Optimal Fiscal Devaluation

François Langot
Paris School of Economics, Université du Mans (GAINS-TEPP) & Cepremap

Lise Patureau
EQUIPPE (Université de Lille 1) & CES

Thepthida Sopraseuth
Université du Mans (GAINS-TEPP) & Cepremap

February 2012

Abstract

We analyze fiscal devaluation in a small-open economy with labor market search frictions. The reform consists in shifting the tax burden from labor taxation to indirect consumption taxation. We provide a positive and normative evaluation of the long-run effects of the tax reform. We also assess its optimal design when taking into account the transitional dynamics. Our analysis shows that both the open-economy dimension and labor market frictions play a key role in shaping the optimal tax scheme. Precisely, fiscal devaluation has two contrasting effects on welfare. By reducing labor market distortions, thereby lowering the gap with the Hosios allocation, the tax reform is welfare-improving. Yet, as it makes relative imports more expensive, fiscal devaluation also lowers the agents' purchasing power, which is welfare-reducing. These contrasting effects give rise to a Laffer curve. Besides, transition matters. If the economy is better off with the tax reform in the long run, saving effort that has to be made in the meantime increases the cost of the tax reform, thereby calling for a moderate magnitude of the fiscal devaluation.

Keywords: fiscal devaluation, consumption tax, payroll tax, labor market search, small open economy, Dynamic General Equilibrium model

JEL classification: E27, E62, H21, J38

1 Introduction

The current euro zone crisis has spurred a renewed interest in fiscal devaluation as a tool to restore growth, correct external balances and boost employment. Fiscal devaluation refers to attempts to improve trade competitiveness through changes in the tax system in countries that cannot devaluate their currency because of exchange rate regimes (fixed exchange rate or monetary union). With a devaluation, a country can make exports cheaper and imports more expensive, thereby boosting the demand for domestic goods and reducing external imbalances. If the country is unwilling to or cannot devaluate, as it is the case in the euro zone, budget-neutral fiscal devaluation can replicate the effects of the devaluation through changes in tax rates. The underlying mechanism is straightforward. Fiscal devaluation consists in reforming the tax scheme by shifting the tax burden from the employers' social contribution towards consumption taxes. Such a tax reform is expected to mimic the effects of exchange rate devaluations, as the cut of the employers' payroll tax would reduce labor costs, thus producer prices, while the consumption tax increase would boost import prices without bearing on exports, whose relative price would fall. The second leading argument behind fiscal devaluation relates to labor market performances. By lowering labor cost, this policy could favor labor demand and employment while ensuring the financial sustainability of social welfare. The need for a reduced labor cost 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)). These lasts induce a labor wedge measured by the ratio between the marginal rate of substitution of consumption for leisure and the marginal product of labor, as it is presented in Shimer (2009). The empirical counterpart of this labor wedge clearly shows that the gap between labor supply and labor demand is characterized by an increasing trend since the beginning of the 1960's. Prescott (2004) studies the role of taxes in accounting for differences in labor market outcomes between European countries and the US. He finds that fiscal distortions on the labor supply explain most of the differences at points of time and the large change in relative (to US) labor market outcomes over time.[1] According to Lucas (2003) the utility consequences for France, of adopting American tax rates on labor and consumption "would be equivalent to a 20 percent increase in consumption with no increase in work effort". This provides a supplementary argument in favor of implementing fiscal devaluation in European countries.

Some countries, such as Denmark (in 1987) or Germany (in 2007) have already implemented

[1] On 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.

such a tax reform. This has also been widely debated among economic and political circles in France and Portugal in the recent years.[2] If some economists have recently called attention on this reform,[3] little is yet known about the magnitude of the potential gains from such fiscal devaluation, notably in terms of employment and welfare. This is the focus of the paper.

We propose a small-open-economy model with labor market search and matching frictions to assess the potential gains from fiscal devaluation. Labor market and trade performances are key aspects of the tax reform. It is then necessary to embody them in our modeling approach. In this framework, we provide a careful evaluation of the positive and normative implications of fiscal devaluation, whose effects are assessed in the long run, as well as when taking into account the transitional dynamics. Since we are interested in labor market outcomes, fiscal devaluation, in this paper, refers to a cut in the employers' social security contribution associated with a rise in consumption tax.[4]

Our contribution to the literature lies in stressing the role of labor market frictions in assessing the effectiveness of fiscal devaluation. The existing papers rather focus on product market imperfections and nominal rigidities (Farhi et al. (2011), Adao et al. (2009)). We discard this issue, which mostly relates to short-run adjustments, by assuming that prices and wages are flexible. However, labor market frictions and wage negotiation lead to an inefficient unemployment level, thereby leaving scope for the fiscal policy. Our originality also consists in pointing out the key role of the open-economy dimension, next to that of labor market frictions, in shaping the optimal tax scheme. In an intertemporal framework, we thus evaluate the long-run as well as the short-run effects of the fiscal devaluation, relying on both analytical results and quantitative simulations. In this respect, our paper contributes to a better understanding of the overall implications of the tax reform.

The paper's contribution can be summarized in three main results. First, we show the analytical conditions under which the tax reform can be welfare-improving in the long run. The first key condition relates to tax base comparison. It should indeed be the case that the consumption tax base is larger than the payroll tax base. Under this condition, we show that fiscal devaluation is always welfare-enhancing in a closed-walrasian setting. Adding the open-economy dimension and labor market frictions make things less trivial. In particular, we show that both dimensions have an opposite effect on welfare. On the one hand, the tax reform is welfare improving as it tends to

[2]See for instance IMF Press Release on Portugal (http://www.imf.org/external/np/sec/pr/2011/pr11160.htm). In France, the fiscal devaluation is referred to as "Social VAT". In January 2012, this is announced to be part of the French government plan to boost job creation.

[3]Cavallo and Cottani on VoxEU (http://www.voxeu.org/index.php?q=node/4666); and IMF (2011).

[4]We do not consider changes in tariff and export subsidy since we want to focus on labor market frictions. Furthermore, 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.

dampen the effect of labor inefficiencies (thereby lowering the gap with the Hosios allocation). On the other hand, it also makes imports relatively more expensive. This relative price effect lowers the agents' purchasing power, which tends to reduce welfare by dampening the beneficial effects of the fiscal reform on output and consumption. These contrasting effects give rise to a Laffer curve.

Our second main result is to provide a carefully calibrated model in order to gauge the potential benefits from the reform in terms of employment and welfare in this setting. To our view, the quantitative exercise has been overlooked in spite of being crucial in the discussion about the relevance of fiscal devaluation. This paper contributes to fill this gap. Using France as the benchmark economy, we thus show that there is room for fiscal devaluation, as our model predicts an optimal payroll tax rate of 22% (versus 34% in the benchmark (current) situation).

As third contribution, we put into evidence some key determinants that condition the effectiveness of the tax reform. Firstly, the optimal tax scheme strongly depends on the surrounding set of labor market institutions. Interestingly, we show that labor market frictions *per se* do not necessarily call for a reduced labor tax. The too high bargaining power of workers and the generous unemployment benefits that characterize the French economy, indeed magnify the effect of the reform. Things are not unequivocal though. With low unemployment benefits, we conversely obtain that the optimal fiscal policy consists in *increasing* labor taxation (anti-fiscal devaluation), as it brings down the workers' bargaining power. This shows that, with search and Nash bargaining on wages, fiscal devaluation might not be optimal. Secondly, transition matters in designing the optimal tax reform. If, by reducing overall tax distortions, fiscal devaluation ensures large welfare gains in the long run, this can only be achieved if agents agree to endure some losses in the short run, associated to the necessary saving effort in the accumulation of assets (capital and employment) that has to be made. Taking into account the transitional costs of the tax reform thereby mitigates the magnitude of the labor tax-cut, hence of the overall fiscal distortions.

The paper is organized as follows. We present the small-open-economy search model in Section 2. In Section 3, we determine the long-run effects of fiscal devaluation in analytical terms. Section 4 proposes a quantitative assessment of the Laffer curve in France. We also provide a sensitivity analysis to labor market institutions and transitional dynamics. Section 5 concludes.

2 The open-economy search model

2.1 Labor market flows

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, at the hiring rate M_t. Let

N_t and V_t, respectively be the number of workers and the total number of new jobs made available by firms, then employment evolves according to:

$$N_{t+1} = (1-s)N_t + M_t$$

with M_t the number of hirings per period, determined by a constant returns to scale matching function (Pissarides (1990)):

$$M_t = \chi V_t^{\psi} \left[e_t(1-N_t)\right]^{1-\psi}, \quad 0 < \psi < 1$$

with ψ the weight of vacant jobs in the match process and e_t the average search effort of all workers. $e_t(1-N_t)$ thus captures the total number of search effort by the unemployed in the economy. $\chi > 0$ is a scale parameter measuring the efficiency of the matching function. 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 $\widetilde{p}_i = \frac{e_i}{e}\frac{M(V,N)}{(1-N)}$. It thus depends on the worker's relative search effort, the number of vacancies as well as the number of unemployed given the matching technology. As standard in the matching model with endogenous search, the number of vacancies has a positive externality on this probability (through M), while other workers' search effort exerts a negative externality. Since all workers are identical, the symmetric equilibrium leads to $e_i = e \ \forall i$, which implies $\widetilde{p}_i = \widetilde{p}$, with $\widetilde{p}$ the aggregate job finding rate. Defining labor market tightness θ as:

$$\theta_t = \frac{V_t}{e_t(1-N_t)} \tag{1}$$

the average job finding rate can be rewritten as: $\widetilde{p}_t = e_t \chi \theta_t^{\psi} = e_t p_t$, 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 $\frac{M}{V}$ or:

$$q_t = \chi \theta_t^{\psi-1} \tag{2}$$

The job finding rate $\widetilde{p}_t$ (the probability of filling a vacant job q_t) is an increasing (decreasing) function of labor market tightness.

2.2 Households

The economy is populated by a large number of identical households whose measure is normalized to one. Each household consists of a continuum of infinitely-lived agents. The household's program consists in an intertemporal arbitrage (consumption-savings) and intratemporal arbitrages (allocation across varieties).

The intertemporal program The consumption smoothing choice interacts with the labor market behavior. Each period, an agent can engage in only one of three activities: working, searching for a job or enjoying leisure. Employed agents (N) work h hours, while unemployed ($1-N$) spend their time searching 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:

$$\sum_{t=0}^{\infty} \beta^t \left[N_t U(C_t^n, h_t) + (1-N_t) U(C_t^u, e_t)\right] \tag{3}$$

with $0 < \beta < 1$ the discount factor. The time period is normalized to 1. C_t^n and C_t^u stand for the consumption of employed and unemployed agents respectively, while h_t denotes worked hours and e_t search effort of the unemployed. We assume separability between consumption and leisure, ie for employed and unemployed workers respectively:

$$U(C_t^n, h_t) = \log C_t^n + \Gamma_t^n \qquad \text{with} \quad \Gamma_t^n = -\sigma_n \frac{h_t^{1+\eta_L}}{1+\eta_L}$$
$$U(C_t^u, e_t) = \log C_t^u + \Gamma_t^u \qquad \text{with} \quad \Gamma_t^u = -\sigma_u \frac{e_t^{1+\eta_L}}{1+\eta_L}$$

with $\eta_L > 0$, $\sigma_n > 0$ and $\sigma_u > 0$. For the representative household, employment lotteries evolve according to:

$$N_{t+1} = (1-s)N_t + e_t p_t (1-N_t) \tag{4}$$

The household's budget constraint is given by:

$$\begin{aligned} P_t B_{t+1} \quad &+ \quad P_t(1+\tau_t^c)\left[N_t C_t^n + (1-N_t) C_t^u\right] \\ &\leq \quad P_{Ht} N_t w_t h_t + (1-N_t) P_{Ht} b_t + P_t B_t (1+i_t^F) + T_t + \pi_t \end{aligned} \tag{5}$$

The real wage w_t and unemployment benefits b_t are assumed to be paid in terms of locally produced goods. T_t is a lump-sum transfer from the government and π_t are lump-sum dividends remitted by firms. Each period, a risk-free interest rate bond is issued (in terms of the consumption bundle); when bought in period t, it yields a rate of return i_t^F in $t+1$. The period's resources are used for consumption expenditures and demand for international assets (B_{t+1}). Consumption expenditures are subject to indirect taxation with τ_t^c the consumption tax rate. Notice the relative price effect in the budget constraint: Consumers care about the consumption basket valued at the consumer price index P while the wage and unemployment benefits are paid in terms of home goods whose price is P_{Ht}. The assumption of complete insurance markets combined to separability between consumption and leisure in the instantaneous utility function imply identical optimal consumption levels between family members, whatever their employment status. From now on, we will only consider the aggregate consumption level C_t.[5]

The intratemporal program Aggregate current consumption (C_t) is spread over domestic goods (C_{Ht}) and imports (C_{Ft}), given CES preferences with elasticity of substitution η:

$$C_t = \left[\xi^{\frac{1}{\eta}} C_{Ht}^{\frac{\eta-1}{\eta}} + (1-\xi)^{\frac{1}{\eta}} C_{Ft}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \qquad \eta > 1 \tag{6}$$

Each period, the household optimizes the consumption bundle (6) subject to the following constraint:

$$P_t C_t = P_{Ht} C_{Ht} + P_{Ft} C_{Ft}$$

with P_{Ht} and P_{Ft} the prices of the domestic and foreign goods respectively, and P_t the associated consumer price index. Solving this program leads to the standard optimal demand functions for the domestic and foreign varieties respectively:

$$C_{Ht} = \xi \left[\frac{P_{Ht}}{P_t}\right]^{-\eta} C_t \tag{7}$$

$$C_{Ft} = (1-\xi) \left[\frac{P_{Ft}}{P_t}\right]^{-\eta} C_t \tag{8}$$

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

$$P_t = \left[\xi P_{Ht}^{1-\eta} + (1-\xi) P_{Ft}^{1-\eta}\right]^{\frac{1}{1-\eta}} \tag{9}$$

2.3 Firms

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

$$Y_t = A K_t^{\alpha} (N_t h_t)^{1-\alpha}, \quad 0 < \alpha < 1 \tag{10}$$

A is the global productivity of factors in the economy (assumed to be constant), K_t the physical capital stock, N_t the firm's employment level and h_t the number of worked hours per employee. The law of motion of physical capital is standard:

$$K_{t+1} = (1-\delta) K_t + I_t \tag{11}$$

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 elasticities

[5] See Appendix A.1 for details on the household's program solving.

of substitution as the consumption basket (equation (6)). In addition, investment is subject to quadratic adjustment costs:

$$AC_{Kt} = \frac{\phi_K}{2}\frac{(K_{t+1} - K_t)^2}{K_t}$$

On the labor market side, search frictions require firms to post vacant jobs to be matched by unemployed workers. Accordingly, each firm chooses a number V_t of job vacancies, the unit cost of maintaining an open vacancy being $\overline{\omega}$. Hence, a firm's labor employment evolves as:

$$N_{t+1} = (1 - s)N_t + q_t V_t \tag{12}$$

Firms are subject to direct labor taxation, with τ_t^f denoting the payroll tax rate ($0 < \tau^f < 1$). Each firm chooses $\{V_t, N_{t+1}, K_{t+1}, I_t | t \geq 0\}$ to maximize the discounted value of the dividend flow:[6]

$$\sum_{t=0}^{\infty} \beta^t \frac{\lambda_{t+1}}{\lambda_t}\pi_t$$

$$\text{with} \quad \pi_t = P_{Ht}Y_t - P_t I_t - P_t\overline{\omega}V_t - P_{Ht}(1 + \tau_t^f)w_t N_t h_t - P_t AC_{Kt}$$

Notice the relative price effect in the firm's profit: The firm produces the home good sold at price P_{Ht} while it pays investment and vacancy costs in terms of the consumption basket whose price is the CPI P_t. In addition, the subsection below will show that the firm negotiates the wage with workers who also care about the CPI.

