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A Steeper slope: the Laffer Tax Curve in Developing and Emerging Economies

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Cardinal Beaufort
The commons hast thou rack'd; the clergy's bags
Are lank and lean with thy extortions.

William Shakespeare - Henry VI, Part 2 Act 1.

Abstract

In comparing the tax burden between developed and developing economies, we argue that the Laffer curve is sensitive to two factors, namely the size of underground economic activities and tax collection costs. The baseline model exhibits counter-intuitive results for developing and emerging economies. Insofar as we find that they are able to extract higher tax rates and revenues in comparison with developed countries, the differences are due to the values computed for structural parameters and steady-state variables. However, when the share of underground activities is taken into account, the Laffer curve is pushed downward, while tax collection costs shift the peak rate to the left.

JEL Codes: **H21, H26, H30, E32, E37**.

Introduction

Even though it depicts an intuitive and well-documented relationship between tax rates and fiscal revenues, the Laffer tax curve remains a controversial concept in academic and policy-making circles. Contrary to spending, taxes are limited by the tax base from which revenues are extracted. Tax authorities can raise revenues by increasing taxes up to the point where a further increase yields no additional revenues, and may even lead to their decline. The Laffer curve effect laid out in Laffer [2004] states that when the tax rate goes past its peak, individuals had little incentive to work or produce additional output, which serves as the tax base.

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The thrust of the debate in the 1980s focused on the issue whether tax rates in developed countries - mainly in Europe - have reached their peak on the Laffer curve, that is to say, the point where tax cuts could increase revenues. Most of the studies in this area follow the intuition later updated in Laffer [2004] by looking at the effects of changes in the marginal income (labour) tax rate on revenues and by implicitly assuming self-financed tax cuts. Laffer [2004] argues that losses from tax cuts generated by reductions in the marginal tax rate are more than offset thanks to changes in income tax brackets that boost economic activities, and thus expand the tax base. Earlier studies were concerned with the level of taxation in developed countries - mainly in Northern Europe- and whether their respective tax rates lay beyond their peak rates. The implication is that these governments can increase revenues through tax cuts. Nevertheless, the literature has quickly restricted itself to study the effects of changes in the marginal income (labour) tax rate on revenues. The focus on labour taxes is mirrored in Prescott [2004], who argues that a substantial share of the discrepancy in worked hours between the United States and Europe can be accounted for by differences in labour tax rates. In his model, Prescott shows that income taxes in Europe are high enough to distort labour supply, and as a result GDP per worked hour is higher in the United States. The immediate conclusion is that an income tax cut in Europe would increase labour supply. Insofar as marginal changes of tax revenues are along the Laffer curve, no mention is made as to whether the tax cut is self-financed, that is, whether labour tax rates in Europe lie to the right of their Laffer curve peaks.

Governments in developing and emerging economies frequently engage in procyclical fiscal policies: they tend to cut taxes in booms, and raise them in recessions. This peculiar fiscal stance stems from the fact that running a budget surplus in booms is politically costly, thus the tax cuts during the expansionary phase of the cycle. By contrast, budget solvency, and subsequent fiscal consolidation measures needed to stench high deficits exert further pressure to raise taxes in recessions. Furthermore, as noted by Talvi and Végh [2005], because of the high variability in the tax base, governments in developing and emerging economies have no other option but to pursue procyclical fiscal policies. In addition, these policies exacerbate the business cycle in developing and emerging economies, which destabilises further the base from which tax revenues are extracted. An additional feature of the Laffer curve in developing and emerging economies is the narrowness of their tax base. The literature frequently refers to the size of the underground economy as a factor that can explain inefficiencies in tax collection and difficulties in raising additional tax revenues. The inability of tax authorities in developing and emerging economies to raise more tax revenues means that they have access to a smaller tax base and lower peak tax rate as a result. Therefore, it can be argued that countries with a large sector of underground economic activities relative to GDP will exhibit a Laffer curve with a depressed shape, as well as a lower revenue-maximising tax rate. The same argument holds regarding the size of agriculture in the economy, which also implies an elusive tax base. In developing and emerging countries, a shrinking tax base places a disproportionate burden on economic activities that are subject to taxation, which in turn depresses the elasticity to the tax rate. The shrinking tax base tends to push the Laffer curve downwards and shifts it to the left, which corresponds to lower tax revenues for a given tax rate, and a lower revenue-maximising tax rate. As a result, governments in developing and emerging economies would improve their tax revenues by reducing the size of underground economic activities relative to GDP. By incorporating a large share of their tax base for assessment, tax authorities can increase their revenues at constant rate.

In this chapter/paper we rely on the framework with which Trabandt and Uhlig [2011, 2012] came up in order to develop a Laffer tax curve specific to developing and emerging economies. We focus on the two main features of these countries, namely the large share of underground economic activities in output, and the collection cost tax authorities face. This allows us to highlight differences in Laffer curve shapes and peak rates between these countries and developed economies. We argue that tax authorities in developing and emerging economies face two broad challenges in implementing their fiscal policy, namely the importance of underground and/or undeclared economic activities relative to GDP, as well as high tax collection costs. Both factors result in either a shrinking tax base, or a variable tax base that prevent governments in these countries from extracting higher tax revenues. We summarise in this paper the differences between the two category groups of countries as follows: first, the Laffer curve is flatter and skewed to the left among developing and emerging economies with respect to developed ones. Second, the former reach a lower peak rate, which translates into lower tax revenues in comparison with the latter. We explain these discrepancies by showing that a large untaxed/undeclared underground sector depresses tax revenues, while high collection costs shift the Laffer curve to the left.

The chapter/paper is outlined as follows: the first section provides a review of the literature that focuses on two central aspects of fiscal policy. First, we address the debate in the literature as to how elastic the bases are to tax changes. In particular, we discuss the literature's predictions on household's labour supply elasticity. We also look at how the literature identifies and adresses the challenges encountered by tax authorities in developing and emerging countries. The second section introduces the model and its extensions. It presents the baseline model which is an alteration of the Trabandt-Uhlig framework. The baseline model is then upgraded with additional components that take into account the existence of undeclared/untaxed economic activities, as well as a quadratic cost of tax collection. The third section introduces the dataset, its sources and the treatment it goes through as a prelude to model simulation. We calibrate numerical values for structural parameters in our model, then estimate them using the Simulated Method of Moments. We compare estimated results against the usual values adopted in the literature for developed countries, and, to a lesser extent, developing ones. The fourth section reports the Laffer tax curves derived from the simulations of our model. We do observe that Laffer curves are flatter and steeper to the right of their peak rates in emerging countries, with lower tax rates and revenues compared to developed countries. The shift to the left is attributed to tax collection costs, whereas the depressed shape is explained by the existence of undeclared/untaxed economic activities. The section also presents and discusses predictions on the size of tax cuts in consumption, labour and capital that are self-financed. It focuses on the differences of self-financing for each component of the tax base, as well as the varying efficacy of such a policy under the baseline model and its two extensions. The fifth and last section concludes.

1 Literature review

We review in this section bodies of the literature that relate to the main contributions of this paper. We underline the main conclusions that the literature derives regarding the distortionary effects of taxes. We also look at the main conclusions derived by the literature regarding taxation and its issues in developing and emerging economies. The seminal contributions of Mirrlees [1971], Diamond and Mirrlees [1971] and Atkinson and Stiglitz [1976] have set the theory of optimal taxation in a rigorous analytical framework. The common thread in this pioneering literature is the importance of agent behaviour and how it considered in government policies. They stress what is a cornerstone of the Lucas [1972] critique, namely that fiscal policy needs to take into account individual economic agents' response to policy changes. Mirrlees [1971] offers an analytical framework where distribution of skill and human capital among the population affects progressive taxation. He also stresses the importance of the consumption/leisure tradeoff in determining labour supply[1]. This paper concerns itself with the amount of fiscal revenues the government can raise through consumption, labour and capital taxes. As such, we are not interested in welfare effects that stem from redistributive taxation, as it is the case in Mirrlees [1971] or Atkinson and Stiglitz [1976].

1.1 Distortionary effects of taxation - labour supply

A more recent body of literature studied the specific distortions of taxation on labour supply. Prescott [2004] studies the determinants of the gap in worked hours between the United States and a set of European countries. He uses a general equilibrium model in order to isolate the wedge effect generated by labour and consumption taxes on household labour supply. Prescott offers predicted volumes of worked hours that fit well with actual levels in Europe and the United States. Using the tax wedge and consumption-to-output ratio at the steady-state, the author concludes that workers in Europe work fewer hours than their American counterparts because the tax wedge is larger due to higher taxes in Europe. Rogerson [2006] agrees that government dynamics - as well as technology- are a prime candidate to account for the gap in worked hours between Europe and the United States. He mentions however that way the government spends its revenues influences the household labour supply schedule. Rogerson identifies two particular cases where labour supply is sensitive to taxation. First, when the government uses tax revenues to fund a lump-sum transfer, it creates an income effect which influences the household labour supply schedule. Second, if the government subsidies leisure instead, there is a substitution effect which alters the household labour supply schedule. The substitution effect is discussed by Langot and Lemoine [2017] in their discussion of shifting the tax burden to consumption and away from labour. They conclude that coordinated fiscal policy can overcome labour market weaknesses brought about by a large tax wedge. Rojas Quintero and Langot [2016] provide an alternative specification to the labour market in order to assess the impact of the tax wedge on labour supply. Using a search & match model *à la* Mortensen and Pissarides [1994], the authors show that they are able to better assess the time-varying impact of taxation on the

[1] Atkinson and Stiglitz [1976] discuss the distortionary effects of taxation in a world of heterogenous economic agents. There are also screening and agency issues the authors discuss, which are not relevant to the topic at hand.

labour market. Rojas Quintero and Langot [2016] are able to mimic the dynamics of worked hours - the intensive margin- as well as labour force participation - the extensive margin- in ten OECD countries between 1980 and 2013. Finally, the aftermath of the 2008 financial crisis and the inability of governments in developed economies to use fiscal instruments to mitigate its economic impact prompted a debate in Trabandt and Uhlig [2011, 2012] and Alesina and Giavazzi [2013] to re-assess the Laffer effects of the aggregate fiscal burden.

The household labour supply elasticity conditions the size of distortions generated by the tax wedge on the substitution effect. The literature defines the Constant Frisch Elasticity (CFE) of labour to wages at constant wealth. It mesures the sensitiveness of labour supply to exogenous shocks, such as changes in the tax rate. There is a great deal of debate as to the range of acceptable values it takes. Chetty *et al.* [2013] review results from micro- and macro-based pieces of evidence collected for developed economies. Their compendium highlights the contradictory results put forward in the literature with respect to household labour supply elasticity. Micro-based estimates rely on household surveys, and increasingly on field and natural experiments in order to give CFE parameter estimates. Chetty [2012] estimates the Frisch elasticity to be around 0.25 for micro-based studies. By contrast, macroeconomic datasets yield a higher estimate for the CFE parameter, ranging from 0.39 in Davis and Henrekson [2005] and values as high as Prescott [2004] at 1.18. On average, macro-based evidence yields a comparatively higher value of 0.71.

Differences in CFE values among developed economies lead to different interpretations of the importance of extensive and intensive margins. A high value for the Frisch elasticity assumes that the household is quite responsive to changes in labour income, at constant wealth level. In particular, the household is more willing to adjust worked hours, which is why we observe that macroeconomic aggregate to be highly procylical. Chetty *et al.* [2013] report that as a result, macro-based evidence tends to assign higher values to the CFE parameter in comparison to microeconometric studies. Macroeconomic models mitigate the effects of the discrepancy by introducing indivisible labour *à la* Hansen [1985] - namely, they take into account the extensive margin of labour supply. In this case, the procyclicality of worked hours is tempered with the much slower dynamics of entrances and exits on the labour market.

The importance of the intensive margin justifies the use of a non-separable utility function in order to describe the dynamics of household decision-making. Under the assumption of non-separability, the Frisch elasticity incorporates both the cross-elasticity of consumption and labour, as well as the intensive margin of the latter itself. Microeconometric evidence from the United States, and supplied by Hall [2009] offers empirical justification to adopt non-separability in the household's utility function. Nevertheless, it is difficult to prove the importance of intensive margins in developing and emerging economies. The literature on field experiments in those economies suggests that cash payments have little effect on working hours for targeted households. Studies from Latin America suggest that while the welfare effects of targeted subsidies are tangible and significant, there are no noticeable or significant changes in worked hours among households. Bloom *et al.* [2009] find that there is an increase in labour supply among women who improve their income thanks to these cash transfers. The change in labour outcome is however observed mainly in terms of new arrivals on the labour market, and not in changes in worked hours. Alzua *et al.* [2010] study the conditional cash transfer programmes enacted in Mexico, Nicaragua and Honduras, and conclude that these programmes do not provide significant disincentives to work. In particular, the targeted households do not exhibit significant changes in worked hours, whereas tremendous changes are reported for child labour, which is halved, and increasing labour participation of female members of these households. In Brasil, Veras Soares *et al.* [2007] find similar results, with no sizeable impact on worked hours as well as labour force participation. Ardington *et al.* [2009] study the impact of a social transfer scheme in South Africa, in the form of increased pensions for retirees. They find that households with at least one pensioner exhibit an increase in employment rates, but no changes in worked hours. These findings suggest that the intensive margin is small to nil in developing and emerging economies. By contrast, the extensive margin effects are large and significant, especially for female members of the workforce.

The cash transfer programmes in Latin America, and pension reforms in South Africa elicit changes in labour supply that can be used as proxies for income shocks. Given the randomness of instruments used by each of these studies, Frisch elasticity estimates can be inferred from changes in labour supply. Given the lack of statistically significant results for the intensive margin, it stands to reason to conclude that these are not as important in developing and emerging economies as they are in developed ones. As a result, we can rule out the importance of cross-elasticity between worked hours and household consumption, and focus instead on the extensive margin. In addition to the preeminence of labour enrolment over worked hours, developing and emerging economies exhibit also specific features regarding the way fiscal policy is carried out, and how tax dynamics play out.

1.2 Taxation in developing and emerging economies

There is a host of issues that can account for differences of shape of tax revenues raised by the Laffer curve between developed and developing and emerging economies. The literature frequently refers to the size of the underground economy as a factor that can account for inefficiencies in tax collection and raised tax revenues. Feld and Schneider [2010] underline the importance of underground economic activities relative to GDP. They point out that these are higher among developing and emerging economies in comparison to developed countries. As a result, the tax base is narrower, and results in significant tax revenu losses. The inability of tax authorities in developing and emerging economies to raise more tax revenues means that they have to contend with a smaller tax base and a lower peak rate as a result. The same argument can be made with respect to the size of agriculture in the economy, which also leads to an unreliable tax base. Khan [2001] reports that for a sample of developing and emerging countries, the steady growth in agricultural GDP has not generated a commensurate increase in fiscal revenues. He ascribes this result to the difficulties tax authorities encounter in those economies in assessing agricultural income for taxation. In addition, tax authorities in developing and emerging countries may face significant costs in tax collection. Fiscal inefficiencies are underlined in Agénor and Montiel [2015]. They argue that the government faces a continuum of small-income earners that represent a disproportionately large share of potential taxpayers. Tax authorities therefore face an inadequate tax base, one where revenues cannot be extracted without incurring substantial collection costs. Furthermore, mediocre institutional quality in those countries implies a potential for corruption that further erodes fiscal efficiency. The political economy of taxation and fiscal policy is also highlighted by Cukierman *et al.* [1992]. These authors show that tax efficiency is positively correlated with political stability and institutional quality, as well as other economic indicators, such as the sector composition of output, urbanisation and openness to trade. Stern [1991] also studies taxation in developing and emerging economies through the prism of their political economy. This has been mentioned by Buchanan and Lee [1982] when they argue that the government sets its short-run tax rate beyond its long-run peak value due to electoral considerations. The fact that governments in developing and emerging economies may have endogenous preferences in forming their policies may have a significant impact on fiscal policy design. This is critical to these economies, since the government frequently steps in to supply public goods, or implement transfer schemes to support its population. As a result, fiscal policy is key, either through taxes as a source of revenues, or through tax incentives that respond to a welfare criterion. The fact the policymakers may have endogenous preferences may skew fiscal policy instruments, and introduce distortions in addition to those of the tax wedge itself.

2 The model

The benchmark setup for our model reprises Trabandt and Uhlig [2011, 2012] where the intertemporal optimisation programmes of firms and households reflect the distortionary effects of taxation. Households maximise their lifetime utility function subject to resources constraint. The programme writes:

$$\max_{c,n,k,i,b} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[u(c_t, n_t) + v(g_t)\right] \tag{2.1}$$

subject to:

$$(1+\tau_t^c)c_t + i_t + b_t \leq (1-\tau_t^n)w_t n_t + (1-\tau_t^k)(r_t - \delta)k_{t-1} + \delta k_{t-1} + R_t^b b_{t-1} + s_t \tag{2.2}$$

$$k_t = (1-\delta)k_{t-1} + i_t \tag{2.3}$$

Where c, n, g denote respectively consumption, labour and government expenditure. Capital law of motion (2.3) states that future capital k is equal to its present value net of depreciation factor δ plus investment i. Notice that the government levies taxes on consumption, labour and capital to fund its expenditure. They also issue a state-contingent one-period bond b with coupon R^b. The government budget constraint writes:

$$g_t + s_t + R^b b_{t-1} \leq \tau_t + b_t \tag{2.4}$$

$$\tau_t = \tau_t^c c_t + \tau_t^n w_t n_t + \tau_t^k (r_t - \delta) k_{t+1} \tag{2.5}$$

Where τ refers to tax revenues from consumption, labour and capital, denoted τ^c,τ^n and τ^k respectively. The government spends g and transfers s to households, while it pays $R^b b$ in debt and coupon. Firms maximise their profits subject to technology, denoted z and output y. Their maximisation programme writes:

$$\max_{k,n} y_t - r_t k_{t-1} - w_t n_t \tag{2.6}$$

subject to

$$y_t = z_t k_{t-1}^{\alpha} n_t^{1-\alpha} \tag{2.7}$$

2.1 Constant Frisch elasticity - labour supply wedge

As noted in Rogerson [2006] and Prescott [2004] among others, the standard optimality condition for labour supply for the household implies that the marginal rate of substitution between consumption and labour is equal to the marginal productivity of the latter. Formally:

$$|MRS^{c,n}| = MPL \tag{2.8}$$

In a model with taxes on consumption and labour however, taxes have a distortionary effect on equation (2.8). The tax wedge, which we denote $\varphi(\tau) \leq 1$ can be computed from the household optimisation programme in equations (2.1) through (2.3). The optimality condition is thus:

$$\left|\frac{\partial U_n}{\partial U_c}\right| = \frac{1-\tau^n}{1+\tau^c} \times w \tag{2.9}$$

Where $w = \dfrac{\partial y}{\partial n}$ and ∂U_x denotes the marginal utility with respect to argument x, with $x \in c, n$. We also write $\varphi(\tau) = \dfrac{1-\tau^n}{1+\tau^c}$ for the tax wedge, and w wages, which are equated with marginal productivity of labour. Equation (2.8) can be rewritten as follows:

$$|MRS_t^{c,n}| = \varphi(\tau_t) MPL_t \tag{2.10}$$

As mentioned before, we make a departure from the benchmark model laid out by Trabandt & Uhlig by assuming separability of consumption and labour in the household's utility function. We propose the following functional form to incorporate in equation (2.1):

$$u(c_t, n_t) = \frac{c_t^{1-\sigma}}{1-\sigma} - \frac{n_t^{1+\phi}}{1+\phi} \tag{2.11}$$

Where $\sigma \geq 1$ denotes the Constant Relative Risk Aversion (CRRA) elasticity of substitution parameter, and $\phi \geq 0$ the inverse Constant Frisch Elasticity (CFE) of labour supply to wages. Equation (2.10) can therefore be rewritten as follows:

$$n_t^{\phi} c_t^{\sigma} = \frac{1-\tau_t^n}{1+\tau_t^c} \times \frac{(1-\alpha) y_t}{n_t} \tag{2.12}$$

We rewrite equation (2.12) in order to provide a tractable expression of after-tax labour supply, which we denote $n_t^s(\tau)$:

$$n_t^s(\tau) = \left[(1-\alpha) y_t c_t^{-\sigma} \varphi(\tau_t)\right]^{1/(1+\phi)} \tag{2.13}$$

Equation (2.13) depends on We can show that after-tax labour supply decreases with the size of the tax wedge, meaning that the larger consumption and labour taxes, the smaller $\varphi(\tau)$ gets, and the higher its distortionary effects on the optimality condition of equation (2.9). We can also show that the elasticity of labour supply to the tax wedge is the inverse of $1+\phi$. Although our specification differs from that of Trabandt & Uhlig, we also find that labour supply can be written as a function of its share of output, $1-\alpha$, the tax wedge, $\varphi(\tau)$ and the Frisch constant elasticity, ϕ. However, our expression is more parsimonious.

2.2 The capital tax wedge

In addition to labour and consumption taxes, the government also taxes capital, which introduces a wedge between its marginal productivity and the rent it pays to capital-holders. Namely:

$$r_t = (1-\tau_t^k)(\alpha y_t/k_{t-1} - \delta) \tag{2.14}$$

At the steady-state, the after-tax capital-to-output ratio is:

$$\frac{\bar{k}}{y} = \left[\frac{\bar{r}}{\alpha(1-\tau^k)} + \frac{\delta}{\alpha}\right]^{-1} \tag{2.15}$$

We observe that the after-tax capital-to-output ratio declines with capital tax τ^k. Since capital stock declines with taxes, its marginal productivity increases as it becomes scarce, and thus rent $\bar{r}$ increases. We argue that the capital-to-output ratio does not give a meaningful idea of the capital tax base and the distortionary effect beyond that on rent $\bar{r}$. Instead, we use the Euler equation from the household's optimisation programme in order to extract an expression for the steady-state after-tax capital stock as a function of its tax τ^k as well as other variables and parameters of interest. We write the full Euler equation as delineated in equations (2.1) to (2.3):

$$\frac{c_t^{-\sigma}}{1+\tau_t^c} = \beta\mathbb{E}\left[\frac{c_{t+1}^{-\sigma}}{1+\tau_{t+1}^c}\left(1+(1-\tau_{t+1}^k)\left(\alpha z_{t+1} n_{t+1}^{1-\alpha} k_t^{\alpha-1} - \delta\right)\right)\right] \tag{2.16}$$

At the steady state, equation (2.16) is rewritten so as to provide an expression for the after-tax capital stock, which writes as follows:

$$\bar{k}(\tau^k) = n\left[\frac{\alpha\beta\bar{z}(1-\tau^k)}{1-\beta+\beta\delta(1-\tau^k)}\right]^{1/(1-\alpha)} \tag{2.17}$$

Balanced growth at the steady-state implies that both capital and labour increase at similar rates. As shown in equation (2.13) after-tax capital stock is also influenced by levels of taxes on labour and consumption. It is also increasing in productivity as measured by steady-state TFP growth rate $\bar{z}$. High values of β, the discount factor, denote low interest rates, and therefore high capital stock. Parameter α has also a positive impact on capital stock, since a high value means that capital captures a larger share of output. Finally, capital stock is decreasing in depreciation factor δ and the tax rate τ^k.

