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# INFRASTRUCTURE ACCUMULATION IN DEVELOPING COUNTRIES: THE ROLE OF THE INFORMAL SECTOR

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# Infrastructure Accumulation in Developing Countries: the Role of the Informal Sector*

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**Abstract**

In this paper, we study the optimal labor income taxation to finance infrastructure in developing countries characterized by high informality. We show that the presence of labor market segmentation, induced by a binding minimum wage, affects the optimal level of taxation/infrastructure and influences how the economy reacts to policy changes in terms of both the size of the informal sector and the income distribution among high- and low- skilled workers.

**Keywords**: Infrastructure, Informality, Optimal Taxation, Development.
**Jel Classification**: O11 O18 O23.

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# 1 Introduction

The economic literature on public infrastructure financing indicates that in a one-sector economy, the optimal tax rate should be determined by the elasticity of aggregate output to infrastructure (Barro, 1990) and it should be lower in developing countries where the informal sector competes with the formal sector for production inputs (Loayza, 1996).

We contribute to this literature by highlighting that in several countries, working in the unofficial sector is not a choice but rather it is a last resort for those who cannot find a job in the official economy (La Porta and Shleifer, 2014). Thus, we classify the informality regime according to whether there is a legally binding minimum wage, $w_{min}$, which induces labor market segmentation (i.e, net wages in the formal sector are always higher than remuneration in the informal sector).

Our findings show that in an economy with $w_{min}$ that maximizes overall consumption: *i*) the optimal tax rate is higher than the *"Barro Rule"*, *ii*) a more productive informal sector does not imply a higher proportion of informality, and *iii*) conflicting interests among low-skilled and high-skilled workers may emerge.

# 2 Theoretical framework

We consider a closed economy with two types of labor (*high skilled*, $H$, and *low skilled*, $L$), two sectors (*formal* and *informal*), and two regimes (*regulated*, i.e. with $w_{min}$, and *unregulated*, i.e. without $w_{min}$). Our analysis applies to poor developing countries characterized by high informality, thus any equilibrium without informality has been excluded. As we focus on the steady-state properties, the variables are without time subscripts.

The formal sector adopts the following Cobb-Douglas production function, as in Docquier et al. (2017):

$$Y_f = Ak^{\epsilon}H^{\alpha}L_f^{1-\alpha}, \tag{1}$$

where $Y_f$ is the output, $A$ is the total factor productivity (TFP), $L_f$ is the number of $L$ workers in the formal sector, $\alpha$ and $1-\alpha$ represent the elasticity of formal sector output with respect to $H$ and $L_f$ respectively, $k$ is the infrastructure stock, and $\epsilon$ is the elasticity of formal output to infrastructure. Like in Loayza (1996)'s research,

infrastructure is normalized to the labor force, depreciates at a constant rate, $\delta$, and is financed taxing formal workers at the rate $\tau$:

$$k = \frac{\tau Y_f}{\delta (L + H)}. \tag{2}$$

In line with Docquier et al. (2017) and Loayza (1996), the output in the informal sector is as follows:

$$Y_i = Bk^{\eta} L_i, \tag{3}$$

where $B$ is the TFP of the informal sector and $B < A$. The informal sector employs only $L_i = L - L_f$ workers and has a lower capability to benefit from infrastructure ($\eta < \epsilon$).

Both sectors operate in perfect competition.[1] In the regulated regime, $L_f$ is determined by equating its marginal productivity with $w_{min}$:

$$(1 - \alpha) \frac{Y_f}{L_f} = w_{min}, \tag{4}$$

otherwise, in the unregulated regime, $L_f$ adjusts until the net wage paid in the formal sector equals the remuneration in the informal sector:

$$(1 - \tau)(1 - \alpha) \frac{Y_f}{L_f} = \frac{Y_i}{L_i}. \tag{5}$$

Given Eq.s (1)-(5), we calculate the steady state for each regime as a function of $\tau$. We then determine the optimal tax rates, distinguishing by regime and policy target, solving the following optimization problems:

$$\max_{\tau} (1 - \tau) \alpha Y_f + [(1 - \tau)(1 - \alpha) Y_f + Y_i] \Gamma_{\{1,0\}}$$

s.t. Eq.s (1)-(3) and Eq. (4) in the regulated regime, or Eq. (5) in the unregulated regime. $\Gamma_{\{1,0\}}$ is an indicator function that takes a value of 1 when the overall consumption, $C$, is maximized (which determines $\tau_C$) and a value of 0 when the focus is on high-skilled workers' welfare (which determines $\tau_H$).

[1] Our analysis assumes that high-skilled wage is higher than low-skilled wage.

Table 1: Optimal $\tau$

| Tax rate | *Unregulated* | *Regulated* |
|---|---|---|
| $\tau_C$ | $\frac{\varepsilon\alpha(1-s_i)+\alpha(1-\alpha)\eta s_i}{\alpha(1-s_i)+(1-\alpha)\eta}$ | $\frac{\varepsilon}{\alpha}\left(1-\frac{Bk^{\eta}(1-\alpha)}{c}\right)+\eta\left(\frac{Bk^{\eta}(1-\alpha)s_i}{c(1-s_i)}\right)$ |
| $\tau_H$ | $\varepsilon-(1-\alpha)\,\eta$ | $\frac{\varepsilon}{\alpha}$ |

$s_i = \frac{L_i}{L}$ is the proportion of low-skilled workers in the informal economy.