2.4 Nash bargaining on the labor market

In 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:

$$\max_{w_t, h_t} (\lambda_t \mathcal{V}_t^F)^{\epsilon} (\mathcal{V}_t^H)^{1-\epsilon} \tag{13}$$

with $\mathcal{V}_t^F$ the marginal value of a match for a firm and $\mathcal{V}_t^H$ the marginal value for a match for a worker. ϵ denotes the firm's share of a job's value. The solving of the problem yields worked hours and wage contracts, whose computation is detailed in Appendix A.3. We obtain that the negotiated amount of individual worked hours is given by:

$$\sigma_n h_t^{\eta_L} = P_{Ht}(1 - \alpha)\frac{Y_t}{h_t N_t}\frac{\lambda_t}{1 + \tau_t^f} \tag{14}$$

[6]See details in Appendix A.2.

The solution for the negotiated wage is given by:

$$(1+\tau_t^f)\frac{P_{Ht}}{P_t}w_t h_t = \epsilon(1+\tau_t^f)\left[\frac{P_{Ht}}{P_t}b_t - \frac{\Gamma_t^n - \Gamma_t^u}{\lambda_t P_t}\right] + (1-\epsilon)\left[\frac{P_{Ht}}{P_t}(1-\alpha)\frac{Y_t}{N_t} + SC_t\right] \tag{15}$$

where SC_t denotes search costs:

$$SC_t = \overline{\omega}\left[\frac{(1-s)}{q_t}\left(1 - \frac{1+\tau_t^f}{1+\tau_{t+1}^f}\right) + e_t\theta_t\left(\frac{1+\tau_t^f}{1+\tau_{t+1}^f}\right)\right]$$

As shown by Equation (14), with an efficient bargaining over wages and hours, the optimal choice of hours worked by employee is close to the walrasian case (up to payroll tax rates). By contrast, according to Equation (15), the wage contract can be interpreted as 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. Besides, the wage contract takes into account the dynamic behavior of taxes and unemployment benefits. We will further exploit these results when investigating the effects of the fiscal devaluation reform in section 3.2.

Finally, given the sharing rule determined by the Nash program, the optimal search effort level is given by:

$$\sigma_u e_t^{\eta_L} = \frac{1-\epsilon}{\epsilon} P_t \overline{\omega}\theta_t \frac{\lambda_t}{1+\tau_{t+1}^f} \tag{16}$$

2.5 Market equilibria

Government 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:

$$P_t G_t + (1-N_t)P_{Ht}b_t + P_t T_t = \tau_t^c P_t C_t + P_{Ht}\tau_t^f w_t h_t N_t \tag{17}$$

In line with the data, we assume that unemployment benefits b_t are a fraction of real wage: $b_t = \rho w_t h_t$ with ρ the unemployment benefit ratio. A higher value of ρ indicates a more generous benefit system. Let us denote $\overline{g}$ ($\bar{t}$ respectively) the government expenditure (transfers) to GDP ratio PG/Y (PT/Y).

Domestic good market The equilibrium condition is given by:

$$Y_t = D_{Ht} + D_{Ht}^* \tag{18}$$

where D_{Ht} and D_{Ht}^* are the demand functions for the home good coming from the domestic and foreign countries respectively. Consistently with our small-open economy setting, foreign demand for the home good, ie the volume of exports is assumed to be exogenous, and constant: $D_{Ht}^* = \overline{X}\ \forall\, t$.

Consumption, investment, costs on job posting and public spending consist of home and foreign goods (equation (6)). The home demand for home manufactured good is therefore:

$$D_{Ht} = \xi \left[\frac{P_{Ht}}{P_t} \right]^{-\eta} D_t$$

with aggregate demand D_t:

$$D_t = C_t + I_t + \varpi V_t + \frac{\phi_K}{2} \frac{(K_{t+1} - K_t)^2}{K_t} + G_t$$

Current account Taking into account all equilibrium conditions in the household's budget constraint delivers the current account dynamics:

$$B_{t+1} - (1 + i_t^F) B_t = \frac{P_{Ht}}{P_t} Y_t - D_t$$

International financial asset markets The introduction of incomplete asset markets alters the property of stationarity of the model, since temporary shocks have permanent effects on macroeconomic variables. Following Kollmann (2002), we assume that the interest rate at which the household can borrow or lend foreign assets i_t^F, equals the exogenous world interest rate i_t^* plus a spread, that is a decreasing function of the country's net foreign asset position (expressed in relative terms to GDP):

$$1 + i_t^F = 1 + i_t^* - \phi_b \frac{P_t B_t}{P_{Ht} Y_t} \qquad \phi_b > 0 \tag{19}$$

where ϕ_b captures the degree of capital mobility (a lower ϕ_b meaning a higher capital mobility).

In solving the model, we adopt the domestic good as numéraire, such as $P_H = 1$. The foreign price P_F and the consumption price index P should consequently be interpreted in relative terms to the Home good price. In order to derive simple analytical solutions, we make two simplifying assumptions. First, we assume that the volume of exports and the foreign interest rate are exogenous and constant ($X_t = \overline{X}$, $i_t^* = i^*$). This captures the fact that the rest of the world is not modeled in our small open economy framework. Second, the trade balance equals zero in the long run.[7] Both assumptions are made in order to make the model's mechanisms more transparent while preserving the relevance of our analysis of fiscal policy.

3 Fiscal devaluation in the long run: Analytical insights

Our first contribution is to provide analytical results about the positive and normative implications of fiscal devaluation. We do so by assessing the long-run effects of the tax reform, ie focusing on

[7] In Section 4.2, we derive the transitional dynamics associated with the tax reform, which does not preclude a non negative trade balance along the transition.

the steady-state of the model. Our model has two distinctive features: the open-economy setting and the labor market frictions. In order to shed light on the mechanisms at work in our model, we adopt a gradual approach by contrasting the results of the search model with those obtained from an economy without labor market frictions in a closed and open framework. Table 1 summarizes the three economies we are going to consider in this subsection. In order to underline the effect of the open-economy dimension, we contrast models (2) with (3), shutting down labor market frictions by considering a walrasian labor market. Comparison between models (1) and (2) will shed light on the specific effect of labor market frictions.

Table 1: Contrasting three economies

		Search open (1)	Walrasien open (2)	Walrasian closed (3)
Labor Market	N	$N<1$	$N=1$	$N=1$
	Frictions	$e, \overline{\omega}, b, s \neq 0$	$e=\overline{\omega}=b=s=0$	$e=\overline{\omega}=b=s=0$
Open Economy	P	$P \neq 1$	$P \neq 1$	$P=1$
	$\overline{X}$			not relevant
	P_F			not relevant

3.1 Fiscal devaluation: Comparing the tax bases

One key argument that underlies the potential gains from the tax reform relates to tax bases. This is made clear in Proposition 1.

Proposition 1. *Without search frictions, for $\tau^f \geq 0$ and $\tau^c \geq 0$, if $1 > \mu \equiv \frac{1-\alpha}{1-\frac{\delta\alpha\beta}{1-\beta(1-\delta)}-\overline{g}}$ then the consumption tax base is larger than the wage tax base. We deduce that $d\tau^c < -d\tau^f$, implying that the fiscal devaluation reduces the overall distortion (ie, the tax wedge $(1+\tau^c)(1+\tau^f)$).*

Proof. Straightforward using Equation (17) in a walrasian economy, holding $\{\overline{g}; \overline{t}\}$ constant, $PC/Y > wh/Y \Leftrightarrow 1+\tau^f > \mu$. Thus, $\mu < 1$ is a sufficient condition for $d\tau^c < -d\tau^f$. □

This result is directly related to one key argument behind fiscal devaluation, which relies on the tax base comparison. The consumption tax base is larger than the wage tax base ($C/Y > whN/Y$). Indeed, as can be seen from equation (5), taxing consumption expenditures indeed is equivalent to taxing both capital and labor income. As a result, by enlarging the tax base, fiscal devaluation makes it possible to compensate the reduction in payroll taxation by a less than proportional increase in the indirect tax rate, given the ratio of government expenditures and transfers. Appendix B.3 derives the condition under which this holds in a closed economy setting. It is straightforward to demonstrate that the same condition applies in the open-walrasian setting, using the system $(OW1)$-$(OW9)$ reported in Appendix C.

In what follows, we always consider this case. For the case with search frictions, we assume that this property is also satisfied. Indeed, if it is not the case, the fiscal devaluation is trivially inefficient.

3.2 Fiscal devaluation and labor market performances

In this section, we assess how fiscal devaluation affects labor market performances by decomposing its impact on the intensive margin (hours worked and search effort) and the extensive margin (employment level). To anticipate on our results, the main difference between both types of margin comes from the impact of taxes. On the one hand, the intensive margin (hours worked and search effort) is governed by the trade-off between consumption (taxed) and leisure (not taxed) with respect to the marginal returns of the labor market participation (taxed). Thus, there is explicitly the option of not paying taxes, implying that the fiscal reform has a direct effect on this trade-off.On the other hand, for the extensive margin (the employment level), the distortions affecting the gap between the marginal rate of substitution of leisure for consumption and the marginal product of employment do not matter, as these taxes have the same impact on the unemployed workers and employees: Thus the employment surplus is not directly affected by the taxes.[8] By consequence, the fiscal policy can only matter through general equilibrium effects, ie by affecting the marginal product of labor, the search costs and the prices. We also characterize how the open-economy dimension implies a direct effect of the adjustment of the price level on all aggregates.

3.2.1 Worked hours

In presence of search frictions, hours are given by:[9]

$$h = \left(\frac{1}{N} \frac{1-\alpha}{(1+\tau^c)(1+\tau^f)\sigma_n \left(1 - \frac{\alpha\beta\delta}{1-\beta(1-\delta)} - \overline{g} - \frac{P\overline{\omega}s\theta^{1-\psi}}{\chi Y/N}\right)} \right)^{\frac{1}{1+\eta_L}} \tag{20}$$

Equation (20) calls for several comments. First, let us first consider a simple walrasian labor market ($e = \overline{\omega} = b = s = 0$ and $N = 1$).[10] Equation (20) boils down to:

$$h = \left(\frac{1-\alpha}{(1+\tau^c)(1+\tau^f)\sigma_n \left(1 - \frac{\alpha\beta\delta}{1-\beta(1-\delta)} - \overline{g}\right)} \right)^{\frac{1}{1+\eta_L}} \tag{21}$$

[8] Elements of demonstration are provided in Appendix A.3.

[9] See Appendix A.5.

[10] Details on the closed- and open- walrasian models are provided in Appendices B and C respectively.

Our first comment relates to tax bases. Equation (21) suggests that the fiscal devaluation would have virtually no impact on worked hours if $d\tau^c = -d\tau^f$. Nevertheless, Proposition 1 states that the tax reform implies a less-than-proportional increase in the indirect tax rate, ie $d\tau^c < -d\tau^f$. Provided it holds, we infer from Equation (21) that fiscal devaluation raises worked hours because of a tax base enlargement.

The second effect relates to labor market frictions: When $e, \overline{\omega}, s$ and ρ are different from zero, then $N \neq 1$. From Equation (20), worked hours now depend on the employment level N. Precisely, the lower N, the higher the marginal product of a worked hour ($(1-\alpha)\frac{Y}{Nh}$). Thus, rigidities on the labor market (low N) give some incentives to supply a larger number of hours, thereby compensating these distortions. If fiscal devaluation can partially compensate the negative impact of labor market frictions by increasing the employment level (N), part of the adjustment will be achieved though the extensive margin of labor input, ie the response of worked hours will be dampened.

The third effect is linked to the open-economy dimension ($P \neq 1$). Given our utility function, the substitution effect is compensated by wealth effect, implying that this has no direct effect on worked hours, in both the search and walrasian environments (as shown in Equation (20) and (21)). Even more, in the walrasian economy (Equation (21)), the adjustment of worked hours comes only from the direct impact of the fiscal devaluation (ie, the change in (τ^c, τ^f), which is the same as would prevail in the closed economy case. The open economy does not matter on hour worked in a frictionless labor market economy.[11] Yet, as we shall see, the open-economy dimension matters by affecting welfare via the consumption dynamics. Moreover, in presence of labor market frictions (Equation (20)), the open-economy dimension does matter on worked hours through general equilibrium effects transiting by N and θ.

3.2.2 The employment level

In presence of labor market frictions, adjustments on the labor market can be less sizable due to the rigidities on job creations. Indeed, only a fraction of the labor market changes can be achieved through the intensive margin (worked hours), the other resulting from the employment level (extensive margin). In Appendix A.5, we show that the employment level in the labor market flow equilibrium is given by:

$$N = \frac{e\chi\theta^{\psi}}{s + e\chi\theta^{\psi}} < 1 \tag{22}$$

The equilibrium employment is a function of labor market tightness θ and search effort e. Notice that the functional form of this equation is not modified if the Hosios conditions are satisfied: the

[11] The same equation than (21) gives also the number of hours worked in a closed economy (Equations (51)).

level of employment becomes optimal though the optimal values for θ and e, when $\tau^f = \tau^c = \rho = 0$ and $\epsilon = \psi$.

The labor market tightness. The labor market tightness θ is derived by the firms' labor demand for a given bargained wage:[12]

$$\theta^{1-\psi}\frac{\overline{\omega}}{\chi} = \frac{\beta\epsilon}{(1-\epsilon\rho)(1-\beta(1-s))}\frac{\eta_L}{(1+\eta_L)}\left[\left(1-\rho-\frac{\rho}{\eta_L}\right)\frac{(1-\alpha)Y/N}{P} - \frac{1-\epsilon}{\epsilon}\overline{\omega}e\theta\right] \tag{23}$$

This calls for two comments. First, tax policy does not have a direct impact on labor market tightness. This is attributable to the fact that all components of the reservation wage are proportional to the wage.[13,14]As a related result, the effects of the tax reform on θ are no longer trivial, as they are channeled only indirectly through general equilibrium effects. Precisely, they depend on the adjustment of the marginal product of labor ($MPN = (1-\alpha)Y/N$) relatively to the one of the consumption price index (P, the open-economy dimension).[15] From Equation (23), we thus infer that fiscal devaluation can increase the filling rate of a vacancy only if the increase in the marginal product of labor (MPN) dominates the increase in the consumption price index (CPI).[16] Otherwise said, if the changes in the ratio MPN/CPI allow the economy to reduce the gap between the decentralized allocation and the one which respects the Hosios conditions, then the fiscal devaluation is welfare-improving. Labor market tightness at the first-best allocation can be uncovered from Equation (23), recalling that in that case $\tau^f = \tau^c = \rho = 0$ and $\epsilon = \psi$:

$$\theta^{1-\psi}\frac{\overline{\omega}}{\chi} = \frac{\beta\psi}{(1-\beta(1-s))}\frac{\eta_L}{(1+\eta_L)}\left[\frac{(1-\alpha)Y/N}{P} - \frac{1-\psi}{\psi}\overline{\omega}e\theta\right] \tag{24}$$

The larger the gap between the first-best allocation (24) and the decentralized allocation (23), the larger the room for fiscal policy, such as fiscal devaluation.

Second, the effects of tax policy on labor market tightness are affected by the set of labor market institutions (through ϵ or ρ). Precisely, comparing Equations (23) and (24) indicates that the unemployment benefit ratio ρ acts like a tax on the marginal product of labor, whereas $\epsilon < \psi$ implies that firms' share in the surplus is too small: They obtain a lower share of bargained surplus

[12]See Appendix A.5

[13]The reservation wage is standardly defined as the sum of unemployment benefits and the marginal rate of substitution between employment and consumption.

