

Informality in Paraguay: Macro-Micro Evidence and Policy Implications



WP/15/245

IMF Working Paper

Informality in Paraguay: Macro-Micro Evidence and Policy Implications

by Jose P Mauricio Vargas

IMF Working Papers describe research in progress by the author(s) and are published to elicit comments and to encourage debate. The views expressed in IMF Working Papers are those of the author(s) and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

I N T E R N A T I O N A L M O N E T A R Y F U N D

IMF Working Paper

Western Hemisphere Department

Informality in Paraguay: Macro-Micro Evidence and Policy Implications**Prepared by Jose P Mauricio Vargas¹**

Authorized for distribution by Roberto Cardarelli

November 2015

IMF Working Papers describe research in progress by the author(s) and are published to elicit comments and to encourage debate. The views expressed in IMF Working Papers are those of the author(s) and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

Abstract

Paraguay's economy features a high degree of informality. Based on different estimation approaches, informal activity represents more than half of total employment in Paraguay, a higher rate than those observed in its Latin American and the Caribbean peers. Theoretical and empirical considerations support the notion that regulations, enforcement policies, and government effectiveness are the ultimate determinants of informality. In all of these areas Paraguay performs weakly compared to regional peers. Using household and enterprise surveys, we find that Paraguay's informal sector absorbs the most vulnerable workers but affects negatively medium and large firms in the formal sector. DSGE model simulations suggest that the optimal combination of policies to reduce informality is not straightforward, and needs to reflect the specific circumstances and objectives of the country.

JEL Classification Numbers: E26, O17

Keywords: Informal Economy, Labor Regulations, Tax System.

Author's E-Mail Address: MVargas@imf.org

¹ A shorter version of this document was published as part of the IMF's Selected Issues Paper series, No. 15/38. I thank Andre Meier, and the participants of the Workshop at the Banco Central del Paraguay for their helpful comments. All errors are my responsibility.

Contents	Page
Abstract	2
I. Introduction.....	4
II. Defining Informality	5
III. Informality: Putting Paraguay on the Map	7
IV. Linkages with Growth, Inequality and Institutions	9
V. Informality, Labor and Firms in Paraguay	12
VI. The Role of Public Policy	16
VII. Final Remarks	18
A. References.....	20
B. APPENDICES	23

Tables

Table 1. Conceptual framework for measuring informal employment.....	7
Table 2. Average Informality (as percent of official GDP, unweighted) by World Bank's Regions.....	8
Table 3. Marginal Effects for the Level of Obstacle of "Practices of Competitors in the Informal Sector"	16

Figures

Figure 1. A Definition of the Extent of the Informal Economy.....	7
Figure 2. Size of Informal Economy Around the World (in percent of official GDP).....	9
Figure 3. Employment in the Informal Economy (in percent of non-agricultural employment, latest year available).....	9
Figure 4. Size of the Informal Economy vs. Growth, Income and Institutions.....	12
Figure 5. Paraguay: Alternative Measures of Informal Labor and Monthly Primary Income.....	13
Figure 6. Paraguay: Informal vs. Formal Labor: Monthly Primary Income and Years of Schooling...	13
Figure 7. Paraguay: Informal vs. Formal Labor: Gender, Poverty Status, and Sector of Activity (2013).....	14
Figure 8. Biggest Obstacle Affecting the Operation of this Establishment (percent of firms).....	15
Figure 9. Does This Establishment Compete Against Unregistered Or Informal Firms?.....	15
Figure 10. Do 'Practices of Competitors in Informal Sector' represent an obstacle?.....	15
Figure 11. Effectiveness of Different Policy Tools in Reducing Evasion and Informality (in percentage points).....	18

I. INTRODUCTION

Informality is a persistent phenomenon in emerging and developing countries, and Paraguay is no exception. In fact, according to several estimation approaches, Paraguay shows unusually high informality compared to peers in Latin America and the Caribbean (LAC), with the informal economy absorbing more than half of total employment and representing around 40 percent of measured output².

As argued by Fleming et al. (2000), informality may affect the overall economy in different ways: i) it generates imprecise and inappropriate economic policy, ii) it reduces government tax revenues, and iii) it affects the level and distribution of income. Moreover, Tanzi and Shome (1993) note that tax evasion (an important manifestation of informality) affects the horizontal and vertical distributional characteristics of tax systems, market competitiveness, the attitude of citizens toward the government, and even legal/statutory systems.

Despite the importance of informality, the academic literature on the topic has failed to yield clear-cut economic policy prescriptions (Tanzi, 1999). Problems start with the basics, including with the lack of an agreement on the definition and measurement of *informality*. However, those limitations did not prevent the emergence of several theoretical models and empirical studies aimed at explaining the rationale behind the decisions of agents to work in the informal sector, thus permitting to identify critical determinants of informality.

Specifically, most authors agree on the importance of the following group of variables as determinants of informality: i) the tax system³, including tax rates, penalties and fines; ii) the regulatory system⁴, which includes regulation on firms as well as workers (for example, the pension fund system); iii) the institutional and social framework, which captures aspects such as bureaucratic efficiency, corruption⁵ and tax morale⁶), and; iv) income level and income distribution, which basically suggest that lower levels of income and higher inequality are

² As described more extensively in section III, these numbers are based on econometric estimations of informality as percent of official GDP. Alternative sources, such as the Censo Económico 2011, suggest that the size of product from informal activities might be relatively smaller.

³ Slemrod and Yitzhaki (2000), Allingham and Sandmo (1972).

⁴ Botero et al. (2003), Loayza et al. (2005), Djankov et al. (2006).

⁵ Mauro (1995), Fjeldstad and Tungodden (2003), Tonoyan et al. (2006), Choi and Thum (2005).

⁶ Frey and Torgler (2007).

commonly associated with more informal economies⁷. While Paraguay's tax burden is low compared to international standards, its regulatory quality, institutional framework and income level are below those of regional peers.

In this paper we present evidence supporting the role of the above-mentioned variables in the determination of informality in Paraguay. We emphasize that informality has wide-ranging effects on Paraguay's economy and may reflect weaknesses in its economic institutions or policies. Our cross-country analysis supports the notion that regulations, enforcement policies, and government effectiveness are the ultimate determinants of informality. We characterize informality in Paraguay based on household and enterprise surveys, and find that Paraguay's informal sector absorbs the most vulnerable workers but has negative spillover for firms in the formal sector, especially the medium and large ones. Finally, we propose a dynamic general equilibrium model (DGE) to illustrate the macro economic implications of informality. We show that identifying the optimal policies to reduce informality is not straightforward and needs to reflect the specific circumstances and objectives of the country. The paper includes some simulations to illustrate the complex interactions among different policy tools, and some of the transmission mechanisms affecting labor markets and production.

The paper is organized as follows. Section II provides relevant definitions of the informal sector; Section III compares Paraguay's economy with other countries using different estimations of the size of the informal economy; Section IV and V bring together evidence on the association of informality with other variables at the macro- and microeconomic level, respectively; Section VI proposes a theoretical tool to assess the mechanisms and incentives behind informality, and; Section VII concludes.

II. DEFINING INFORMALITY

Informality is a multi-faceted phenomenon that defies an unequivocal definition since it affects multiple dimensions of the economy. Ultimately, however, it relates to incomplete compliance with government taxes and regulations. *Black*, *underground* and *shadow* are commonly used terms to identify what we will call the "informal economy". There is no agreement on why one term would be better than other, and the distinction between terms is usually motivated by the purpose of the study. Vito Tanzi (1982, 1983) was a pioneer in measuring the size of the

⁷ Giles et al. (2002), Ahmed et al. (2007), Kim (2005).

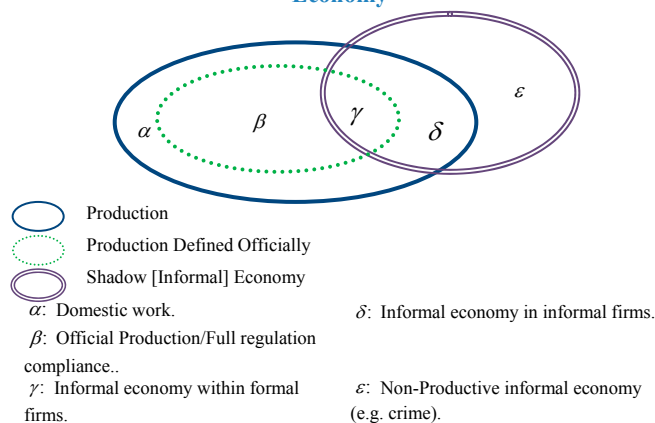
underground economy, but even his early attempts were subject to criticisms about the appropriateness of the definitions being used (Acharya, 1984; Feige 1983).

