the firm, the vacancy filling rate $q_t$ is $\frac{M_t}{V_t}$ or $q_t = \chi \theta_t^{\psi-1}$. The job finding rate $\tilde{p}_t$ (the probability of filling a vacant job $q_t$) is an increasing (decreasing) function of labor market tightness.

3.1.2 The household

The economy is populated by a large number of identical households whose measure is normalized to one. Employed agents ($N$) work $h$ hours. If there are search
frictions, there are unemployed workers \((1 - N)\) who spend \(e\) hours searching for a job. Unemployed agents are randomly matched with job vacancies. Individual idiosyncratic risks faced by each agent in his job match are smoothed by using employment lotteries. Hence, the representative household’s preferences are:

\[
\sum_{t=0}^{\infty} \beta^t [N_t U(C^n_t, h_t) + (1 - N_t)U(C^u_t, e_t) + \Phi \log G_t] \tag{43}
\]

with \(0 < \beta < 1\) the discount factor and \(N_t = 1\) without labor market frictions. \(C^n_t\) and \(C^u_t\) stand for the consumption of employed and unemployed agents respectively. We assume separability between consumption and leisure, i.e. for employed and unemployed workers respectively:

\[
U(C^n_t, h_t) = \log C^n_t + \Gamma^n_t \quad \text{with} \quad \Gamma^n_t = -\sigma_L \frac{h_t^{1+\eta_L}}{1 + \eta_L} \tag{44}
\]

\[
U(C^u_t, e_t) = \log C^u_t + \Gamma^u_t \quad \text{with} \quad \Gamma^u_t = -\sigma_u \frac{e_t^{1+\eta_L}}{1 + \eta_L} \tag{45}
\]

with \(\eta_L > 0, \sigma_L > 0\) and \(\sigma_u > 0\). In an economy with labor market frictions, the representative household expects that the employment lotteries evolve according to: \(N_{t+1} = (1 - s)N_t + e_t p_t (1 - N_t)\). The household’s budget constraint is given by \(P_tC_t \leq P_H t C_{Ht} + P_F t C_{Ft} + P_t \pi_t\), where \(C_t\) and \(P_t\) denote respectively the aggregate consumption\(^{27}\) and CPI. Aggregate current consumption \((C_t)\) is spread over domestic goods \((C_{Ht})\) and imports \((C_{Ft})\), given CES preferences with elasticity of substitution \(\eta\):

\[
C_t = \left[ \xi^{\frac{1}{\eta}} C_{Ht}^{\frac{\eta-1}{\eta}} + (1 - \xi)^{\frac{1}{\eta}} C_{Ft}^{\frac{\eta-1}{\eta}} \right] \xi^{\frac{1}{\eta}} \quad \eta > 1 \tag{46}
\]

Each period, the household optimizes the consumption bundle \((46)\) subject to the following constraint \(P_tC_t = P_{Ht} C_{Ht} + P_{Ft} C_{Ft}\), with \(P_{Ht}\) and \(P_{Ft}\) the prices of the domestic and foreign goods respectively, and \(P_t\) the associated consumer price

\(^{27}\)The assumption of complete insurance markets combined with separability between consumption and leisure in the instantaneous utility function implies identical optimal consumption levels between family members, whatever their employment status.
index. Solving this program leads to the standard optimal demand functions for
the domestic and foreign varieties respectively:

\[ C_{Ht} = \xi \left( \frac{1}{P_t} \right)^{-\eta} C_t \quad \text{and} \quad C_{Ft} = (1 - \xi) \left( \frac{\phi_t}{P_t} \right)^{-\eta} C_t \]  

(47)

with the consumption price index (CPI) a function of national goods prices:

\[ P_t = \left[ \xi + (1 - \xi) \phi_t^{1-\eta} \right]^{\frac{1}{1-\eta}} \]  

(48)

3.1.3 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:

\[ Y_t = AK_t^{1-\alpha}(N_t h_t)^{\alpha}, \quad 0 < \alpha < 1 \]  

(49)

\( A \) is the global productivity of factors in the economy (assumed to be constant), \( K_t \) the physical capital stock, and \( N_t = 1, \forall t \) in an economy without labor market frictions. The law of motion of physical capital is

\[ K_{t+1} = (1 - \delta)K_t + I_t \]  

(50)

with \( 0 < \delta < 1 \) the capital depreciation rate and \( I_t \) aggregate investment. To preserve homogeneity in aggregate demand, investment is assumed to be a CES aggregator with the same elasticity of substitution as the consumption basket (Equation (46)).