[14]When unemployment benefits are indexed to the wage, the reservation wage is proportional to the gap between the costs of working and of searching for a job (ie, $\Gamma^n - \Gamma^u$). Given that unemployed workers and employees are similarly taxed, this cost differential is proportional to the gap of the productivities in both activities, and thus independent from the tax system. This can be shown analytically combining Equations (eq:cpohfinal), (15) and (16) in steady state.

[15]Notice that if vacancy costs do not also include foreign goods, the direct impact of P on θ disappears.

[16]By raising the relative price of imports (P_F), fiscal devaluation is expected to increase the home CPI. We demonstrate this point analytically in the walrasian economy.

than the planner would have chosen, and unemployed workers receive a larger fraction of search costs. Notice that this last result can be counteracted by a fiscal policy that discourages them from searching intensively.[17] This suggests that an optimal tax scheme may exist, which allows the economy to reach a second-best allocation where frictions induced by inefficient labor market institutions are offset, even in a closed economy. We further come back to this question of labor wedge reduction (adopting so the terminology of Shimer (2009), Prescott (2004) or Rogerson (2006)) in Section 4.1.2.

The incentive to look for a job. The tax reform may indeed improve labor market outcomes by enticing unemployed workers to provide the optimal search effort. The magnitude of this effect depends on the tax base effect but also on θ, as can be inferred from the optimal choice of e (Equation (25)):

$$e = \left(\frac{1}{\sigma_u(1+\tau^c)(1+\tau^f)} \frac{1-\epsilon}{\epsilon} \frac{1}{1 - \frac{\delta\alpha\beta}{1-\beta(1-\delta)} - \overline{g} - \frac{P\varpi s\theta^{1-\psi}}{\chi Y/N}} \frac{P\varpi\theta}{Y} \right)^{\frac{1}{\eta_L}} \tag{25}$$

Both labor market frictions (via workers' bargaining power, $1-\epsilon$) and fiscal distortions affect the level of search effort. Since fiscal devaluation implies a less-than-proportional increase in the indirect tax rate, ie $d\tau^c < -d\tau^f$, the tax reform raises search effort, therefore the job finding rate. Fiscal devaluation can then be useful to reduce the gap between the decentralized allocation and the first-best allocation defined by:

$$e = \left(\frac{1}{\sigma_u} \frac{1-\psi}{\psi} \frac{1}{1 - \frac{\delta\alpha\beta}{1-\beta(1-\delta)} - g - \frac{P\varpi s\theta^{1-\psi}}{\chi Y/N}} \frac{P\varpi\theta}{Y} \right)^{\frac{1}{\eta_L}} \tag{26}$$

By comparing Equations (25) and (26), and assuming $\epsilon < \psi$ (workers' bargaining power is too high, which is the case in our benchmark calibration), it appears that search effort can be too high in the decentralized search economy, for a given value of θ. Everything else equal, ie for a given θ, this source of inefficiency shall be eliminated by an increase in labor taxation, so as to discourage unemployed workers to search too intensively. Things are less trivial though, as the policy recommendation also depends on the gap between labor market tightness at the decentralized and the first-best solution (Equations (23) and (24)). Precisely, this reasoning still holds if labor market tightness θ is close enough to its first-best counterpart[18]. Yet, this direct effect of labor market institutions on the search effort can be overcompensated by a largely lower equilibrium

[17] See the discussion below on the unemployed search effort.

[18] As shown by the comparison between Equations (23) and (24), this can be the case when $\epsilon > \psi$ and/or small ρ.

value of labor market tightness θ than at the first-best allocation.[19] In this case, and even though workers get a too large share of the match surplus ($\epsilon < \psi$), this surplus is too small, leading firms and workers to search less intensively than at the first-best allocation. The policy must therefore incite to search more, calling for a reduced labor cost. Our analytical investigations cannot allow us to conclude about the appropriate link between the tax scheme, labor market institutions and the search effort, as it ultimately depends on general equilibrium effects through labor market tightness (Equation (23)). We further investigate these points in Section 4.1.2.

3.3 The role of the open-economy dimension

In steady-state, the trade balance equilibrium condition can be expressed as:

$$\overline{X} = \left[\frac{(1-\xi)P_F^{1-\eta}}{\xi + (1-\xi)P_F^{1-\eta}}\right] A^{\frac{1}{1-\alpha}} \left[\frac{\alpha\beta}{1-\beta(1-\delta)}\right]^{\frac{\alpha}{1-\alpha}} P^{\frac{-\alpha}{1-\alpha}} hN \tag{27}$$

Without labor market frictions. When the open-economy exhibits a frictionless labor market ($N = 1$), the trade balance equation simplifies to:

$$\overline{X} = \left[\frac{(1-\xi)P_F^{1-\eta}}{\xi + (1-\xi)P_F^{1-\eta}}\right] A^{\frac{1}{1-\alpha}} \left[\frac{\alpha\beta}{1-\beta(1-\delta)}\right]^{\frac{\alpha}{1-\alpha}} P^{\frac{-\alpha}{1-\alpha}} h \tag{28}$$

From Equation (28), we can derive the impact of the tax reform on P_F, without labor market frictions.

Proposition 2. *In a frictionless labor market, the impact of the fiscal devaluation on P_F goes only through the change in h. If fiscal devaluation leads to a increase in h, then P_F increases, so does P.*

Proof. See Appendix C.2. □

Proposition 2 means that, if fiscal devaluation raises worked hours, then the competitiveness of the domestic economy is improved in the long run.

In presence of labor market frictions. As indicated by the trade balance equation in that case (Equation (27)), the impact of the tax reform on P_F goes through changes in h *and* N. Unambiguously, the relative price of foreign goods P_F will go up as worked hours and the employment level increase with the fiscal devaluation. Since the employment response depends on labor market institutions (Equations (22) and (23)), this will also be the case of the competitive effect. Besides,

[19] Conversely, this can be the case for large values of the unemployment benefits, that strongly increase labor costs. See Figure 6 and related comments.

Equation (27) determines the response of the foreign relative price P_F, hence the consumer price index P (Equation (9)) and the extent of the output response to the tax reform. The magnitude of the relative price effect notably depends on the elasticity of substitution between domestic and foreign goods (η). We will consequently pay attention to the role of both dimensions on our results. At this stage though, no simple analytical insight can be derived, and we have to rely on a quantitative assessment (Section 4).

3.4 Fiscal devaluation and welfare

The fiscal devaluation must be implemented if the reform improves not only labor market outcomes but also agents' welfare.

In closed economy and without labor market frictions. Let us first consider what happens without labor market frictions in order to stress the impact of the open economy dimension. In this case, welfare is given by:

$$(1-\beta)\mathcal{W} = \log(C) - \sigma_n \frac{h^{1+\eta_L}}{1+\eta_L} \quad \text{with} \quad \begin{cases} C = \left(1 - \frac{\delta\alpha\beta}{1-\beta(1-\delta)} - \overline{g}\right) Y \\ Y = A^{\frac{1}{1-\alpha}} \left(\frac{\alpha\beta}{1-\beta(1-\delta)}\right)^{\frac{\alpha}{1-\alpha}} h \end{cases} \tag{29}$$

The welfare function defines a potential trade-off: fiscal devaluation increases consumption but also decreases leisure.

Proposition 3. *Fiscal devaluation unambiguously increases welfare in a closed walrasian economy if* $(1+\tau^c)C > wh \Leftrightarrow (1+\tau^f)(1+\tau^c) > \mu$.

Proof. Because $(1-\beta)\frac{d\mathcal{W}}{dh} = \frac{1}{h} - \sigma h^{\eta_L}$, we deduce that $\frac{d\mathcal{W}}{dh} > 0$ iff, $\frac{1}{h} > \sigma h^{\eta_L}$ which is satisfied if $(1+\tau^c)C > wh$. This restriction is necessary to have $d\tau^c < -d\tau^f$. Thus, if fiscal devaluation increases h (Proposition 1), it continuously improves welfare. □

Corollary 1. *Combining Proposition 1 and 3 implies that tax base enlargement is a sufficient condition in a closed walrasian economy for the fiscal devaluation to be welfare-improving.*

In open economy and without labor market frictions. In open economy, the welfare is given by

$$(1-\beta)\mathcal{W} = \log(C) - \sigma_n \frac{h^{1+\eta_L}}{1+\eta_L} \quad \text{with} \quad \begin{cases} C = \left(1 - \frac{\delta\alpha\beta}{1-\beta(1-\delta)} - \overline{g}\right) \frac{Y}{P} \\ Y = A^{\frac{1}{1-\alpha}} \left(\frac{\alpha\beta}{1-\beta(1-\delta)}\right)^{\frac{\alpha}{1-\alpha}} P^{\frac{-\alpha}{1-\alpha}} h \end{cases} \tag{30}$$

Notice that output and consumption in the open economy model are the same as in the closed economy setting,[20] except for the presence of the relative price effect captured by P. Thus, fiscal devaluation has two contrasting effects on consumption. The first one is similar to the closed economy case: Fiscal devaluation increases worked hours, output and real wages. Thus, the tax reform raises consumption in spite of the increased consumption tax. The second one relates to the relative price effect, that conversely tends to lower consumption, and whose magnitude is determined by the trade balance adjustment (Equation (28)). As the consumption price index increases with the tax reform (Proposition 2), the purchasing power of real wages goes down. The open-economy dimension does matter due to this relative price effect on consumption. Proposition 4 states the condition under which the tax reform is welfare-improving in the open walrasian economy.

Proposition 4. *Assuming that* $f(P_F) \equiv \frac{(1-\xi)P_F^{1-\eta}}{\xi+(1-\xi)P_F^{1-\eta}} < \frac{\eta-1}{\eta}$*, the fiscal devaluation increases welfare in an open walrasian economy if* $\Upsilon(P_F)(1+\tau^c)(1+\tau^f) > \mu$*, with* $\Upsilon(P_F)$ *defined as:* $\Upsilon(P_F) \equiv 1 - \frac{\frac{1}{1-\alpha}f(P_F)}{(\eta-1)(1-f(P_F))+\frac{\alpha}{1-\alpha}f(P_F)}$.

Proof. Expression (30) leads to:

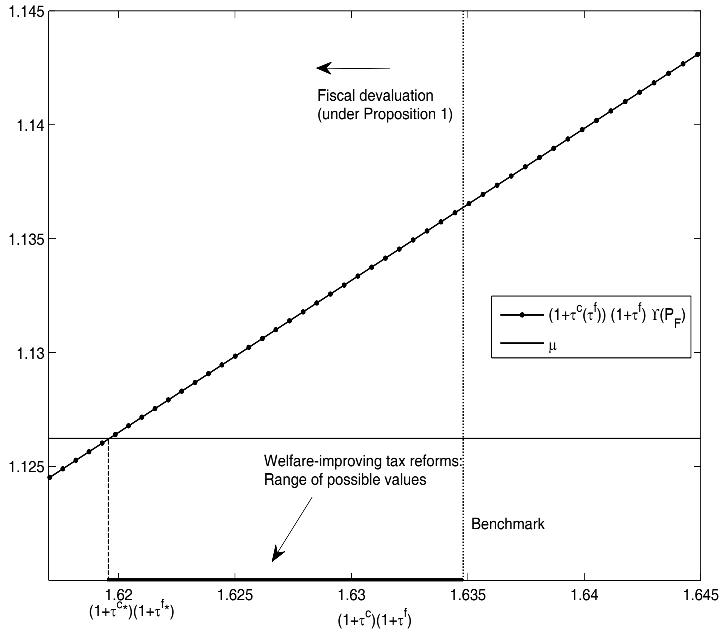
$$(1-\beta)\frac{d\mathcal{W}}{dh} = \frac{1}{h}\left[1 - \frac{1}{1-\alpha}f(P_F)\frac{dP_F/P_F}{dh/h}\right] - \sigma_n h^{\eta_L}$$

where $f(P_F) = \frac{(1-\xi)P_F^{1-\eta}}{\xi+(1-\xi)P_F^{1-\eta}}$ and $\frac{dP_F/P_F}{dh/h} = \frac{1}{(\eta-1)(1-f(P_F))+\frac{\alpha}{1-\alpha}f(P_F)}$. Given the definition of $\Upsilon(P_F)$, we get that $(1-\beta)\frac{d\mathcal{W}}{dh} = \frac{1}{h}\Upsilon(P_F) - \sigma_n h^{\eta_L}$. Then, we have that $(1-\beta)\frac{d\mathcal{W}}{dh} > 0$ if $\frac{1}{h}\Upsilon(P_F) > \sigma_n h_L^{\eta} \Leftrightarrow \Upsilon(P_F) > \sigma_n h^{1+\eta_L}$. This expression shows that a necessary condition for $(1-\beta)\frac{d\mathcal{W}}{dh} > 0$ is $\Upsilon(P_F) > 0 \Rightarrow f(P_F) < \frac{\eta-1}{\eta}$. If this necessary condition is satisfied, the sufficient condition for $\frac{d\mathcal{W}}{dh} > 0$ is thus $\Upsilon(P_F)(1+\tau^c)(1+\tau^f) > \frac{1-\alpha}{1-\frac{\alpha\beta\delta}{1-\beta(1-\delta)}-\bar{g}} \equiv \mu$. □

This last result suggests that an optimal fiscal scheme can exist. This possibility is illustrated in Figure 1 where the parameters are set to their calibrated values (see Appendix A.6). Figure 1 displays on the x-axis total fiscal distortion $(1+\tau^c)(1+\tau^f)$. Under Proposition 1, fiscal devaluation reduces the overall tax wedge $(1+\tau^c)(1+\tau^f)$ (from the benchmark calibration ($\tau^f = 0.34, \tau^c = 0.22$), moving to the left along the x-axis in Figure 1). The upward sloping $\Upsilon(P_F)(1+\tau^c)(1+\tau^f)$ and the flat line μ, are both reported as a function of total fiscal distortion $(1+\tau^c)(1+\tau^f)$ on the y-axis. Fiscal devaluation is welfare improving as long as $\Upsilon(P_F)(1+\tau^c)(1+\tau^f) > \mu$, which defines a set of possible welfare improving values. When this condition does not hold, which happens for a (too) large fiscal devaluation (a greater fall in $(1+\tau^c)(1+\tau^f)$ starting from the benchmark value), the change in the tax scheme can actually decrease welfare. Since the relative price of foreign goods

[20] Appendix C.2, Equation (61) is similar to Equation (52), and Equation (59) similar to Equation (50)

Figure 1: Existence of an optimal fiscal devaluation scheme



P_F, thus P, will rise following the fiscal devaluation, this relative price effect is likely to lower consumption. The open economy dimension introduces an hump-shaped welfare function with a maximum that defines the optimal fiscal devaluation: The peak of the Laffer curve on welfare is reached for $(1+\tau^c)(1+\tau^f)$ located at the intersection of $\Upsilon(P_F)(1+\tau^c)(1+\tau^f)$ and μ (ie here, for $(\tau^{f*} = 0.306, \tau^{c*} = 0.24)$. Thus, the lower the elasticity of worked hours relatively to the one of the CPI (ie, μ relative to $\Upsilon(P_F)$), the larger the optimal magnitude of the fiscal devaluation. This last point is of quantitative order, that we further investigate in Section 4.2.