Although it is not possible to obtain an analytic solution for $\tau_C$ in terms of exogenous parameters, the formulations reported in Table 1 provide some important insights: *i*) a positive relationship between $\tau_C$ and the proportion of informality labor emerges in both regimes, while the size of the informal sector does not affect $\tau_H$; *ii*) optimal taxation depends on $\varepsilon$ in the unregulated regime (in line with the *"Barro Rule"*) and on $\frac{\varepsilon}{\alpha}$ in the regulated regime. This difference results from the fact that in the regulated regime, $L_f$ depends on $\tau$ only through $k$, and indeed, $\frac{\varepsilon}{\alpha}$ is the elasticity of $L_f$ with respect to $k$.

We calibrate the economy to match some key facts of low income countries: $\varepsilon = 0.1$ (Bom and Ligthart, 2014), $\delta = 0.085$ (Gibson and Rioja, 2019) and $\frac{H}{L+H} = 3\%$ (Docquier et al., 2017). Although Docquier and Iftikhar (2019) obtain $\frac{A}{B} = 14$, we opt for a lower ratio, $\frac{A}{B} = 10$, because our framework accounts for infrastructure. $\eta$ ranges from 0 to 0.08. $\alpha$ is endogenously determined to be consistent with $\frac{L_i}{L+H}$ equal to $80\%$ (Loayza, 2016). We use the unregulated regime with $\eta = 0.04$ as benchmark and obtain $\alpha = 0.6419$; $w_{min}$ ranges between 1.5 and 2 times the $L$ wage emerging in the benchmark scenario, $w_b$.

## 3 Results

This section reports the simulation results for different values of $w_{min}$ and $\eta$, assuming $\tau = \tau_C$. As reported in Table 2, $C$ *i*) increases in $\eta$ as the production frontier improves and *ii*) decreases in $w_{min}$ as the inefficient segmentation among $L$ increases. The same explanations hold for the behavior of $\tau_C$ which *i*) increases in $\eta$ as the incentive to finance infrastructure increases with its productivity and *ii*) increases in $w_{min}$ to stimulate labor demand for $L_f$ through infrastructure accumulation. Overall, although the "*Barro rule*" is confirmed in the unregulated regime

with $\eta = 0$, our results provide elements to justify higher levels of tax rates.

Table 2: Consumption and $\tau_C$

| | *Unregulated* | | *Regulated* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.5*$w_b$ | | 1.625*$w_b$ | | 1.75*$w_b$ | | 1.875*$w_b$ | | 2*$w_b$ | |
| $\eta$ | $C_r$ | $\tau_C$ | $C_r$ | $\tau_C$ | $C_r$ | $\tau_C$ | $C_r$ | $\tau_C$ | $C_r$ | $\tau_C$ | $C_r$ | $\tau_C$ |
| 0 | 0.951 | 0.100 | 0.931 | 0.119 | 0.924 | 0.121 | 0.918 | 0.123 | 0.913 | 0.125 | 0.907 | 0.126 |
| 0.02 | 0.974 | 0.121 | 0.957 | 0.148 | 0.951 | 0.152 | 0.945 | 0.156 | 0.939 | 0.159 | 0.934 | 0.162 |
| 0.04 | 1.000 | 0.145 | 0.988 | 0.178 | 0.982 | 0.184 | 0.976 | 0.190 | 0.971 | 0.195 | 0.965 | 0.199 |
| 0.06 | 1.030 | 0.173 | 1.023 | 0.210 | 1.018 | 0.218 | 1.012 | 0.225 | 1.007 | 0.232 | 1.002 | 0.238 |
| 0.08 | 1.064 | 0.206 | 1.063 | 0.244 | 1.058 | 0.255 | 1.054 | 0.264 | 1.049 | 0.273 | 1.044 | 0.281 |

$C_r$ is consumption normalized to the benchmark.

Table 3 reports the behavior of the informal economy size in terms of both employment and output. While the role of $w_{min}$ is intuitive (a larger $w_{min}$ reduces $L_f$), the role of $\eta$ is more articulated. In an unregulated regime, the proportion of informality is monotonically increasing in $\eta$ as it implies a higher remuneration for $L$. In a regulated regime, a higher $\eta$ does not make $L$ services more expensive for the formal sector. The endogenous relationship between $\eta$ and $\tau_c$, along with the positive impact of infrastructure on productivity, explains why the demand for $L_f$ increases with $\eta$. However, the consequent changes in $\frac{L_i}{L}$ may not correspond to similar changes in $\frac{Y_i}{Y_i+Y_f}$. Indeed, when $\eta$ is higher, the productivity of infrastructure in the informal sector increases, which has a positive effect on $Y_i$. Overall, the positive relationship between productivity in the informal sector and its size, which characterizes the unregulated regime, vanishes in the presence of labor market segmentation.

