The B.E. Journal of Macroeconomics

Topics

Volume 12, *Issue* 1 | 2012 | *Article* 29

The Laffer Curve in a Frictional Labor Market

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Recommended Citation

Francesco Zanetti (2012) "The Laffer Curve in a Frictional Labor Market," *The B.E. Journal of Macroeconomics*: Vol. 12: Iss. 1 (Topics), Article 29.

DOI: 10.1515/1935-1690.2014

The Laffer Curve in a Frictional Labor Market*

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Abstract

This paper investigates whether labor market search frictions affect the long run responses of government revenues to changes in income taxes. The findings show that labor market parameters may significantly change the tax base and affect the reaction of government receipts in the long run.

KEYWORDS: Laffer curve, labor market frictions

*I would like to thank Bob Hills, Peter Ireland, Lydia Silver and an anonymous referee for extremely helpful comments and suggestions.

"The art of taxation consists in so plucking the goose as to obtain the largest possible amount of feathers with the smallest possible amount of hissing." Jean Baptiste Colbert, Minister of Finance under King Louis XIV of France, 1619-1683.

1 Introduction

The effect of tax changes on government revenues is an old issue. Adam Smith in the *Wealth of Nations* (1776) and John Maynard Keynes in the *General Theory of Employment, Interest, and Money* (1936), describe how increasing taxation would lower government revenue past a certain tax rate. It was Arthur Laffer that popularized this concept in the late 1970s, and it has been labelled with his name since then.[1]

The Laffer curve formalizes the relationship between tax rates and government revenues. It expresses the intuition that a change in tax rates has two offsetting effects on government revenues: on the one hand it might move revenues in the same direction of the tax rate change, since the tax rate establishes the share of the tax base that the government collects; on the other hand, it might move revenues in the opposite direction, since a variation in tax rate provides incentives to adjust work and production in a way that would work against the sign of the tax change therefore changing the tax base. Ultimately, the reaction of tax receipts to tax changes determines what effect would prevail. Seminal studies by Fullerton (1982) and Malcomson (1986), using a static general equilibrium model, identify the structure of the labor market as particularly important to the reaction of households and firms to tax changes. A high labor supply elasticity implies that households are more likely to adjust their labor supply in response to changes in taxes, thereby amplifying the reaction of production and ultimately the tax base. Recently the topic has been studied in the context of dynamic neoclassical growth models, as detailed below. These models also indicate the importance of the labor market, but in these models it is costless to establish a work relationship and workers do not suffer involuntary unemployment. In practice though, labor markets are characterized by frictions that prevent the competitive market mechanism from determining labor market equilibrium allocations, as surveyed by Bean (1994) and Nickell (1997). Merz (1995) and Andolfatto (1996) show that labor market search frictions enable the standard neoclassical growth model to match key stylized facts. Rogerson, Shimer and Wright (2005) show that models based on labor market search frictions accurately describe the functioning of the labor market. Furthermore, theoretical work by Pissarides (2000, Ch.9) shows that labor market search frictions are important to determine

[1] See Wanniski (1978).

the effects of tax changes. By modelling search frictions, the analytical set up is able to consider how the incentives to create and destroy jobs, the wage bargaining power and the costs of establishing a work relationship might affect the impact of income tax rate changes on government revenues. Importantly, these labor market attributes might change the incentives that firms have to hire, retain workforce, and produce in response to changes in tax rates. As detailed below, there is no existing work that studies the effect of income tax changes on government revenues in the context of labor market frictions.

This paper takes on this task. In particular, it focuses on the question: does the presence of labor market frictions alter the long-run effect of income tax changes on government revenues? The paper addresses this question by enriching a standard neoclassical growth model with Diamond-Mortensen-Pissarides search frictions in the labor market and including fiscal policy in the form of income tax. The model is able to generate the Laffer curve, whose shape is used to evaluate how a frictional labor market varies the long-run effects of tax changes.

The theoretical model is used as a laboratory. By varying the value of various labor market parameters one is able to determine what part of the labor market particularly affects the reaction of tax receipts to changes in income taxes. The findings show that, in general, a number of key labor market parameters are quantitatively important to determining the effects of income tax changes on government revenues in the long run. In particular, high levels of unemployment benefits, households' wage bargaining power, elasticity of labor supply, and a high cost of establishing a work relationship and disutility of work all significantly affect the marginal impact of income taxes on government revenues, and they all dampen the reaction of government revenues to changes in taxation. The intuition is straightforward. In a frictional labor market the wage bargaining between workers and firms splits the benefits of establishing a work relationship. As detailed below, a high value for these labor market parameters increases the bargained wage, which induces firms to cut down on hiring, thereby reducing the number of workers since a fraction of jobs get destroyed in every period. The reduction in labor input suppresses production and consequently shrinks the tax base, thereby dampening the effect of changes in the income tax rate on government revenues. Interestingly, as detailed below, only changes in the job separation rate are unable to alter the reaction of government revenues to tax changes.

Before proceeding, this section discusses the context provided by related studies. Early studies focused on the effect of capital and labor taxes on government revenues abstracting from labor market decision and, with the exception of Ireland (1994), without investigating the effect of income tax changes. Fullerton (1982) and Malcomson (1986) establish that simple general equilibrium models are able to deliver the inverted-U-shaped Laffer curve for capital and labor taxes under reasonable theoretical assumptions. Ireland (1994), using an AK model of endogenous growth shows that this stylized setting is also able to generate a Laffer curve for income taxes. Building on this, Pecorino (1995) and Agell and Persson (2001) develop a dynamic version of the AK model in which, in a time-varying environment, most of the static properties of capital and labor taxes are preserved. Subsequent studies include labor market decisions in the analysis, by assuming that households decide over hours of work, thereby allowing for an elastic labor supply. Mankiw and Weinzierl (2006) use a standard neoclassical growth model to show that only a small fraction of capital and labor tax changes can be self-financing over time. Trabandt and Uhlig (2009) echo their findings and also evaluates the shape of the Laffer curve for the US and EU. Leeper and Yang (2008) show that the extent to which capital and labor tax changes are self-financed over time crucially depends on the conduct of fiscal policy. Despite these recent studies pointing out the importance of an elastic labor supply, they assume perfectly competitive labor markets. Moreover, with the exception of Trabandt and Uhlig (2009), they do not examine the effect of income tax. The present paper is similar in theme but it conducts the analysis using a neoclassical growth model characterized by labor market search frictions, which enables consideration of a broader range of labor market parameters, and it focuses explicitly on the effect of income tax. Similar to this paper, Shi and Wen (1999) study capital and labor taxes in the context of a labor market search model, but they do not investigate the effect of income taxes and leave the question of how taxes affect equilibrium government revenues unaddressed. Finally, Shapiro (2004) uses a stylized labor market search model to show that taxation distorts labor participation decisions, which could potentially be reduced by wage pressures generated in a frictional labor market. Although labor market frictions are pivotal to his findings, the effect of income taxes on government income is not investigated.