In the open economy with labor market frictions. By reducing the level of employment through labor market tightness and search effort, labor market rigidities can induce an additional dividend to fiscal devaluation: In a economy where the equilibrium level of employment is too low, fiscal devaluation can reduce the structural inefficiencies. This suggests that, in such a context, the optimal tax reform may be of larger magnitude than in the walrasian economy (ie, a larger fall in τ^f starting from the benchmark case). This additional dividend of the reform comes from the gap between the decentralized allocation and the first best allocation obtained when the Hosios conditions are satisfied. The larger the gap on the labor market (the size of unemployment benefits ρ, the distance between the bargaining power and the share in the matching function ($\epsilon \neq \psi$), the larger this additional dividend of fiscal devaluation. Welfare is now defined by:

$$(1-\beta)\mathcal{W} = \log(C) - N\sigma_n \frac{h^{1+\eta_L}}{1+\eta_L} - (1-N)\sigma_u \frac{e^{1+\eta_L}}{1+\eta_L} \tag{31}$$

Labor market frictions introduce two additional elements on welfare: the disutility of search effort and employment, that are expected to increase simultaneously following the fiscal devaluation. Moreover, the magnitude of consumption, hours, search effort and employment responses now depends on labor market institutions. Accordingly, their impacts on welfare depend on the gap with respect to the Hosios conditions. We have discussed the effects of fiscal devaluation on a non-walrasian labor market: Everything else equal, worked hours increase because the consumption tax base is larger than the wage tax base (Proposition 1), whereas the impact of this reform on job creation, thus employment and the job finding rate, depends on labor market institutions. As the walrasian case, the welfare implications of the reform are also ambiguous due to the negative impact of the CPI on consumption. The complexity of the model does not allow us to provide analytical result. This calls for a quantitative assessment.

4 Optimal fiscal devaluation: A quantitative assessment

In this section, we evaluate the optimal tax scheme in quantitative terms. To our view, the quantitative exercise has been overlooked in spite of being crucial in the discussion about the relevance of fiscal devaluation. This section contributes to fill this gap.

We retain France as the benchmark country, as it exemplifies a rigid labor market. To convincingly do so, we proceed to a to a careful calibration of the model's deep parameters, as we fully detail in Appendix A.6. Let us briefly describe here our calibration strategy. First, we estimate a sub-set of deep parameters to make the artificial economy consistent with the main empirical features of the French economy. In particular, we pay attention to match the tax base difference in consumption and payroll taxes. In addition, for the benchmark (French) calibration, labor market institutions indeed appear inefficient (with $\epsilon < \psi$, generous unemployment benefits, or sizeable search costs). Second, given these deep parameters' values, we assess the implications of the tax reform on the main macroeconomic variables, starting from the benchmark initial calibration with the tax scheme $\{\tau^f = 0.34, \tau^c = 0.22\}$. In our simulations, we treat the payroll tax rate as exogenous and we derive the endogenous value of the indirect tax rate τ^c at the general equilibrium of the model, that is notably consistent with the government's budget constraint (17), holding constant the ratios of public spending $\overline{g}$ and transfers $\overline{t}$ (relative to GDP). This experiment is consistent with the budget neutrality inherent to fiscal devaluation.

We provide a quantitative assessment of the optimal tax reform by adopting a two-step approach. In a first step, we characterize the long-run effects of the fiscal devaluation, without taking into account the transitional dynamics leading from the pre-reform steady state to the post-reform steady state. This confirms the role of the two opposite effects of the tax reform on aggregate welfare (reduced distortions on labor input and the relative price effect), that we uncovered in analytical terms. Besides, this allows us to investigate the sensitivity of the optimal tax reform to the set of labor market institutions in place, in direct parallel with our analytical discussions of Section 3.2. In a second step, we take into account the transitional dynamics of the tax reform. In this setting, we characterize the optimal tax reform, using France as the benchmark economy.

4.1 Assessing the long-run effects of fiscal devaluation

Our objective here is to determine the optimal tax scheme, that is the couple $\left\{\tau^c, \tau^f\right\}$ that maximizes long-run welfare. Before going further, let us mention that we depart here from the benchmark calibration (as reported in Appendix A.6), by adopting an elasticity of substitution between national and foreign goods which is underestimated in light of the range of values commonly retained in the literature when assessing the effects of permanent shocks (see Ruhl (2008)). As will be further clarified, this allows us to magnify the relative price effect of the tax reform, and thus to show off a Laffer curve on welfare.[21,22]

4.1.1 The Laffer curve

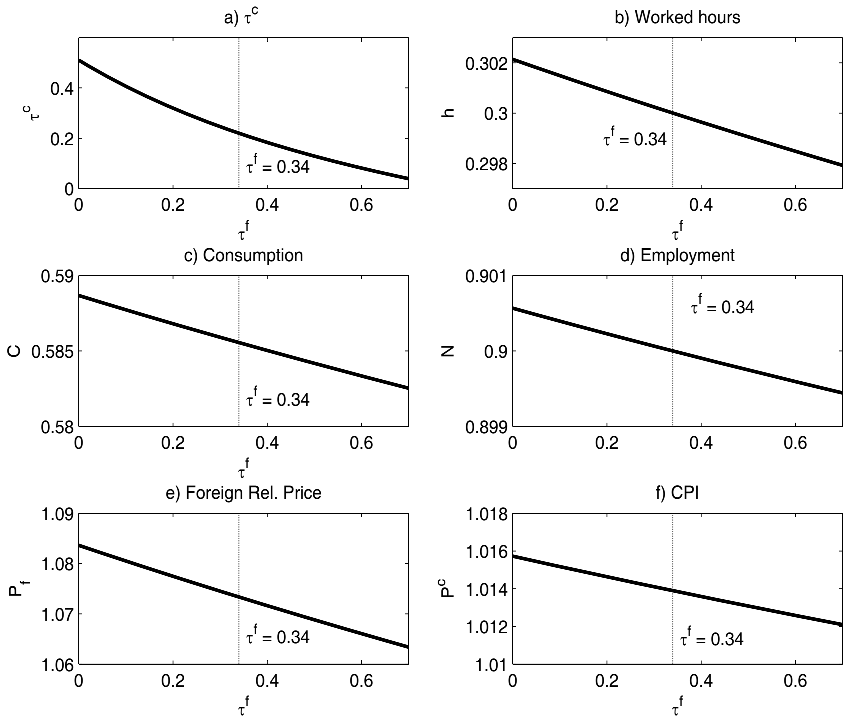
Figures 2, 3 and 4 report the long-run predictions of the labor market search model. Precisely, they display the long-run values of all variables, for varying values of the payroll tax rate τ^f.

From Figure 2, panel (a), we can see that a given reduction in labor cost (through a fall in τ^f) requires a less than proportional decrease in the consumption tax (τ^c). This illustrates our tax base enlargement effect (Proposition 1). Panel (b) indicates that worked hours increase with the fiscal devaluation. In line with our analytical results (Section 3, Equation (20)), this means that the direct effect of the tax reform dominates at the general equilibrium, such that worked hours increase with the reduction in τ^f, provided Proposition 1 holds (panel (a)). The reduction in labor taxation also raises labor input along the extensive margin, as the employment level increases with

[21] Precisely, we adopt the calibration $\eta = 1.9$ throughout this section (versus $\eta = 3.5$ in the benchmark calibration). We check that the deep parameters estimation is not affected by this modification. The only changes occur for the implied steady-state values of $\overline{X}$, P_F and P, that we accordingly adjust. Yet, preliminary experiments reveal that these changes are minor and do not significantly affect our quantitative results.

[22] For the benchmark calibration ($\eta = 3.5$), the magnitude of the price effect is not strong enough to imply an arbitrage for the tax policy in the long run, for positive values of the payroll tax rate. The predicted optimal payroll tax rate is zero, with the entire tax burden falling on consumption, that features the lower tax elasticity.

Figure 2: Fiscal devaluation in the search economy



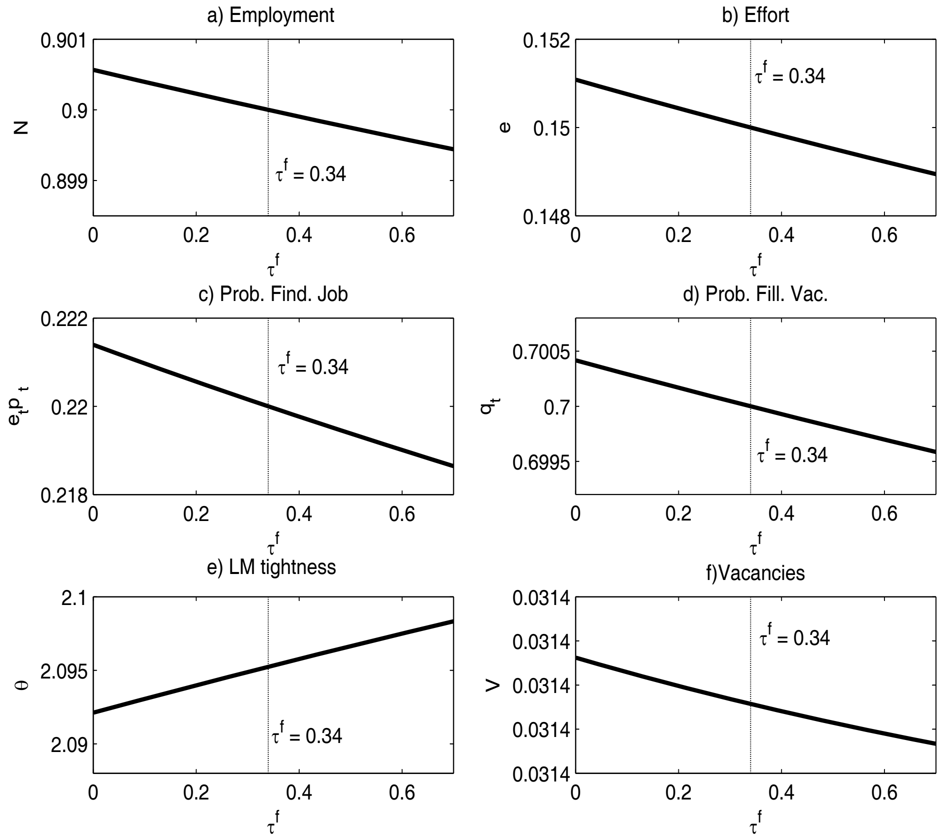
the fiscal devaluation(panel (d)). With the fall in the payroll tax, panel (e) illustrates the improved competitiveness (the rise in the foreign relative price, Proposition 2) and the resulting long run CPI inflation (panel (f)). In spite of the spike in consumption tax and the decrease in the purchasing power, consumption increases (panel (c)) because total income goes up.

In Figure 3, we report the implications of the tax reform on labor market performances, with an increase in the employment level, search effort, probability of finding a job and filling a vacancy. By reducing overall tax distortions, the fiscal devaluation improves the incentives to search more, on both the workers' and the firms' sides (panels (b) and (f)). With more search effort and more vacancies, the probability of finding a job rises (panel (c)). As well, the rise in the employment level implies a reduction in the unemployment duration.

In Figure 4, we focus on the model's predictions regarding aggregate welfare in an open economy setting. It depicts the welfare effects of the tax reform in the model with labor market search frictions (solid line, right-y axis) and in the open-walrasian economy (dashed line, left y-axis).

Let us first consider the walrasian labor market (dashed line). The welfare curve displays a hump-shape behavior (Proposition 4), meaning that, starting from the benchmark value of $\tau^f = 0.34$, the

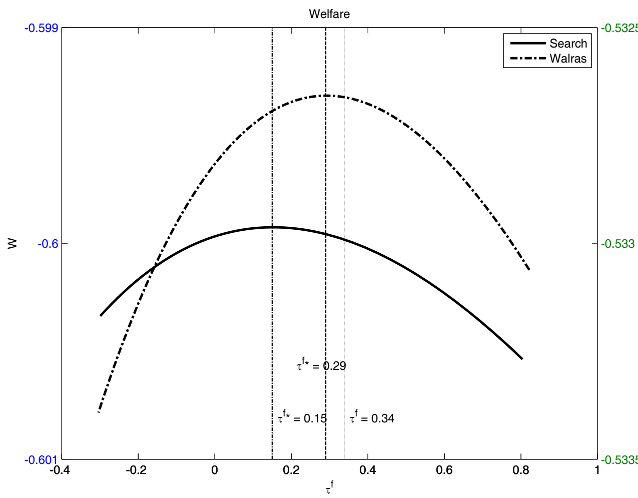
Figure 3: Fiscal devaluation and labor market performances



fiscal devaluation first improves welfare by reducing fiscal distortions. The rise in consumption dominates the increase in the disutility of work. However, the competitive effect (Proposition 2) tends to lower consumption. The purchasing power of wages is eroded by the increase in the home price index, itself attributable to the rise in the relative price of imports. With a more significant fall in τ^f, this effect tends to dominate, thereby leading to a decreasing welfare, hence the Laffer curve. Welfare is maximized for $\tau^{f^*} = 0.29$. For the benchmark calibration, the French economy stands on the right hand side of the Laffer curve: Fiscal devaluation could be welfare improving in France provided it is conducted with care. A large fall in payroll tax could actually be too large, meaning welfare decreasing.

Echoing our initial guess (Section 3), the hump shape shifts to the left with labor market frictions (solid line): With labor market rigidities, the welfare-maximizing payroll tax is lower than in the walrasian economy ($\tau^{f^*} = 0.15$ versus $\tau^{f^*} = 0.29$, with the associated indirect tax rates being respectively $\tau^{c^*} = 0.36$ vs $\tau^{c^*} = 0.25$). The presence of labor market frictions strengthens the need

Figure 4: Fiscal devaluation and welfare



Welfare in the search economy is reported on the right vertical axis.
Welfare in the walrasian economy is reported on the right vertical axis.

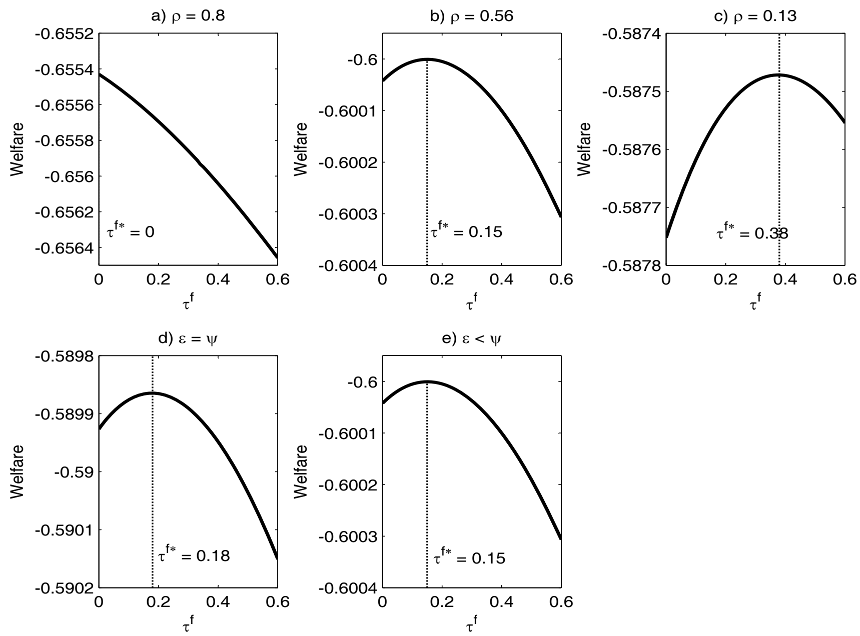
for a reduced payroll tax rate (in comparison with the walrasian economy), so as to reduce the labor market inefficiency gap. The lower the labor market rigidities, the smaller the gap between the optimal taxation in the walrasian and the search economies. However, our analytical results suggest that the interplay between labor market frictions and fiscal devaluation is not trivial. This drives us to explore this point with more depth in section 4.1.2.