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 \( \omega \). Hence, a firm’s labor employment evolves as \( N_{t+1} = (1 - s)N_t + q_t V_t \). Firms are subject to direct labor taxation, with \( \tau^f_t \) denoting the payroll tax rate \( (0 < \tau^f < 1) \). Each firm chooses \( C_w = \{ h_t, K_{t+1}, I_t | t \geq 0 \} \) if there aren’t labor market frictions (LMF) or

\footnote{For the same reason, we also make this assumption for public spending \( G_t \) and the cost of job posting in the search model \( \bar{\omega}V_t \).}
\[ C_m = \{V_t, N_{t+1}, K_{t+1}, I_t | t \geq 0 \} \] if there are LMF, to maximize the discounted value of the dividend flow:

\[
\max \sum_{t=0}^{\infty} \beta^t \frac{\lambda_{t+1}}{\lambda_t} \pi_t \quad \text{with} \quad \pi_t = \begin{cases} 
Y_t - (1 + \tau f_t) w_t h_t - P_t I_t & \text{without LMF} \\
Y_t - (1 + \tau f_t) w_t N_t h_t - P_t [I_t + \varpi V_t] & \text{with LMF}
\end{cases}
\]

### 3.1.4 Wage, hours and search effort in a economy with LMF

In the presence of labor market search frictions, the match between a worker and a firm gives rise to a rent, that is shared by both players through a bargaining process. We assume that wages and hours are determined via generalized Nash bargaining according to

\[
\max w_t, h_t (\lambda_t V_F^t)^{1-\epsilon} (\lambda_t V_H^t)^{\epsilon}, \quad \text{with} \quad V_F^t \quad \text{the marginal value for a firm and} \quad V_H^t \quad \text{the marginal value for a worker.} \quad \epsilon \quad \text{denotes the firm's bargaining power.}
\]

The solving of the problem yields worked hours and wage contracts. The negotiated amount of individual worked hours is given by:

\[
\alpha \frac{Y_t}{N_t h_t} = T W_t \sigma_L h_t n_t P_t C_t \quad (51)
\]

The solution for the negotiated wage is given by:

\[
(1 + \tau f_t) w_t h_t = \epsilon \left[ b_t + T W_t (\Gamma_u^n - \Gamma_l^n) P_t C_t \right] + (1 - \epsilon) \left[ \alpha \frac{Y_t}{N_t} + SC_t \right] \quad (52)
\]

where \(SC_t \equiv \varpi \left[ \frac{1-s}{qt} \left( 1 - \frac{1+\tau f_t}{1+\tau f_t+1} \right) + \epsilon_t \theta_t \left( \frac{1+\tau f_t}{1+\tau f_t+1} \frac{1-\tau f_t}{1-\tau f_t} \right) \right].\) As shown by Equation (51), 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). By contrast, according to Equation (52), 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 powers of both players, distorted by the tax rates. Finally, given the sharing rule determined by the Nash program, the optimal search effort level is given by:

\[
\frac{1-\epsilon}{\epsilon} \omega \theta_t = T W_t \sigma_u e_t n_t C_t \quad (53)
\]
3.1.5 Market equilibria

We rule out public indebtedness by assuming that the government runs a balanced budget each period. The government’s budget constraint is thus written as:

\[ P_t G_t + (1 - N_t) (1 - \tau^w_t) b_t = \tau^c_t P_t C_t + \left( \tau^f_t + \tau^w_t \right) w_t h_t N_t + P_t \ell_t \]  \tag{54}

With LMF and in line with the data, we assume that unemployment benefits are a fraction of real wages: \( b_t = \rho_b w_t h_t \) with \( \rho_b \) the unemployment benefit ratio. A higher value of \( \rho_b \) indicates a more generous unemployment benefit system. Our exercise is performed under the constraints that \( P_t G_t = \rho_g Y_t \) and \( P_t \ell_t = \rho_T Y_t \) with \( \rho_g \) and \( \rho_T \) constant. In section 3.2.3, we will measure how our results change if we modify this assumption. Equilibria on the home and foreign good market are respectively

\[ C_{Ht} + I_{Ht} + G_{Ht} = Y_t - \phi_t^{\sigma^*} \]  \tag{55}
\[ C_{Ft} + I_{Ft} + G_{Ft} = \phi_t^{\sigma^*-1} \]  \tag{56}

Thus, the equilibrium condition on the home good is given by:

\[ Y_t = D_{Ht} + X_t \]  \tag{57}

with \( D_{Ht} = \xi P_t^\eta D_t \), \( D_t = C_t + I_t + \varphi V_t + G_t \) and \( X_t = \phi_t^{\sigma^*} \). Finally, the zero trade balance implies \( D_{Ft} = \phi_t^{\sigma^*-1} \) with \( D_{Ft} = (1 - \xi) \left[ \frac{\phi_t}{P_t} \right]^\eta D_t \).

3.2 Numerical experiments

Given that we ultimately want to model an economy with labor market frictions, we consider France as a benchmark economy, as it exemplifies a rigid labor market (and even though we abstract from them in this section). We thus proceed to a careful calibration of the model’s deep parameters (full details are provided in Appendix B). At the benchmark equilibrium, the model matched 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}. Concerning the policy evaluations, we adopt a conservative benchmark calibration with $\Phi = 0$. We will discuss the case of $\Phi > 0$ and alternative budget adjustments in Section 3.2.3.

