Optimal Taxation and Informality

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May 8, 2018

Abstract

Informality is a widespread phenomenon in developing economies with negative consequences on productivity and inequality. Several policies have been implemented to decrease informality such as decreasing corporate tax rates for small businesses, to make formality more attractive, or reducing payroll taxes to promote formal employment. However, these policies introduce a new set of distortions and is not clear that introducing them is optimal. Although the theory of optimal taxation in an economy has been widely studied in economics, the informal economy has been largely ignored in this literature. In this paper, we fill this gap by developing a theory of optimal taxation in an economy with an informal sector. We construct a novel dataset combining a census of formal and informal businesses in Peru, administrative records from tax authorities and the national household survey in the country, which allow us to get a unique characterization of the informal economy that we use to quantify the welfare gains from imposing the optimal tax scheme in this economy.

JEL Codes: J46, H21, H3

1 Introduction

Informality is defined as the set of economic activities that occur outside of an economy's regulatory framework. This is a widespread phenomenon in developing economies. Approximately 46.8% of non-agricultural employees in Latin America are informal (Gomez, 2016) and around 40% of its GDP is produced in the informal sector. In Sub-Saharan Africa, 80% of the labor force is employed in the informal sector, which contributes to 55% of the GDP.

The high prevalence of informality has various negative consequences. Informality is usually associated with lack of protection on the worker side, and lack of compliance on the firm side. Governments cannot tax the informal sector, limiting the extent to which taxes and spending can be used as a tool for redistribution. Additionally, informality is thought to hinder productivity as firms and individuals deviate from optimal behaviors in order to avoid the scope of the government radar.

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The negative consequences of informality brought the topic to the center of the academic and policy debate in developing countries (Perry, 2007). Poorly designed tax systems and burdensome regulations have been pointed as a potential cause of the high levels of informality (Levy, 2010). Naturally, the proposed fixes also point at reforms of the tax code. A popular policy involves introducing special tax regimes for small firms or other populations more prone to become informal. Another approach is to reduce payroll taxes and replace the forgone income by increasing other taxes. However, both measures introduce new distortions: when governments introduce size-dependent policies they create distortions leading to misallocation and with potentially large negative effects on productivity, and increasing corporate taxes distorts on organizational form and long-run capital accumulation, increasing labor income taxes lessens labor supply.

The discussion above suggests that we need a framework to characterize the optimal mix of different tax distortions in an economy where informality is a choice. We propose such a framework and characterize optimal, unrestricted, tax functions for business and for individual income. The model proposed captures the basic choice between working and starting a firm, in a context where it is very hard for the government to observe small firm activity. How to fund a country's fiscal needs in an optimal way is one of the most studied questions in economics (Ramsey, 1927; Mirrlees, 1971; Stantcheva, 2017). However, the phenomenon of informality has not been taken into account in answering this question. In this paper we fill the gap by developing a theory of optimal taxation in an economy with informality that captures the main features of this phenomenon.

An important challenge of any work related to informality is that of having good sources of information. By definition, the informal sector does not show up in admistrative data and has to be measured by survey or census data. At the same time, the quality of survey and census data on income and tax payments is known to be limited and the best source are the administrative records. In this paper, we combine novel sources of information for the informal sector in Peru to address the above challenges. We use data from the Economic Census of Peru, a unique dataset including financial and operational information of all establishments in the country, be it formal or informal. We also use aggregate administrative tax records provided from the national tax authorities to identify some features of the formal sector. Finally, we use the national household survey, ENAHO[1] to have an adequate description of the formal and informal labor force. To the best of our knowledge, in the context of developing countries, the only dataset comparable to the Economic Census of Peru is the Economic Census of Mexico[2], but Mexico does not make tax data available. By combining the economic census of Peru, together with administrative records from the tax authorities and the household survey of Peru, we obtain a unique data that allows us to get a detailed characterization of the formal and informal sectors in Peru.

In line with existing evidence for other developing countries, we find that informal employees are more prevalent in small firms, they earn less than formal ones, and tax evasion is decreasing in firm size. We also find kinks in the administrative records at the points where the law introduces discontinuities. The kinks can arise because firms decisions are distorted by the tax code, or because they lie when filing taxes. Comparing tax records with census data allows us to disentagle misreporting from behavioral distortions. We do not find kins at the points of discontinuous tax treatment in the data reported only for statistical purposes, suggesting that misreporting plays an important role to explain those kinks.

We procede in two steps. We first devolop a positive model and calibrate it for Peru. Using the current Peruvian tax code, the model is able to replicate the main empirical

[1] In Spanish, "Encuesta Nacional de Hogares"

[2] Although El Salvador has also implemented an economic census, it excludes establishments with less than five workers. As we show in the description of this data, approximately 95% of businesses have fewer than 5 employees, which largely limits the analysis that can be done with such dataset.

regularities found in the data. Next, we solve the problem of a benevolent planner who has preferences for redistribution.

In the positive model, individuals chose to become entrepreneurs or to work for a wage in either, the formal or the informal sector. Entrepreneurs maximize profits producing output with formal and informal employees. They can only pay payroll taxes on formal workers but face an increasing marginal cost on informal workers reflecting the fact that the more informal workers they hire, the more likely they are to be detected and the higher the expected fine from the authorities (As in Meghir, Narita, and Robin (2015) and Ulyssea (2017)). Entrepreneurs set up firms having to pay taxes on corporate profits -if big enough- but might chose to misreport them taking into account that larger deviations from the real profits are harder to justify and generate an expected penalty. Workers chose how many hours they provide in the formal and the informal labor market and pay income taxes.