Definitions of informality are usually motivated by available data and the purpose of each individual study. Several definitions arise in the literature; for instance, Schneider (2005) proposes the following:

The shadow economy includes all market-based legal production of goods and services that are deliberately concealed from public authorities for the following reasons: (1) to avoid payment of income, value added or other taxes, (2) to avoid payment of social security contributions, (3) to avoid having to meet certain legal labor market standards, such as minimum wages, maximum working hours, safety standards, etc., and (4) to avoid complying with certain administrative procedures, such as completing statistical questionnaires or other administrative forms. (Schneider, 2005, pp. 4-5)

The above notion of informality is expressed more succinctly by Loayza (1997), who, based on the work of De Soto (1989), defines the informal sector as “...the set of economic units that do not comply with government-imposed taxes and regulations” (pp. 1).

Figure 1. A Definition of [the Extent of] the Informal Economy



Source: Based on Cowell (1990).

Another relevant definition is provided by Cowell (1990). It regards the productive underground economy (i.e. excluding crime) as two subsets: (γ) representing informal operations within formal firms, and (δ) capturing informal operations within informal firms (see Figure 1).

Cowell's scheme nests most of the alternative characterizations of the informal economy at an aggregate level. Thus, informality may be interacting in several markets and through different economic agents, translating at the end in one or more of the following indicators: increasing tax

evasion and smuggling, low social security coverage, a large share of small firms, and high levels of corruption and inequality.

Informality must also be understood at the level of production factors. Measuring the contribution of the informal sector at an aggregate output level is a natural first attempt to assess the importance of the informal economy. However, it is clear that a parallel approach could focus on the contributions of the different production factors to this sector. From this perspective, and focusing on labor, the International Conference of Labour Statisticians (ICLS) proposed specific definitions distinguishing between informal sector and informal employment. In the following table, cells A and C represent the informal workforce (i.e. informal workers can be employed either in informal or formal firms). Analogously, A and B represent informal firms (i.e., such firms can either employ informal or formal workers)⁸.

Table 1. Conceptual Framework for Measuring Informal Employment

Production units	Informal jobs	Formal jobs
Informal enterprises	A	B
Other units of production	C	D

Source: ILO (2013)

In the past, estimates of informality were dominated by macro aggregate approaches. In recent years, however, the analysis of informality based on microeconomic data has gained a fresh perspective. For instance, Levy (2008) and Levy et al. (2012), analyzing the labor market in Mexico, define informal firms and informal employment based on the distinction between salaried and non-salaried workers. Usually, bounded definitions are consistent with the extent of their analysis, but it is clear from this section that they might be representing only a subset of a broader definition of informality.

III. INFORMALITY: PUTTING PARAGUAY ON THE MAP

Macroeconomic studies on the size of the informal economy have commonly identified informality as a problem for emerging and developing economies. One of the most comprehensive empirical studies of informality at the level of GDP is that of Schneider (2010), who estimates the size of the shadow economy for 162 countries from 1999 to 2007. According to it, the size of the informal economy (in percent of official GDP) in advanced economies is half that observed in other parts of the world. Indeed, high Income OECD countries show the smallest extent of informality (Table 2). By contrast, LAC was found to have the largest size of

⁸ See Appendix for the complete definitions used by the ICLS. Note the analogy with the areas δ and γ in Cowell's scheme.

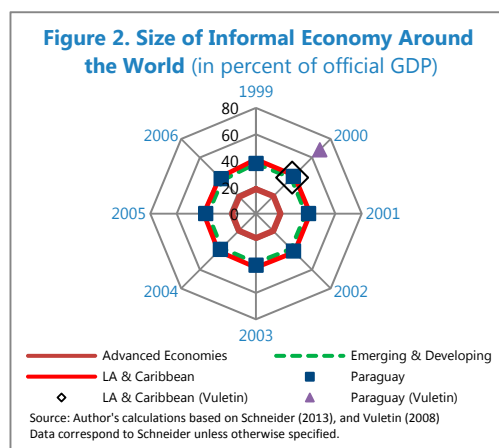
the informal economy in the world, followed closely by Sub-Saharan Africa and Europe and Central Asia.

**Table 2. Average Informality (as percent of official GDP, unweighted)
by World Bank's Regions**

Region	Mean	Median	Min	Max	Standard Deviation
East Asia and Pacific	32.3	32.5	12.7	51.0	13.3
Europe and Central Asia	38.5	35.8	18.2	66.7	11.0
Latin America and the Caribbean	41.2	38.7	19.3	66.1	12.3
Middle East and North Africa	28.0	32.7	18.2	37.2	7.9
High Income OECD	16.8	16.0	8.7	27.9	5.6
Other High Income	22.8	25.0	12.4	33.4	6.7
South Asia	33.2	35.3	22.2	43.7	6.9
Sub Saharan Africa	40.8	40.5	22.6	61.8	7.6
World	33.1	33.5	8.7	66.7	12.8
Paraguay	38.8	38.7	37.4	40.1	1.0

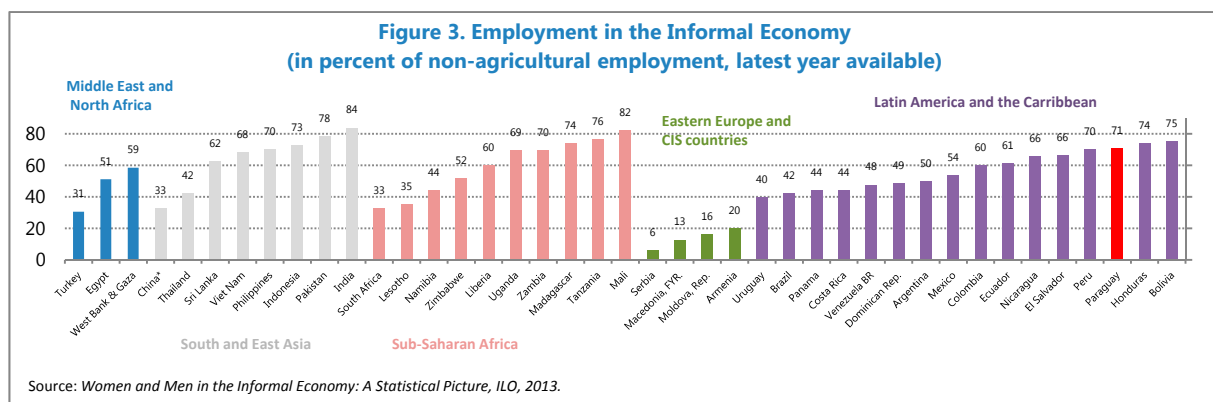
Source: Extended from Schneider (2010)

The size of the informal economy in Paraguay, in percent of GDP, according to Schneider (2010), coincides with the median of the group of Latin American and Caribbean countries. However, evidence about the size of the product associated with informal activities is not free of controversy, indeed, Vuletin (2008) reaches a different conclusion; his estimations match Schneider's for the average of countries in LAC, but rank Paraguay as the country with the largest informal economy in the region, at 68 percent of GDP; on the other hand, results from the Censo Economico 2011 for Paraguay suggest that the product associated with informal activities might be much smaller since 8.5 percent of the largest firms of Paraguay (most of them formal firms) produce 94 percent of the total income.



With regard to cross-country microeconomic data on informal employment, a recent International Labour Organization (2013) study compares the share of employment in the informal sector across 47 developing and emerging economies. Paraguay ranks in the top three of LAC countries with the largest share of employment in the informal economy (Figure 3.) The

study states as well that developed countries are less likely to have a large share of the workforce in the informal sector (as defined in the publication).⁹ Specifically, three regions show a particularly high share of the workforce in the informal economy: LAC, Eastern Europe and the Commonwealth of Independent States CIS countries, and Sub-Saharan Africa.



For Paraguay, the ILO's publication, based on 2009 data, shows that 70.7 percent of non-agricultural employment is located in the informal sector. This level is only surpassed by Bolivia and Honduras in the region, and matches the levels of informality observed in Zambia and the Philippines. These high levels of informality in Paraguay are also confirmed by Moody's Investors Service (2013), which, using an alternative definition, estimates that the informal sector includes around 60 percent of the employed population¹⁰.

IV. LINKAGES WITH GROWTH, INEQUALITY AND INSTITUTIONS

From a cross-country perspective, high informality is associated with higher levels of inequality, greater corruption, and lower-quality economic institutions. Figure 4 links the size of the informal economy (in percent of GDP) with several other dimensions of economic performance. Specifically, the charts suggest that higher levels of informality are usually associated with:

- i) lower levels of GDP per capita (in purchasing power parity terms),
- ii) higher levels of inequality (measured by the Gini coefficient, where 100 implies maximum inequality), and
- iii) lower efficiency of economic institutions, as captured by three different measures:

⁹ "Informality, as defined in developing countries, does not affect the majority of the workforce in developed countries. However, a large proportion of the workforce in developed countries works under employment arrangements which offer limited benefits and social protection...The number of such non-standard employment arrangements in these countries is considerable...The concepts used in the developed-country context are related to the concept of informal employment but are not identical to it...Neither non-standard nor undeclared work can therefore be considered as proxy for informal employment." (ILO, 2013, pp. 23)

¹⁰ They define informality as the share of the employed population (excluding domestic workers) that lacks a work contract (using data for 2011).

