Marginal Cost of Public Funds under the Presence of Informality

Ceyhun Elgin* Orhan Torul†
Boğaziçi University Boğaziçi University

PRELIMINARY DRAFT

Abstract

Marginal cost of public funds (MCF) measures the welfare cost of raising an additional unit of tax revenue. In this paper we investigate the behaviour of the MCF using different taxes under the presence of informality. To this end, we build a dynamic general equilibrium model with formal and informal sectors, and allow government to use consumption, capital and labor income taxes to raise revenue needed to finance government purchases. Then, we use the simulations of the model to evaluate how the MCF is associated with levels of different distortionary taxes and tax enforcement. Finally, using country-level data on taxes, we calibrate and measure MCF for a panel of developed and developing countries.

JEL codes: E26; H26.

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*Department of Economics, Boğaziçi University, Natuk Birkan Building, 34342 Bebek, Istanbul, Turkey. Phone: +90-212-359-7653, Fax: +90-212-287-2453. E-mail: ceyhun.elgin@boun.edu.tr.
†Department of Economics, Boğaziçi University, Natuk Birkan Building, 34342 Bebek, Istanbul, Turkey. Phone: +90-212-359-6677, Fax: +90-212-287-2453. E-mail: orhan.torul@boun.edu.tr.
1 Introduction

Raising tax revenue in order to finance government spending generally has distortionary consequences for the economy, unless financed exclusively by lump-sum taxes or lump-sum tax equivalents\(^1\). For instance, taxes on earnings and sales taxes typically distort labor supply choice of workers, and taxes on capital income gains disincentivize physical capital investment motivation of capital owners. Assuming the economy functions on the “correct side” of the Laffer curve, i.e. raising taxes does not actually result in less revenue collection, the concept of \textit{marginal cost of public funds} (MCF) formalizes the measurement of economic distortion due to increasing taxes by calculating the loss incurred by the society in raising one dollar revenue in order to finance government expenditure.

The trade-off behind MCF is a well-known, fundamental and yet a crucial one, rooting all the way back to the analyses by Pigou (1947), later being enriched by Stiglitz and Dasgupta (1974), Diamond and Mirrlees (1971) and Atkinson and Stern (1974), among others. While the first attempt to formalize the measurement of MCF is done by Browning (1976), the idea of applying the MCF concept to different environments for different purposes have started both empirical and theoretical and computational line of literature in public economics soon after Browning (1976).\(^2\) Dahlby (1998) examines the effects of progressivity of taxation on MCF, Sandmo (1998) investigate MCF when there is redistribution across heterogeneous households, Kleven and Kreiner (2006) study the role of labor force participation when measuring MCF, Auriol and Warlters (2012) study MCF in the presence of informality in a static basic set-up, and Hashimzade and Myles (2012) investigate MCF in a standard neoclassical growth model.

In this paper, we study MCF in the presence of informality within a dynamic general equilibrium framework. Studying MCF in a rich set-up with the informal sector is critical, because analyses lacking informality have economy-wide incorrect predictions, thereby reducing the quality of both policy recommendations and conclusions derived from economic theory. Ignoring the dynamic aspects is also undesirable, as the behavior of capital accumulation is

\(^1\)A proportional sales tax on consumption good that is demanded inelastically can \textit{de facto} serve as lump-sum tax, hence considered as a lump-sum tax equivalent.

\(^2\)For a review on the recent developments, see Kleven and Kreiner (2006), Dahlby (2008), and Hashimzade and Myles (2013), among others.
critical for macroeconomic success and well-being, and static models fall short in addressing these key aspects of the economy.

Our agenda in this paper is two-folds: first we evaluate the effects of different types of taxes, in particular consumption, capital and labor income taxes, in a dynamic general equilibrium setting featuring informality. We report the impacts of different taxes for the comparability of the costs of financing. For this goal, we use simulations of the model for a broad range of functional forms and specifications to evaluate how the MCF is associated with levels of different distortionary taxes and tax enforcement. Then, using the data on taxes on the empirical level, we calibrate and measure MCF for a panel of developed and developing countries.

Our very preliminary findings show that in this setting, capital income tax is the most distortionary one, as in the spirit of the Chamley-Judd result. We also show that limited tax enforcement in the informal sector and 20%+ rates convexify the MCF by the capital income tax. Consumption (sales) tax displays monotone and linear costs, increasing in the rate imposed and decreasing in the enforcement capacity. Further, formal wage tax increases steeply beyond 30% with potential non-monotonicities, and tax enforcement capacity and tax on the informal sector both reduce MCF.