### 3.2.1 The optimal tax scheme at the steady state

We first determine the optimal tax scheme by only focusing on the comparison of steady states. In accordance with our analytical results (section 2.1.4), the welfare curve displays in Figure 1 a hump-shape for the economy with and without LMF. Starting from the benchmark value of $\tau_f = 0.34$, the shift from direct to indirect taxes (moving left on the x-axis) first improves welfare by reducing fiscal distortions. If we abstract from the transition, the rise in consumption largely dominates the increase in the disutility of work. For a greater tax reform, the competitive effect exerts a downward pressure on consumption. The purchasing power of wages is

![Figure 1: Optimal tax reform in economy without LMF (left) and with LMF (right), steady state analysis](image-url)
eroded by the increase in the home price index, itself attributable to the rise in the relative price of imports ($\phi$ goes up). With a more significant fall in $\tau^f$, this effect tends to dominate, thereby leading to decreasing welfare. The steady state optimal tax scheme is $\{\tau^{f*} = -0.46, \tau^{c*} = 1.26\}$ in an economy without LMF, and $\{\tau^{f*} = -0.64, \tau^{c*} = 2.22\}$ in an economy with LMF. The larger shift to the left of the hump-shaped curve in an economy with LMF compared with an economy without LMF is consistent with our analytical results (section 2.2.4). Indeed, the presence of labor market frictions strengthens the need for a reduced payroll tax rate (in comparison with the economy without LMF), so as to reduce the labor market inefficiency gap.

### 3.2.2 Taking into account the dynamics of the tax reform

The previous analysis neglects the transitional dynamics of the tax reform. We now take this dimension explicitly into account. In the spirit of Lucas (1987) and (2003), the welfare gain (or loss) of a given reform is evaluated by the compensation $\zeta$ such as: $W \left[ \left\{ (1 + \zeta)C^0, h^0, G^0 \right\}_{t=0}^\infty \right] = W^* \left[ \left\{ C^*_t, h^*_t, G^*_t \right\}_{t=0}^\infty \right]$. A positive (negative) value of $\zeta$ means that the reform is welfare-improving (welfare-deteriorating). To determine the optimal tax policy, we derive the values of $\zeta$ associated with a various range of tax rates ($\tau^f, \tau^c$), the optimal tax scheme being reached when $\zeta$ is maximized. The results are shown in Figure 2. As in the long-run case, we obtain a hump-shaped welfare curve of the tax reform. However, quantitative results are very different.

In an economy without LMF, starting from the benchmark current tax policy ($\tau^f = 0.34$ and $\tau^c = 0.22$), the optimal tax reform is reached for $\tau^{f*} = 0.36$ (and $\tau^{c*} = 0.21$). This contrasts with the analysis focussing only on the steady state. This difference comes from the bigger responses of worked hours 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 fall in the payroll tax can be welfare-improving in the long run (Figure 1), these potential gains may not compensate for the short-run effort necessary for the accumulation process. Thus, when the promise of a better
Figure 2: Optimal tax reform in economy without LMF (left) and with LMF (right), with transition

In an economy with LMF, the welfare-maximizing payroll tax is lower than in the economy without LMF ($\tau_f^* = 0.17$ versus $\tau_f^* = 0.36$, with the associated consumption tax rates being respectively $\tau_c^* = 0.33$ vs $\tau_c^* = 0.21$). Thus, in this economy, the short run costs of the transition are over-compensated for by the long run gains of the tax reform. This result comes from two sources. First, as suggested by the steady state analysis, the long run gains are greater in an economy with LMF. Secondly, the labor market adjustments are made more sluggishly in
an economy with LMF\textsuperscript{29}. Thus, in the short run, even if the workers work more, this additional effort to reach a steady state, characterized by a greater amount of capital, is smoothed over time. This sluggishness of the labor market adjustment insures the workers against the overshooting behavior of the disutility of participating.

Finally, for the benchmark calibration (column 1 of the Table 1), the shift from direct to indirect taxation results in an increase of lifetime consumption of 0.03\%.\textsuperscript{30} The gains from the tax policy are small. However, we will show in the sensitivity analysis that the welfare gains can significantly increase in the case of alternative budget adjustments or valuations of government spending.

\subsection*{3.2.3 Sensitivity analysis}

In this section, we will conduct a sensitivity analysis in two directions. Firstly, for the same budget adjustment, we will change some structural parameters: the one that gives the weight of the public spending in the utility function, the ones that govern the labor market frictions (unemployment benefits and bargaining power), and the one that determines the sensitivity of the trade balance. Secondly, we will study different budgetary adjustments, namely constant \textit{level} of the government size rather than constant \textit{relative size} in terms of output.

\textbf{Sensitivity to utility valuation of government spending $\Phi$.} How sensitive is our evaluation of the policy reform to the valuation of government spending by the private agents? In Figure 3, we present the optimal levels of $\tau^l$, including the costs of the transition, for different values of $\Phi$. In these scenarii, we take as given the observed ratio $G/Y$, at its sub-optimal level. The higher the valuation of public spending, the larger the magnitude of the tax reform (for $\Phi = \{0.3; 0.2; 0.1; 0\}$, we have $\tau^l = \{-0.65; -0.425; -0.15; 0.17\}$ and $\tau^c = \{2.3079; 1.2019; 0.645; 0.32\}$).

\textsuperscript{29}The impulse response functions of the main macroeconomic variables are presented in Appendix C (Figures 9 and 10).