The effects of high payroll taxes combined with low (zero) corporate taxes for small firms are amplified by the endogenous worker-entrepreneurial desicion. High payroll taxes induce workers to become entrepreneurs and low corporate taxes for small firms incentivize low-scale operations. In turn, hiring informal workers is cheaper for small firms as the probability of detection is low.

We then solve for the allocation that maximizes a social welfare function reflecting prefences for redistribution. The planner can choose any arbitrary tax system, but cannot perfectly observe all economic activity. Specifically, informal markets cannot be observed by the planner. The planner chooses the optimal tax system subject to the obsevability restrictions, trading off effciency and redistribution motives.

The remainder of this paper is structured as follows. In Section 2 we describe the different datasets used in this paper and describe the main features of the informal and the formal sector. In Section 3 we develop a model of occupational choice incorporating the main features of the informal economy. After solving the model and the problem of the benevolent social planner, we calibrate the model to the Peruvian data in Section 4 and conclude in Section 5

2 Data

We use three sources of information: the 2007 Economic Census of Peru, the 2007 National Household Survey of Peru (ENAHO)[3], and aggregate administrative records from the tax administration (SUNAT)[4]. The Economic Census of Peru collects information from all establishments, formal or informal, operating in the year 2007 in Peru. A total of 940,336 establishments were surveyed in the census covering all economic sectors except for agriculture, public administration and defense, and economic activities that are not performed in fixed establishments. The information collected includes taxes payed, price and quantities of the main products and services sold, intermediate purchases, wages payed, financial statements, and use of technology, among others.

ENAHO is a standard household survey run by the national statistics department of Peru (INEI). It is run on a monthly basis on the 24 departments of Peru, including the Lima metropolitan region, and includes information about education, employment, income, expenses, and demographic composition of the household. A total of 22,640 households were surveyed in 2008 including 8,816 rural and 13,824 urban households. The ENAHO survey is representative at the department (regional) level. Every year, approximately one third of the households are surveyed again to generate the panel sample of the survey. To have a comparable sample we limit our analysis to Lima, the capital and largest city of

[3]"Encuesta Nacional de Hogares" in Spanish.

[4]"Superintendencia Nacional de Aduanas y Administracion Tributaria"

Peru and the only city for which there is a representative sample in the ENAHO. We also remove establishments with profits beyond the top 1%.

We obtain aggregate administrative records from the national tax authority in Peru (SUNAT). Given the source of information, data from SUNAT is informative exclusively of formal businesses that report to the tax authorities. This information includes distribution of monthly sales for all establishments, profits, number of workers, workforce expenses.

2.1 Economic Census

There are 342,374 establishments in the economic census that operate in Lima. The distribution of such establishments by sector of economic activity is reported in Table 1. Commerce, hotels and Restaurants and manufacturing encompass 79% of the establishments in the Census.

Table 1: Distribution of establisments by sector of activity

	N	Percentage
Administrative and support	4,139	1.76
Arts	1,586	0.67
Commerce	137,813	58.57
Construction	1,390	0.59
Education	5,174	2.20
Elecricity and gas	62	0.03
Financial sector	652	0.28
Fishing	798	0.34
Health	4,274	1.82
Hotels and restaurants	28,940	12.30
Manufacturing	23,716	10.08
Mining	153	0.07
Other services	14,621	6.21
Professional/Scientific	6,128	2.60
Real estate	775	0.33
Transportation and storage	4,822	2.05
Water treatment/provision	235	0.10

Information on financial balances, sales, and general operation, are only available for establishments that were fully operational in the year 2007. For this reason, although 342,374 establishments were included in the census, the questionnaire about financial information was answered by 274,981. We report some statistics for these establishments in Table 2[5] after removing the top 1% in profits.

We note that most establishments are young as the average age is 7.2 years and less than 25% of establishments have been operating for more than a decade. The median establishment has annual profits of $11,327 USD and the average amount of taxes payed in the form of corporate income is $605.6. This corresponds to an average payment of 5% of profits in the form of corporate profit tax. It is also important to note that less than 25% of establishments are actually paying some form of corporate income tax. The value of all assets included in the operation is, on average, four times the level of profits. The average establishment size, in terms of number of employees, is 4.35 and less than 25% of them have more than 3 workers.

[5]Monetary variables are reported in $USD considering an exchange rate of 0.315 USD/ PEN (sol).

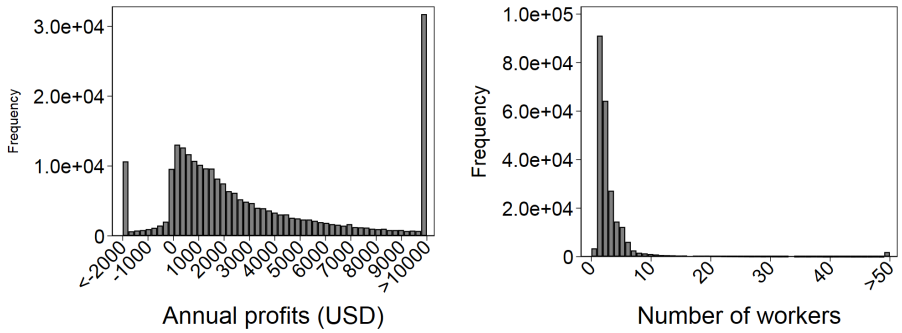
Table 2: Descriptive Statistics

	Mean	Median	Std. Dev	P-25	P-75	N
Age	7.23	4.00	7.92	2.00	10.00	235,278
Profits (USD)	11,327.36	1,952.37	540,869.76	585.27	5,142.93	235,278
Corporate Income Tax (USD)	605.62	0.00	4,107.30	0.00	0.00	235,278
Assets (USD)	45,901.20	315.00	1,635,276.70	0.00	1,575.00	235,278
Workers	4.35	2.00	34.93	1.00	3.00	235,278

Note: monetary variables are reported in $USD considering an exchange rate of 0.315 USD/ PEN (sol).