2.3 Extensions of the Laffer baseline model

The baseline model described in the section above uses a neoclassical setting in order to build a micro-founded Laffer curve. Nonetheless, the model does not make provisions for cases where the government is unable to extract full revenues from its tax bases, or faces collection costs.For instance, the neoclassical model suggests that labour supply shifts entirely to leisure (or non-market activities) when it is taxed at 100%. Such an extreme case does not take into account the possibility that some residual share of household labour supply remains untaxed. This would be the case either because the government cannot tax it, or would bear prohibitive costs in doing so. The extensions to the baseline model explore two ways to account for imperfect governance in the Laffer curve. The first is to assume that resources are only partially subjected to taxation. The second posits that tax authorities lose a fraction of their fiscal revenues when they are collected.

2.3.1 The benchmark model with untaxed/undeclared tax base

The core components of the baseline are kept in place. We now assume that only a fraction $p \in)0;1]$ of the tax base is available for the government to extract fiscal revenues. The rationale behind this model is that underground economic activities exist regardless of current levels of taxation. We argue that factors other than taxation may have an impact on the size of the underground economy relative to GDP. Feige and McGee [1983] argue that the Swedish tax system is too onerous and provides incentives for economic agents to evade taxes through undeclared economic activities. As far as developing and emerging economies go, that may well be also true in their case, though it is not realistic to assume that the underground economy is all about tax evasion. A large shadow economy relative to output could also be the sign of an unhealthy relationship between citizens in a given country, and their government. Per Frey and Schneider [2000] and Schneider *et al.* [2010], lack of confidence in government institutions may lead agents to hide their resources away from tax authorities. In addition, developing and emerging economies exhibit a higher share of undeclared economic activities relative to GDP either because the dominant sectors are difficult to assess for taxation, or because the government needs to exert costly efforts to assess its tax base. Agriculture is a pertinent example to illustrate the ambiguity of underground economic activities and the difficulties surrounding their tax assessment. We propose to model the share of taxable economic activities as a probability ρ that an individual economic agent pays taxes on consumption, labour and capital stock. As a result, economic agents adapt their optimisation programme in order to reflect both effects of differentiated taxation and its distortions on their choices. Household optimisation seeks to maximise lifetime utility in equation (2.1) on consumption and labour, subject to the new resources constraints below:

$$c_t(\rho(1+\tau_t^c)+(1-\rho))+i_t+b_t-w_t n_t(\rho(1-\tau_t^n)+(1-\rho))-(r_t-\delta)(\rho(1-\tau_t^k)+(1-\rho))-R_t^b r_{t-1} \quad (2.18)$$

The optimisation programme for the household reflects the impact of untaxed/undeclared economic activities. First order conditions for consumption and labour yield the optimality condition which equates the household marginal rate of substitution with marginal productivity of labour, namely:

$$c_t^{\sigma} n_t^{\phi} = \frac{1-\rho+\rho(1-\tau_t^n)}{1-\rho+\rho(1+\tau_t^c)} w_t \tag{2.19}$$

The wedge in equation (2.19) is denoted $\varphi(\tau, p)$ such that $\varphi(\tau, p) \geq \varphi(\tau)$ the tax wedge derived for equation (2.9). The government's inability to extract taxes from the full labour tax base results in smaller distortion effects. This means that a government that can only tax a share ρ of its tax base generates fewer distortions. Indeed, the neoclassical setting of our model predicts that fraction, $1-\rho$, of underground/undeclared labour behaves according to the optimality conditions set out in equation (2.8). As a result, the overall distortionary effect of taxation is mitigated. The tax wedge takes into account tax rates for labour and consumption, as well as the share ρ of taxed/declared activities. The steady-state expression for after-tax labour supply, denoted $n^s(\tau, p)$, writes:

$$n^s(\rho, \tau) = \left[(1-\alpha)\frac{c}{y}\frac{1-\rho+\rho(1-\tau^n)}{1-\rho+\rho(1+\tau^c)}\right]^{1/(1+\phi)} \tag{2.20}$$

Equation (2.20) shows that the distortion effect is lower in the after-tax labour supply than in the benchmark expression of equation (2.13). By contrast, the labour Laffer tax curve will also be constrained by the fraction ρ of taxed wages. As a result, the effective tax base is now $\tau^n \rho w n$, implying a narrower labour tax base for any rate τ^n. The labour Laffer tax curve will be therefore flatter than the one predicted in the baseline model.

We proceed with the same steps in writing the after-tax capital stock. We rewrite the Euler equation (2.16) in order to incorporate shares ρ and $1-\rho$ of taxable and undeclared marginal returns of capital, as well as consumption. We obtain the following expression:

$$\frac{c_t^{-\sigma}}{1-\rho+\rho(1+\tau_t^c)} = \beta\mathbb{E}\left[\frac{c_{t+1}^{-\sigma}(1-\rho+\rho(1-\tau_{t+1}^k))}{1-\rho+\rho(1+\tau_{t+1}^c)}\left(1+\alpha z_{t+1} n_{t+1}^{1-\alpha} k_t^{\alpha-1} - \delta\right)\right] \tag{2.21}$$

Note that the Euler equation takes into account not only present and future tax rates for consumption and capital, but also the distortionary effect of partial access to tax bases. The same interpretation as for equation (2.20) applies. The expression of after-tax capital stock can be written as follows:

$$k(\rho, \tau) = n(\rho, \tau)\left[\frac{\alpha\beta\bar{z}(1-\rho+\rho(1-\tau^k))}{1-\beta+\beta\delta(1-\rho+\rho(1-\tau^k))}\right]^{1/(1-\alpha)} \tag{2.22}$$

The distortionary effects of taxation on after-tax capital stock are increasing in the size of declared/taxed share ρ. When ρ converges to unity, steady-state capital stock described in equation 2.22 converges to its baseline expression (equation (2.17)).

2.3.2 The benchmark model with collection costs

In collecting its tax revenues, the government loses a fraction of it, either in the form of bureaucratic processing costs, or because of inherent inefficiencies. We use the quadratic form for the collection cost to incorporate in the budget constraint. Equation 2.23 allows us to introduce tax revenue losses with each tax rate change in the model. Parameter κ captures the amount of marginal revenue loss as the ratio between actual tax burden and the theoretical contribution of each tax rate to total fiscal revenues.

$$g_t + s_t + R_t^b b_{t-1} \leq \tau_t + b_t - \frac{\kappa}{2}\tau_t^2 \tag{2.23}$$

$$\tau_t = \tau_t^c c_t + \tau_t^n w_t n_t + \tau_t^k (r_t - \delta) k_{t-1} \tag{2.24}$$

Recall that τ is total fiscal revenues. When expressed as a percentage of output, it becomes aggregate tax burden τ/y. For every marginal change in the overall tax burden, the government loses a fraction κ, hence the quadratic component $0.5\kappa\tau^2$. The collection cost encompasses various inefficiencies, ranging from high effort the government needs to exert to extract taxes, to inefficient loopholes in domestic legislation. Given that the quadratic cost is not included in the household's optimisation programme, enters in the Laffer curve on the revenue side as a result of government tax policy. As a result, the government no longer sets a tax rate τ for each component of its tax base. Instead, we replace each tax rate of the baseline model by a new rate denoted τ^κ such that $\tau^\kappa = \tau(1 + \kappa\tau/2)$. Instead of taxing at rate τ the government taxes at τ^κ with $\tau \leq \tau^\kappa$. The collection cost implies a loss of fiscal revenues proportional to the tax rate. Due to their budget constraint, tax authorities increase their tax rate by the same amount. As a result, the Laffer curve becomes more sensitive to tax rate changes: The baseline model predicts $\partial\tau$, while the extension model implies $\partial\tau^\kappa = (1 + \kappa)\partial\tau$. This collection cost results not only in higher effective tax rates, it also accelerates the convergence to the peak rate, which generates a reduction in the amount of tax revenues the government can collect. Changes in the tax rate become more expensive as tax authorities need to offset tax collection costs. Consequently, the economy reaches more rapidly its peak rate, which implies a shift of the Laffer curve to the left. Furthermore, as the distortionary effects become larger, the tax base narrows, and tax revenues associated with the peak rate decline.

2.3.3 Shapes of the Laffer tax curve

We have defined in the previous section the after-tax expressions of labour supply and capital stock, as well as the distortionary effects of taxation. We are now able to formulate expressions for the labour and capital Laffer tax curves, denoted respectively $\mathfrak{L}(n, \tau^n)$ and $\mathfrak{L}(k, \tau^k)$. For each factor of production, we multiply its tax base x by its tax rate τ^x to get tax revenues $\mathfrak{L}(x, \tau^x)$ such that $\mathfrak{L}(x, \tau^x) = \tau^x x$. Marginal returns from the tax base are computed as follows: $\dfrac{\mathfrak{L}(x, \tau^x)}{\partial x}$, whereas the marginal tax revenues for the government are written as follows: $\dfrac{\mathfrak{L}(x, \tau^x)}{\partial \tau^x}$. The Laffer curve for each tax base exhibits a non-monotonic: tax revenues are concave and increasing in the tax rate until the latter reaches its peak value. Beyond this point, tax revenues decline until they reach zero.

The curve, its peak rate and revenues are all function of structural parameters. For labour supply, the literature has discussed exhaustively the impact of the tax wedge $\varphi(\tau)$ as well as the size elasticity of substitution. By contrast, it has devoted little time to study the impact of other structural parameters and steady-state variables. Other components can also influence the Laffer curve and its shape: for instance, the consumption-to-output ratio, which measures the income effect, may dominate the substitution effect (CFE parameter ϕ). Labour share of output, $1-\alpha$, also contributes to the income effect in determining labour's share of total output. Similarly, other factors can influence the capital Laffer tax curve. After-tax capital stock is increasing in labour, as well as the steady-state productivity growth rate ($\bar{z}$). The capital tax Laffer curve is also sensitive to interest rate net of depreciation ($\bar{r}-\delta$), the discount factor, β, and the capital share of output α.

3 Data and descriptive statistics

3.1 Data sources

We use data from available open sources and seek to build the largest set possible of countries to incorporate in our sample set. To that effect, we use the World Bank [2018] World Development Indicators (WDI), the Groningen Growth & Development Center database in Feenstra *et al.* [2015] (formerly the Penn World Table - PWT) and KPMG consultancy firm database of corporate tax rates[2] These three sources allow us to calibrate and estimate the structural parameters of the model in this paper. These datasets also allow us to compute the effective tax rates that match these of our model. Mendoza *et al.* [1994] point out that official tax rates do not form a pertinent basis for cross-country comparison due to the plethora of differences in domestic legislation, tax collection enforcement and allowances for tax deductions. As a result, they propose to compute effective tax rates using common tax bases. Fortunately, the WDI dataset has already harmonised to a large degree cross-country tax rates, although we still need to introduce some alterations following the methodology of Mendoza *et al.* [1994]. The discrepancies between advertised and effective tax rates are well illustrated with the tax rates compiled by KPMG for a fairly large country sample set. Using the Laffer capital tax curve, we investigate whether the corporate tax rate lies beyond its peak rate value for instance. Finally, we also use Schneider *et al.* [2010] and their measure of the underground economy in GDP for a large set of countries to compute the share of undeclared and untaxed economic activities in GDP.

Table 1 below reports the main macroeconomic variables used for our calibration/estimation exercice. The table also reports the relevant data sources and references, as well as transformations introduced to achieve this objective. Real GDP extracted from the WDI dataset is used as a proxy for output in our model. GDP is expressed in real Dollars for adequate cross-country comparisons. Other macroeconomic aggregates, such as household expenditure and gross capital formation are used as stand-ins for consumption and investment, respectively. We prefer to extract these variables in terms of fractions of GDP from the PWT dataset for two reasons:

[2] Available on KPMG's website -corporate tax rates table. Accessed July 2018.

first, they provide adequate time series in order to compute steady-state values for our model. Second, we can avoid national accounting discrepancies when both variables are incorporated in real Dollars instead. We also use data on capital stock in order to calibrate values for capital share of output α and depreciation factor δ. Capital stock is also expressed in real Dollars for cross-country comparisons. Productivity, defined as Total Productivity Factors (TFP), is measured as relative TFP to the United States in the PWT database. Given that the literature has formed a broad consensus on an annual 2% for the long-run TFP growth in the United States, TFP growth rates for each country is computed as the product of its relative productivity and 1.02 (1+2%). As mentioned earlier, we have argued for incorporating labour in the model as an enrolment rate rather than a share of worked hours. As a result, we look for data on the share of employed individuals in the 15-64 age cohort for each country. Interest rate is computed from lending interest rate adjusted for inflation. Individual values for countries may differ wildly because many developing and emerging economies have experienced episodes of hyperinflation in the past. As a result, we expect structural parameters that are calibrated out of this variable to exhibit significant cross-country differences. Finally, taxes are kept unchanged except the variable for labour taxes and contributions. We multiply this variable by $\frac{\alpha}{1-\alpha}$ in order to substitue the denominator (profits and revenues) with wages. The dataset we have built from these macroeconomic variables reported in table 1 is then used for assigning numerical values to our structural parameters, first by means of calibration, and then with estimation techniques. The dataset also provides long-run averages for steady-state values of our model's variables.

3.2 Calibration

Given the sample size of our country group, as well as the constraints on data availability across our data sources, we opt for a streamlined process in assigning numerical values to our parameters. To that effect, we follow the advice given by Kydland and Prescott [1998] where discipline should be exercised as to the calibration strategy of the model's deep structural parameters. For instance, we expect significant differences in parameter values, even among seemingly homogenous country groups. By contrast, the literature opts for a unique set of calibrated values, as is the case in Trabandt and Uhlig [2011, 2012]. The authors calibrate similar values for EU-14 countries and the United States, even though small but significant differences subsist between the two sets of calibrated values. That is why, in contrast to this avenue, we calibrate specific values for each country in our sample set, following Kydland and Prescott [1998] and Cooley and Prescott [1995]. Namely, we compute long-run averages and ratios for the relevant macroeconomic aggregates and time series, and extract calibrated values for our structural parameters. We show that for some of these, the Laffer curve is quite sensitive and alter its shape significantly from one country to another. Table 2 below reports the structural parameters for our model, their respective economic interpretations, as well as the support range of acceptable values and calibration formulas. The calibrated values for the structural parameters of our model are computed using steady-state values for the relevant macroeconomic aggregates, as underlined by Cooley and Prescott [1995]. For instance, we use the Cobb and Douglas [1928] production function in equation (2.7) in order to calibrate the numerical value of α, the capital share of output.

Table 1: Core macroeconomic variables used for calibration/estimation of structural parameters.

Variable	Set	Reference	Comments
Output y	WDI	NY.GDP.MKTP.KD	GDP (constant 2010 US$)
	PWT	RGDPO	Output-side real GDP at chained PPPs (in mil. 2011US$)
Consumption c	WDI	NE.CON.PETC.ZS	Household final consumption expenditure, etc. (% of GDP)
	PWT	CSHC	Share of household consumption at current PPPs
Capital k	PWT	CK	Capital stock at current PPPs (in mil. 2011US$)
Investment i	WDI	NE.GDI.TOTL.ZS	Gross capital formation (% of GDP)
	PWT	CSHI	Share of gross capital formation at current PPPs
Productivity z	PWT	CTFP	TFP level at current PPPs (USA=1)
Labour n	WDI	SL.TLF.CACT.ZS	labour force participation rate (ILO estimate)
	PWT	EMP	Number of persons engaged (in millions)
Interest rate r	WDI	FR.INR.RINR	Real Interest rate
Tax burden τ	WDI	GC.TAX.TOTL.GD.ZS	Tax revenue (% of GDP)
Cons. tax τ^c	WDI	GC.TAX.GSRV.VA.ZS	Taxes on goods and services (% value added of industry and services)
Capital tax τ^k	WDI	GC.TAX.YPKG.RV.ZS	Taxes on income, profits and capital gains (% of revenue)
Labour tax τ^n	WDI	IC.TAX.LABR.CP.ZS	labour tax and contributions (% of commercial profits)

Note: Data for all sources spans 1950-2015. We use long-run average on available data points for each country in our sample set.

Table 2: Structural parameters - benchmark and extension models.

Par.	Interpretation	Support	Definition
α	Capital share	)0; 1]	$\frac{\ln \bar{y} - \ln \bar{n}}{\ln \bar{k} - \ln \bar{n}}$
β	Discount factor	< 1	$1/(1+\bar{r})$
δ	Capital depreciation	)0; 1]	$1 + \bar{i}/k - (1+g^k)(1+g^n)$
ϕ	Firsch elasticity (CFE)	)-1,1]	$\frac{\partial n^s}{\partial w}\frac{w}{n^s} = \frac{1}{1+\phi}$
σ	CRRA parameter	≥ 1	$\frac{\bar{r} - \ln \beta}{\Delta \bar{c}}$
ρ	Declared activities	)0; 1]	Schneider *et al.* [2010]
κ	Tax collection cost	$\mathbb{R}$	$\frac{\bar{\tau}/y}{c/y\bar{\tau}^c + \alpha\bar{\tau}^k + (1-\alpha)\bar{\tau}^n} - 1$

Note: We use long-run averages of macroeconomic variables to approximate the steady-state expressions of model variables. The calibration methods adopted for the hyper-parameter $\theta = [\beta, \delta, \alpha, \sigma, \phi, \rho, \kappa]$ are based on steady-state expressions and ratios. Frisch elasticity parameter ϕ is computed using as an elasticity of labour supply relative to real wages. Tax collection cost κ measures the gap between actual tax burden and its implied value using calibrated parameters for the frictionless tax burden level.

Similarly, we use capital accumulation to compute the investment-to-capital ratio in order to calibrate δ, the capital depreciation. We use the standard Euler equation in order to calibrate values for the discount factor, β, as well as the CRRA parameter, σ. The CFE parameter, ϕ, affects the extensive margin of labour supply, so we compute it as a function of the employment elasticity to wages. As mentioned earlier, the Constant Frisch Elasticity (CFE) parameter is debated in the literature: values estimated from macroeconomic aggregates differ significantly from those derived from households surveys. Hall [2009] uses this argument in order to incorporate cross-elasticity between consumption and worked hours. Trabandt and Uhlig [2011, 2012] use this argument in turns to formulate non-separability in the household's utility function. In our model however, we ignore cross-elasticity between consumption and worked hours, as labour dynamics are more driven by the extensive margin than the intensive margin in developing and emerging economies. The parameter ρ is calibrated in a straightforward way: we use estimates from Schneider *et al.* [2010] to compute the share of declared and/or legitimate economic activities, ρ. The fraction, $1-\rho$, refers to the size of underground economic activities in GDP. Finally, the parameter κ denotes the tax collection cost. We calibrate it to match the discrepancy between the overall tax burden (relative to GDP) and the sum of the contributions of each tax base component with respect to their steady-state values. We use this proxy instead of the indicator used by Yesin [2004] due to the lack of administrative data on resources allocated to tax collection in developing and emerging countries.

3.3 Country groups and benchmarks

We use different sub-categories to classify countries in our sample set for several reasons. First, there is no agreement on the set of criteria that breaks down countries into developed economies on the one side, and developing and emerging economies on the other side. Second, a unique criteria is likely to be arbitrary, and may introduce bias in cross-group comparisons. In order to address these limitations, we propose to formulate several sets of criteria in order to consolidate our sample set into various sub-category groups. We focus mainly on two classifications. First, we use the World Bank Atlas method based on an income criterion. The World Bank cut-offs at \$12,056 and \$955 in real income per capita to create three sub-groups: High, Middle and Low-income country groups. Both Middle- and Low-income groups are treated as developing and emerging economies, while the High-income economies category is considered as a proxy for developed countries. The World Bank further breaks down the Middle-income bracket into Upper-Middle and Lower-Middle sub-groups with $[\$12,055-\$3,896]$ and $[\$3,895-\$955]$ in real income per capital, respectively. Second, we use a geographical criterion by creating regional country groups. We exclude High-income countries and create the following sub-groups: Latin America & the Caribbean, Sub-Sahara Africa, Middle-East & North Africa, Central & Eastern Europe, Balkans & Central Asia, and South Asia & Pacific. The main advantage of this criterion is that it is exogenous to other factors that may affect tax rates and revenues.

For robustness checks, we use three other classifications. We first start by assigning an institution-based criterion to define developed countries: G7, core Organisation for Economic Cooperation and Development (OECD) countries and OECD countries. G7 refers to the seven major global economies, namely the United States, United Kingdom, Japan, Italy, Germany, France and Canada. The category Core OECD refers to founding members and countries that have joined the OECD before the 1990s. Category OECD refers to the current membership[3]. Another criterion we use for our analysis looks at attributes other than income in our country sample. We look at differences from the perspective of institutional quality, using the Freedom House ranking score. Our sample is divided into three sub-categories: Free, Partially Free and not Free per Freedom House scoring method. Finally, we look at our sample set through the prism of economic activities, namely the weight of agriculture and natural resources rents relative to GDP. We create decile-based categories in order to compare on the one hand agrarian *versus* non-agrarian economies, and resources-rich/poor country groups on the other hand. Results for these classifications are reported in the appendix.

3.4 Summary statistics: structural parameters

We calibrate the numerical values of our sample set of 152 countries using macroeconomic aggregates and formulas reported in tables 1 and 2 respectively. We obtain individual values for each country for the parameter set $\theta = [\beta, \delta, \alpha, \sigma, \phi, \rho, \kappa]$. In this subsection, we start by reporting descriptive and summary statistics for the whole sample. Then, using the subcategories discussed earlier, we compare differences in mean values between the income and regional categories. Table 3 reports summary statistics for the whole sample. We notice that the sample-wide average values for our structural parameters fall within range of acceptable values in the literature. Cooley and Prescott [1995] compute credible values using the calibration methods referred to in table 2. The parameter β denotes the discount factor with a sample-wide average value of 0.929. This implies a long-run average interest rate of 7.6% *per annum*. This value is pretty high compared to figures used in the literature, namely Cooley and Prescott [1995] and King and Rebelo [1999]. Notice however that there are a couple of countries whose long run average interest rate skew the mean to lower values for parameter β. Zimbabwe, Brazil, Ecuador and

[3] As of July 2018.

Mongolia exhibit exceedingly low values for parameter β. By excluding these countries, we reach the higher sample average of 0.942, which is close to the median value reported on table 2.

Table 3: Structural parameters - whole sample

Statistics	β	δ	α	σ	ϕ	ρ	κ
Mean	0.929	0.028	0.311	2.710	0.379	0.668	0.252
Std. Dev.	0.055	0.023	0.216	2.077	0.637	0.136	1.254
Median	0.942	0.024	0.268	1.913	0.372	0.663	.010
Maximum	0.999	0.150	0.943	13.127	4.158	0.914	9.711
Minimum	0.559	0.000	0.010	1.021	-4.379	0.312	-.945

Note: The baseline dataset covers the period 1950-2015. Calibrated values are computed for available data points within this time period. Unweighted averages and other statistics are reported for all 152 countries in the sample. The parameter ρ is computed from Schneider *et al.* [2010] for the period 1996-2006 and for 132 countries in our sample set. Economic interpretations of structural parameters are reported on table 2

The literature usually calibrates parameter β by using the 3-months maturity for the United States Treasury Bills (T-Bills). Their long-run average being at around 1% quarterly, β is calibrated at 0.99 or 0.961 in annual terms. Cooley and Prescott [1995] offer an alternative calibration in which parameter β depends on additional parameters. They use the Euler equation at the steady-state in order to extrapolate a value for β which is function of capital depreciation δ, capital share of output α and capital-to-output ratio $\bar{k}/y$ at the steady state. Using the numerical values of these parameters, Cooley and Prescott [1995] calibrate an annual value of $\beta = 0.947$. Hairault and Portier [1995] calibrates β on French quarterly data, at 0.953 using an annual interest rate of 4.9%. By contrast, Laffargue *et al.* [1992] and King and Rebelo [1999] calibrate for real interest rate such that $\beta = 0.98$ on an annual basis. For small open economies, Schmitt-Grohé and Uribe [2005] calibrate $\beta = 0.96$ for Canada, which implies an annual interest rate of 4.1%. García-Cicco *et al.* [2010] calibrate a parameter value $\beta = 0.922$ for Argentina, using an average interest rate of 8.41% *per annum*.