The rest of the paper is organised as follows: In section 2, we describe the model environment, in section 3, we report and discuss about our findings, and in section 4 we conclude.

2 Model

2.1 Benchmark Model

In this section, we describe the two-sector dynamic general equilibrium model that we use in our analysis, which is borrowed from Ihrig and Moe (2004) to a great extent. The infinitely-lived representative household is endowed with $K_0$ units of initial productive physical capital and a total of $T > 0$ units of time each period. The agent chooses how much time to allocate to leisure, as well as the formal and informal employment. The formal sector, denoted by the subscript $F$, has a standard Cobb-Douglas production technology and
is subject to full taxation. The informal sector, denoted by the subscript $I$, however, uses only labor as input. It is plausible to assume that the informal sector is more labor-intensive compared to the formal sector.\footnote{A possible interpretation of this assumption might be that the informal sector has a fixed amount of productive capital and cannot possibly accumulate physical capital. (Ihrig and Moe, 2004).} Furthermore, the informal sector is subject to taxation only when it is caught by the monitoring authorities. Accordingly, we introduce a tax enforcement parameter $\rho$, which captures the frequency of being caught, thereby resulting \textit{de facto} tax payments at the same rate. We assume that the tax revenue collected by the government is resulting in wasteful spending, or in other words spent for unproductive activities.

Formally, the problem by the representative household is as follows:

$$\max_{\{C_t, K_{t+1}, L_t, N_{It}, N_{Ft}\}_{t=0}^\infty} \sum_{t=0}^\infty \beta^t U(C_t, L_t)$$

s.t. 

$$(1 + \tau_c)C_t + K_{t+1} - (1 - \delta)K_t = (1 - \tau_k)r_tK_t +$$

$$(1 - \tau_n)w_{Ft}N_{Ft} + (1 - \rho\tau_i)(w_{It}N_{It} + \pi_{It})$$

$$N_{It} + N_{Ft} + L_t = T$$

We assume that for each period, our representative firm operates a constant-returns-to-scale (CRS) technology in the formal sector and a decreasing-returns-to-scale (DRS) technology in the informal sector\footnote{For the sake of simplicity we assume that the same firm operates in both sectors.} represented by the following production functions, respectively:

$$Y_{Ft} = \theta_{Ft}K_t^\alpha N_{It}^{1-\alpha}$$

$$Y_{It} = \theta_{It}N_{It}^\gamma$$

As before, the firm’s optimization problem simplifies to a period-by-period profit maximization problem. If we assume that the firm is a price-taker, then for each $t = 0, 1, \ldots, T$, the firm
solves the following profit maximization problems:

\[
\max_{K_t, N_{Ft}} \pi_{Ft} = Y_{Ft} - r_t K_t - w_{Ft} N_{Ft} \tag{1}
\]
subject to \( K_t \geq 0, \ N_{Ft} \geq 0. \)

and

\[
\max_{N_{It}} \pi_{It} = Y_{It} - w_{It} N_{It} \tag{2}
\]
subject to \( N_{It} \geq 0. \)

Simple optimization procedures give the first-order conditions that solve the profit maximization problems; as before, the marginal products should equal their price for each \( t = 0, 1, \ldots, T: \)

\[
\frac{\partial Y_{Ft}}{\partial K_t} - r_t = 0 \\
\frac{\partial Y_{Ft}}{\partial N_{Ft}} - w_{Ft} = 0 \\
\frac{\partial Y_{It}}{\partial N_{It}} - w_{It} = 0
\]

The CRS technology for the formal sector implies \( \pi_{Ft} = 0, \) whereas the DRS technology in the informal sector leads to positive profits in this sector, i.e. \( \pi_{It} = (1 - \gamma) \theta_{It} N_{It}^\gamma > 0 \) Now we proceed to characterize the competitive equilibrium (CE) below.