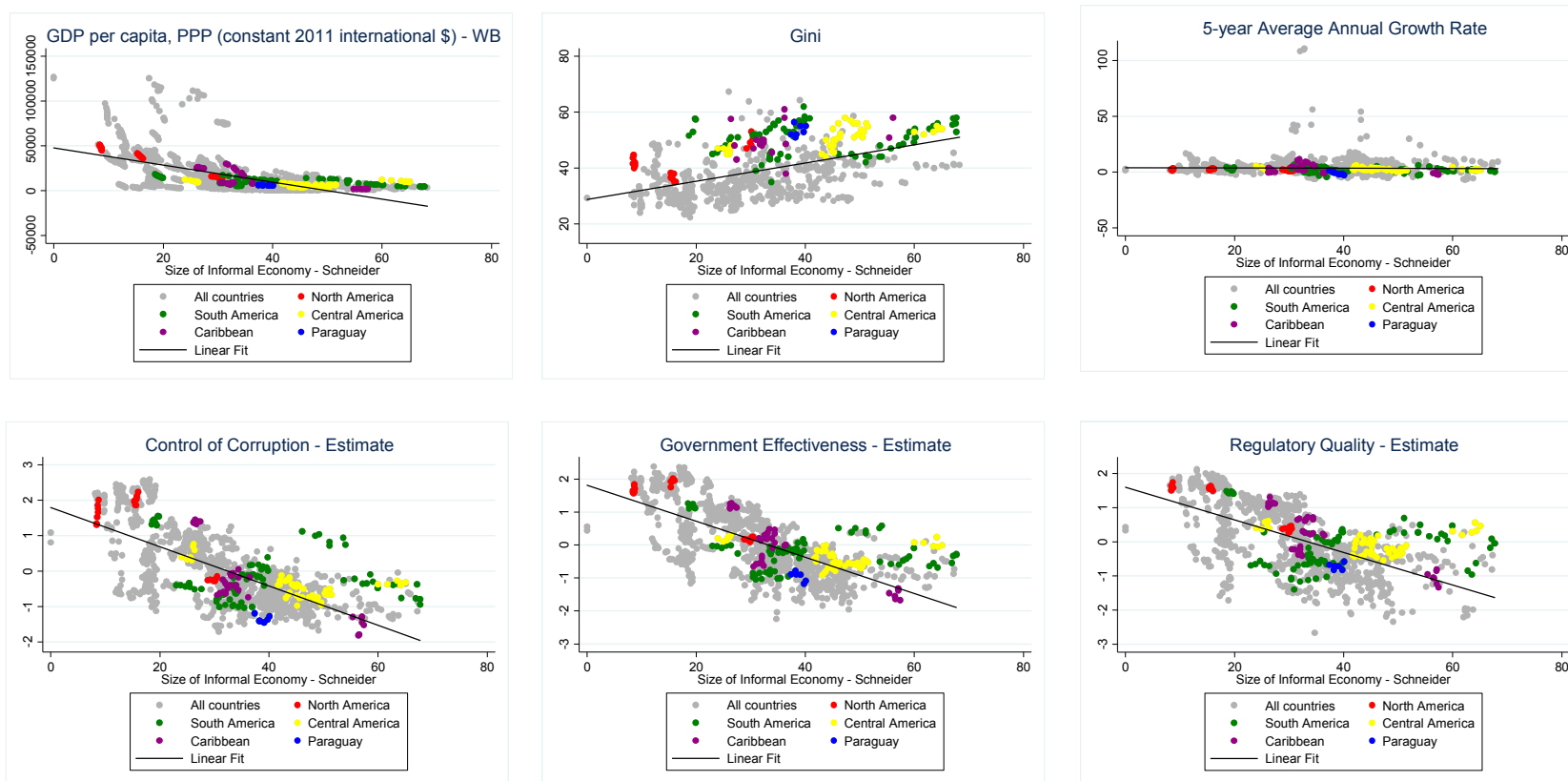
Regulatory Quality, Control of Corruption, and Government Effectiveness (all three from the World Bank's Worldwide Governance Indicators). The association between economic growth and informality is unclear from this simple unconditional comparison.

We formalize this bivariate graphic approach by running several panel data regressions with country-specific fixed effects and country/time-fixed effects. Appendix (Table A1) reports the results, which suggest robust empirical relationships with the expected signs, except for GDP per capita. The first six columns of Table A1 show the partial association between the size of the informal economy and each of the other variables of interest, one at a time, and including country-specific fixed effects. This first group of results point to GDP per capita as having large explanatory power, as apparent from the R-squared statistic. The results in the second group (columns 7 to 12) include time-fixed effects in addition to country-fixed effects. All coefficients keep their signs but the coefficient of the GDP per capita term is two-thirds smaller than in the initial specifications (columns 1 and 7). One plausible reason is that GDP per capita may follow a time trend that is captured by the time fixed effects in specification 7. The third group of results (columns 13 to 15) retain the three first variables (GDP per capita, Gini, and growth), and include only one of the institutional variables at a time, along with country-fixed effects¹¹. The fourth set of results (columns 16 to 18) is like the third, but adding time-fixed effects. By comparing the fourth group with the third group, we confirm that the large effect attributed to GDP per capita may be driven by a time trend in the data. Our preferred specifications are shown in columns 16 and 18. Here, the association between the size of the informal economy and the level of income is inconclusive, while all other variables [are significant and] have the expected signs. Thus, we conclude that a large informal sector is associated negatively with growth and sound economic institutions, and positively with inequality. A caveat is that these results reflect statistical associations that may not have a causal interpretation.

The levels of the six economic indicators included in our analysis are lower for Paraguay than the regional mean. Consequently, a large degree of informality is not surprising. The next section illustrates and confirms that informality is an important phenomenon for Paraguay's economy.

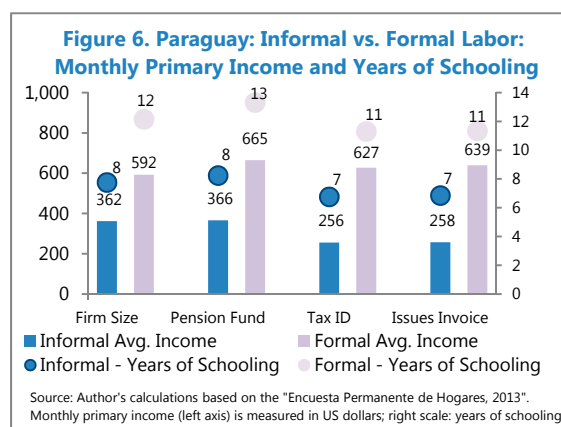
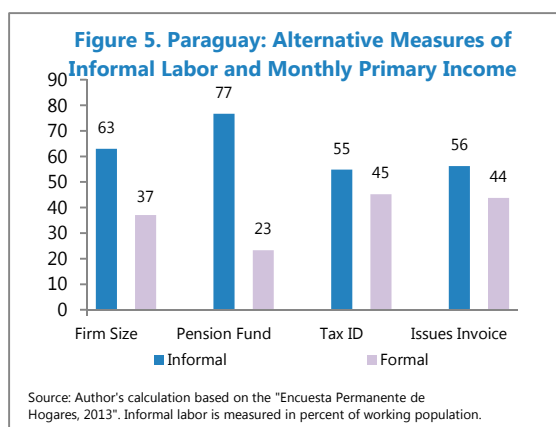
¹¹ The three institutional variables share large correlations (around 0.9). Thus, including the three variables jointly may generate a multicollinearity problem.