\textsuperscript{30}The fiscal reform reduces the gap between the welfare of the decentralized economy and the welfare of the economy chosen by the social planner. However, the gap remains significant (welfare under the social planner is 0.07 versus -0.32 under the benchmark calibration at the end of the transition) because the fiscal policy consists in changing distortionary taxation only.
Indeed, even if, in the short run, the costs of the transition are higher with large tax changes, the long run gains compensate for this effect. This is illustrated in Figure 4. This figure shows that workers work more in the short run to reach higher capital levels in the long run in all economies. Even if this effort is greater with higher $\Phi$, the utility value of government spending, which jumps in the short run, partially compensates for these costs associated with labor market activities. In the medium run, because the speed of adjustment of public spending is higher than the one prevailing on the labor market, Panel (e) of Figure 4 shows that the gap for the instantaneous utilities before and after the reform becomes more quickly positive for higher values of $\Phi$. This analysis also shows that when government spending is an argument of the utility function, there isn’t only the crowding-out effect. Even if it is difficult to calibrate $\Phi$, it seems rational to set $\Phi > 0$ in order to give a positive counterpart to the distortions induced by its financing. We will
Figure 4: Adjustment dynamics for the optimal tax reform with different value for $\Phi$, with LMF and transition.

![Graphs showing adjustment dynamics](image)

We discuss, in the last part of this section, the impact of the gap between the observed government spending ratio and its optimal value.

**Sensitivity to labor market institutions.** In Figure 5, we show the welfare curve obtained when the open-search economy features a low unemployment benefit ratio. We retain $\rho_b = 0.25$ (vs $\rho_b = 0.56$ in the benchmark scenario), which corresponds to the values observed in the United-States and the United-Kingdom in recent decades (1995-2003). The optimal tax policy is reached for $\tau^{f*} = 0.38$. Starting from the benchmark calibration, the optimal tax reform consists of an increase in direct taxation. This result stands in sharp contrast with the one obtained with a more generous unemployment benefit system ($\tau^{f*} = 0.17$ on

---

This calibration is based on OECD data as provided in Nickell’s (2006) CEP database.
Figure 5: Optimal tax reform with low unemployment benefit $\rho_b = 0.25$ (vs $\rho_b = 0.56$ in the benchmark scenario), model with LMF and with transition $\rho_b = 0.25$.

Figure 2). This result is consistent with analytical insights (equation (41)). 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 $\rho_b$ also reduces the unemployed search effort. This effect suggests that a large $\rho_b$ 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. In Column 2 of Table 1, it can be seen that the welfare gains from the fiscal policy are significantly reduced in an economy with lower unemployment benefits, compared with the benchmark case with generous unemployment benefits (Column 1).

Our modeling allows for another potential labor market inefficiency. The case where the firm’s bargaining power ($\epsilon$) differs from its contribution to the matching process ($\psi$) indeed constitutes another structural inefficiency that may be addressed by the tax policy. In the case $\epsilon < \psi$, the optimal tax reform consists in lowering the payroll tax rate, with $\tau_f^* = 0.07$ for $\epsilon = 0.45$ 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 as a priority for the tax policy to increase the
firm’s search effort, which is achieved by lowering the payroll tax (See equation (41)) and results in larger welfare gains than in the benchmark case with $\epsilon = \psi$ (Column 3 of Table 1).

Figure 6: Optimal tax policy with $\epsilon < \psi$, model with LMF and transition

![Graph showing the optimal tax policy with $\epsilon < \psi$]

Table 1: Sensitivity Analysis, with LMF and transition

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Benchmark</td>
<td>Low $\rho_b$</td>
<td>$\epsilon &lt; \psi$</td>
<td>High $\sigma^*$</td>
</tr>
<tr>
<td>$\tau^{J^*}$</td>
<td>0.170</td>
<td>0.380</td>
<td>0.070</td>
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<tr>
<td>$\tau^{c^*}$</td>
<td>0.327</td>
<td>0.168</td>
<td>0.430</td>
<td>0.494</td>
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<tr>
<td>$dTW \times 100$</td>
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<td>-1.404</td>
<td>-6.437</td>
<td>-10.421</td>
</tr>
<tr>
<td>$\zeta \times 100$</td>
<td>0.033</td>
<td>0.002</td>
<td>0.084</td>
<td>0.166</td>
</tr>
</tbody>
</table>

Sensitivity to the open-economy dimension. When goods are more substitutable (high $\sigma^*$), the centralized allocation converges to that in a perfect competitive market: thus, tax reform is not slowed down by the opportunity to keep a markup on the tradable goods. The magnitude of the tax changes rises with $\sigma^*$. Moreover, a larger elasticity of substitution dampens the increase in the terms of trade that follows the tax reform, thereby isolating the home market from international fluctuations. In that case, we expect the output gains of the tax reform
to be only slightly dampened by the increase in the home CPI, its optimal tax rate being largely the result of the larger consumption tax base than the wage tax base. In other words, labor market inefficiencies are likely to play a dominant role, calling for a reduced labor cost. According to this reasoning, the higher $\sigma^*$, the lower the optimal tax rate $\tau^f_*$. The results shown in Figure 7 confirm the relevance of the previous reasoning. In an economy with LMF and with $\sigma^* = 2$ (versus 1.5 in the benchmark calibration), the optimal tax policy is reached for a null (even slightly negative) payroll tax rate ($\tau^f_* = -0.02$).\(^{32}\) Column 4 of Table 1 show that the magnitude of welfare gains is significantly affected by this parameter, thereby illustrating the importance of the open-economy dimension in the model. When goods are more substitutable (high $\sigma^*$), any change in the foreign price induces larger consumption switching between goods. This dampens the fall in the agents’ purchasing power, linked to the openness of the economy that puts a brake on the magnitude of the tax-cut.

