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LAFFER CURVES WITH INFORMALITY: THE CASE OF MEXICO

CARLOS ALBERTO ALBA FAJARDO

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Asesor:

Stephen McKnight

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Abstract

In this thesis Laffer curves for distortionary taxes on labor income, capital income, and consumption are estimated for Mexico by comparing the balance growth paths of a neoclassical growth model, which is extended to incorporate informality in two slightly different ways: as a market informal economy or as a home production economy. By considering the only-formal model, it is shown that government can increase tax revenues by 91.30% by raising labor taxes and by 39% by raising capital income taxes. In respect of the Laffer curve for consumption taxes, results suggest that this curve does not have a peak and is increasing in the consumption tax throughout. These results change significantly if the analysis incorporates informality. In this case, government can only increase tax revenues by 21% by raising labor taxes and by 26% by raising capital income taxes. The evidence also shows that the Laffer curve for consumption taxes shifts down and becomes flatter. The robustness of these results is tested using a sensitivity analysis for particular important parameters and changing the structure/assumptions of the model.

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1 Introduction

According to the economic theory, an increase in distortionary taxes can have two opposite effects: on the one hand, it can directly increase tax collections; on the other hand, however, it can indirectly reduce collection as the higher income taxes discourage labor supply, higher capital taxes discourage investment, and higher consumption taxes can reduce consumption. This idea was part of the motivation of Arthur Laffer to determine the point at which it is optimal to set a tax rate on income and expenditure in order to maximize government revenues.[1] Graphically, Laffer's proposal can be characterized in the plane with an inverted U-shaped curve where the y-axis represents government revenues and the x-axis the distortionary tax rate. If the tax burden of a country is below that which maximizes collection, then increasing tax rates will generate more revenue for the government. However, if the tax burden exceeds this limit, then additional increases in tax rates would generate reductions in revenues.

By comparing the effective tax rates in the international context, for which the estimates of Trabandt and Uhlig (2011) and Lozano and Arias (2018) are considered, it is observed that the effective tax rates in Mexico on labor income, 13.8%, and on capital income, 8.5%, are significantly lower than the effective tax rates in United States and Colombia. In United States such tax rates amounts to 28.07% for labor and 36.38 for capital, while in Colombia they amounts to 22.5% for labor and 18.5% for capital. A comparison can also be done among Mexico and the average of fourteen main economies of the European Union: Belgium, Denmark, Germany, Ireland, Greece, Spain, France, Italy, Holland, Austria, Portugal, Finland, Sweden and the United Kingdom. The evidence suggest that the effective tax rates on the income of factors of production in Mexico also is significantly lower than the effective tax rates of the European average, 40.6% for labor and 32.7% for capital. In respect of the effective tax rate on consumption, evidence suggests that this rate is well below of the European average and the Colombian case, 17% and 14.1% respectively, but slightly above of the American rate, 4.6%.

Currently, Mexico is the OECD country member with the lowest tax collection, the lowest capital income taxes, and the more unequal member by considering concentration of wealth. Table 1 shows that in 2016 the tax revenues as percentage of GDP in Mexico were 16.6%, less than half than the average of all members together, and almost six percentage points fewer than Chile, the only other Latin American member of the OECD in 2016. Given this, it is widely accepted that if the Mexican government wants to implement its new social policy by means of greater government spending, then it will be necessary to increase tax revenues; in particular, from the taxation of capital. In this sense, it is useful to know how the Laffer curves for Mexico are characterized and, therefore, how tax revenues are adjusted to changes in alternative taxes. In other words, it is necessary to derive the government's possible tax-related fiscal space by comparing the current effective tax rates on the factors of production and consumption against that which would maximize the government's revenues. How far is the country from the point in which is optimal to establish a tax rate on the labor income, capital income and consumption? How do tax revenues adjust if distortionary taxes are changed? This work aims at providing answers to these questions.

Despite being a useful instrument of fiscal policy, the literature on Laffer curves for tax rates on labor income, capital gains and consumption in Mexico is relatively small. Beltrán (2014) found that Mexico is far from

[1]See, for example, Wanniski (1978)

Table 1
Tax revenue as % of GDP in OECD countries, 2016

Country	Percentage of GDP
France	45.5
Austria	42.2
Spain	33.2
United States	25.9
Chile	22.2
Mexico	16.6
Average of 36 members	34

Source: Revenue statistics 2018, OECD

the prohibitive range of the Laffer curves for both the tax rates on labor income and the tax rates on capital gains. Therefore, taking into consideration the results of Beltrán (2014), the Mexican government could undertake significant adjustments in tax rates in order to increase tax collection. Nevertheless, although Beltrán's work is a good starting point for policy development, it ignores a distinctive characteristic of labor markets in Mexico and, in general, the emerging market economies: informality. According to Levy (2008), Maloney (2004), and Pratap and Quintin(2006), Mexico has high rates of transition across the informal and formal sectors and, in addition, lacks market segmentation, which suggest that higher tax rates not necessarily implies higher collection or, at least, no precisely in the way that Beltran's estimations suggest. There exist a point in which it could be better remain in the informal sector, perhaps generating less income but without pay taxes, than being in the formal sector with greater income but paying taxes. Additionally, acording to Restrepo-Echavarría (2011), formal and informal consumption are highly substitutable mainly in the retail sector, where goods sold by the informal vendor, such as fruits, vegetables and electronics, are practically the same as goods sold by the formal vendor. This high level of substitution between formal and informal goods can cause a reduction of the consumption tax base by the side of consumption and, therefore, of the potential revenues that government could obtain.

Given the importance of the informal sector, Boz et al. (2009), Altug et al. (2011), Fernández and Meza (2011), Li (2011), and Lama and Urrutia (2013) are some studies that have incorporated informality into a general equilibrium framework. With regard to Latin America, Powell (2013) suggests that the average of informality across countries of this region is 44.1% and the emerging economies display high levels of informal employment relative to developed economies. According to Levy (2008), Mexican informal employment accounts for more than half of the labor force, which is in line with the ENOE's recent reports, where is observed that Mexico registers almost 31 million people working in the informal sector, i.e. a rate of informal labor of 56.88%. Table 2 shows some of the OECD countries with the greatest size of informal economy as percentage of national GDP in 2011, according to estimates done by OECD (2016). Additionally, this table shows the same information for the average of thirty three OECD countries members.[2] As can be observed in table, some of these countries are: Mexico, Stonia, Korea, Turkey, Poland, Greece and Chile. The infor-

[2]These countries are: Mexico, Estonia, Korea, Turkey, Poland, Greece, Slovenia, Hungary, Israel, Italy, Chile, Portugal, Spain, Belgium, Czech Republic, Slovak Republic, Norway, Sweden, Denmark, Finland, Germany, Ireland, Canada, France, United Kingdom, Australia, Netherlands, New Zealand, Japan, Luxembourg, Austria, Switzerland, United States.

mation contained in this table permits to observe that the informality in Mexico represents approximately one-third of the final production and, in addition, that such proportion is almost twice as high as the average of thirty three OECD country members. The information contained in table 2 also permits to observe that the size of the informal economy in Mexico as percentage of GDP is ten percentage points higher compared with Chile, the only other Latin American member of the OECD in 2011.

Table 2
Estimates of the size of the informal economy in OECD countries, 2011: Percentage of national GDP

Country	Percentage of GDP
Mexico	30.2
Estonia	28.6
Korea	28.1
Turkey	27.7
Poland	25
Greece	24.3
Chile	20.1
Average of 33 countries	16.6

Source: OECD Studies on SMEs and Entrepreneurship

In view of the above, in this thesis Laffer curves for taxes on labor income, capital gains, and consumption are estimated for Mexico, a representative emerging market economy with a large informal sector. Such curves are estimated by comparing the balanced growth paths of a neoclassical growth model proposed by Trabandt and Uhlig (2011), which is extended to model an informal economy in two slightly different ways: as a market informal economy or as a home production economy. The first one considers as informality the production of legal goods and services in total noncompliance with tax and labor regulations. The second one only considers as informality the production of home goods as a substitute of market goods. Given this, we initially look at three different versions of the model. The formal only benchmark of Trabandt and Uhlig (2011) and two alternative versions where informality is either treated as home production or self-employment. The latest way of modelling informality is in line with Fernández and Meza (2014), who found self-employment is a good proxy for informality in Mexico, and with Loayza and Rigolini (2006), who have argued that self-employment is a good approximation of informality in developing economies.

In the previous three versions of the model it is assumed that all markets are perfectly competitive. It may be important, however, to allow for monopolistic competition, when examining the consequences of changing labor and capital taxation. Taking this into account, following Trabandt and Uhlig (2012), we also consider a version of informal model of self-employment where monopolistic competition is introduced into the formal sector and not the informal sector.

The results of this thesis suggest that Mexico is still far from the slippery slope of the Laffer curves. Nevertheless, the consideration of informality into the analysis generates significant changes in the shape of Laffer curves and, therefore, in the tax-related fiscal space. In general, the peak of the Laffer curves is shifted downwards and to the left once informality is considered. These changes are especially visible in the Laffer curves for labor income taxation. Considering this, the implications for the design of economy policy change significantly due to the increase of the degree of substitution between the labor tax and the capital tax. This result can be analyzed from other perspective by observe "the Laffer hills", which show the combined budgetary effect of changing labor and capital income taxation. The obtained results imply that either increases of the same magnitude in the labor tax or the capital tax now lead to more similar increases in the government's collection, in comparison with the model without informality. In addition, the results of this thesis show that the Laffer curve for consumption taxes does not have a peak and is increasing in the consumption tax throughout, which is according with the theory and the evidence. With regard to the extended model to incorporate monopolistic competition, the results show that the Mexican economy is closer to the peak of the labor tax Laffer curve and farther away from the peak of the capital tax Laffer curve, once the perfect competition assumption is abandoned.

There is a cosiderable literature on Laffer curves at the international level. Trabandt and Uhlig (2011) characterize Laffer curves for United States and fourteen main economies of the European Union by comparing the balanced growth paths of a neoclassical growth model when tax rates are varied. The results of Trabandt and Uhlig (2011) suggest that these economies are still far from the prohibitive rank of the Laffer curves. Nevertheless, according to these authors, endogenous growth and human capital accumulation affects the results significantly by locate these economies closer to the peak of the Laffer curves. In addition, in terms of the "Laffer hills", which are used to analyzed the combined effect of changing the labor income taxes and the capital income taxes, both US and the average of these fourteen main economies of the European Union are on the wrong side of the peak with respect to their capital tax rates.

Taking into account that the model in Trabandt and Uhlig (2011) appears to overstate total tax revenues to GDP compared to the data, Trabandt and Uhlig (2012) extend such model by allowing for monopolistic competition as well as partial taxation of pure profit income. With these changes, the fit to the data considerably improves and the analyzed economies get closer to the peak of the labor tax Laffer curve and move away from the peak of the capital tax Laffer curve. Feve et al. (2013) estimates Laffers curves for distortionary taxes in United States by considering a neoclassical growth model with incomplete markets and heterogeneous agents, where either transfers or government debt can vary to balance the government budget constraint. The results of Feve et al. (2013) show that the Laffer curves have the traditional U-inverted form with a single maximum point when transfers vary, regardless of what incomplete or complete markets are assumed. Nevertheless, such curves appear to have a form of a horizontal S when debt varies and incomplete markets are assumed, which implies that three tax rates compatible with the same level of fiscal revenues can exist. In an overlapping generations framework with single and married households subject to idiosyncratic income risk, extensive and intensive margins of labor supply and endogenous accumulation of work experience, Holter et al. (2014) shows how tax progressivity and household heterogeneity can affect the income tax Laffer curves. The estimates done by Holter et al.(2014) shows that the maximum additional tax revenues can increase 7% if the progressive tax code is replaced with a at labor income tax. In addition, According to Holter et al. (2014) in the presence of an extensive margin of labor supply, taxes more progressive can increase the labor force participation of single women. This, together with more labor market experience can offset the negative effect of tax progressivity on labor supply along the intensive margin.

For the Mexican case, Beltrán (2014) shows, through a general equilibrium model and a long-term analysis, that Mexico is far from the slippery slope of the Laffer curves for both the tax on labor and tax on capital. Similarly, Lozano and Arias (2018) using a neoclassical growth model with endogenous human capital accumulation of the type initially developed by Uzawa (1965) and Lucas (1988) and subsequently extended by Trabandt and Uhlig (2011) for US and some European economies, find that, while the Colombian economy is also far from the prohibitive range, the low concavity of the capital tax Laffer curve implies that the gains in revenues would be really marginal if the capital tax rates are further increased.

The thesis is organized as follows: the baseline model where informality is modeled is presented in chapter 2. Chapter 3 explains the calibration and parameterization. In chapter 4 Laffer curves are presented along with a sensitivity analysis. In chapter 5 informality is modeled as a home production economy and Laffer curves are estimated again. In chapter 6 the model with informality is extended to incorporate monopolistic competition: the model and new results for Laffer curves are presented in this section. Finally, chapter 7 concludes. The document also contains an appendix with the detailed solution of each theoretical model.

2 A baseline model with informality

In this chapter, the baseline model of Trabandt and Uhlig (2011) is described and extended to incorporate informality. The model consists of two sectors, formal and informal, and is comprised of a representative household, firm and a government. International trade is introduced by allowing a exogenous flow of payments that can capture a negative or positive trade balance. It is assumed that the household derives utility from leisure and consumption of both formal and informal goods. Following Trabandt and Uhlig (2011), household preferences feature a constant Frish elasticity of labor supply in line with King and Rebelo (1999). The representative agent uses income to purchase formal goods and also produces informal goods for her own consumption by allocating a share of her capital and labor supply. It is further assumed that the representative agent chooses how much labor to allocate to each sector. This assumption is motivated by the fact that Mexico has high rates of transition across the informal and formal sectors and lacks market segmentation according to Levy (2008), Maloney (2004), and Pratap and Quintin (2006).

In the formal sector, the representative firm is assumed to be perfectly competitive and produces goods renting capital and hiring labor from the representative household. Formal firms are assumed to have higher productivity levels compared to the self-employed producer, motivated by the fact that, according to Pagés (2010), Powell (2013) and Busso et al. (2012), there exists a large productivity gap between formal and informal activities in Mexico as well as other emerging market economies. Following Fernández and Meza (2014), in order to compute a balanced growth path equilibrium, it is assumed that informal sector grows at the same rate, but at a lower level, than the formal sector. Finally, government provides a public good which is financed using three different distortionary taxes on income, capital, and consumption.

2.1 The representative household

The representative household's problem is to maximize the discounted sum of expected lifetime utility given by:

$$\max_{c_t^f, c_t^i, n_t^f, n_t^i, k_t^f, k_t^i, b_t} E_0 \sum_{t=0}^{\infty} \beta^t [U(c_t, n_t) + V(g_t)] \tag{1}$$

where $\beta \in (0,1)$ is the discount factor and n_t denotes aggregate labor supply, which is defined as the sum of labor supplied in the formal f and informal i sectors:

$$n_t = n_t^f + n_t^i \tag{2}$$

Consequently, formal and informal labor are assumed to be perfect substitutes.

Aggregate consumption c_t is modeled as a CES aggregator of formal c_t^f and informal c_t^i consumption as follows:

$$c_t = [a(c_t^f)^e + (1-a)(c_t^i)^e]^{1/e} \tag{3}$$

where $a \in [0,1]$ denotes the weight of each consumption good in the CES aggregator and $e > 0$ determines the elasticity of substitution between formal and informal goods $1/(1-e)$. Government consumption g_t is taken as given and provides utility to the household.

Following Trabandt and Uhlig (2011), the preferences for the representative agent are assumed to take the following specific functional form:

$$u(c,n) = \log(c) - \kappa n^{1+\frac{1}{\varphi}} \quad if \quad \eta = 1 \tag{4}$$

or

$$\frac{1}{1-\eta}(c^{1-\eta}(1-\kappa(1-\eta)n^{1+\frac{1}{\varphi}})^{\eta} - 1) \quad if \quad \eta \neq 1 \tag{5}$$

This type of preferences is known as "constant Frisch elasticity" preferences, where $\eta > 0$ is the inverse of the intertemporal elasticity of substitution, $\kappa > 0$ is a parameter that represents the disutility of working and $\varphi > 0$ is the Frish elasticity that measures the sensitivity of the labor supply against changes in disposable labor income.

The representative household optimally chooses c_t^f, c_t^i, k_t^f, k_t^i, n_t^f, n_t^i and b_t subject to the following period budget constraint:

$$(1+\tau_t^c)c_t^f + p_t c_t^i + x_t^f + p_t x_t^i + b_t = (1-\tau_t^n)w_t n_t^f + (1-\tau_t^k)(d_t - \delta_f)k_{t-1}^f + \delta_f k_{t-1}^f + R_t^b b_{t-1} + s_t + \Pi_t + m_t + p_t y_t^i \tag{6}$$

where k_t^f denotes the stock of capital used in the formal sector, k_t^i is the stock of capital used in the informal sector, b_t is government bonds, x_t^f denotes investment in the formal sector, x_t^i is investment in the informal sector, p_t is the relative price of the informal good and the payments m_t are income from an exogenous asset. These payments m_t can be negative and, therefore, can represent liabilities. At the beginning of each period, the household has allocations of both capital assets, k^f_{t-1} and k^i_{t-1}, and government bonds b_{t-1}. The capital stock and labor supplied in the formal sector are used by formal firms in the production of final formal goods. The household receives wages w_t, dividends d_t and profits Π_t from these firms. On the other hand, the capital stock and labor supplied in the informal sector are used by the self-employed producer (the household) in order to produce the amount of final informal goods y^i_t. The household also receives lump-sum transfers s_t and interest earnings R^b_t from the government and has to pay consumption taxes τ^c_t, labor income taxes τ^n_t and capital income taxes τ^k_t, only in the formal sector. In addition, following Prescott (2002, 2004) and Mendoza et al.(1994), capital income taxes are levied on dividends net-of-depreciation δ_f.

The representative household accumulates two different capital stocks, physical capital in the formal sector k^f_t and physical capital in the informal sector k^i_t, which depreciate at a rate δ^f and δ^i respectively as follows:

$$k^f_t = (1-\delta^f)k^f_{t-1} + x^f_t \tag{7}$$

$$k^i_t = (1-\delta^i)k^i_{t-1} + x^i_t \tag{8}$$

Finally, the household also has access to a technology in the informal sector given by

$$y^i_t = \zeta^t_i (k^i_{t-1})^{\theta_i}(n^i_t)^{1-\theta_i} \tag{9}$$

where $0 < \theta_i < 1$ is the informal capital share in production and ζ^t_I denotes the trend of total factor productivity in the informal sector.

The representative agent's maximization problem yields the following first-order conditions:[3]

$$a[a(c^f_t)^e + (1-a)(c^i_t)^e]^{\frac{1-\eta}{e}-1}(c^f_t)^{e-1}[1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}}]^\eta = \lambda_t(1+\tau^c_t) \tag{10}$$

$$(1-a)[a(c^f_t)^e + (1-a)(c^i_t)^e]^{\frac{1-\eta}{e}-1}(c^i_t)^{e-1}[1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}}]^\eta = p_t\lambda_t \tag{11}$$

$$\eta(1+\frac{1}{\varphi})[a(c^f_t)^e + (1-a)(c^i_t)^e]^{\frac{1-\eta}{e}}[1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}}]^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} = -\lambda_t(1-\tau^n_t)w_t \tag{12}$$

$$\eta(1+\frac{1}{\varphi})[a(c^f_t)^e + (1-a)(c^{ie}_t]^{\frac{1-\eta}{e}}[1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}}]^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} = -\lambda_t(1-\theta_i)p_t\frac{y^i_t}{n^i_t} \tag{13}$$

$$E_t\lambda_{t+1}[(1-\tau^k_{t+1})(d_{t+1}-\delta_f)+1] = \lambda_t \tag{14}$$

[3]See appendix 1 for further details.

$$E_t\lambda_{t+1}[\theta_i \frac{y^i_{t+1}}{k^i_t} + (1-\delta_i)] = \frac{p_t}{E_t p_{t+1}}\lambda_t \tag{15}$$

$$E_t\lambda_{t+1}R^b_{t+1} = \lambda_t \tag{16}$$

where λ_t denotes the shadow price of wealth.

2.2 The representative firm

The representative firm operates in the formal sector and chooses capital and labor to maximize profits. Formally,

$$\max_{k^f_{t-1}, n^f_t} \Pi_t = y^f_t - d_t k^f_{t-1} - w_t n^f_t \tag{17}$$

Production technology is given by:

$$y^f_t = \zeta^t_f (k^f_{t-1})^{\theta_f} (n^f_t)^{1-\theta_f} \tag{18}$$

where $0 < \theta_f < 1$ is the formal capital share in production and ζ^t_f denotes the trend of total factor productivity in the formal sector.