For capital depreciation factor δ, we adopt the calibration formula of Cooley and Prescott [1995]: $\delta = 1 + \bar{i}/k - (1 + g^k)(1 + g^n)$. $\bar{i}/k$ denotes the investment-to-capital ratio, g^k and g^n denote capital stock and demographic growth rates, respectively. By taking into account these growth rates there is a large discrepancy between our calibrated values, and these used in the literature. In our sample, capital depreciation parameter δ displays a value of 0.028 on average, which is lower than the value typically found in the literature. Hairault and Portier [1995] reports a quarterly depreciation rate of 0.0125 for the French economy, which yields an annual value of $\delta = 0.051$. King and Rebelo [1999] assign a close value of $\delta = 0.06$ on the basis of postwar data in the United States. They also admit that a higher depreciation factor of 10% can yield similar results. Trabandt and Uhlig [2011, 2012] also calibrate a close average value $\delta = 0.07$, ranging from 0.048 (Sweden) to 0.098 (Portugal). For emerging economies, García-Cicco *et al.* [2010] retain $\delta = 0.1255$ for Argentina, while Aguiar and Gopinath [2007] assign a lower value of $\delta = 0.05$ in their study of business cycles in emerging economies. Despite lower values on average for capital depreciation δ, some countries in our sample exhibit double-digits depreciation rates. Azerbaijan, Zimbabwe and Equatorial Guinea all exhibit values larger than 10%.

Parameter α refers to capital share of output, and it is calibrated using capital stock and output per capital in log terms, *i.e.* $\alpha = \dfrac{\ln y - \ln n - \ln z}{\ln k - \ln n}$. The literature calibrates for α a usual value of 1/3, derived from Solow [1957] and his investigation of the Total Factor Productivity (TFP) residual in the United States. García-Cicco *et al.* [2010] use a similar value for their simulation of business cycles in Argentina. King and Rebelo [1999] also use the Solow estimate of $\alpha = 1/3$. Schmitt-Grohé and Uribe [2005] use a similar value $\alpha = 0.32$ to calibrate a small open economy. By contrast, Cooley and Prescott [1995] assign a slightly higher value $\alpha = 0.4$ to capital share of output. They obtain this value by excluding government capital stock and income from the macroeconomic aggregates. Hairault and Portier [1995] and Hairault [1995] both calibrate comparatively higher values for the French economy, with $\alpha = 0.46, 0.42$ respectively. The literature has therefore formed a consensus on a range of acceptable values for α, belonging to the interval $[0.24; 0.43]$, as reported in Christiano and Fitzgerald [1998]. Our estimates lead to broadly similar values, with a sample average value of 0.31 and a median value of 0.26, which suggests that there are outliers on the upper bound set for parameter α.

Parameter σ denotes the inverse of intertemporal elasticity of substitution among households. It is also the Constant Relative Risk Aversion (CRRA) parameter, with $\sigma = |U''_c/U'_c|$ the ratio of the second and first utility derivative with respect to consumption. The method adopted to calibrate σ uses the standard growth theory as in Barro and Sala-i Martin [2004]. Household's consumption growth rate at the steady state is proportional to deviations of the interest rate from its equilibrium value, *i.e.*: $\Delta\bar{c} = (r - \ln\beta)/\sigma$. CRRA Parameter σ can therefore be written as a function of the average consumption rate and interest rate in long-run, as well as the discount factor β. Lucas [2003] estimates consumption growth rate using a linear time trend. We opt instead for the geometric mean to calibrate the average growth rate of household consumption. We observe that 75% of our sample exhibit a σ value of 3.2 and less, which suggest that our calibration method leads to calibrated values consistent with those used in the literature. In the literature, the parameter σ is usually calibrated at a value equal to or greater than one. For instance Cooley and Prescott [1995] use $\sigma = 1$ which implies $U(c) = \ln c$. In his investigation of welfare costs of the business cycle, , Lucas [2003, 1990] offers alternative calibrated values for σ ranging from 1 (logarithmic) to 2.5. The consensus in the literature seems to be $\sigma = 2$. Schmitt-Grohé and Uribe [2005] calibrate this value for Canada as a small open economy, while García-Cicco *et al.* [2010] do the same for Argentina. Aguiar and Gopinath [2007] also adopt a similar value in their study of business cycles in a large set of emerging economies. We depart from the literature by using our own calibrated results, which show yield an average value of $\sigma = 2.71$. Although the standard deviation is large (2.07), the median value of $\sigma = 1.91$ is much closer to the consensus formed in the literature.

The Constant Frisch Elasticity (CFE) parameter denotes changes in labour supply due to an income shock. In our model, ϕ is the inverse of labour supply elasticity, namely $\phi = 1/\epsilon^{s,n} - 1$ where $\epsilon^{s,n} = \frac{\partial n^s}{\partial w}\frac{w}{n^s}$. The literature does not form a clear consensus as to the appropriate set of values for which it calibrates ϕ. In fact, micro-based evidence collected from household survey and field experiments contradict results from macroeconomic aggregates. Chetty *et al.* [2013] find that CFE values for labour supply lie between 0.3 and 0.25 for micro-based studies, and 0.25 to 0.5 for macro-based estimations. García-Cicco *et al.* [2010] calibrate the CFE parameter at $\phi = 1.6$ for Argentina, meaning that the implied labour supply elasticity is 0.384. Aguiar and Gopinath [2007] calibrate their value such that households devote a third of their available time to work at the steady state, which implies a CFE value of 1.77. Our sample value of $\phi = 0.379$ implies a labour supply elasticity of 1.64, which is not far away from either the micro- or the macro-based evidence referenced in Chetty *et al.* [2013]. We should note however that in our sample, 12 countries exhibit a negative value for labour supply elasticity, with an average value of -1.78. Most of these are located in Central & Eastern Europe and the Baltics, as well as Zimbabwe. This negative elasticity assumes that the household actually decreases its labour supply after a positive income shock. Parameter ρ captures the percentage of declared economic activities over GDP. We report the data compiled by Schneider *et al.* [2010] as the fraction $1 - \rho$ of undeclared or underground economic activities. On average, declared and/or legitimate economic activities make up for 67% of GDP. The median share is at 66.3% which is close enough to suggest that most countries cluster around the mean with no significant outliers. We can report that only 10% of our sample has a share ρ of declared economic activities below 10% of GDP. Finally, parameter κ captures the inefficiencies or cost of collection of taxes. As shown on table 2, parameter κ captures the gap between the total tax burden, and the contributions of each tax component to total fiscal revenues. The trivial case where $\kappa = 0$ refers to an exact match between the aggregate tax burden on one side, and the individual components of tax revenues on the other. We report a substantial degree of heterogeneity among the countries in our sample. Although average cost of collection is 29.65%, median value is slightly higher at 30.5%. On average, countries in our sample lose a little under 30% of their tax revenues due to a mixture of tax collection inefficiencies, costs and specific domestic legislation. The fact that minimum and maximum values are so far away from each other suggest that there are substantial cross-country differences to discover.

In order to expand on results discussed above, we report in figure 1 the histogram and estimated distribution of the structural parameters for our country sample. The Kernel-based density estimates can provide a visual illustration of how our structural parameters are distributed across our country sample set. Although most parameters congregate within range of the usual values adopted in the literature, there are substantial outliers to the distribution of several parameters. As mentioned before, countries with double-digit average interest rate exhibit a low value for the discount factor β. In total, 15 countries out 152 exhibit a long run average interest rate of 15% or more. This means that all these countries calibrate their respective discount factors at 0.87 or less. These countries are distributed roughly equally across Central and Southern Latin America, Central Asia, Central & Eastern Europe and the Caucasus, as well as Sub-Sahara Africa[4]. Otherwise, the rest of our sample set calibrates values close to these used in the literature.

[4]Countries with a low discount factor β are: Angola, Armenia, Belarus, Brazil, Ecuador, Ghana, Kazakhstan, Kyrgyzstan, Madagascar, Mongolia, Nicaragua, Paraguay, Uruguay and Zimbabwe. Yemen from The Middle East & North Africa is the only regional outlier.

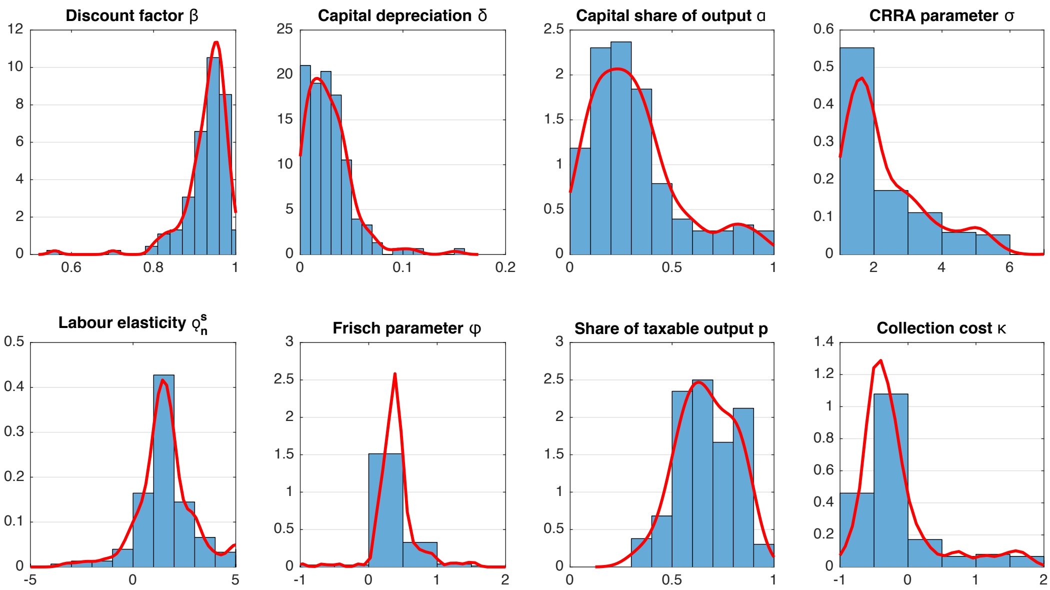


Figure 1: Histogram and estimated density - structural parameters
Note: See comments on table 3. Estimated density is computed using the Normal kernel.

Regarding capital depreciation δ, we have explained before why our calibrated values are set lower compared to what the literature usually attributes to this parameter. Nevertheless, we do observe some outliers to the right of the distribution, mainly with δ values at 10% or higher. Three countries exhibit a large depreciation factor, namely Azerbaijan, Equitorial Guinea and Zimbabwe. The remaining countries in our sample set cluster closely to the reported mean in table 2. Although parameter α shows a similar shape of distribution, there are more outliers with respect to the usual values of the literature. Using the range $[0.24; 0.43]$ computed by Christiano and Fitzgerald [1998] we find that only 57 countries out of 152 are included. Most of these are High-income countries, which means that the calibration method is sound regardless. This heterogenous distribution is reflected in the small mode to the left, close to 1 in figure 1.

CRRA parameter σ is more homogenous, with 110 countries out of 152 with a value of 3 or less. Only 16 countries exhibit a CRRA value of 5 or more. Labour supply elasticity and the CFE parameter ϕ are closely linked, which is why both are plotted for their respective estimated densities. There is strong clustering of labour supply elasticity around its mean value of 1.86. Similarly, we observe that many countries in our sample set congregate around the mean CFE value of 0.378. Nevertheless, we observe that there are outliers on both tails of the distribution. Labour elasticity has a small cluster of outliers to the right, with very high elasticity values. We report the same for the CFE parameter ϕ. The distribution of parameter ρ is more homogenous: 118 countries of 152 are located in the interval $[0.5; 1]$. The remaining countries exhibit lower values, with the smallest ρ begin 0.312. Finally, collection cost parameter κ is mostly set on the interval $[-1; 1]$ with 127 countries. The remaining 25 exhibit a higher value for κ which implies a highly efficient collection system. Table 4 below reports the calibrated values for our sample set of 152 countries consolidated into sub-categories. We use various sub-groups as proxies for wealthy countries: G7, core OECD, present-day OECD and EMU. The table reports average values for all proxies of developed economies, as well as the remaining countries as stand-ins for developing and emerging ones. We report an average β value for the G7 group at 0.964 with a standard deviation of 0.019. It is larger than the core OECD or OECD groups, at 0.957 and 0.953, respectively. Europe also exhibits a large β value on average, with 0.958 and 0.957 for the EMU and EU14+US groups, respectively. By contrast, the discount factor β value for the remaining 116 countries that are neither in Europe, G7 or the OECD is on average lower with a value of 0.922 and a larger standard deviation of 0.06. The same level of discrepancy is reported for the CRRA parameter σ. All proxies for wealthy economies exhibit values close to 2, the standard value in the literature. By contrast, average value for σ in the rest of the world is higher at 2.9, with a larger standard deviation of 2.29. Another parameter with similar properties is ρ, share of declared and/or taxable resources. Average values for our proxies of developed economies range between 0.79 and 0.85 with standard deviations between 0.06 and 0.09. We contrast these values with those computed for the rest of the world, where average ρ stands at 0.62 and a standard deviation of 0.12. Capital share of output α also shares in the same patterns, where we calibrate similar values for all proxies of developed countries. α values for these groups range between 0.33 and 0.36, while developing and emerging economies experience a lower average of 0.31. Parameter δ offers an additional contrast between our proxies of developed countries, and the rest of the world. Average values for developed countries range between 0.017 and 0.023, while the rest of the world calibrates an average value of 0.03. CFE parameter ϕ is relatively low in G7, OECD and European countries, with mean groups ranging between 0.179 and 0.274. For the rest of the world though, the Frisch elasticity parameter is at 0.419, with a larger standard deviation. Finally, we report a heterogenous distribution of κ across country groups, whose average value is negative across the board. Given the small size sample of the G7 group, average value for κ can be biased by individual countries, such as Italy, whose collect cost is the highest among G7. Nevertheless, all aver values for the proxy groups of wealthy countries are lower than the rest of the world. The remaining 95 countries in our sample exhibit a group mean of -0.388 with a comparatively larger standard deviation of 0.28. Tables 5 and 13 provide further categories using income, regions and Freedom House scores as categories.

Although these comparisons provide us with first-hand evidence of cross-country differences, we cannot conclude as to how statistically significant they are. Our results show that the calibrated values we have computed for G7 countries fit well within the range of acceptable values adopted in the literature. However, we are not sure whether calibrated values for developing and emerging economies are statistically different from G7 values. To that effect, we propose to test group means using the G7 group as a benchmark, against OECD, core OECD and the rest of the world as the remaining groups. We use one-way Analysis of Variance (ANOVA) testing. ANOVA posits a null hypothesis that all mean values for our category groups are equal. This is equivalent to an F-test with q constraints, where q is the number of category groups. Using the G7 and high income countries as base level groups, we test differences in mean values for each parameter. We first start by comparing G7 to core OECD, OECD and the rest of the world, then move to income-based and region-based categories. As far as selected proxies for developed countries go, we report statistically significant differences for some parameters, though many others appear to be similar across group categories. The discount factor β is lower in the rest of the world compared to G7 base level, whereas no meaningful differences can be reported as to OECD and core OECD groups.

Table 4: Structural parameters - average values per category: G7/OECD vs the rest of the world

Group/Parameter	β	δ	α	σ	ϕ	ρ	κ
G7 (Mean)	0.964	0.017	0.342	1.959	0.189	0.846	-0.369
Std.Dev.	(0.019)	(0.012)	(0.054)	(1.037)	(0.108)	(0.059)	(0.161)
Median	0.967	0.022	0.352	1.524	0.148	0.846	-0.306
Min	0.928	0.001	0.228	1.113	0.096	0.728	-0.644
Max	0.986	0.029	0.388	3.985	0.365	0.912	-0.236
Sample size	7	7	7	7	7	7	7
Core OECD	0.957	0.018	0.34	2.135	0.216	0.827	-0.268
	(0.016)	(0.012)	(0.064)	(0.935)	(0.084)	(0.065)	(0.172)
	0.958	0.021	0.353	1.768	0.203	0.839	-0.281
	0.925	0	0.163	1.113	0.096	0.67	-0.644
	0.986	0.04	0.446	4.758	0.365	0.914	-0.001
	24	24	24	24	24	24	24
OECD	0.953	0.021	0.33	2.089	0.249	0.791	-0.255
	(0.021)	(0.013)	(0.083)	(0.864)	(1.079)	(0.084)	(0.187)
	0.955	0.023	0.345	1.768	0.225	0.804	-0.281
	0.886	0	0.138	1.03	-4.379	0.584	-0.644
	0.986	0.051	0.522	4.758	4.157	0.914	0.219
	36	36	36	36	36	36	32
EMU	0.958	0.023	0.36	1.957	0.274	0.768	-0.187
	(0.015)	(0.019)	(0.06)	(0.814)	(1.47)	(0.091)	(0.218)
	0.96	0.022	0.363	1.704	0.209	0.775	-0.272
	0.928	0	0.27	1.03	-4.379	0.584	-0.528
	0.986	0.074	0.455	3.985	4.157	0.902	0.393
	19	19	19	19	19	19	19
EU14US	0.957	0.017	0.348	2.305	0.175	0.818	-0.242
	(0.017)	(0.011)	(0.043)	(1.059)	(0.059)	(0.06)	(0.133)
	0.96	0.022	0.355	1.767	0.158	0.817	-0.275
	0.928	0	0.27	1.268	0.096	0.701	-0.528
	0.986	0.031	0.418	4.758	0.322	0.912	-0.001
	15	15	15	15	15	15	15
Non G7/OECD	0.922	0.03	0.306	2.902	0.419	0.622	-0.388
	(0.06)	(0.024)	(0.244)	(2.297)	(0.413)	(0.123)	(0.28)
	0.934	0.024	0.24	1.958	0.404	0.62	-0.444
	0.559	0	0.011	1.021	-2.541	0.312	-0.989
	0.999	0.15	0.944	13.127	2.236	0.867	0.792
	116	116	116	116	116	96	95

Note: Standard errors reported in parentheses. See comments on table 3. Summary statistics are computed for sub-categories.

Share of declared/taxable economic activities ρ is significantly lower among newcomers to the OECD relative to G7. This is also the case for the rest of the world. We can interpret these results as follows: regardless of how groups of developed economies are arranged, the discount factor is always higher among the selected proxy group. G7 and OECD groups exhibit a higher β value on average, and the difference with developing and emerging economies is statistically significant. We do not report significant differences in terms of capital depreciation and share of output. Similarly, the CRRA σ parameter appears to be statistically the same across groups.

Only parameter ρ is statistically significant for both newcomers to the OECD and the rest of the world. It suggests that underground economic activities represent a larger share in these economies than G7. We report no statistically significant differences for the other parameters. In order to check for the robustness of our results and the proxies used in table **??**, we use the income criterion the World Bank Atlas method.

Table 5: Structural parameters - average values per income category (World Bank Atlas method)

Group/Parameter	β	δ	α	σ	ϕ	ρ	κ
Low Income	0.909	0.03	0.348	3.273	0.521	0.572	-0.456
	(0.087)	(0.03)	(0.29)	(2.829)	(0.246)	(0.09)	(0.263)
	0.916	0.024	0.239	2.698	0.495	0.569	-0.479
	0.559	0.001	0.011	1.075	0.238	0.398	-0.989
	0.999	0.15	0.931	13.127	1.458	0.804	0.303
	23	23	23	23	23	19	23
Middle Low	0.921	0.025	0.292	2.896	0.456	0.589	-0.419
	(0.05)	(0.018)	(0.255)	(2.572)	(0.242)	(0.126)	(0.231)
	0.929	0.02	0.181	1.874	0.39	0.584	-0.438
	0.803	0.002	0.033	1.044	0.234	0.312	-0.887
	0.997	0.065	0.92	11.235	1.307	0.86	0.211
	34	34	34	34	34	28	26
Middle High	0.921	0.032	0.29	2.964	0.401	0.628	-0.394
	(0.056)	(0.027)	(0.241)	(1.954)	(0.418)	(0.105)	(0.203)
	0.937	0.024	0.24	2.276	0.403	0.643	-0.418
	0.701	0	0.029	1.15	-0.983	0.367	-0.833
	0.994	0.111	0.944	10.185	2.236	0.865	-0.04
	39	39	39	39	39	33	31
High Income	0.951	0.024	0.33	2.162	0.304	0.782	-0.242
	(0.026)	(0.016)	(0.116)	(1.202)	(0.896)	(0.09)	(0.287)
	0.955	0.024	0.341	1.78	0.282	0.803	-0.281
	0.832	0	0.085	1.021	-4.379	0.485	-0.785
	0.996	0.074	0.844	7.781	4.157	0.914	0.792
	53	53	53	53	53	49	44

Note: Standard errors reported in parentheses. See comments on table 3. Summary statistics are computed for sub-categories.

Table 15 reports all differences in means using the World Bank Atlas method. High income countries are identified as these with a real income per capita of \$12,056 or more. Middle income countries are split into two categories, Middle-High income countries, whose real income per capita falls within the range [\$12,055 − \$3,896] and Middle-Low income countries, with range [\$3,895 − \$955]. Low-income countries are these with real income per capita of \$955 and below. Although Middle-income countries are closer in terms of real income per capita to High-income economies, their discount factor β is significantly lower. This reflects a higher long-run average interest rate among countries in this group category. As a result, the difference in average β between this category and the base level is statistically significant. A similar observation is reported with respect to Middle-Low and Low-income countries. Both exhibit statistically significant differences between their respective average β on the one side, and the average β parameter for the base level. Using High-income countries as a proxy for developed ones, we can conclude that the discount factor is significantly higher in developed countries than developing and emerging ones.

Apart from Middle-High income countries, parameters δ, α, σ and ϕ all appear to be identical across group categories. The differences in mean groups with respect to the base level are not statistically significant, except for the countries whose real income per capita fits in the interval [$\$12,055 - \$3,896$]. In that sense, the literature may be right to apply universal values for its structural parameters. Since there are no obvious differences on average between developed (High-income) countries and developing and emerging economies, we can safely presume that the same calibration for both is appropriate. We observe however that for parameters p, κ there are statistically significant differences alike between the base level and other group categories. Share ρ of declared/taxable resources is substantially higher at 0.782 in High-income countries, whereas Middle-High income countries lose about 16 percentage points from the base level, and Low-income countries lose 22 percentage points on average. Parameter κ captures collection costs and tax inefficiencies. We observe that High-income countries exhibit a low level at -0.242. It is substantially lower than the rest of the sample set, with the highest losses for Low-income countries. In comparison, Middle-High income countries lose only 14.2 percentage points of tax revenues above these lost on average by High-income countries. Low-income countries on the other hand, lose almost 22 percentage points with respect to the base level tax inefficiency.