The remainder of the paper is organized as follows. Section 2 lays out the theoretical model and its calibration. Section 3 presents the results and examines their robustness. Section 4 considers some extensions such as the inclusion of capital and labor income taxes, the sensitivity of the results to the assumption that unemployment benefits are financed through lump-sum transfers, and it relates the results to the empirical estimates to the Laffer curve. Section 5 concludes.

2 The model

A standard neoclassical growth model is enriched to allow for labor market search frictions of the Diamond-Mortensen-Pissarides search model of unemployment, as in Blanchard and Galí (2010) and Mandelman and Zanetti (2008). This framework relies on the assumption that the processes of job search and hiring are costly for both the firm and the worker and a constant fraction of jobs get destroyed at any period t. The economy is populated by a continuum of infinite-living identical households, firms, and a fiscal authority. The rest of the section describes the optimizing behavior of households and firms, the structure of the labor market and the conduct of fiscal policy. The last subsection presents the model's calibration.

2.1 The Representative Household

During each period, $t = 0, 1, 2, ...$, the representative household maximizes the utility function:

$$E\sum_{t=0}^{\infty}\beta^t\left[C_t^{1+\sigma}/(1+\sigma)-\chi N_t^{1+\phi}/(1+\phi)\right], \tag{1}$$

where C_t is consumption, N_t is the fraction of household members who are employed, and β is the discount factor such that $0<\beta<1$. The parameters σ and ϕ are the coefficient of relative risk aversion and the inverse of the elasticity of labor supply respectively. The parameter χ captures the degree of disutility that an additional unit of labor generates. Full labor market participation guarantees that a members of the household can be either employed or unemployed, which implies $0<N_t<1$. The representative household enters period t with bonds B_t. At the beginning of the period, the household receives a lump-sum nominal transfer G_t from the fiscal authority and nominal profits Π_t from the representative firm. The household supplies N_t units of labor at the wage rate W_t, and K_t units of capital at the rental rate Q_t to the representative firm during period t. While unemployed, the household receives b_t unemployment benefits from the fiscal authority. The household uses part of this additional money to purchase B_{t+1} new bonds at nominal cost B_{t+1}/R_t, where R_t represents the gross nominal interest rate between t and $t+1$. The household may also use the income for consumption, C_t, or investment, I_t. By investing I_t units of output during period t, the household increases the capital stock K_{t+1} available during period $t+1$ according to

$$K_{t+1} = (1-\delta_k)K_t + I_t, \tag{2}$$

where the depreciation rate satisfies $0<\delta_k<1$. The household is therefore subject to the budget constraint

$$C_t + I_t + B_{t+1}/r_t = B_t + G_t + W_tN_t + Q_tK_t + (1-N_t)b_t + \Pi_t \tag{3}$$

for all $t = 0,1,2,....$ Thus the household chooses $\{C_t, K_{t+1}, I_t, B_{t+1}\}_{t=0}^{\infty}$ to maximize its utility (1) subject to the evolution of capital stock (2) and the budget constraint (3) for all $t = 0,1,2,....$ Substituting equation (2) into (3) and letting Λ_t denote the non-negative Lagrange multiplier on the resulting equation, the first order conditions are

$$\Lambda_t = 1/C_t^{\sigma}, \tag{4}$$

$$\Lambda_t = \beta E_t \Lambda_{t+1} \left[\theta Y_{t+1}/K_{t+1} + (1-\delta_k)\right], \tag{5}$$

and

$$\Lambda_t = \beta R_t E_t \Lambda_{t+1}. \tag{6}$$

According to equation (4), the Lagrange multiplier must equal the household's marginal utility of consumption. Equation (5) is the standard Euler equation for capital, which links the intertemporal marginal utility of consumption to the real remuneration of capital. Finally, equation (6) is the Euler equation for consumption that describes the marginal utility at period t equals the discounted expected marginal utility at period $t+1$ remunerated at the rate R_t.

2.2 The Labor Market

During each period $t = 0, 1, 2, \ldots$, total employment is given by the sum of the number of workers who survive the exogenous separation, $(1-\delta_n)N_{t-1}$, and the number of new hires, H_t. Hence, total employment evolves according to

$$N_t = (1-\delta_n)N_{t-1} + H_t, \tag{7}$$

where δ_n is the job separation rate, and $0 < \delta_n < 1$. Accounting for job separation, the pool of household's members unemployed and available to work before hiring takes place is:

$$U_t = 1 - (1-\delta_n)N_{t-1}. \tag{8}$$

It is convenient to represent the job creation rate, f_t, by the ratio of new hires over the number of unemployed workers such that:

$$f_t = H_t/U_t, \tag{9}$$

with $0 < f_t < 1$, given that all new hires are selected from the pool of unemployed workers. The cost of hiring a worker is equal to ν.