The first order conditions of the firm are given by:

$$\frac{\partial \Pi_t}{\partial k^f_{t-1}} : \quad \theta_f \zeta^t_f (k^f_{t-1})^{\theta_f - 1} (n^f_t)^{1-\theta_f} - d_t = 0 \tag{19}$$

$$\implies \quad d_t = \theta_f \frac{y^f_t}{k^f_{t-1}} \tag{20}$$

$$\frac{\partial \Pi_t}{\partial n^f_t} : \quad (1-\theta_f)\zeta^t_f (k^f_{t-1})^{\theta_f} (n^f_t)^{-\theta} - w_t = 0 \tag{21}$$

$$\implies \quad w_t = (1-\theta_f)\frac{y^f_t}{n^f_t} \tag{22}$$

2.3 Government

Government faces the following budget constraint,

$$g_t + s_t + R_t^b b_{t-1} = b_t + T_t \tag{23}$$

where government tax revenues are obtained by levying taxes on consumption, labor income and capital income, in the formal sector:

$$T_t = \tau_t^c c_t^f + \tau_t^n w_t n_t^f + \tau_t^k (d_t - \delta_f) k_{t-1}^f \tag{24}$$

2.4 Market clearing and equilibrium

The two conditions that describe market clearing in the goods market for both types of goods are:

$$y_t^f = c_t^f + x_t^f + g_t - m_t \tag{25}$$

$$y_t^i = c_t^i + x_t^i \tag{26}$$

Therefore, aggregate output and investment are defined respectively as:

$$y_t = y_t^f + p_t y_t^i \tag{27}$$

and

$$x_t = x_t^f + p_t x_t^i \tag{28}$$

Hence, m_t, that represents income from an exogenous asset, can be interpreted as net imports and opens up the economy to international trade in a simple way.

Equilibrium. A rational-expectations equilibrium for this model is a set of allocations $c_t, c_t^f, c_t^i, k_t^f, k_t^i, n_t, n_t^f, n_t^i, b_t, x_t^f$, x_t^i, y_t, y_t^i, y_t^f and prices w_t, d_t, R_t^b, p_t satisfying: (i) the optimality conditions of the representative agent; (ii) the optimality conditions of the formal firm; (iii) the government's budget constraint; and (iv) all markets clear.

2.5 Balanced growth path equilibrium and Laffer curve characterization

The principal objective of this thesis is to analyze how the balanced growth path equilibrium shifts, as tax rates are adjusted. Considering this, following Trabandt and Uhlig (2011), it is assumed that all other variables grow at a constant rate $\psi = \zeta_f^{\frac{1}{1-\theta_f}}$, except for hours worked, interest rates, prices and taxes, where ψ is the growth factor of formal output. In this sense, for instance, $m_t = \psi^t \bar{m}$ and government debt as well as government spending do not deviate from their balanced growth paths, i.e. $b_{t-1} = \psi^t \bar{b}$ and $g_t = \psi^t \bar{g}$. In what follows a bar is used to denote a steady-state variable. When tax rates are adjusted, government transfers adjust according to the government budget constraint (23), rewritten as $s_t = \psi^t \bar{b}(\psi - R_t^b) + T_t - \psi^t \bar{g}$.[4] In addition, in line with Fernández and Meza (2014), the initial difference between ζ_f^t and ζ_i^t is assumed to be pin down by a parameter $0 < \gamma < 1$, which reflects the productivity gap between the two sectors in the steady state as follows: $\zeta_i^t = \gamma \zeta_f^t$.

Taking the above into account this, the balanced growth path equilibrium and Laffer curves can be characterized by a set of balanced growth relationships that are summarized below.

The equation that defines the level of formal labor on the balanced growth path is given by:

$$\frac{1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}}}{\eta\kappa\overline{n}^{\frac{1}{\varphi}}\overline{n}^{f}} = \frac{(1+\tau^c)}{(1-\tau^n)}\frac{\left(1+\frac{1}{\varphi}\right)}{(1-\theta_f)}\frac{\overline{c}^f}{\overline{y}^f}\left(\frac{a(\overline{c}^f)^e+(1-a)(\overline{c}^i)^e}{a\overline{c}^{f\,e}}\right) \tag{29}$$

where $\frac{\overline{c}^f}{\overline{y}^f}$ denotes the consumption-output ratio in the formal sector.

Note that in the absence of an informal sector, equation (29) collapses to:

$$\frac{1-\kappa(1-\eta)\overline{n}^{f\,1+\frac{1}{\varphi}}}{\eta\kappa\overline{n}^{f\,1+\frac{1}{\varphi}}} = \frac{(1+\tau^c)}{(1-\tau^n)}\frac{\left(1+\frac{1}{\varphi}\right)}{(1-\theta)}\frac{\overline{c}^f}{\overline{y}^f} \tag{30}$$

The level of informal labor in the steady state is given by:

$$\frac{1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}}}{\eta\kappa\overline{n}^{\frac{1}{\varphi}}\overline{n}^{i}} = \frac{\left(1+\frac{1}{\varphi}\right)}{(1-\theta_i)}\frac{\overline{c}^i}{\overline{y}^i}\left(\frac{a(\overline{c}^f)^e+(1-a)(\overline{c}^i)^e}{(1-a)\overline{c}^{i\,e}}\right) \tag{31}$$

where $\frac{\overline{c}^i}{\overline{y}^i}$ denotes the consumption-output ratio in the informal sector.

The balanced growth path value of the consumption-output ratio in the formal and informal sectors are given by:

$$\frac{\overline{c}^f}{\overline{y}^f} = \chi + \gamma\frac{1}{\overline{n}^f} \tag{32}$$

$$\frac{\overline{c}^i}{\overline{y}^i} = 1 - (\psi - 1 + \delta_i)\frac{\overline{k}^i}{\overline{y}^i} \tag{33}$$

where $\chi = 1-(\psi-1+\delta_f)\frac{\overline{k}^f}{\overline{y}^f}$ and $\gamma = (\bar{m}-\bar{g})\left(\frac{\overline{k}^f}{\overline{y}^f}\right)^{\frac{-\theta_f}{1-\theta_f}}$ which remain the same as in a formal-only economy. $\frac{\overline{k}^f}{\overline{y}^f}$ and $\frac{\overline{k}^i}{\overline{y}^i}$, that respectively denote the balanced growth path value of the capital-output ratio in the formal and informal sectors, are given by the following expressions:

$$\frac{\overline{k}^f}{\overline{y}^f} = \left(\frac{\overline{R}-1}{\theta_f(1-\tau^k)} + \frac{\delta_f}{\theta_f}\right)^{-1} \tag{34}$$

[4] The system of equations that define the steady-state equilibrium can be found in appendix 1.

$$\frac{\overline{k}^i}{\overline{y}^i} = \left(\frac{\overline{R}-1}{\theta_i} + \frac{\delta_i}{\theta_i}\right)^{-1} \tag{35}$$

Considering the previous two expressions and substituting equations (32) and (33) into (29) and (31) therefore yields a two-dimensional nonlinear system for $\bar{n}^f$ and $\bar{n}^i$, which can be solved given values for the parameters of the model, the tax rates and the levels of $\bar{b}$, $\bar{g}$ and $\bar{m}$.

Labor productivity in the formal sector is given by:

$$\frac{\overline{y}^f}{\overline{n}^f} = \left(\frac{\overline{k}^f}{\overline{y}^f}\right)^{\frac{\theta_f}{1-\theta_f}} \tag{36}$$

After some algebra, total tax revenues in the steady state can be computed as:

$$\overline{T} = \left(\tau^c \frac{\overline{c}^f}{\overline{y}^f} + \tau^n(1-\theta_f) + \tau^k\left(\theta_f - \delta_f \frac{\overline{k}^f}{\overline{y}^f}\right)\right)\overline{y}^f \tag{37}$$

and equilibrium transfers as:

$$\overline{s} = \overline{b}(\psi - R^b) + \overline{T} - \overline{g} \tag{38}$$

Let x denote one of τ^k, τ^n or τ^c, and considering that the balanced growth path of y_t^f can be expressed as:

$$\overline{y}^f = \left(\frac{\overline{k}^f}{\overline{y}^f}(x)\right)^{\frac{\theta_f}{1-\theta_f}} \overline{n}^f \tag{39}$$

then, equation (37) can be rewritten to obtain the following Laffer curve $L(x)$:

$$L(x) = \left(\tau^c \frac{\overline{c}^f}{\overline{y}^f}(x) + \tau^n(1-\theta_f) + \tau^k\left(\theta_f - \delta_f \frac{\overline{k}^f}{\overline{y}^f}(x)\right)\right)\left(\frac{\overline{k}^f}{\overline{y}^f}(x)\right)^{\frac{\theta_f}{1-\theta_f}} \overline{n}^f(x) \tag{40}$$

where $\frac{\overline{k}^f}{\overline{y}^f}(x)$ varies only for $x = \tau^k$ and $\frac{\overline{c}^f}{\overline{y}^f}(x)$ and $\overline{n}^f(x)$ change for $x = \tau^k, \tau^n$ or τ^c.

3 Calibration and parameterization

The model is calibrated at an annual frequency for Mexico. A summary of the calibration is provided in Table 3. Some parameters are set following the existing literature, whereas other model parameters are calibrated using Mexican data from the national accounts system and the OECD database.

Table 3
Baseline calibration

Variable	Baseline	Description	Source
$\overline{b/y}$	0.385	Annual government debt to GDP	OECD
$\overline{g/y}$	0.137	Gov.consumption + invest. to GDP	INEGI
ψ	1.003	Annual balanced growth rate	OECD
$\overline{m/y}$	-0.017	Net imports to GDP	OECD
κ	1.9944	Weight of labor	$\overline{n}^f = 0.33$
$\overline{R} - 1$	0.0406	Annual real interest rate	Fernández and Meza (2014)
β	0.9667	Discount rate	Satisfies steady state condition: $\overline{R} = \psi^\eta/\beta$
δ	0.05	Depreciation rate of capital	Aguiar and Gopinath (2007)
θ_f	0.35	Formal capital share in production	García and Verdú (2005)
θ_i	0.20	Informal capital share in production	Restrepo-Echavarría (2011)
a	0.683	Share of formal goods in aggregate consumption	Fernández and Meza (2014)
e	0.875	Sets elasticity of substitution between goods	Restrepo-Echavarría (2011)
η	2	Inverse of IES	Aguiar and Gopinath (2007)
φ	1	Frisch labor supply elasticity	Trabandt and Uhlig (2011)
$\overline{n}^i/(n^i + n^f)$	0.351	Share of balanced growth informal labor	Fernández and Meza (2014)
τ^n	0.138	Labor tax rate	OECD and INEGI
τ^k	0.085	Capital tax rate	OECD and INEGI
τ^c	0.068	Consumption tax rate	OECD and INEGI

The annual general government debt-to-GDP ratio is obtained using the OECD database from 1995 to 2016. The average value of this ratio $\overline{b/y}$ is equal to 38.5%, which is consistent with Aguiar and Gopinath (2007), who set this ratio at 10% for a quarterly calibration. For government spending we use data from INEGI focusing specifically on the consumption and investment series of the general government. This variable is divided by nominal GDP and, subsequently, its average value $\overline{g/y} = 13.7\%$ is calculated for the period 1993 to 2016. The annual balanced growth rate ψ, which is calculated as growth of GDP per capita, and net imports to GDP $\overline{m/y}$ are calibrated using data from the OECD database and they correspond to average values from 1993 to 2016. We calibrated $\psi = 1.3\%$ and $\overline{m/y} = -1.7\%$.

The weight of labor or the parameter that determines the disutility working κ is set equal to 1.99 implying that the steady-state share of time devoted to labor in the formal sector $\overline{n}^f$ is one-third. This result is also consistent with several reports showing that Mexico is the OECD member where more numbers of hours are worked. The annual real interest rate $\overline{R}$ is set equal to 0.0406 following Fernández and Meza (2014), who set this parameter at 0.0145 for a quarterly calibration. Considering this, we get a value for the discount factor β equal to 0.9667 implying that the steady state condition $\overline{R} = \psi^{\eta}/\beta$ is satisfied.

Given the lack of data on capital and investment in the informal sector, the depreciation rate of capital is equated with the value for the formal sector, i.e. $\delta^f = \delta^i = \delta$. We set a value for this parameter of 0.05 in line with Aguiar and Gopinath (2007).

Regarding capital income shares, the formal capital share θ_f is set equal to 0.35 in line with García-Verdu (2005).[5] In the case of the informal capital share, according to Restrepo- Echavarría (2011), informal production is less capital intensive and, as a consequence, θ_i is set equal to 0.2 in line with this author. However, a sensitivity analysis will be conducted for this parameter.

With regard to the share of formal goods in aggregate consumption a, Fernández and Meza (2014) calculate that this parameter is equal to 0.683. Following Fernández and Meza (2014), we set $a = 0.683$. On the other hand, Following Restrepo-Echavarría (2011), the parameter that determines the elasticity of substitution between formal and informal goods e is set equal to 0.875, implying an elasticity of 8.[6,7] A sensitivity analysis on a and e will also be undertaken.

Following Trabandt and Uhlig (2011) among others, we set an unitary Frisch labor supply elasticity, $\varphi = 1$, and an intertemporal elasticity of substitution $1/\eta$ equal to 0.5, which is consistent with Aguiar and Gopinath (2007). In an international context, whereas Presscott (2006) suggests that the labor supply elasticity can be equal to three, an extensive literature suggests also that such elasticity can be between zero and one: Domeij and Floden (2006), Ziliak and Kniesner (2005) and Kimball and Shapiro (2003). In addition, House and Shapiro (2006), who consider the macroeconomic implications of the timing of some tax cuts under a dynamic general equilibrium analysis, suggest an Frisch labor supply elasticity equal to one. On the other hand, Fernández and Meza (2014) following Aguiar and Gopinath (2007) set a value of $\varphi = 1.6$. Considering the above, a sensitivity analysis of φ and $1/\eta$ will be done.

Following Fernández and Meza (2014), the share of informal employment, $\overline{n}^i/(n^i + n^f)$, is set equal to 0.3514, which is the average across three proxies of informality that the authors estimate for Mexico.

The average effective tax rates for labor income, capital income and consumption are calculated for Mexico using data from 1993 to 2016 and following the methodology of Mendoza et al. (1994). These rates result from the ratio of the collection of a specific tax net of grants to the corresponding value of the potential base tax. This methodology is summarized below and the data needed to calculate these effective tax rates and their corresponding sources are provided in Tables 4 and 5.

The consumption tax rate τ^c is calculated as follows:

[5] The results of García-Verdu (2005) show that factor shares in Mexico and United States are considerably similar and factor shares in Mexico have remained almost constant

[6] Restrepo-Echavarría (2011) argue that formal and informal consumption are highly sustitutable mainly in retail sector, where goods sold by the formal vendor are practically the same than goods sold by the formal vendor. Examples of this types of goods include fruits, vegetables or electronics.

[7] This is consistent with Fernández and Meza (2014), who following Restrepo-Echavarría (2011) also set a same value of e in their work.

Table 4
Revenue Statistics

Key	Description	Source
1100	Taxes on income, profits and capital gains of households	OECD
1200	Taxes on income, profits and capital gains of corporations	OECD
2000	Total social security contributions	OECD
2200	Employer's contribution to social security	INEGI
3000	Taxes on payroll and workforce	OECD
4100	Recurrent taxes on immovable property	OECD
4400	Taxes on financial and capital transactions	OECD
5110	General taxes on goods and services	OECD
5121	Excise taxes	OECD

Table 5
National accounts

Key	Description	Source
C	Private final consumption expenditure	INEGI
G	Government final consumption expenditure	INEGI
GW	Compensation of employees paid by producers of government services	INEGI
OSPUE	Operating surplus of private unincorporated enterprises (mixed income)	INEGI
PEI	Household's property and entrepreneurial income	INEGI
W	Wages and salaries	INEGI
OS	Net operating surplus of the economy	INEGI

$$\tau^c = \left[\frac{5110 + 5121}{C + G - GW - 5110 - 5121} \right] \tag{41}$$

This tax rate is defined as the percentage difference between the revenue from indirect taxation and the base of the consumption tax. The numerator of this ratio includes general taxes on goods and services plus excise taxes, whereas the denominator is measured as post-tax consumption expenditures minus the revenue from indirect taxation. Note that government consumption minus compensation of its employees is considered in the tax base in order to take into account the purchases of goods and nonfactor services of the government. The latter is necessary given that the indirect tax revenue also includes taxes paid by government on these purchases.

Following the methodology of Mendoza et al. (1994), before calculating the effective average tax rate on labor income τ^l, it is necessary first to estimate the total household income tax rate τ^h. The latter tax rate can be used to estimate the revenue from the income tax on wages and salaries as $\tau^h W$. The total household income tax rate is calculated as follows:

$$\tau^h = \left[\frac{1100}{OSPUE + PEI + W}\right] \tag{42}$$

This tax rate corresponds to the percentage difference between individual income tax revenue and pre-tax household income. The numerator of this expression represents the difference between post-tax and pre-tax individual income and the denominator is the sum of wages and salaries, property and entrepreneurial income, and the operating surplus of private unincorporated enterprises.

The effective average tax rate on labor income τ^l is estimated using:

$$\tau^l = \left[\frac{\tau^h W + 2000 + 3000}{W + 2200}\right] \tag{43}$$

The numerator of this expression includes tax on wages and salaries, social security contributions and payroll taxes, whereas the denominator, the tax base, is given by the sum of wages and salaries plus contribution to social security.

Finally, the effective tax rate on capital income τ^k is calculated as follows:

$$\tau^k = \left[\frac{\tau^h(OSPUE + PEI) + 1200 + 4100 + 4400}{OS}\right] \tag{44}$$

where the numerator of this expression is the sum of the revenue from the capital income tax on individuals, which is estimated as $\tau^h(OSPUE + PEI)$, the payments of capital income taxes made by corporations, all recurrent taxes on immovable property paid by households and others, and the revenue from specific taxes on financial and capital transactions. In addition, the tax base is the operating surplus of the economy as a whole.

This study is not the first to estimate the average effective rates on consumption, labor income and capital income for Mexico. Dalsgaard (2000) estimates such rates considering data from 1980 to 1996 using a modified version of the methodology of Mendoza et al. (1994). Dalsgaard (2000) explicitly treats imputed wages to the self-employed as labor income, in contrast to Mendoza et al. (1994), who attribute the entire operating surplus of unincorporated enterprise to capital. For the period from 1993 to 2001, Antón (2005) also estimates effective tax rates following the same methodology of Mendoza et al. (1994) and other extensions such as Carey and Tchilinguirian (2000) and Carey and Rabesona (2002). Unfortunately, the information available for Antón (2005) on Mexico for total taxes on income, profits and capital gains was not divided between individuals and corporations. Nevertheless, considering some evidence shown by Dalsgaard (2000), Antón (2005) assumes that 50% of total taxes on income, profits and capital gains are paid by households, whereas the remaining 50% is paid by corporations.[8] More recently, and also following the methodology of Mendoza et al. (1994), Beltrán (2014) estimates effective tax rates from 2003 to 2010. Table 6 summarizes the results of these authors and those of this work.

Table 6
Average effective tax rates on labor income, capital income and consumption

Variable	Dalsgaard (2000) 1980 - 1996	Antón (2005) 1993 - 2001	Beltrán (2014) 2003 - 2010	Present work 1993 - 2016
τ^n	11.5	12.6	13.6	13.8
τ^k	5.6	9.6	6.5	8.5
τ^c	13.8	7.1	6.7	6.8

The fifth column of table 5 illustrates the estimates for average effective tax rates following the methodology of Mendoza et al. (1994). Due to the lack of information and in line with Antón (2005), the effective tax rates on income labor and capital are estimate assuming that, from 1993 to 2001, 50% of total taxes on income, profits and capital gains are paid by households, whereas the remaining 50% is paid by corporations. For the remaining years, the new disposable information provided by OECD database already includes a division between households and corporations and, therefore, estimates are done considering this. In addition, this new information permits to appreciate that the share of total taxes on income, profits and capital gains paid by households is on average around 50%. The latter can also support, to some extent, the assumption done in order to calculate these taxes from 1993 to 2001.

4 Results

4.1 Formal vs Informal market model

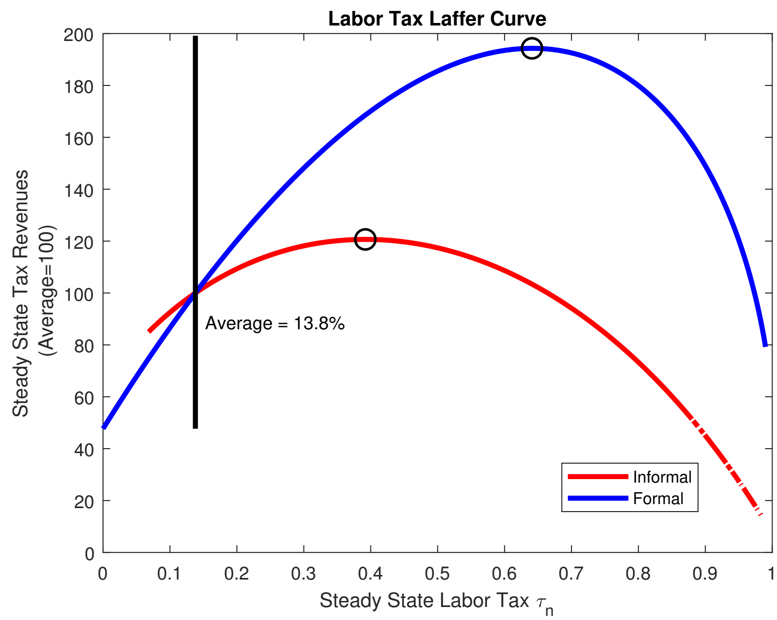
In this section Laffer curves for labor income, capital income and consumption in Mexico are estimated and presented. These curves are estimated by comparing the balanced growth paths of two neoclassical growth models: the first of those is the formal-only model of trabandt and Uhlig (2011), whose presentation and detailed solution is found in the annex two. The second model, which was presented in the section two, incorporates informality and is an extended version of the first one. The key difference among these two models is basically that the agents can now choose, on one side, how much labor and capital to allocate to each sector and, on the other side, how much to consume of both formal and informal goods. This decision depends, among other factors, of the different distortionary taxes on labor income, capital income, and consumption that government decides to impose. Considering this, in comparison with the model of Trabandt and Uhlig (2011), an increase of any of these tax rates can now have stronger opposite effects due to the agents now produce informal goods for her own consumption by allocating, as was already mentioned, a share of their capital and labor supply without any kind of tax burden.