4.1.2 The Laffer curve and labor market institutions

In this section, we analyze the specific role of labor market rigidities on our results on optimal fiscal devaluation. Labor market institutions are summarized by two parameters in the model, the unemployment benefit replacement rate ρ and the firm's bargaining power ϵ. Fiscal devaluation can reduce the inefficiency gap due to $\rho > 0$ and $\epsilon \neq \psi$. This suggests that the optimal fiscal policy can also compensate for these structural distortions. Results are reported in Figure 5.

In panels (a), (b) and (c), we evaluate the role of the generosity of the unemployment benefit system, by varying the ratio ρ everything else equal. The results can be accounted for by recalling the previous analytical insights of Section 3.2. The direct effect of the unemployment benefits is to increase the labor costs which reduce the labor market tightness θ (Equation (23)), and thus the search effort (Equation (25)). This effect suggests that a large ρ must be compensated by lower fiscal distortions (fiscal devaluation). Nevertheless, all three panels (a), (b) and (c) retain the benchmark calibration $\epsilon < \psi$. This second source of labor market inefficiency reduces the incentives for firms to

Figure 5: Fiscal devaluation and labor market institutions



search relative to the first-best allocation, whereas the too large bargaining power given to workers conversely induces too much search effort of the unemployed. The combination of the two labor market institutions therefore leads to an ambiguous message concerning the economic policy. As underlined in Section 3.2, if the distortion $\epsilon < \psi$ dominates (ie, if θ is close enough to its first-rank allocation), the priority shall be to reduce incentive for unemployed worker to search for a job, which calls for a rise in fiscal distortions. This case is exemplified in panel (c). When unemployment benefits are small enough ($\rho = 0.13$), the too large bargaining power of workers calls for an increase in the tax burden. This is done optimally via raising the payroll tax rate $\tau^{f*} = 0.38$ (vs 0.34). As a related consequence, the indirect tax rate is reduced, but less than proportionally ($\tau^{c*} = 0.16$ vs 0.22). Accordingly, the optimal fiscal policy is an "anti-fiscal devaluation". By contrast, when unemployment benefits are generous, there is not enough investment in the search process for both sides. In terms of Equations (23) vs (24), labor market tightness is too low, implying a low search effort on both sides (in spite of $\epsilon < \psi$). This calls for a reduction in τ^f, hence in the overall fiscal distortions, so as to reduce the inefficiency gap. Figure 5 shows that it is the case for our benchmark calibration ($\rho = 0.56$, panel (b)), but also in a economy where the unemployment benefits are larger. For $\rho = 0.8$ (panel (a)), the optimal fiscal devaluation is such that the payroll tax rate is equal to zero.

In panels (d) and (e) of Figure 5, we focus on the distortion $\epsilon \neq \psi$. They indicate that, for a given level of unemployment benefits (benchmark value of $\rho = 0.56$), the magnitude of the optimal fiscal policy is reduced when $\epsilon = \psi$. When the bargaining power of the firms is equal to their weight in the matching function ($\epsilon = \psi$, panel (d)), implying less distortions, the optimal fiscal devaluation is less aggressive than in the (benchmark) case where $\epsilon < \psi$ (panel (e)): The need for a labor subsidy counteracting the excessive workers' bargaining power partially disappears. Thus, $\tau^{f\star}(\epsilon = \psi) > \tau^{f\star}(\epsilon < \psi)$ (0.18 vs 0.15), leading to $\tau_c^\star(\epsilon = \psi) < \tau_c^\star(\epsilon < \psi)$ (0.32 vs 0.36).

4.2 Transitional dynamics and Laffer curve

So far, we have assessed the long-run effects of the tax reform without looking at its transitional impact. We now evaluate the optimal tax reform when its short-run effects are taken into account.

To evaluate the welfare gain (or loss) of a given reform, and compare the various scenarios in this respect to determine the best one, we rely on the approach developed by Lucas (1987) and Lucas (2003). We calculate the welfare gain associated with a given tax reform, by comparing two economies both starting from the initial steady-state (before the tax change). The first economy is not hit by the fiscal reform and remains *ad vitam* at its initial steady state. By contrast, the second economy is hit by the fiscal shock. Let denote $\{C_t^*, N_t^*, h_t^*, e_t^*\}_{t=0}^\infty$ the paths of consumption, employment, worked hours and search effort in the second economy, and

$$\mathcal{W}\left[\{C_t^*, N_t^*, h_t^*, e_t^*\}_{t=0}^\infty\right] = \sum_{t=0}^\infty \beta^t \left[\log C_t^* - N_t^* \sigma_n \frac{(h_t^*)^{1+\eta_L}}{1+\eta_L} - (1-N_t^*)\sigma_u \frac{(e_t^*)^{1+\eta_L}}{1+\eta_L}\right]$$

the associated discounted welfare. Let us also define:

$$\mathcal{W}\left[\{(1+\phi)C_t, N_t, h_t, e_t\}_{t=0}^\infty\right] = \sum_{t=0}^\infty \beta^t \left[\log\left((1+\phi)C^0\right) - N^0 \sigma_n \frac{(h^0)^{1+\eta_L}}{1+\eta_L} - (1-N^0)\sigma_u \frac{(e^0)^{1+\eta_L}}{1+\eta_L}\right]$$

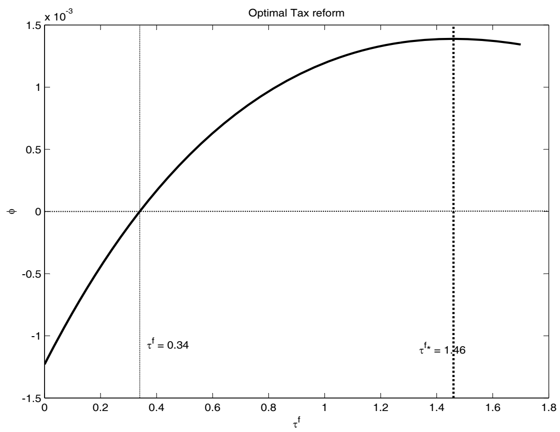
the discounted welfare in the economy that permanently remains in the initial regime (C^0, N^0, etc.) and whose consumption level is each period multiplied by the compensation $1+\phi$. We determine the welfare gain (or loss) of a given reform by the compensation level ϕ:

$$\mathcal{W}\left[\{(1+\phi)C_t, N_t, h_t, e_t\}_{t=0}^\infty\right] = \mathcal{W}^*\left[\{C_t^*, N_t^*, h_t^*, e_t^*\}_{t=0}^\infty\right]$$

ϕ captures the compensation that should be given to agents for them to accept to stay in the economy that does not benefit from the fiscal reform.

Comparing the optimal tax reform with and without the dynamics of the tax reform, illuminates the result that transition matters. Figure 4 depicts the optimal tax scheme in the long run (for the underestimated value of η). Figure 6 reports the results when the transitional dynamics is taken into account. For the same (low) value of η, we calculate the welfare gains (or losses) of the tax reform, measured by ϕ, for various values of changes in payroll taxes τ^f. Starting from the actual policy, $\tau^f = 0.34$ and $\tau^c = 0.22$, the optimal tax reform consists in *increasing* fiscal distortions (with $\tau^{f\star} = 1.46$ and $\tau^{c\star} = -0.17$). This result stands in sharp contrast with the optimal policy ($\tau^{f\star} = 0.15$ and $\tau^{c\star} = 0.36$) when we abstract for the transition.

Figure 6: Optimal tax policy with transition, the case of a low η



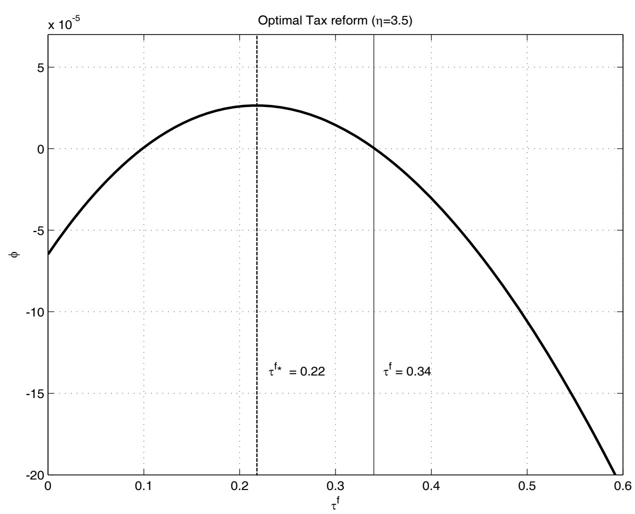
Clearly, transition matters. This can be accounted for as follows. First, it is costly in the short run to work and save in order to reach the level of assets (employment and capital) which characterize the final steady state. Second, in order to compensate these transitional costs, the final steady state must insure the agents against the purchasing power losses, thus calling for a limited (and even reversed) relative price effect in the long run. In order to understand this last effect, let us recall the results without taking account the transitional dynamics. The presence of labor market frictions tends to shift the summit of the Laffer curve to the left, as more labor market inefficiencies call for a reduced labor cost. In contrast, the open-economy dimension tends to shift it to the right: As fiscal devaluation increases the price index, it lowers the consumer's purchasing power, hence welfare.

Figure 6 suggests than even if the fiscal devaluation can be welfare-improving in the long run (Figure 4), these potential gains cannot compensate the short-run effort necessary for the accumulation process. Thus, when the promise of a better economy in the long run is not sufficiently valued by the agents, the optimal reform (transition includes) is rather to consume more in the short run and to less participate at the exchange on the labor market. The optimal fiscal policy is biased against working. Accordingly, the optimal tax policy consists in an "anti-fiscal devaluation".

Pursuing along this line of reasoning, it is clear that fiscal devaluation will still be optimal only if the long-run promise is sufficiently large to compensate the costs of the transition. A sufficient condition is that the negative long run impact of the price effect remains small enough. The price effect is governed by the set of parameters determining the sensitivity of the trade balance to the foreign price P_F (see Equation (27)). In particular, it is sensitive to the elasticity of substitution between home and foreign goods η. The intuition is straightforward. When goods are more substitutable (high η), any change in the foreign price induces larger consumption switching between home and foreign goods. Thus, 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, the output gains of the fiscal devaluation are 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 play a dominant role, calling for a reduced labor cost. According to this reasoning, the higher η, the lower the optimal tax rate $\tau^{f\star}$, and the lower the tax wedge.

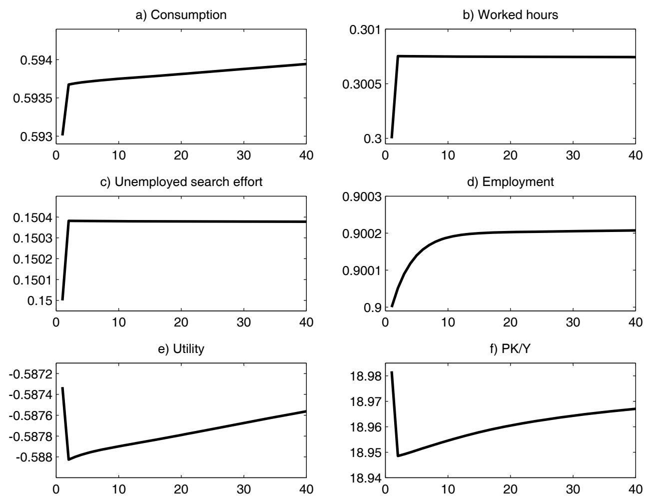
This drives us to characterize the optimal tax policy (with transition) for the benchmark (higher) elasticity of substitution $\eta = 3.5$. As detailed in Appendix A.6, we believe this calibration is well-suited for our analysis, as we focus on long run impact of the fiscal devaluation. Figure 7 reports the results: The optimal fiscal policy is $\tau^{f\star} = 0.22$ and $\tau^{c\star} = 0.30$. Consistently with our intuition, with a higher η, the Laffer curve shifts to the left (relative to Figure 6). A higher substitutability between home and foreign goods implies a dampened relative price effect, which gives room for fiscal devaluation.

Figure 7: Optimal tax reform, η calibrated as a long-run elasticity



For this calibration, abstracting for the transition dynamics leads to the prediction that the optimal fiscal devaluation is such that all the taxes are based on consumption, the payroll taxes being equal to zero.[23] Provided that the country is sufficiently sheltered from international competition (ie, goods are sufficiently substitutable for dampening the relative price effect), thereby insuring large welfare gains in the long run, the agents agree to endure some losses in the short run, associated to accumulation of assets (capital and employment). To illustrate this point, we report the short-run adjustments to the optimal tax reform ($\tau^{f*} = 0.22$) in Figure 8.

Figure 8: Optimal tax reform ($\eta = 3.5$): the transitional dynamics



Panels (b) and (c) of Figure 8 indicate that the intensive margins adjust quickly to their long-run values. This is mainly due to the rapid adjustment of the consumption tax to its final value. The overall fiscal distortions thus reaches its optimal value after only 6 quarters, allowing the intensive margins to jump on their long run values rather quickly as well. By contrast, panels (d) and (f) underline that the accumulation of assets (capital, employment) is a longer process. In particular, the capital-to-output ratio falls along the transition.[24] The instantaneous utility function (panel (e)) provides additional proof that the transition is costly. The instantaneous utility function becomes

[23]We do not report the welfare function in this case for sake of space saving. It is available upon request to the author.

[24]It is worth noticing that the foreign debt dynamics contributes to mitigate the severity of the transition. As the country becomes a net debtor along the transition, this increases the interest rate spread (Equation (48)). This consequently rewards more largely the agents for their saving effort in capital accumulation. According to this reasoning, the higher ϕ_B, the lower the costs of transition. In preliminary experiments, we check the relevance of this intuition. If this proved our guess to be correct, this experiment also revealed that the sensitivity of the reform to the parameter ϕ_b is small: By multiplying it by 10, we obtain that the optimal fiscal devaluation is $\{\tau^{f\star}, \tau^{c\star}\} = \{0.20; 0.31\}$. By dividing it by 10, it becomes $\{\tau^{f\star}, \tau^{c\star}\} = \{0.23; 0.25\}$. Thus, we conclude that our results are robust to the calibration of this financial channel.

higher than its initial level only after 65 quarters. This clearly shows that the costs of the transition are significant. But, they are acceptable because the long-run dividends of the decrease in fiscal distortions are sufficiently large.

5 Conclusion

We analyze fiscal devaluation in a small-open economy search model. We evaluate the effectiveness of the tax reform relying on both analytical results and quantitative simulations. We put into evidence the analytical conditions under which the tax reform can be welfare-improving in the long run. First, we show that the key condition under which there is scope for fiscal devaluation relates to a tax base comparison. It should indeed be the case that the consumption tax base is larger than the payroll tax base. Under this condition, we show that fiscal devaluation is always welfare-enhancing in a closed walrasian setting. The adding of the open-economy dimension and of labor market frictions makes things less trivial. Interestingly, our results indicate that both dimensions have an opposite effect on welfare. Fiscal devaluation is welfare-improving as it tends to dampen the effect of labor inefficiencies (thereby lowering the gap with the Hosios allocation). By contrast, by raising the relative price of imports, the fiscal devaluation induces a relative price effect, which exerts a downward pressure on the home agents' purchasing power. This, in turn, tends to reduce welfare by dampening the beneficial effects of the fiscal reform on output and consumption. These contrasting effects give rise to a Laffer curve.

We also provide a clear analysis of the tax incidence on the key labor market dimensions (worked hours, employment, search effort and labor market tightness). In particular, while worked hours and search effort directly depend on tax rates, the employment and the labor market tightness are impacted by the fiscal reform only through general equilibrium effects, hence the importance of labor market institutions in the elasticity evaluations of the labor market outcomes with respect to this policy change. In this perspective, our paper contributes to design a policy which aims at reducing the labor wedges observed in the European-type economies (see Shimer (2009), Prescott (2004) or Rogerson (2006)).