In Figure 1 we explore further the size distribution of firms in terms of profits and number of workers. Most very few establishments report profits over $10,000, and most of them employ between one and two workers.

Figure 1: Size Distribution of firms



Although small businesses are prevalent, these business employ a small share of productive resources, and explain a small portion of the overall taxes payed in and of the aggregate value added in the economy. In Table 3 we note that establishments with fewer than five employees represent 90% of the distribution but only employ 41% of the workers, utilize 14% of the total physical capital being used in the data, contribute 21% to the total value added of establishments in the census and pay 24% of all taxes. The establishments employing more than fifty workers represent 1% of the total distribution but they employ 34% of workers, use 53% of the total physical capital, explain 48% of the total value added and are responsible for the 32% of total tax payments of all establishments.

Table 3: Share of establishments/workers/capital/VA/taxes by firm size

Employees	Establishments	Employees	Capital	Value Added	Taxes
$[0-5]$	0.90	0.41	0.14	0.21	0.24
$[6-10]$	0.05	0.09	0.07	0.08	0.10
$[11-50]$	0.03	0.16	0.27	0.23	0.34
$[50+]$	0.01	0.34	0.53	0.48	0.32

2.2 ENAHO (2007) Household Survey

The ENAHO survey of 2007 contains information for 95,469 individuals, out of which 11,608 live in Lima. The size of the economically active population, composed of those who are working or who are looking for a job, is of 6,050 individuals. Out of those, 5.97% are unemployed. We present some descriptive statistics of those who are working in Table 4.

Table 4: Descriptive Statistics (ENAHO)

	Mean	Median	Std. Dev	P-25	P-75	N
Age	37.55	36.00	14.46	26.00	48.00	6,004
Monthly income	216.32	160.11	244.45	58.60	278.03	6,004
Schooling (years)	10.79	11.00	3.86	9.00	14.00	6,004
Men	0.54	1.00	0.50	0.00	1.00	6,004
Contribute to Social Security	0.20	0.00	0.40	0.00	0.00	6,004

Note: monetary variables are reported in $USD considering an exchange rate of 0.315 USD/ PEN (sol).

Individuals are on average 37 years old, their monthly income is the equivalent of $216.32 USD and have 10.8 years of schooling. 54% of them are men and only 20% report to contribute to social security, which is often used as an indicator of informality. In Table 5 we report the distribution of sectors among the workers in the sample. Comparing the distribution of the workforce across sectors of economic activity with that of establishments reported in Table 1, we note that commerce, restaurants and hotels, manufacturing, and services, are the most prevalent sectors.

Table 5: Distribution of sector of activity (ENAHO)

	N	Percentage
Commerce, restarutans, hotels	1,654	29.32
Construction	335	5.94
Elecricity, gas, water	11	0.19
Financial sector	60	1.06
Fishing	438	7.76
Manufacturing	865	15.33
Mining	29	0.51
Services	1,735	30.75
Transportation and storage	515	9.13

The definition of informality that we follow in this work is that of economic activities that are legal but that are not regulated or taxed by the corresponding authorities. As such, we define an employee to be in an informal labor relationship if she does not have a written contract guaranteeing the benefits and responsibilities established in the labor code. For self-employed and employers, ENAHO asks the question of whether or not their main occupation is in the informal sector or not. Non-remunerated workers are considered by definition as informal workers and we consider workers who report "other" occupational category to be informal if they have no contract. We report the distribution of informal workers in each occupational category according to this definition in Table 6.

Table 6: Distribution of occupational categories and informality (ENAHO)