In a labor market characterized by search frictions the wage, whose determination is explained below, splits the surplus of working. The household and firm's surpluses are determined as follows. Let $\mathscr{W}_t^N$, and $\mathscr{W}_t^U$, denote the marginal value of the expected income of an employed, and unemployed worker respectively. The employed worker earns a wage, suffers disutility from work, and separates from the job with probability δ_n. Hence, the marginal value of establishing a work relationship is:

$$\mathscr{W}_t^N = W_t - \frac{\chi N_t^{\phi}}{\Lambda_t} + \beta E_t \frac{\Lambda_{t+1}}{\Lambda_t} \left\{ \left[1 - \delta_n \left(1 - f_{t+1}\right)\right] \mathscr{W}_{t+1}^N + \delta_n \left(1 - f_{t+1}\right) \mathscr{W}_{t+1}^U \right\}. \tag{10}$$

This equation states that the marginal value of a job for a worker is given by the wage less the marginal disutility that the job produces to the worker, and the expected-discounted net gain from being either employed or unemployed in period $t+1$.

The unemployed worker expects to move into employment with probability f_t. Hence, the marginal value of unemployment is:

$$\mathscr{W}_t^U = b_t + \beta E_t \frac{\Lambda_{t+1}}{\Lambda_t} \left[f_{t+1} \mathscr{W}_{t+1}^N + \left(1 - f_{t+1}\right) \mathscr{W}_{t+1}^U \right], \tag{11}$$

where, as in Pissarides (2000), unemployment benefits b_t are set as a fraction of the established wage, such that $b_t = \alpha W_t$, and α is the replacement ratio of unemployment benefits. Equation (11) states that the marginal value of unemployment is made up of unemployment benefits and the expected-discounted capital gain from being either employed or unemployed in period $t+1$.

The structure of the model guarantees that a realized job match yields some pure economic surplus. As mentioned, the share of this surplus between the worker and the firm is determined by the wage level. As in Pissarides (2000), the wage is set according to the Nash bargaining solution. The worker and the firm split the surplus of their matches with the share $0 < \eta < 1$, which represents the household's bargaining power. The difference between equation (10) and (11) determines the worker's economic surplus. As in Blanchard and Galí (2010), the firm's surplus, $\mathscr{J}_t$, is given simply by the cost per hire, ν. Hence, the total surplus from a match is the sum of the worker's and firm's surpluses. The wage bargaining rule for a match is

$$\eta \mathscr{J}_t = (1-\eta)(\mathscr{W}_t^N - \mathscr{W}_t^U).$$

Substituting equations (10) and (11) in this last equation produces the agreed wage:

$$W_t = \chi N_t^{\phi} / \Lambda_t + b_t + \nu [\eta / (1-\eta)] \left[1 - \beta \left(1 - \delta_n\right) E_t \left(\Lambda_{t+1} / \Lambda_t\right) \left(1 - f_{t+1}\right)\right]. \tag{12}$$

Equation (12) shows that the wage equals the marginal rate of substitution between consumption and leisure, the unemployment benefits together with current hiring costs, and the expected savings in terms of the future hiring costs if the match continues. The influence of these last two terms on the wage depends on the relative bargaining power of the worker, $\eta / (1-\eta)$.

2.3 The Representative Firm

During each period, $t = 0, 1, 2, ...$, each representative firm manufactures Y_t units of goods using N_t units of labor input and K_t units of capital from the representative household according to the production technology

$$Y_t = AK_t^{\theta} N_t^{1-\theta}, \tag{13}$$

where $0 < \theta < 1$ represents the capital share of production, and the variable A is the equilibrium value of the Solow residual. The government levies a proportional income tax on production, τ_t. Thus the firm chooses $\{N_t, H_t, K_{t+1}\}_{t=0}^{\infty}$ to maximize its total market value given by

$$E_0 \sum_{t=0}^{\infty} \left(\beta^t \Lambda_t / P_t\right) \Pi_t, \tag{14}$$

where $\beta^t \Lambda_t / P_t$ measures the marginal utility value to the representative household of an additional dollar in profits received during period t, and

$$\Pi_t = (1 - \tau_t) P_t Y_t - N_t W_t - K_t Q_t - \nu H_t \tag{15}$$

for all $t = 0, 1, 2, ...$ Solving equation (7) for H_t and substituting the outcome into equation (15) permits to write the first order conditions as

$$W_t = (1 - \tau_t)(1 - \theta) Y_t / N_t - \nu[1 - \beta(1 - \delta_n)(E_t \Lambda_{t+1} / \Lambda_t)], \tag{16}$$

and

$$Q_t = (1 - \tau_t) \theta Y_t / K_t. \tag{17}$$

Equation (16) states that the wage equals the marginal product of labor minus the cost of creating the job and the foregone expected cost if the job is not destroyed in period $t + 1$. Equation (17) imposes that the rate of capital remuneration equals the marginal product of capital in each period t.

2.4 The Fiscal Authority

During each period $t = 0, 1, 2, \ldots$, the fiscal authority conducts fiscal policy using the following rule

$$G_t = \tau_t Y_t - (1 - N_t) b_t. \tag{18}$$

Equation (18) states that the government collects income tax revenues and pays unemployment benefits, whose difference is redistributed in the form of lump-sum transfers to the households. Mankiw and Weinzierl (2006) and Trabandt and

Uhlig (2009) use a similar fiscal policy rule. Section 4 extends the analysis to consider alternative taxes and government financing schemes.

By using equations (3), (15) and (18), in equilibrium, the aggregate output is $Y_t = C_t + I_t + \nu H_t$. Hence equations (2), (4)-(9), (12)-(13), (16)-(18), the definition of unemployment benefits and aggregate output describe the behavior of the endogenous variables $\{Y_t, C_t, H_t, K_t, I_t, G_t, f_t, U_t, N_t, \Lambda_t, W_t, b_t, R_t, Q_t\}$.

2.5 Calibration

The model's parameters are calibrated on quarterly frequencies using US data. The value of each parameter is described below and reported in Table 1.