We extend our ANOVA breakdown to regional groups, using High-income countries as our proxy for developed economies. We use the regional breakdown adopted by the World Bank and consolidate the remaining countries in our sample set into the following regions: Latin America & the Caribbean, Sub-Sahara Africa, Middle-East & North Africa, Central & Eastern Europe, Balkans & Central Asia, and South Asia & Pacific. Table 6 reports ANOVA regression results. We find similar patterns with respect to differences between High-income countries ad other developing and emerging economies.

All regional groups excluding South Asia & the Pacific and MENA exhibit a lower average discount factor β than he High-income group. This translates into a higher average long-run interest rate in the three regional groups with respect to the base level of High-income countries. The Central & Eastern Europe and Central Asia group exhibits a statistically significant larger depreciation factor δ, whereas no significant group differences have been reported with respect to capital share of output α. All regional groups exhibit a smaller share ρ of taxable resources with respect to High-income countries. Countries in Central & Eastern Europe, Central Asia, Latin America and Sub-Sahara Africa all exhibit a larger average value for CRRA parameter σ. High-income country group computes an average value of 2.16, close to the standard value adopted in the literature. Three regional groups differ substantially from this benchmark, while MENA and South Asia & Pacific appear to exhibit no statistically significant differences with the base level of 2.16. Apart from Sub-Sahara Africa, no other regional group exhibits statistically significant differences with the CFE ϕ parameter for the base level. Average value for CFE is 0.304 for High-income countries, whereas Sub-Sahara Africa exhibits a larger average value of .484, a difference of 0.18 and statistically significant.

Table 6: Structural parameters - ANOVA regression results, High Income countries as group base level - regional groups.

Variable	β	δ	α	σ	ϕ	ρ	κ
CEEBCA	-0.044***	0.017**	0.059	1.405**	0.047	-0.251***	-0.104
	(0.015)	(0.006)	(0.062)	(0.566)	(0.183)	(0.030)	(0.081)
LATCAB	-0.049***	-0.003	-0.091	1.382***	0.140	-0.213***	-0.181**
	(0.013)	(0.006)	(0.056)	(0.511)	(0.166)	(0.027)	(0.071)
MENA	0.007	0.012	-0.011	-0.610	0.071	-0.083**	-0.118
	(0.018)	(0.008)	(0.078)	(0.715)	(0.232)	(0.035)	(0.093)
SEAPAC	-0.012	-0.001	-0.09	-0.224	0.034	-0.115***	-0.228***
	(0.014)	(0.006)	(0.060)	(0.553)	(0.179)	(0.028)	(0.086)
SUBSAF	-0.039***	0.006	-0.007	1.138***	0.180***	-0.200***	-0.193***
	(0.011)	(0.005)	(0.047)	(0.428)	(0.139)	(0.023)	(0.059)
Base	0.951***	0.024***	0.330***	2.162***	0.304***	0.782***	-0.242***
	(0.007)	(0.003)	(0.030)	(0.272)	(0.088)	(0.014)	(0.038)
N	152	152	152	152	152	132	127
R2 Adjusted	0.124	0.045	0.012	0.088	-0.02	0.499	0.076
RMSE	0.051	0.022	0.216	1.983	0.643	0.097	0.255
RSS	0.381	0.071	6.793	574.234	60.352	1.174	7.888
Fisher	5.259	2.429	1.361	3.916	0.401	27.114	3.058

Available data for 132 countries for ρ, 127 countries for κ. Standard errors are reported in parentheses. Level of significance is denoted with stars. Legend: * < 1%. ** 5% and ∗ 10%. Intercept reports High-income countries mean group and level of significance. Estimated coefficients report differences in mean groups. **CEEBCA:** Central & Eastern Europe and Central Asia. **LATCAB:** Latin America and the Caribbean. **MENA:** Middle East & North Africa. **SEAPAC:** South Asia & the Pacific. **SUBSAF:** Sub-Sahara Africa

The consistence of ANOVA results confirms the soundness of our calibration strategy. Although some parameters appear to be impervious to group categories, some others exhibit tremendous differences between groups and base levels. Capital share of output α does not differ from one group to the other, whereas share of taxable and/or declared economic activities is systematically lower among countries used as proxies for developing and emerging economies. The same is observed for the CFE parameter ϕ, with the exception of the regional category and Sub-Sahara Africa. Parameters ϕ and α are critical to plotting capital and labour Laffer tax curves respectively. They determine their shapes, as well as their respective extreme and peak tax rates.

From these ANOVA regression results, we can conclude that country-specific calibrations are preferable to using standard values from the literature. This is the case for these parameters with different mean values as well as these similar across category groups. We find that some parameters can be safely calibrated for developing and emerging economies using values for developed ones. Nevertheless, significant differences between the two groups remain, and our calibration strategy makes provisions for these cases.

3.5 Estimation - GMM

Although calibration has been a staple of General Equilibrium models, there is much criticism to be made of its use. Reliance on long run averages and ratios does not always provide accurate measurement of numerical values for structural parameters. Too often, the literature mentioned above does not delve into the rationale behind values assigned to some parameters. In addition, there are frequent contradictions between micro-based estimates derived from panel studies, and macro-based aggregates with time series analysis. CFE parameter ϕ in our model is an apropos instance of the limitations of calibration. Finally, as noted in Blanchard [2018], the literature frequently relies on an unconvincing *ad hoc* mixture of Bayesian estimation and calibration.

We propose to offer an additional set of estimated parameter to the calibration results reported above. Favero [2001] and Canova [2007] discuss at length the pitfalls of econometric misspecification for structural parameters. Bad econometrics may yield a robust or consistent estimator, yet one with no obvious intuitions as to its economic interpretation. To that effect, we use Generalised Method of Moment in order to provide estimates of the parameter set $\theta = [\beta, \delta, \alpha, \sigma, \phi]$. We denote moments $g(\theta, X)$ where X is a matrix of macroeconomic variables. $g(.)$ are moments derived from the optimality conditions of our model. The GMM estimator seeks to minimise the following criterion:

$$\arg\min_{\theta} \left[\frac{1}{T}\sum_{t=1}^{T} g(\theta, X)\right]' W^{-1} \left[\frac{1}{T}\sum_{t=1}^{T} g(\theta, X)\right] \tag{3.1}$$

Where W is the variance-covariance matrix, T is the time period of aggregate macroeconomic variables incorporated in moments $g(\theta, X)$. W^{-1} weighs moments inversely commensurate to their variance in order to minimise the GMM criterion in equation (3.1). Given our use of annual data, we are limited in the number of data points per country. The time period T is short, as we get at most 64 observations per variable. In order to improve our estimator, we adapt the procedure laid out in McFadden [1989] used for a Simulated Method of Moments (SMM). He states that the SMM method is handy when the moment function has an intractable analytical expression, yet is easy to simulate. In our case, intractability comes from the small sample size from which observations are drawn. All conditions for the practical use of SMM are observed in our case: the Monte Carlo simulation are based on well-behaved functions, and are easily calculated using just-identified instruments. The asymptotic variance-covariance of estimator $\hat{\theta}$ is computable. We use our limited sample to generate a large set from which we draw our GMM/SMM estimator. For each country, we compute the optimisation programme in equation (3.1) using 1.000 draws from the available data points. This allows us to compute an estimator and its standard error. Moments $g(\theta, X)$ write:

$$\begin{bmatrix} \dfrac{y_t - z_t - n_t}{k_{t-1} - n_t} \\ \dfrac{1}{1 + r_t} \\ 1 + \dfrac{i_t}{k_{t-1}} - (1 + g_t^k)(1 + g_t^n) \\ \dfrac{r_t - \ln\beta}{\Delta c_t} \\ \dfrac{(\ln(1-\alpha) + y_t - \sigma c_t - n_t)}{n_t} \end{bmatrix}$$

We then compare our results with those of the standard calibration strategy using estimated densities for both methods. Table 7 below reports the summary statistics of our estimates for the whole sample. GMM estimates are somewhat lower compared to the calibrated values reported in table 3. This can be explained by the fact that there are more outliers to the left-hand side of the distribution for each parameter. Indeed, almost all structural parameters reported in table 7 exhibit a null minimal value, something that was not reported for calibrated values in table 3. Nonetheless, calibrated and estimated median values are much closer to each other, which is a testimony to the robustness of the calibration strategy laid out in the previous section. Estimated results show that calibration is a parsimonious method for attributing numerical values. Our results also show that calibration can provide meaningful values to the model's structural parameters. We provide additional evidence that GMM estimates and calibrated values describe the same distribution for core structural parameters in our model. Figure 2 below plots the estimated densities for both GMM and calibrated values.

Table 7: Structural parameters - GMM estimations.

Statistics	α	β	δ	σ	ϕ
Mean	0.296	0.881	0.026	2.523	0.361
Mean (Calibration)	0.311	0.929	0.028	2.710	0.379
Std. Dev.	0.221	0.215	0.023	2.128	0.641
Median	0.259	0.941	0.022	1.792	0.365
Median (Calibration)	0.268	0.942	0.024	1.913	0.372
Min	0	0	0	0	-4.379
Max	0.944	0.999	0.150	13.126	4.157

Note: Baseline dataset spans the period 1950-2015. GMM estimation sampled 1000 non-negative observations from available data points, with replacement. Moments $g(\theta, X)$ are just-identified, using the same number of instruments as there are moments. The parameter set vector θ minimises the criterion set out in equation (3.1). Yellow rows report calibrated values of table 3 for comparison. Summary statistics are reported un-weighted for economies in the sample set. Standard errors are reported for the whole sample set of 152 countries. Individual standard errors are reported in the annex.

Comparison between densities for calibrated and estimated parameter values suggest that both methods yield essentially the same results. We can describe the same bimodal distribution for parameter α capital share of output. Most countries cluster around the interval $[0; 0.4]$ whereas a small model is observed around 0.8. The discount factor β replicate similar properties, with a large cluster around a value of $\beta = 0.95$ (or a long-run interest rate of 5.2%). Estimated values for capital depreciation δ are for the most part lower than 5%. They replicate adequately the distribution of calibrated values, which suggests that the method advocated by Cooley and Prescott [1995] fits well most countries in our diverse sample set. We report similar estimated results for CRRA parameter σ in terms of clustering around acceptable values. Most countries see their estimated σ parameter fall within range of $[1; 3]$. This interval comprises the oft-used value of 2 in the literature mentioned earlier, and the estimated distribution fits that of calibrated values. Our estimations also confirm the calibration strategy adopted for CFE parameter ϕ. There is significant clustering around the mean value of 0.380 the same way we reported for calibrated values. Overall, GMM estimates confirm the calibration strategy and its results as laid out in the previous section.

Results reported in table 7 are better illustrated with the estimated densities for calibrated

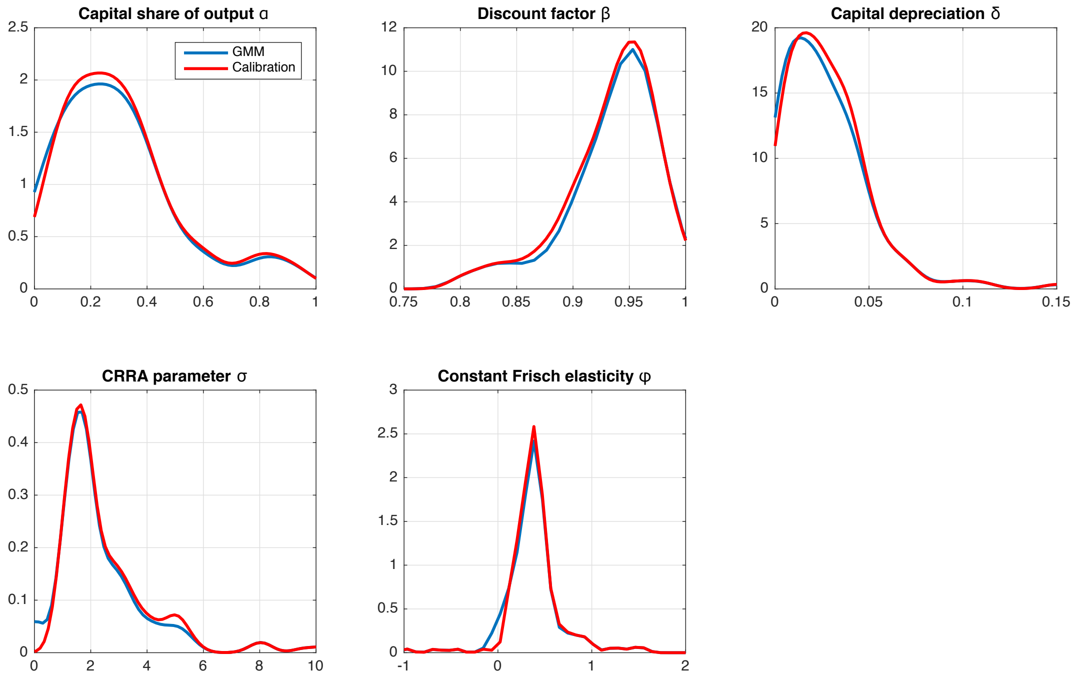


Figure 2: Histogram and estimated density - GMM vs calibrated structural parameters
Note: See comments on tables 3 and 7. Estimated densities are computed using the Normal kernel.

and estimated values of the model's structural parameters. We have used in this section the standard calibration methods advocated in the literature. The parsimonious specifications adopted for this model have yielded adequate values for our sample set. Calibrated values for developed economies fall well within range of acceptable and usual values adopted in the literature, while most developed and emerging economies calibrate comparable values. We have then used GMM estimation to test the robustness of our calibrated values, and confirm that they are. We now move to building the Laffer curve for our model.

4 Results - the micro-founded Laffer curve

In this section, we use calibrated values for our structural parameters to build country-specific Laffer curves. In the baseline model, we use equations (2.13) and (2.17), and calibrated values computed in the previous section. We study the properties of Laffer tax curves, their respective tax peak rates and revenues. We then move to the extension of imperfect governance to our model, and compare their Laffer curves.

Figure 3 reports median Laffer labour and capital tax rate curves for the sample set of 152 countries. We observe the standard shape of the Laffer curve, with increasing revenues for low tax rates, until the curve reaches its peak. Beyond their respective extrema, tax revenues decline until they reach zero at 100% tax rate. Based on the calibrated values of our sample set, the median country exhibits peak tax rates for labour and capital at 19.72% and 34.03%, respectively. We also observe that tax revenues for labour decline at a faster pace when taxes are set past their peak value. Trabandt and Uhlig [2011, 2012] report higher values for their

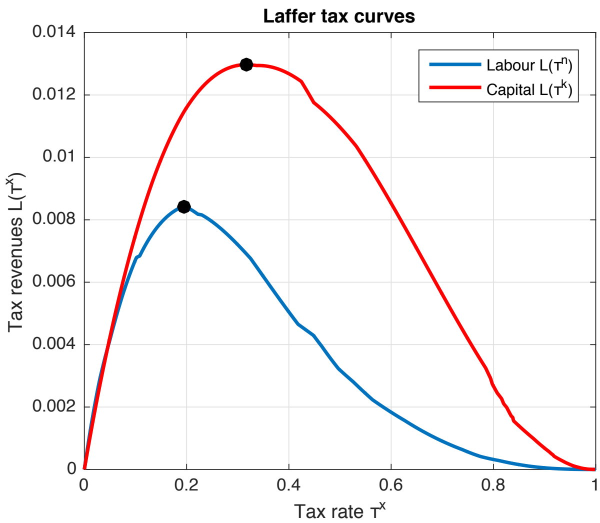


Figure 3: Median Laffer curve for capital and labour taxes. Medians are computed for the whole sample set, 152 countries.

sample set of EU-14 countries and the United States. They compute that maximum labour tax rates in their sample set are set between 51% and 72%. They also compute high peak rate values for capital taxes, set between 44% and 64%. The Laffer curve shapes are also different, both capital and labour tax revenues are skewed sharply to the left, hence the higher peak rates.

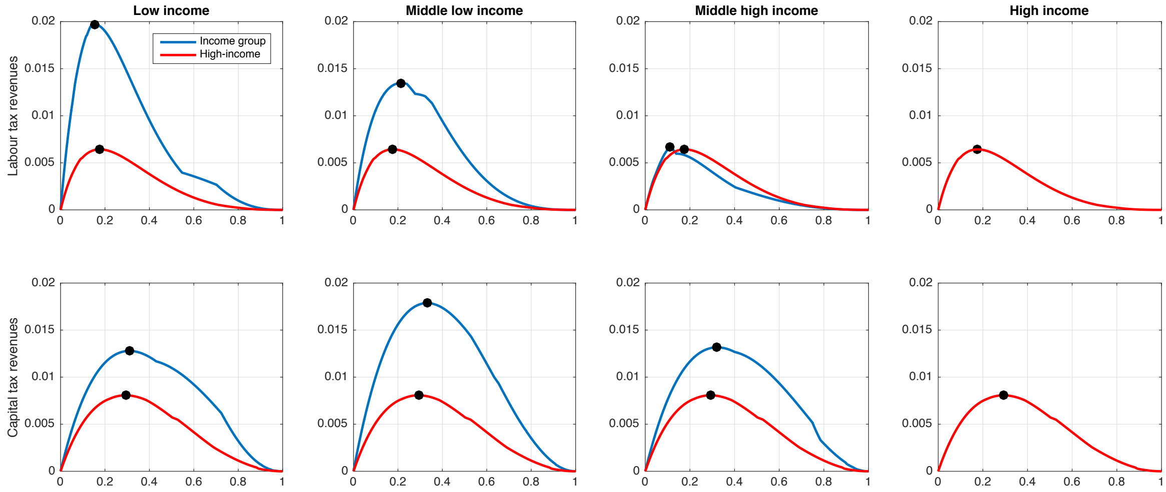
4.1 Baseline model

4.1.1 Income group categories

Using the sub-categories delineated in the previous section, we first start by using the World Bank Atlas method of income group. We create a proxy for developed economies with the High-income category, while developing and emerging economies are consolidated into the remaining income category groups. Figure 5 reports median curves for labour and capital taxes per income group. Each subplot compares the Laffer tax curve for High-income and other income country groups.

Middle-Low income countries exhibit the highest median peak labour tax rate at 21.5%. High-income economies are at a lower peak rate of 17.8%, while the median Low-income country computes a peak tax rate of 15.6%. Middle-high income economies exhibit the lowest median of all income groups at 11.2%. In addition, the Laffer labour tax curve, is higher in Low-income countries, compared to that of our proxy group for developed economies. Such a counter-intuitive result runs counter to expectations that governments in developing and emerging economies experience more difficulties in extracting fiscal revenues. We would except that non-High-income countries would exhibit a lower Laffer curve and skewed to the left in comparison with High-income economies. On the contrary, the baseline model predicts that developing and emerging economies are able to tax labour at a higher or similar rate, and extract higher tax revenues than High-income countries. We account for this paradoxical result by recalling the after-tax labour supply $n^s(\tau^n)$ expression in equation (2.13). Household labour supply is an increasing function of the consumption-to-output ratio. This means that labour tax revenues themselves are increasing

Figure 4: Median Laffer curve for capital and labour taxes - World Bank Atlas method, income categories.



in household consumption share of output. This ratio is highest among low-income countries: High-income countries exhibit an average consumption ratio of 0.56, while low-income countries report a higher average ratio of 0.74. Figure 5 reports the distribution of consumption share of output per income group, and illustrates the discrepancy. At the steady state, a large share of output allocated to consumption means that the household is likely to increase its labour supply if income decreases. This means that it is inelastic to taxes, hence higher tax revenues. Given that low-income countries exhibit on average a high consumption-to-output ratio, it is expected that they would yield commensurately higher labour tax revenues. The importance of consumption share of output is such that it accounts for 80% of the gap in tax revenues between low- and High-income countries. The consumption ratio also explains to a similar degree the gap between developed economies and the other income groups.

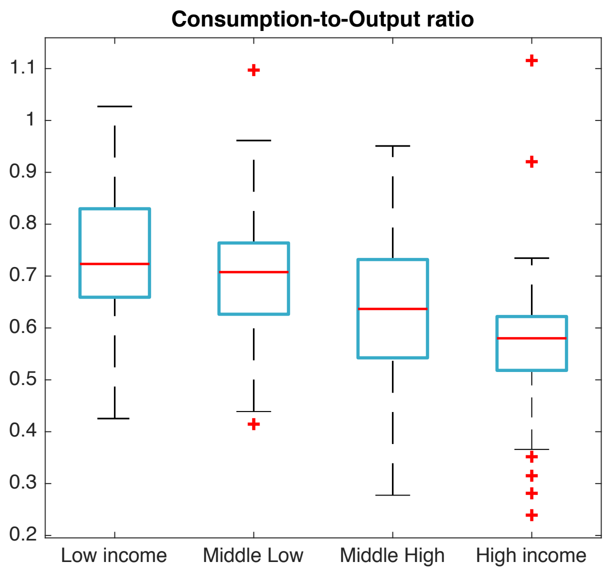


Figure 5: Whisker-plot of consumption-to-output ratio - World Bank Atlas method, income categories.

We observe that peak rate values for our proxies of developed and developing and emerging economies are close to each other. High-income countries exhibit the lowest median value of 29.5%. All other income country groups compute median peak rates between 31% and 33%. Nevertheless, we report significant discrepancies in tax revenues between High-income and other income group economies. The largest gap in fiscal revenues is observed between high- and middle-high income country groups. The latter raise twice as much as the former in the neighbourhood of their respective tax rate peaks. We explain the discrepancy in tax revenues with differences in labour supply, productivity and capital returns (real interest rate). Recall that low-income countries exhibit a higher consumption share of output, which makes labour in these economies inelastic to taxes. As a result, capital tax revenues are also higher in low- and middle-low income countries. In addition, we also report significant cross-country differences in productivity growth rates. TFP growth is higher in developing and emerging economies on average, as productivity growth rates decrease with real income per capita. According to equation (2.17) after-tax capital stock is an increasing function of productivity growth rate at the steady-state. We compute an average High-income productivity growth rate of 2.5%, while developing and emerging economies experience a higher average growth on average. We find that the productivity differential accounts for 45% of the discrepancy in capital tax revenues between high- and middle-low income countries. In addition, low- and middle-low income countries exhibit higher interest rates on average than middle high- and High-income economies. Differences in average interest rates contribute positively to capital tax revenues, as differences in interest rate levels contribute an additional 50% in explaining differences of capital tax rates between developed economies on the one hand, and emerging and developing economies on the other.

4.1.2 Regional group categories

We proceed with a similar analysis for regional groups. We use High-income countries as a proxy for developed economies, while the remaining countries in our sample set are consolidated into five regional areas: Latin America & the Caribbean, Sub-Sahara Africa, Middle-East & North Africa, Central & Eastern Europe, Balkans & Central Asia, and South Asia & Pacific. Figure 6 reports Laffer labour tax curves for the median country in each regional group category. It compares the median Laffer tax curve of High-income countries against that of each regional group.

The common feature to all five regional groups is that their respective median peak tax revenues are higher than the median peak for High-income countries. There are different levels of discrepancy in tax revenues, with Latin America & Caribbean and the Middle-East & North Africa exhibiting the largest gaps. At peak revenues, the two regional groups raise 2.77 and 1.71 times more tax revenues than the median High-income country, respectively. South Asia & Pacific is close behind with peak revenues at 1.38 times these of High-income countries.