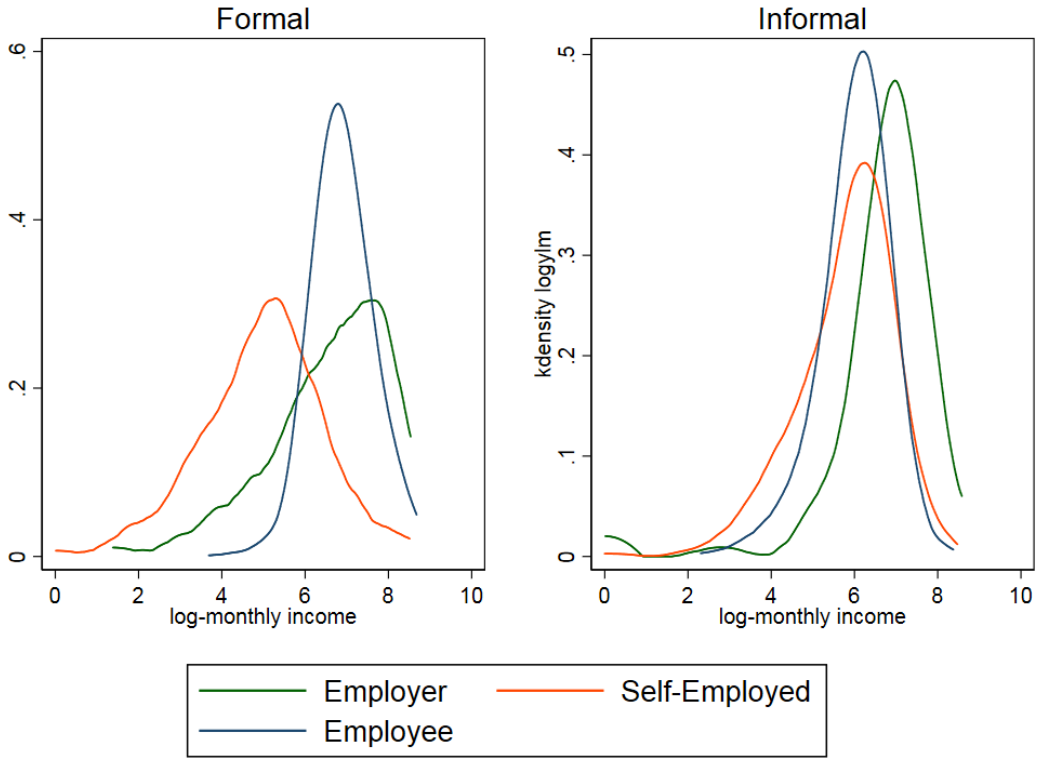
	Number of individuals	% in labor force	% who are informal
Employee	3,354	59.38	53.46
Employer	328	5.81	75.91
Non-remunerated	356	6.30	100.00
Other	8	0.14	100.00
Self-employed	1,602	28.36	92.38
Total	5648	100.00	68.76

We observe that most individuals are employees and approximately half of them are informal. Self-employed is the next category in terms of proportion of individuals work-

ing in such a way, corresponding to 28% of which 92% are informal. Out of the 5.86% of individuals who are employers, 76% are informal and individuals who report "other" occupational category are informal.

We report the distribution of wages in Figure 2 and Tables 7 and 8. Within formal workers, employers are the best remunerated, followed by employees. Self-employed workers in the formal sector earn about one fourth of what employers earn. For informal workers, employers are still the highest payed but employees and self-employed earn about the same. It is important to recall that the number of formal self-employed workers is relatively small.

Figure 2: Distribution of earnings



Note: density estimates using Epanechnikov kernel, bandwidth=0.5.

Table 7: Monthly earnings - Formal workers

	Employees	Employers	Self-employed
Mean	388.01	443.33	115.62
SD	297.76	426.51	213.70

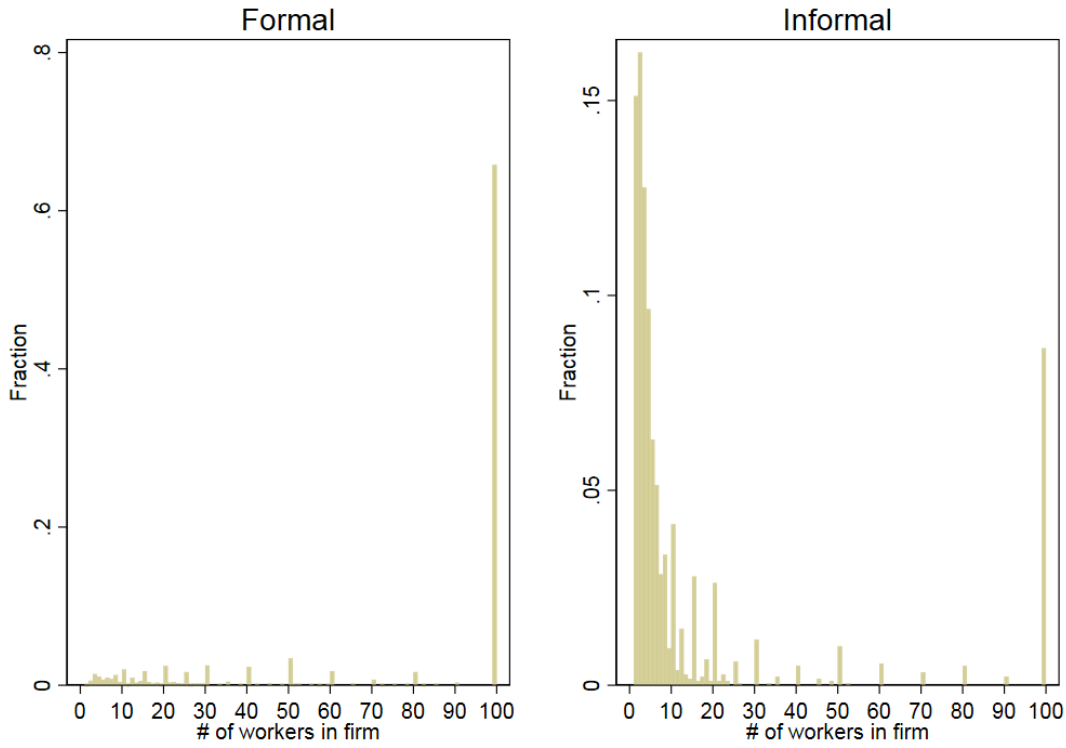
Table 8: Monthly earnings - Informal workers

	Employees	Employers	Self-employed
Mean	168.66	391.79	169.88
SD	131.80	316.68	173.19

Finally, we note that among employees, informality is correlated with firm size. Most informal workers are concentrated in small firms whereas the distribution is more spread

for formal workers. In figure we show how informal and formal workers are distributed across firm size.