Table 1. Benchmark Parameter Values

Parameter		Value
β	Discount factor	0.99
ϕ	Inverse of the elasticity of labor supply	2
σ	Coefficient of relative risk aversion	1
δ_n	Job separation rate	0.08
δ_k	Capital destruction rate	0.025
θ	Capital share	0.33
ν	Cost of posting a vacancy	0.5
A	Solow residual	5
χ	Disutility of work	3.5
τ	Income tax rate	0.05
η	Wage bargaining power	0.5

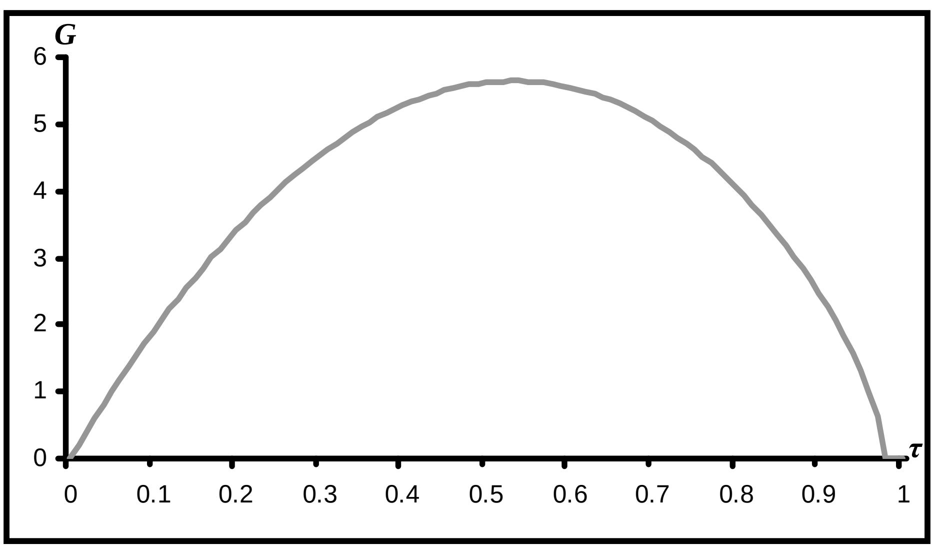
Similarly to King and Rebelo (1999), the discount factor, β, is set equal to 0.99. The inverse of the intertemporal elasticity of substitution of labor supply, ϕ, is set equal to 2, such that the elasticity of labor supply is 0.5, as in Mankiw and Weinzierl (2006) and Leeper and Yang (2008). The coefficient of relative risk aversion, σ, is set equal to 1, as in King and Rebelo (1999). Consistent with Davis, Haltiwanger and Schuh (1996), the job separation rate, δ_n, is set equal to 8%, and the capital destruction rate, δ_k, is set to 2.5%, as in King and Rebelo (1999). The production capital share, θ, is set equal to 0.33, in line with King and Rebelo (1999). The cost for establishing a work relationship, ν, determines the steady-state share of hiring costs over total output. Since a precise empirical evidence on this parameter is unavailable, in line with Blanchard and Galí (2010), its value is set equal to

0.5, such that hiring costs represent approximately 1% of total output, which is a reasonable upper bound for this parameter. The equilibrium value of the Solow residual, A, is set equal to 5, as in Ireland (2004), who estimates this value on US data. The parameter of the disutility of labor, χ, is set equal to 3.5, in order to generate a steady-state value of employment rate equal to 70% as in Blanchard and Galí (2010). The household's wage bargaining power, η, is set equal to 0.5, as estimated by Petrongolo and Pissarides (2001). The income tax rate, τ, is equal to 5%, as estimated by Carey and Rabesona (2002). Finally, the benchmark calibration of the model abstracts from unemployment benefits, by setting the replacement ratio α equal to 0.

3 Results

This section discusses the findings. First, it focuses on the steady-state version of the model, which is used to determine the Laffer curve; it then undertakes some robustness analysis.

Figure 1. Laffer Curve for the Benchmark Calibration of the Model



Notes: The figure shows the Laffer curve for the benchmark calibration of the model. It plots the steady-state government revenues, G, on the vertical axis and the income tax, τ, on the horizontal axis.

Figure 1 plots the Laffer curve for the benchmark calibration of the model. The Laffer curve is obtained by computing the equilibrium government revenues associated with values of the income tax rate between 0 and 100%. Similar to Fullerton (1982), Ireland (1994) Pecorino (1995) and Trabandt and Uhlig (2009), changes in the income tax rate generate the familiar inverted-U-shaped Laffer curve. The shape of the Laffer curve reveals that changes in income tax rates have a sizeable impact on government revenues. The tax rate that maximizes government revenues equals approximately 0.5.[2]