[8]As alternative solution it is also assumed that only 25% of these taxes are paid by households.

4.1.1 Labor tax Laffer curves

The figure 1 shows the Laffer curves for labor income taxation in Mexico. In this experiment, labor taxes are varied between 0% and 100% and all other taxes, parameters and paths for government spending g, debt b and net imports m are held constant. The steady state tax revenues that are represented on the vertical axis are normalized, so that the value of 100 corresponds to the average of the tariff (13.8%). The results are provided to the formal-only model, continuous blue line, and for the baseline informal market model, continuous red line. As the theory suggests, the estimated Laffer curves have the U-inverted form with a single maximum point. In addition, the rate that maximizes the revenues decreases significantly when informality is incorporated into the model.

Figure 1

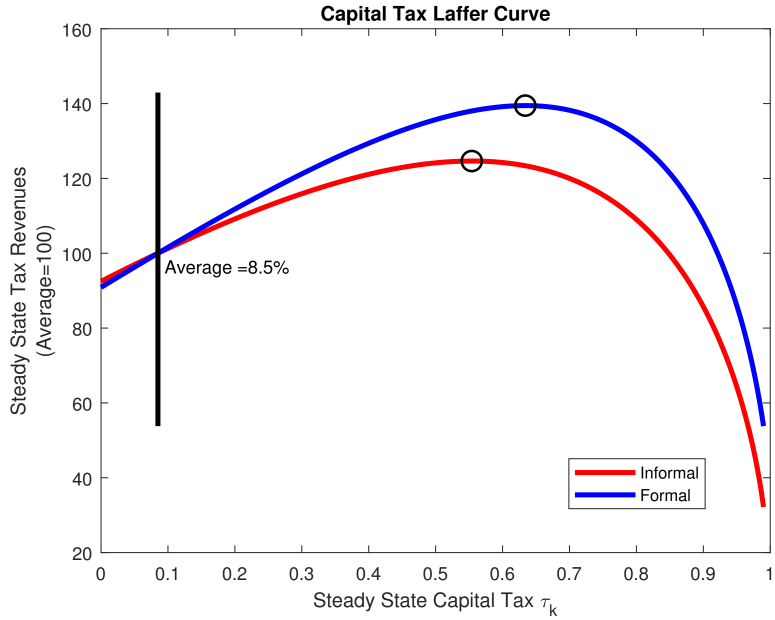


According to these results, if the informal sector is not considered, the Mexican government would be able to increase the tax revenues by 91.30% by raising the labor taxes to 64%. This estimation is consistent with Beltrán (2014), who found that tax rate that maximize the revenues is 60%. Nevertheless, if the model considers informality, increasing the labor taxes to maximum allowed by the Laffer curve's slope, 38%, would only increase the tax collection in approximately 21%.

4.1.2 Capital tax Laffer curves

The Laffer curves for capital income taxation in Mexico are shown in Figure 2. As in the previous experiment, capital taxes are varied between 0% and 100% and all other taxes parameters are held constant. In the same way, the steady state tax revenues that are represented on the vertical axis are normalized, so that the value of 100 corresponds to the average of the tariff (8.5%). In this case, two elements stand out with respect to the Laffer curves for taxes on labor: First, the concavity of the curves is much less pronounced, especially before the maximum point; second, the rate that maximizes the revenues seems to be less sensitive to changes in the specification of the model, so the differences of additional collection among these cases are less notorious.

Figure 2



From the comparison between the effective rate that would maximize the collection versus the average rate, it is concluded that there exist an ample space to promote adjustments in taxes on capital in order to increase the steady state tax revenues. Nevertheless, as can be observed, while the government has a large margin to effect adjustments in taxes on capital, the concavity of the curves implies that, in comparison with the labor, the additional tax revenue arising from this factor will be relatively low, 39%, if the model does not incorporate informality, and relatively high, 26%, if the model incorporates it.

4.1.3 Consumption tax Laffer curves

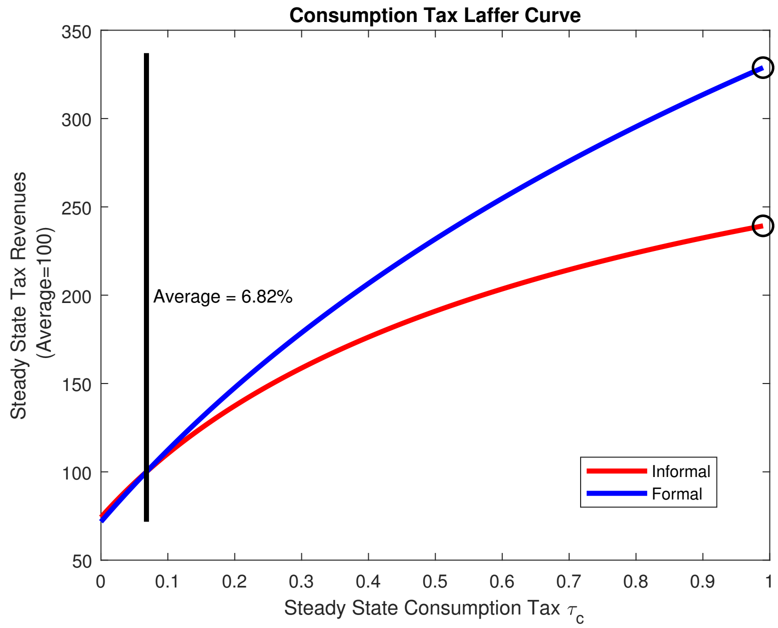
To conclude this section, consumption tax Laffer curves are estimated for Mexico. In the figure 3 can be observed that these curves have an atypical form compared with the others curves. Intuitively, this result from the fact that the positive effect of increasing the rate on tax revenues is greater than the negative marginal distortion on consumption and labor supply of the households. A detailed discussion of this issue can be found in Trabandt and Uhlig (2011).

As with previous curves, the steady state tax revenues are represented on the vertical axis and they are normalized. Consumption taxes are varied between 0% and 100% while all other taxes parameters are held constant. The results are provided for the baseline and informal model. As can be observed the government can increase significantly the revenues particularly if the model does not incorporate an informal sector.

4.2 Sensitivity analysis

So far the Laffer curves have been estimated with the parameters presented in the table 3. In this section a sensitivity analysis is done by considering changes in the following parameters: φ and η.

Figure 3



Frisch labor supply elasticity

In this subsection the formal-only model and the baseline informal market model will also be calibrated by considering a Frisch labor supply elasticity φ equal to 3. This is in line with Trabandt and Uhlig (2011), who consider the same values of φ by estimating Laffer curves for United States and 14 of the main economies of the OECD. In the figure 4 are represented the Laffer curves for labor income by comparing the balanced growth paths of these two neoclassical growth models. As the theory suggests, independently of the specified model, the rate that maximize the revenues decrease when more elastic Frisch elasticities are used. Intuitively, the more sensitive the labor supply is to changes in after-tax wages, the lower the margin the government will have to increase taxes without this being reflected in greater disincentives to work and falls in fiscal income.

In addition to the above, the figure 5 shows the capital Laffer curves for the two same neoclassical growth models. In this case, one element stand out with respect to the Laffer curve for taxes on labor: the rate that maximizes the revenues does not depend on the value of Frisch's elasticity, so the differences of additional collection among these cases are marginal.

Figure 4

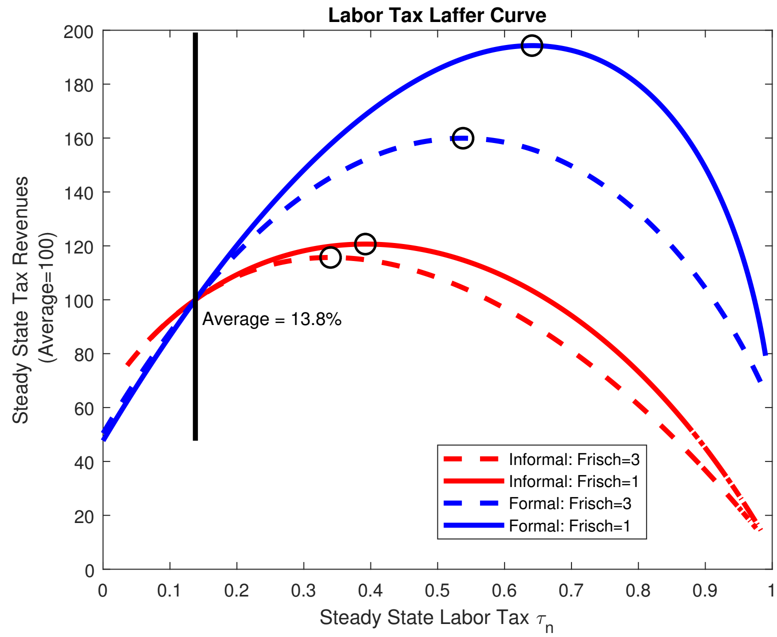
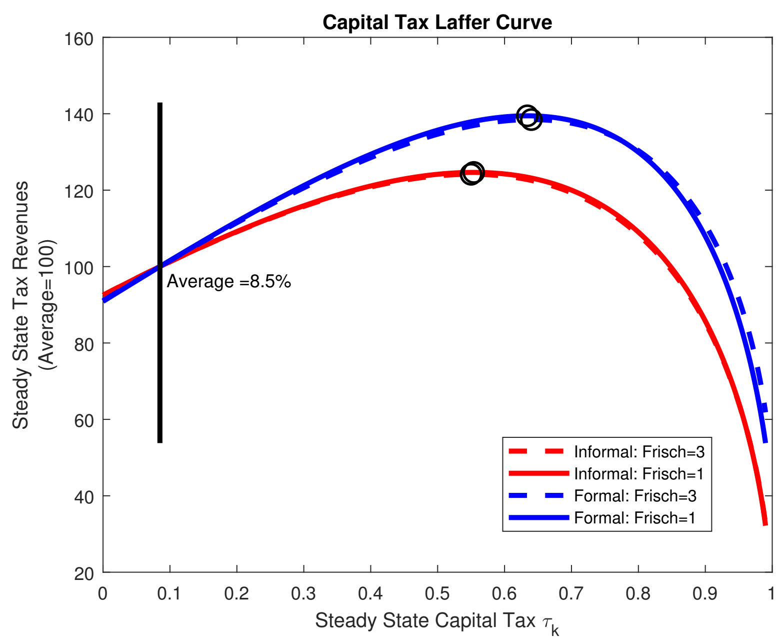


Figure 5



Inverse of IES

Figure 6 and figure 7 contain a sensitivity analysis for η considering the Laffer curves for labor and capital income respectively. This parameter was previously set equal to 2 and in this experiment a value of one is considered as well, i.e. when the preferences are characterized by a logarithmic functional way. As can be observed, when $\eta = 1$ and the model does not incorporates informality, the labor tax Laffer curve is shifted upwards and rightwards, whereas the capital tax Laffer curve remains practically unchanged. Nevertheless, if the informality is taking into account, the results change noticeable. In this case, both Laffer curves are more sensible to changes in η and even, the capital tax Laffer curve shifts up and to the right notably.

Figure 6

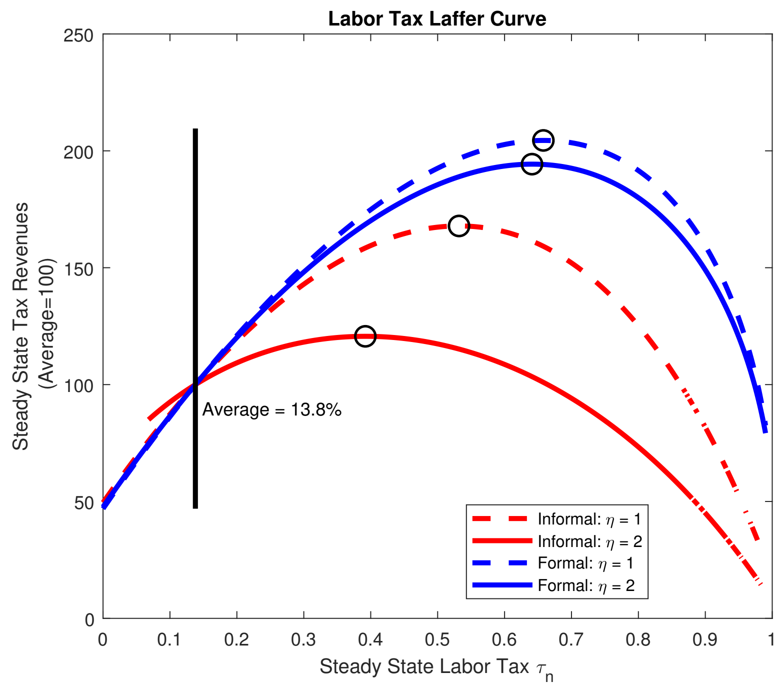
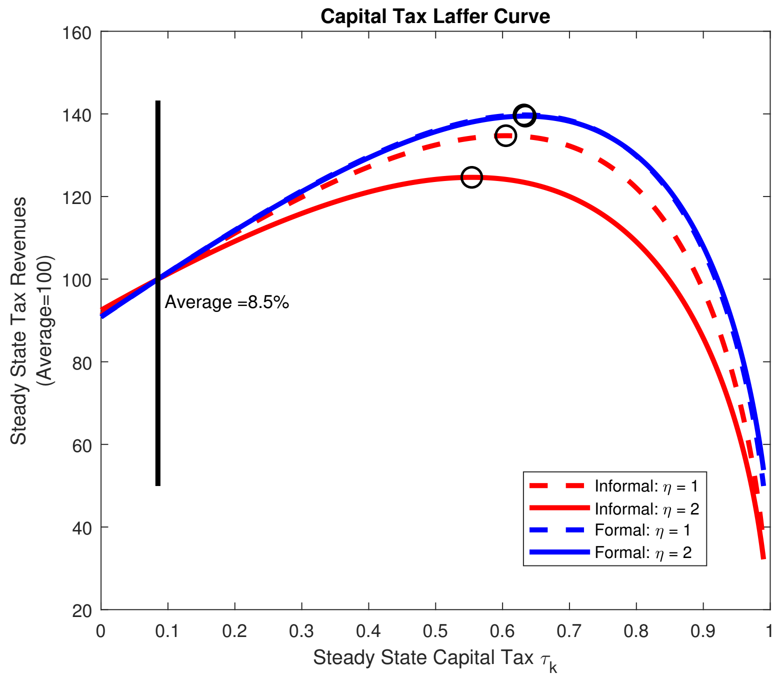


Figure 7



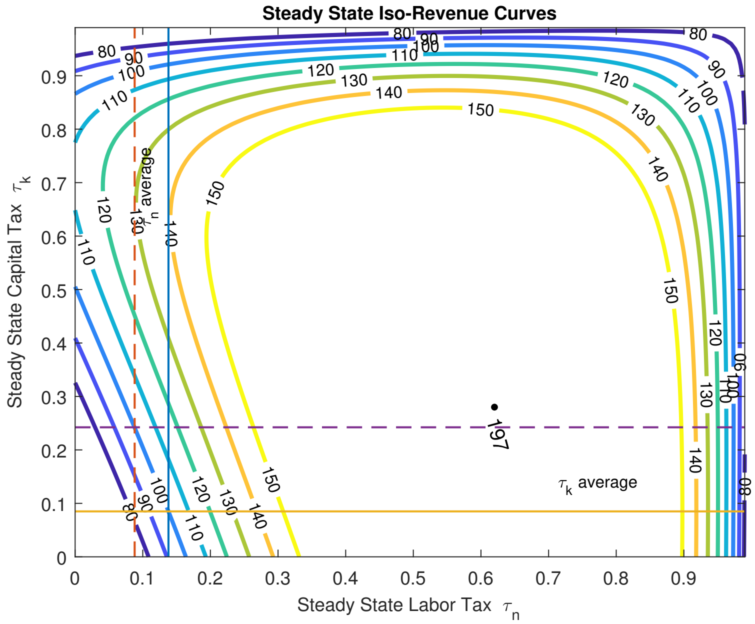
4.3 Combined budgetary effect of changing labor and capital income taxation

In this section is analyzed the combined budgetary effect of changing labor and capital income taxation. The resulting estimates of this exercise lead to what in the literature is known as iso-revenue curve or "Laffer hill". In the figure 8 are represented the contour lines of a "Laffer hill" to Mexico by considering the baseline model. These lines depict different levels of steady state total tax revenues when both capital taxes and labor taxes are varied between 0% and 100%, while consumption taxes and other parameters are held constant. Total tax revenues at the average tax rates are normalized to 100. Baseline model results are provided for CFE preferences with $\varphi = 1$ and η=2.

Similarly to Laffer curves, a country can be on the "wrong" or "right" side of the "Laffer hill". If the government can not increase tax revenues without necessarily decreasing one or both of the production factors taxes, then the economy will be on the "wrong" side. When balanced growth paths in the Mexican economy are compared, it turns out that revenue is maximized -tax revenues is equal to 197- when both labor taxes and capital taxes are increased. This means that Mexico currently is on "right" side of the "Laffer hill", i.e. the peak of the hill is in the higher right hand side corner of this figure.

An possible experiment could be to analyze the possible combinations of the effective tax rates on the factors of production that maintain the revenues unaltered. Observe that if the starting point is the crossing of the two continuous lines, $(\tau^n, \tau^k) = (13.8, 8.5)$, and for some reason the government wants to reduce taxes on work, for example, in five percentage points and, in addition, does not want to sacrifice tax revenues, i.e. keep them in 100, such reduction must necessarily be accompanied with an increase in taxes on capital of approximately 16 percentage points (dotted lines). This result is expected given the low concavity of the

Figure 8



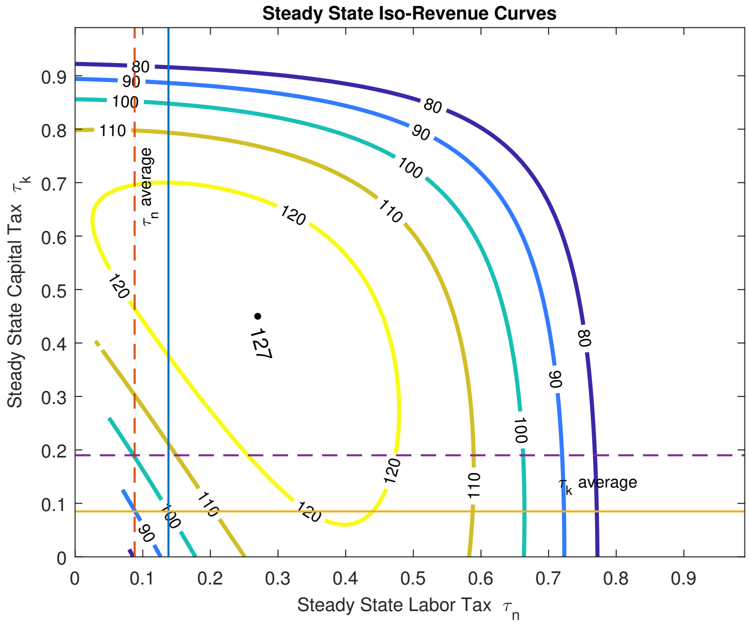
capital tax Laffer curve that implies that the additional tax revenue arising from capital is relatively low in comparison with the the additional tax revenue arising from labor.

However, if these contour lines are estimated by considering the model with informality, results change significantly. Figure 9 shows the “Laffer hill” to Mexico once informality is incorporated into the analysis. Although Mexico is still on "right" side of the “Laffer hill”, when the balanced growth paths are compared, the government can only improve tax collection in 27% by increasing both capital and labor taxes, 70 percentage points less than previous case. In addition, if the same experiment is carried out and the government wants to reduce taxes on work in five percentage points without sacrifice tax revenues, in this case, such reduction must be accompanied now with an increase in taxes on capital of approximately 10 percentage points. This result is in line with the low concavity of the labor tax Laffer. This implies that additional tax revenue losses arising from labor are relatively low and, therefore, the less tax capital increases are necessary in order to maintain tax revenues unchanged. These results help to understand a little bit more why taking into account informality into the analysis increases the degree of substitution between the labor tax and the capital tax.

5 Home production vs Informal Market economy

In this section Laffer curves for labor income, capital income and consumption in Mexico are estimated and presented once again by comparing the balanced growth paths of two neoclassical growth models: informal market model and home production model: The first one considers as informality the production of legal goods and services in total noncompliance with tax and labour regulations. The second one only considers as informality the production of home goods as a substitute of market goods. The last model, whose presentation and detailed solution is found in the annex three, is an extended version of the baseline model that

Figure 9



introduces home production as a substitute for market-produced goods, which permits to model informality in a slightly differently manner. The key difference among the informal market model and the home production model is that; in the second one, the informal output (home production) can only be consumed and, therefore, the physical capital in the informal sector only can increase by the investment done in the formal sector. Formally,

$$y_t^i = c_t^i \tag{45}$$

$$x_t = x_t^f = k_t^f - (1-\delta^f)k_{t-1}^f + k_t^i - (1-\delta^i)k_{t-1}^i \tag{46}$$

Taking the above into account, the balanced growth path value of the consumption-output ratio in the formal and informal sectors are given by:

$$\frac{\overline{c}^f}{\overline{y}^f} = \chi + \gamma \frac{1}{\overline{n}^f} \tag{47}$$

$$\frac{\overline{c}^i}{\overline{y}^i} = 1 \tag{48}$$

Where $\chi = 1 - (\psi - 1 + \delta_f)\frac{\overline{k}^f}{\overline{y}^f} - (\psi - 1 + \delta_i)\frac{\overline{k}^i}{\overline{y}^i}\frac{\overline{y}^i}{\overline{y}^f}$ and $\gamma = (\bar{m} - \bar{g})\left(\frac{\overline{k}^f}{\overline{y}^f}\right)^{\frac{-\theta_f}{1-\theta_f}}$. Noted that, in comparison with the informal market model, the parameter χ now depends on the rate of depreciation of the informal capital, the balanced growth path value of the capital-output ratio in the informal sector, and the ratio between informal and formal output in the steady state $\frac{\overline{y}^i}{\overline{y}^f}$. The rest of the balanced growth path equations remain the same.