Figure 4. Size of the Informal Economy vs. Growth, Income and Institutions



V. INFORMALITY, LABOR AND FIRMS IN PARAGUAY

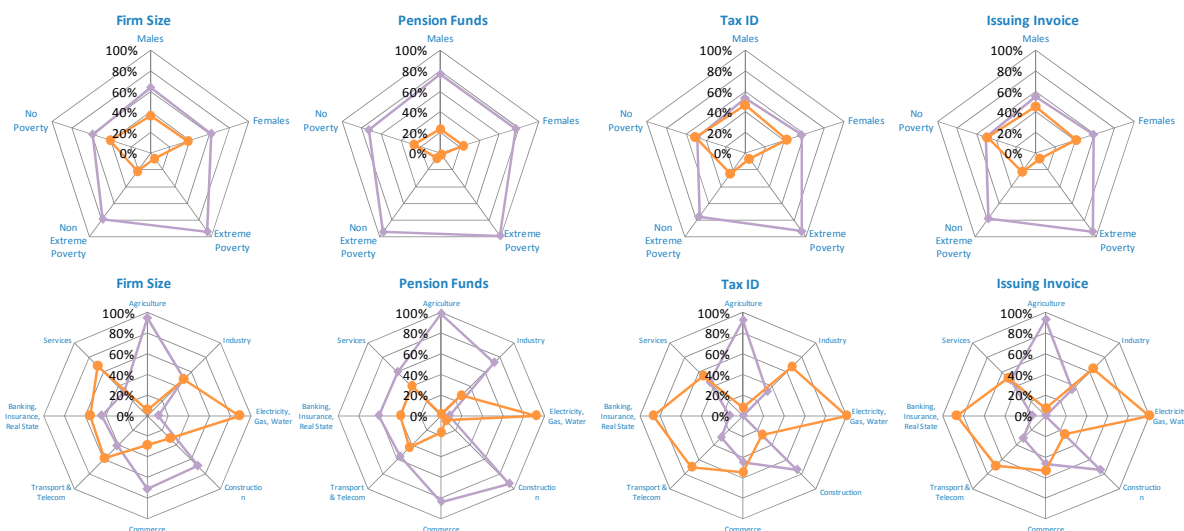
The majority of employment in Paraguay is generated in the informal sector. Using the household survey “Encuesta Permanente de Hogares, 2013”, we assess the size of the informal economy using several alternative and complementary measures. First, we restrict the sample of the survey to include only the employed population with income greater than zero, and excluding non-remunerated household work. Subsequently, we apply four different trigger conditions to identify the share of the workforce in the informal sector: a) firm size: considers that anybody working in a firm with five or less employees belongs to the informal sector; b) pension fund participation: anybody contributing to a pension fund is considered part of the formal economy, otherwise she is an informal worker; c) tax ID: a worker whose firm has a tax ID belongs to the formal sector, otherwise she is an informal worker, and; d) issuing invoices: a worker whose firm issues invoices/receipts on its sales is judged to be in the formal sector, otherwise she is part of the informal economy. According to these criteria, we estimate that between 55 percent and 77 percent of the workforce is employed in the informal economy (Figure 5) confirming that the Paraguayan labor market is highly informal.



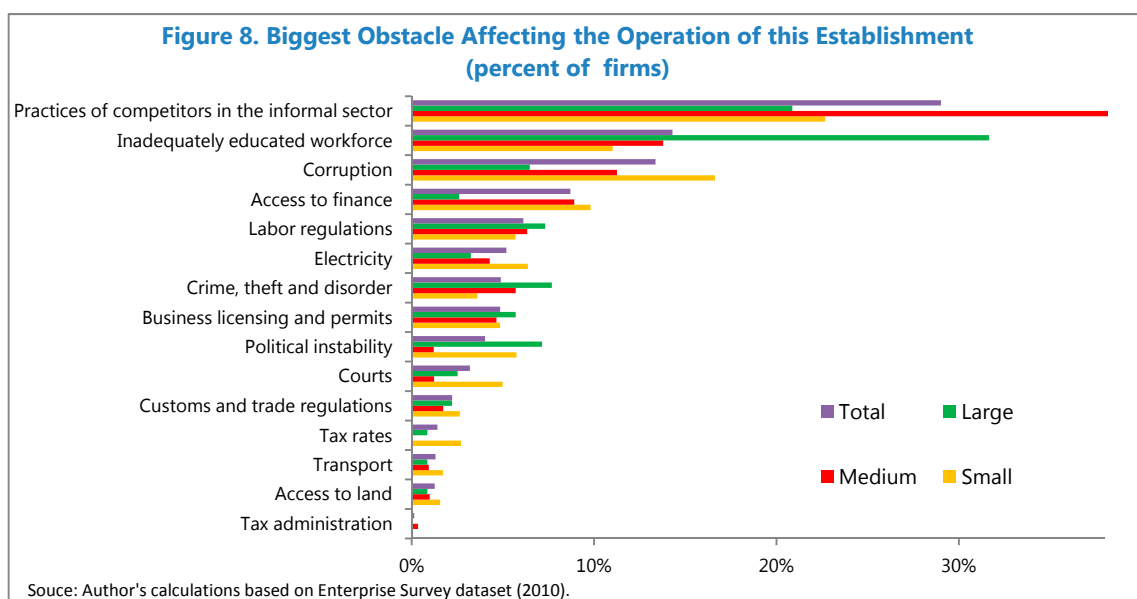
Moreover, workers in the informal sector are less well-paid than their peers in the formal sector—a difference that at least partly seems to reflect the constraints of informality. Monthly salaries in the formal sector are usually twice as large as those in the informal sector; and the workforce in the formal sector has, on average, four more years of education. To a certain extent, lower salaries in the informal sector may just represent an underlying weakness of human capital. But is the difference in terms of educational background sufficient to explain the large observed difference in salaries? To address this question, we estimate a Mincer equation for workers' income levels. Our findings show that the average salary of an informal worker is still around 40 percent below that of a formal worker, after controlling for individual characteristics including education, age, experience, and gender. Accordingly, it appears that

informal sector employment imposes a distinct constraint on income generation, perhaps related to lower productivity and less favorable conditions for growth.

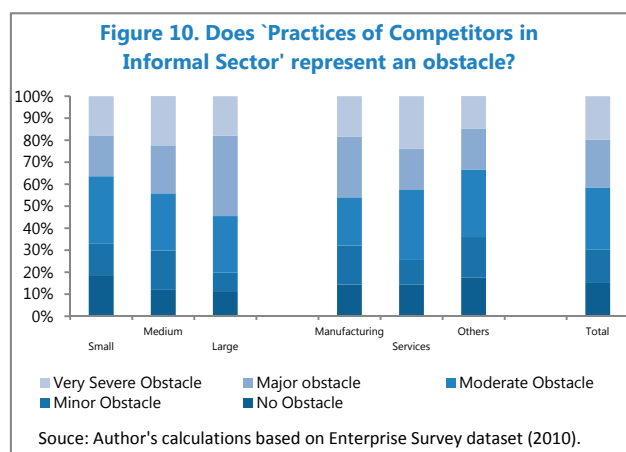
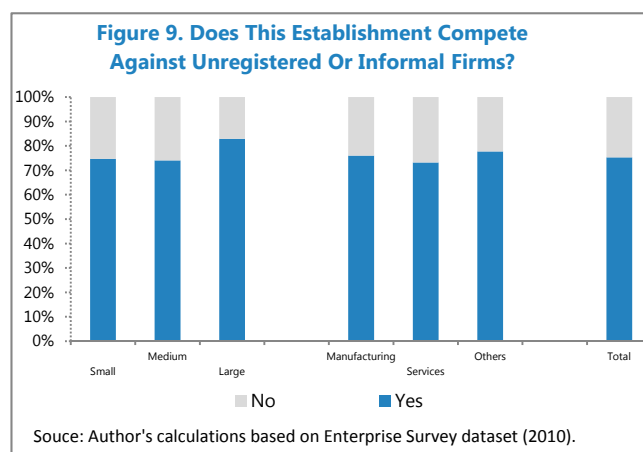
Figure 7. Paraguay: Informal vs. Formal Labor: Gender, Poverty Status and Sector of Activity (2013)



With regard to gender, poverty and differences by sector of activity (Figure 7), males and females are similarly distributed between the informal and formal sectors, indicating no significant gender difference (e.g. according to the firm size criterion, 64 percent of the male employed population works in the informal sector; similarly, 62 percent of the female employed population works in the informal economy). However, with regard to poverty, extremely poor and poor workers are found almost exclusively in the informal sector. For instance, 94 (98) percent of extremely poor workers, according to the firm size (pension funds) criterion, are part of the informal sector, which means that only 6 (2) percent of the extremely poor employed population work in the formal sector. This provides further suggestive evidence that workers in the informal sector have lower productivity. From a sectoral perspective, informal workers are mostly concentrated in agriculture, construction and commerce (Figure 7). In contrast, the “electricity, gas and water” sector has the lowest share of informal employment.



So far, we have seen that the labor force in the informal sector is worse off than in the formal economy, but what about the interaction between the formal and informal economy? There is evidence suggesting that formal firms face negative spillovers from informal firms. The World Bank's 'Enterprise Surveys' (ES) for Paraguay (2010)¹² provides useful information on what are perceived to be the biggest constraints on the operation of formal sector firms. Almost 30 percent of respondents identify the 'Practices of Competitors in the Informal Sector' as the biggest obstacle to their operations (Figure 8). That perception is even stronger among medium firms. 'Inadequately Educated Workforce' and 'Corruption' complete the list of the top three



¹² "The Enterprise Survey for Paraguay is representative of the non-agricultural economy [in Asuncion and the surrounding business area of Departamento Central]. It comprises: all manufacturing sectors according to the group classification of ISIC Revision 3.1: (group D), construction sector (group F), services sector (groups G and H), and transport, storage and communications sector (group I). This definition excludes the following sectors: financial intermediation (group J), real estate and renting activities (group K, except sub-sector 72, IT, which was added to the population under study), and all public or utilities-sectors". Technical Note "The Paraguay 2010 Enterprise Surveys Data Set" pp. 1.

obstacles for formal firms.