\(^{32}\)The two values $\sigma^* = 1.5, 2$ lie in the range of values commonly retained in the open-macroeconomic literature (see Backus et al. (1995), among others).
**Impact of government adjustment.** In Columns 3 to 5 of Table 2, we show welfare gains from a fall in $\tau_f$ from 0.34 to 0.17 under alternative budget adjustments. We recall in Columns 1 and 2 the benchmark results with and without LMF. In Column 3, government spending and transfers are held constant at their initial steady state levels, the consumption tax adjusts to balance the government budget. The shift from direct to indirect taxation then results in a 1.88% decrease in government-to-GDP $PG/Y$ and transfer-to-GDP $PT/Y$ ratios. With the decline in the government crowding-out, the welfare gains from the fiscal reform increase to 0.63% of lifetime consumption. In Columns 4-5, it can be seen that the welfare gains are even higher when $\tau_c$ remains constant after the fall in direct taxation. In Column 4 (in Column 5), the level of transfers (government spending) adjusts to balance the government budget. The welfare gains significantly go up as the economy benefits from a shift from direct distortionary taxation to lump-sum taxation (Column 4) or to an economy with less government crowding-out (Column 5). The welfare gains from the reform are high (8.71%) in Column 5 since the economy shifts to a state when there is less crowding out by government expenditures. These high welfare gains are also linked to the fact that households do not value government spending in their utility function ($\Phi = 0$). With $\Phi = 0.2$ (Column 8), the fall in government expenditures reduces the welfare gains, although they remain significant (3.89% increase in lifetime consumption). Finally, let us now compare Columns 8 and 6, in both cases households value government spending in their utility function. Notice that welfare gains are greater when the shift from direct to indirect taxation is implemented (Column 6). In our view, Column 6 represents the relevant policy since the fiscal distortion is reduced while the size of government spending is optimal. The significant welfare gains in Columns 4, 5 and 8 are reminiscent of Prescott (2004)’s results on the significant benefits from lowering direct taxation. In his exercise, using a closed-economy model without LMF, the reduction 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. In contrast, in the benchmark case (Column 2 of Table 2), the tax scheme is designed so as to preserve the size of welfare state programs, i.e. with
constant ratios of public spending and transfers relative to GDP. This difference in budgetary adjustment undoubtedly mitigates the reduction in tax distortions induced by fiscal devaluation reform in comparison with Prescott’s exercise, hence the welfare gain associated with the tax reform.

Table 2: Impact of alternative budget adjustments, with transition

<table>
<thead>
<tr>
<th>Column number</th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<td>LMF</td>
<td>LMF</td>
<td>LMF</td>
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<td>Budget adjustment</td>
<td>(a)</td>
<td>(a)</td>
<td>(b)</td>
<td>(c)</td>
<td>(d)</td>
<td>(e)</td>
<td>(a)</td>
<td>(d)</td>
</tr>
<tr>
<td>Φ</td>
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<td>0.17</td>
<td>0.17</td>
<td>0.17</td>
<td>0.34</td>
<td>0.17</td>
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<tr>
<td>τ^c</td>
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<td>0.32</td>
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</tr>
<tr>
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<td>0.13</td>
<td>0.13</td>
<td>0.13</td>
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<td>0.13</td>
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<tr>
<td>dTW × 100</td>
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<td>-12.69</td>
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<td>ζ × 100</td>
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<td>0.03</td>
<td>0.63</td>
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<td>d(PG/Y) × 100</td>
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<td>-58.41</td>
<td>-1.88</td>
<td>0</td>
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<td>-1.88</td>
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</tbody>
</table>

(a) PG/Y and PT/Y constant; (b) G and T constant; (c) G constant, T adjusts, τ^c constant; (d) T constant, G adjusts, τ^c constant; (e) G/C = Φ constant, PT/Y constant, τ^c adjusts

Fiscal and tax reforms when Φ > 0. The previous quantitative results were obtained under the assumption that households do not value government spending in their utility (Φ = 0). As shown previously, we hence retained the least favorable calibration in terms of welfare gains, for a given ratio PG/Y. But, when Φ > 0, the welfare gains stemming from implementation of tax and fiscal reforms can be higher. Thus, we assume that at the date of the tax reform, the government decides to bring the economy to the optimal ratio of government spending to consumption: G/C = Φ. In order to grasp the quantitative impact of this new element, compared with the benchmark calibration, we show in Column 6 of Table 2 the predicted welfare effect of a fall in τ^f from 0.34 to 0.17 with Φ = 0.2. The deterministic 0.2 is chosen because it satisfies restrictions (12) and (13) and lies within the range of calibrated values in the literature (Christiano & Eichenbaum (1992), Finn (1998), Christiano et al. (2011)). However, it is difficult to exactly pin down the value of this parameter since authors,
simulation is performed under the following assumptions: the economy without reform is the benchmark economy. The economy with reform benefits from a fall in $\tau^f$ and a shift in the government spending-to-consumption ratio $G/C$ set to $\Phi$, consistently with the planner’s optimal choice of $G$. As can be seen from Column 6 of Table 2, under the benchmark budget adjustment, the welfare gains are significantly increased, up to 5.23% in terms of lifetime consumption.