5.1 Results

One new parameter $\frac{\overline{y}^i}{\overline{y}^f}$ is needed to calibrate the model. Considering the estimates done by OECD (2016), which were exposed in the table 2, $\frac{\overline{y}^i}{\overline{y}^f}$ is set equal to 30.2. Nevertheless, a previous explanation is needed. The estimates done by OECD (2016) are for the size of the informal economic activities, i.e. the production of legal goods and services in partial or total noncompliance with tax and labour regulations, as percentage of national GDP. Therefore, these estimates may not be a good proxy for $\frac{\overline{y}^i}{\overline{y}^f}$, which really reflects, in this case, only the weight of the home-produced goods as percentage of market-produced goods.

The figure 10, 11 and 12 show the Laffer curves for labor income, capital income and consumption respectively. The steady state tax revenues are represented on the vertical axis and they are normalized. The taxes also are varied between 0% and 100% and all other taxes, parameters and paths for government spending g, debt b and net imports m are held constant. As the theory suggests, the results show that the Laffer curves estimated from a model with home production also have the U-inverted form with a single maximum point, except for the consumption tax Laffer curve. In addition, the rate that maximizes the revenues is a little higher in comparison with the informal market model. Nevertheless, the differences among the informal market model and home production model are not really significant.

Table 7 summarizes part of the found results by considering the three models: formal-only model, baseline informal market model and home production model. As can be observed, this table reports the maximum additional tax revenues that can be obtained by increasing the tax rates to maximum allowed by the Laffer curves' slope. The results are reported for labor, capital and consumption.

Table 7

Model	Max. additional tax revenue labor	Max. additional tax revenue capital	Max. additional tax revenue consumption
Formal-only model	91.30%	39%	231%
Baseline informal market model	21%	26%	160%
Home production model	45%	36%	140%

Figure 10

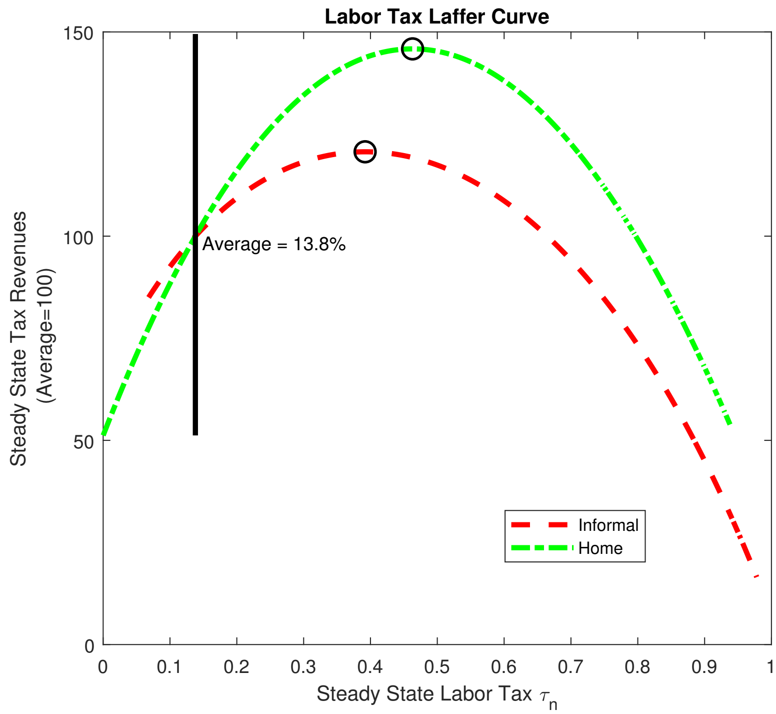


Figure 11

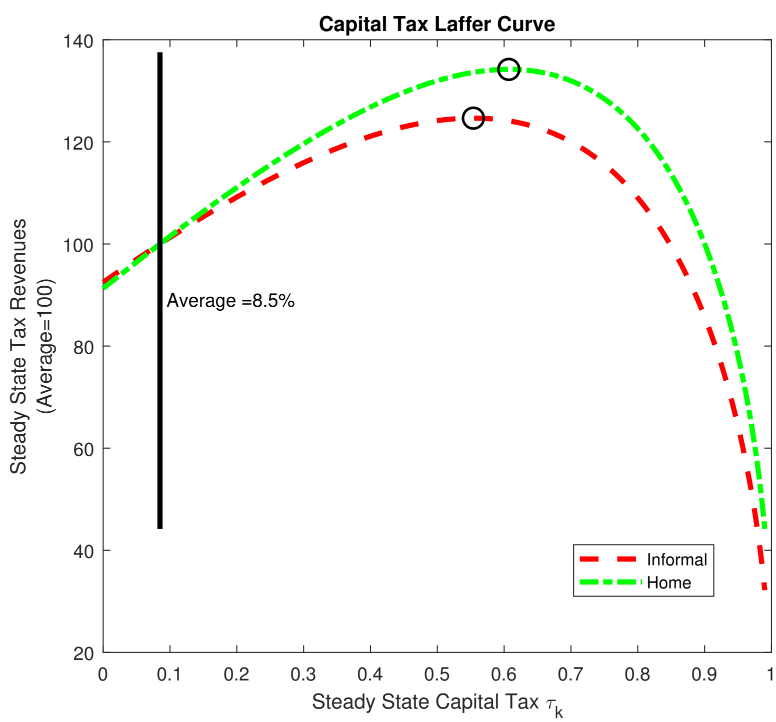
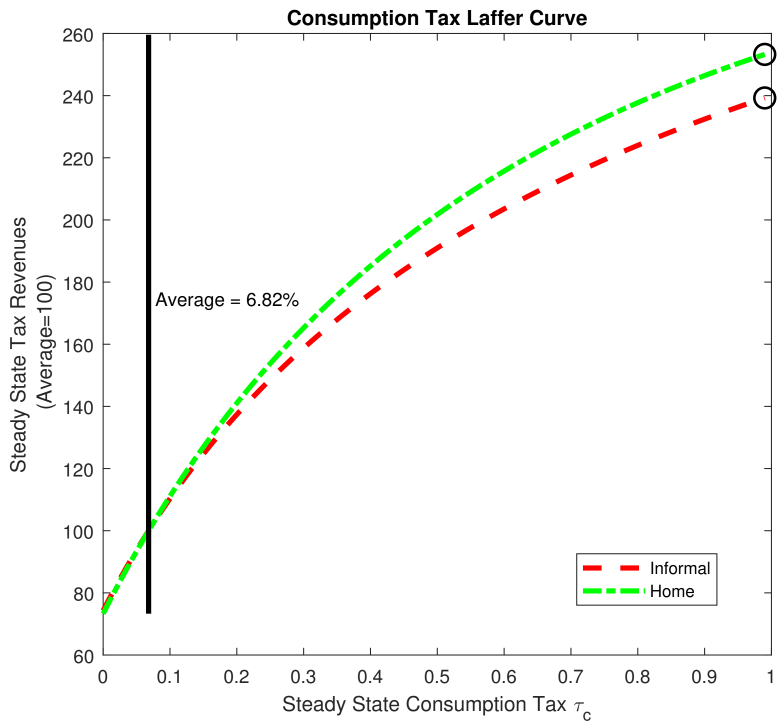


Figure 12



5.2 Sensitivity analysis

In this subsection a sensitivity analysis is done by considering changes in the following parameters: $\overline{n}^i/(n^i + n^f)$, θ_i, e, and a.

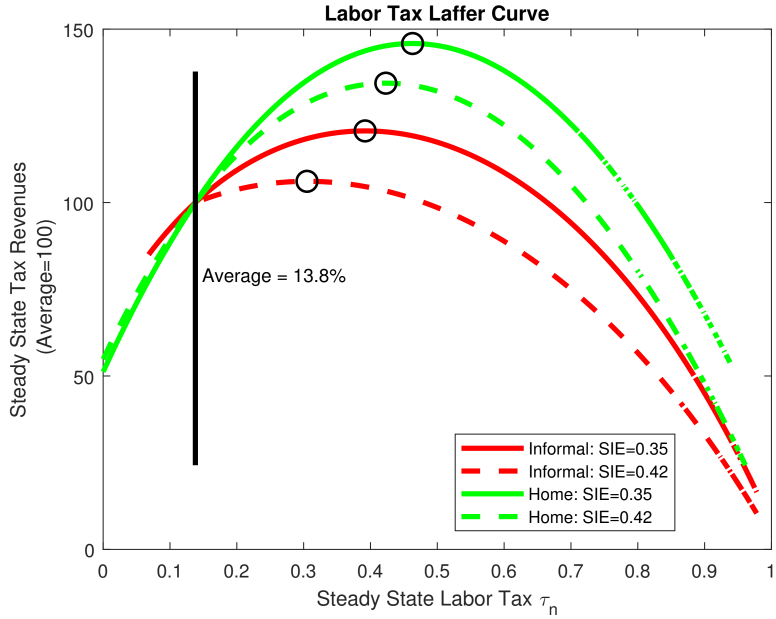
Share of balanced growth informal employment (SIE)

The share of balanced growth informal employment, $n^i/(n^i + n^f)$, which was set equal to 35.1%, is the average across three proxies of informality that Fernández and Meza (2014) found in their work. In this part of the analysis, it will be done a comparison by considering the higher value among these proxies of informality: 42%.

The figure 13 shows the Laffer curves for labor income by considering two types of models: informal model and home production economy. As can be observed, in both cases the peaks moves to the left and the Laffer curves as such shift down once the new value of the SIE is considered. This result is obvious considering that the new value of the SIE reduces part of the tax base. If the informal model is considered, even though the Mexican economy is not still into the prohibitive rank of the Laffer curve, the government would have a small fiscal space to increase its revenues. In the case of home production economy, increasing the labor taxes to maximum allowed by the Laffer curve's slope will increase the tax collection in approximately 50%.

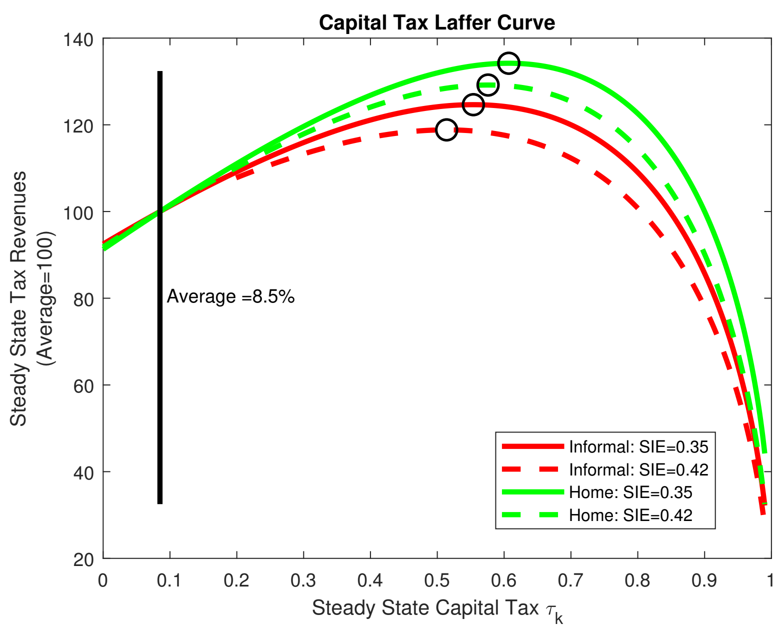
On the other hand, in the figure 14 are depicted the capital tax laffer curves taking into account the new value of the SIE. Again, similar to the previous case, the peaks move to the left and the Laffer curves

Figure 13



shift down once the new value of SIE is considered. In the informal model case, increasing the labor taxes to maximum allowed will increase the tax collection in 18.83%. In the other case, considering the home production economy model, increasing the labor taxes to maximum allowed by the Laffer curve's slope will increase the tax collection in approximately 29.17%.

Figure 14



Informal capital share in production

Figure 15 and 16 represent the Laffer curves for labor and capital income respectively. These curves are estimated by considering values of the informal capital share in production θ_i equal to 0.2 and 0.35. As can be observed, in both cases, home production and informal market economy, the Laffer curves shifts up and to the right. These results are consisten given that a higher value of θ_i increases the balanced growth path value of the capital-output ratio in the informal sectors and, therefore, reduces the consumption-output ratio and the labor supply in the same sector. According to that reasoning, the labor supply in the formal sector can increase and, as a consequence, also the tax base and the revenues of the government.

Figure 15

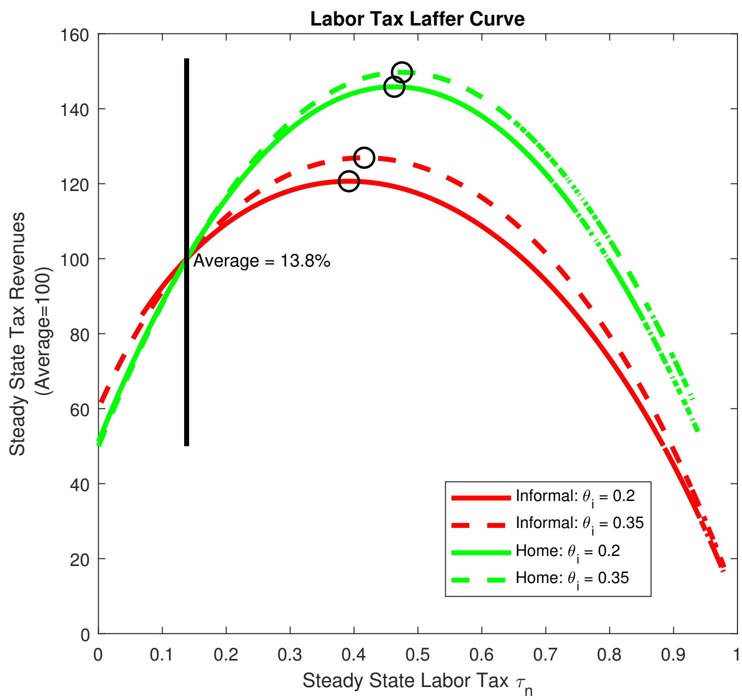
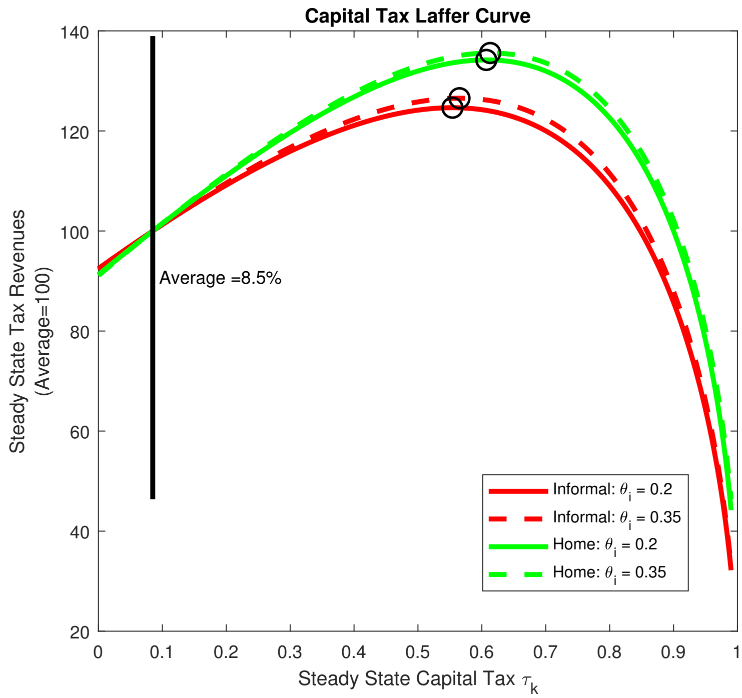


Figure 16



Elasticity of substitution between goods and share of formal goods in aggregate consumption

With regard to changes in the elasticity of substitution between goods $1/(1-e)$ and the share of formal goods in aggregate consumption a, the Laffer curves for labor income, capital income and consumption remain practically unchanged. In other words, the Laffer curves appear to be insensitive to changes in the parameters e and a. Therefore, we omitted the results in this thesis.

6 Informality and monopolistic competition

In this chapter, the baseline model presented in chapter 2 is extended to incorporate monopolistic competition, following Trabandt and Uhlig (2012). Considering this, first of all, the more relevant aspects of the model that incorporates monopolistic competition will be presented.[9] Subsequently, Laffer curves for taxes on labor income and capital will be estimated for Mexico by comparing the balanced growth paths of this extended model.

6.1 The model

As before, The model consists of two sectors, formal and informal, and is comprised by a representative household, a government and three types of firms: final firms, intermediate firms and monopolistically competitive firms. The representative final formal firm is assumed to be perfectly competitive and produces final goods renting capital and demanding an homogenous input, which in turn is also produced by competitive

[9] See appendix 4 for further details.

formal firms. The latter firms demands intermediate inputs, which are produced by monopolistically competitive formal firms. These intermediate inputs are produced hiring labor from the representative household. As before, informal sector is assumed to grow at the same rate, but at a lower level, than the formal sector.

6.1.1 The representative household

The representative households optimization problem is the same as chapter 2, except for the budget constraint, which changes slightly in the following way:

$$\begin{aligned}(1+\tau_t^c)c_t^f + p_t c_t^i + x_t^f + p_t x_t^i + b_t =& (1-\tau_t^n)w_t n_t^f + (1-\tau_t^k)(d_t - \delta_f)(k_{t-1}^f + \phi\Pi_t) \\ &+ \delta_f k_{t-1}^f + R_t^b b_{t-1} + s_t + (1-\phi)\Pi_t + m_t + p_t y_t^i\end{aligned} \tag{49}$$

In this case, it is assumed that the household has to pay capital income taxes τ_t^k on dividends and on a share ϕ of profits. Nevertheless, the optimality conditions given by (10)-(16) also hold with monopolistic competition.[10]

6.1.2 The representative final firm

The representative final firm operates in the formal sector and chooses capital and an homogenous input z_t to maximize profits. Formally,

$$\max_{k_{t-1}^f, z_t} y_t^f - d_t k_{t-1}^f - p_t^z z_t \tag{50}$$

Production technology is given by:

$$y_t^f = \zeta_f^t (k_{t-1}^f)^{\theta_f} (z_t)^{1-\theta_f} \tag{51}$$

where $0 < \theta_f < 1$ is the formal capital share in production, ζ_f^t denotes the trend of total factor productivity in the formal sector and p_t^z denotes the price of the homogenous input, z_t, which in turn is also produced by competitive firms.

The first order conditions of the firm are given by:

$$\frac{\partial \Pi_t}{\partial k_{t-1}^f} : \quad \theta_f \zeta_f^t (k_{t-1}^f)^{\theta_f - 1} (z_t)^{1-\theta_f} - d_t = 0 \tag{52}$$

$$\implies \quad d_t = \theta_f \frac{y_t^f}{k_{t-1}^f} \tag{53}$$

[10] See appendix 3 for further details.

$$\frac{\partial \Pi_t}{\partial z_t}: \quad (1-\theta_f)\zeta_f^t (k_{t-1}^f)^{\theta_f}(z_t)^{-\theta_f} - p_t^z = 0 \tag{54}$$

$$\implies \quad p_t^z = (1-\theta_f)\frac{y_t^f}{z_t} \tag{55}$$

6.1.3 The representative intermediate firm

The representative intermediate firm that operates in the formal sector chooses intermediate inputs $z_{t,i}$, which are produced by monopolistically competitive firms, to maximize profits. Formally,

$$\max_{z_{t,i}} p_t^z z_t - \int p_{t,i}^z z_{t,i} d_i \tag{56}$$

subject to $z_t = \left(\int z_{t,i}^{\frac{1}{\omega}} d_i\right)^{\omega}$ with the gross markup $\omega > 1$.

6.1.4 The monopolistically competitive firms

The monopolistically competitive firms operate in the formal sector and choose prices to maximize profits. Formally,

$$\max_{p_{t,i}^z} p_{t,i}^z z_{t,i} - w_t n_{t,i}^f \tag{57}$$

subject to their demand functions and production technologies:

$$z_{t,i} = \left(\frac{p_t^z}{p_{t,i}^z}\right)^{\frac{\omega}{\omega-1}} z_t \tag{58}$$

$$z_{t,i} = n_{t,i}^f \tag{59}$$

The first order condition of the firms are given by:

$$\frac{\partial \Pi_t}{\partial P_{t,i}^z}: \quad \left(1-\frac{\omega}{\omega-1}\right) P_{t,i}^{z\ \frac{-\omega}{\omega-1}} P_t^{z\ \frac{\omega}{\omega-1}} z_t + \left(\frac{\omega}{\omega-1}\right) w_t P_{t,i}^{z\ \frac{-\omega}{\omega-1}-1} P_t^{z\ \frac{\omega}{\omega-1}} z_t = 0 \tag{60}$$

$$\implies \quad p_{t,i}^z = p_t^z = \omega w_t \tag{61}$$

In equilibrium, all firms set the same price. This price is a markup ω over marginal costs w_t, i.e. $p_{t,i}^z = p_t^z =$

ωw_t. Considering this, aggregate equilibrium profits are given by $\Pi_t = (\omega - 1) w_t n_t^f$.