Furthermore, around three quarters of formal firms in Paraguay report that they have to compete against unregistered or informal firms (Figure 9). This refutes the perception that informal firms operate in entirely separate markets from those of formal firms. Typically, wages in informal firms are lower (and informal firms are more likely not to pay social insurance and to evade taxes). These elements affect negatively its own workers and lower the costs of informal firms, which can weaken the competitiveness of the formal sector.

For many formal firms, the 'Practices of Competitors in the Informal Sector' constitute a major or very severe obstacle. The World Bank's survey asks respondents to measure the strength of different obstacles. Responses are ranked on a five-level scale: No Obstacle, Minor Obstacle, Moderate Obstacle, Major Obstacle, and Very Severe Obstacle. When asked about competition with informal sector firms, more than 40 percent of formal firms, and more than half of large formal firms, respond that they face major or very severe obstacles (Figure 10). Across productive sectors, manufacturing seems to be the most affected by informal sector activities (46 percent of firms declare that the informal sector represents a major or very severe obstacle). On the other hand, only 15 percent of firms report that the informal economy represents no problem at all.

We confirm these findings by running an ordered probit regression to estimate the likelihood associated with each of the five potential answers to the question, controlling for size and sector effects (see a description of the model in Appendix II).

Table 3. Marginal Effects for the Level of Obstacle of "Practices of Competitors in the Informal Sector"

	Pr (Y1=0)	Pr (Y1=1)	Pr (Y1=2)	Pr (Y1=3)	Pr (Y1=4)
Variable	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx
Size = Small >=5 and <=19					
Size = Medium >=20 and <=99	-0.072*	-0.041*	-0.017	0.038*	0.092*
Size = Large >=100	-0.093***	-0.067**	-0.050	0.042***	0.167**
Sector: Services	-0.083**	-0.047*	-0.020	0.043**	0.106*
Industry = Foods	-0.074*	-0.050*	-0.031	0.037**	0.119
Industry = Textiles	0.121*	0.045**	-0.008	-0.063*	-0.096**

dy/dx is for discrete change of dummy variable from 0 to 1

Y1=0: No Obstacle; Y1=1: Minor Obstacle; Y1=2: Moderate Obstacle Y1=3: Major Obstacle, Y1=4: Very Severe Obstacle.

* 10% of significance; ** 5% of significance, *** 1% of significance

The results shown in Table 3 reveal that medium and large firms are more likely to face more severe challenges because of the competition with informal firms. With regard to activities,

firms in the services and foods (a sub category of manufacturing) sectors express the greatest concerns over obstacles posed by informal sector competitors.

VI. THE ROLE OF PUBLIC POLICY

As the previous sections have shown, the size of the informal economy in Paraguay is significant. This section addresses two related important questions: What are the motivations to work in the informal sector? And what are the available policy tools to reduce the size of the informal economy?

We present a theoretical model that helps to illustrate how informality is determined by taxes, regulation, government effectiveness and penalties applied to illegal or informal activities¹³. In order to formalize the rationale behind the choice of whether to operate in the formal or informal firms, we propose a dynamic general equilibrium model that encompasses the above elements. The model considers that regulations and taxes impose a cost on economic activity (captured by a tax on output, τF), though this cost may be fully or partially circumvented, giving rise to the existence of informal markets.¹⁴ However, there is no free lunch on avoiding regulations, as three more elements interact in the model: the statutory penalty for tax evasion within formal firms (s); a penalty for working in informal firms (t); and government effectiveness (q)—this latter variable determines the enforcement intensity through a probability of detection of informal workers/firms. The outcome of this setup is a model where the share of informal firms, on the one hand, and tax evasion rates, on the other hand, are determined endogenously¹⁵. The model is calibrated to the characteristics of a representative South American economy.

We focus on the set of policy tools $\Omega = [\tau F, q, s \text{ and } t]$ to assess the sensitivity of informality to the interaction of these instruments. We find that the various policy tools have different effects on the occurrence of evasion and informality, precluding a simple assessment of the optimal policy mix. Indeed, the model illustrates that not all the policy tools at hand are equally useful with respect to lowering evasion rates and informality, respectively. Figure 11 below shows a simple measure of effectiveness for the set of four alternative policies. The horizontal axis in the first, second and third charts below shows the relative size of evasion, informal labor (percent of

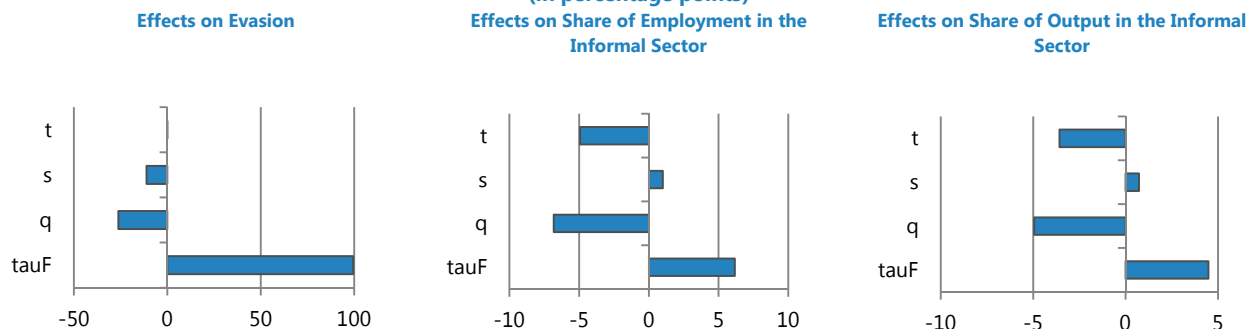
¹³ Other similar theoretical models can be found in Busato et al. (2011) and Chen (2003).

¹⁴ The notion of taxes in the model can be extended to consider the costs or benefits derived from pension fund systems or subsidy schemes.

¹⁵ The full specification of the model can be found in Appendix III. The results of the model are not calibrated specifically for Paraguay but for an average of South American countries.

workforce) and informal economy (percent of GDP), all normalized to a 0-100 scale, respectively¹⁶.

Figure 11. Effectiveness of Different Policy Tools in Reducing Evasion and Informality 1/
(in percentage points)



1/ Horizontal axis shows the change in the relevant informality measure implied by moving from the minimum to the maximum value of the respective policy tool.

For instance, when penalties on informal sector operations [t] are equal to the minimum ($t=1$ or a 0 percent penalty rate¹⁷), evasion is equal to 19 percent, informal labor and the share of output in the informal sector are around 46 percent and 44 percent, respectively. On the other hand, when the penalty [t] is at its maximum ($t=1.95$ or a 95 percent penalty rate¹⁸), evasion, the share of informal workers and the share of informal output are 19 percent, 41 percent and 40 percent, respectively. The difference between the maximum and minimum effects is reflected in the length of the bars in the charts above.

Raising government effectiveness produces favorable results in all dimensions. Improving the performance of the government increases the probability of detecting informal firms and workers, and moving them toward the formal sector. Similarly, it raises the likelihood of detecting tax evasion, enhancing compliance in the formal sector. Although government effectiveness is defined somewhat narrowly in these terms, the result has more general plausibility: a more effective government (whether as an enforcer of rules or a provider of public services) heightens the relative cost of staying outside of the formal and law-abiding sector of the economy.

¹⁶ The magnitude of the bars measures the difference between the maximum and minimum levels of evasion [share of informal labor, share of output in the informal sector] produced by the maximum and minimum values of each of the potential policy tools considered in Ω . The numbers behind the charts can be found in Appendix Tables A3, A4 and A5.

¹⁷ Values of s and t equal to 1 reflect that there is no penalty when formal firms and workers are caught, even though they must pay the undeclared taxes. A value of $s=2$, in turn, indicates that the penalty is equal to 100 percent of the undeclared taxes.

¹⁸ Calibration responds to the representative statutory penalty found on data from PricewaterhouseCoopers LLP.

Higher penalties for informal activities, unsurprisingly, assist the effort to discourage informal output and employment, whereas higher penalties on formal sector tax evasion may increase informality. Tax enforcement policies are usually aimed at monitoring and disciplining registered firms. In this regard, the model results suggest that focusing enforcement actions on formal firms can be costly, in terms of encouraging migration to the informal sector. A better strategy, therefore, needs to include elements to incentivize informal firms to formalize themselves. A higher penalty for informality (or a bigger subsidy for formalizing) can achieve this result, as can a reduction in (unnecessary) regulatory and tax burdens.

To minimize the harmful effects of the informal sector, considerations on output, welfare, fiscal sustainability and inequality are additional elements to include in the choice of an optimal combination of policies. So far, we have not considered the deeper implications of a change in the size of the informal sector. However, it must be clear that the distortions caused by informality can be important. In fact, the empirical evidence presented in previous sections points to informality disproportionately affecting the most vulnerable and possibly dampening growth through lower productivity. A dynamically consistent balance between considerations of efficiency, inequality and sustainability must be in place, and the effectiveness of government, in addition to other statutory variables, seems to play a key role.