We provide a quantitative assessment of the Laffer curve in France. We propose to decompose the impact of the fiscal devaluation between its long/short run effects. In a first step, we show that the optimal fiscal devaluation must take into account trade-off between its positive impact on production factor adjustments, in particular the labor input, and its negative impact on the purchasing power of the consumer. In a second step, by taking into account the transitional dynamics of the tax reform, we show that the costs of the transition are not negligible: The fiscal devaluation can only be optimal if the negative long-run impact of the price effect remains small enough, allowing the agents to endure the short-run costs of the reform. The magnitude of this effect notably depends of the elasticity of substitution between home and foreign varieties. For a realistic value of this elasticity, our simulations show that this fiscal devaluation is welfare improving.

Our results are derived under the assumption of perfect competition. Future work shall extend our results to the case of monopolistic competition in order to get a more subtle message on price behavior. In addition, we somehow understate the inefficiency associated with the open-economy dimension as we preclude in the paper any permanent change in external balance. One might also wonder about the fiscal policy response from the foreign country to the change in tax scheme in the home country. All elements are interesting questions that are left for future research.

References

Adao, B., Correia, I. & Teles, P. (2009), 'On the relevance of exchange rate regimes for stabilization policy', *Journal of Economic Theory* **144**(4), 1468–1488.

Albertini, J. & Fairise, X. (2009), Optimal unemployment benefit financing scheme: A transatlantic comparison, EPEE Working Paper 09-01, EPEE.

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

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

Chéron, A. & Langot, F. (2004), 'Labor market search and real business cycles: reconciling nash bargaining with the real wage dynamics', *Review of Economic Dynamics* pp. 476–493.

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

Farhi, E., Gopinath, G. & Itskhoki, O. (2011), Fiscal devaluations, NBER Working paper 17662, NBER.

Fiorito, R. & Zanella, J. (2008), Labor supply elasticities: Can micro be misleading for macro?, Working paper 547, Univerity of Sienna.

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

Hairault, J.-O., LeBarbanchon, T. & Sopraseuth, T. (2011), The ins and outs of french unemployment, Mimeo, french version with y. dubois, dares 2011-167, decembre 2011, PSE.

Imbs, J. & Méjean, I. (2011), Elasticity optimism, Working paper 7177, CEPR.

IMF (2011), *Fiscal Monitor: Addressing Fiscal Challenges to Reduce Economic Risks*, IMF, Washington D.C.

Kollmann, R. (2002), 'Monetary policy rules in the open economy: Effects on welfare and business cycles', *Journal of Monetary Economics* **49**, 989–1015.

Krause, M. & Lubik, T. A. (2007), 'The (ir)relevance of real wage rigidity in the new keynesian model with search frictions', *Journal of Monetary Economics* **54**(4), 706–727.

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

Lane, P. & Milesi-Ferretti, G. (2001), 'Long-term capital movements', *NBER Macroeconomics Annual* **16**, 73–116.

Langot, F. (1995), Unemployment and real business cycle : A matching model, *in* P. Hénin, ed., 'Advances in Economic Business Cycles Theory', Springer Verlag, chapter 8.

Langot, F. (1996), 'A-t-on besoin d'un modèle d'hystérèse pour rendre compte de la persistance du chômage?', *Annales d'Economie et de Statistique* **44**, 29–57.

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

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

Nickell, W. (2006), The cep - oecd institutions dataset (1960-2004), Discussion Paper 0759, Centre for Economic Performance.

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

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

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

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

Ruhl, K. J. (2008), 'The International Elasticity Puzzle'.

Shimer, R. (2009), 'Convergence in macroeconomics: The labor wedge', *American Economic Journal: Macroeconomics* **1**, 280–297.

A Search model

A.1 The household's program

The dynamic problem of a typical household can be written as follows:

$$\mathcal{W}^H(\Omega_t^H) = \max_{C_t^n, C_t^u, B_{t+1}} \left\{ N_t U(C_t^n, h_t) + (1-N_t)U(C_t^u, e_t) + \beta \mathcal{W}^H(\Omega_{t+1}^H) \right\} \tag{32}$$

subject to constraints (4) and (5) and given some initial conditions (N_0, K_0). With λ_t the shadow price of the budget constraint, the first order conditions with respect to consumption and international bonds are respectively:

$$\frac{1}{C_t^n} = \frac{1}{C_t^u} = (1+\tau_t^c)\lambda_t P_t \tag{33}$$

$$P_t \lambda_t = \beta[(1+i_{t+1}^F)\lambda_{t+1} P_{t+1}] \tag{34}$$

As indicated by Equation (33), $C_t^n = C_t^u = C_t$.

A.2 The firm's program

Each firm chooses $\{V_t, N_{t+1}, K_{t+1}, I_t | t \geq 0\}$ to maximize the discounted value of the dividend flow:

$$\begin{aligned} \mathcal{W}(\Omega_t^F) &= \max_{V_t, N_{t+1}, K_{t+1}, I_t} \left\{ \pi_t + \beta \left[\frac{\lambda_{t+1}}{\lambda_t} \mathcal{W}(\Omega_{t+1}^F) \right] \right\} \\ \text{with} \quad \pi_t &= P_{Ht} Y_t - P_t I_t - P_t \overline{\omega} V_t - P_{Ht}(1+\tau_t^f) w_t N_t h_t - P_t AC_{Kt} \end{aligned}$$

given the technology production function (10) and the constraints (11) and (12). Denoting Tobin's q_t^K as:

$$q_t^K = 1 + \phi_K \frac{K_{t+1} - K_t}{K_t}$$

the first-order conditions of the firm's problem are given by:

$$\frac{\overline{\omega}}{q_t} = \beta \left[\frac{P_{t+1}\lambda_{t+1}}{P_t \lambda_t} \left\{ \frac{P_{Ht+1}}{P_{t+1}} (1-\alpha) \frac{Y_{t+1}}{N_{t+1}} - (1+\tau_{t+1}^f) \frac{P_{Ht+1}}{P_{t+1}} w_{t+1} h_{t+1} + (1-s) \frac{\overline{\omega}}{q_{t+1}} \right\} \right] \tag{35}$$

$$q_t^K = \beta \left[\frac{P_{t+1}\lambda_{t+1}}{P_t \lambda_t} \left\{ \frac{P_{Ht+1}}{P_{t+1}} \alpha \frac{Y_{t+1}}{K_{t+1}} + q_{t+1}^K - \delta + \frac{\phi_K}{2} \left(\frac{I_{t+1} - \delta K_{t+1}}{K_{t+1}} \right)^2 \right\} \right] \tag{36}$$

A.3 Nash bargaining on the labor market

Wage and hours contracts are solutions of maximizing the match surplus according to Equation (13). Given the firm's value function $\mathcal{W}_t^F$, the marginal value of a match $\mathcal{V}_t^F = \frac{\partial \mathcal{W}_t^F}{\partial N_t}$ is equal to:

$$\mathcal{V}_t^F = P_{Ht}F'_{Nht}h_t - P_{Ht}w_t h_t \left(1+\tau_t^f\right) + (1-s)\,\beta\left[\frac{\lambda_{t+1}}{\lambda_t}\mathcal{V}_{t+1}^F\right] \tag{37}$$

where F'_{Nht} stands for the marginal product of labor input and $F'_{Nht}h_t$ is the output for a person that works h_t hours.

The marginal value of the match for the household is defined as $\mathcal{V}_t^H = \Psi_t^n - \Psi_t^u$, where Ψ_t^n and Ψ_t^n represent the marginal values of being employed and unemployed respectively. As in Langot (1995), these values are defined as $\Psi_t^n \equiv \frac{\partial \mathcal{W}_t^H}{\partial N_t}$ and $\Psi_t^u \equiv \frac{\partial \mathcal{W}_t^H}{\partial U_t} = \frac{\partial \mathcal{W}_t^H}{\partial N_t}\frac{\partial N_t}{\partial U_t} = -\frac{\partial \mathcal{W}_t^H}{\partial N_t}$, with $U_t = 1 - N_t$ the unemployment state variable and $\mathcal{W}_t^H$ the value function of the household according to Equation (32). Alternatively, Ψ_t^u can be interpreted as the threat point of the worker in the Nash bargaining.

Before deriving the expressions for Ψ_t^n and Ψ_t^u, it is convenient to rewrite the household's problem as a function of the two state variables N_t, U_t summarizing the worker's employment status:

$$\mathcal{W}^H(N_t, U_t, B_t) = \max_{C_t, B_{t+1}} \left\{\log C_t + N_t\Gamma_t^n + U_t\Gamma_t^u + \beta\mathcal{W}^H(N_{t+1}, U_{t+1}, B_{t+1})\right\} \tag{38}$$

subject to the set of constraints:

$$\begin{aligned}
N_{t+1} &= (1-s)N_t + e_t p_t U_t \\
U_{t+1} &= (1-e_t p_t)U_t + sN_t \\
(1+\tau_t^c)P_t C_t + P_t B_{t+1} &= P_{Ht}w_t h_t N_t + P_{Ht}b_t U_t + P_t B_t(1+i_t^F) + T_t + \pi_t
\end{aligned}$$

With λ_t the shadow price of the budget constraint, we thus obtain the following expressions for Ψ_t^n and Ψ_t^u:

$$\begin{aligned}
\Psi_t^n &= P_{Ht}\lambda_t w_t h_t + \Gamma_t^n + \beta\left[(1-s)\Psi_{t+1}^n + s\Psi_{t+1}^u\right] \\
\Psi_t^u &= P_{Ht}b_t\lambda_t + \Gamma_t^u + \beta\left[e_t p_t\Psi_{t+1}^n + (1-e_t p_t)\Psi_{t+1}^u\right]
\end{aligned}$$

From the above equations and the definition for $\mathcal{V}_t^H$ as $\frac{\partial \mathcal{W}_t^H}{\partial N_t} \equiv \mathcal{V}_t^H = \Psi_t^n - \Psi_t^u$, we get that the marginal value of a match for the household is given by:

$$\mathcal{V}_t^H = \Gamma_t^n - \Gamma_t^u + P_{Ht}\lambda_t\left[w_t h_t - b_t\right] + (1-s-e_t p_t)\,\beta\mathcal{V}_{t+1}^H \tag{39}$$

Given the marginal values of a match for a firm and a worker as expressed by Equations (37) and (39), maximizing the match surplus (13) with respect to w_t and h_t delivers the set of first-order conditions:

$$\frac{\epsilon}{\mathcal{V}_t^F}\frac{\partial \mathcal{V}_t^F}{\partial h_t} \quad + \quad \frac{1-\epsilon}{\mathcal{V}_t^H}\frac{\partial \mathcal{V}_t^H}{\partial h_t} = 0 \tag{40}$$

$$\underbrace{\frac{\epsilon}{\lambda_t}\mathcal{V}_t^H}_{LHS} \quad = \quad \underbrace{\frac{1-\epsilon}{1+\tau_t^f}\mathcal{V}_t^F}_{RHS} \tag{41}$$

Negotiation on worked hours Making use of Equation (41), the first-order condition on worked hours (40) can be rewritten as:

$$\lambda_t \frac{1}{1+\tau_t^f}\frac{\partial \mathcal{V}_t^F}{\partial h_t} + \frac{\partial \mathcal{V}_t^H}{\partial h_t} = 0 \tag{42}$$

Besides, from Equation (39), we get that:

$$\frac{\partial \mathcal{V}_t^F}{\partial h_t} \quad = \quad P_{Ht}F'_{Nht} - P_{Ht}w_t(1+\tau_t^f) \tag{43}$$

$$\frac{\partial \mathcal{V}_t^H}{\partial h_t} \quad = \quad \lambda_t P_{Ht} w_t - \sigma_n h_t^{\eta_L} \tag{44}$$

Replacing (43) and (44) into (42) and dividing by $P_t\lambda_t$ yields Equation (14) as solution for the negotiated amount of worked hours.

Wage contract Using Equations (39) and (41), the left-hand side of Equation (41) yields:

$$LHS \equiv \frac{\epsilon}{\lambda_t}\mathcal{V}_t^H = \frac{\epsilon}{\lambda_t}\left[\begin{array}{c} \Gamma_t^n - \Gamma_t^u + P_{Ht}\lambda_t\left[w_t h_t - b_t\right] \\ +\left(1-s-e_t p_t\right)\beta\left[\frac{1-\epsilon}{\epsilon}\frac{1}{1+\tau_{t+1}^f}\lambda_{t+1}\mathcal{V}_{t+1}^F\right] \end{array}\right] \tag{45}$$

Besides, using Equation (37) allows to rewrite the RHS of Equation (41) as :

$$RHS \equiv \left(\frac{1-\epsilon}{1+\tau_t^f}\right)\mathcal{V}_t^F = \left(\frac{1-\epsilon}{1+\tau_t^f}\right)\left[\begin{array}{c} P_{Ht}F'_{Nht}h_t - P_{Ht}w_t h_t\left(1+\tau_t^f\right) \\ +\left(1-s\right)\beta\left[\frac{\lambda_{t+1}}{\lambda_t}\mathcal{V}_{t+1}^F\right] \end{array}\right] \tag{46}$$

Equating Equations (45) and (46) in accordance with Equation (41) and dividing by P_t finally delivers the wage contract (Equation (15)).

Optimal search effort The optimal search effort is obtained as the solution for maximizing the threat point Ψ_t^u:

$$\frac{\partial \Psi_t^u}{\partial e_t} = 0 \Rightarrow -\frac{\partial \Gamma_t^u}{\partial e_t} = e_t p_t \beta \mathcal{V}_{t+1}^H$$

Using Equation (41) to replace $\mathcal{V}^H_{t+1}$ by $\mathcal{V}^F_{t+1}$, we get

$$-\frac{\partial \Gamma^u_t}{\partial e_t} = \frac{1-\epsilon}{\epsilon} e_t p_t \beta \left[\frac{1}{1+\tau^f_{t+1}} \mathcal{V}^H_{t+1} \right] \tag{47}$$

Besides, the firm's first-order condition with respect to employment (that finally delivers Equation (35)) is given by:

$$\frac{P_t \overline{\omega}}{q_t} = \beta \left[\frac{\lambda_{t+1}}{\lambda_t} \mathcal{V}^F_{t+1} \right]$$

Using this in Equation (47), as well as the definition of Γ^u_t, finally delivers Equation (16).