**Income tax versus payroll tax.** Rather than reducing the payroll tax rate, the fall in direct taxation may be driven through a reduction in the employee’s tax rate $\tau^w$. We then evaluate the optimal design for such a tax reform, where the reduction in $\tau^w$ is offset by an adequate increase in $\tau^c$ so as to maintain the same ratios of public spending and transfers relative to output, as well as a constant payroll tax rate (Column 7 of Table 2). The results are shown in Figure 8. As Figure 8: Alternative optimal tax scheme (Reducing $\tau^w$), with LMF and transition displayed in Figure 8, and in line with our previous results, the welfare effect of the tax reform still displays a hump-shape, with the peak of the hump-shaped welfare such as Christiano et al. (2011), pick $\Phi$ such that the model replicates the $PG/Y$ ratio. We cannot use this approach as our point is that the decentralised $PG/Y$ actually differs from its socially optimal value.
curve reached for $\tau_w^* = 0$. The optimal tax reform is reached for approximately the same value of the tax wedge $TW$ (equal to $1.7849$ for $\tau_f^* = 0.17$ and $1.7825$ for $\tau_w^* = 0$ in this section). This confirms that what matters in the tax reform is the tax wedge, as shown in our analytical results (equation (41)).

4 Conclusion

This paper characterize the issue of switching from direct to indirect taxation in an open economy search model. We provide analytical insights showing that, in the absence of labor market frictions, the open-economy dimension *per se* introduces a pecuniary externality that drives a wedge between the centralized and decentralized economy. The Ramsey government can use the switching from direct to indirect taxation to bring the economy closer to the first best. In an economy with a Walrasian labor market, our quantitative result show that the transition associated with this policy is so costly that the Ramsey solution actually calls for an increase in direct taxation. We also show that switching from direct to indirect taxation is welfare-improving as it tends to dampen the effect of labor inefficiencies (thereby lowering the gap with the Hosios allocation). The more rigid the labor market institutions, the lower the Ramsey payroll tax. Our calibrated DGE on the French economy indicates that there is room for a lower payroll tax in France, as our model predicts an optimal payroll tax rate of $17\%$ (versus $34\%$ in the benchmark (current) situation). In line with the supporters of the reform, employment increases with the tax reform, as well as most macroeconomic aggregates (output, consumption, investment). Yet, the potential benefits of the tax reform should be mitigated unless the size of the welfare state, measured by the ratio $(G/Y)$ changes.

We somewhat understate the inefficiency associated with the open-economy dimension as we preclude in the paper any change in the external balance. Furthermore, welfare losses of the tax reform due to the relative price effect are likely to be mitigated by the presence of a non-tradable sector. One might also wonder about the fiscal policy response from the foreign country to the change in tax scheme in the home country. Finally, unlike Correia (2010), we leave aside the equity issue
of the tax system and adopt a representative agent framework. Nevertheless, she shows that switching from direct labor taxation to indirect consumption taxation does not necessarily imply a trade-off between equity and efficiency. All these elements raise interesting questions that are left for future research.

References


A Analytical solutions

A.1 The model without LMF

A.1.1 Centralized economy

$h^{sp}$ is given by equation (19) and $Y^{sp}$ by equation (2). In addition, we have

$$\rho_g^{sp} = \frac{\Phi}{\xi + (1-\xi)^{\frac{\sigma-1}{\sigma}} + \Phi}, \phi^{sp} = \left(\frac{(1-\xi)^{\frac{\sigma-1}{\sigma}} Y^{sp}}{\xi + (1-\xi)^{\frac{\sigma-1}{\sigma}} + \Phi}\right)^{\frac{1}{\sigma}}, C_H^{sp} = \frac{\xi}{\xi + (1-\xi)^{\frac{\sigma-1}{\sigma}} + \Phi} Y^{sp}$$

and $C_F^{sp} = \left(\frac{(1-\xi)^{\frac{\sigma-1}{\sigma}} Y^{sp}}{\xi + (1-\xi)^{\frac{\sigma-1}{\sigma}} + \Phi}\right)^{\frac{\sigma-1}{\sigma}}$.

A.1.2 Decentralized economy

We have

$$\phi^{dec} = \left(\frac{(1-\xi)(1-\rho_g) Y^{dec}}{\xi + (1-\xi)^{\frac{\sigma-1}{\sigma}} + \Phi}\right)^{\frac{1}{\sigma}}, C_H^{dec} = \xi(1-\rho_g) Y^{dec}, \text{ and } C_F^{dec} = \left(\frac{(1-\xi)(1-\rho_g) Y^{dec}}{\xi + (1-\xi)^{\frac{\sigma-1}{\sigma}} + \Phi}\right)^{\frac{\sigma-1}{\sigma}}$$

along with equations (15), (2) and $G^{dec} = \rho_g Y^{dec}$.