VII. FINAL REMARKS

Informality in Paraguay is at least as pervasive as in other countries of the region, posing a significant policy challenge. Some indicators show Paraguay on par with its LAC peers, though the incidence of informal employment appears to be at the high end of the spectrum for the region. Cross-country data show that high informality is associated with other unfavorable attributes, notably high inequality, corruption and weak institutions. From a microeconomic perspective, informality in Paraguay is concentrated among workers with low incomes, even after controlling for other factors. Informal firms not only suffer from low productivity, but also appear to affect negatively the performance of formal firms and workers; medium and large firms in the formal sector are particularly likely to face challenges from the competition with informal firms. The most informal sectors are agriculture, construction and commerce.

Designing a strategy to reduce informality is not straightforward, though a few key elements are likely to be instrumental:

- Improvements in government effectiveness, which raises the relative cost of staying outside of the formal sector.

- Phasing out of unnecessarily onerous regulations, which in the case of Paraguay may include certain licensing and registration requirements that are also a potential source of corruption.

A suitable structure of penalties for non-compliance, although consideration could also be given to providing positive incentives for formalization.

A. References

- Acharya S., 1984. "The Underground Economy in the United States: Comment on Tanzi," *IMF Staff Papers*, 31, issue 4, p. 742-746.
- Ahmed E., J. B. Rosser Jr. and M. V. Rosser, 2007. "Income Inequality, Corruption, and the Non-Observed Economy: A Global Perspective", published in *Complexity Hints for Economic Policy*, pp 233-252, Springer.
- Allingham M. and A. Sandmo, 1972. "Income tax Evasion: A Theoretical Analysis", *Journal of Public Economics*, Vol. 1, N° 3-4, pp. 323-338.
- Botero J., S. Djankov, R. La Porta, F. Lopez-de-Silanes and A. Shliefer, 2003, "The Regulation of Labor", National Bureau of Economic Research, Working Paper 9756.
- Busato F., B. Chiarini and E. Marchetti, 2011. "Indeterminacy, underground activities and tax evasion," *Economic Modelling*, Elsevier, vol. 28(3), pages 831-844, May.
- Chen B., 2003. "Tax Evasion in a Model of Endogenous Growth," *Review of Economic Dynamics*, Elsevier for the Society for Economic Dynamics, vol. 6(2), pages 381-403, April.
- Choi J and M. P. Thum, 2005. "Corruption and the Shadow Economy", *International Economic Review*, Vol. 46, N° 3.
- Cowell F., 1990. "Cheating the Government," The MIT Press.
- De Soto H., 1989. "The Other Path," Harper & Row, New York.
- Djankov S., C. McLiesh and R. Ramalho, 2006. "Regulation and Growth", mimeo, World Bank.
- Feige E., 1986. "A Re-Examination of the 'Underground Economy' in the United States: A Comment on Tanzi," *IMF Staff Papers*, Palgrave Macmillan, vol. 33(4), pages 768-781, December.
- Fjeldstad O. and B. Tungodden, 2003. "Fiscal Corruption: A vice or a Virtue?", *World Development*, Vol. 31, N° 8.
- Fleming M.H., J. Roman and G. Farrel, 2000. "The shadow economy", *Journal of International Affairs*, Spring 2000, No. 53/2, pp.64-89.
- Frey B. and B. Torgler, 2007. "Tax morale and conditional cooperation," *Journal of Comparative Economics*, Elsevier, vol. 35(1), pages 136-159, March.
- International Labour Organization (ILO), 2013. "Women and Men in the Informal Economy: A Statistical Picture", Second Edition.

- Kim B., 2005. "Poverty and Informal Economy Participation, Evidence from Romania", *Economics of Transition*, Volume 13.
- Lesica G., 2011. "Estimating the size of the informal sector in Latin America". Degree: MA, Economics, Eastern Illinois University.
- Levy S., 2008. "Good Intentions, Bad Outcomes," Washington DC: Brookings Institution.
- Levy S., M. Busso and M. Fazio, 2012. "(In)Formal and (Un)Productive: The Productivity Costs of Excessive Informality in Mexico," Research Department Publications 4789, Inter-American Development Bank, Research Department.
- Loayza N., 1997. "The Economics of the Informal Sector: A Simple Model and Some Evidence for Latin America," Policy Research Working Paper 1727, World Bank.
- Loayza N., A. M. Oviedo and L. Servén, 2005. "The Impact of Regulation on Growth and Informality", Policy Research Working Paper Series 3623, The World Bank.
- Mauro P., 1995. "Corruption and Growth", *The Quarterly Journal of Economics*.
- Schneider F., 2005. "Shadow Economies of 145 Countries All Over the World: What do we really know?," Working Paper 2005-13, Center for Research in Economics, Management and the Arts (CREMA).
- Schneider F., A. Buehn and C. E. Montenegro, 2010. "Shadow economies all over the world : new estimates for 162 countries from 1999 to 2007," Policy Research Working Paper Series 5356, The World Bank.
- Slemrod J. and S. Yitzhaki, 2000. "Tax Avoidance, Evasion and Administration", NBER Working Paper 7473.
- Tanzi V., 1982. "The Underground Economy in the United States: Estimates and Implications," in *The Underground Economy in the United States and Abroad*, ed. by Vito Tanzi (Lexington, Massachusetts: Lexington Books, 1982), pp. 69-92.
- 1983, "The Underground Economy in the United States: Annual Estimates, 1930-80," *Staff Papers*, International Monetary Fund (Washington), Vol. 30 (June 1983), pp. 283-305.
- 1999, "Uses and Abuses of Estimates of the Underground Economy", *The Economic Journal*, Vol. 109, N°456.
- Tanzi, Vito and S. Parthasarathi, 1993. "A Primer on Tax Evasion", *IMF Staff Papers*, 40, issue 4, p. 807-828.
- Tonoyan V., R. Strohmeier, M. Habib and M. Perlitz, 2006. "Corruption and Entrepreneurship: How Formal and Informal Institutions Shape Firm Behavior in Mature and Emerging Market Economies", *Academy of Management Best Conference Paper*.
- Vargas J., 2009. "Calidad Regulatoria, Evasión y Economía Subterránea", Tesis de Doctorado en Economía, Universidad de Chile.

Vuletin G., 2008. "Measuring the Informal Economy in Latin America and the Caribbean". IMF Working Papers 08/102, International Monetary Fund.

B. APPENDICES

I. Definitions of the International Labour Organization (ILO, 2013, pp. 62)

The *informal sector* was defined by the 15th ICLS (1993) as private unincorporated enterprises that are unregistered or small in terms of the number of employed persons (e.g. less than five employees). An enterprise is unincorporated if it is not constituted as a separate legal entity, independently of its owner(s), and does not maintain a complete set of accounts. Units engaged in the production of goods or services exclusively for own final use by the household are excluded, as are enterprises engaged in agriculture, hunting, forestry and fishing. National statistical definitions of the informal sector vary to some extent; however, the countries for which data are presented in the appendix have all used the international definition of informal sector.

Informal employment was defined by the 17th ICLS (2003) as encompassing the following:

- (a) Own-account workers and employers employed in their own informal enterprises;
- (b) Members of informal producers' cooperatives (not established as legal entities), if any;
- (c) Own-account workers producing goods exclusively for final use by their households (if considered employed, given that their production comprises an important contribution to total household consumption and is included in the national definition of employment);
- (d) Contributing family workers in formal or informal enterprises; and
- (e) Employees holding informal jobs in formal enterprises (including government units and non-profit institutions), informal enterprises or as paid domestic workers employed by households.