We have shown earlier that household consumption share of output accounts for an important fraction of the gap in median tax revenues. We extent this analysis to all core components of after-tax labour supply for each regional group. Table 8 reports the respective contributions of consumption-to-output ratio, capital share of output α and CFE parameter ϕ to the gap in labour tax revenues between each regional group and High-income countries. Table 8 reports

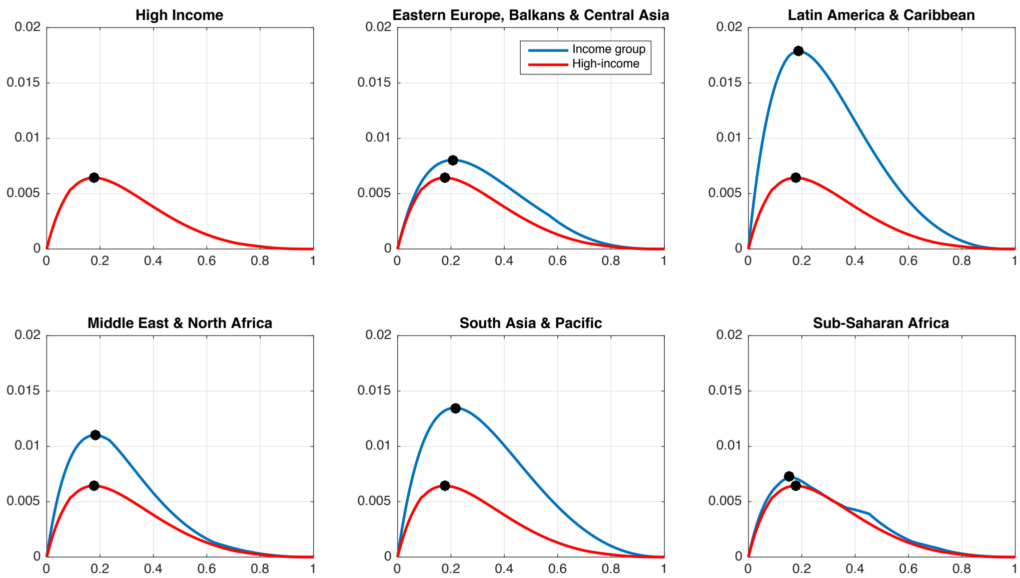


Figure 6: Median Laffer labour tax curves. Sample set broken down into regional groups.

countries in Latin America and South Asia with the largest gaps in tax revenues relative to High-income countries. Results in both regional groups are quite sensitive to differences in Frisch elasticity, as can be seen from its contribution to the gap in median tax revenues. In South Asia, differences in CFE value are enough to account for almost 80% of the gap in median tax revenues with High-income countries. Similarly, we report a large effect of CFE parameter ϕ in Latin America. Differences in median tax revenues can be explained up to 86% by differences in median values for the Frisch elasticity between that regional group, and these of developed countries. To a lesser degree, labour supply elasticity ϕ also pleases an important role in the MENA group, since 40% of the gap in median tax revenues can be explained by differences in CFE ϕ values.

Table 8: Median gap in tax revenues and relative contributions (%) of labour supply components.

Regional group	Median gap	C/Y	α	ϕ
C.E.Europe, Balkans & C.Asia	1.65	20.21	1.97	25.47
Latin America & Caribbean	3.09	26.10	.	86.54
MENA	1.40	27.53	15.17	40.08
South Asia & Pacific	2.87	2.09	3.12	79.21
Sub-Sahara Africa	1.21	70.92	16.17	.

Note: Median gap reports the ratio of median tax revenues between regional groups and High-income countries. Contributions (%) of structural parameters in after-tax labour supply are computed by substituting each component individually by its median value of High-income countries and plugging it in labour tax revenues for each regional group.

For other regional groups however, consumption-to-output remains a key component to account for differences in peal tax rates with the benchmark group of developed economies. The discrepancy in median tax revenues between developed economies and Sub-Sahara Africa is accounted for at 71% by differences in household consumption ratio C/Y. For labour tax revenues, household supply is determined by two key components, namely consumption share C/Y and Frisch elasticity ϕ. The income-based criterion suggests that the former matters a lot in the Laffer labour tax curve. The region-based criterion suggests that while the consumption ratio is still an influential factor for some regional groups, most others are more sensitive to the Frisch parameter. In any case, we have presented a convincing argument to account for the counter-intuitive result of higher tax revenues in developing and emerging economies relative to developed ones.

We extend the same analysis to capital tax revenues for regional groups and High-income countries. In contrast to labour taxes, there is a great deal of heterogeneity in tax revenues between developed countries on one side, developing and emerging economies on the other. Some regional groups replicate the same counter-intuitive result of higher tax revenues than developed countries, while others fit the more believable outcome of lower tax revenues. It is expected that developing and emerging economies would raise a lower amount of tax revenues out of capital taxes, because they have a lower level of capital stock to being with. Nevertheless, there are other factors that can belie this prediction, as it is the case for many regional groups reported in figure 7. The figure below reports median Laffer capital tax curves for each regional group, compared against the benchmark category of developed economies. Two outliers exhibit extreme shapes for their respective tax revenues. The median countries in Eastern Europe & the Balkans, as well as Sub-Sahara Africa can raise respectively 8.5 and 3.5 times more tax revenues than High-income economies at peak revenues. Latin America raises 40% more tax revenues than developed economies, while the two remaining regional groups exhibit Laffer curves below that of the median High-income country. Contrary to after-tax labour supply, there are more parameters and steady-state variables involved in the expression of after-tax capital stock. In particular, capital tax revenues are also a function of interest rate (net of depreciation) and labour supply itself. We concentrate on these variables and parameters that are key to explain the gap in capital tax revenues between developed economies and other regional groups. We identify labour, net interest rate and productivity as likely candidates to account for the gap in tax revenues. Labour has been identified through its own dynamics, as discussed above. Net real interest rate accounts for the availability of capital stock.

Paradoxically, high tax revenues from capital may be due to its own scarcity, since it boosts interest rates. Because these are the expression of marginal productivity of capital, high interest rates are at once the expression of low capital stock, and a lucrative source of fiscal revenues for the government. Productivity is the third candidate, with emerging and developing economies exhibiting a higher productivity growth rate than developed countries. Other parameters, such as α and β account for the residual contributions that neither candidates has explained. Table 9 reports the contributions of each component to the gap in median capital tax revenues between each regional group and High-income economies. We focus on these groups with significant positive gaps with the benchmark category. Table 9 shows that Eastern Europe, Balkans & Central Asia could extract more than ten times the amount of tax revenues developed economies can obtain from their capital stock. Labour supply contributes a little over half to this gap in tax revenues, while differences in productivity growth accounts for a little over a fifth. A slightly

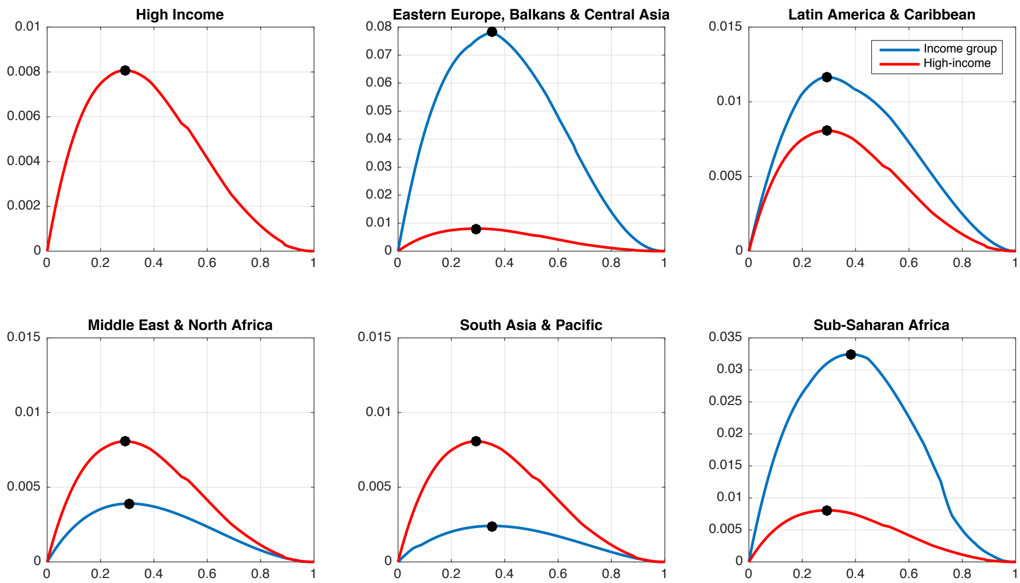


Figure 7: Median Laffer capital tax curves. Sample set broken down into regional groups.

different contribution breakdown can be reported for Latin America & Caribbean. Differences in productivity are the primary component to explain the gap in tax revenues, with 37% of it attributable to TFP growth. Labour supply contributes about a third of the gap in tax revenues, while net interest rate accounts for almost a fourth of differences in median tax revenues between Latin America and our proxy for developed countries. Sub-Sahara Africa tends to replicate a breakdown similar to that of Eastern Europe & Central Asia, with 61% of the gap between its median tax revenues and these of developed countries attributable to differences in levels of labour supply. All in all, the three candidate variables and parameters can account for 83% to 93% of the gap in median capital tax revenues between developing and emerging economies on the one side, and developed countries on the other.

Table 9: Median gap in tax revenues and relative contributions (%) of labour supply components.

Regional group	Median gap	$n(\tau)$	$\bar{r}-\delta$	$\bar{z}$
C.E.Europe, Balkans & C.Asia	10.29	50.63	18.29	21.27
Latin America & Caribbean	1.57	31.17	24.46	37.59
MENA	0.52	.	.	.
South Asia & Pacific	0.34	.	.	.
Sub-Sahara Africa	4.56	60.67	12.76	10.32

Note: Median gap reports the ratio of median tax revenues between regional groups and High-income countries. Contributions (%) of structural parameters in after-tax labour supply are computed by substituting each component individually by its median value of High-income countries and plugging it in labour tax revenues for each regional group.

This section has shown that the Laffer labour tax curve in the baseline model yields counter-intuitive results. The median emerging and developing country is predicted to raise more tax revenues than the median developed country. Differences in parameter and ratio values account in large part for this result. Households in countries with high consumption-to-output ratio are likely to exhibit labour supply inelastic to taxes. As a result, governments in developing countries can extract higher tax revenues from labour. Similarly, countries with a high Frisch elasticity parameter ϕ are likely to have a low labour supply elasticity. The respective contributions of consumption share C/Y and Frisch elasticity ϕ varies cross-categories.The income-based criterion identifies the former as the main driver of discrepancies in median tax revenues, while the region-based criterion attributes differences in labour supply elasticity for the most part.

Capital stock is also sensitive to the way the sample set is consolidated into group categories. The income-based criterion delivers a similar counter-intuitive prediction that developing and emerging economies will raise more capital taxes than developed ones. By contrast, the region-based criterion identifies two regional areas where developed economies are the ones with higher median tax revenues. Differences in capital tax revenues and the Laffer curve are accounted for with three major components of after-tax capital returns. Countries with low capital stock typically exhibit higher real interest rates (net of depreciation). This inflates capital tax revenues compared against developed economies with low interest rates, but higher capital stock. Productivity also plays a role in explaining the gap in median capital tax revenues. Developing and emerging economies experience higher productivity growth rates on average, and that has a positive impact on capital stock at the steady-state. Finally, labour dynamics influence after-tax capital returns, and all counter-intuitive results for the Laffer labour tax curve affect capital tax revenues as well.

4.2 Extensions: Underground economy and tax collection costs.

4.2.1 Underground economy: partial access to the tax base.

The baseline model describes the relationship between tax rates and fiscal revenues. these are decreasing in the tax rate when it is set beyond its peak value. Nevertheless, the model assumes that tax authorities can assess the whole tax base for their revenues. Such an assumption is not realistic, in that domestic legislation may allow for deductions and loopholes. Furthermore, the government may be unable to tax these economic activities that are underground and/or undeclared. With that in mind, the first extension of our model assumes that tax authorities can only assess a fraction $]0;1]$ of their tax base. The model is run through the numerical values calibrated for our sample set of 152 countries. We compare our results with those of the baseline predicted outcome. Figure 8 reports the median Laffer curves for capital and labour under both specifications. It compares the Laffer curves of the baseline model, where tax authorities have full access to their tax base, against the extension where economic activities are declared only at a fraction $p \in]0;1]$.

The baseline model predicts that peak tax rates for capital and labour will be function of country-specific parameters and steady-state variable values. For labour, the peak rate is a function of its share of output $1-\alpha$, consumption ratio C/Y and CFE parameter ϕ. The first two contribute positively to tax revenues through a revenue effect. A high Frisch parameter value denotes a household with low elasticity to taxes, which means that fiscal authorities can extract higher revenues as well. For capital, the same dynamics apply as it is increasing in

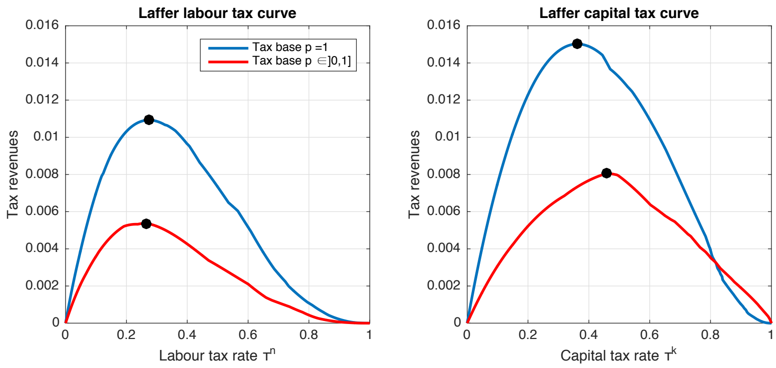


Figure 8: Median Laffer curve for capital and labour taxes - full ($\rho = 1$) and incomplete access to the tax base. Medians are computed for the sample set of 152 countries.

labour. Capital tax revenues are also increasing in productivity growth rate z and the discount factor β. Countries with low capital stock as most developing and emerging economies are, can makeup in revenue shortfall with higher returns on capital.

The neo-classical framework used in this paper predicts ambiguous results. On the one hand, a low value for parameter ρ translates into a large share of underground economic activities that go untaxed. As a result, there is a smaller wedge effect, since the tax burden on overall economic activities is low. The tax base, be it capital, labour or consumption, is larger in comparison to the case of full taxation $\rho = 1$. On the other hand, although a low value for parameter ρ leads to fewer distortions and a larger tax base, the government does not benefit. Indeed, a low value for ρ means that the effective tax rate is $\rho\tau$ instead of τ. As a result, tax revenues are low as well.

The extension model builds on the assumption of partial access to the tax base as a way to explain further the counter-intuitive results. In this analysis, we use the High-income country group in the baseline model as a counterfactual for developing and emerging economies. We argue that it is the relevant benchmark because the fiscal systems of our proxy for developed economies, the High-income country group, are reportedly more efficient than these of developing and emerging countries, thanks to the high quality of their institutions. This link has been documented exhaustively in the literature. Borge *et al.* [2008] establish a link between institutions, democracy and fiscal efficiency. Alonso and Garcimartín [2013] focus on institutional quality and its interactions with sound tax systems. High institutional quality allows citizens to scrutinise the use of taxes the government raises. As a result, fiscal authorities have every incentive to make their tax system as efficient as possible. Pertinent use of fiscal revenues has also been mentioned in Stroup [2007] where economic freedom is found to be well correlated with efficient use of taxes to fund public goods. In this case, economic freedom is equated to the rule of law, protection of patents and property rights, all of which are guaranteed by sound and good quality institutions. Another way the literature deals with the link between institutional quality and taxes is advocated by Tanzi and Zee [2000]. He looks at the constitutional constraints imposed upon governments and their ability to raise taxes. Quality of institutions is determined through how well these constitutional constraints work to prevent governments from raising taxes through *ad hoc* or arbitrary decisions.

The elements discussed above supply the justification for using the Laffer tax of High-income countries in the baseline model as a benchmark. The significant differences in structural parameter values between High-income and other country groups are such that we need to focus on the exclusive effects of parameter ρ on peak tax rates and revenues. The comparison is only relevant if the benchmark does not exhibit issues related to tax inefficiencies. Given that High-income countries are proven to have fairly efficient tax systems, it makes sense to use the baseline model as a reference point. Furthermore, in using the baseline High-income Laffer curve, we focus on the sole effects of partial access to the tax base. Differences between the High-income baseline Laffer curve and these of developing and emerging economies in the extension model can be accounted for thanks to differences in values for parameter ρ. Finally, partial access to the tax base is the only component in the model where policymaking is actionable. In this neoclassical model, there is little in the way of implementing a fiscal policy beyond raising or cutting taxes along the Laffer curve. By using the baseline High-income Laffer curve as a reference, we can assess the importance of gains in tax revenues where governments in developing and emerging economies decide to expand their tax base, rather than raise their tax rates.

A large size of underground economic activities relative to GDP is relevant to our study of the Laffer curve. In comparing values for parameter ρ, we find that declared economic activities make up for a larger share of output in developed economies than in developing and emerging ones. Mean and median values for ρ among the High-income country group are 0.782 and 0.803, respectively. For all remaining countries - proxies for developing and emerging economies- the values are 0.601 and 0.598 in mean and median, respectively. Results from the ANOVA regressions in tables 15 through 6 conclude that there are statistically significant differences between High-income economies and all other countries in our sample set. The importance of underground/undeclared economic activities manifests itself through the government's inability to raise more taxes than they would like to. The effects of partial taxation are in on themselves ambiguous. On the other hand, a large share of undeclared economy means that they are not subjected to taxation. As a result, the distortionary effects of the tax wedge are limited to share ρ. The effective tax burden is such that it encourages an extension of the tax base. Unfortunately, the government does not get to benefit from this happenstance, since it can only tax $\rho\tau$ rate on its base. The neoclassical framework we have adopted to build the Laffer curve predicts that the latter effect will dominate. In order to prove this, we look at the expressions of after-tax labour supply and capital stock of the extension model, namely equations (2.20) and (2.21). Under partial access to the tax base, labour supply $n^s(\tau, p)$ is larger than $n^s(\tau)$ where $\rho = 1$, thanks to the lower wedge effect $\varphi(\tau, p) \geq \varphi(\tau)$. Nevertheless, tax revenues in the extension model are lower because the effective tax rate is $\rho\tau$ and not τ as in the baseline model. This is due to fact that $\rho\tau$ dominates over the tax base effect. The extent to which the tax effect dominates is determined by the numerical values assigned to CFE parameter ϕ. A high value means that labour supply is inelastic to taxes and therefore to the wedge effect. As a result, there is likely to be little effect in terms of tax revenues. On the contrary, a low value for parameter ϕ means that the household is very elastic in its supply to taxes. As a result, the base effect may be large enough to alleviate the tax effect on revenues.

In addition, when the tax base expands, the peak rate shifts to the right and increases.

Similarly, the potential for tax revenues expands with its base. However, because the effective tax rate is $\rho\tau$, the peak tax revenue decreases accordingly. We can therefore predict that countries with a large share of underground - or undeclared - economic activities will have a low parameter value ρ. Their potential tax base expands, or is larger than these with a small underground sector. As a result, the peak tax rate shifts to the right, but at the same time, the effective tax rate $\rho\tau$ depresses the Laffer curve. Consequently, the peak tax rate yields comparatively lower peak revenues.

Notwithstanding the high elasticity of labour supply to taxes, median and mean values for parameter ϕ we have computed for each category group do not differ significantly from these of the benchmark High-income group. In other words, parameter ϕ rarely differs significantly among groups of developing and emerging economies relative to developed ones. As a result, we conclude that the elasticity effect is not high enough among the former group of countries to neutralise the tax effect $\rho\tau$. Regardless, values for parameter ρ can contribute significantly to reduce the gap in peak revenues between High-income and other developing and emerging economies. The counter-intuitive results of the baseline are likely to be reversed for small values of that parameter.

Figure 9 compares the model extension for developing and emerging economies against their benchmark, the baseline Laffer curve for developed economies, as represented by their proxy of the High-income country group. The figure shows substantial improvements on the baseline model, where income groups with significant counter-intuitive results have reversed or bridged their gap with the High-income group benchmark.

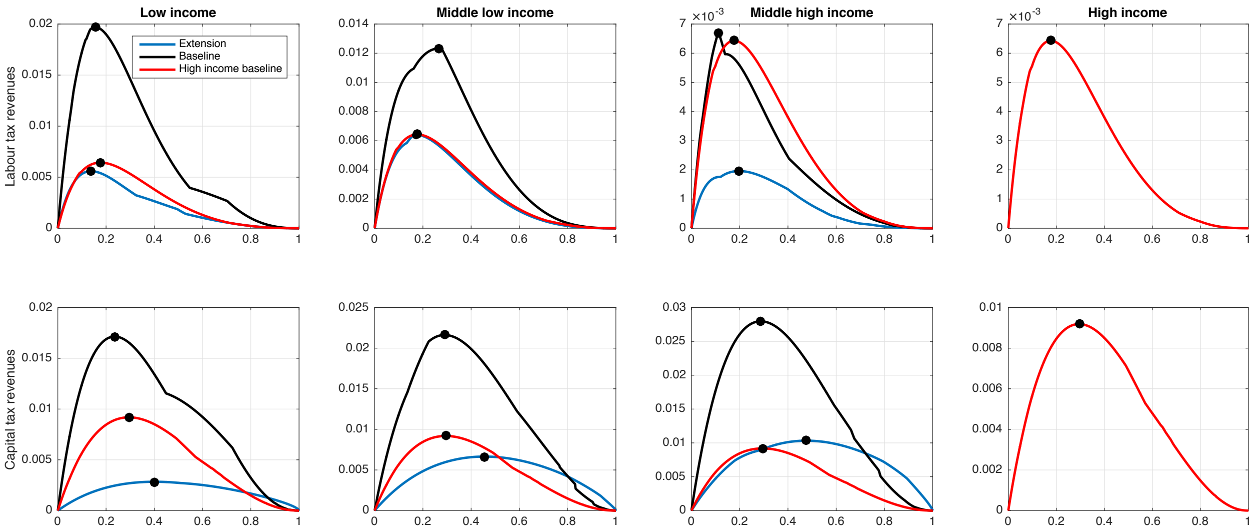


Figure 9: Median Laffer curve for capital and labour taxes - full and incomplete access to the tax base. Income groups - World Bank Atlas method.

Figure 9 above compares the median Laffer curve for each income category in its baseline and extension models against the baseline High-income category group. The figure shows that for all income groups, there is a uniform trend of lower peak revenues for capital and labour. With respect to labour taxes, there is a steep decline in peak revenues with respect to the baseline model. By comparison however, peak tax rates differ significantly across income groups.

Differences in values for parameter p affect both the shape of the Laffer curve as well as its peak rate. Low- and Middle-low income countries see their peak rates shift to the right, which implies a dominant effect of parameter ρ. Namely, that these countries have comparatively very low shares of declared or taxable economic activities. By contrast, Middle-high income countries shift their peak labour tax rate to the right, which means that there is a large tax base effect. In all cases however, the strongly dominant effect remains the effective tax rate $\rho\tau$ which depresses the Laffer curve. For capital taxes, a similar decline is reported for all income category groups. Notice however that all income groups shift their respective peak rates to the right, which is evidence of a positive tax base effect.