Figure 3: Distribution of informal workers and establishment size

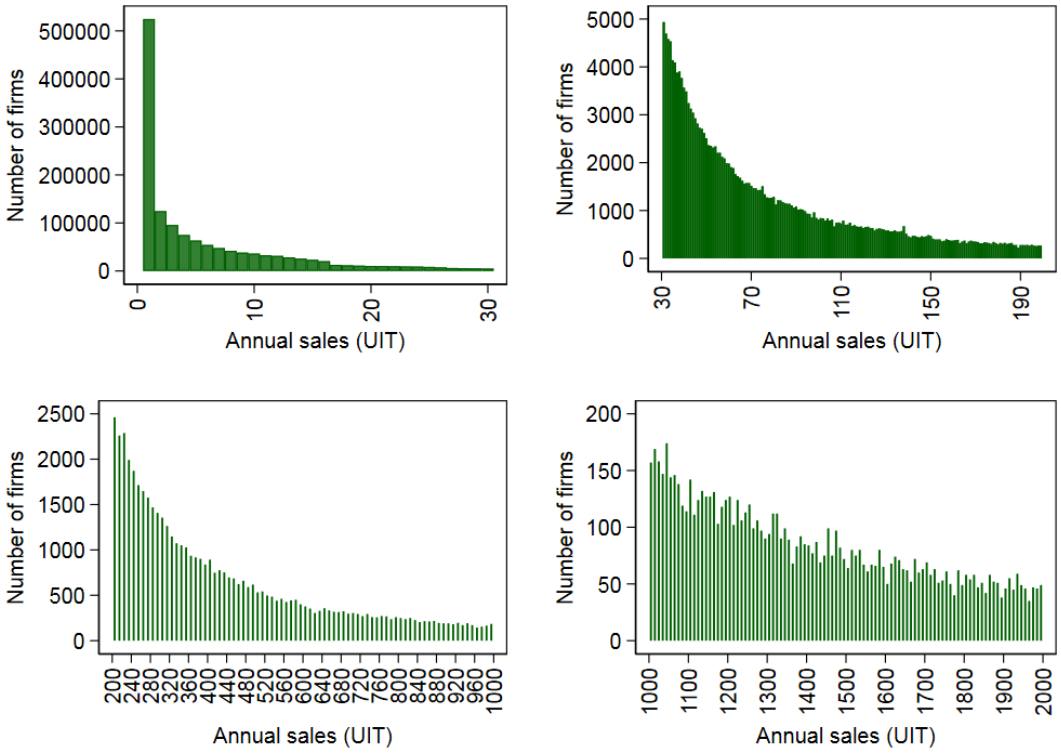


2.3 SUNAT dataset

The information provided by SUNAT includes distribution of monthly sales for all establishments, profits, number of workers, and workforce expenditure. In Figure 4 we report the distribution of firms by the volume of their annual sales in 2014, in UIT units[6].

[6]SUNAT uses UIT units as a measure of reference. In 2014 1 UIT=3,800 Sol=$1,177 USD.

Figure 4: Distribution of firms by annual sales

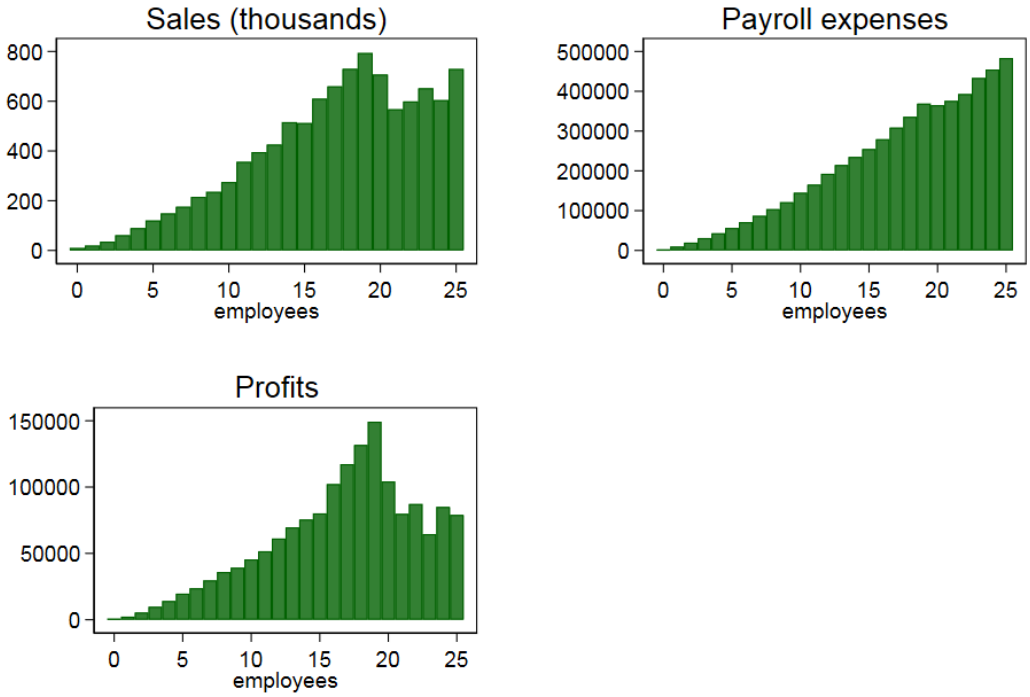


Note: 1 UIT=3,800 Sol=$1,177 USD.