6.1.5 Balanced growth path equilibrium and Laffer curve characterization

The equation that defines the level of formal labor on the balanced growth path is given by:

$$\frac{1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}}}{\eta\kappa\overline{n}^{\frac{1}{\varphi}}\overline{n}^f} = \frac{\omega(1+\tau^c)}{(1-\tau^n)} \frac{\left(1+\frac{1}{\varphi}\right)}{(1-\theta_f)} \frac{\overline{c}^f}{\overline{y}^f} \left(\frac{a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e}{a\overline{c}^{f\,e}}\right) \tag{62}$$

Note that in the absence of monopolistic competition, $\omega = 1$, equation (14) collapses to equation ()

As before, the level of informal labor in the steady state is given by:

$$\frac{1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}}}{\eta\kappa\overline{n}^{\frac{1}{\varphi}}\overline{n}^i} = \frac{\left(1+\frac{1}{\varphi}\right)}{(1-\theta_i)} \frac{\overline{c}^i}{\overline{y}^i} \left(\frac{a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e}{(1-a)\overline{c}^{i\,e}}\right) \tag{63}$$

The balanced growth path value of the consumption-output ratio in the formal and informal sectors also remain the same and are given by:

$$\frac{\overline{c}^f}{\overline{y}^f} = \chi + \gamma \frac{1}{\overline{n}^f} \tag{64}$$

$$\frac{\overline{c}^i}{\overline{y}^i} = 1 - (\psi - 1 + \delta_i)\frac{\overline{k}^i}{\overline{y}^i} \tag{65}$$

where $\chi = 1 - (\psi - 1 + \delta_f)\frac{\overline{k}^f}{\overline{y}^f}$ and $\gamma = (\bar{m} - \bar{g})\left(\frac{\overline{k}^f}{\overline{y}^f}\right)^{\frac{-\theta_f}{1-\theta_f}}$. As before, $\frac{\overline{k}^f}{\overline{y}^f}$ and $\frac{\overline{k}^i}{\overline{y}^i}$, that respectively denote the balanced growth path value of the capital-output ratio in the formal and informal sectors, are given by the following expressions:

$$\frac{\overline{k}^f}{\overline{y}^f} = \left(\frac{\overline{R}-1}{\theta_f(1-\tau^k)} + \frac{\delta_f}{\theta_f}\right)^{-1} \tag{66}$$

$$\frac{\overline{k}^i}{\overline{y}^i} = \left(\frac{\overline{R}-1}{\theta_i} + \frac{\delta_i}{\theta_i}\right)^{-1} \tag{67}$$

Considering the previous two expressions and substituting equations (16) and (17) into (14) and (15) therefore yields a two-dimensional nonlinear system for $\bar{n}^f$ and $\bar{n}^i$, which can be solved given values for the parameters of the model, the tax rates and the levels of $\bar{b}$, $\bar{g}$ and $\bar{m}$.

Labor productivity in the formal sector remains the same and is given by:

$$\frac{\overline{y}^f}{\overline{n}^f} = \left(\frac{\overline{k}^f}{\overline{y}^f}\right)^{\frac{\theta_f}{1-\theta_f}} \tag{68}$$

After some algebra, total tax revenues in the steady state can be computed as:

$$\overline{T} = \left(\tau^c \frac{\overline{c}^f}{\overline{y}^f} + \tau^n \frac{(1-\theta_f)}{\omega} + \tau^k \left(\theta_f - \delta_f \frac{\overline{k}^f}{\overline{y}^f} + \frac{\phi(\omega-1)(1-\theta_f)}{\omega} \left(\theta_f \left(\frac{\overline{k}^f}{\overline{y}^f}\right)^{-1} - \delta_f\right)\right)\right) \overline{y}^f \tag{69}$$

Note that in the absence of monopolistic competition, equation (21) collapses to:

$$\overline{T} = \left(\tau^c \frac{\overline{c}^f}{\overline{y}^f} + \tau^n (1-\theta_f) + \tau^k \left(\theta_f - \delta_f \frac{\overline{k}^f}{\overline{y}^f}\right)\right) \overline{y}^f \tag{70}$$

As before, equilibrium transfers are given by:

$$\overline{s} = \overline{b}(\psi - R^b) + \overline{T} - \overline{g} \tag{71}$$

Let x denote one of τ^k, τ^n or τ^c, and considering that the balanced growth path of y_t^f can be expressed as:

$$\overline{y}^f = \left(\frac{\overline{k}^f}{\overline{y}^f}(x)\right)^{\frac{\theta_f}{1-\theta_f}} \overline{n}^f \tag{72}$$

then, equation (22) can be rewritten to obtain the following Laffer curve $L(x)$:

$$L(x) = \left(\tau^c \frac{\overline{c}^f}{\overline{y}^f}(x) + \tau^n \frac{(1-\theta_f)}{\omega} + \tau^k \left(\theta_f - \delta_f \frac{\overline{k}^f}{\overline{y}^f}(x) + \frac{\phi(\omega-1)(1-\theta_f)}{\omega} \left(\theta_f \left(\frac{\overline{k}^f}{\overline{y}^f}(x)\right)^{-1} - \delta_f\right)\right)\right) \left(\frac{\overline{k}^f}{\overline{y}^f}(x)\right)^{\frac{\theta_f}{1-\theta_f}} \overline{n}^f(x) \tag{73}$$

In the absence of monopolistic competition, equation (25) collapses to:

$$L(x) = \left(\tau^c \frac{\overline{c}^f}{\overline{y}^f}(x) + \tau^n (1-\theta_f) + \tau^k \left(\theta_f - \delta_f \frac{\overline{k}^f}{\overline{y}^f}(x)\right)\right) \left(\frac{\overline{k}^f}{\overline{y}^f}(x)\right)^{\frac{\theta_f}{1-\theta_f}} \overline{n}^f(x) \tag{74}$$

where $\frac{\overline{k}^f}{\overline{y}^f}(x)$ varies only for $x = \tau^k$ and $\frac{\overline{c}^f}{\overline{y}^f}(x)$ and $\overline{n}^f(x)$ change for $x = \tau^k, \tau^n$ or τ^c.

6.2 Results

Two new parameters are needed to calibrate the model: the first is the gross markup, ω, due to monopolistic competition. This parameter is set equal to 1.1, which appears to be a reasonable value, given in the literature. The second parameter is the share of monopolistic competition profits, ϕ, which are subject to capital taxes. Following Trabandt and Uhlig (2012), this parameter is set equal to the formal capital share, i.e. to 0.38.

Figures 17 and 18 show the labor and capital Laffer curves, respectively. These curves are estimated for Mexico by comparing the balanced growth paths of four models: formal-only model of Trabandt and Uhlig (2011), formal-only model with monopolistic competition of Trabandt and Uhlig (2012), informal model and informal model with monopolistic competition. Blue lines represent formal-only model's Laffer curves and red lines represent informal model's Laffer curves. Independently of the model considered and in line with Trabandt and Uhlig (2012), Mexico is now somewhat closer to the peak of the labor tax Laffer curve and somewhat farther away from the peak of the capital tax Laffer curve.

Figure 17

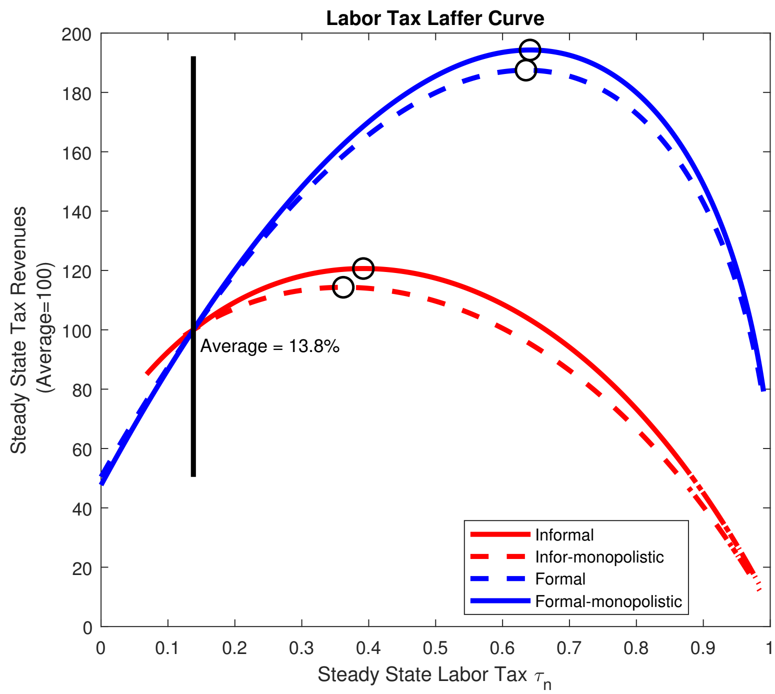
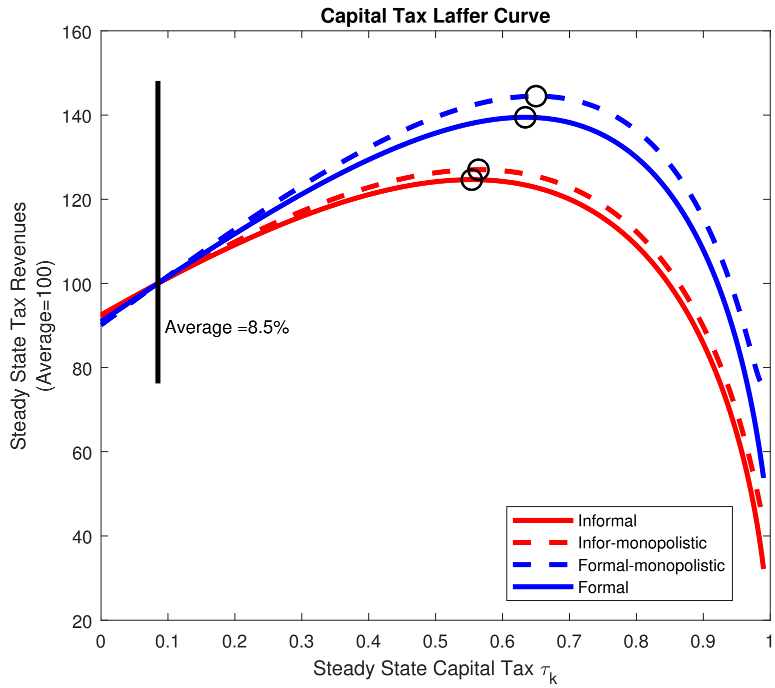


Figure 18



Considering the above, on the one hand, in the case of labor Laffer curves, the government would have a narrower fiscal space to carry out tax adjustments without reducing tax revenues. By considering the formal-only model with monopolistic competition, government can increase tax revenues by 87% by raising labor taxes to 64% (almost nine percentage points less in comparison with the baseline model without monopolistic competition). In the case of the informal model with monopolistic competition, increasing the labor taxes to maximum allowed by the Laffer curve's slope, 36%, will only increase the tax collection in approximately 14% (almost seven percentage points less in comparison with the same model without monopolistic competition, which the maximum tax allowed is 38%).

On the other hand, in the case of capital Laffer curves, the results predict that the economy would have a little wider fiscal space. The curve estimated by considering the formal-only model with monopolistic competition suggests that government can increase tax revenues by 44% by raising capital taxes to 65%. This represents a difference of almost five percentage points more in comparison with the formal-only model without monopolistic competition, which the maximum tax allowed is 64%. Similarly, when informality and monopolistic competition are incorporated into the model, the results suggest that increasing the labor taxes to maximum allowed by the Laffer curve's slope, 57%, will increase the tax collection in 28.76%, almost three percentage points more in comparison with the case that does not incorporated monopolistic competition.

6.3 Sensitivity analysis

In this subsection a sensitivity analysis is done by considering changes in the gross markup ω and the share of monopolistic-competition prots subject to capital taxation ϕ. Figure 19 and figure 20 contain a sensitivity analysis for ω considering the Laffer curves for labor and capital income respectively. This parameter was previously set to 1.1 and in this experiment a value of one is considered as well, i.e. when there is not market power by intermediate goods producers. As can be observed, when $\omega = 1$ the model overstates labor tax revenues and understates capital tax revenues. In other words, when the model incorporates monopolistic competition through intermediate inputs, a gross markup $\omega > 1$ reduces the labor tax base and increases the capital tax base. On the other hand, figure 21 contains a sensitivity analysis for ϕ considering only the Laffer curves for capital income. As can be noted, when the profits are fully subject to capital taxation, i.e $\phi = 1$, the capital Laffer curve is slightly shifted upwards, which is consistent with the increase of the capital tax base as a result of the inclusion of $\phi\Pi_t$. In addition, in line with Trabandt and Uhlig (2012), the impact of ϕ on hours worked is practically null and, therefore, the effect of this parameter on Laffer curves for labor income is insignificant. Considering this, the labor tax Laffer curve is omitted of the analysis.

Figure 19

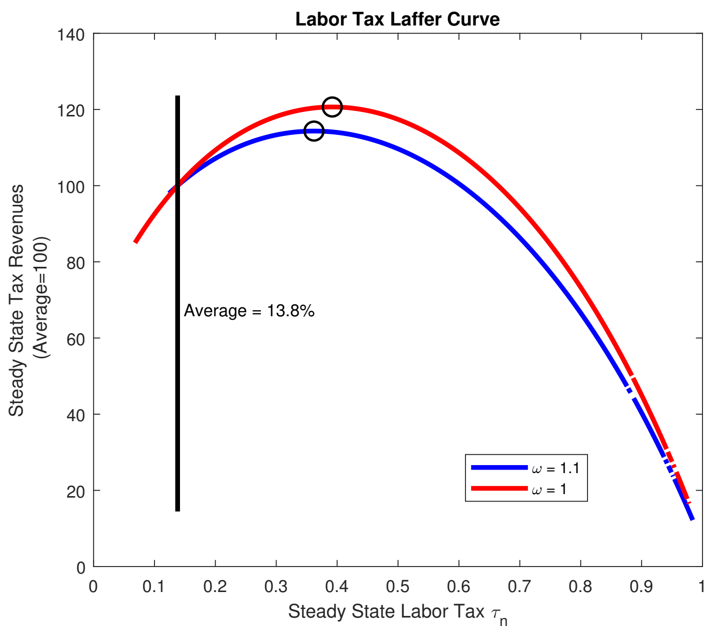


Figure 20

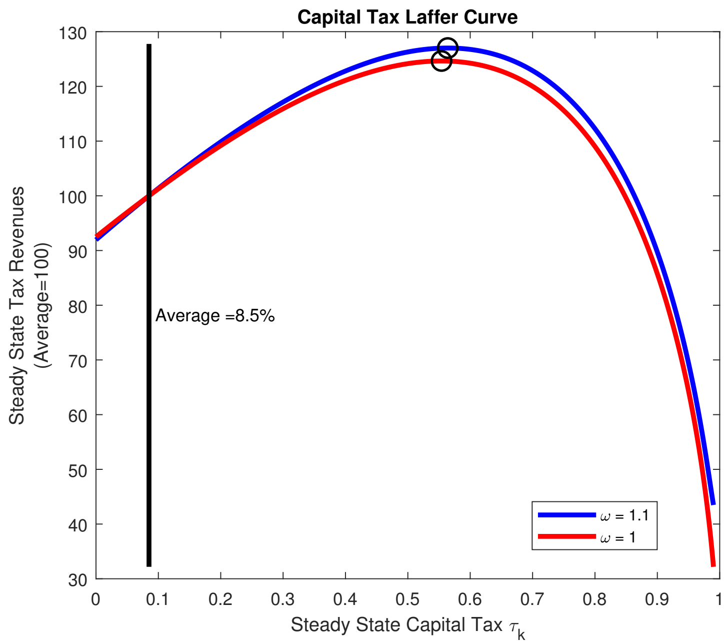
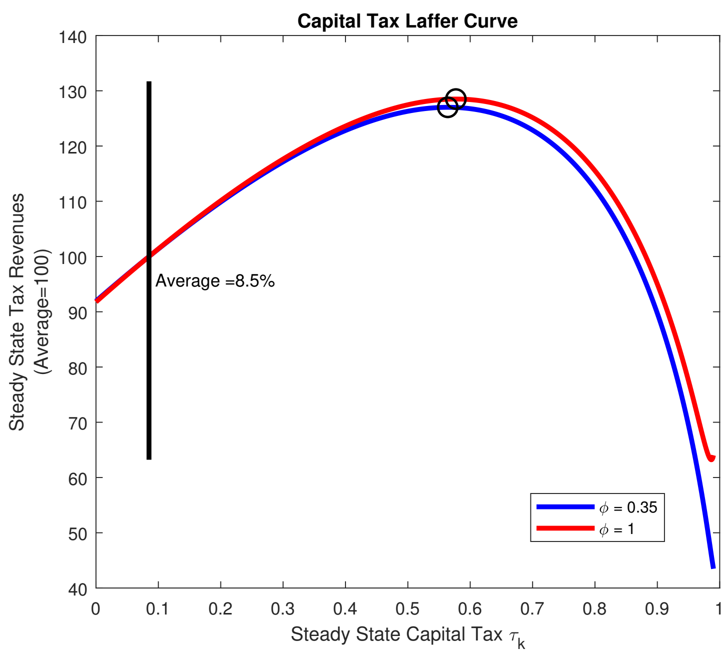


Figure 21



7 Conclusion

In this thesis the formal-only model of Trabandt and Uhlig (2011) has been extended to incorporate informality, an important feature of many developing countries. Given this, Laffer curves for taxes on labor income, capital gains, and consumption have been estimated for Mexico. The analysis done by considering the formal-only model of Trabandt and Uhlig (2011) suggests that the Mexican government has an important margin of space to adjust taxes rates on income and expenditure. However, the low concavity of the capital tax Laffer curve implies that the additional tax revenue arising from this factor will be relatively low in comparison with the labor. For benchmark parameters, it is shown that government can increase tax revenues by 91.30% by raising labor taxes and by 39% by raising capital income taxes. In respect of the Laffer curve for consumption taxes, results suggest that this curve does not have a peak and is increasing in the consumption tax throughout. Nevertheless, these results change significantly if the analysis incorporates informality. In this case, government can only increase tax revenues by 21% by raising labor taxes and by 26% by raising capital income taxes. The evidence also shows that the Laffer curve for consumption taxes shifts down and becomes flatter. In addition, the analysis done by analysing the combined budgetary effect of changing labor and capital income suggest that although Mexico is still on the "right" side of the “Laffer hill”, government can only improve tax collection in 27% by increasing both capital and labor taxes, 70 percentage points less than what the only-formal model suggest.

The robustness of these results has been tested using a sensitivity analysis for particular important parameters. The sensitivity analysis on the Frisch labor supply elasticity shows that if this parameter is higher, the tax-related fiscal space on the labor will reduce. In addition, the degree of sensitivity of the labor tax Laffer curve with respect to the Frisch labor supply elasticity is higher if the model incorporates informality. In the case of the capital tax Laffer curve, regardless of the used model, the rate that maximizes the revenues does not depend on the value of Frisch's elasticity. With regard to the intertemporal elasticity of substitution, the results show that if this parameter is higher, regardless of the used model, the labor tax Laffer curve shifts up and to the right. In addition, the capital tax Laffer curve remains practically unchanged if the model does not incorporates informality, but, it shifts up and to the right notably if the model considers informality.

The robustness of these findings has also been tested by changing the structure/assumptions of the model. Informality was also treated as home production. Nevertheless, the results found are not significantly different in comparison with the informal market model. A sensitivity analysis for the informal market model and the home production model was also done by considering changes in the share of balanced growth informal employment, the informal capital share in production, the elasticity of substitution between goods and the share of formal goods in aggregate consumption. The obtained results show that: first, an increase in the share of balanced growth informal employment generates that the peaks of the curves moves to the left and the Laffer curves as such shift down. Second, if the informal capital share in production increases, the Laffer curves shifts up and to the right. Third, With regard to changes in the elasticity of substitution between goods and the share of formal goods in aggregate consumption, the Laffer curves remain practically unchanged.

Regardless of the analyzed model, the results obtained once the perfect competition assumption is abandoned show that the Mexican economy gets closer to the peak of the labor tax Laffer curve and gets away from the peak of the capital tax Laffer curve. For benchmark parameters and without informality, the evidence suggests that government can increase tax revenues by 87% by raising labor taxes and by 44% by raising capital income taxes. In the case with informality, government can increase tax revenues by 14% by raising labor taxes and by 28.76% by raising capital income taxes.

Considering the results of this thesis, the implications for the design of economy policy can change significantly. The estimated Laffer curves for labor income and capital income suggest that incorporates informality into the analysis increases the degree of substitution between the labor tax and the capital tax. In other words, the additional tax revenue arising from labor and capital are relatively more equal if the model incorporates informality. Therefore, the results of this thesis support, from other perspective, the idea widely accepted that it is necessary to increase the fiscal collection coming from the capital income. Finally, the results found in this paper should be taken with caution. Effective rates that maximize tax revenues do not necessarily coincide with the optimal rates that maximize the welfare. If government consumption is not valued by households, welfare losses increase with the level of taxation: the higher the level of distortionary taxes in the model, the higher are the efficiency losses associated with taxation.