This tax base effect is however still dominated by the effective tax rate $\rho\tau$, since all Laffer curves are depressed. As far as the income-based comparison goes, the model extension contributes significantly to reduce the discrepancies in peak revenues between High-income countries and the other proxies for developing and emerging ones. Differences in parameter values and steady-state variables in developing and emerging economies create a larger tax base in comparison with developed ones. With the model extension, partial access to the tax base dominates over the counter-intuitive results and reduces their respective Laffer curves. Similar dynamics are reported for regional groups. We fit countries in our sample set into regional groups, whose respective median Laffer curves are compared against the High-income benchmark group. Figure 10 reports median Laffer curves for regional groups under baseline and extension models. Each regional group is compared against the High-income baseline median Laffer curve. Just as in the income-based comparison, regional groups all exhibit a decline of varying degrees in their respective Laffer curves. Similarly, peak rates have shifted in both sides with respect to the baseline. For instance, countries in Eastern Europe, the Balkans & Central Asia see their median peak rate shifts to the left with respect to their baseline curve. This is also true for Latin America & Caribbean, as well as MENA regional groups. By contrast, countries in South Asia see their median peak tax rate shift right, which suggests a large and positive effect on the tax base. For Sub-Sahara Africa however, the median peak rate does not change significantly. Differences in shifts of the labour tax peak rate are due to the impact of parameter ρ, and how it expands the tax base thanks to a lower wedge effect.

As reported in the previous section, developed economies are proxied by the High-income category group and exhibit high values for parameter ρ. The cross-group mean differences are significant enough to attribute the changes in Laffer curve shapes to the size of undeclared/untaxed economic activities relative to output.

As mentioned previously in tables 15 through 6, parameter ρ in High-income countries exhibits a statistically significant difference with respect to other income and regional groups. Nevertheless, some categories are not that far off from the High-income group. Although the differences are statistically significant, ANOVA results in tables **??** and 6 in particular show only a moderate gap in mean-group value for parameter ρ between the benchmark group and specific group categories. In particular, we notice that there are slight differences in mean-group between High and Middle-High income groups, as well as South Asia & Pacific and MENA for the region-based category. The lack of large differences between High-income and other group categories explains why the Laffer curve for capital taxes is still counterintuitive for the Middle-

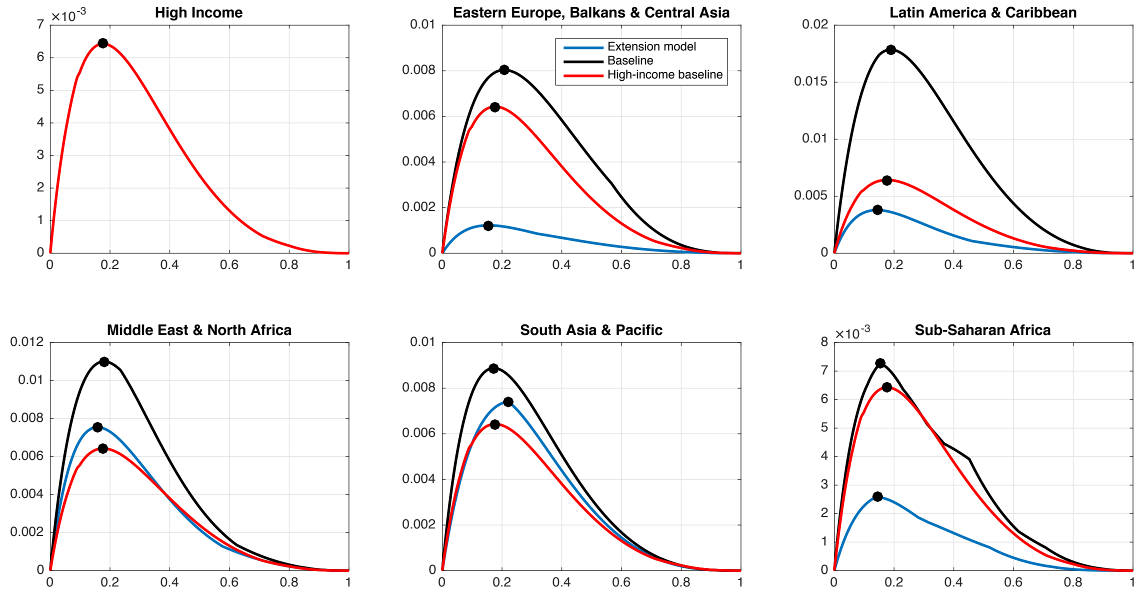


Figure 10: Median Laffer labour tax curves. Sample set broken down into regional groups.

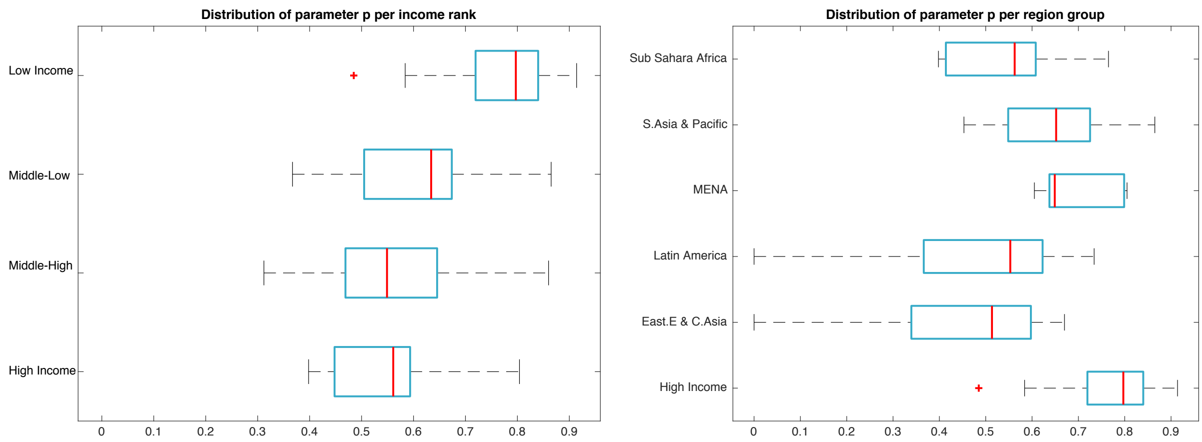


Figure 11: Whiskerplot distribution of parameter p per income and region category groups. Sample set of 132 countries.

High income group, as well as MENA and South Asia & Pacific. These two regional groups still offer counter-intuitive results with respect to the Laffer curve in High-income countries, albeith at a much lower degree, as reported in figure 12.

The income-based comparison of the Laffer capital tax curve has shown that there are shifts in both ways for the extension model. We observe a similar trend for region-based comparison. There is a uniform decline in peak tax revenues for regional groups with respect to the baseline, though at varying degrees. The median countries in Eastern Europe & Balkans, Latin America and to a lesser degree Sub-Sahara Africa see their respective peak tax rates shift to the left in the extension model. It means that the tax rate effect has been large enough to depress the tax base, even though it expands thanks to a smaller wedge effect. these are all country groups with significantly lower mean-group values for parameter ρ, hence the dramatic shift in peak revenues and tax rates. By contrast, country groups with comparatively high mean-group

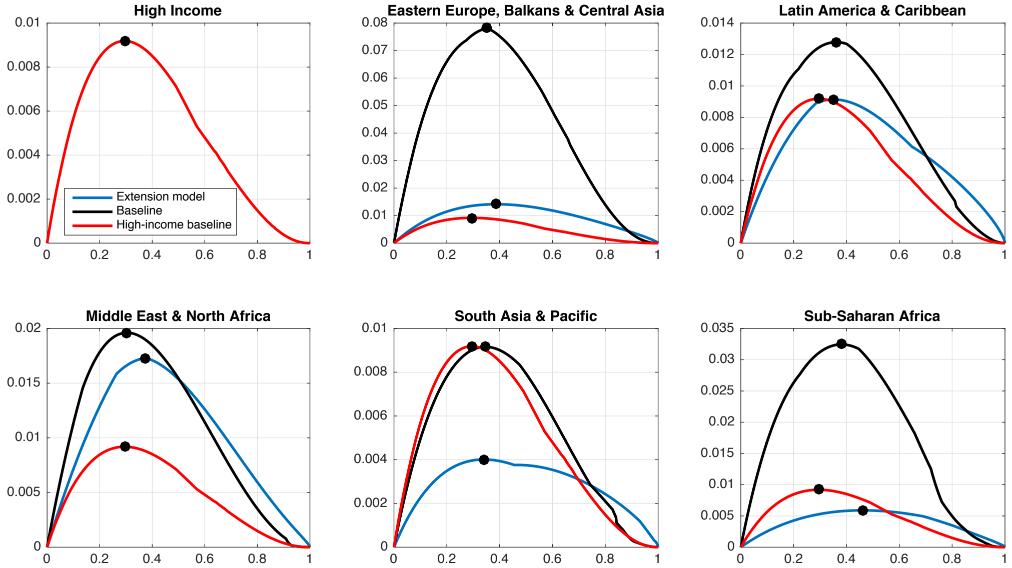


Figure 12: Median Laffer capital tax curves. Sample set broken down into regional groups.

values for ρ see their median peak tax rate shift to the right. This is due to the fact that there was a comparatively low tax base effect. After all, their median values for ρ are close to the High-income group, and they stand to gain little in terms of tax base expansion. As a result, the decline is less pronounced, and their respective Laffer curves remain counter-intuitive in their peak revenues.

4.2.2 Tax collection costs and inefficiences

In depicting the interactions between the tax rate set by the government and its impact on its tax base, the baseline model assumes that there are no frictions in tax collection. In other words, tax authorities collect revenues as expected, whether they have full access to the tax base or not. In the second extension of the baseline model, we have assumed that the government faces a quadratic cost κ when it sets the tax rate. As a result, tax authorities need to raise $\tau(1+\kappa\partial\tau)$ instead, in order to make up for losses due to the collection cost. Figure 13 plots median Laffer curves for labour and capital taxes. It compares the benchmark case against the two extensions discussed in this section.

The second extension model yields adverse results with respect to the baseline. Collection costs generate a decline in the tax base as well as the tax revenues. Because the government loses a fraction of its revenues, they need to set a higher rate than in the baseline model. As a result, there is a larger wedge effect that adversely affects the tax base. Consequently, they need to set their tax rate higher to extract the same level of revenues. This means that the government sets taxes at higher effective rates than the baseline, shrinking the tax base in the process. The collection cost affects the Laffer curve on both aspects of peak rate and revenues: first, the peak tax rate declines due to the shrinking tax base brought about by the larger wedge effect. Second, the shrinking tax base means that the government cannot extract as much revenue as it expects. The Laffer curve therefore shifts to the left, and is depressed with respect to the baseline curve.

The income-based category groups show that there are still counter-intuitive results with

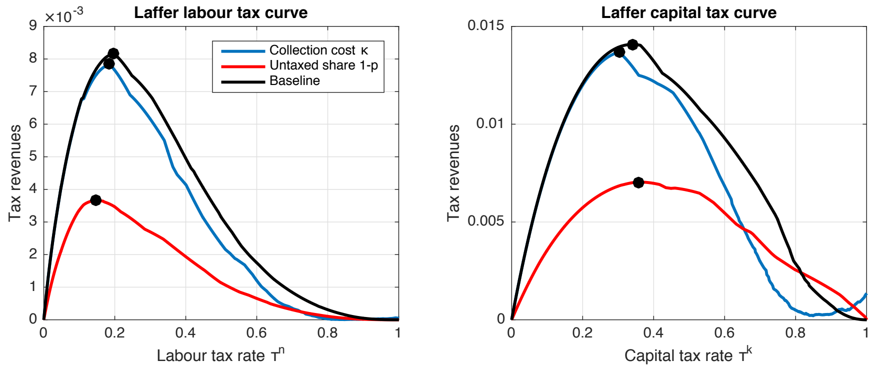


Figure 13: Median Laffer curve for capital and labour taxes - baseline vs model extensions. Medians are computed for the sample set of 152 countries for the baseline, 132 for the first extension, and 127 for the second.

respect to the High-income country group benchmark. The second extension with collection cost κ does not predict a different outcome with respect to the counter-intuitive results of the baseline model. Nevertheless, the model alteration shows an important result, where almost all country category groups see their Laffer curves shift to the left and slightly depressed in comparison with the baseline model. It reflects the impact of collection costs attached to signs of an inefficient fiscal system, a feature more common among developing and emerging economies. Although Middle-High income countries see no significant changes with respect to their median labour Laffer peak tax rate, the slope becomes slightly steeper on the slippery side, nevertheless. Although the same counter-intuitive results remain, we do observe that the collection cost κ affects the peak tax rate, and generates a steeper slope for rates beyond the peak. These observations are reported in figure 14.

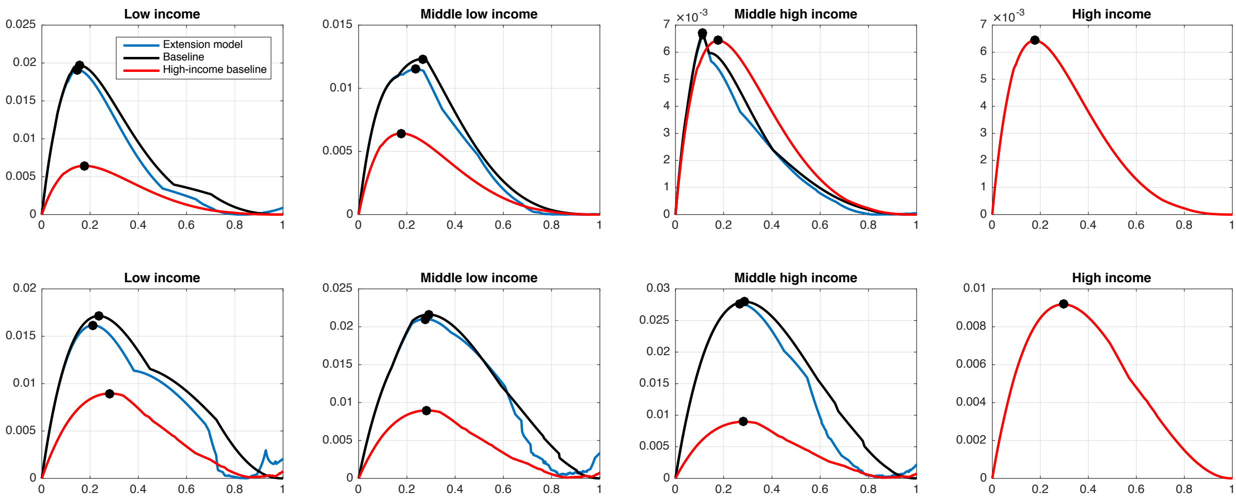


Figure 14: Median Laffer curve for capital and labour taxes - collection cost κ. Income groups - World Bank Atlas method.

The differences between the baseline and extension models are significant enough to conclude to the importance of tax collection costs in developing and emerging economies. The extension model isolates the effects of an inefficient tax system in order to show its effects, regardless of the size of underground economic activities in GDP. We have shown that developing and emerging economies exhibit higher mean-group values for parameter *kappa* than developed countries. As a result, the effects of tax collection costs are more significant in the former group, and reflect adversely on their ability to extract tax revenues. Figures 14, 15 and 16 show that compared to High-income countries, developing and emerging economies extract fewer revenues with lower peak tax rates, regardless of the counter-intuitive outcome.

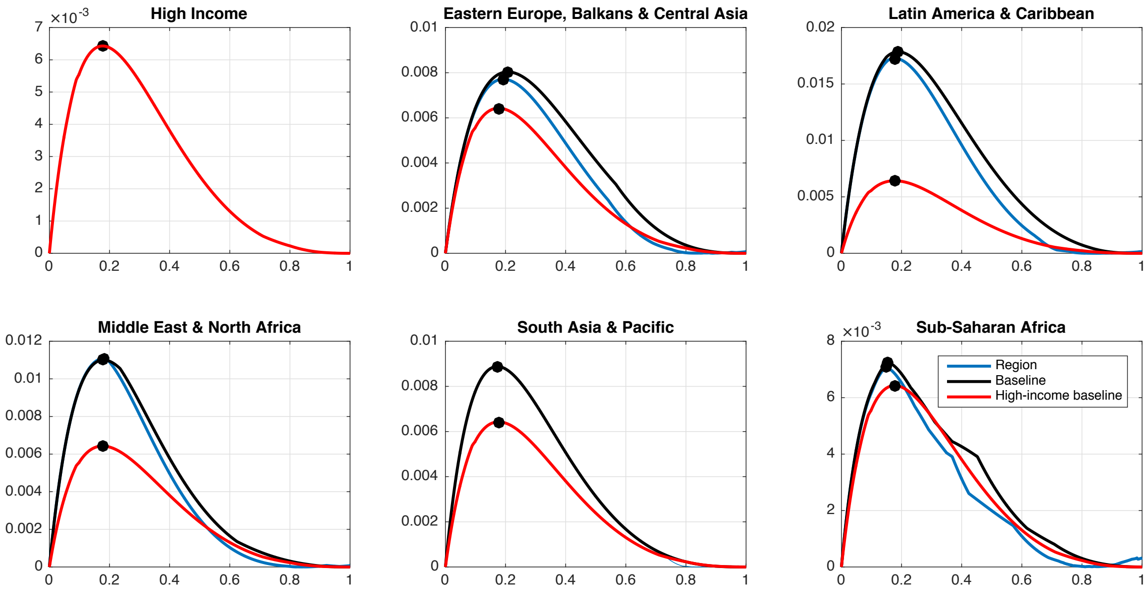


Figure 15: Median Laffer labour tax curves. Sample set broken down into regional groups.

Figure 16 shows that the capital Laffer curve is quite sensitive to collection cost κ. Some regions, like South-Asia and the Pacific exhibit significant changes in the median capital Laffer curve, as it declines both in terms of peak tax rate and revenues with respect to its baseline shape. All other regional groups exhibit a decline in their respective median peak rates. The downward side slope of their respectives curves becomes steeper due to the introduction of tax collection costs.

This extension affects the Laffer curve in a different manner compared to the first extension model. In this configuration, tax collection cost κ brings about only the tax base effect in altering the baseline Laffer curve shape. Because the government needs to set higher tax rates in order to raise the same level of tax revenues, the wedge effect incorporated in the baseline model increases, which has a shrinking effect on the tax base. As a result, the curve shifts left, and for a high enough value for κ, it is depressed. A secondary effect of the collection cost is a steeper downward slope for the Laffer curve, which suggests that tax revenues decline even more rapidly because of tax collection costs. In comparison with the first extension model, the second one does little to reduce the gap in Laffer curves between developing and emerging economies on the one side, and developed ones on the other. Nevertheless, the main takeaway is that tax collection costs are high enough in the former due to their tax inefficiencies that they shift their respective Laffer curves significantly. The combination of the two extensions into a third model gives more insight into what the Laffer curve may look like in developing and emerging economies.

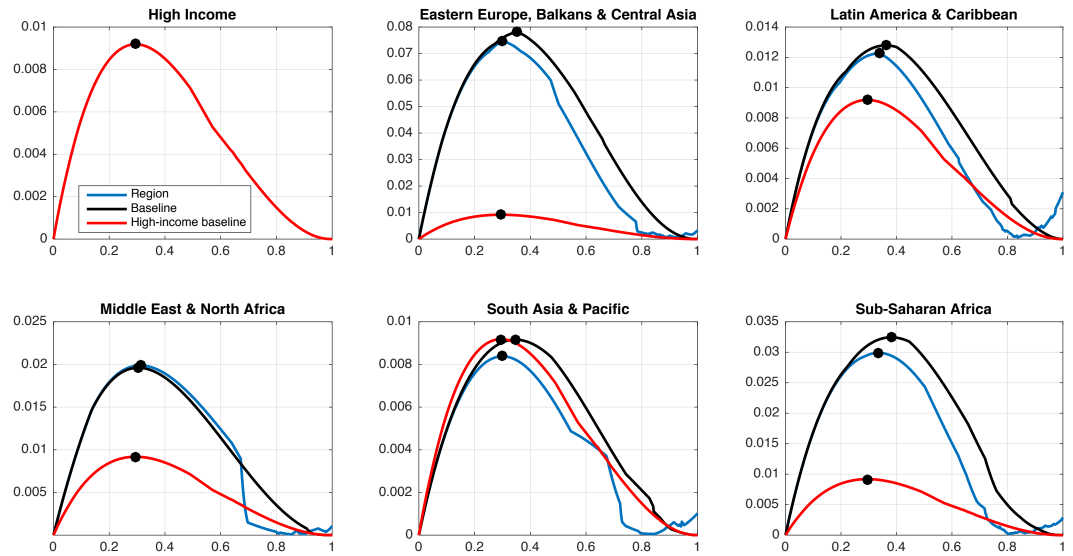


Figure 16: Median Laffer capital tax curves. Sample set broken down into regional groups.

Tax authorities also resort to taxing consumption in order to raise revenues. In contrast to capital and labour, governments can put significantly larger taxes on consumption. With an excise tax for instance, authorities can set tax rates larger than unity, though they do not have a marginal effect on the household consumption optimisation programme. Nevertheless, the tax wedge effect still distorts consumption at the steady-state, and peak rates can be computed for the baseline and its two extensions.

4.3 The Consumption tax Laffer curve

Contrary to labour and capital, household consumption is not a shrinking tax base. In other words, the household does not shift its consumption away to non-market activities when the tax rate is set beyond its peak. This conclusion shared in Trabandt and Uhlig [2011, 2012] stipulates that the consumption tax can in fact be set above 100% and still yield increasing revenues. Such a result is however predicated on the assumption that the labour tax rate is set at zero. This is not realistic nor logical with respect to the household's optimisation programme and the existence of the tax wedge. Instead, when the income tax is also varied, we obtain a similar Laffer-shaped curve with a peak rate. By comparison to labour and capital, the peak rate is higher for the baseline and extension models.

Figure 17 compares the consumption tax Laffer curves across all three specifications. It compares the sample-wide median against High-income and other countries. In this graph, we use High-income countries as a proxy for developed economies, while the remaining countries are consolidated into a proxy for developing and emerging economies. In all three specifications, High-income countries exhibit the highest peak revenues. The baseline model predicts also that the proxy for developed countries exhibit a higher peak tax rate. The consumption Laffer curve exhibits similar properties in changing between the baseline and the two extensions in this paper. Recall that with partial access to the tax base, there are two contradictory effects on the Laffer curve.

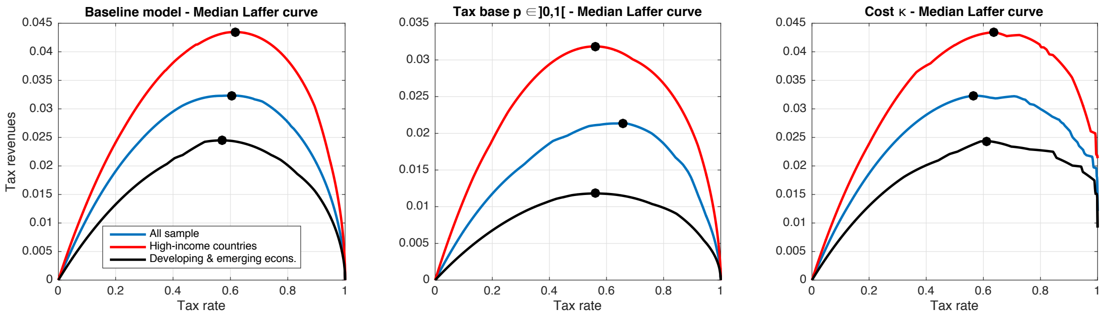


Figure 17: Median Laffer consumption curve: Sample-wide, High-income and other countries.