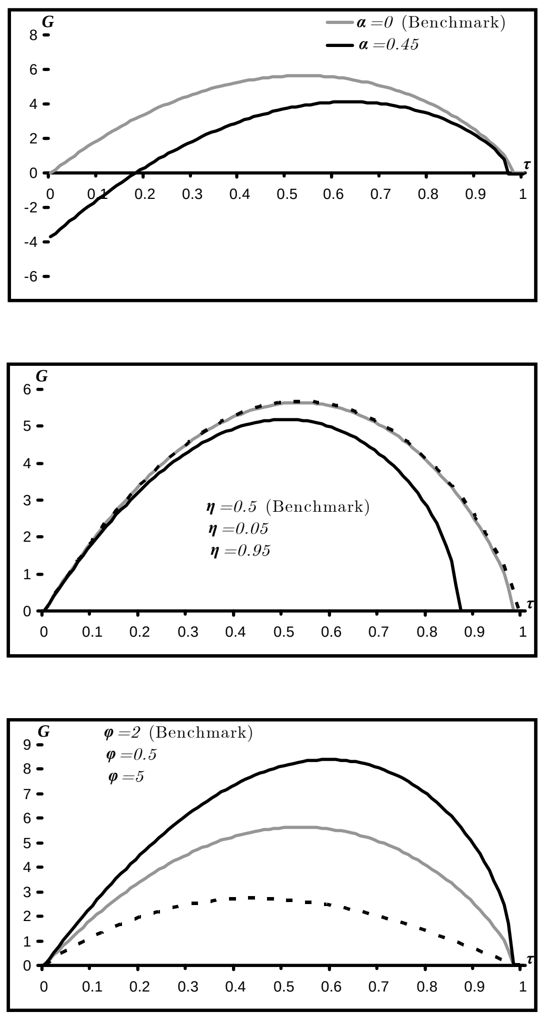
To determine to what extent the structure of the labor market affects government revenues, this part experiments with alternative calibrations to trace out how the level and the slope of the Laffer curve change compared to the benchmark calibration. To investigate the importance of unemployment benefits, the top panel of Figure 2 plots the Laffer curve for a value of the replacement ratio, α, equal to 0.45, which is around the estimate in the US, as detailed in Nickell (1997). The presence of unemployment benefits has two effects. First, it directly decreases net government revenues, since unemployment benefits expand public spending, as from equation (18). Second, it raises wages as the workers outside option improves. Given the increase in the cost of labor, the firm reduces hiring, which depresses employment and consequently production, thereby shrinking the tax base. These two effects work towards decreasing government revenues, generating a sizeable reduction in government receipts for any given income tax rate, which is reflected by the pronounced downward shift of the level of the Laffer curve. Note also that the slope of the Laffer curve changes; it becomes steeper and the curve's peak shifts to the right. Higher unemployment benefits decrease output, thereby increasing the impact that a marginal tax change generates on government transfers, as reflected by a steeper Laffer curve. The peak shifts to the right, as for higher unemployment benefits output becomes less sensitive to tax changes, as shown by the numerical simulation.

In order to investigate the effect of the degree of wage bargaining power, the middle panel of Figure 2 plots the Laffer curve for calibration of the parameter η equal to 0.05 and 0.95 respectively. A high firm's bargaining power, when $\eta = 0.05$, leaves the Laffer curve substantially unchanged, while a high household's bargaining power, when $\eta = 0.95$, generates a lower overall level and a steeper slope of the slippery part of the Laffer curve. This occurs since when the household enjoys high bargaining power the established wage increases, as from equation (12). The increase in the cost of labor input incentives the firm to cut down on hiring which consequently reduces employment, since a constant fraction of jobs are destroyed in every period, as from equation (7). This suppresses production, thereby generating

[2]Here, as in other similar studies such as Trabandt and Uhlig (2009) and Cuñat, Deák and Maffezzoli (2008), due to the simplicity of the model, the aim is not to pinpoint exact numbers, but rather to set up a coherent numerical framework to conduct the investigation.

lower government revenues and consequently shifting the Laffer curve downwards. The same decrease in production also implies that changes in taxes have a more pronounced contraction on government receipts, as reflected by a steeper slope of the Laffer curve. For a high firm's bargaining power, when, $\eta = 0.05$, the contribution of search frictions to the wage becomes very small, as from equation (12), so that changes in taxes are unable to generate sizeable changes in government revenues, leaving the level and the slope of the Laffer curve substantially unaffected.

Figure 2. Laffer Curve for Alternative Calibrations of the Model



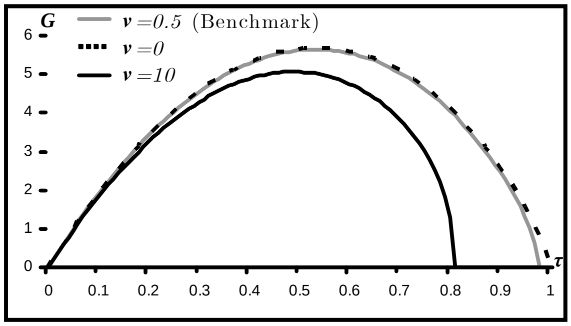
Notes: Each panel plots the steady-state government revenues, G, on the vertical axis and the income tax, τ, on the horizontal axis. Top panel: unemployment benefits, α; middle panel: the wage bargaining power, η; bottom panel: the inverse of the elasticity of labor supply, ϕ.

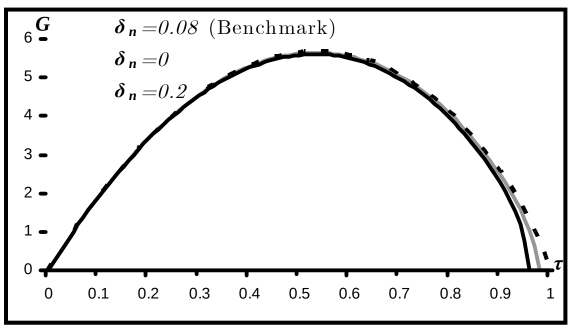
The bottom panel of Figure 2 plots the Laffer curve for calibrations of the inverse of the elasticity of labor supply, ϕ, equal to 0.5 and 5, which imply a labor supply elasticity of 0.2 and 2 respectively.[3] In line with the findings of Fullerton (1982), Mankiw and Weinzierl (2006) and Leeper and Yang (2008), changes in the elasticity of labor supply significantly impact on government receipts. An increase in the elasticity of labor supply induces a higher number of members of the household to be unemployed for a given tax rate, which triggers a contraction in hiring and production. This effect shrinks the tax base, thereby reducing government revenues and shifting the Laffer curve downwards. In addition, a higher elasticity induces unemployment to rise as the income tax rises, so that the Laffer curve becomes flatter and reaches a peak at a lower rate. A decrease in the elasticity of labor supply generates the opposite effects.