Appendix 1: The informal market model

The household chooses allocations of c_t^f, c_t^i, k_t^f, k_t^i, n_t^f, n_t^i and b_t to maximize its utility. The lagrangian for this problem is given by:

$$\begin{aligned}&\mathscr{L} = E_0 \sum_{t=0}^{\infty} \beta^t [(U(c_t, n_t) + V(g_t)) + \\ &\lambda_t((1-\tau_t^n) w_t n_t^f + (1-\tau_t^k)(d_t - \delta_f) k_{t-1}^f + \delta_f k_{t-1}^f + R_t^b b_{t-1} + s_t + \Pi_t + m_t + p_t \zeta_i^t (k_{t-1}^i)^{\theta_i} (n_t^i)^{1-\theta_i} - \\ &(1+\tau_t^c) c_t^f - p_t c_t^i - k_t^f + (1-\delta_f) k_{t-1}^f - p_t k_t^i + (1-\delta^i) p_t k_{t-1}^i - b_t)]\end{aligned} \tag{75}$$

The first order conditions are the following:

$$\frac{\partial \mathscr{L}}{\partial c_t^f}: \quad U'_{c^f}(c_t, n_t) - \lambda_t (1+\tau_t^c) = 0 \tag{76}$$

$$\frac{\partial \mathscr{L}}{\partial c_t^i}: \quad U'_{c^i}(c_t, n_t) - p_t \lambda_t = 0 \tag{77}$$

$$\frac{\partial \mathscr{L}}{\partial n_t^f}: \quad U'_{n^f}(c_t, n_t) + \lambda_t (1-\tau_t^n) w_t = 0 \tag{78}$$

$$\frac{\partial \mathscr{L}}{\partial n_t^i}: \quad U'_{n^i}(c_t, n_t) + \lambda_t (1-\theta_i) p_t \zeta_i^t (k_{t-1}^i)^{\theta_i} (n_t^i)^{-\theta_i} = 0 \tag{79}$$

$$\Longrightarrow \quad U'_{n^i}(c_t, n_t) + \lambda_t (1-\theta_i) p_t \frac{y_t^i}{n_t^i} = 0 \tag{80}$$

$$\frac{\partial \mathscr{L}}{\partial k_t^f}: \quad E_t \lambda_{t+1}((1-\tau_{t+1}^k)(d_{t+1} - \delta_f) + \delta_f + (1-\delta_f)) - \lambda_t = 0 \tag{81}$$

$$\Longrightarrow \quad E_t \lambda_{t+1}((1-\tau_{t+1}^k)(d_{t+1} - \delta_f) + 1) = \lambda_t \tag{82}$$

$$\frac{\partial \mathscr{L}}{\partial k_t^i}: \quad E_t \lambda_{t+1}(\theta_i p_{t+1} \zeta_I^{t+1} (k_t^i)^{\theta_i - 1} (n_{t+1}^i)^{1-\theta_i} + p_{t+1}(1-\delta_i)) - p_t \lambda_t = 0 \tag{83}$$

$$\Longrightarrow \quad E_t \lambda_{t+1}(\theta_i \frac{y_{t+1}^i}{k_t^i} + (1-\delta_i)) = \frac{p_t}{E_t p_{t+1}} \lambda_t \tag{84}$$

$$\frac{\partial \mathscr{L}}{\partial b_t}: \quad E_t \lambda_{t+1} R^b_{t+1} - \lambda_t = 0 \tag{85}$$

$$\Longrightarrow \quad E_t \lambda_{t+1} R^b_{t+1} = \lambda_t \tag{86}$$

Given that,

$$U^{'}_{c^f}(c_t, n_t) = a(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}-1}(c^f_t)^{e-1}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} \tag{87}$$

$$U^{'}_{c^i}(c_t, n_t) = (1-a)(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}-1}(c^i_t)^{e-1}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} \tag{88}$$

and

$$U^{'}_{n^f}(c_t, n_t) = -\eta(1+\frac{1}{\varphi})(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} \tag{89}$$

$$U^{'}_{n^i}(c_t, n_t) = -\eta(1+\frac{1}{\varphi})(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} \tag{90}$$

Equations (76)-(79) can be rewritten as

$$a(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}-1}(c^f_t)^{e-1}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} = \lambda_t(1+\tau^c_t) \tag{91}$$

$$(1-a)(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}-1}(c^i_t)^{e-1}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} = p_t\lambda_t \tag{92}$$

$$\eta(1+\frac{1}{\varphi})(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} = \lambda_t(1-\tau^n_t)w_t \tag{93}$$

$$\eta(1+\frac{1}{\varphi})(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} = \lambda_t(1-\theta_i)p_t\frac{y^i_t}{n^i_t} \tag{94}$$

On the other hand, it follows from equations (82), (84) and (86):

$$R_{t+1}^{b} = (1-\tau_{t+1}^{k})(d_{t+1}-\delta_f)+1 \tag{95}$$

$$R_{t+1}^{b} = \theta_i \frac{y_{t+1}^{i}}{k_t^{i}} + (1-\delta_i) \tag{96}$$

In addition, with some of algebra, $y_t^f = \zeta_f^t (k_{t-1}^f)^{\theta_f}(n_t^f)^{1-\theta_f}$ can be rewritten as:

$$\frac{y_t^f}{n_t^f} = \left(\zeta_f^t \left(\frac{k_t^f}{y_t^f}\right)^{\theta_f}\right)^{\frac{1}{1-\theta_f}} \tag{97}$$

Considering the above, the first order conditions of the firms, the budget constraints of government and the market clearing conditions, the system of equations used to solve the model is summarized as follows:

$$a(a(c_t^f)^e + (1-a)(c_t^i)^e)^{\frac{1-\eta}{e}-1}(c_t^f)^{e-1}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} = \lambda_t(1+\tau_t^c) \tag{98}$$

$$(1-a)(a(c_t^f)^e + (1-a)(c_t^i)^e)^{\frac{1-\eta}{e}-1}(c_t^i)^{e-1}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} = p_t\lambda_t \tag{99}$$

$$\eta(1+\frac{1}{\varphi})(a(c_t^f)^e + (1-a)(c_t^i)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} = \lambda_t(1-\tau_t^n)w_t \tag{100}$$

$$\eta(1+\frac{1}{\varphi})(a(c_t^f)^e + (1-a)(c_t^i)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} = \lambda_t(1-\theta_i)p_t\frac{y_t^i}{n_t^i} \tag{101}$$

$$R_{t+1}^{b} = (1-\tau_{t+1}^{k})(d_{t+1}-\delta_f)+1 \tag{102}$$

$$R_{t+1}^{b} = \theta_i \frac{y_{t+1}^{i}}{k_t^{i}} + (1-\delta_i) \tag{103}$$

$$d_t = \theta_f \frac{y_t^f}{k_{t-1}^f} \tag{104}$$

$$w_t = (1-\theta_f)\frac{y_t^f}{n_t^f} \tag{105}$$

$$\frac{y_t^f}{n_t^f} = \left(\zeta_f^t \left(\frac{k_t^f}{y_t^f}\right)^{\theta_f}\right)^{\frac{1}{1-\theta_f}} \tag{106}$$

$$g_t + s_t + R_t^b b_{t-1} = b_t + T_t \tag{107}$$

$$T_t = \tau_t^c c_t + \tau_t^n w_t n_t^f + \tau_t^k (d_t - \delta_f) k_{t-1}^f \tag{108}$$

$$y_t^f = c_t^f + x_t^f + g_t - m_t \tag{109}$$

$$y_t^i = c_t^i + x_t^i \tag{110}$$

Considering that all other variables grow at a constant rate $\psi = \zeta_f^{\frac{1}{1-\theta_f}}$, except for hours worked, interest rates, prices and taxes, then the previous system can be detrending by dividing all the rest of variables by $\zeta_f^{\frac{t}{1-\theta_f}}$. The obtained results are the following:

$$a(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}-1}(\overline{c}^f)^{e-1}(1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta} = \overline{\lambda}(1+\tau^c) \tag{111}$$

$$(1-a)(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}-1}(\overline{c}^i)^{e-1}(1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta} = \overline{p}\overline{\lambda} \tag{112}$$

$$\eta(1+\frac{1}{\varphi})(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta-1}\kappa\overline{n}^{\frac{1}{\varphi}} = \overline{\lambda}(1-\tau^n)\overline{w} \tag{113}$$

$$\eta(1+\frac{1}{\varphi})(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta-1}\kappa\overline{n}^{\frac{1}{\varphi}} = \overline{\lambda}(1-\theta_i)\overline{p}\frac{\overline{y}^i}{\overline{n}^i} \tag{114}$$

$$\overline{R} = (1-\tau^k)(\overline{d}-\delta_f)+1 \tag{115}$$

$$\overline{R} = \theta_i\frac{\overline{y}^i}{\overline{k}^i} + (1-\delta_i) \tag{116}$$

$$\overline{d} = \theta_f\frac{\overline{y}^f}{\overline{k}^f} \tag{117}$$

$$\overline{w} = (1-\theta_f)\frac{\overline{y}^f}{\overline{n}^f} \tag{118}$$

$$\frac{\overline{y}^f}{\overline{n}^f} = \left(\frac{\overline{k}^f}{\overline{y}^f}\right)^{\frac{\theta_f}{1-\theta_f}} \tag{119}$$

$$\overline{s} = \overline{b}(\psi - \overline{R}) + \overline{T} - \overline{g} \tag{120}$$

$$\overline{T} = \tau_t^c\overline{c}^f + \tau_t^n\overline{w}\overline{n}^f + \tau_t^k(\overline{d}-\delta_f)\overline{k}^f \tag{121}$$

$$\overline{y}^f = \overline{c}^f + \overline{x}^f + \overline{g} - \overline{m} \tag{122}$$

$$\overline{y}^i = \overline{c}^i + \overline{x}^i \tag{123}$$

where $\overline{\lambda} = \frac{\lambda_t}{\psi^{-\eta t}}$

Based on (111) and (113), it is possible to obtain a equation to find the level of formal labor in the steady state. This equation is given by:

$$\frac{a(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}-1}(\overline{c}^f)^{e-1}(1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta}}{\eta(1+\frac{1}{\varphi})(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta-1}\kappa\overline{n}^{\frac{1}{\varphi}}} = \frac{\overline{\lambda}(1+\tau^c)}{\overline{\lambda}(1-\tau^n)\overline{w}} \tag{124}$$

After some of algebra and using (118), then (124) can be rewritten as:

$$\frac{1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}}}{\eta\kappa\overline{n}^{\frac{1}{\varphi}}\overline{n}^{f}} = \frac{(1+\tau^{c})}{a(1-\tau^{n})}\frac{(1+\frac{1}{\varphi})}{(1-\theta_{f})}\frac{\overline{c}^{f}}{\overline{y}^{f}}\left(\frac{a(\overline{c}^{f})^{e}+(1-a)(\overline{c}^{i})^{e}}{\overline{c}^{f\,e}}\right) \tag{125}$$

Using equations (112) and (114) it is possible to obtain a equation to find the level of informal labor in the steady state. This equation is given by:

$$\frac{1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}}}{\eta\kappa\overline{n}^{\frac{1}{\varphi}}\overline{n}^{i}} = \frac{(1+\frac{1}{\varphi})}{(1-a)(1-\theta_{i})}\frac{\overline{c}^{i}}{\overline{y}^{i}}\left(\frac{a(\overline{c}^{f})^{e}+(1-a)(\overline{c}^{i})^{e}}{\overline{c}^{i\,e}}\right) \tag{126}$$

Using (117), equation (115) can be rewritten as:

$$\frac{\overline{k}^{f}}{\overline{y}^{f}} = \left(\frac{\overline{R}-1}{\theta_{f}(1-\tau^{k})}+\frac{\delta_{f}}{\theta_{f}}\right)^{-1} \tag{127}$$

For the informal sector, after some algebra equation (116) can be rewritten as:

$$\frac{\overline{k}^{i}}{\overline{y}^{i}} = \left(\frac{\overline{R}-1}{\theta_{i}}+\frac{\delta_{i}}{\theta_{i}}\right)^{-1} \tag{128}$$

where $\overline{R}=\psi^{\eta}/\beta$.

Dividing (122) by $\overline{y}^{f}$ yields:

$$\frac{\overline{c}^{f}}{\overline{y}^{f}} = 1-\frac{\overline{x}^{f}}{\overline{y}^{f}}+\frac{\overline{m}-\overline{g}}{\overline{y}^{f}} \tag{129}$$

The capital flow equation can be divided by ψ^{t} to obtain

$$\psi\overline{k}^{f} = (1-\delta_{f})\overline{k}^{f}+\overline{x}^{f} \tag{130}$$

where $k_{t}^{f}=\psi^{t+1}\overline{k}^{f}$.

Consequently, (129) can be expressed as:

$$\frac{\overline{c}^{f}}{\overline{y}^{f}} = 1-\frac{\psi\overline{k}^{f}}{\overline{y}^{f}}+(1-\delta_{f})\frac{\overline{k}^{f}}{\overline{y}^{f}}+\frac{(\overline{m}-\overline{g})}{\overline{y}^{f}}\frac{\overline{n}^{f}}{\overline{n}^{f}} \tag{131}$$

Given that $\psi^t = \zeta_f^{\frac{t}{1-\theta_f}}$, the production function can be divided by ψ^t to obtain

$$\overline{y}^f = (\overline{k}^f)^{\theta_f}(\overline{n}^f)^{1-\theta_f} \tag{132}$$

Therefore, equation (131) is now rewritten as:

$$\frac{\overline{c}^f}{\overline{y}^f} = 1 - (\psi - 1 + \delta_f)\frac{\overline{k}^f}{\overline{y}^f} + \frac{(\overline{m} - \overline{g})}{\overline{y}^f}\left(\frac{\overline{y}^f}{(\overline{k}^f)^{\theta_f}}\right)^{\frac{1}{1-\theta_f}}\frac{1}{\overline{n}^f} \tag{133}$$

$$\implies \quad \frac{\overline{c}^f}{\overline{y}^f} = \chi + \gamma\frac{1}{\overline{n}^f} \tag{134}$$

where $\chi = 1 - (\psi - 1 + \delta_f)\frac{\overline{k}^f}{\overline{y}^f}$ and $\gamma = (\bar{m} - \bar{g})(\frac{\overline{k}^f}{\overline{y}^f})^{\frac{-\theta_f}{1-\theta_f}}$.

Finally, dividing (123) by $\overline{y}^i$ yields:

$$\frac{\overline{c}^i}{\overline{y}^i} = 1 - \frac{\overline{x}^i}{\overline{y}^i} \tag{135}$$

And taking into account that the capital flow equation in the informal sector can be rewritten as:

$$\psi\overline{k}^i = (1 - \delta_i)\overline{k}^i + \overline{x}^i \tag{136}$$

equation (135) can be expressed as:

$$\frac{\overline{c}^i}{\overline{y}^i} = 1 - (\psi - 1 + \delta_i)\frac{\overline{k}^i}{\overline{y}^i} \tag{137}$$

Appendix 2: The formal-only model

The household chooses allocations of c_t, k_t, n_t and b_t to maximize its utility. The lagrangian for this problem is given by:

$$\mathscr{L} = E_0\sum_{t=0}^{\infty}\beta^t[U(c_t, n_t) + V(g_t)]+$$
$$\lambda_t((1-\tau_t^n)w_t n_t + (1-\tau_t^k)(d_t - \delta)k_{t-1} + \delta k_{t-1} + R_t^b b_{t-1} + s_t + \Pi_t + m_t - (1+\tau_t^c)c_t - k_t + (1-\delta)k_{t-1} - b_t) \tag{138}$$

The first order conditions are the following:

$$\frac{\partial \mathscr{L}}{\partial c_t}: \quad U_c^{'}(c_t, n_t) - \lambda_t(1+\tau_t^c) = 0 \tag{139}$$

$$\frac{\partial \mathscr{L}}{\partial n_t}: \quad U_n^{'}(c_t, n_t) + \lambda_t(1-\tau_t^n)w_t = 0 \tag{140}$$

$$\frac{\partial \mathscr{L}}{\partial k_t}: \quad \lambda_{t+1}((1-\tau_{t+1}^k)(d_{t+1}-\delta) + \delta + (1-\delta)) - \lambda_t = 0 \tag{141}$$

$$\implies \quad \lambda_{t+1}((1-\tau_{t+1}^k)(d_{t+1}-\delta) + 1) = \lambda_t \tag{142}$$

$$\frac{\partial \mathscr{L}}{\partial b_t}: \quad \lambda_{t+1}R_{t+1}^b - \lambda_t = 0 \tag{143}$$

$$\implies \quad \lambda_{t+1}R_{t+1}^b = \lambda_t \tag{144}$$

Given that,

$$U_c^{'}(c_t, n_t) = c_t^{-\eta}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} \tag{145}$$

and

$$U_n^{'}(c_t, n_t) = -\eta(1+\frac{1}{\varphi})(c_t^{1-\eta}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}}) \tag{146}$$

Equations (139) and (140) can be rewritten as:

$$c_t^{-\eta}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} = \lambda_t(1+\tau_t^c) \tag{147}$$

$$-\eta(1+\frac{1}{\varphi})(c_t^{1-\eta}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}}) = -\lambda_t(1-\tau_t^n)w_t \tag{148}$$

On the other hand, it follows from equations (142) and (144):

$$R^b_{t+1} = (1 - \tau^k_{t+1})(d_{t+1} - \delta) + 1 \tag{149}$$

The representative firm chooses capital and labor to maximize profits. Formally,

$$\max_{k_{t-1}, n_t} \Pi_t = \zeta^t k^\theta_{t-1} n^{1-\theta}_t - d_t k_{t-1} - w_t n_t \tag{150}$$

where the first order conditions are:

$$\frac{\partial \Pi_t}{\partial k_{t-1}} : \quad \theta \zeta^t k^{\theta-1}_{t-1} n^{1-\theta}_t - d_t = 0 \tag{151}$$

$$\implies \quad d_t = \theta \frac{y_t}{k_{t-1}} \tag{152}$$

$$\frac{\partial \Pi_t}{\partial n_t} : \quad (1 - \theta) \zeta^t k^\theta_{t-1} n^{-\theta}_t - w_t = 0 \tag{153}$$

$$\implies \quad w_t = (1 - \theta) \frac{y_t}{n_t} \tag{154}$$

Lastly, the government sets policies that satisfy its budget constraint

$$g_t + s_t + R^b_t b_{t-1} = b_t + T_t \tag{155}$$

subject to

$$T_t = \tau^c_t c_t + \tau^n_t w_t n_t + \tau^k_t (d_t - \delta) k_{t-1} \tag{156}$$

In addition, with some of algebra, $y_t = \zeta^t k_{t-1}^{\theta} n_t^{1-\theta}$ can be rewritten as:

$$\frac{y_t}{n_t} = \left(\zeta^t \left(\frac{k_t}{y_t}\right)^{\theta}\right)^{\frac{1}{1-\theta}} \tag{157}$$

Considering the above, the first order conditions of the firms, the budget constraints of government and the market clearing conditions, the system of equations used to solve the model is summarized as follows:

$$c_t^{-\eta}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} = \lambda_t(1+\tau_t^c) \tag{158}$$

$$-\eta(1+\frac{1}{\varphi})(c_t^{1-\eta}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}}) = -\lambda_t(1-\tau_t^n)w_t \tag{159}$$

$$R_{t+1}^b = (1-\tau_{t+1}^k)(d_{t+1}-\delta)+1 \tag{160}$$

$$d_t = \theta\frac{y_t}{k_{t-1}} \tag{161}$$

$$w_t = (1-\theta)\frac{y_t}{n_t} \tag{162}$$

$$\frac{y_t}{n_t} = \left(\zeta^t \left(\frac{k_t}{y_t}\right)^{\theta}\right)^{\frac{1}{1-\theta}} \tag{163}$$

$$g_t + s_t + R_t^b b_{t-1} = b_t + T_t \tag{164}$$

$$T_t = \tau_t^c c_t + \tau_t^n w_t n_t + \tau_t^k(d_t-\delta)k_{t-1} \tag{165}$$

$$y_t = c_t + x_t + g_t - m_t \tag{166}$$

Considering that all other variables grow at a constant rate $\psi = \zeta^{\frac{1}{1-\theta}}$, except for hours worked, interest rates and taxes, then the previous system can be detrending by dividing all the rest of variables by $\zeta^{\frac{t}{1-\theta}}$. The obtained results are the following:

$$\overline{c}^{-\eta}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} = \overline{\lambda}(1+\tau_t^c) \tag{167}$$

$$\eta(1+\frac{1}{\varphi})(\overline{c}^{1-\eta}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}}) = \overline{\lambda}(1-\tau_t^n)\overline{w} \tag{168}$$

$$\overline{R} = (1-\tau^k)(\overline{d}-\delta)+1 \tag{169}$$

$$\overline{d} = \theta\frac{\overline{y}}{\overline{k}} \tag{170}$$

$$\overline{w} = (1-\theta)\frac{\overline{y}}{\overline{n}} \tag{171}$$

$$\frac{\overline{y}}{\overline{n}} = \left(\frac{\overline{k}}{\overline{y}}\right)^{\frac{\theta}{1-\theta}} \tag{172}$$

$$\overline{s} = \overline{b}(\psi-\overline{R}) + \overline{T} - \overline{g} \tag{173}$$

$$\overline{T} = \tau_t^c \overline{c} + \tau_t^n \overline{wn} + \tau_t^k (\overline{d} - \delta)\overline{k} \tag{174}$$

$$\overline{y} = \overline{c} + \overline{x} + \overline{g} - \overline{m} \tag{175}$$

where $\overline{\lambda} = \frac{\lambda_t}{\psi^{-\eta t}}$

Based on (167) and (168), it is possible to obtain a equation to find the level of labor in the steady state. This equation is given by:

$$\frac{\overline{c}^{-\eta}(1 - \kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta}}{\eta(1+\frac{1}{\varphi})(\overline{c}^{1-\eta}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}})} = \frac{\frac{\lambda_t}{\psi^{-\eta t}}(1+\tau^c)}{\frac{\lambda_t}{\psi^{-\eta t}}(1-\tau^n)\overline{w}} \tag{176}$$

After some of algebra and using (171), then (176) can be rewritten as:

$$\frac{1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}}}{\eta\kappa n_t^{1+\frac{1}{\varphi}}} = \frac{(1+\tau^c)}{(1-\tau^n)} \frac{(1+\frac{1}{\varphi})}{(1-\theta)} \frac{\overline{c}}{\overline{y}} \tag{177}$$

$$\implies \quad \left(\eta\kappa\bar{n}^{1+\frac{1}{\varphi}}\right)^{-1} + 1 - \frac{1}{\eta} = \alpha\overline{c/y} \tag{178}$$

where

$$\alpha = \left(\frac{1+\tau^c}{1-\tau^n}\right)\left(\frac{1+\frac{1}{\varphi}}{1-\theta}\right) \tag{179}$$

Using (170), equation (169) can be rewritten as:

$$\frac{\overline{k}}{\overline{y}} = \left(\frac{\overline{R}-1}{\theta(1-\tau^k)} + \frac{\delta}{\theta}\right)^{-1} \tag{180}$$

where $\overline{R} = \psi^{\eta}/\beta$.