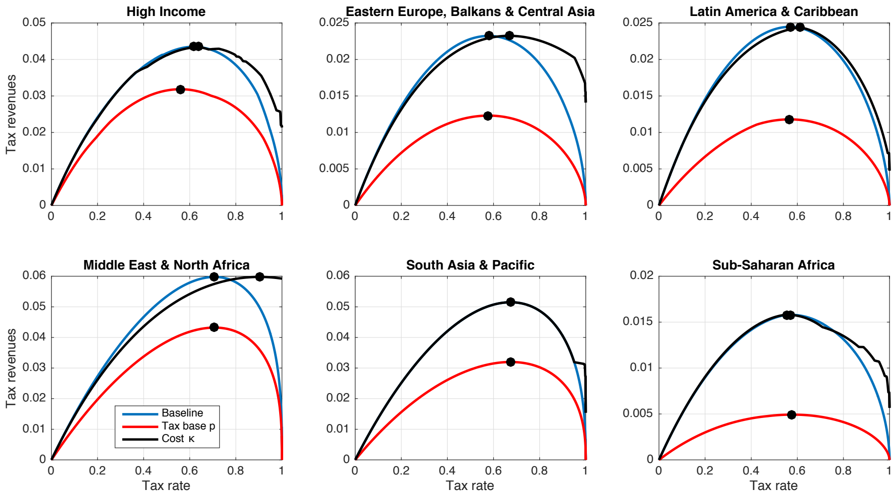


Figure 18: Median Laffer consumption tax curve: High-income and regional groups.

Access to share ρ of the tax base means that the tax wedge is lower, thus having a positive impact and expending it. On the other hand, because the government can tax only a fraction p, this negates the tax base effect. As a result, the peak rate is higher in the extension model in comparison with the baseline, while lowering the peak revenue consecutively. The region-based comparison depicted in figure 18 yields more comprehensive results. For almost all regional groups, the peak tax rate increases between the baseline and the extension with collection cost κ. The differences were low for regional groups like the benchmark High-income countries and South Asia & the Pacific. The peak tax rates differ more significantly for regional groups like MENA and countries in Central Europe, Balkans & Central Asia.

In comparison with capital and labour, there are substantial gains to be made from taxing consumption. First, peak revenues are higher in comparison to the two other tax bases. Second, the peak rate is also comparatively higher. This is due to the fact that the Laffer curve is determined by the CRRA elasticity of substitution - whose inverse makes sure that consumption is quite inelastic to changes in the tax rate. As a result, tax authorities can extract significantly more revenues out of household consumption.

As we have established the dynamics of Laffer tax curves for capital, labour and consumption taxes, we have identified the differences between category groups built out of our country sample. In particular, the shape and peak values for tax rate and revenues are shown to be function of structural parameter values and steady-state variables. In comparing peak rates and steady-state values computed from the dataset, we are able to assess whether a given country - or country group- is below or beyond its peak value. The distance allows us to compute the tax gains (or losses) from a tax cut. The Laffer curve predicts increasing gains when the tax rate is set beyond its peak value. In this case, any reduction in the steady-state tax rate is bound to generate additional revenues. If the steady-state tax rate is below its peak value, then a further tax cut is likely to reduce tax revenues, though not at a commensurate rate. Indeed, the tax revenue loss due to the reduction in the tax rate is partially offset by the expanding tax base due to the lower tax wedge effect. The offset is referred to as the share of self-financed tax cut, *i.e.* the percentage of tax losses for which the expanding base makes up.

4.4 Self-financed tax cuts

One of the main contentions of the Laffer curve is that a tax cut is fully self-financed when the tax rate is set beyond its peak rate. In other words, for excessively high levels of taxation, cutting taxes actually increases tax revenues. The converse of this assertion is that when the tax rate is below its peak value, it is only partially funded. However, note that the close the tax rate is to its peak value, the higher the fraction of self-financed tax cut. Table 10 below reports the median values for self-financed tax cuts when the rate is lowered by one percentage point. The self-financed tax cut is computed as the ratio of revenue loss due to the decline in tax rate relative to the gains in expanding tax base.

The baseline model suggests that the median tax cut of 1% varies across tax bases. Self-financed tax cuts are highest for consumption taxes at 96.7% for the baseline and second extension models. This means that a tax cut of 1% in the consumption rate is likely to be almost fully funded. The same argument applies with a tax increase of 1% in consumption tax rate will yield almost the same in revenues. The self-funded tax cut increases slightly to 98% under the partial access to the tax base extension model. Labour taxes are also highly self-funded when they are cut around the steady-state value - with 93.1% and 93.2% for the baseline and second extension models. The self-financed cut increases to 95.6% under the first model extension. Finally, capita tax cuts are the least self-funded, with values ranging from 68 to 85% between the three model specifications. We report these differences for relatively low benefits from at capital tax cut because most countries are far away from their peak rate values. The median peak value for the sample set for capital tax rates is 34% to 33% should be compared against the median value of steady-state capital tax rate of 19.56%.

It is worthwhile to point out the higher gains from a tax cut in the first extension model with respect to the baseline and second extension. Under partial access to the tax base, the tax burden is higher on declared/taxed economic activities - in this case, capital returns. In contrast with the baseline, a tax cut does not affect the whole tax base when the government has a partial access to it. In addition, because of the tax base effect mentioned in the previous section, the peak rate is comparatively higher under the first extension model. The combination of the two explanations can account for the low level of self-funding in a corporate tax cut. The tax cuts effects vary across countries for two reasons: first, there are different values for structural

Table 10: Median values for a self-financed tax cut of 1%.

Tax	Median	Baseline	ρ share	cost κ
τ^c	9.23%	96.67	97.94	96.61
τ^n	8.30%	93.16	96.66	93.22
τ^k	19.56%	68.27	85.28	68.54

Note: The self-financed tax cut is computed as the elasticity of tax revenues to changes in the tax rate in the neighbourhood of its steady-state value. The table reports median values for each country in the sample set.

parameters and steady-state variables. This is critical because the analytical expressions for peak tax rates for all three tax bases are function of these parameters. Second, the steady-state tax rates for each country may be close to the implied peak rates of their respective Laffer curves. Some countries may be close or past their peak rates, which means that tax cuts are fully self-funded, or generate additional revenues. Others are well below their peak rates, so self-financed cuts are not as large. In order to compare the effects of tax cuts and the magnitude of their self-funding, we compute the median self-financed tax cut for each income group using the World Bank Atlas method. Table 11 reports median self-financed tax cuts. We use the High-income category as a benchmark and the other income groups as proxies for developed and emerging economies.

Table 11: Median values for a self-financed tax cut of 1% - income group.

	Consumption tax τ^c			Labour tax τ^n			Capital tax τ^k		
Income group	Baseline	p share	cost κ	Baseline	p share	cost κ	Baseline	p share	cost κ
Low Income	97.33	98.13	97.31	87.38	91.78	86.82	76.64	89.93	74.42
Middle Low	96.33	96.93	96.27	96.48	95.94	96.49	72.67	87.58	73.09
Middle High	95.76	97.35	95.68	93.08	93.76	93.22	68.29	84.33	70.65
High Income	96.61	96.55	96.57	93.61	95.32	93.48	65.45	77.24	66.87
Others	96.76	97.82	96.67	92.58	93.70	93.00	71.97	87.58	71.95

Note: Median self-financed tax cut. Income group category groups, World Bank Atlas method. The percentage of self-financed tax cut is computed as the elasticity of tax revenues to changes in the tax rate in the neighbourhood of its steady-state value. 'Others' category refers to non-High income countries in the sample set.

Although all income groups exhibit high median self-financed tax cuts for consumption taxes, there are significant differences between model versions. First, the percentage of self-funding increases between the baseline and the first model extension for all income groups except for the High-income category. We explain this with the fact that the benchmark group exhibits a high level of declared tax base. As a result, proxies for developing and emerging economies show that a tax cut is more self-funded thanks to the tax base effect described in the previous sections.

The consistency of consumption taxes is not observed for labour taxes however. Although the percentage of self-funding tax cut larger in the first extension model, Middle-low income

Table 12: Median values for a self-financed tax cut of 1% - income group.

	Consumption tax τ^c			Labour tax τ^n			Capital tax τ^k		
Region	Baseline	p share	cost κ	Baseline	p share	cost κ	Baseline	p share	cost κ
Hi-Income	96.61%	96.55%	96.57%	93.61%	95.32%	93.48%	65.45%	77.24%	66.87%
CEEBCA	93.93%	96.71%	93.85%	90.76%	92.11%	92.29%	85.35%	93.91%	85.21%
LATCAB	95.68%	96.86%	95.67%	93.06%	93.65%	93.09%	71.97%	88.31%	70.65%
MENA	97.52%	98.34%	97.49%	88.51%	92.12%	89.56%	59.39%	77.95%	57.54%
SEAPAC	97.89%	98.38%	97.86%	98.35%	98.13%	98.34%	74.91%	82.75%	75.45%
SUBSAF	96.81%	97.74%	96.74%	90.55%	91.78%	90.22%	64.02%	86.85%	62.56%

Note: Median self-financed tax cut. Income group category groups, World Bank Atlas method. The percentage of self-financed tax cut is computed as the elasticity of tax revenues to changes in the tax rate in the neighbourhood of its steady-state value. **CEEBCA:** Central & Eastern Europe, Balkans & Central Asia. **LATCAB:** Latin America & the Caribbean. **MENA:** Middle-East & North Africa. **SEAPAC:** South Asia & Pacific. **SUBSAF:** Sub-Sahara Africa.

countries see their median self-financed tax cut drops from 96.5% to 96% between the baseline and the first extension models. Capital taxes are the least self-financed in the three tax bases of the model. This is due to the fact that most effective corporate tax rates are far away from their respective peak values. As a result, taxes are less self-funded, and there is little gain from cutting the corporate tax rate. In the baseline model, the median self-funded capital tax cut for High-income countries is 64.5% whereas that number is higher at 72% for others, proxies for developing and emerging countries. The baseline predictions are moderate in comparison with the first model extension, respectively at 77% and 87.6%.

We extend the same analysis to the regional groups built as proxies for developing and emerging economies. Table 12 above reports the median values for self-financed tax cuts for each regional group and compared against the proxy for developed economies, the High-income category group. Self-funding for a consumption tax cut is high and close to one across the board. There are slight variations in comparing the baseline model against its two extensions. Emerging economies continue to exhibit higher self-funding for a tax cut in the first extension model. Because the share of underground economic activities in GDP is higher among developing and emerging economies, a tax cut benefits the consumption tax base on two counts: first, a tax cut reduces the size of its wedge effect on its base. Second, the tax cut effect dominates, which explains why the self-funding is not at unity or above. The distortion introduced by parameter ρ is lower in developed countries, which is why self-funding for a tax cut declines for the benchmark group between the baseline and first extension models.

This is not the case for labour taxes, however. All regional groups see their self-funding share of a tax cut increase from the baseline to the extension with partial access to the tax base, except one. The median country in South Asia & the Pacific exhibit a slight decline in its self-financed tax cut. This can be accounted for by looking at figure 10. The baseline model predicts a lower peak rate in comparison to the extension with partial access ρ to the tax base. A lower peak rate means that there is a smaller distance with the steady-state rate, and thus greater gains from a tax cut. In the case of countries in South Asia, the baseline model predicts a lower peak rate in comparison with the first extension. This means that tax cut gains would be higher for the baseline model, thus the slight decline for this regional group. The tax cost effect of the second extension model is different across tax bases: the consumption tax cut sees its self-financed share slightly declines for all regional groups, regardless of level of income. This is not the case for the income tax, however. Countries with a high collection cost κ see the most gains from a labour tax cut. This is the case because when tax authorities scale back their rate, the wedge effect on labour supply declines. As a result, the gains from an expanding tax base are large enough to almost pay entirely for the tax reduction.

Capital tax cuts are the least likely to self-fund at a large percentage. The baseline model and its second extension predict relatively low levels of self-funding, ranging from 62% for Sub-Sahara Africa to 85% for Central Europe & Central Asia. We have explained before that median steady-state capital tax rates are low across the board and quite far from the peak rate values computed in the baseline model. Such an explanation is weakened for the first extension model. As mentioned before, under partial access to the tax base, a tax cut boosts the base because it weakens further the wedge effect of taxation. In the case of capital, the gains from a smaller wedge are large enough to increase significantly the percentage of self-finance for a capital tax cut. The distribution of such gains is not homogenous across regional groups however. Countries with the smallest share of self-funding tax cut are the ones benefitting the most: the median country in Sub-Sahara Africa sees the percentage of its self-financing share from 62-64% to 86.85%. This is the case because the region has one of the lowest shares of declared and/or taxable economic activities in GDP. This is also the case for MENA countries, where the median sees a capital tax cut increase its self-funding from 57-60% to 78% when the percentage of taxable/declared activities is taken into account. High-income countries increase their share of self-funding for a corporate tax cut, but not as much as developing economies. We explain this results by the fact that these countries have an efficient fiscal system, so parameter ρ is already close to unity. Second, the gains from a smaller tax wedge are not large enough to generate the virtuous effect of an expanding tax base. As a result, the percentage of self-funding for a tax cut we compute for High-income countries is between 67% and 77%, a figure closer to findings in the literature, *e.g.* Mankiw and Weinzierl [2006].

Figure 19 below reports the Laffer curves for all three tax bases under the three specifications of our model: baseline, partial access to the tax base and tax collection costs.

The figure plots the median Laffer curves for the whole sample, High-income and other developing and emerging economies. It also plots the median steady-state values of tax rates and revenues for each country in the sample set. The figure uses the two sub-categories to stylise developed countries (High-income) and the remaining items in the sample set (developing and emerging). We use throughout this paper the High-income country group as a proxy for developed economies, while the remaining countries in our sample set are considered to be developing and emerging. In comparing the Laffer curves for each tax base between the two sub-categories, figure 19 shows that self-funding for tax cuts changes substantially from the baseline to the first extension model. The partial access of ρ share in the tax base alters significantly the tax peak rate, and as a result the distance with the observed steady-state tax rate affects the percentage of self-funding for a tax cut. It is also sensitive to the curvature of the revenue functions. Because the curve is usually flatter for the first extension model, there are higher gains to be made from a tax cut, even if the steady-state tax rate is far from its peak value. This explains why High-income countries can still improve the percentage of self-funding

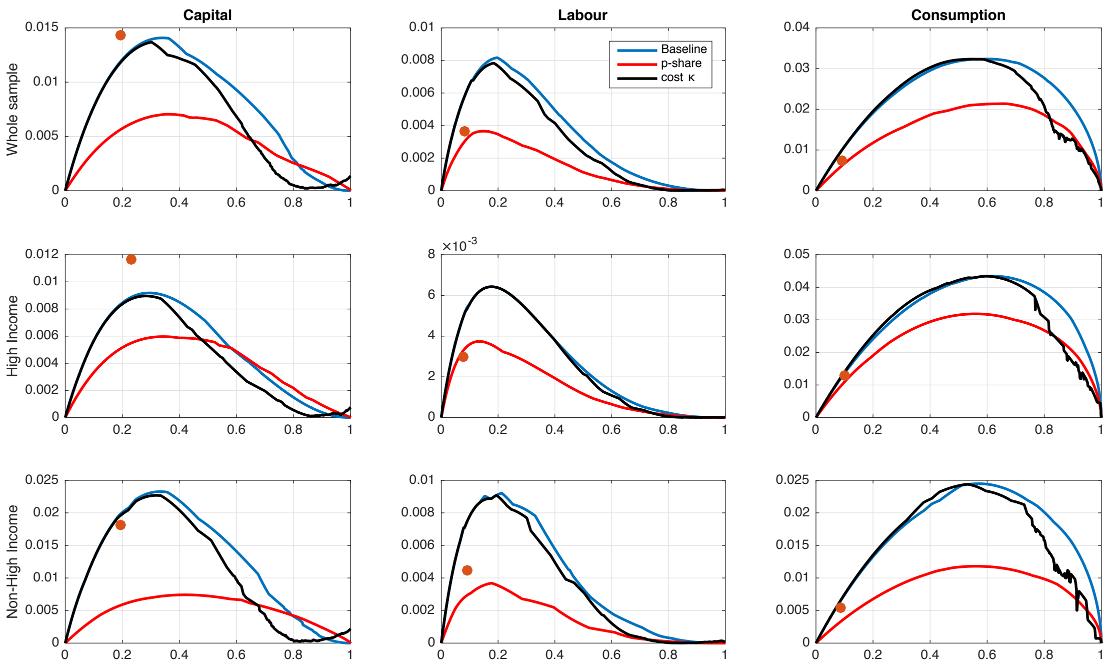


Figure 19: Median Laffer tax curves: baseline vs. extensions. Sample set, High-income and other non-High income countries.

of their capital tax cut, even though it is far from its peak value. Although a tax cut is desirable in all three cases given the high percentage of self-funding, the gains are uneven. Indeed, it appears that capital tax cuts, which are frequently touted as a necessary policy to boost capital accumulation, appear to exhibit the lowest percentage of self-finance. This is due to the fact that most countries in our sample set have considerably reduced their respective corporate rates over the last couple of decades. This means that there is little room from tax base gains when the government reduces further their capital tax rates. By contrast, consumption tax rates are considerably low in comparison with their peak values, which suggests room for funding the shortfall in tax cuts for labour and/or capital.

For developing and emerging economies however, the challenge lies beyond changes in the tax rate and its self-funding share. The first extension of the baseline appears to be a more realistic representation of the limitations facing tax authorities in these countries. The fact that the government can only tax a fraction of its base generates a paradoxical result: on the one hand, the underground economy is freed from the tax wedge, and expands its base as a result. On the other hand, the tax burden falls more heavily on declared activities, which does not translate into higher tax revenues for the government as a result. Developing and emerging economies stand to benefit significantly from increasing their value of parameter ρ, namely the share of declared/taxable economic activities. Following the summary results reported in figure 19, they can more than double tax revenues while at the same time reduce the peak rate of their taxes on capital and labour. There are also positive gains from consumption taxes, though in this case a tax increase is more profitable since consumption is easier to tax *via* value-added taxes, for instance. Another avenue that governments in developing and emerging economies may find interesting to explore is the cost of tax collection. There are substantial losses recorded in collecting taxes as expressed in parameter κ. We have shown earlier that although there are no significant changes with respect to the baseline, the tax collection model introduces two important features that weaken tax authorities ability to collect revenues. Collection cost κ shifts the Laffer curve slightly to the left, which means that the peak revenue declines, even if slightly. Furthermore, the curve also is slightly depressed, which means that tax authorities also lose revenues in the process. Another feature that is important to the Laffer predictions is that the slope curve becomes steeper past the peak rate. In other words, revenue losses from tax increases are larger the higher the tax rate. This means that collection costs become crippling when tax authorities set their tax rate beyond its peak value. In this instance, there are gains to be made from reducing the gap between overall tax burden and the sum base-specific revenues. The inefficiencies may be due to inadequate legislation, or choices made by policymakers that exacerbate the distortionary effects of taxation on its sources of revenues.

To sum up, the Laffer curve is an adequate tool to assess how far developing and emerging economies are from their respective peak rates. Although the majority have not reached it yet, they are hampered by other factors in increasing their tax revenues. The importance of underground economic activities, as illustrated by the partial access ρ to the tax base has been relevant to the size of undeclared and/or untaxable economic sectors relative to GDP. Thanks to the first model extension, the Laffer curve is more relevant to the specifics of developing and emerging economies and their inability to increase tax rates and revenues without reaching their peak values. Tax collection costs also contribute to skew tax revenues downward and to the left, reflecting the revenue losses that tax authorities need to make up for by increasing taxe rates even higher.

5 Conclusions

Our paper contributes to the literature on the Laffer curve by applying it to emerging and developing countries. Using the model developed in Trabandt and Uhlig [2011, 2012] we argue that the Laffer curve is sensitive to two factors, namely the size of underground economic activities and tax collection costs. More specifically, relative to Trabandt & Uhlig, we assume that household utility function is separable in labour and consumption. This alteration is motivated by the fact that there is no cross-elasticity between consumption and worked hours. Furthermore, empirical evidence shows that households in developing and emerging economies face the extensive, rather than intensive margin. In other words, the labour supply choice is between working and not working, rather than in volume of worked hours. This alters significantly the dynamics of the household optimisation programme. Our model stipulates that the household maximises their utility over consumption and labour, constrained by their resources. Capital, labour and consumption are all taxed at their respective rates, which creates wedges in all three. Labour supply in particular, equates the marginal rate of substitution between consumption and labour with its marginal productivity. The equality is distorted with a wedge tax that reduces labour supply as taxes increase.

The baseline model exhibits counter-intuitive results for developing and emerging economies. The differences in Laffer curve shapes are due to the values computed for structural parameters and steady-state variables. Developing and emerging economies are more likely to exhibit higher share of consumption-to-output ratios, which means that the income effect is large enough for households to be elastic to tax changes. Labour tax revenues are also function of the Frisch elasticity, a key component given the controversy in the literature as to the range of acceptable values they may take. The same differences are reported with respect to capital tax revenues. Developing and emerging economies exhibit higher levels of real interest rate, and as a result they are likely to exhibit higher tax revenues at the peak level. Furthermore, the same set of countries also exhibits higher levels of productivity growth rates, which have a positive impact on after-tax capital stock. By contrast, consumption tax revenues are higher among developed countries. The baseline model is further extended in two directions: the first extension assumed that tax authorities do not have full access to the tax base. In other words, they would observe only a fraction ρ of their tax base, and tax it accordingly. The model predicts two contradictory effects: partial access to the tax base means that the tax wedge effect is weaker than the baseline, which boosts the former. However, the government can only extract revenues at a smaller effective tax rate. Ultimately, the second effect clearly dominates, which pushes the Laffer curve downwards, while shifting the peak rate to the right. This extension has improved tremendously the model's ability to predict the Laffer curves of developing and emerging economies with respect to developed ones. Although many of the former improve their respective peak rates, their revenues decline accordingly, more than commensurate to the differences in values of parameter ρ between the two country groups.

In the second extension, we have assumed that authorities face a different kind of limitation, in the form of tax collection costs. The government faces costs that arise from inefficiency or difficulties in identifying the tax base. Given the large values we have computed for parameter κ, developing and emerging economies face larger costs in setting their tax rates. This has the effect of shifting the Laffer curve to the right and downwards. This is due to the fact that the effective tax rate is higher than expect, and so would the tax wedge effect be on the three tax bases. As a result, the government extracts fewer revenues, and hits a comparatively smaller level of tax peak rate. It also means that the peak tax revenue would be lower as a result.

The main prediction of the Laffer curve in its original specification is that if the tax rate is set beyond its peak value, then any tax cut actually increases revenues. In other words, the reduction in tax rates is self-financed. By contrast, when the tax rate is below its peak value, a further tax cut is only partially self-financed. Two factors can have an impact on the percentage of self-funding when the tax rate is reduced: the distance of its steady-state value from the peak, and the curvature of the Laffer curve. We have found that for most countries, the peak rate is higher than its steady-state value. As a result, tax cuts do not increase revenues, but pay for themselves at higher fractions that usually reported in the literature. For consumption and labour taxes, we explain this by the fact that most countries are either at their respective peak rates and/or exhibit steep curvature that increase self-funding when tax rates are cut. Results are more nuanced for capital taxes, which exhibit the lowest percentage of self-finance. We have explained this by the fact that most countries have engaged in steady reduction of their respective corporate rates. As a result, the steady-state tax rates are much lower than their peak values, and there are comparatively little gains from further tax cuts. As a result, should governments in developing and emerging economies seek to reduce their overall tax burden and boost their tax bases, they would do well to chose a specific combination of tax cuts and increases that would maximise revenues without too much distortion.