**Definition:** Given the government policy variables \( \{\tau_c, \tau_i, \tau_k, \tau_n, \rho\}, \) a competitive equilibrium of this two-sector model is a set of sequences of allocations \( \{C_t, L_t, K_{t+1}, N_{It}, N_{Ft}\}_{t=0}^{\infty} \) and prices \( \{w_{Ft}, w_{It}, r_t\}_{t=0}^{\infty} \) such that

1. Given the prices and policy \( \{C_t, L_t, K_{t+1}, N_{It}, N_{Ft}\}_{t=0}^{\infty} \) maximizes representative agent’s life-time utility.
2. Given the prices \( \{N_{It}, N_{Ft}, K_t\}_{t=0}^{\infty} \) solve the profit maximization problems
3. All markets clear.
4. Government budget constraint is given by \( R = \tau_c C + \tau_k \alpha Y_f + \tau_n (1 - \alpha) Y_f + \rho \tau_i \)

Assuming logarithmic utility (i.e. \( U(C_t, L_t) = \log(C_t) + \phi \log(L_t) \)), the maximization problem of the household yields:

\[
\frac{C_{t+1}}{C_t} = \beta [(1 - \tau_k) \theta_F \alpha K_{t+1}^{\alpha \gamma} N_{Ft+1}^{1-\gamma} + 1 - \delta]
\]

Since at equilibrium marginal products of two sectors must be equal, we have:

\[
(1 - \tau_n) \theta_F (1 - \alpha) K_t^{\alpha \gamma} N_{Ft}^{1-\gamma} = (1 - \rho \tau) \theta_I \gamma N_t^{1-\gamma}
\]

By rearranging the Euler equation, one can obtain \( K_t \) in terms of \( N_{Ft} \):

\[
K_{t+1} = N_{Ft+1} \left[ \frac{(1 - \tau_k) \theta_F \alpha}{(1 + g_c)/\beta - 1 + \delta} \right]^{1 - \gamma}
\]

Moreover, the time spent on informal labor can be obtained now using MP equality:

\[
N_{It+1} = \left\{ \frac{(1 - \rho \tau) \gamma \theta_I}{(1 - \tau_n)(1 - \alpha) \theta_F} \left[ \frac{(1 + g_c)/\beta - 1 + \delta}{\alpha(1 - \tau_k) \theta_F} \right]^{1 - \gamma} \right\}^{1 - \gamma}
\]

So at the steady state (i.e. when \( g_c = 0 \)), the informal and formal labor become:

\[
N_I = \left\{ \frac{(1 - \rho \tau) \gamma \theta_I}{(1 - \tau_n)(1 - \alpha) \theta_F} \left[ \frac{1/\beta - 1 + \delta}{\alpha(1 - \tau_k) \theta_F} \right]^{1 - \gamma} \right\}^{1 - \gamma}
\]

\[
N_F = \frac{(T - N_I) \gamma (1 - \rho \tau) \theta_I N_I^{\gamma - 1} - \phi (1 - \rho \tau) \theta_I N_I^{\gamma - 1}}{\gamma (1 - \rho \tau) \theta_I N_I^{\gamma - 1} + \phi ((\alpha(1 - \tau_k) + (1 - \alpha)(1 - \tau_n)) \theta_F (\frac{\alpha(1 - \gamma) \theta_F}{1/\beta - 1 + \delta})^{1 - \gamma} - \delta (\frac{\alpha(1 - \gamma) \theta_F}{1/\beta - 1 + \delta})^{1 - \gamma})}
\]

Once we have the steady state expressions for \( N_I \) and \( N_F \), we can obtain
Finally we can define the marginal cost of public funds for three different taxes as follows:

\[
MCF_{\tau_k} = -\frac{\partial U/\partial \tau_k}{\partial R/\partial \tau_k}
\]
\[
MCF_{\tau_c} = -\frac{\partial U/\partial \tau_c}{\partial R/\partial \tau_c}
\]
\[
MCF_{\tau_n} = -\frac{\partial U/\partial \tau_n}{\partial R/\partial \tau_n}
\]
\[
MCF_{\tau_i} = -\frac{\partial U/\partial \tau_i}{\partial R/\partial \tau_i}
\]  

(3)

3 Results

In this section, we first report and discuss model-based MCF measures for different taxes. As mentioned for the utility function, we use the standard logarithmic utility of the form

\[
U(C_t, L_t) = \log(C_t) + \phi \log(L_t).
\]

For the benchmark parameter values, we use the following values to match the main macroeconomic aggregates for the U.S. economy:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\phi)</td>
<td>0.100</td>
<td>Ihrig and Moe (2004)</td>
</tr>
<tr>
<td>(\theta_i)</td>
<td>25.000</td>
<td>Ihrig and Moe (2004) &amp; (R/Y_f \approx 20%)</td>
</tr>
<tr>
<td>(\theta_f)</td>
<td>10.000</td>
<td>Ihrig and Moe (2004) &amp; (Y_i/Y_f \approx 10%)</td>
</tr>
<tr>
<td>(\alpha)</td>
<td>0.360</td>
<td>RBC Literature</td>
</tr>
<tr>
<td>(\beta)</td>
<td>0.960</td>
<td>RBC Literature</td>
</tr>
<tr>
<td>(\gamma)</td>
<td>0.495</td>
<td>Ihrig and Moe (2004)</td>
</tr>
<tr>
<td>(\delta)</td>
<td>0.080</td>
<td>RBC Literature</td>
</tr>
<tr>
<td>(T)</td>
<td>1.000</td>
<td>Normalization</td>
</tr>
</tbody>
</table>
For this parametrization, we next investigate the MCF for different taxes with varying enforcement parameter values, $\rho$, and display our findings in Figure 1-4.