Table 3: Informal Sector Shares

| | *Unregulated* | | *Regulated* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $1.5^{*}w_b$ | | $1.625^{*}w_b$ | | $1.75^{*}w_b$ | | $1.875^{*}w_b$ | | $2^{*}w_b$ | |
| $\eta$ | $\frac{L_i}{L+H}$ | $\frac{Y_i}{Y_i+Y_f}$ | $\frac{L_i}{L+H}$ | $\frac{Y_i}{Y_i+Y_f}$ | $\frac{L_i}{L+H}$ | $\frac{Y_i}{Y_i+Y_f}$ | $\frac{L_i}{L+H}$ | $\frac{Y_i}{Y_i+Y_f}$ | $\frac{L_i}{L+H}$ | $\frac{Y_i}{Y_i+Y_f}$ | $\frac{L_i}{L+H}$ | $\frac{Y_i}{Y_i+Y_f}$ |
| 0 | 0.769 | 0.528 | 0.859 | 0.603 | 0.872 | 0.617 | 0.882 | 0.629 | 0.891 | 0.639 | 0.898 | 0.649 |
| 0.02 | 0.783 | 0.545 | 0.854 | 0.604 | 0.868 | 0.617 | 0.878 | 0.629 | 0.887 | 0.639 | 0.895 | 0.649 |
| 0.04 | 0.800 | 0.567 | 0.851 | 0.608 | 0.864 | 0.621 | 0.875 | 0.633 | 0.885 | 0.643 | 0.892 | 0.653 |
| 0.06 | 0.818 | 0.592 | 0.847 | 0.615 | 0.861 | 0.628 | 0.872 | 0.640 | 0.882 | 0.650 | 0.890 | 0.659 |
| 0.08 | 0.837 | 0.619 | 0.844 | 0.624 | 0.858 | 0.637 | 0.870 | 0.649 | 0.879 | 0.659 | 0.888 | 0.668 |

Informality Shares: $\frac{L_i}{L+H}$ (Labor) $\frac{Y_i}{Y_i+Y_f}$ (Output)

Concerning $H$, the difference between $\tau_C$ and $\tau_H$ monotonically increases in $\eta$ in an unregulated regime while the opposite occurs in a regulated regime (Table 4). This is due to the different effect of $\eta$ on the amount of $L_f$, which, through the complementarity among labor services, affects the remuneration for $H$. $H$ are better off when the difference between $\tau_H - \tau_C$ is minimized. This occurs when $\eta = 0$ in unregulated regimes and with non-extreme values of $\eta$ in regulated regimes.

With regard to income distribution, Gibson and Rioja (2019), who disregard informality but account for different forms of taxation, suggest that optimal infrastructure financing through labor income tax is expected to improve the welfare of all workers. Our results show that this may not be the case. $H$ may experience a decrease in their net income while $C$ experiences an increase, which indicates diverging interests among workers with different skills.

Table 4: Tax Rates and $H$ Net income

| | *Unregulated* | | *Regulated* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.5*$w_b$ | | 1.625*$w_b$ | | 1.75*$w_b$ | | 1.875*$w_b$ | | 2*$w_b$ | |
| $\eta$ | $\tau_C - \tau_H$ | $w_{H.r}$ | $\tau_C - \tau_H$ | $w_{H.r}$ | $\tau_C - \tau_H$ | $w_{H.r}$ | $\tau_C - \tau_H$ | $w_{H.r}$ | $\tau_C - \tau_H$ | $w_{H.r}$ | $\tau_C - \tau_H$ | $w_{H.r}$ |
| 0 | 0.000 | 1.074 | 0.029 | 0.865 | 0.027 | 0.827 | 0.025 | 0.793 | 0.023 | 0.763 | 0.022 | 0.736 |
| 0.02 | 0.028 | 1.042 | 0.000 | 0.869 | -0.004 | 0.830 | -0.008 | 0.796 | -0.011 | 0.765 | -0.014 | 0.737 |
| 0.04 | 0.058 | 1.000 | -0.030 | 0.865 | -0.036 | 0.826 | -0.041 | 0.791 | -0.046 | 0.759 | -0.051 | 0.730 |
| 0.06 | 0.093 | 0.947 | -0.062 | 0.856 | -0.070 | 0.815 | -0.077 | 0.779 | -0.084 | 0.746 | -0.090 | 0.717 |
| 0.08 | 0.132 | 0.884 | -0.096 | 0.841 | -0.107 | 0.798 | -0.116 | 0.760 | -0.125 | 0.727 | -0.133 | 0.696 |

$w_{H.r}$ is $H$ net income normalized to the benchmark

Our steady-state analysis highlighted how identifying the (predominant) type of informality that characterizes an economy is crucial for determining the optimal level of taxation/infrastructure and its consequences on both informal size and income distribution among workers.[2]

These results represent a starting point for future research. Specifically, it is worth deepening the inter-generational welfare analysis considering the lag between financing and the availability of infrastructure. It is also important to consider the effects of endogenous migration and human capital accumulation on labor force dynamics.

[2]García (2017) reports that there is not yet a consensus regarding which type of informality better characterizes developing countries.

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