The top panel of Figure 3 shows the Laffer curve for calibrations of the costs of establishing a work relationship, ν, equal to 0 and 10 respectively, which imply shares of hiring costs on total output of 0 and approximately 2.5% respectively. An increase in ν makes it more costly to establish a work relationship, which leads to an increase in the wage and induces the firm to cut down on hiring. This puts downward pressures on employment and production, thereby reducing the tax base and consequently shifting the level of the Laffer curve downwards. If the cost of establishing a work relationship is absent, when $\nu = 0$, the contribution of search frictions to the wage disappears, as from equation (12), thereby amplifying the reaction of government revenues to tax changes, similarly to the case of a high firm's bargaining power. Quantitatively, since hiring costs are approximately 1% of total output in the benchmark calibration, for $\nu = 0.5$ the Laffer curve remains substantially unchanged from the benchmark case. Interestingly, the bottom panel of Figure 3 shows that the Laffer curve remains equally unchanged for calibrations of the rate of job separation, δ_n, equal to 0 and 20% respectively. In fact, an increase in the job separation rate has two offsetting effects on government revenues. On the one hand, from the firm's perspective, it decreases the wage, since, for a higher job separation rate, more unemployed workers would be available to work therefore decreasing the firm's search costs. A lower labor cost encourages recruitment, which in turn increases employment and production, thereby working towards expanding the tax base. On the other hand, from the household's perspective, the higher job separation rate increases unemployment, which puts downward pressures on production and contracts the tax base.

[3] The value of the elasticity of labor supply is controversial in the literature. Microeconomic studies, as surveyed by Card (1994), estimate this elasticity to be small, close to 0 and not higher than 0.5. Macroeconomic studies of the business cycle, use higher elasticities, typically equal to unity or higher, as in King and Rebelo (1999).

Figure 3. Laffer Curve for Alternative Calibrations of the Model



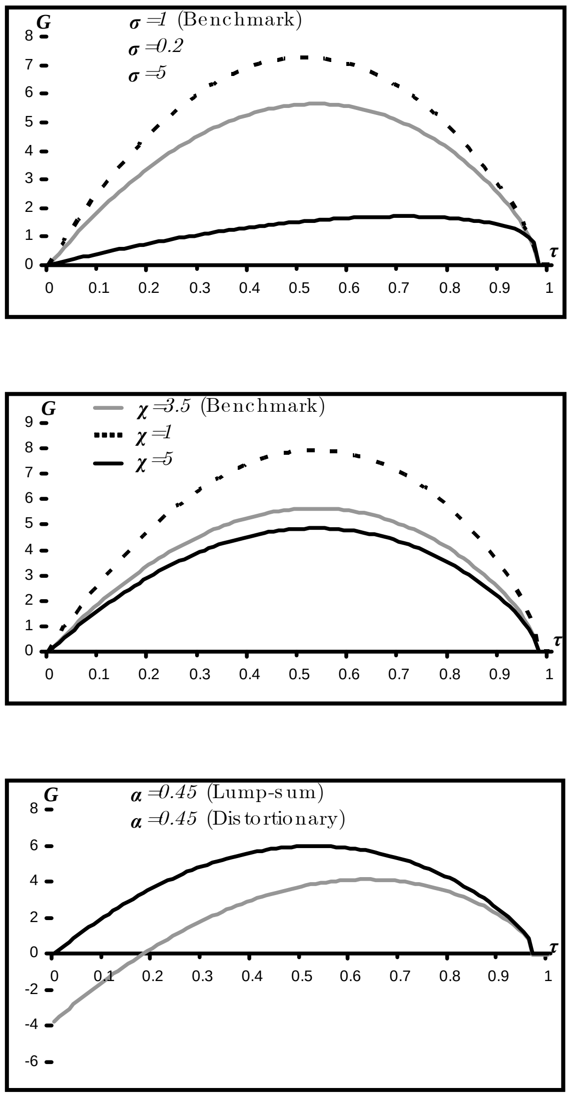


Notes: Each panel plots the steady-state government revenues, *G*, on the vertical axis and the income tax, τ, on the horizontal axis. Top panel: the cost of establishing a work relationship, ν; bottom panel: the rate of job separation, δ_n.

Since these two effects offset each other, the effect of the job separation rate on the reaction of government revenues to tax changes is limited, and the level and slope Laffer curve remain substantially unchanged for different values of δ_n. Overall, these findings point out that the structure of the labor market alter the reaction of tax receipts to tax changes in the long run, but the extent crucially depends on the labor market parameter considered.

In order to establish whether the results are robust to perturbations to the benchmark calibration of the model, this part undertakes a number of robustness checks. In particular, it investigates to what extent the results are sensitive to variations in the disutility of work, χ, and the intertemporal elasticity of consumption, σ, whose values are kept constant in the preceding analysis, since they are commonly used in models with a frictionless labor market. The top panel of Figure 4 compares the Laffer curve in the benchmark calibration against those generated by setting σ equal to 0.2 and 5 respectively. A higher relative risk aversion, when $\sigma = 5$, dampens the impact of tax changes on government revenues, as underlined by the downward shift of the Laffer curve. A decrease in σ has the reverse effect. Intuitively, if the coefficient of relative risk aversion increases, the household is less inclined to exchange consumption overtime, thereby preventing consumption, and in turn output, from accommodating changes in taxes.