This distribution only includes formal firms. However, even in the formal sector, most firms are small: 524,661 firms report sales of less than $1,177 USD, out of a total of 1,647,529.

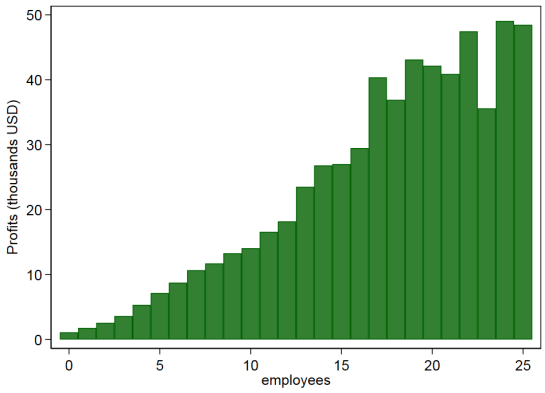
In Figure 5 we report median sales, payroll expenses, and profits, for 2014, depending on the number of employees a firm reports to have. We observe an increasing trend in the three series but we notice a discontinuity in sales and profits around twenty workers. In Peru, firms with more than twenty workers are subject to a regime in which they have to distribute a proportion of their profits with their workers. The proportion depends on the economic sector of activity for each firm. For firms in communications and manufacturing this figure corresponds to 10% of their after-tax profits, 8% for mining, services, restaurants and hotels and 5% for the remaining sectors. We argue that such regulation generates an incentive for firms to misreport their profits might explain the discontinuity observed in both, sales and profits to avoid their tax burden as there are no technological reasons why we should observe such a pattern in these series.

Figure 5: Median annual sales, profits, and payroll (USD)



In Figure 6 we report the median profits for establishments according to the number of employees. Note that the discontinuity observed in Figure 5 is not present in the reports of the Economic Census.

Figure 6: Median profits (USD) in the Economic Census



2.4 Corporate tax regimes in Peru

In 2007, firms payed corporate income taxes according to one of the three tax regimes existing at the moment. These regimes are RUS[7], RER[8], and the general regime for corporate income tax. RUS is designed for natural persons with entrepreneurial activities.

[7]"Régimen único simplificado" in Spanish, which translates to "unique simplified regime"
[8]"Régimen Especial de Impuesto de renta" which translates to "Special corporate income tax rate"

Eligibility into this regime requires having monthly income under 30,000 soles, value of assets of less than 70,000 soles, and having all operations of the business in one location at most, among others[9]. Under this regime, the corporate income tax and the value added tax is replaced by a monthly quota determined by the monthly income of the business as described in Table 9. Moreover, businesses are exempt from paying value added taxes which had a rate of 19% in 2007, and are not required to have updated financial ledgers[10].

Table 9: RUS tax scheme

Category	Monthly income (Soles)	Monthly payments (Soles)
1	5,000	20
2	8,000	500
3	13,000	200
4	20,000	400
5	30,000	600

As the RUS, the RER is a tax regime designed to small businesses. However, RER is targeted exclusively to legal entities as well as legal persons. To be eligible in the RER, a business should have net annual income of no more than S/. 360,000[11], the total value of the assets should be under S/. 87,500 and the total amount of annual purchases, excluding acquisition of fixed assets, should also be under S/. 360,000. As in the case of the RUS, the RER also excludes some economic activities[12].

Businesses registered under the RER scheme are required to pay value added tax, and to keep updated financial ledgers. Under this regime, the tax on profits is substituted by a tax on net income of the business. Businesses operating in the service sector pay 2.5% of their monthly net income and the corresponding rate for businesses operating in commerce or industry is of 1.5%.

All businesses not eligible for either the RUS or the RER scheme, are subject to the regulation of the general regime of taxation. Businesses registered in the general regime are required to pay 30% of their profits at the end of the year. We summarize the tax regimes with its corresponding obligations and requirements in Table 10.

Monthly tax obligation for businesses

$$\text{Taxes} = \begin{cases} 20S/. \text{ if total income} \leq 5,000S/. \\ 50S/. \text{ if total income} \leq 8,000S/. \\ 200S/. \text{ if total income} \leq 13,000S/. \\ 400S/. \text{ if total income} \leq 20,000S/. \\ 600S/. \text{ if total income} \leq 30,000S/. \\ 1.5-2.5\% \text{ of total income, depending on sector, if total income} \leq 30,000S/. \\ 30\% \text{ of profits if total income} > S/.30,000 \\ 35\%-40\% \text{ of profits if total income} > S/.30,000 \text{ and more than 20 workers} \end{cases} \tag{1}$$

[9] activities such as transportation, gambling, finance, travel agencies, real estate, or commercialization of oil and hydrocarbon are excluded from the RUS. Businesses who export part of their merchandise are also not eligible to pay taxes according to this regime.

[10] In addition to the categories mentioned in Table **??** there is a special category called "Nuevo RUS" (New RUS) directed to agricultural businesses with annual income under 60,000 S/. As we do not consider the agricultural sector in the analysis we do not go much into the detail of this category.