Table A1. Size of the Informal Economy: Growth, Inequality and Institutions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
VARIABLES	Country FE						Country/Time FE						Country FE			Country / Time FE		
GDP per capita, PPP (constant 2011 international \$)	-0.00*** (-0.37)						-0.00*** (-0.12)						-0.00*** (-0.31)	-0.00*** (-0.32)	-0.00*** (-0.32)	0.00* (0.06)	0.00 (0.04)	0.00* (0.05)
Gini		0.03* (0.02)						0.03** (0.02)					0.04*** (0.02)	0.03** (0.02)	0.04*** (0.02)	0.02* (0.01)	0.02 (0.01)	0.02* (0.01)
5-year Average Annual Growth Rate			-0.07*** (-0.04)					-0.05*** (-0.03)					-0.35*** (-0.08)	-0.36*** (-0.09)	-0.33*** (-0.08)	-0.28*** (-0.07)	-0.30*** (-0.07)	-0.27*** (-0.07)
Government Effectiveness - Estimate				-1.01*** (-0.08)				-1.29*** (-0.10)					-0.14 (-0.01)			-0.72*** (-0.05)		
Regulatory Quality - Estimate					-0.94*** (-0.07)				-1.04*** (-0.08)					0.69*** (0.05)			0.27 (0.02)	
Control of Corruption - Estimate						-0.65** (-0.05)				-1.03*** (-0.08)					-0.67*** (-0.05)			-0.93*** (-0.07)
Constant	36.94*** (.)	30.03*** (.)	33.31*** (.)	32.75*** (.)	32.76*** (.)	32.72*** (.)	35.09*** (.)	31.24*** (.)	34.17*** (.)	33.71*** (.)	33.73*** (.)	33.69*** (.)	35.75*** (.)	35.75*** (.)	35.84*** (.)	31.67*** (.)	31.72*** (.)	31.72*** (.)
Observations	1,391	680	1,369	1,110	1,110	1,110	1,391	680	1,369	1,110	1,110	1,110	516	516	516	516	516	516
R-squared	0.18	0.01	0.06	0.01	0.01	0.01	0.41	0.61	0.46	0.41	0.41	0.41	0.64	0.65	0.65	0.78	0.78	0.79
Number of Countries	158	144	158	161	161	161	158	144	158	161	161	161	135	135	135	135	135	135
RMSE	1.2304	1.1866	1.2303	1.3544	1.3544	1.3586	1.0513	0.7532	0.9333	1.0475	1.0520	1.0508	0.6994	0.6919	0.6927	0.5467	0.5540	0.5388

Normalized beta coefficients in parentheses

*** p<0.01, ** p<0.05, * p<0.1. FE:Fixed effects

II. Measuring the Severity of the Obstacle “Practices of Competitors in the Informal Sector”

We seek to determine whether this obstacle affect firms differently according to their characteristics. To achieve this goal, we specify a reduced-form econometric model to identify the main determinants of firms’ answers to the obstacle question. First, we will name a vector of constraint levels Y_1^* , which depends linearly on some matrix of explanatory (control) variables X_1 .

$$Y_1^* = \alpha X_1 + e_1 \quad (1)$$

Where e_1 is a vector of independent and identically distributed random variables, and α is a vector of coefficients to estimate. As we utilize a discrete measure of perceived constraints, we assume that each observed perception for any firm i ($y_{1,i}$) is determined from a latent constraint level ($y_{1,i}^*$) according to the following rule:

$$y_{1,i} = \begin{cases} 0 & \text{if } y_{1,i}^* \leq \gamma_1 \\ 1 & \text{if } \gamma_1 \leq y_{1,i}^* \leq \gamma_2 \\ 2 & \text{if } \gamma_2 \leq y_{1,i}^* \leq \gamma_3 \\ 3 & \text{if } \gamma_3 \leq y_{1,i}^* \leq \gamma_4 \\ 4 & \text{if } \gamma_4 < y_{1,i}^* \end{cases} \quad (2)$$

We may solve the following log-likelihood function maximization problem (namely, an ordered probit). The transformation depends on the non-continuous form of the observed variable Y_1 according to the Limited Dependent Variable (LDV) literature.

$$l(\alpha, \gamma) = \sum_{i=1}^N \sum_{j=0}^4 \log(Pr(y_{1,i} = j | x_{1,i}, y_{2,i}, \alpha, \gamma)) \cdot 1(y_{1,i} = j) \quad (2)$$

where j can take the values: 0=No Obstacle, 1= Minor Obstacle, 2= Moderate Obstacle, 3= Major Obstacle, 4= Very Severe Obstacle; N is the number of observations; the vector X_1 may consider variables that characterize firms such as firm size, legal status of the firm, firm's industry, number of years of experience of the top manager, city, firm’s current legal status, percent of the firm owned by the largest shareholder, principal owner’s gender, origin of the investment financing needed to start the establishment, years of experience of the top manager, international-recognized quality certification status, and annual growth of labor (as

a proxy to firm's performance). The vectors α and γ contain the coefficients and endogenous cut points to be estimated, respectively.

Table A2. Ordered Probit Model

Dependent Variable: Are Practices of Competitors in the Informal Sector an Obstacle?		
REGRESSORS	OProbit	
	Coef.	P-value
Size = Small ≥ 5 and ≤ 19		
Size = Medium ≥ 20 and ≤ 99	0.334	0.075
Size = Large ≥ 100	0.531	0.019
Sector: Services	0.385	0.046
Percentage held by largest owner (0-24%)	-0.663	0.114
Industry = Foods	0.394	0.085
Industry = Textiles	-0.441	0.051
Legal Status = Sole (proprietorship)	0.665	0.005
/cut_1	-0.660	0.000
/cut_2	-0.114	0.505
/cut_3	0.646	0.000
/cut_4	1.309	0.000

/cut 1 to 4 stand for the parameters γ in equation (2).

III. A Theoretical Model to Explain the Size of the Underground Economy

We briefly describe the main elements of a theoretical model to explain the rationale behind agents' decision to work either in the informal or formal economy. While this model considers that imposing taxes is the main government intervention, 'taxes' can be understood in a broad way (e.g. contributions to social security system, negative subsidy, etc.)

We consider a consumer/producer representative agent model where taxes are levied on firm's output and labor's wages. Production technology includes two sectors:

- The official sector, known and recorded by the government. Within this sector, tax returns of firms cannot be confirmed for free by the government, so firms have an incentive to only a share of their true income level. This means this sector may show fiscal *evasion*.
- A second sector – which we call informal – is not directly observed nor recorded by the government. This sector *defrauds* the whole amount of taxes on labor's wages and firm's income. This sector uses the rest of total capital and labor in the economy.

The specification includes the government sector, which provides public goods and services; and exogenously determines the tax burden on output and labor. Another innovative characteristic is that the model considers the effect of the extent of corruption control (government effectiveness)¹⁹ on agents' decisions, integrating them through the probability of being caught evading or operating in the informal sector. This means that a higher (better) control of corruption/government effectiveness index improves government capacity to catch evaders and informal workers. Households face a utility function which depends on consumption and labor supply of the representative agent. Below we describe more precisely each agent's conditions and the functional forms of the model.

Firms

We assume that a representative firm can work simultaneously in both the formal/official and informal sectors. Each sector has a production function which depends on labor and capital, and also includes a positive externality derived from government expenditure *à la*

¹⁹ We use 'Corruption Control' and 'Government Effectiveness' as related terms because of their high statistical association (a correlation coefficient close to 0.9 according to the Worldwide Governance Indicators project).

Barro (1992). We suppose production functions have positive and decreasing returns in each factor separately, whereas they are homogenous of degree one in labor, capital and government expenditures; in addition they fulfill the so-called Inada conditions.

$$y^O \equiv y^O(z^O, k^O, l^O, g) \text{ and } y^U \equiv y^U(z^U, k^U, l^U, g).$$

Total output of the representative firm is equal to the sum of production in both sectors: $y = y^O + y^U$ ²⁰. Firms' income from output sales is equal to y (normalizing prices to 1). Nevertheless, we must subtract taxes and/or penalties that firms have to pay besides the payments to productive factors.

The government collects taxes on the official output y^O according to a proportional tax rate τ_F . Since the government does not know the firm's true production, firms may declare just a share ξ of it, where $0 < \xi < 1$.²¹ The government detects firms' evasion with a probability p , and if being caught, firms must pay a proportional penalty s on evaded taxes (with $s > 1$), which includes the repayment of the originally undeclared tax.

Firms' also potentially derive income from underground operations y^U . We suppose that firms in the underground sector face a detection probability (o) and penalties (t), which could be equal or distinct to those in the official sector. In addition, firms decide the labor (capital) share assigned to the official sector and implicitly the labor (capital) share assigned to the informal sector. With these elements in mind, the profit function is given by:

$$\pi \equiv (1 - \tau_E) y^O + (1 - o \cdot t \cdot \tau_F) y^U - w \cdot l - (r + \delta) \cdot k \quad (1)$$

where $\tau_E \equiv \tau_F (\xi + p \cdot s \cdot (1 - \xi))$, and we consider also that $\rho k = k^O$, $(1 - \rho) k = k^U$, $\mu l = l^O$, $(1 - \mu) l = l^U$, $k^O + k^U = k$ and $l^O + l^U = l$.

Under the assumption of perfectly competitive markets, the firm (taking w , r and the level of labor as given) will maximize its profits assuming that capital marginal productivity is equal to rental price. That is to say:

$$r^* = y_k^O (1 - \tau_E) + y_k^U (1 - o \cdot t \cdot \tau_F) - \delta \quad (2)$$

²⁰ A lowercase variable represents per capita units, namely $x \equiv X / N$, where N is equal to population and X represents the aggregate value for the whole economy.

²¹ An interior solution is guaranteed under a wide and feasible range of parameter conditions (demonstration available upon request).