Figure 4. Laffer Curve for Alternative Calibrations of the Model



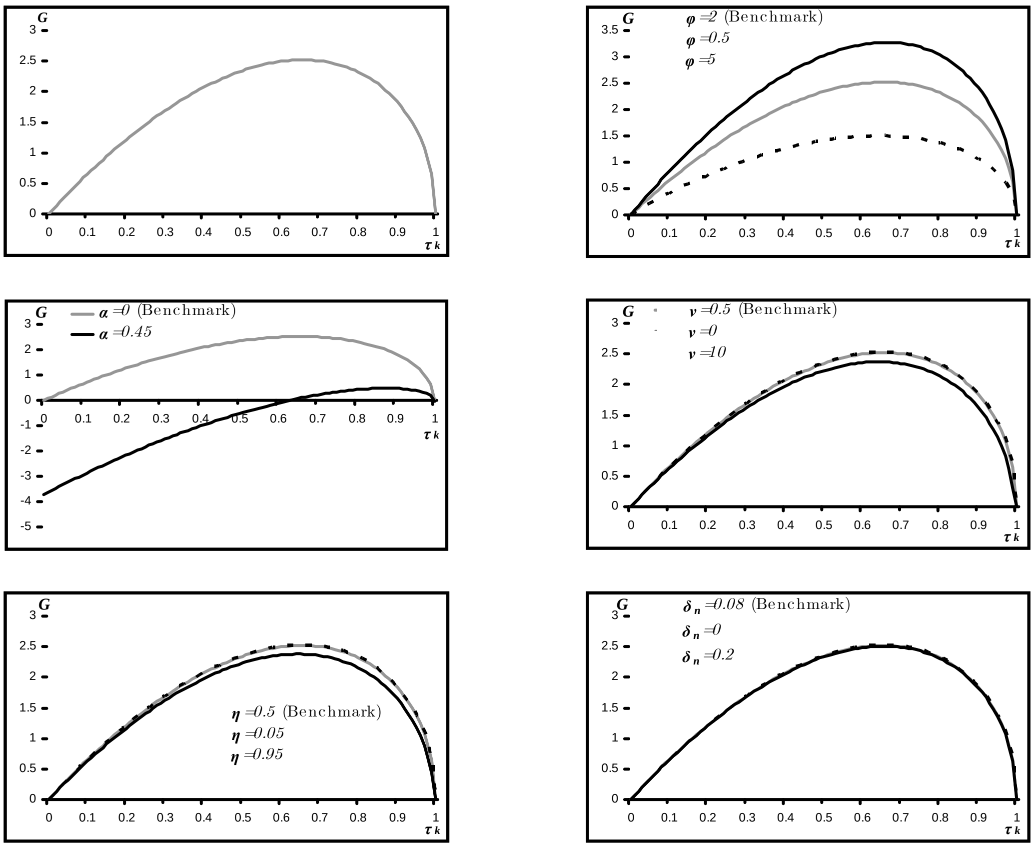
Notes: Each panel plots the steady-state government revenues, G, on the vertical axis and the income tax, τ, on the horizontal axis. Top panel: the coefficient of relative risk aversion, σ; middle panel: the disutility of work, χ; bottom panel: unemployment benefits, α, for lump-sum transfers and distortionary income taxation.

The steady-state effects for alternative calibrations of the disutility of labor, χ, equal to 1 and 5 respectively, are depicted in the middle panel of Figure 4. The middle panel of Figure 4 shows that a decrease in this parameter amplifies the long-run reaction of tax receipts to tax changes, shifting the Laffer curve upwards. A decrease in the disutility of work reduces the wage, as from equation (12), which in turn stimulates hiring, increases employment and production, thereby expanding the tax base and shifting the Laffer curve upwards. An increase in χ has the reverse effect. To summarize, the robustness analysis shows that the long-run effect of tax changes on government revenues is sensitive to the values of parameters which are not directly related to labor market search frictions.

4 Extensions and interpretations

Although the focus of the paper is on income taxation, it is interesting to consider whether labor market frictions also alter the effect of capital and labor income taxes on government receipts. As in Mankiw and Weinzierl (2006), capital income taxation is embedded in the model by replacing the term Q_tK_t with $(1-\tau_k)Q_tK_t$ into the household budget constraint (3), and appending the term $\tau_kQ_tK_t$, to the government budget constraint (18), which represents additional government revenues from capital taxation. Otherwise the model is the same as that in Section 3. The top-left panel in Figure 5 plots the Laffer curve for capital income taxation. In this instance, an increase in capital tax rate expands the share that the government collects but it also decreases capital and production, thereby reducing the tax base. This tradeoff gives raise to the Laffer curve. A few considerations are in place. First, in comparison to the income tax, capital income taxation collects lower government revenues and second, the peak of the Laffer curve shifts right. Government receipts are lower since capital income taxation affects the tax base through its effect on capital, rather than output, as in the case of the income tax, thereby raising lower revenues. The peak of the Laffer curve shifts right since the reduction in the tax base generated by the increase in capital tax is mitigated by the increase in the share of the tax base that the government collects. These results corroborate the findings in Trabandt and Uhlig (2009) who also point out that capital income taxation produces a Laffer curve with similar shape. As in Section 3, in order to assess to what extent changes in the structure of the labor market affect government revenues for the case of capital income taxation, the entries in Figure 5 plot the Laffer curve for alternative calibrations of labor market parameters. The qualitative properties identified in the case of the income tax are preserved. For instance, high levels of unemployment benefits, household's wage bargaining power, elasticity of labor supply, and a high cost of establishing a work relationship and disutility of work all dampen the reaction of government revenues to changes in capital taxation, similarly to the case of income taxation. However, as mentioned, the extent to which labor market parameters affect government receipts is reduced.