[11] net annual income is equal to gross annual income less discounts, returns, or other similar practices done by businesses.

[12] Construction, transportation, finance, gambling, travel agencies, real estate, judiciary services, accounting, architecture, and business consulting are all excluded from the RER. Doctors, dentists, and veterinarians are also ineligible.

Table 10: Tax regimes in Peru

Tax regime	Main Eligibility requirements	Tax obligations
RUS	Natural persons Monthly gross income under S/. 30,000	Monthly payments of up to S/.600 No VAT obligations
RER	Annual net income under S/. 360,000 No more than S/. 87,500 in assets	Tax rate of 1.5% to 2.5% on net income VAT rate of 19%
General Regime		Corporate profit tax rate of 30% VAT rate of 19%

Average non-wage cost of salaried labor as % of net wages of formal salaried workers in Peru represents 68%. This is decomposed into 31% to mandatory contributions, 16% bonus, 8% of annual leave and 12% of severance payment.

3 Model

We analyze a static economy that captures the basic entrepreneurial choice model and analyzes optimal taxes in such a setting. We study distortions to the entry margin into entrepreneurship as well as taxes on payroll, labor income and corporate income.

3.1 Primitives

The economy consists of a continuum of individuals and a government. Individuals can do one of two things, become an entrepreneur or work for a wage. If they decide to work for a wage they also need to decide the distribution of time between the formal and informal sector. Entrepreneurs (firms) can choose to hire formal or informal workers, for which they do not pay payroll taxes. Additionally, they can chose to misreport their profits to avoid taxes. Individuals are heterogeneous with respect to how productive they are in each activity. In particular, each individual is identified by a pair $\theta = (\theta_w, \theta_e)$ where θ_w denotes productivity in the labor market and θ_e is entrepreneurial productivity and in each sector s we assume $\theta_s \in \left[\underline{\theta_s}, \bar{\theta_s}\right]$.

Upon becoming a worker of skill θ_w, an individual decides how much time to allocate to informal work l_i and how much time to spend in the formal labor market l_f subject to the time constraint $l_f + l_i = 1$. w_s denotes the wage rate in the sector $s \in \{i, f\}$. A worker of skill θ_w provides $l_s\theta_w$ effective units of work in sector s. Income in each sector is given by $\theta_w l_s w_s$. Individuals pay taxes according to the function $T(w_f\theta_w l_f)$, which can be negative to denote a transfer from the government.

The transfer function $T(.)$ depends exclusively on the income from the formal market. We assume that income from the informal market is not observed by the tax authority. For this reason, individuals might decide to provide labor supply in the informal labor market to manipulate the transfer function in their benefit. However, participating in the informal market is increasingly costly and this is denoted by a utility penalty $\frac{\kappa(l_i)^{1+\rho}}{1+\rho}$. This penalty incorporates the fact that it is costly to supply labor in the informal sector either because it becomes increasingly harder to hide large amounts of income or because individuals are excluded from the benefits of the formal labor market such as access to health insurance, unemployment benefits, and pensions, among others.

Entrepreneurs, characterized by skill θ_e, can produce $y = \theta_e q(n)$. n is the total number of effective workers hired and we assume that informal and formal workers are perfect substitutes in the production function: $n = n_i + n_f$.

Entrepreneurs pay payroll taxes on the value of their formal payroll. Payroll taxes are given by a function $T_n(n_f w_f)$. Informal hires are not observed by the authorities, and hence does not comply with regulations. However, entrepreneurs face a cost $k_p(n_i)$ when hiring informal workers. In line with Ulyssea (2017) and Meghir et al. (2015), we interpret this cost to be an expected penalty and we assume it to be increasing and convex. We also assume that monitoring informal activity is costly for the government. To simplify matters, we will start by assuming that the enforcement agency breaks even: the cost of monitoring is equal to the revenue raised by the fines and forfeits. This assumption will be relaxed later on. We will use the parametric function $k_p(n_i) = \frac{\delta}{1+\gamma} n_i^{1+\gamma}$.

In addition to payroll taxes, the government can raise funds by levying a corporate profit tax (T_c), payed on the operating profits of firms. As for payroll taxes, we allow the function $T_c(.)$ to take arbitrary forms, as long as it only depends on operating profits. Motivated by the empirical evidence provided in section 2, we allow entrepreneurs to underreport operating profits by an amount (z). Underreporting profits is also costly and we assume an increasing and convex cost denoted by $k_c(z) = \frac{\beta}{1+\sigma} z^{1+\sigma}$.

The government has a third option to raise revenue: personal income taxes. Following the mirleessian tradition, personal income taxes depend on formal income $\theta_w l$ but cannot depend separately on ability θ_f or effort l_f. Henceforth, the (unrestricted) personal income tax function will be denoted $T_p(.)$

We denote by $i \in \{0, 1\}$, an individual's decision about entry into entrepreneurship where $i = 1$ represents entry into entrepreneurship.

The role government is to raise taxes in order to pay for transfers, trading off efficiency and redistribution motives, but subject to information frictions.