A.4 The model including transition

Here comes the list of 28 equations:

$$
\begin{aligned}
K_{t+1} &= (1-\delta)K_t + I_t \\
N_{t+1} &= (1-s)N_t + M_t \\
B_{t+1} &= (1+i_t^F)B_t + \frac{Y_t}{P_t} - D_t \\
P_t G_t &= \overline{g} Y_t \\
P_t G_t &= \tau_t^c P_t C_t + \tau_t^f N_t w_t h_t - \rho w_t h_t (1-N_t) - T_t \\
P_t T_t &= \bar{t} Y_t \\
q_t^k &= 1 + \phi_K \frac{I_t - \delta K_t}{K_t} \\
\theta_t &= \frac{V_t}{e_t(1-N_t)} \\
q_t &= \chi \theta_t^{\psi - 1} \\
p_t &= \frac{M_t}{e_t(1-N_t)} \\
Y_t &= A K_t^{\alpha} (N_t h_t)^{1-\alpha} \\
M_t &= \chi V_t^{\psi} \left[e_t (1-N_t) \right]^{1-\psi} \\
\Gamma_t^n &= -\sigma_n \frac{h_t^{1+\eta_L}}{1+\eta_L} \\
\Gamma_t^u &= -\sigma_u \frac{e_t^{1+\eta_L}}{1+\eta_L} \\
Y_t &= \xi P_t^{\eta} D_t + \overline{X} \\
D_t &= C_t + I_t + \overline{\omega} V_t + \frac{\phi_K}{2} \frac{(I_t - \delta K_t)^2}{K_t} + G_t \\
P_t &= \left[\xi + (1-\xi) P_{Ft}^{1-\eta} \right]^{\frac{1}{1-\eta}} \\
D_{Ft} &= (1-\xi) \left(\frac{P_{Ft}}{P_t} \right)^{-\eta} D_t \\
SC_t &= \overline{\omega} \left[\frac{1-s}{q_t} \left(1 - \frac{1+\tau_t^f}{1+\tau_{t+1}^f} \right) + e_t \theta_t \left(\frac{1+\tau_t^f}{1+\tau_{t+1}^f} \right) \right] \\
BS_t &= \frac{1}{P_t} (1-\alpha) \frac{Y_t}{N_t} + SC_t
\end{aligned}
$$

$$
\begin{aligned}
\frac{1}{C_t} &= (1+\tau_t^c)P_t\lambda_t \\
\sigma_n h_t^{1+\eta_L} &= \frac{1}{(1+\tau_t^c)(1+\tau_t^f)}(1-\alpha)\frac{Y_t}{N_t}\frac{1}{P_tC_t} \\
\sigma_u e_t^{1+\eta_L} &= \frac{1}{(1+\tau_t^c)(1+\tau_t^f)}\frac{1-\epsilon}{\epsilon}\overline{\omega}e_t\theta_t\frac{1}{C_t} \\
w_th_t &= \frac{1-\epsilon}{1+\tau_t^f}P_tBS_t+\epsilon\left[\rho w_th_t+\frac{\Gamma_t^u-\Gamma_t^n}{\lambda_t}\right] \\
1+i_t^F &= 1+i_t^*-\phi_B\frac{P_tB_t}{Y_t} \\
\frac{\overline{\omega}}{q_t} &= \beta\left[\frac{P_{t+1}\lambda_{t+1}}{P_t\lambda_t}\left\{\frac{1}{P_{t+1}}(1-\alpha)\frac{Y_{t+1}}{N_{t+1}}+(1-s)\frac{\overline{\omega}}{q_{t+1}}-(1+\tau_{t+1}^f)w_{t+1}h_{t+1}\right\}\right] \\
q_t^k &= \beta\left[\frac{P_{t+1}\lambda_{t+1}}{P_t\lambda_t}\left\{\frac{1}{P_{t+1}}\alpha\frac{Y_{t+1}}{K_{t+1}}+q_{t+1}^k-\delta+\frac{\phi_K}{2}\left(\frac{I_{t+1}-\delta K_{t+1}}{K_{t+1}}\right)^2\right\}\right] \\
1 &= \beta\left[\frac{P_{t+1}\lambda_{t+1}}{P_t\lambda_t}\left\{1+i_{t+1}^*-\phi_b\frac{P_{t+1}B_{t+1}}{Y_{t+1}}\right\}\right]
\end{aligned}
$$

Note that SC refers to search costs, and BS to the bargained surplus.

- the set of 28 endogenous variables is:

$$q^k, I, K, \theta, q, Y, h, N, C, \lambda, P, SC, \tau^f, e, BS, \Gamma^n, \Gamma^u, w, M, D, V, G, i^F, B, D_F, T, P, P_F$$

- the set of exogenous parameters being

$$\alpha, \beta, \delta, \overline{\omega}, \eta, \eta_L, \xi, A, \psi, \epsilon, \chi, \sigma_n, \sigma_u, \tau^c, g, \bar{t}, \overline{X}, i^\star, \phi_B$$

In accordance with the small-open economy assumption, the foreign interest rate $i^\star$ and the volume of exports $\overline{X}$ are treated as exogenous. They are also assumed to be constant. The transition dynamics is computed using Dynare. We checked that the long-run results obtained from Dynare are the same as the ones presented in section 3.

A.5 The search model in steady-state

The list of equations In steady-state, and under the assumption of a null trade balance (ie, $B = 0$), the previous set of equations simplifies to the system of 15 equations:

$$(S1) \qquad \overline{X}/Y = \frac{(1-\xi)P_F^{1-\eta}}{\xi + (1-\xi)P_F^{1-\eta}}$$

$$(S2) \qquad \frac{P\overline{\omega}}{\chi}\theta^{1-\psi} = \frac{\beta}{1-\beta(1-s)}\frac{Y}{N}\left[(1-\alpha) - (1+\tau^f)\frac{whN}{Y}\right]$$

$$(S3) \qquad \sigma_n h^{1+\eta_L} = \frac{1-\alpha}{(1+\tau^f)(1+\tau^c)}\frac{1}{N}\left[\frac{1}{PC/Y}\right]$$

$$(S4) \qquad \sigma_u e^{1+\eta_L} = \frac{1}{(1+\tau^c)(1+\tau^f)}\frac{1-\epsilon}{\epsilon}\frac{P\omega e\theta}{Y}\left[\frac{1}{PC/Y}\right]$$

$$(S5) \qquad k = \left[\frac{\alpha\beta}{1-\beta(1-\delta)}\right]^{\frac{1}{1-\alpha}} A^{\frac{1}{1-\alpha}} P^{\frac{-1}{1-\alpha}}$$

$$(S6) \qquad P = \left[\xi + (1-\xi)P_F^{1-\eta}\right]^{\frac{1}{1-\eta}}$$

$$(S7) \qquad \overline{g} = \tau^c(PC/Y) + \tau^f\frac{whN}{Y} - \rho\frac{wh(1-N)}{Y} - \bar{t}$$

$$(S8) \qquad Y = Ak^\alpha Nh$$

$$(S9) \qquad \frac{whN}{Y} = \frac{\eta_L(1-\epsilon)\frac{P\overline{\omega}e\theta N}{Y} + [1+\eta_L(1-\epsilon)](1-\alpha)}{(1+\tau^f)(1+\eta_L)(1-\rho\epsilon)}$$

$$(S10) \qquad sN = ep(\theta)(1-N)$$

$$(S11) \qquad p(\theta) = \theta q(\theta)$$

$$(S12) \qquad q(\theta) = \chi\theta^{\psi-1}$$

$$(S13) \qquad 1 = \frac{PC}{Y} + \frac{PI}{Y} + \frac{P\overline{\omega}V}{Y} + \overline{g}$$

$$(S14) \qquad \frac{PI}{Y} = \frac{\alpha\beta\delta}{1-\beta(1-\delta)}$$

$$(S15) \qquad V = \theta e(1-N)$$

with $k \equiv \frac{K}{Nh}$, $\overline{g} \equiv \frac{PG}{Y}$ and $\bar{t} \equiv \frac{PT}{Y}$.

Obtaining Equation (23) We detail here some calculus to obtain steady-state results. To obtain the steady-state labor market tightness, we start combining the firm's labor demand (($S2$)) with the wage contract equation ($S9$). From Equation ($S2$), labor demand can be rewritten as:

$$\frac{P\overline{\omega}\theta^{1-\psi}}{\chi} = \frac{\beta}{1-\beta(1-s)}\Pi \qquad (48)$$

with Π defined as:

$$\Pi \equiv (1-\alpha)\frac{Y}{N} - (1+\tau^f)wh$$

Using the bargained wage solution, we can rewrite Π such as:

$$\Pi = \left[\frac{\epsilon(\eta_L(1-\rho)-\rho)}{(1+\eta_L)(1-\epsilon\rho)}\right](1-\alpha)\frac{Y}{N} + \frac{\eta_L(1-\epsilon)}{(1+\eta_L)(1-\epsilon\rho)}P\overline{\omega}e\theta$$

Using this in Equation (48), we finally obtain

$$\frac{\overline{\omega}\theta^{1-\psi}}{\chi} = \frac{\beta\epsilon}{(1-\epsilon\rho)(1-\beta(1-s))(1+\eta_L)}\left[(\eta_L(1-\rho)-\rho)\frac{(1-\alpha)Ak^\alpha h}{P} - \eta_L\frac{1-\epsilon}{\epsilon}\overline{\omega}\theta\right]$$

that is, Equation (23).

A.6 Calibration

France is the benchmark economy as it exemplifies a rigid labor market. Our quantitative strategy can be decomposed into a two-stage process.

A.6.1 Estimation stage

Our objective is to estimate the model's deep parameters so as the initial steady state is consistent with the key empirical properties of the French economy. In particular, we pay attention to match the tax base difference in consumption and payroll taxes. Not all the deep parameters are estimated though. We indeed calibrate some parameters whose value is pinned down by econometric studies. We estimate the values of the other parameters such that the model matches key features of the French data.

In the estimation procedure, the system ($S1-S15$) is solved by partitioning the set of parameters and variables so as to match a certain number of empirical targets as summarized in Table 2, with the values for the 15 endogenous variables and/or parameters reported in Table 3. Table 2 reports the calibrated parameters and the corresponding references used to pin down their value.

We estimate the sub-set of deep parameters so as the benchmark long-run equilibrium of the model matches the following empirical targets. The first one relates to output decomposition. Since the consumption tax applies to all consumption expenditures, the consumption aggregate includes non durables and durables, which implies $PC/Y = 62\%$ and $PI/Y = 11\%$. This low value of investment to output ratio will result in a low depreciation rate of capital δ. The second set of targets deals with the tax bases considered in the fiscal devaluation (PC/Y versus wNh/Y). We observe in the French data $(1+\tau^f)wNh/Y$ and wNh/Y, which yields τ^f. We also observe tax revenues from indirect taxation $\tau_c\frac{PC}{Y}$ and employer's social security contributions $\tau^f\frac{wNh}{Y}$ (Landais et al. (2011)), which yields τ_c given τ^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). One leading argument advocated by the reform's proponent relies on tax base comparison. In the data, indeed, the tax base of indirect taxation ($PC/Y = 62\%$) is larger than that of payroll taxation ($wNh/Y = 50\%$): the reduction in the payroll tax rate is expected to require a less-than-proportional increase in the indirect tax rate everything else equal for a given ratio of public spending and transfers (Proposition 1). Finally, the value of transfers (relative to GDP) $\bar{t}$ is endogenously derived so as to balance the government's budget constraint, given the tax bases, tax rates and government ratio $\bar{g}$.

We also pay attention to the adequacy of the open-economy dimension of the model with the data. We compute $\overline{X}$ such that the steady state mimics the exports-to-output ratio. In addition, the value of trade elasticities is a debated issue in the empirical literature. The calibration of the elasticity of substitution η is delicate, as there is little consensus as to the relevant value in the empirical literature. Ruhl (2008) recalls that trade elasticities measured by studying the high frequency changes in prices and quantities (therefore likely to capture short run fluctuations) range between 0.2 and 3.5, while estimates based on changes in trade policy, other trade costs, or cross-country variation (therefore in response to permanent changes) range between 4 and 15. We then analyze the model's predictions using $\eta = 3.5$ since it is compatible with both types of estimates. This allows us to convey a message on the transition dynamics as well as on a long-run perspective. Besides, this value is consistent with the range of empirical estimates obtained by Imbs & Méjean (2011) using French data.

Last, we want our model to be consistent with the main labor market features of the benchmark economy. The deep parameters are set so as to match the unemployment rate, the vacancy filling probability and the job finding rate observed in France. Table 2 reports the targeted features and calibrated values.

Table 3 reports the estimated parameters. These values are such that the long run equilibrium from the model replicates the empirical targets in Table 2. Our choice to replicate both the labor share and the gross labor cost implies a calibrated value of $\tau^f = 0.34$ for the payroll tax rate. The calibration $\tau^c = 0.22$ is obtained by combining our targeting choices reported in Table 2 with information provided by Landais et al. (2011).[25]

[25] In France in 2006, fiscal revenues from indirect taxation amounted to $\tau^c PC = 195.5$ billions of euros, while payroll taxation revenues amounted to $\tau^f wNh = 232.5$ billions of euros. Given our calibration of τ^f, $\frac{wNh}{Y}$ and $\frac{PC}{Y}$, this implicitly defines an indirect tax rate of $\tau^c = 0.22$. This value stands in accordance with data provided by Nickell (2006) for France over 1980-2005. Also note that, if the tax base of indirect taxation is larger than that of direct payroll taxation ($\frac{PC}{Y} > \frac{wNh}{Y}$), the order is reversed regarding the corresponding fiscal revenues, as $\frac{\tau^c PC/Y}{\tau^f wNh/Y} = 0.82$

Table 2: Estimation Step: Calibrated parameters and empirical targets

Empirical Target		Value	Reference
Label	Notation		
Labor market features			
Unemployment rate	$1-N$	0.1	France, 1995-2008([a])
Working time	h	0.33	Andolfatto (1996)
Search effort time	e	$h/2$	Andolfatto (1996)
Job finding rate	$\widetilde{p} = ep$	0.22	Mean duration of unemployment 14 months in France, 1995-2008([a])
Unemployment benefit ratio	ρ	0.56	France, 1995-2008([a])
Vacancy finding rate	q	0.7	Krause & Lubik (2007)
Firms' weight in match	ψ	0.6	Langot (1996)
Labor supply elasticity	η_L	10	Fiorito & Zanella (2008)
Open-economy dimension			
Exports-to-output ratio	$\overline{X}/Y$	0.19	France, 1995-2008([b])
Imports-to-output ratio	$1-\xi$	0.2	France, 1995-2008([b])
Long-run elasticity of substitution between Home and Foreign goods	η	3.5	Ruhl (2008)
Key ratios (relative to GDP) and fiscal policy			
Consumption ratio	PC/Y	0.62	France, 1995-2008([b])
Investment ratio	PI/Y	0.11	France, 1995-2008([b])
Public spending ratio	$\overline{g} \equiv PG/Y$	0.25	France, 1995-2008([b])
Labor share	$(1+\tau^f)wNh/Y$	0.67	France, 1995-2007, Cotis (2009)
Gross labor cost	wNh/Y	0.5	France, 1995-2007, Cotis (2009)
Preferences and technology			
TFP level	A	1	Normalization
Discount rate	β	0.99	Annual real interest rate of 4%, France, 1995-2008([a])

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

([b]): Authors calculations, based on National Accounts provided by the statistical French administration INSEE.

The value for $\overline{\omega}$, altogether with the endogenous values of P, Y and V, implies a ratio $P\overline{\omega}V/Y$ equal to 0.02. This value lies within the range commonly used in the literature (0.005 in Chéron & Langot (2004), 0.01 in Hairault (2002) or 0.05 in Krause & Lubik (2007)). The quarterly destruction rate s is consistent with the monthly estimate of 1.2% found by Hairault et al. (2011) using French *Labor Force Survey* between 1990 and 2010. Finally, labor market tightness θ might seem high. However, the values of θ in the literature refer to estimates that abstract from search effort. After multiplying by the search effort e, the French labor market tightness hovers around 0.3, which lies within the range found in the literature (0.2 in Albertini & Fairise (2009), 0.55 in **?**). Finally,

Table 3: Estimation Step: The results (search model)

Target		Value
Label	Notation	
Structural parameters		
Separation rate	s	0.024
Matching efficiency	χ	0.941
Cost of job posting	$\overline{\omega}$	0.609
Disutility of work	σ_n	432103
Disutility of search	σ_u	274984.10^3
Firm's bargaining power	ϵ	0.45
Technology parameter	α	0.30
Depreciation rate	δ	0.006
Transfers to GDP ratio	$\bar{t} \equiv PT/Y$	0.025
Payroll tax rate	τ^f	0.34
Indirect tax rate	τ^c	0.22
Variables		
Relative price of imports	P_F	1.026
Consumption price index	P	1.005
Labor market tightness	θ	2.095
Number of vacancies	V	0.03
Capital to labor ratio	k	67.2
Exports volume	$\overline{X}$	0.18
GDP	Y	0.958

notice that the firm's bargaining power is lower than its contribution to the match ($\epsilon < \psi$), which introduces an additional source of inefficiency in the model.