A.2 The matching model

A.2.1 The centralized economy

In what follows, we detail the calculation for the job creation condition (29). Recall first the set of FOC of the planner’s problem and the market equilibrium conditions: equations (7), (8), (24), (25), (26), (27), (36). Incorporating Equation (26) in Equation (8) gives:

$$\phi^{\sigma*} = \frac{1-\xi}{\xi + (1-\xi)^{\frac{\sigma-1}{\sigma}}} C_H.$$ Using this equations and (7) in the home good market equilibrium condition (25), we obtain the value of home consumption for the home good as a function of production (net of the cost of job posting):

$$C_H = \frac{\xi}{\xi + (1-\xi)^{\frac{\sigma-1}{\sigma}}} (AN - \omega V).$$

Given Equations (27) and (24), this ultimately delivers a relation between $C_H$ and $V$. Using the same reasoning, we can express $\phi$ and $C_F$ as functions of the net production:

$$\phi = \left[\frac{(1-\xi)^{\frac{\sigma-1}{\sigma}}}{\xi + (1-\xi)^{\frac{\sigma-1}{\sigma}}} (AN - \omega V)\right]^{\frac{1}{\sigma}}$$

and

$$C_F = \left[\frac{(1-\xi)^{\frac{\sigma-1}{\sigma}}}{\xi + (1-\xi)^{\frac{\sigma-1}{\sigma}}} (AN - \omega V)\right]^{\frac{\sigma-1}{\sigma}}.$$ As a result, we get that $C_H + \frac{\sigma^*}{\sigma-1} \phi C_F = \frac{\xi}{\xi + (1-\xi)^{\frac{\sigma-1}{\sigma}}} (AN - \omega V)$. Replacing this in Equation (36) gives the job creation condition (29) in the centralized economy.
A.2.2 The decentralized economy

Obtaining the zero-profit condition. We demonstrate here that the free-entry condition also leads to zero profits in the decentralized economy. Given the relation between the job filling rate and the probability of job finding, the free-entry condition indeed rewrites as $\omega = p (A - (1 + \tau_f)w)$. Given that $p = L$ and that $U = 1$, this amounts having $\omega V = L(A - (1 + \tau_f)w)$. This implies that:

$$wN = \frac{A_N - \omega V}{1 + \tau_f} \Leftrightarrow 0 = AN - \omega V - (1 + \tau_f)wN \equiv \pi,$$

which we recognize as the zero-profit condition.

About the relation between $\tau_c$ and $\tau_f$. The objective is to derive the Ramsey value of the payroll tax rate $\tau_f^R$ from the Ramsey value of the tax wedge (41) given the relation $\tau_c(1 - \rho_g)wN + \tau_f(Y - \omega V) = \rho g(Y - \omega V) + (1 - \tau_w)\tilde{b}(1 - N)$. Making use of the zero-profit condition, we get:

$$\tau_c(1 - \rho_g)(Y - \omega V) + (\tau_f + \tau_w)wN + \rho_T(Y - \omega V) = \rho g(Y - \omega V) + (1 - \tau_w)\tilde{b}(1 - N).$$

B Calibration

B.1 Calibration of the search model

Step 1: The calibrated parameters using external information. We calibrate a first set of parameters using econometric studies. The 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 $\epsilon = \psi$.

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 $\delta$. 45
Table 3: Calibrated parameters, DGE with LMF (Step 1)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firms’ weight in match</td>
<td>$\psi$</td>
<td>0.6</td>
</tr>
<tr>
<td>Firm’s bargaining power</td>
<td>$\epsilon$</td>
<td>0.6</td>
</tr>
<tr>
<td>Labor supply elasticity</td>
<td>$1/\eta_L$</td>
<td>0.56</td>
</tr>
<tr>
<td>Home elasticity of subst. between goods</td>
<td>$\eta$</td>
<td>1</td>
</tr>
<tr>
<td>Foreign elasticity of subst. between goods</td>
<td>$\sigma^*$</td>
<td>1.5</td>
</tr>
<tr>
<td>TFP level</td>
<td>$A$</td>
<td>1</td>
</tr>
<tr>
<td>Discount rate</td>
<td>$\beta$</td>
<td>0.99</td>
</tr>
</tbody>
</table>

Secondly, we observe in the French data $(1 + \tau_f)wNh/Y$ and $wNh/Y$, which yields $\tau_f$. We also observe tax revenues from indirect taxation $\tau_cPC/Y$ and employer’s social security contributions $\tau_f wNh/Y$ (Landais et al. (2011)), which yields $\tau_c$ given $\tau_f$. In addition, National Accounts yields the macroeconomic ratios $PC/Y$, $PI/Y$ and $PG/Y$, where 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. In the table 5, we present the parameter values that allow the model to match these targets. The unemployment benefit ratio $\rho_b$ is close to the value predicted by OECD French data between 1995 and 2008.

B.2 Calibration of the model without LMF

We derive the deep parameters values so as to be consistent with the empirical ratios ($PC/Y$, $PI/Y$, etc.) in France. We specify preferences with a higher labor supply elasticity than in the search model. Note that we adopt a different calibration of
Table 4: Empirical targets, DGE with LMF (Step 2)

<table>
<thead>
<tr>
<th>Label Notation</th>
<th>Value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment rate</td>
<td>$1 - N$</td>
<td>0.1</td>
</tr>
<tr>
<td>Working time</td>
<td>$h$</td>
<td>0.33</td>
</tr>
<tr>
<td>Search effort time</td>
<td>$e$</td>
<td>$h/2$</td>
</tr>
<tr>
<td>Job finding rate</td>
<td>$\tilde{p} = ep$</td>
<td>0.22</td>
</tr>
<tr>
<td>Search costs</td>
<td>$P\pi V/Y$</td>
<td>0.01</td>
</tr>
<tr>
<td>Vacancy finding rate</td>
<td>$q$</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Key ratios (relative to GDP) and fiscal policy