In the two extensions, the model offers alternative sets of policies for tax authorities in developing and emerging economies to improve their tax revenues without changing their tax rates. For instance, a larger share of declared/taxable economic activities improves tax revenues without distorting significantly the tax base. Indeed, the governments of these economies can afford to cut taxes when they integrate a higher percentage of underground economic activities. Similarly, reducing tax cost collection reduces the tax wedge effect, and thus boost the tax base as a result. These policy measures are more linked to the political economy of developing and emerging economies. The integration of undeclared/untaxed economic activities, or the reduction tax collection cost call for changes in institutional arrangements, or cracking down on corruption and inefficiencies to improve tax collection. The distance between steady-state tax rates and their peak values would therefore be function of institutional quality indicators, with the more advanced economies bridging the gap at a faster rate than these with institutions of lesser quality.

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Table 13: Structural parameters - average values per Freedom House status category.

Group/Parameter	β	δ	α	σ	ϕ	ρ	κ
Free	0.942	0.023	0.32	2.442	0.315	0.755	-0.253
	(0.042)	(0.015)	(0.172)	(1.472)	(0.865)	(0.106)	(0.229)
	0.949	0.022	0.341	1.858	0.332	0.773	-0.254
	0.701	0	0.033	1.03	-4.379	0.485	-0.759
	0.986	0.074	0.917	8.124	4.157	0.914	0.393
	57	57	57	57	57	50	49
Partially Free	0.92	0.028	0.284	3.048	0.429	0.604	-0.41
	(0.065)	(0.025)	(0.231)	(2.616)	(0.531)	(0.123)	(0.272)
	0.934	0.023	0.225	1.978	0.415	0.61	-0.442
	0.559	0	0.011	1.037	-2.541	0.312	-0.989
	0.999	0.15	0.944	13.127	2.236	0.867	0.792
	65	65	65	65	65	56	54
Not Free	0.926	0.036	0.357	2.484	0.39	0.639	-0.439
	(0.047)	(0.026)	(0.258)	(1.648)	(0.166)	(0.132)	(0.264)
	0.92	0.034	0.282	1.773	0.391	0.622	-0.482
	0.813	0.005	0.011	1.021	0.116	0.367	-0.887
	0.996	0.111	0.92	8.161	0.772	0.865	0.303
	30	30	30	30	30	26	24

Note: Standard errors reported in parentheses. See comments on table 3. Summary statistics are computed for sub-categories.

Table 14: Structural parameters - average values per region group category.

Group/Parameter	β	δ	α	σ	ϕ	ρ	κ
High Income	0.951	0.024	0.330	2.162	0.304	0.782	-0.242
	(0.026)	(0.016)	(0.116)	(1.202)	(0.896)	(0.090)	(0.287)
	0.955	0.024	0.341	1.780	0.282	0.803	-0.281
	0.832	0.000	0.085	1.021	-4.379	0.485	-0.785
	0.996	0.074	0.844	7.781	4.157	0.914	0.792
	53	53	53	53	53	49	44
E.C. Europe & Central Asia	0.907	0.041	0.390	3.567	0.350	0.531	-0.346
	(0.048)	(0.026)	(0.215)	(2.993)	(1.055)	(0.106)	(0.222)
	0.905	0.039	0.351	2.559	0.269	0.547	-0.279
	0.813	0.006	0.131	1.044	-2.541	0.312	-0.833
	0.981	0.111	0.944	10.662	2.236	0.670	-0.060
	16	16	16	16	16	13	13
Latin America & Caribbean	0.902	0.021	0.240	3.544	0.444	0.569	-0.423
	(0.064)	(0.015)	(0.233)	(1.694)	(0.114)	(0.109)	(0.192)
	0.925	0.019	0.191	3.496	0.428	0.590	-0.448
	0.701	0.000	0.033	1.673	0.234	0.319	-0.759
	0.967	0.046	0.917	8.124	0.800	0.734	-0.040
	21	21	21	21	21	17	18
Middle East & North Africa	0.958	0.036	0.319	1.552	0.375	0.699	-0.359
	(0.039)	(0.023)	(0.271)	(0.576)	(0.103)	(0.083)	(0.257)
	0.958	0.036	0.250	1.314	0.372	0.649	-0.327
	0.869	0.005	0.106	1.037	0.239	0.605	-0.809
	0.997	0.067	0.920	2.671	0.525	0.805	0.087
	9	9	9	9	9	9	9
South Asia & Pacific	0.939	0.023	0.241	1.938	0.337	0.667	-0.470
	(0.042)	(0.024)	(0.239)	(0.921)	(0.060)	(0.123)	(0.099)
	0.942	0.018	0.152	1.783	0.330	0.668	-0.446
	0.803	0.000	0.031	1.089	0.254	0.453	-0.612
	0.980	0.091	0.809	5.021	0.477	0.865	-0.318
	17	17	17	17	17	16	11
Sub-Sahara Africa	0.912	0.031	0.324	3.300	0.484	0.583	-0.435
	(0.074)	(0.029)	(0.283)	(2.884)	(0.206)	(0.082)	(0.284)
	0.917	0.023	0.199	2.275	0.438	0.578	-0.481
	0.559	0.001	0.011	1.075	0.165	0.398	-0.989
	0.999	0.150	0.931	13.127	1.458	0.765	0.303
	36	36	36	36	36	28	32

Note: Standard errors reported in parentheses. See comments on table 3. Summary statistics are computed for sub-categories.

Table 15: Structural parameters - ANOVA regression results, G7 as group base level

Variable	β	δ	α	σ	ϕ	ρ	κ
No G7/OECD	-0.042**	0.013	-0.036	0.943	0.229	-0.224**	-0.02
	(0.021)	(0.009)	(0.085)	(0.805)	(0.248)	(0.044)	(0.12)
OECD	-0.018	0.011	-0.033	0.038	0.126	-0.125**	0.14
	(0.025)	(0.011)	(0.104)	(0.983)	(0.304)	(0.053)	(0.143)
Core OECD	-0.01	0.001	-0.002	0.248	0.037	-0.027	0.131
	(0.024)	(0.01)	(0.098)	(0.928)	(0.287)	(0.05)	(0.133)
Base	0.964***	0.017**	0.342**	1.959**	0.189*	0.846***	-0.369***
	(0.02)	(0.008)	(0.083)	(0.781)	(0.108)	(0.042)	(0.117)
N	152	152	152	152	152	132	127
R2 Adjusted	0.044	0.017	-0.017	0.009	-0.006	0.331	0.033
RMSE	0.053	0.022	0.219	2.067	0.638	0.112	0.261
RSS	0.422	0.074	7.086	632.623	60.302	1.594	8.385
Fisher	3.308	1.868	0.163	1.452	0.72	22.571	2.446

Note: Available data for 132 countries for ρ, 127 countries for κ. Standard errors are reported in parentheses. Level of significance is denoted with stars. Legend: * $<$ 1%. ** 5% and $*$ 10%. Intercept reports G7 mean group and level of significance. Estimated coefficients report differences in mean groups.

Table 16: Structural parameters - ANOVA regression results, High Income countries as group base level.

Variable	β	δ	α	σ	ϕ	ρ	κ
Middle High	-0.031***	0.009*	-0.045	0.778*	0.029	-0.157***	-0.142**
	(0.011)	(0.005)	(0.045)	(0.424)	(0.132)	(0.023)	(0.058)
Middle Low	-0.03***	0.001	-0.039	0.734	0.152	-0.194***	-0.177***
	(0.012)	(0.005)	(0.048)	(0.451)	(0.14)	(0.025)	(0.063)
Low Income	-0.042***	0.006	0.017	1.111	0.218	-0.21***	-0.214***
	(0.013)	(0.006)	(0.054)	(0.513)	(0.159)	(0.028)	(0.065)
Base	0.951***	0.024***	0.33***	2.162***	0.304***	0.782***	-0.242***
	(0.007)	(0.003)	(0.03)	(0.282)	(0.088)	(0.015)	(0.038)
N	152	152	152	152	152	132	127
R2 Adjusted	0.071	0.009	-0.007	0.021	-0.003	0.42	0.083
RMSE	0.053	0.022	0.218	2.054	0.637	0.104	0.254
RSS	0.41	0.074	7.018	624.647	60.12	1.381	7.954
Fisher	4.832	1.482	0.641	2.1	0.871	32.671	4.8

Notes: Available data for 132 countries for ρ, 127 countries for κ. Standard errors are reported in parentheses. Level of significance is denoted with stars. Legend: * $<$ 1%. ** 5% and $*$ 10%. Intercept reports High-income countries mean group and level of significance. Estimated coefficients report differences in mean groups.

Table 17: Calibrated values - whole sample.

ISO	Country	β	δ	α	σ	ϕ	ρ	κ
AGO	Angola	0.833	0.022	0.267	8.161	0.406	0.564	-0.353
ALB	Albania	0.971	0.006	0.396	1.291	0.814	0.637	-0.418
ARE	United Arab Emirates	0.934	0.038	0.269	1.455	0.643	0.731	0.09
ARG	Argentina	0.963	0.024	0.437	1.086	0.243	0.745	-0.5
ARM	Armenia	0.851	0.053	0.494	5.168	-2.541	0.513	-0.256
ATG	Antigua and Barbuda	0.933	0.004	0.345	3.274	0.127		0.186
AUS	Australia	0.949	0.01	0.303	1.512	0.341	0.854	-0.549
AUT	Austria	0.946	0.005	0.294	2.454	0.127	0.902	-0.296
AZE	Azerbaijan	0.903	0.111	0.798	1.558	0.116	0.367	-0.833
BDI	Burundi	0.962	0.019	0.599	1.214	0.579	0.601	-0.488
BEL	Belgium	0.934	0.022	0.418	3.33	0.158	0.775	-0.278
BEN	Benin	0.912	0.023	0.474	2.839	0.468	0.502	-0.472
BFA	Burkina Faso	0.918	0.029	0.629	2.911	0.352	0.578	-0.671
BGD	Bangladesh	0.934	0.02	0.52	2.837	0.427	0.641	0.658
BGR	Bulgaria	0.961	0.073	0.944	2.378	2.236	0.615	-0.582
BHR	Bahrain	0.939	0.031	0.334	1.781	0.5	0.811	0.255
BHS	Bahamas. The	0.964	0.012	0.479	2.678	0.481	0.741	3.777
BIH	Bosnia and Herzegovina	0.9	0.053	0.48	10.185	-0.129		-0.279
BLR	Belarus	0.813	0.055	0.367	3.232	0.295	0.502	-0.099
BLZ	Belize	0.895	0.036	0.73	3.677	0.44	0.553	-0.133
BOL	Bolivia	0.943	0.008	0.605	1.795	0.389	0.319	-0.484
BRA	Brazil	0.701	0.042	0.191	8.124	0.335	0.595	1.406
BRB	Barbados	0.94	0.048	0.844	1.714	0.46		0.657
BTN	Bhutan	0.929	0.003	0.237	1.953	0.323	0.7	1.588
BWA	Botswana	0.964	0.021	0.154	1.574	0.356	0.662	3.894
CAF	Central African Republic	0.903	0.024	0.45	5.256	0.714	0.509	-0.56
CAN	Canada	0.967	0.001	0.345	1.113	0.365	0.837	-0.644
CHE	Switzerland	0.973	0.04	0.376	1.709	0.266	0.914	-0.492
CHL	Chile	0.908	0.023	0.138	2.003	0.355	0.797	-0.473
CHN	China	0.98	0.049	0.062	1.273	0.312	0.865	1.699
CIV	Cote d'Ivoire	0.917	0.045	0.627	1.757	0.465	0.587	-0.594
CMR	Cameroon	0.9	0.008	0.587	3.046	0.403	0.665	-0.643
COG	Congo. Rep.	0.912	0.045	0.046	2.033	0.418	0.499	-0.017
COL	Colombia	0.907	0.008	0.26	2.485	0.429	0.59	-0.423
CPV	Cabo Verde	0.928	0.037	0.248	3.514	0.325		-0.198
CRI	Costa Rica	0.929	0.039	0.112	1.728	0.434	0.734	-0.461
CYP	Cyprus	0.976	0.028	0.447	1.457	0.264	0.706	0.393
CZE	Czech Republic	0.967	0.032	0.522	1.983	0.894	0.802	-0.18
DEU	Germany	0.928	0.029	0.371	3.985	0.096	0.84	-0.369
DMA	Dominica	0.948	0.046	0.917	3.274	0.8		-0.759
DNK	Denmark	0.93	0.02	0.345	4.758	0.182	0.817	-0.104
DOM	Dominican Republic	0.899	0.024	0.192	2.037	0.403	0.677	-0.437
DZA	Algeria	0.994	0.036	0.352	1.15	0.507	0.643	-0.158
ECU	Ecuador	0.8	0.022	0.197	5.718	0.404	0.634	-0.68
EGY	Egypt. Arab Rep.	0.97	0.06	0.92	1.648	0.239	0.647	-0.809
ESP	Spain	0.964	0.014	0.293	1.636	0.209	0.771	-0.528
EST	Estonia	0.986	0.04	0.341	1.299	4.157	0.597	-0.234
ETH	Ethiopia	0.979	0.069	0.615	1.381	0.411	0.58	-0.399

Notes: Available data for 132 countries for ρ, 127 countries for κ.

Table 18: Calibrated values - whole sample.

ISO	Country	β	δ	α	σ	ϕ	ρ	κ
FIN	Finland	0.966	0.028	0.382	1.366	0.135	0.815	-0.072
FJI	Fiji	0.957	0.091	0.102	2.471	0.477	0.652	-0.407
FRA	France	0.972	0.022	0.352	1.268	0.148	0.846	-0.289
GBR	United Kingdom	0.986	0.022	0.33	1.524	0.151	0.871	-0.236
GEO	Georgia	0.872	0.037	0.219	1.044	1.184	0.312	1.098
GHA	Ghana	0.851	0.002	0.202	3.165	0.533	0.568	-0.429
GIN	Guinea	0.934	0.025	0.011	2.698	0.772	0.598	0.303
GMB	Gambia. The	0.872	0.001	0.022	4.599	0.495	0.541	-0.569
GNQ	Equatorial Guinea	0.884	0.102	0.029	1.684	0.165	0.657	8.653
GRC	Greece	0.96	0.007	0.388	1.767	0.166	0.701	-0.154
GRD	Grenada	0.944	0.013	0.079	2.667	0.354		-0.04
GTM	Guatemala	0.941	0.036	0.08	1.673	0.408	0.475	-0.665
HKG	Hong Kong SAR. China	0.954	0.032	0.241	1.891	0.274	0.828	-0.616
HND	Honduras	0.912	0.019	0.128	2.418	0.469	0.491	-0.432
HRV	Croatia	0.926	0.036	0.386	4.812	0.96	0.653	0.023
HUN	Hungary	0.956	0.024	0.293	3.258	-0.663	0.742	-0.186
IDN	Indonesia	0.94	0.051	0.129	1.11	0.326	0.801	1.465
IND	India	0.942	0.006	0.167	1.345	0.353	0.86	1.095
IRL	Ireland	0.977	0	0.27	1.704	0.21	0.84	-0.304
IRN	Iran. Islamic Rep.	0.958	0.007	0.25	1.632	0.39	0.805	-0.545
ISL	Iceland	0.955	0.007	0.423	1.995	0.319	0.838	-0.14
ISR	Israel	0.886	0.012	0.262	3.112	0.352	0.782	2.64
ITA	Italy	0.953	0.001	0.38	2.674	0.104	0.728	-0.306
JAM	Jamaica	0.944	0	0.24	4.066	0.486	0.619	-0.254
JOR	Jordan	0.95	0.067	0.108	1.037	0.441	0.797	0.087
JPN	Japan	0.978	0.018	0.228	1.858	0.138	0.886	0.83
KAZ	Kazakhstan	0.87	0.048	0.294	4.965	0.168	0.547	-0.557
KEN	Kenya	0.94	0.016	0.126	1.409	0.447	0.645	-0.579
KGZ	Kyrgyz Republic	0.843	0.041	0.131	10.662	0.564	0.58	-0.518
KHM	Cambodia	0.899	0.005	0.138	5.021	0.388	0.485	-0.397
KOR	Korea. Rep.	0.964	0.031	0.197	1.672	0.24	0.718	-0.519
KWT	Kuwait	0.965	0.039	0.353	1.778	0.69	0.791	-0.785
LAO	Lao PDR	0.911	0.018	0.132	2.032	0.267	0.684	-0.446
LBN	Lebanon	0.944	0.005	0.32	2.276	0.352	0.649	-0.257
LBR	Liberia	0.892	0.026	0.141	4.007	0.392	0.577	-0.989
LCA	St. Lucia	0.925	0.009	0.041	5.13	0.417		-0.199
LKA	Sri Lanka	0.965	0.009	0.109	1.978	0.354	0.547	-0.318
LSO	Lesotho	0.952	0.01	0.061	1.295	0.35	0.679	3.869
LTU	Lithuania	0.953	0.024	0.292	1.03	-4.379	0.681	0.219
LUX	Luxembourg	0.96	0.003	0.446	1.362	0.353	0.901	-0.054
LVA	Latvia	0.951	0.011	0.41	1.247	1.546	0.584	-0.343
MAC	Macao SAR. China	0.983	0.064	0.144	1.325	0.282	0.861	1.832
MAR	Morocco	0.951	0.057	0.106	1.192	0.372	0.621	-0.327
MDA	Moldova	0.92	0.027	0.262	1.079	1.307		-0.199
MDG	Madagascar	0.829	0.006	0.05	13.127	0.579	0.615	-0.412

Notes: Available data for 132 countries for ρ, 127 countries for κ.

Table 19: Calibrated values - whole sample.

ISO	Country	β	δ	α	σ	ϕ	ρ	κ
MDV	Maldives	0.934	0.002	0.805	1.783	0.359	0.689	-0.546
MEX	Mexico	0.967	0.01	0.225	1.735	0.45	0.698	0.747
MKD	Macedonia. FYR	0.903	0.035	0.242	4.435	0.993	0.638	1.145
MLI	Mali	0.916	0.015	0.777	3.395	0.354	0.561	-0.482
MLT	Malta	0.962	0.074	0.281	1.809	0.173	0.73	-0.204
MMR	Myanmar	0.978	0.012	0.809	1.686	0.254		-0.444
MNG	Mongolia	0.803	0.02	0.225	1.971	0.255	0.808	-0.36
MOZ	Mozambique	0.894	0.027	0.931	3.162	0.393		-0.751
MUS	Mauritius	0.917	0.011	0.084	1.963	0.273	0.765	-0.335
MYS	Malaysia	0.965	0	0.241	1.633	0.33	0.687	-0.606
NAM	Namibia	0.946	0.04	0.155	1.251	0.446	0.675	-0.217
NER	Niger	0.911	0.01	0.239	2.487	0.681		0.014
NGA	Nigeria	0.977	0.018	0.863	1.634	0.556		0.116
NIC	Nicaragua	0.822	0.003	0.165	5.468	0.682	0.542	-0.458
NLD	Netherlands	0.953	0.009	0.363	2.703	0.249	0.87	-0.175
NOR	Norway	0.949	0.037	0.366	1.769	0.196	0.805	-0.047
NPL	Nepal	0.968	0.022	0.031	1.788	0.32	0.631	-0.472
NZL	New Zealand	0.955	0.027	0.294	1.985	0.332	0.868	-0.294
OMN	Oman	0.948	0.011	0.252	1.789	0.372	0.806	-0.539
PAK	Pakistan	0.961	0.015	0.07	1.77	0.344	0.621	1.669
PAN	Panama	0.934	0.004	0.128	1.06	0.399		-0.452
PER	Peru	0.874	0.031	0.101	3.496	0.413	0.382	-0.479
PHL	Philippines	0.957	0.02	0.152	1.089	0.38	0.549	-0.612
POL	Poland	0.926	0.042	0.22	2.023	-0.451	0.72	-0.285
PRT	Portugal	0.965	0.025	0.299	1.48	0.21	0.775	-0.272
PRY	Paraguay	0.855	0.038	0.07	5.07	0.428	0.591	-0.373
QAT	Qatar	0.996	0.045	0.257	1.021	0.508	0.82	1.333
RUS	Russian Federation	0.937	0.045	0.332	1.629	0.169	0.514	2.741
RWA	Rwanda	0.923	0.011	0.225	2.064	0.43		-0.487
SDN	Sudan	0.893	0.035	0.763	5.139	0.392		-0.887
SEN	Senegal	0.919	0.04	0.163	2.881	0.539	0.536	-0.401
SGP	Singapore	0.956	0.001	0.295	1.881	0.325	0.867	-0.425
SLE	Sierra Leone	0.999	0.04	0.817	1.099	0.523	0.569	-0.821
SLV	El Salvador	0.893	0.036	0.033	3.85	0.234	0.525	-0.591
SRB	Serbia	0.948	0.014	0.387	1.571	-0.983		-0.06
STP	Sao Tome and Principe	0.88	0.01	0.146	11.235	0.423		0.211
SUR	Suriname	0.925	0.001	0.288	4.406	0.451	0.581	1.586
SVK	Slovak Republic	0.942	0.051	0.355	1.708	0.424	0.803	-0.331
SVN	Slovenia	0.944	0.037	0.455	2.898	0.86	0.72	0.049
SWE	Sweden	0.955	0.031	0.355	2.632	0.156	0.804	-0.001
SYC	Seychelles	0.933	0.019	0.235	4.124	0.371		0.792
SYR	Syrian Arab Republic	0.987	0.018	0.115	1.314	0.525	0.804	-0.486

Notes: Available data for 132 countries for ρ, 127 countries for κ.

Table 20: Calibrated values - whole sample.

ISO	Country	β	δ	α	σ	ϕ	ρ	κ
TGO	Togo	0.916	0.012	0.111	1.936	0.603		-0.409
THA	Thailand	0.941	0.043	0.162	1.213	0.268	0.453	-0.56
TJK	Tajikistan	0.907	0.02	0.335	2.74	0.238	0.558	-0.207
TTO	Trinidad and Tobago	0.938	0.035	0.085	1.78	0.365	0.646	-0.479
TUN	Tunisia	0.997	0.039	0.141	1.047	0.291	0.605	-0.262
TUR	Turkey	0.925	0.024	0.163	3.362	0.242	0.67	-0.285
TZA	Tanzania	0.943	0.032	0.148	1.104	0.495	0.398	-0.479
UGA	Uganda	0.996	0.045	0.011	1.075	0.415	0.561	-0.559
UKR	Ukraine	0.981	0.022	0.394	1.778	0.931	0.451	-0.202
URY	Uruguay	0.832	0.01	0.204	7.781	0.38	0.485	-0.148
USA	United States	0.962	0.026	0.388	1.291	0.322	0.912	0.482
VCT	St. Vincent and the Grenadines	0.945	0.006	0.084	3.874	0.424		-0.243
VEN	Venezuela. RB	0.966	0.018	0.295	1.743	0.473	0.667	-0.499
YEM	Yemen. Rep.	0.869	0.033	0.562	2.671	0.258	0.723	-0.478
ZAF	South Africa	0.97	0.013	0.155	1.86	0.353	0.705	-0.501
ZMB	Zambia	0.995	0.065	0.195	1.313	0.458	0.492	-0.538
ZWE	Zimbabwe	0.559	0.15	0.539	9.538	1.458	0.43	-0.21

Notes: Available data for 132 countries for ρ, 127 countries for κ.