Dividing (175) by $\overline{y}^f$ yields:

$$\frac{\overline{c}}{\overline{y}} = 1 - \frac{\overline{x}}{\overline{y}} + \frac{\overline{m} - \overline{g}}{\overline{y}} \tag{181}$$

The capital flow equation can be divided by ψ^t to obtain

$$\psi\overline{k} = (1-\delta)\overline{k} + \overline{x} \tag{182}$$

where $k_t = \psi^{t+1}\overline{k}$.

Consequently, (181) can be expressed as:

$$\frac{\overline{c}}{\overline{y}} = 1 - \frac{\psi\overline{k}}{\overline{y}} + (1-\delta)\frac{\overline{k}}{\overline{y}} + \frac{(\overline{m}-\overline{g})}{\overline{y}}\frac{\overline{n}}{\overline{n}} \tag{183}$$

Given that $\psi^t = \zeta^{\frac{t}{1-\theta_f}}$, the production function can be divided by ψ^t to obtain

$$\overline{y} = \overline{k}^{\theta}\overline{n}^{1-\theta} \tag{184}$$

Therefore, equation (183) is now rewritten as:

$$\frac{\overline{c}}{\overline{y}} = 1 - (\psi - 1 + \delta)\frac{\overline{k}}{\overline{y}} + \frac{(\overline{m}-\overline{g})}{\overline{y}}\left(\frac{\overline{y}}{\overline{k}^{\theta}}\right)^{\frac{1}{1-\theta}}\frac{1}{\overline{n}} \tag{185}$$

$$\implies \quad \overline{c/y} = \chi + \gamma\frac{1}{\overline{n}} \tag{186}$$

Where $\chi = 1 - (\psi - 1 + \delta)\overline{k/y}$ and $\gamma = (\bar{m} - \bar{g})\overline{k/y}^{\frac{-\theta}{1-\theta}}$.

Let x denote one of τ^k, τ^n or τ^c, and considering that the balanced growth path of y_t can be expressed as:

$$\overline{y} = \left(\frac{\overline{k}}{\overline{y}}(x)\right)^{\frac{\theta}{1-\theta}}\overline{n} \tag{187}$$

then, equation (174) can be rewritten to obtain the following Laffer curve $L(x)$:

$$L(x) = (\tau^c\overline{c/y(x)} + \tau^n(1-\theta) + \tau^k(\theta - \delta\overline{k/y(x)}))\overline{k/y(x)}^{\frac{-\theta}{1-\theta}}\overline{n}(x) \tag{188}$$

where $\overline{k/y(x)}$ varies only for $x = \tau^k$ and $\overline{c/y(x)}$ and $\overline{n}(x)$ change for $x = \tau^k, \tau^n$ or τ^c.

Appendix 3: Home production model

The household chooses allocations of c_t^f, c_t^i, k_t^f, k_t^i, n_t^f, n_t^i and b_t to maximize its utility. The lagrangian for this problem is given by:

$$\begin{aligned}
&\mathscr{L} = E_0 \sum_{t=0}^{\infty} \beta^t [(U(c_t, n_t) + V(g_t))+ \\
&\lambda_t((1-\tau_t^n) w_t n_t^f + (1-\tau_t^k)(d_t - \delta_f) k_{t-1}^f + \delta_f k_{t-1}^f + R_t^b b_{t-1} + s_t + \Pi_t + m_t + p_t \zeta_i^t (k_{t-1}^i)^{\theta_i} (n_t^i)^{1-\theta_i} - \\
&(1+\tau_t^c) c_t^f - p_t c_t^i - k_t^f + (1-\delta_f) k_{t-1}^f - p_t k_t^i + (1-\delta^i) p_t k_{t-1}^i - b_t)]
\end{aligned} \tag{189}$$

The first order conditions are the following:

$$\frac{\partial \mathscr{L}}{\partial c_t^f}: \quad U_{c^f}^{'}(c_t, n_t) - \lambda_t (1+\tau_t^c) = 0 \tag{190}$$

$$\frac{\partial \mathscr{L}}{\partial c_t^i}: \quad U_{c^i}^{'}(c_t, n_t) - p_t \lambda_t = 0 \tag{191}$$

$$\frac{\partial \mathscr{L}}{\partial n_t^f}: \quad U_{n^f}^{'}(c_t, n_t) + \lambda_t (1-\tau_t^n) w_t = 0 \tag{192}$$

$$\frac{\partial \mathscr{L}}{\partial n_t^i}: \quad U_{n^i}^{'}(c_t, n_t) + \lambda_t (1-\theta_i) p_t \zeta_i^t (k_{t-1}^i)^{\theta_i} (n_t^i)^{-\theta_i} = 0 \tag{193}$$

$$\implies \quad U_{n^i}^{'}(c_t, n_t) + \lambda_t (1-\theta_i) p_t \frac{y_t^i}{n_t^i} = 0 \tag{194}$$

$$\frac{\partial \mathscr{L}}{\partial k_t^f}: \quad E_t \lambda_{t+1} ((1-\tau_{t+1}^k)(d_{t+1} - \delta_f) + \delta_f + (1-\delta_f)) - \lambda_t = 0 \tag{195}$$

$$\implies \quad E_t \lambda_{t+1} ((1-\tau_{t+1}^k)(d_{t+1} - \delta_f) + 1) = \lambda_t \tag{196}$$

$$\frac{\partial \mathscr{L}}{\partial k_t^i}: \quad E_t \lambda_{t+1} (\theta_i p_{t+1} \zeta_I^{t+1} (k_t^i)^{\theta_i - 1} (n_{t+1}^i)^{1-\theta_i} + p_{t+1}(1-\delta_i)) - p_t \lambda_t = 0 \tag{197}$$

$$\implies \quad E_t \lambda_{t+1} (\theta_i \frac{y_{t+1}^i}{k_t^i} + (1-\delta_i)) = \frac{p_t}{E_t p_{t+1}} \lambda_t \tag{198}$$

$$\frac{\partial \mathscr{L}}{\partial b_t}: \quad E_t \lambda_{t+1} R^b_{t+1} - \lambda_t = 0 \tag{199}$$

$$\implies \quad E_t \lambda_{t+1} R^b_{t+1} = \lambda_t \tag{200}$$

Given that,

$$U^{'}_{c^f}(c_t, n_t) = a(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}-1}(c^f_t)^{e-1}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} \tag{201}$$

$$U^{'}_{c^i}(c_t, n_t) = (1-a)(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}-1}(c^i_t)^{e-1}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} \tag{202}$$

and

$$U^{'}_{n^f}(c_t, n_t) = -\eta(1+\frac{1}{\varphi})(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} \tag{203}$$

$$U^{'}_{n^i}(c_t, n_t) = -\eta(1+\frac{1}{\varphi})(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} \tag{204}$$

Equations (190)-(193) can be rewritten as

$$a(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}-1}(c^f_t)^{e-1}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} = \lambda_t(1+\tau^c_t) \tag{205}$$

$$(1-a)(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}-1}(c^i_t)^{e-1}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} = p_t\lambda_t \tag{206}$$

$$\eta(1+\frac{1}{\varphi})(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} = \lambda_t(1-\tau^n_t)w_t \tag{207}$$

$$\eta(1+\frac{1}{\varphi})(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} = \lambda_t(1-\theta_i)p_t\frac{y^i_t}{n^i_t} \tag{208}$$

On the other hand, it follows from equations (196), (198) and (200):

$$R^b_{t+1} = (1-\tau^k_{t+1})(d_{t+1}-\delta_f)+1 \tag{209}$$

$$R^b_{t+1} = \theta_i \frac{y^i_{t+1}}{k^i_t} + (1-\delta_i) \tag{210}$$

In addition, with some of algebra, $y^f_t = \zeta^t_f (k^f_{t-1})^{\theta_f}(n^f_t)^{1-\theta_f}$ can be rewritten as:

$$\frac{y^f_t}{n^f_t} = \left(\zeta^t_f \left(\frac{k^f_t}{y^f_t}\right)^{\theta_f}\right)^{\frac{1}{1-\theta_f}} \tag{211}$$

Considering the above, the first order conditions of the firms, the budget constraints of government and the market clearing conditions, the system of equations used to solve the model is summarized as follows:

$$a(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}-1}(c^f_t)^{e-1}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} = \lambda_t(1+\tau^c_t) \tag{212}$$

$$(1-a)(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}-1}(c^i_t)^{e-1}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} = p_t\lambda_t \tag{213}$$

$$\eta(1+\frac{1}{\varphi})(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} = \lambda_t(1-\tau^n_t)w_t \tag{214}$$

$$\eta(1+\frac{1}{\varphi})(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} = \lambda_t(1-\theta_i)p_t\frac{y^i_t}{n^i_t} \tag{215}$$

$$R^b_{t+1} = (1-\tau^k_{t+1})(d_{t+1}-\delta_f)+1 \tag{216}$$

$$R^b_{t+1} = \theta_i \frac{y^i_{t+1}}{k^i_t} + (1-\delta_i) \tag{217}$$

$$d_t = \theta_f \frac{y^f_t}{k^f_{t-1}} \tag{218}$$

$$w_t = (1-\theta_f)\frac{y^f_t}{n^f_t} \tag{219}$$

$$\frac{y^f_t}{n^f_t} = \left(\zeta^t_f \left(\frac{k^f_t}{y^f_t}\right)^{\theta_f}\right)^{\frac{1}{1-\theta_f}} \tag{220}$$

$$g_t + s_t + R^b_t b_{t-1} = b_t + T_t \tag{221}$$

$$T_t = \tau^c_t c_t + \tau^n_t w_t n^f_t + \tau^k_t(d_t-\delta_f)k^f_{t-1} \tag{222}$$

$$y^f_t = c^f_t + x^f_t + g_t - m_t \tag{223}$$

$$y^i_t = c^i_t \tag{224}$$

Considering that all other variables grow at a constant rate $\psi = \zeta_f^{\frac{1}{1-\theta_f}}$, except for hours worked, interest rates, prices and taxes, then the previous system can be detrending by dividing all the rest of variables by $\zeta_f^{\frac{t}{1-\theta_f}}$. The obtained results are the following:

$$a(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}-1}(\overline{c}^f)^{e-1}(1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta} = \overline{\lambda}(1+\tau^c) \tag{225}$$

$$(1-a)(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}-1}(\overline{c}^i)^{e-1}(1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta} = \overline{p}\overline{\lambda} \tag{226}$$

$$\eta(1+\frac{1}{\varphi})(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta-1}\kappa\overline{n}^{\frac{1}{\varphi}} = \overline{\lambda}(1-\tau^n)\overline{w} \tag{227}$$

$$\eta(1+\frac{1}{\varphi})(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta-1}\kappa\overline{n}^{\frac{1}{\varphi}} = \overline{\lambda}(1-\theta_i)\overline{p}\frac{\overline{y}^i}{\overline{n}^i} \tag{228}$$

$$\overline{R} = (1-\tau^k)(\overline{d}-\delta_f)+1 \tag{229}$$

$$\overline{R} = \theta_i\frac{\overline{y}^i}{\overline{k}^i} + (1-\delta_i) \tag{230}$$

$$\overline{d} = \theta_f\frac{\overline{y}^f}{\overline{k}^f} \tag{231}$$

$$\overline{w} = (1-\theta_f)\frac{\overline{y}^f}{\overline{n}^f} \tag{232}$$

$$\frac{\overline{y}^f}{\overline{n}^f} = \left(\frac{\overline{k}^f}{\overline{y}^f}\right)^{\frac{\theta_f}{1-\theta_f}} \tag{233}$$

$$\overline{s} = \overline{b}(\psi-\overline{R}) + \overline{T} - \overline{g} \tag{234}$$

$$\overline{T} = \tau_t^c\overline{c}^f + \tau_t^n\overline{w}\overline{n}^f + \tau_t^k(\overline{d}-\delta_f)\overline{k}^f \tag{235}$$

$$\overline{y}^f = \overline{c}^f + \overline{x}^f + \overline{g} - \overline{m} \tag{236}$$

$$\overline{y}^i = \overline{c}^i \tag{237}$$

where $\overline{\lambda} = \frac{\lambda_t}{\psi^{-\eta t}}$

Based on (225) and (227), it is possible to obtain a equation to find the level of formal labor in the steady state. This equation is given by:

$$\frac{a(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}-1}(\overline{c}^f)^{e-1}(1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta}}{\eta(1+\frac{1}{\varphi})(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta-1}\kappa\overline{n}^{\frac{1}{\varphi}}} = \frac{\overline{\lambda}(1+\tau^c)}{\overline{\lambda}(1-\tau^n)\overline{w}} \tag{238}$$

After some of algebra and using (232), then (238) can be rewritten as:

$$\frac{1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}}}{\eta\kappa\overline{n}^{\frac{1}{\varphi}}\overline{n}^{f}} = \frac{(1+\tau^{c})}{a(1-\tau^{n})}\frac{(1+\frac{1}{\varphi})}{(1-\theta_{f})}\frac{\overline{c}^{f}}{\overline{y}^{f}}\left(\frac{a(\overline{c}^{f})^{e}+(1-a)(\overline{c}^{i})^{e}}{\overline{c}^{f\,e}}\right) \tag{239}$$

Using equations (226) and (228) it is possible to obtain a equation to find the level of informal labor in the steady state. This equation is given by:

$$\frac{1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}}}{\eta\kappa\overline{n}^{\frac{1}{\varphi}}\overline{n}^{i}} = \frac{(1+\frac{1}{\varphi})}{(1-a)(1-\theta_{i})}\frac{\overline{c}^{i}}{\overline{y}^{i}}\left(\frac{a(\overline{c}^{f})^{e}+(1-a)(\overline{c}^{i})^{e}}{\overline{c}^{i\,e}}\right) \tag{240}$$

Using (231), equation (229) can be rewritten as:

$$\frac{\overline{k}^{f}}{\overline{y}^{f}} = \left(\frac{\overline{R}-1}{\theta_{f}(1-\tau^{k})}+\frac{\delta_{f}}{\theta_{f}}\right)^{-1} \tag{241}$$

For the informal sector, after some algebra equation (230) can be rewritten as:

$$\frac{\overline{k}^{i}}{\overline{y}^{i}} = \left(\frac{\overline{R}-1}{\theta_{i}}+\frac{\delta_{i}}{\theta_{i}}\right)^{-1} \tag{242}$$

where $\overline{R} = \psi^{\eta}/\beta$.

Dividing (236) by $\overline{y}^{f}$ yields:

$$\frac{\overline{c}^{f}}{\overline{y}^{f}} = 1-\frac{\overline{x}^{f}}{\overline{y}^{f}}+\frac{\overline{m}-\overline{g}}{\overline{y}^{f}} \tag{243}$$

The capital flow equation can be divided by ψ^{t} to obtain

$$\psi\overline{k}^{f}+\psi\overline{k}^{i} = (1-\delta_{f})\overline{k}^{f}+(1-\delta_{i})\overline{k}^{i}+\overline{x}^{f} \tag{244}$$

where $k_{t}^{f} = \psi^{t+1}\overline{k}^{f}$.

Consequently, (243) can be expressed as:

$$\frac{\overline{c}^{f}}{\overline{y}^{f}} = 1-\frac{\psi\overline{k}^{f}}{\overline{y}^{f}}+(1-\delta_{f})\frac{\overline{k}^{f}}{\overline{y}^{f}}-\frac{\psi\overline{k}^{i}}{\overline{y}^{f}}+(1-\delta_{i})\frac{\overline{k}^{i}}{\overline{y}^{f}}+\frac{(\overline{m}-\overline{g})}{\overline{y}^{f}}\frac{\overline{n}^{f}}{\overline{n}^{f}} \tag{245}$$

Given that $\psi^t = \zeta_f^{\frac{t}{1-\theta_f}}$, the production function can be divided by ψ^t to obtain

$$\overline{y}^f = (\overline{k}^f)^{\theta_f} (\overline{n}^f)^{1-\theta_f} \tag{246}$$

Therefore, equation (245) is now rewritten as:

$$\frac{\overline{c}^f}{\overline{y}^f} = 1 - (\psi - 1 + \delta_f) \frac{\overline{k}^f}{\overline{y}^f} - (\psi - 1 + \delta_i) \frac{\overline{k}^i}{\overline{y}^i} \frac{\overline{y}^i}{\overline{y}^f} + \frac{(\overline{m} - \overline{g})}{\overline{y}^f} \left(\frac{\overline{y}^f}{(\overline{k}^f)^{\theta_f}} \right)^{\frac{1}{1-\theta_f}} \frac{1}{\overline{n}^f} \tag{247}$$

$$\Longrightarrow \quad \frac{\overline{c}^f}{\overline{y}^f} = \chi + \gamma \frac{1}{\overline{n}^f} \tag{248}$$

where $\chi = 1 - (\psi - 1 + \delta_f) \frac{\overline{k}^f}{\overline{y}^f} - (\psi - 1 + \delta_i) \frac{\overline{k}^i}{\overline{y}^i} \frac{\overline{y}^i}{\overline{y}^f}$ and $\gamma = (\bar{m} - \bar{g}) (\overline{k/y}^f)^{\frac{-\theta_f}{1-\theta_f}}$

Finally, dividing (237) by $\overline{y}^i$ yields:

$$\frac{\overline{c}^i}{\overline{y}^i} = 1 \tag{249}$$

Appendix 4: Informality and monopolistic competition: the model

The household chooses allocations of c_t^f, c_t^i, k_t^f, k_t^i, n_t^f, n_t^i and b_t to maximize its utility. The lagrangian for this problem is given by:

$$\begin{aligned}
\mathscr{L} = {} & E_0 \sum_{t=0}^{\infty} \beta^t [(U(c_t, n_t) + V(g_t)) + \\
& \lambda_t ((1 - \tau_t^n) w_t n_t^f + (1 - \tau_t^k)(d_t - \delta_f)(k_{t-1}^f + \phi \Pi_t) + \delta_f k_{t-1}^f + R_t^b b_{t-1} + s_t + (1 - \phi)\Pi_t + m_t + p_t \zeta_i^t (k_{t-1}^i)^{\theta_i} (n_t^i)^{1-\theta_i} - \\
& (1 + \tau_t^c) c_t^f - p_t c_t^i - k_t^f + (1 - \delta_f) k_{t-1}^f - p_t k_t^i + (1 - \delta^i) p_t k_{t-1}^i - b_t)]
\end{aligned} \tag{250}$$