Since full market equilibrium demands a zero profit, the wage rate must be equal to the marginal productivity of labor corresponding to the capital level associated with equation (2):

$$w^* = \frac{(1-\tau_E)(y^O - k \cdot y_k^O) + (1-o \cdot t \cdot \tau_F)(y^U - k \cdot y_k^U)}{l} \quad (3)$$

where y_k^j represents the marginal productivity of capital in sector j . Besides, firms choose to declare (to the government) a share ξ^* of their income according to the next first-order condition:

$$\frac{\partial \pi}{\partial \xi} = 0 \quad (4)$$

Finally, firms establish the share of labor and capital that they will employ within official productive technology μ and ρ , respectively by solving simultaneously both conditions of (5):

$$\frac{\partial \pi}{\partial \mu} = 0 \quad \frac{\partial \pi}{\partial \rho} = 0 \quad (5)$$

We define the following functional forms for the productive processes:

$$y^O = e^{z^O} (k\rho)^\alpha (\mu l)^\theta (\nu g)^{1-\alpha-\theta} \quad (6)$$

$$y^U = e^{z^U} \cdot ((1-\rho) \cdot k)^\alpha \cdot ((1-\mu) \cdot l)^{1-\alpha} \cdot (\varphi g)^{1-\alpha-\theta} \quad (7)$$

In equations (6)-(7) z^O and z^U may or may not represent stochastic variables. In addition, we take into account the fulfillment of the following restrictions: $0 < \rho < 1$, $0 < \mu < 1$, $0 < \theta < 1$, $0 < \alpha < 1$, $\alpha + \theta < 1$, $0 < \nu$, $\varphi < 1$ and $\nu > \varphi$. The last inequality reflects that the positive externality of government expenditure on the production function is smaller in the underground sector than in the official sector.

Finally, probabilities of being caught, p and o , can be considered as functions of government effectiveness level q .

$$p = \frac{(f - \xi)}{j \cdot \tau[F] \cdot (1 + e^{-(T_1 + T_2 q)})} \quad (8)$$

$$o = \frac{1}{1 + e^{-(W_1 + W_2 q)}} \quad (9)$$

In (8) $f > 1$, $j > 0$ and $T_2 > 0$ so that it is possible to prove that for a broad value of parameters we have $0 < p < 1$ and $0 < o < 1$ ²². In addition, the index of government effectiveness is bounded in the interval $(0,1)$, where higher values represent better government effectiveness, and will depend positively on a proportion ω of government expenditures g ²³. The last two restrictions are reflected in the following equations:

$$q_t = \frac{1}{1 + e^{-(\bar{q}_t)}} \quad (10)$$

$$\tilde{q}_t = \bar{q}_t + H(\omega g_t) \quad (11)$$

Variable \bar{q}_t may be understood as an *autonomous* regulatory quality, and would include all those elements of regulatory quality that are not affected directly by government expenditures.²⁴

Households

Consumers look to maximize their expected utility (U), which in this case depends on consumption (c) and labor (l) discounted by factor β over an infinite period of time:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t U(c_t, l_t) \quad (12)$$

Households use the income they do not consume (after taxes) to accumulate assets (a) according to the following accumulation rule, which takes into account that workers pay a proportional tax rate τ_L on their wage.

$$a_{t+1} - a_t = (1 - \tau_L) w_t \mu_t l_t + (1 - o \cdot t \cdot \tau_L) w_t (1 - \mu_t) l_t + r_t \cdot a_t - c_t \quad (13)$$

²² We do not require special restrictions in (8) to be bounded between $0 < o < 1$, but parameters W_i are elements of the set of real numbers. Additional conditions to ensure $0 < p < 1$ can be found in the first proposition of Vargas (2009).

²³ The relative weight between the effects of autonomous regulatory quality and the government expenditure destined to regulatory quality is reflected by parameter H .

²⁴ We can consider that this variable is associated with cultural elements, such as tax morale or acceptance of corruption. Empirically, we consider this as a standardized variable.

As stated before, we assume that households seek to maximize their utility derived from the discounted flow of consumption and work. According to the Bellman Principle, the system can be expressed as:

$$V(a_t) = \max \{U(c_t, l_t) + \beta \cdot E[V(a_{t+1})]\} \quad (14)$$

Solving the optimization problem we find first-order conditions which maximize the associated utility when optimal amounts of consumption and labor are chosen. These conditions are shown in equations (15) and (16):

$$1 = E_t \left[\beta \cdot \frac{U_{c,t+1}}{U_{c,t}} \cdot (1 + r_{t+1}) \right] \quad (15)$$

$$1 = E_t \left[- \frac{U_{l_t}}{U_{c_t} (1 - \tau_L) w_t \cdot \mu_t + (1 - o \cdot t \cdot \tau_L) w_t \cdot (1 - \mu_t)} \right] \quad (16)$$

Since households own the assets, it is possible to equal $a_t = k_t$ in (13). Next, we use equations (2) and (3) and the identity $y_t = y_t^o + y_t^u$ to arrive at the following expression, which is simply the resource constraint of the economy:

$$k_{t+1} - k_t = y_t - g_t - k_t \cdot \delta - c_t \quad (17)$$

We define a utility function with constant coefficient of risk aversion (CRRA) separable in consumption and leisure $(1-l)$:

$$U(c_t, l_t) = \frac{c_t^{1-\sigma} - 1}{1-\sigma} + h \frac{(1-l_t)^{1-\eta}}{1-\eta} \quad (18)$$

where $h \geq 0$ and $1/\eta$ represents the inter-temporal substitution elasticity of leisure.

Government

The government collects taxes from a proportional rate imposed on firms' output and labor's wages. In addition, there are tax revenues related to penalties which are triggered when firms are caught evading taxes and/or producing in the underground sector.

From the behavior of firms, it is straightforward to define revenues from activities within the official sector:

$$R_o \equiv Y^o \cdot \tau_F (\xi + p \cdot s \cdot (1 - \xi)) + w \cdot L \cdot \mu \cdot \tau_L \quad (19)$$

Using the identity $\tau_E \equiv \tau_F (\xi + p \cdot s \cdot (1 - \xi))$ we can express (21) as:

$$R_o \equiv Y^o \cdot \tau_E + w \cdot L \cdot \mu \cdot \tau_L \quad (20)$$

On the other hand, revenues collected when government detects underground activities are:

$$R_U \equiv o \cdot t \cdot Y^U \cdot \tau_F + o \cdot t \cdot L \cdot (1 - \mu) \cdot w \cdot \tau_L \quad (21)$$

With these definitions at hand, the government budget constraint will be:

$$Y^O \tau_E + w \cdot L \cdot \mu \cdot \tau_L + Y^U \cdot o \cdot t \cdot \tau_F + o \cdot t \cdot L \cdot (1 - \mu) \cdot w \cdot \tau_L \\ \max_{\nu, \varphi} \cdot G + \omega \cdot G + (1 - \max_{\nu, \varphi} - \omega) G \equiv G \equiv R_O + R_U \quad (22)$$

where $\max_{\nu, \varphi}$ stands for the maximum of $\{\nu, \varphi\}$ which are the shares of government expenditure in the official and underground production functions, respectively. The left side of equation [(22)] indicates that government expenditures can be distributed between: i) goods that are useful in the production of goods, ii) resources supporting regulatory quality, and iii) expenditures that do not belong to groups i) nor ii) (i.e. they do not produce positive or negative externalities).

Equilibrium

The saddle path - or policy function - of this economy is determined by solving the system formed by equations (15) - (17). Thus, the model integrates and considers three different definitions for the informal economy in a dynamic general equilibrium model: tax evasion $(1 - \xi)$, informal labor $(1 - \mu)$, and informal output y^U .

Results of the Model

Table A3. Effectiveness of Policy Tools on Evasion

	Min	Max	Evasion when policy = Min	Evasion when policy = Max	Maximum Impact of Policy
tauF	0.01	0.86	0.01	1.00	0.995
q	0.12	0.86	0.36	0.09	-0.262
s	1.00	1.95	0.22	0.11	-0.111
t	1.00	1.95	0.19	0.19	-0.001

Source: Author's calculations.

Table A4. Effectiveness of Policy Tools on the Share of Labor in the Informal Sector

	Min	Max	Informal Labor when policy = Min	Informal Labor when policy = Max	Maximun Impact of Policy
tauF	0.01	0.86	0.37	0.43	0.062
q	0.12	0.86	0.46	0.39	-0.068
s	1.00	1.95	0.44	0.45	0.010
t	1.00	1.95	0.46	0.41	-0.049

Source: Author's calculations.

Table A5. Effectiveness o Policy Tools on the Share of Output produced by the Informal Sector

	Min	Max	Informal Output when policy = Min	Informal Output when policy = Max	Maximun Impact of Policy
tauF	0.01	0.81	0.37	0.41	0.045
q	0.12	0.86	0.43	0.38	-0.049
s	1.00	1.95	0.42	0.43	0.007
t	1.00	1.95	0.44	0.40	-0.036

Source: Author's calculations.