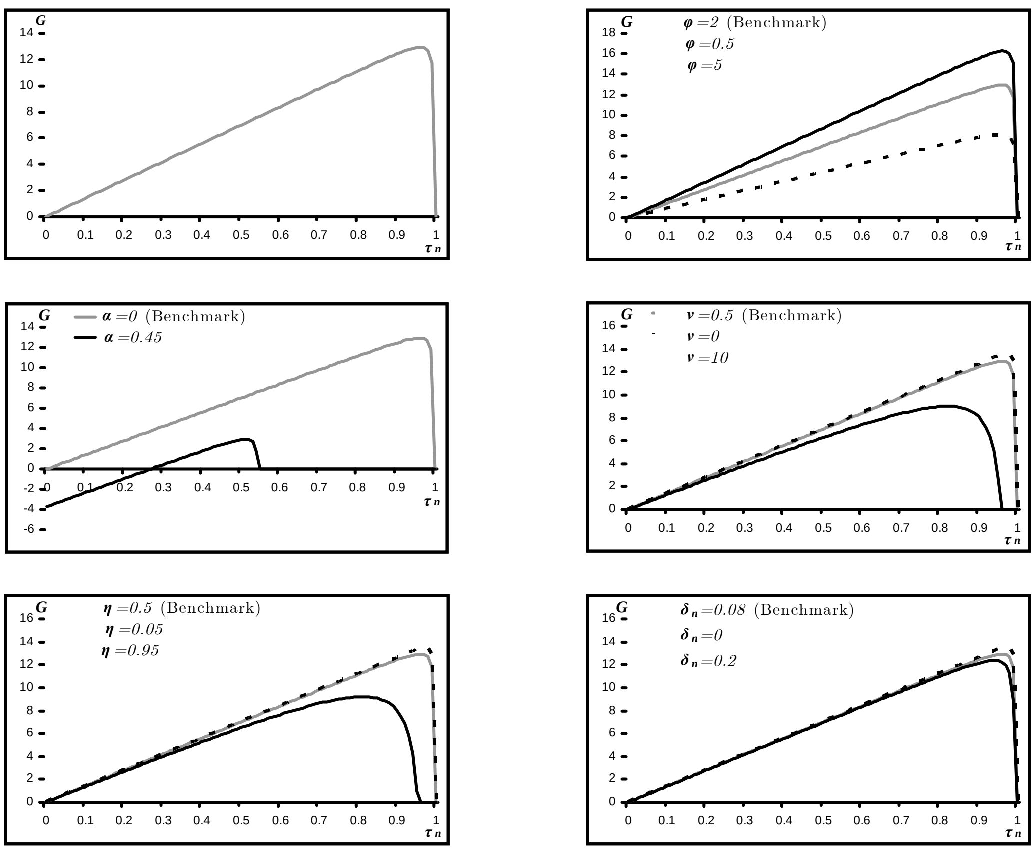
Figure 5. Laffer Curve for Capital Income Taxation



Notes: Each panel plots the steady-state government revenues, G, on the vertical axis and the capital income tax, τ_k, on the horizontal axis. The top-left panel plots the Laffer curve for the benchmark calibration. Other panels plot the Laffer curve for alternative calibrations of the labor market parameters.

Labor income taxation is embedded in the model similarly to capital income taxation. The top-left panel in Figure 6 plots the Laffer curve for labor income taxation for the benchmark calibration of the model. In this instance, the peak of the curve shifts right compared to both consumption and capital income taxes, as an increase in the labor income taxation expands the share that the government collects proportionally more than the decrease in labor input and production that the increase in labor taxes generates. A few considerations are worthy of note. First, the qualitative properties identified for both consumption and capital income taxes still hold in the case of labor income taxation, as changes in labor market parameters have a similar qualitative effect on the Laffer curve. Second, the level of the Laffer curve is higher for labor income taxation, which corroborates the finding that taxing labor is more profitable than taxing capital, as in Trabandt and Uhlig (2009).

Figure 6. Laffer Curve for Labor Income Taxation



Notes: Each panel plots the steady-state government revenues, G, on the vertical axis and the labor income tax, τ_n, on the horizontal axis. The top-left panel plots the Laffer curve for the benchmark calibration. Other panels plot the Laffer curve for alternative calibrations of the labor market parameters.

Another interesting consideration regards the sensitivity of the results to the assumption that unemployment benefits are financed through lump-sum transfers. As Leeper and Yang (2008) point out, in a standard neoclassical growth model the effect of taxation on government revenues may differ depending on the government financing scheme. In this paper, to keep the analysis simple, as in Mankiw and

Weinzierl (2006) and Trabandt and Uhlig (2009), we assume lump-sum transfers. To point out that indeed results depend on the government financing scheme, the bottom panel of Figure 4 shows the alternative case in which unemployment benefits are financed with distortionary income tax. In this instance, government revenues are always positive and higher than the case in which fiscal policy is achieved through lump-sum transfers. The reason for this is straightforward. With distortionary taxes, unemployment benefits do not subtract from government revenues, thereby inducing positive government receipts, and they also expand the tax base, which increases the level of government revenues. This simple example points out that results are sensitive to the government financing scheme. Extending the analysis to a more comprehensive assessment of alternative financing schemes would certainly be a useful task for future research.

Finally, it is interesting to relate the findings of the paper to the empirical evidence on the Laffer curve. Trabandt and Uhlig (2009) produce estimates of the Laffer curve both for the US and the EU-14. They detect that the Laffer curve for the EU-14 is flatter and its peak is associated with lower taxation than in the US. The findings of this paper allow drawing a few considerations on what features of the labor marker may reconcile this evidence. The analysis in Section 3 shows that labor market features such as high unemployment benefits, or high wage bargaining power, or high costs of establishing a work relationship, or high elasticity of labor supply generate an inward shift of the Laffer curve which, other things equal, would explain the difference between the Laffer curve for the EU-14 and the US. Interestingly, these labor market attributes are in line with those that characterize differences between the European and North American labor markets, as detailed in Bean (1994) and Nickell (1997).

5 Conclusion

This paper has investigated whether a frictional labor market alters the long run responses of government revenues to changes in income tax. The presence of labor market search frictions enables the standard neoclassical growth model to shed light on the effects of a broad range of labor market parameters such as the job separation rate, the wage bargaining power, unemployment benefits, the disutility of work and the cost of forming a work relationship. The analysis points out that, with the exception of the job separation rate, changes in labor market parameters are able to alter the reaction of tax receipts to tax changes, due to their impact on the cost of labor, which affect the firm's hiring decisions, employment, production and consequently the size of the long-run tax base.

The analysis might be enriched in further work in several ways. It would be interesting to investigate whether the results are robust across alternative specifications of the model, such as different household utility functions and departures from neoclassical production. Also, extending the analysis to investigate more sophisticated government financing schemes would certainly be a useful task for future research. The model might also be extended to assign a role to aggregate demand, as in the New Keynesian tradition, which could potentially interact with labor market frictions to affect the dynamics of tax receipts. Yet, the analysis might be broadened to investigate the effect of labor market frictions on the transitional path of government revenues and to incorporate the size and timing of tax changes, which Laffer (2004) suggests as important elements to determine the behavior of tax receipts. Finally, the findings suggest that empirical studies should incorporate frictional labor markets when attempting to determine the shape of the Laffer curve.

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