The first order conditions are the following:

$$\frac{\partial \mathscr{L}}{\partial c_t^f} : \quad U'_{c^f}(c_t, n_t) - \lambda_t (1 + \tau_t^c) = 0 \tag{251}$$

$$\frac{\partial \mathscr{L}}{\partial c_t^i} : \quad U'_{c^i}(c_t, n_t) - p_t \lambda_t = 0 \tag{252}$$

$$\frac{\partial \mathscr{L}}{\partial n_t^f}: \quad U'_{n^f}(c_t, n_t) + \lambda_t (1 - \tau_t^n) w_t = 0 \tag{253}$$

$$\frac{\partial \mathscr{L}}{\partial n_t^i}: \quad U'_{n^i}(c_t, n_t) + \lambda_t (1 - \theta_i) p_t \zeta_i^t (k_{t-1}^i)^{\theta_i} (n_t^i)^{-\theta_i} = 0 \tag{254}$$

$$\implies \quad U'_{n^i}(c_t, n_t) + \lambda_t (1 - \theta_i) p_t \frac{y_t^i}{n_t^i} = 0 \tag{255}$$

$$\frac{\partial \mathscr{L}}{\partial k_t^f}: \quad E_t \lambda_{t+1} ((1 - \tau_{t+1}^k)(d_{t+1} - \delta_f) + \delta_f + (1 - \delta_f)) - \lambda_t = 0 \tag{256}$$

$$\implies \quad E_t \lambda_{t+1} ((1 - \tau_{t+1}^k)(d_{t+1} - \delta_f) + 1) = \lambda_t \tag{257}$$

$$\frac{\partial \mathscr{L}}{\partial k_t^i}: \quad E_t \lambda_{t+1} (\theta_i p_{t+1} \zeta_I^{t+1} (k_t^i)^{\theta_i - 1} (n_{t+1}^i)^{1-\theta_i} + p_{t+1}(1 - \delta_i)) - p_t \lambda_t = 0 \tag{258}$$

$$\implies \quad E_t \lambda_{t+1} (\theta_i \frac{y_{t+1}^i}{k_t^i} + (1 - \delta_i)) = \frac{p_t}{E_t p_{t+1}} \lambda_t \tag{259}$$

$$\frac{\partial \mathscr{L}}{\partial b_t}: \quad E_t \lambda_{t+1} R_{t+1}^b - \lambda_t = 0 \tag{260}$$

$$\implies \quad E_t \lambda_{t+1} R_{t+1}^b = \lambda_t \tag{261}$$

Given that,

$$U'_{c^f}(c_t, n_t) = a(a(c_t^f)^e + (1-a)(c_t^i)^e)^{\frac{1-\eta}{e} - 1} (c_t^f)^{e-1} (1 - \kappa(1-\eta) n_t^{1+\frac{1}{\varphi}})^\eta \tag{262}$$

$$U'_{c^i}(c_t, n_t) = (1-a)(a(c_t^f)^e + (1-a)(c_t^i)^e)^{\frac{1-\eta}{e} - 1} (c_t^i)^{e-1} (1 - \kappa(1-\eta) n_t^{1+\frac{1}{\varphi}})^\eta \tag{263}$$

and

$$U'_{n^f}(c_t, n_t) = -\eta(1 + \frac{1}{\varphi})(a(c_t^f)^e + (1-a)(c_t^i)^e)^{\frac{1-\eta}{e}}(1 - \kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} \tag{264}$$

$$U'_{n^i}(c_t, n_t) = -\eta(1 + \frac{1}{\varphi})(a(c_t^f)^e + (1-a)(c_t^i)^e)^{\frac{1-\eta}{e}}(1 - \kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} \tag{265}$$

Equations (251)-(254) can be rewritten as

$$a(a(c_t^f)^e + (1-a)(c_t^i)^e)^{\frac{1-\eta}{e}-1}(c_t^f)^{e-1}(1 - \kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} = \lambda_t(1 + \tau_t^c) \tag{266}$$

$$(1-a)(a(c_t^f)^e + (1-a)(c_t^i)^e)^{\frac{1-\eta}{e}-1}(c_t^i)^{e-1}(1 - \kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta} = p_t\lambda_t \tag{267}$$

$$\eta(1 + \frac{1}{\varphi})(a(c_t^f)^e + (1-a)(c_t^i)^e)^{\frac{1-\eta}{e}}(1 - \kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} = \lambda_t(1 - \tau_t^n)w_t \tag{268}$$

$$\eta(1 + \frac{1}{\varphi})(a(c_t^f)^e + (1-a)(c_t^i)^e)^{\frac{1-\eta}{e}}(1 - \kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} = \lambda_t(1 - \theta_i)p_t\frac{y_t^i}{n_t^i} \tag{269}$$

On the other hand, it follows from equations (257), (259) and (261):

$$R_{t+1}^b = (1 - \tau_{t+1}^k)(d_{t+1} - \delta_f) + 1 \tag{270}$$

$$R_{t+1}^b = \theta_i\frac{y_{t+1}^i}{k_t^i} + (1 - \delta_i) \tag{271}$$

In addition, the problem of the monopolistically competitive firms can be rewritten as:

$$\max_{p_{t,i}^z} \Pi_t = p_{t,i}^z\left(\frac{p_t^z}{p_{t,i}^z}\right)^{\frac{\omega}{\omega-1}} z_t - w_t\left(\frac{p_t^z}{p_{t,i}^z}\right)^{\frac{\omega}{\omega-1}} z_t \tag{272}$$

and, therefore, the first order condition is given by:

$$\frac{\partial \Pi_t}{\partial P^z_{t,i}}: \quad \left(1-\frac{\omega}{\omega-1}\right) P^z_{t,i}{}^{\frac{-\omega}{\omega-1}} P^z_t{}^{\frac{\omega}{\omega-1}} z_t + \left(\frac{\omega}{\omega-1}\right) w_t P^z_{t,i}{}^{\frac{-\omega}{\omega-1}-1} P^z_t{}^{\frac{\omega}{\omega-1}} z_t = 0 \tag{273}$$

$$\implies \quad p^z_{t,i} = p^z_t = \omega w_t \tag{274}$$

$$\implies \quad z_{t,i} = z_t = n^f_t \tag{275}$$

In equilibrium all firms set the same price. This price is a markup ω over marginal costs w_t, i.e. $p^z_{t,i} = p^z_t = \omega w_t$. Considering this, aggregate equilibrium profits are given by:

$$\Pi_t = \omega w_t n^f_t - w_t n^f_t \tag{276}$$

$$\implies \Pi_t = (\omega - 1) w_t n^f_t \tag{277}$$

Taking the above into account, with some of algebra, $y^f_t = \zeta^t_f (k^f_{t-1})^{\theta_f} (z_t)^{1-\theta_f}$ can be rewritten as:

$$\frac{y^f_t}{n^f_t} = \left(\zeta^t_f \left(\frac{k^f_t}{y^f_t}\right)^{\theta_f}\right)^{\frac{1}{1-\theta_f}} \tag{278}$$

Considering the above, the first order conditions of the final firms, the budget constraints of government and the market clearing conditions, the system of equations used to solve the model is summarized as follows:

$$a(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}-1}(c^f_t)^{e-1}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^\eta = \lambda_t(1+\tau^c_t) \tag{279}$$

$$(1-a)(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}-1}(c^i_t)^{e-1}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^\eta = p_t\lambda_t \tag{280}$$

$$\eta(1+\frac{1}{\varphi})(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} = \lambda_t(1-\tau^n_t)w_t \tag{281}$$

$$\eta(1+\frac{1}{\varphi})(a(c^f_t)^e + (1-a)(c^i_t)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)n_t^{1+\frac{1}{\varphi}})^{\eta-1}\kappa n_t^{\frac{1}{\varphi}} = \lambda_t(1-\theta_i)p_t\frac{y^i_t}{n^i_t} \tag{282}$$

$$R^b_{t+1} = (1-\tau^k_{t+1})(d_{t+1}-\delta_f) + 1 \tag{283}$$

$$R^b_{t+1} = \theta_i \frac{y^i_{t+1}}{k^i_t} + (1-\delta_i) \tag{284}$$

$$d_t = \theta_f \frac{y^f_t}{k^f_{t-1}} \tag{285}$$

$$w_t = \frac{(1-\theta_f)}{\omega}\frac{y^f_t}{n^f_t} \tag{286}$$

$$\frac{y^f_t}{n^f_t} = \left(\zeta^t_f \left(\frac{k^f_t}{y^f_t}\right)^{\theta_f}\right)^{\frac{1}{1-\theta_f}} \tag{287}$$

$$g_t + s_t + R_t^b b_{t-1} = b_t + T_t \tag{288}$$

$$T_t = \tau_t^c c_t^f + \tau_t^n w_t n_t^f + \tau_t^k (d_t - \delta_f)(k_{t-1}^f + \phi(\omega - 1) w_t n_t^f) \tag{289}$$

$$y_t^f = c_t^f + x_t^f + g_t - m_t \tag{290}$$

$$y_t^i = c_t^i + x_t^i \tag{291}$$

Considering that all other variables grow at a constant rate $\psi = \zeta_f^{\frac{1}{1-\theta_f}}$, except for hours worked, interest rates, prices and taxes, then the previous system can be detrending by dividing all the rest of variables by $\zeta_f^{\frac{t}{1-\theta_f}}$. The obtained results are the following:

$$a(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}-1}(\overline{c}^f)^{e-1}(1 - \kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta} = \overline{\lambda}(1+\tau^c) \tag{292}$$

$$(1-a)(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}-1}(\overline{c}^i)^{e-1}(1 - \kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta} = \overline{p}\overline{\lambda} \tag{293}$$

$$\eta(1+\frac{1}{\varphi})(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}}(1 - \kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta-1}\kappa\overline{n}^{\frac{1}{\varphi}} = \overline{\lambda}(1-\tau^n)\overline{w} \tag{294}$$

$$\eta(1+\frac{1}{\varphi})(a(\overline{c}^f)^e + (1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}}(1 - \kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta-1}\kappa\overline{n}^{\frac{1}{\varphi}} = \overline{\lambda}(1-\theta_i)\overline{p}\frac{\overline{y}^i}{\overline{n}^i} \tag{295}$$

$$\overline{R} = (1-\tau^k)(\overline{d} - \delta_f) + 1 \tag{296}$$

$$\overline{R} = \theta_i \frac{\overline{y}^i}{\overline{k}^i} + (1-\delta_i) \tag{297}$$

$$\overline{d} = \theta_f \frac{\overline{y}^f}{\overline{k}^f} \tag{298}$$

$$\overline{w} = \frac{(1-\theta_f)}{\omega}\frac{\overline{y}^f}{\overline{n}^f} \tag{299}$$

$$\frac{\overline{y}^f}{\overline{n}^f} = \left(\frac{\overline{k}^f}{\overline{y}^f}\right)^{\frac{\theta_f}{1-\theta_f}} \tag{300}$$

$$\overline{s} = \overline{b}(\psi - \overline{R}) + \overline{T} - \overline{g} \tag{301}$$

$$\overline{T} = \tau_t^c \overline{c}^f + \tau_t^n \overline{w}\overline{n}^f + \tau_t^k(\overline{d} - \delta_f)(\overline{k}^f + \phi(\omega-1)\overline{w}\overline{n}^f) \tag{302}$$

$$\overline{y}^f = \overline{c}^f + \overline{x}^f + \overline{g} - \overline{m} \tag{303}$$

$$\overline{y}^i = \overline{c}^i + \overline{x}^i \tag{304}$$

where $\overline{\lambda} = \frac{\lambda_t}{\psi^{-\eta t}}$

Based on (292) and (294), it is possible to obtain a equation to find the level of formal labor in the steady state. This equation is given by:

$$\frac{a(a(\overline{c}^f)^e+(1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}-1}(\overline{c}^f)^{e-1}(1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^\eta}{\eta(1+\frac{1}{\varphi})(a(\overline{c}^f)^e+(1-a)(\overline{c}^i)^e)^{\frac{1-\eta}{e}}(1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}})^{\eta-1}\kappa\overline{n}^{\frac{1}{\varphi}}}=\frac{\overline{\lambda}(1+\tau^c)}{\overline{\lambda}(1-\tau^n)\overline{w}} \tag{305}$$

After some of algebra and using (299), then (305) can be rewritten as:

$$\frac{1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}}}{\eta\kappa\overline{n}^{\frac{1}{\varphi}}\overline{n}^f}=\frac{\omega(1+\tau^c)}{a(1-\tau^n)}\frac{(1+\frac{1}{\varphi})}{(1-\theta_f)}\frac{\overline{c}^f}{\overline{y}^f}\left(\frac{a(\overline{c}^f)^e+(1-a)(\overline{c}^i)^e}{\overline{c}^{f\,e}}\right) \tag{306}$$

Using equations (293) and (295) it is possible to obtain a equation to find the level of informal labor in the steady state. This equation is given by:

$$\frac{1-\kappa(1-\eta)\overline{n}^{1+\frac{1}{\varphi}}}{\eta\kappa\overline{n}^{\frac{1}{\varphi}}\overline{n}^i}=\frac{(1+\frac{1}{\varphi})}{(1-a)(1-\theta_i)}\frac{\overline{c}^i}{\overline{y}^i}\left(\frac{a(\overline{c}^f)^e+(1-a)(\overline{c}^i)^e}{\overline{c}^{i\,e}}\right) \tag{307}$$

Using (298), equation (296) can be rewritten as:

$$\frac{\overline{k}^f}{\overline{y}^f}=\left(\frac{\overline{R}-1}{\theta_f(1-\tau^k)}+\frac{\delta_f}{\theta_f}\right)^{-1} \tag{308}$$

For the informal sector, after some algebra equation (297) can be rewritten as:

$$\frac{\overline{k}^i}{\overline{y}^i}=\left(\frac{\overline{R}-1}{\theta_i}+\frac{\delta_i}{\theta_i}\right)^{-1} \tag{309}$$

where $\overline{R}=\psi^\eta/\beta$.

Dividing (303) by $\overline{y}^f$ yields:

$$\frac{\overline{c}^f}{\overline{y}^f}=1-\frac{\overline{x}^f}{\overline{y}^f}+\frac{\overline{m}-\overline{g}}{\overline{y}^f} \tag{310}$$

The capital flow equation can be divided by ψ^t to obtain

$$\psi\overline{k}^f=(1-\delta_f)\overline{k}^f+\overline{x}^f \tag{311}$$

where $k_t^f=\psi^{t+1}\overline{k}^f$.

Consequently, (310) can be expressed as:

$$\frac{\overline{c}^f}{\overline{y}^f} = 1 - \frac{\psi \overline{k}^f}{\overline{y}^f} + (1-\delta_f)\frac{\overline{k}^f}{\overline{y}^f} + \frac{(\overline{m}-\overline{g})}{\overline{y}^f}\frac{\overline{n}^f}{\overline{n}^f} \tag{312}$$

Given that $\psi^t = \zeta_f^{\frac{t}{1-\theta_f}}$, the production function can be divided by ψ^t to obtain

$$\overline{y}^f = (\overline{k}^f)^{\theta_f}(\overline{n}^f)^{1-\theta_f} \tag{313}$$

Therefore, equation (312) is now rewritten as:

$$\frac{\overline{c}^f}{\overline{y}^f} = 1 - (\psi - 1 + \delta_f)\frac{\overline{k}^f}{\overline{y}^f} + \frac{(\overline{m}-\overline{g})}{\overline{y}^f}\left(\frac{\overline{y}^f}{(\overline{k}^f)^{\theta_f}}\right)^{\frac{1}{1-\theta_f}}\frac{1}{\overline{n}^f} \tag{314}$$

$$\implies \quad \frac{\overline{c}^f}{\overline{y}^f} = \chi + \gamma\frac{1}{\overline{n}^f} \tag{315}$$

where $\chi = 1 - (\psi - 1 + \delta_f)\frac{\overline{k}^f}{\overline{y}^f}$ and $\gamma = (\bar{m} - \bar{g})(\frac{\overline{k}^f}{\overline{y}^f})^{\frac{-\theta_f}{1-\theta_f}}$.

Finally, dividing (304) by $\overline{y}^i$ yields:

$$\frac{\overline{c}^i}{\overline{y}^i} = 1 - \frac{\overline{x}^i}{\overline{y}^i} \tag{316}$$

And taking into account that the capital flow equation in the informal sector can be rewritten as:

$$\psi\overline{k}^i = (1-\delta_i)\overline{k}^i + \overline{x}^i \tag{317}$$

equation (316) can be expressed as:

$$\frac{\overline{c}^i}{\overline{y}^i} = 1 - (\psi - 1 + \delta_i)\frac{\overline{k}^i}{\overline{y}^i} \tag{318}$$

References

Aguiar, M., Gopinath, G., 2007. Emerging market business cycles: the cycle is the trend. Journal of Political Economy115, 69–102.

Altug, S., Kabaca, S., Poyraz, M., 2011. Search frictions, financial frictions, and labor market fluctuations in emerging economies. Koc University Working Paper 1136.

Antón, A. 2005. Average effective Tax Rates in Mexico. Economía Mexicana Nueva Época, XIV(2), segundo semestre.

Beltrán Silva, F. 2014. Estimación de la recaudación potencial en el impuesto al trabajo y a los ingresos al capital: comparativo entre México y Estados Unidos. Revista Mexicana de Economía y Finanzas. Nueva Época / Mexican Journal of Economics and Finance, 9 (2), 175-194.

Boz, E., Durdu, C.B., Li, N., 2009. Labor market search in emerging economies. International Finance Discussion Papers, No. 989.

Busso, M., Fazio, M.V., Levy, S., 2012. (In)formal and (un)productive: the productivity costs of excessive informality in Mexico. IDB Working Paper Series No. IDB-WP-341.

Carey, D. y J. Rabesona. 2002. Tax Ratios on Labour and Capital Income and Consumption. OECD Economic Studies, 35, pp. 129-74.

Carey, D. y H. Tchilinguirian. 2000. Average Effective Tax Rates on Capital, Labour and Consumption. OECD Economics Department, Working Papers No.258, OECD Publishing.

Dalsgaard, T. 2000. The Tax System in Mexico: A Need for Strengthening the Revenue Raising Capacity. OECD Economics Department, OECD Publishing.

Domeij, D. and M. Flod en, 2006, The Labor-Supply Elasticity And Borrowing Constraints: Why Estimates Are Biased,Review Of Economic Dynamics, vol. 9, 242-262.

Fernández, A., Meza, F., 2011. Labor, output and consumption in business cycle models of emerging economies. Universidad de Los Andes. Documentos CEDE 9249.

Fernandez, A., Meza, F., 2014. Informal Employment and Business Cycles in Emerging Economies: The Case of Mexico. Review of Economic Dynamics, Vol. 18, 381-405.

Feve, P., Matheron, J., Sahuc, J. 2013 The Laffer Curve in an Incomplete-market Economy,IDEI Working Papers No.707.

Garcia-Verdu, R., 2005. Factor shares from household survey data. Banco de Mexico Working Papers, 2005-05.

Holter, H.A., Krueger, D., Stepanchuk ,S. 2014. How Does Tax Progressivity and Household Heterogeneity Affect Laffer Curves, NBER Working Paper 20688.

House, Christopher, L., and Matthew D. Shapiro. 2006. "Phased-In Tax Cuts and Economic Activity." American Economic Review, 96 (5): 1835-1849.

Kimball, M.S., Shapiro, M.D., 2003. Labor supply: Are the income and substitution effects both large or both small? NBER Working Paper 14208, NBER

King, R.S., Rebelo, S.T., 1999. Resuscitating real business cycles. In: Taylor, J.B., Woodford, M.(Eds.), Handbook of Macroeconomics , vol.1B. Elsevier, Amsterdam, pp.927–1007.

Lama, R., Urrutia, C., 2013. Employment protection and business cycles in emerging economies, working paper.

Levy, S., 2008. Good Intentions, Bad Outcomes: Social Policy, Informality, and Economic Growth in Mexico. Brookings Institution Press.

Li, Nan, 2011. Cyclical wage movements in emerging markets compared to developed economies: the role of interest rates. Review of Economic Dynamics14, 686–704.

Loayza, N., Rigolini, J., 2006. Informality trends and cycles. World Bank Policy Research Working Paper 4078.

Lozano, I., Arias, F. 2018. Curvas Laffer de la Tributación en Colombia. Borradores de Economía. Banco de la República de Colombia. Núm. 668.

Lucas, R.E., 1988. On the mechanics of economic development. Journal of Monetary Economics 22, 3–42.

Mankiw, G.N., Weinzierl, M., 2006. Dynamic scoring: a back-of-the-envelope guide. Journal of Public Economics 90 (8–9), 1415–1433.

Maloney, F.W., 2004. Informality revisited. World Development32 (7), 1159–1178.

Mendoza, E.G., Razin, A., Tesar, L.L., 1994. Effective tax rates in macroeconomics: cross-country estimates of tax rates on factor incomes and consumption. Journal of Monetary Economics 34, 297–323.

OECD, 2016. Estimates of the size of the informal economy in OECD countries, 2011: Percentage of national GDP, in SME and Entrepreneurship Policy in Israel 2016. OECD Studies on SMEs and Entrepreneurship. OECD Publishing, Paris. https://doi.org/10.1787/9789264262324-graph20-en.

Pagés, C. (Ed.), 2010. The Age of Productivity: Transforming Economies from the BottomUp. Development in the Americas, Inter-American Development Bank. Palgrave Macmillan.

Powell, A. (Ed.), 2013. Rethinking Reforms: How Latin America and the Caribbean Can Escape Suppressed World Growth. Inter-American Development Bank, Washington, DC. Latin American and Caribbean Macroeconomic Report.

Pratap, S., Quintin, E., 2006. Are labor markets segmented in developing countries? A semiparametric approach. European Economic Review50, 1817–1841

Prescott, E.C., 2002. Prosperity and depression. American Economic Review 92, 1–15.

Prescott, E.C., 2004. Why do Americans work so much more than Europeans? Quarterly Review, Federal Reserve Bank of Minneapolis 28, 2–13. Trabandt, M., Uhlig, H., May 2011. The Laffer curve revisited. Journal of Monetary Economics 58 (4), 305–327.

Prescott, E.C., 2006. Nobel lecture: the transformation of macroeconomic policy and research. Journal of Political Economy 114(2), 203–235.

Ragan, K., 2006. Taxes, Transfers, and Time Use: Fiscal Policy in a Household Production Model. PhD diss. University of Chicago.

Restrepo-Echavarria, P., 2011. Macroeconomic volatility: the role of the informal economy, working paper.

Trabandt, M., Uhlig, H., May 2011. The Laer curve revisited. Journal of Monetary Economics 58 (4), 305–327.

Trabandt, M., Uhlig, H., 2012. How Do Laffer Curves Differ Across Countries? NBER Working Paper 17862.

Uzawa, H.,1965. Optimum technical change in an aggregative model of economic growth. International Economic Review 6, 18–31.

Wanniski, J., 1978. Taxes, revenues, and the Laffer curve. The Public Interest 50, 3–16.

Ziliak, James P. and Thomas J. Kniesner, 2005. The Effect of Income Taxation on Consumption and Labor Supply, Journal of Labor Economics, vol. 23(4), 769-796.