A.6.2 Assessing the effects of fiscal devaluation

When evaluating the effects of the tax reform, we calibrate the deep parameters to the values estimated in the Estimation step, and let the macroeconomic variables endogenously adjust to the fiscal environment. Table 4 sums up the whole set of calibrated values (in both the walrasian and search models).

The absence of labor market frictions in the walrasian model implies some slight changes in the calibration, as reported in Table 4. The absence of job posting spending modifies the good market equilibrium condition. Accordingly, we derive the ratio of public spending to output $\overline{g}$ consistent with the empirical targets of PC/Y and PI/Y. As well, the absence of unemployment benefits modifies the government's budget constraint, hence the calibrated value of the transfers-to-output ratio $\bar{t}$. Last, as explained in Section 4, we adopt a lower value of η than the benchmark value of

Table 4: Calibration when assessing the effects of fiscal devaluation

Parameter	Value	Parameter	Value
Labor market			
s	0.024	ϵ	0.45
χ	0.941	ψ	0.6
$\overline{\omega}$	0.608		
Preferences and technology			
σ_n	432103	η_L	10
σ_u	274984.10^3	β	0.99
α	0.30	δ	0.006
A	1		
Open-economy features			
ξ	0.8	η	1.9/3.5(^{a})
$\overline{X}$	0.18	ϕ_B	0.0019
Governmental policy			
$\overline{g}$	0.27/0.25(^{a})	$\overline{t}$	0.043/0.025(^{a})

(^{a}): The first number refers to the calibration in the walrasian model. The second one, in the search model.

$\eta = 3.5$. This allows us to magnify the relative price effect, hence to show off a Laffer curve (Figure 2).

Note that, given our assumption that $B = 0$ in the long-run, the interest rates (i^F and i^*) do not intervene in the steady-state equilibrium (system ($S1 - S15$)). Yet, they will intervene in the transition dynamics of the tax reform. In this exercise, the foreign interest rate i^* is treated as exogenous and constant. Its value can be derived from Equations (34) and (19) considered in steady-state, given our assumption $B = 0$: $i^* = \frac{1}{\beta} - 1$. We calibrate $\phi_B = 0.0019$, based on the empirical estimates of Lane & Milesi-Ferretti (2001).

Table 5 summarizes the status of the parameters and variables at each step, with "Step 1" referring to the Estimation stage and "Step 2" to the evaluation of the fiscal devaluation. At each stage, the statement "Exo" means that the variable or parameter is exogenous, while the statement "Endo" means that it is by contrast endogenously derived.

B Closed-economy Walrasien model

We use the same notations as in the main text of the paper.

Table 5: Exogenous vs endogenous variables in the long-run: Summary

Label	Step 1	Step 2	Label	Step 1	Step 2
α	Endo	Exo	PI/Y	Exo	Endo
β	Exo	Exo	PC/Y	Exo	Endo
s	Endo	Exo	$p(\theta)$	Exo	Endo
ρ	Exo	Exo	$q(\theta)$	Exo	Endo
$\overline{\omega}$	Endo	Exo	Y	Endo	Endo
ψ	Exo	Exo	N	Exo	Endo
$\bar{t}$	Endo	Exo	h	Exo	Endo
$\overline{g}$	Exo	Exo	e	Exo	Endo
A	Exo	Exo	k	Endo	Endo
η_L	Exo	Exo	θ	Endo	Endo
η	Exo	Exo	P_F	Endo	Endo
ξ	Exo	Exo	wNh/Y	Exo	Endo
δ	Endo	Exo	V	Endo	Endo
χ	Endo	Exo	$\overline{X}/Y$	Exo	Endo
ϵ	Endo	Exo	$\overline{X}$	Endo	Exo
σ_n	Endo	Exo	τ^f	Exo	Exo
σ_u	Endo	Exo	τ^c	Exo	Exo

B.1 The economy

Household: The household's program is:

$$\begin{aligned}\max \mathcal{U} &= \sum_t \beta^t \log(C_t) - \sigma_n \frac{h_t^{1+\eta_L}}{1+\eta_L} \\ s.t. \quad & (1+\tau_t^c)C_t + I_t = w_t h_t + r_t K_t \\ & K_{t+1} = (1-\delta)K_t + I_t\end{aligned}$$

with $\eta_L > 0$ and $\sigma_L > 0$.

Firms: The firm's program can be written as:

$$\begin{aligned}\max \Pi_t &= P_{Ht}Y_t - (1+\tau_t^f)w_t h_t - r_t P_t K_t \\ s.t. \quad & Y_t = A_t K_t^{\alpha} h_t^{1-\alpha}\end{aligned}$$

Government and good market equilibrium: The balanced budget is:

$$G_t = \tau_t^c C_t + \tau_t^f w_t h_t + T_t \tag{49}$$

In addition, the good market equilibrium is:

$$Y_t = C_t + I_t + G_t$$

Steady state equilibrium : The long-run equilibrium can be summarized by a system of 7 equations:

$$\begin{array}{ll}
(CW1) & (1-\alpha)\dfrac{Y}{h} = (1+\tau^f)w \\
(CW2) & \delta K = I \\
(CW3) & \dfrac{K}{Y} = \dfrac{\alpha\beta}{1-\beta(1-\delta)} \\
(CW4) & Y = AK^{\alpha}h^{1-\alpha} \\
(CW5) & w = \sigma_n h^{\eta_l}(1+\tau^c)C \\
(CW6) & Y = C + I + G \\
(CW7) & \overline{g} = \tau^c \dfrac{C}{Y} + \tau^f \dfrac{wh}{Y} + \overline{t}
\end{array}$$

B.2 Welfare

Using $(CW1)$ and $(CW3)$, we obtain

$$\frac{I}{Y} = \frac{\delta\alpha\beta}{1-\beta(1-\delta)}$$

Integrating this result in $(CW6)$ and given $PG/Y = \overline{g}$, we deduce:

$$\frac{C}{Y} = 1 - \frac{\delta\alpha\beta}{1-\beta(1-\delta)} - \overline{g} \tag{50}$$

Using this last result in the labor market equilibrium (Equations $(CW1)$ and $(CW5)$), we obtain:

$$h = \left(\frac{1-\alpha}{\sigma_n(1+\tau^f)(1+\tau^c)\frac{C}{Y}}\right)^{\frac{1}{1+\eta_L}}$$

Given (50), this yields the long-run value for labor input:

$$h = \left(\frac{1-\alpha}{\sigma_n(1+\tau^f)(1+\tau^c)\left(1-\frac{\delta\alpha\beta}{1-\beta(1-\delta)}-\overline{g}\right)}\right)^{\frac{1}{1+\eta_L}} \tag{51}$$

Equation $(CW4)$ leads to:

$$Y = A^{\frac{1}{1-\alpha}}\left(\frac{\alpha\beta}{1-\beta(1-\delta)}\right)^{\frac{\alpha}{1-\alpha}} h \tag{52}$$

We make use of these results when deriving the welfare effects of the tax reform in the closed-economy walrasian case (Equation (30)).

B.3 Tax base comparison in the closed economy setting

Equation (50) yields C/Y while the tax base of the payroll tax is given by equation $(CW1)$, therefore $\frac{C}{Y} > \frac{wh}{Y}$ if:

$$1 - \frac{\delta\alpha\beta}{1-\beta(1-\delta)} - \overline{g} > \frac{(1-\alpha)}{(1+\tau^f)} \tag{53}$$

or

$$(1+\tau^f) > \frac{(1-\alpha)}{1 - \frac{\delta\alpha\beta}{1-\beta(1-\delta)} - \overline{g}} \equiv \mu \tag{54}$$

which defines a lower bound on τ^f. It is trivial to check that this condition is fulfilled for any $\tau^f > 0$, which we now assume.

C Open economy Walrasien model

C.1 The economy

The household: The household consumption choice is the same as in the main text (equations (6)-(9)). The budget constraint is:

$$(1+\tau_t^c)P_tC_t + P_tI_t = w_th_t + P_tr_tK_t$$

The firms: The firm's program is

$$\begin{aligned} \max \Pi_t &= Y_t - (1+\tau_t^f)w_th_t - r_tP_tK_t \\ s.t. \quad & Y_t = A_tK_t^{\alpha}h_t^{1-\alpha} \end{aligned}$$

The household's and firm's first order conditions can be combined to be written as:

$$\begin{aligned} \sigma_L h_t^{\eta_L} C_t &= \frac{1-\alpha}{(1+\tau_t^c)(1+\tau_t^f)} \frac{1}{P_t} \frac{Y_t}{h_t} \\ \frac{1}{(1+\tau_t^c)C_t} &= \beta \frac{1}{(1+\tau_{t+1}^c)C_{t+1}} \left[1 - \delta + \frac{1}{P_{t+1}} \alpha \frac{Y_{t+1}}{K_{t+1}}\right] \end{aligned}$$

The government and good market equilibrium: The balanced budget each period is:

$$P_tG_t + P_tT_t = \tau_t^c P_tC_t + \tau_t^f w_th_t$$

The home good market is such that:

$$Y_t = C_{Ht} + I_{Ht} + G_{Ht} + X_t \tag{55}$$

The zero trade balance is such that

$$P_{Ht}\overline{X} = P_{Ft}\left[C_{Ft} + I_{Ft} + G_{Ft}\right] \tag{56}$$

With $P_{Ht} = 1$ and Equations (7)-(8), this can be rewritten as:

$$\overline{X} = \frac{1-\xi}{\xi} P_{Ft}^{1-\eta}\left[C_{Ht} + I_{Ht} + G_{Ht}\right] \tag{57}$$

Using Equation (55) in (57) yields:

$$\overline{X} = \frac{(1-\xi)P_F^{1-\eta}}{\xi + (1-\xi)P_F^{1-\eta}} Y \tag{58}$$

In addition, since the trade balance is zero, the resource constraint of our economy is such that production equals absorption, which yields, in terms of the home good

$$Y_t = P_t\left(C_t + I_t + G_t\right)$$

The steady state equilibrium: The open-economy walrasian model yields a system of 9 equations :

$$\begin{array}{ll}
(OW1) & (1-\alpha)\dfrac{Y}{h} = (1+\tau^f)w \\
(OW2) & \delta K = I \\
(OW3) & \dfrac{PK}{Y} = \dfrac{\alpha\beta}{1-\beta(1-\delta)} \\
(OW4) & Y = AK^{\alpha}h^{1-\alpha} \\
(OW5) & w = \sigma_n h^{\eta_l}(1+\tau^c)PC \\
(OW6) & Y = P(C+I+G) \\
(OW7) & \overline{X} = \left[\dfrac{(1-\xi)P_F^{1-\eta}}{\xi + (1-\xi)P_F^{1-\eta}}\right] Y \\
(OW8) & P = \left[\xi + (1-\xi)P_F^{1-\eta}\right]^{\frac{1}{1-\eta}} \\
(OW9) & \overline{g} = \tau^c \dfrac{PC}{Y} + \tau^f \dfrac{wh}{Y} - \overline{t}
\end{array}$$

with the values of public spending and transfers maintained constant relative to output, ie $PG/Y = \overline{g}$ and $PT/Y = \overline{t}$.

Compared with the closed economy model, we get similar equations except for the relative price terms that appears whenever the equilibrium equation involves home good versus consumption basket goods or foreign goods. The added equations $(OW7)$ and $(OW8)$ respectively determine the foreign relative price and the consumer price index.

C.2 The long-run equilibrium in a small-open economy

Considering Equations ($OW2$) and ($OW3$), we get:

$$\frac{PI}{Y} = \frac{\delta\alpha\beta}{1-\beta(1-\delta)}$$

Using this result in Equations ($OW5$)-($OW6$) and given $PG/Y = \overline{g}$, we get the steady-state consumption-to-output ratio (in value):

$$\frac{PC}{Y} = 1 - \frac{\delta\alpha\beta}{1-\beta(1-\delta)} - g \tag{59}$$

With this last result in the labor market equilibrium (Equations ($OW1$) and ($OW5$)), we obtain:

$$h = \left(\frac{1-\alpha}{\sigma_n(1+\tau^f)(1+\tau^c)\frac{PC}{Y}}\right)^{\frac{1}{1+\eta_L}}$$

Combined with the domestic good market equilibrium condition ($OW6$), using ($OW10$) and the law of motion of capital in steady state ($OW2$) gives the long-run value for labor input:

$$h = \left(\frac{1-\alpha}{\sigma_n(1+\tau^c)(1+\tau^f)\left(1-\frac{\alpha\beta\delta}{1-\beta(1-\delta)}-g\right)}\right)^{\frac{1}{1+\eta_L}} \tag{60}$$

The production function ($OW4$) leads to:

$$Y = A^{\frac{1}{1-\alpha}}\left(\frac{\alpha\beta}{1-\beta(1-\delta)}\frac{1}{P}\right)^{\frac{\alpha}{1-\alpha}} h \tag{61}$$

Using this last result with ($OW7$) and ($OW8$), we deduce the trade balance equilibrium condition:

$$\overline{X} = \left[\frac{(1-\xi)P_F^{1-\eta}}{\xi+(1-\xi)P_F^{1-\eta}}\right] A^{\frac{1}{1-\alpha}}\left(\frac{\alpha\beta}{1-\beta(1-\delta)}\frac{1}{\left[\xi+(1-\xi)P_F^{1-\eta}\right]^{\frac{1}{1-\eta}}}\right)^{\frac{\alpha}{1-\alpha}} h$$

Elements of Proofs of Proposition 2 The previous trade balance equation can be rewritten as:

$$\overline{X} = h\underbrace{A^{\frac{1}{1-\alpha}}\left(\frac{\alpha\beta}{1-\beta(1-\delta)}\right)^{\frac{\alpha}{1-\alpha}}}_{Z}\underbrace{\frac{(1-\xi)P_F^{1-\eta}}{\xi+(1-\xi)P_F^{1-\eta}}}_{f(P_F)}\underbrace{\left(\xi+(1-\xi)P_F^{1-\eta}\right)^{\frac{\alpha}{(\eta-1)(1-\alpha)}}}_{g(P_F)} \tag{62}$$

Equation (62) shows that the impact of the tax reform has an impact on P_F only via the change in h. Let us determine the sign of $\frac{dP_F}{dh}$, which is enough to predict the effect of the fiscal devaluation on the relative price of foreign goods. The first difference of equation (62) can be written as

$$\begin{aligned} 0 &= Zf(P_F)g(P_F)dh + Zh[f'(P_F)g(P_F) + f(P_F)g'(P_F)]dP_F \\ &= Zhf(P_F)g(P_F)\left[\frac{dh}{h} + \frac{dP_F}{P_F}\left(\frac{\xi(1-\eta)}{\xi+(1-\xi)P_F} - \frac{\alpha}{1-\alpha}f(P_F)\right)\right] \end{aligned}$$

which, with $\eta > 1$, implies

$$\frac{dh}{h} = \left(\frac{\xi(\eta-1)}{\xi+(1-\xi)P_F} + \frac{\alpha}{1-\alpha}f(P_F)\right)\frac{dP_F}{P_F}$$

As it is straightforward that $\left(\frac{\xi(\eta-1)}{\xi+(1-\xi)P_F} + \frac{\alpha}{1-\alpha}f(P_F)\right)$ is always positive, this establishes Proposition 2.