We start our discussion with MCF for capital income tax, and illustrate our findings in Figure 1. The horizontal axes refer to the tax rate for capital income tax $\tau_k$ and the tax enforcement parameter $\rho$, while the vertical axis refers to the degree of MCF. The positive values MCF takes implies capital income taxation is costly, as it should given that it disincentivizes capital stock accumulation, which is in the spirit of the Chamley-Judd result. We further observe that the higher the enforcement on tax collection from the informal sector, the lower the MCF of capital income taxes get. Moreover, we report that greater tax rates on capital income tax rate amplifies MCF, and for high enough capital income tax rates, as in the case for 15% tax rate and limited enforcement, we see the cost of public funds to convexify, displaying significant non-linearities. In other words, especially in the presence of limited tax enforcement, a 1% increase in the capital income tax rate gets much costlier when the same tax rate is above 15%.

Next, we focus on the MCF for consumption sales tax, and report our findings in Figure
2. First, we verify that sales taxes are also costly by showing that MCF takes only positive values, yet much lower compared to capital income taxes given the magnitude of MCF for sales taxes are almost an order of one lower. Next, we show that tax enforcement reduces the MCF of consumption sales taxes, similar to the case for capital income taxes. Contrary to the former case, however, we observe that there exists no non-linearities and the MCF for sales taxes display a monotone pattern. This can be attributed to the fact that the time-invariant sales taxes do not distort the Euler equation, and given the homothetic preferences proxied by logarithmic utility function, linear increases in the sales tax rate are transmitted as linear costs of public funds.

We concentrate on the nature of formal sector wage taxes next, and display our results in Figure 3. Our findings reveal that for a wide range of wage tax rates, MCF for formal sector wage is positive and quite lower than the capital income taxes. Further, we show that an increase in the enforcement rate mildly reduces the cost of public financing from formal sector wage taxation. However, we also show that for tax rates approximately above 35%, there seems to be a peculiar non-linearity in the form of a U-shape over the enforcement parameter:
initially an increase in the enforcement rate reduces the cost of public funds for formal sector wages, however after roughly 25%, further increases in the tax enforcement rate actually boosts the MCF. This might be due to the no-arbitrage condition of wages among the two sectors, and the higher enforcement in the informal sector to make the time spent at the informal sector unfavorable, thereby reducing the overall welfare of the labor-force, who spent their time in both sectors.

Next, we investigate the marginal cost of public funds for the informal sector wages and how it interacts with different informal sector wage taxes and enforcement. First, we observe symmetry and monotonicity in the two dimensions, since both and increase in the tax rate or an increase in the enforcement parameter both reduce the disposable earnings in the informal sector. Second, the negative values the MCF for informal sector taxes take suggest that for the benchmark parametrization, it is welfare improving to raise informal sector wage taxes. Further, the shape suggests welfare gains from raising informal sector taxes are decreasing over the tax enforcement values, implying that informal sector tax gains are very moderate, given that actual payment by informal sector workers are the multiplication of the tax rate
and the enforcement power, hence, when both are not negligibly small, the welfare gains are getting considerably low in magnitude.

After exploring the fundamental determinants, channels, and dynamics of MCFs, next we turn to our model-based estimation for calculating MCFs for a panel of developed and developing countries. This part is work-in-progress and currently we are retrieving and organizing data on different taxes so as to calibrate country-level MCFs for these four major different types of taxes. In this analysis, we will use total factor productivity and tax enforcement parameters to calibrate country-level per-capita output relative to the U.S. economy, and government revenue as a share of relative GDP of countries in order to compute the MCFs for the country-specific tax costs by evaluating at their actual values.

\[ \tau_n = 25\%, \tau_k = 10\%, \tau_c = 5\%, R/Y_f \approx 20\% \& Y_i/Y_f \approx 10\% \]
4 Conclusion

... in progress ...
References