<table>
<thead>
<tr>
<th>Parameter Notation</th>
<th>Value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption ratio</td>
<td>$PC/Y$</td>
<td>0.62</td>
</tr>
<tr>
<td>Investment ratio</td>
<td>$PI/Y$</td>
<td>0.13</td>
</tr>
<tr>
<td>Public spending ratio</td>
<td>$PG/Y = \rho_g$</td>
<td>0.25</td>
</tr>
<tr>
<td>Imports-to-output ratio</td>
<td>$Z/Y$</td>
<td>0.25</td>
</tr>
<tr>
<td>Labor share</td>
<td>$(1 + \tau^f)\omega Nh/Y$</td>
<td>0.67</td>
</tr>
<tr>
<td>Gross labor cost</td>
<td>$wNh/Y$</td>
<td>0.5</td>
</tr>
<tr>
<td>Employee’s labor tax</td>
<td>$\tau^w$</td>
<td>0.13</td>
</tr>
<tr>
<td>Payroll tax rate</td>
<td>$\tau^f$</td>
<td>0.34</td>
</tr>
<tr>
<td>Indirect tax rate</td>
<td>$\tau^c$</td>
<td>0.22</td>
</tr>
</tbody>
</table>

\(^{(a)}\): Authors calculations, based on OECD data.  
\(^{(b)}\): Authors calculations, based on National Accounts (INSEE)

Table 5: Calibration results, DGE with LMF (Step 2)

<table>
<thead>
<tr>
<th>Parameter Notation</th>
<th>Value</th>
<th>Parameter Notation</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separation rate</td>
<td>$s$</td>
<td>0.024</td>
<td>Share of imports</td>
</tr>
<tr>
<td>Matching efficiency</td>
<td>$\chi$</td>
<td>0.941</td>
<td>Disutility of work</td>
</tr>
<tr>
<td>Cost of job posting</td>
<td>$\omega$</td>
<td>0.4558</td>
<td>Disutility of search</td>
</tr>
<tr>
<td>Unemployment benefit ratio</td>
<td>$\rho_b$</td>
<td>0.56</td>
<td>Labor supply preference</td>
</tr>
<tr>
<td>Technology parameter</td>
<td>$1 - \alpha$</td>
<td>0.32</td>
<td>Transfers to GDP ratio</td>
</tr>
<tr>
<td>Depreciation rate</td>
<td>$\delta$</td>
<td>0.006</td>
<td></td>
</tr>
</tbody>
</table>

---

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the labor supply elasticity than in the model with LMF. Indeed, given that all
the workforce is employed \((N = 1)\) without LMF, all changes in labor input occur
along the intensive margin (worked hours \(h\)). This drives us to retain a larger
labor supply elasticity in the Walrasian model. We follow Prescott (2004) and
calibrate the parameters \((\sigma_L, \eta_L)\) so as to replicate a log-specification on leisure.\(^{34}\)
The estimation stage is shown in Table 6.

\[\text{Table 6: Calibration, DGE without LMF}\]

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1 - \alpha)</td>
<td>0.32</td>
<td>(\xi)</td>
<td>0.75</td>
</tr>
<tr>
<td>(\delta)</td>
<td>0.0065</td>
<td>(\eta)</td>
<td>1</td>
</tr>
<tr>
<td>(\sigma_L)</td>
<td>3.21</td>
<td>(\eta_L)</td>
<td>0.429</td>
</tr>
<tr>
<td>(\tau^f)</td>
<td>-0.1214</td>
<td>(\sigma^*)</td>
<td>1.5</td>
</tr>
<tr>
<td>(\tau^c)</td>
<td>0.34</td>
<td>(A)</td>
<td>1</td>
</tr>
<tr>
<td>(\beta)</td>
<td>0.99</td>
<td>(\rho_g)</td>
<td>0.25</td>
</tr>
<tr>
<td>(\tau^w)</td>
<td>0.13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C  IRFs following a fall in \(\tau^f\) from 34% to 17%

Our quantitative results indicate a modest gain in terms of employment (Figure
9, panel (c)): The tax reform indeed leads to a 0.191 percentage point increase in
the employment rate, which corresponds to a gain of around + 50,000 employed
workers.\(^{35}\). The tax reform also induces a 1.8% increase in GDP. The V shape of
the welfare response (Figure 10, panel (e)) suggests that the transition is costly.

\(^{34}\)In the log-utility case, labor supply elasticity is equal to \((1 - h)/h\). With \(h\) the steady-state
amount of worked hours equal to \(h = 1/3\), this implies a labor supply elasticity of 2.33. We
replicate the case of a log-specification on leisure with our more general specification (Equation
\((44)\)). This implies a value of \(\eta_L = 1/2.33 = 0.429\) and \(\sigma_L = 3.21\). In contrast, calibration of the
search model implies a much lower elasticity of worked hours, around 0.5. See Table 6.

\(^{35}\)This is based on the employed workforce in France, which amounts to 26,337,759 persons in
2008 (INSEE data).
Figure 9: IRFs to the optimal tax reform (1)

Figure 10: IRFs to the optimal tax reform (2)