An allocation in this economy is described by specifying consumption, as well as entrepreneurial choice, hours worked in case of becoming a worker, and formal and informal labor hired by entrepreneurs given by

$$\{c(\theta), i(\theta), l_f(\theta), l_i(\theta), n_f(\theta), n_i(\theta), z(\theta)\}_{\theta \in \Theta}$$

An allocation is said to be feasible if it satisfies:

$$\int_\Theta c(\theta)\, dF(\theta) = \int_\Theta \left\{ \left[\theta_e q\left(n(\theta_e)\right) - k_n\big(n_i(\theta_e)\big) - k_c\big(z(\theta_e)\big)\right] i(\theta) - k_l\big(l_i(\theta_w)\big)(1 - i(\theta)) \right\} dF(\theta) \tag{2a}$$

$$\int_\Theta n_f(\theta_e) i(\theta)\, dF(\theta) = \int_\Theta \theta_w l_f(\theta)\,(1 - i(\theta))\, dF(\theta) \tag{2b}$$

$$\int_\Theta n_i(\theta_e) i(\theta)\, dF(\theta) = \int_\Theta \theta_w l_i(\theta)\,(1 - i(\theta))\, dF(\theta) \tag{2c}$$

The first equation states that all the output -net of the efficiency costs resulting from non-compliance- is consumed. The second equation is the formal labor market clearing condition. And the third equation is the informal labor market clearing condition. Notice the composition of workers is irrelevant for production by entrepreneurs. In other words, entrepreneurs are assumed to be hiring a representative population of workers, and workers choose to take formal or informal jobs.

3.2 Equilibrium with Taxes

In this section we describe the competitive equilibrium, taking tax functions as given. Later in section 3.3, we will solve for the optimal tax functions given a social welfare function. There are only two commodities in the economy, namely consumption good and units of effective labor. We use w to denote the price of an effective unit of labor in terms of consumption good.

Entrepreneurs

We define the operating profits of an entrepreneurial firm, $\pi(\theta_e, n_i, n_f)$, as production production $\theta_e (n_i + n_f)^\alpha$ net of payroll $w(n_i + n_f)$ and payroll taxes $T_n(n_f)$

$$\pi(\theta_e, n_i, n_f) = \theta_e (n_i + n_f)^\alpha - w_i n_i - w_f n_f - T_n(n_f)$$

Entrepreneurs choose the number of formal workers to hire n_f, the number of informal workers to hire n_i, and how much of its profits to hide, in order to maximize her benefits.

The benefits of an entrepreneur of ability θ_e are described in equation 3,

$$\begin{aligned}\Pi(\theta_e) = \max_{n_f, n_i, z} \; & \theta_e (n_i + n_f)^\alpha - w_i n_i - w_f n_f - T_n(n_f) \\ & - T_c\big(\theta (n_i + n_f)^\alpha - w_i n_i - w_f n_f - T_n(n_f) - z\big) \\ & - \frac{\delta}{1+\gamma} n_i^{1+\gamma} - \frac{\beta}{1+\sigma} z^{1+\sigma} \end{aligned} \tag{3}$$

The first line of equation 3 displays operating profits. The second line shows corporate income taxes. Note that the base of the tax is the operating profit net of under-reporting. The third line, represents the costs of not complying with regulations. The term $\frac{\delta}{1+\gamma} n_i^{1+\gamma}$ is the cost of deviating workers to the informal sector, and the term $\frac{\beta}{1+\sigma} z^{1+\sigma}$ is the cost of underreporting profits.

The optimality conditions characterizing the solution of problem 3 are the following,

$$(\theta_e(n_i + n_f)^\alpha - w)\left(1 - T_c'(\pi(\theta_e, n_i, n_f) - z)\right) = \delta n_i^\gamma \tag{4}$$

$$\left(\theta_e(n_i + n_f)^\alpha - w - T_p'(n_f)\right)\left(1 - T_c'(\pi(\theta_e, n_i, n_f) - z)\right) = 0 \tag{5}$$

$$T_c'(\pi(\theta_e, n_i, n_f) - z) = \beta z^\sigma \tag{6}$$

Equation 4 equates the marginal cost of an effective hour of informal labor with its marginal benefit. Equation 5 is the analog for the formal sector. Taken together, the two equation imply that the benefit of hiring a worker informally instead of formally -that is, the net savings in payroll taxes-, is equal to the marginal increase in the expected penalty of hiring informal workers. Equation 6 says that optimal under-reporting occurs when the marginal savings in corporate taxes are equal to the marginal change in the corresponding expected penalty.

To gain some intuition about firm behavior, we consider the special (but empirically common) case of constant marginal tax rates. If we assume that corporate taxes are not confiscatory ($T_c < 1$), the firm size is given by,

$$n_i + n_f = \left(\frac{\alpha \theta_e}{w + T_n}\right)^{\frac{1}{1-\alpha}} \tag{7}$$

That is, firm size is increasing in managerial ability. Also notice that in this special case,

$$n_i = \left(\frac{1}{\delta} T_n'(1 - T_c')\right)^{\frac{1}{\gamma}} \tag{8}$$

With flat taxes, firms would hire a constant number of informal workers, that would be zero in the absence of payroll taxes.

The two observations above, imply that the fraction of informal workers is decreasing in firms size, and that very small firms do not hire formal workers. This is in accordance with the empirical evidence described in section 2.

Last, when taxes are flat, evasion is given by,

$$z = \left(\frac{T_c}{\beta}\right)^{\frac{1}{\sigma}} \tag{9}$$

The equation above says that firms hide a constant amount of their profits, that would be zero in the absence of corporate taxes. As size and profits are increasing in ability, very small firms do not report any profits, consistent with the data from the Economic Census.

Workers

The workers' problem takes the following form,

$$V(\theta_w \mid w_f, w_l) = \max_{l_f, l_i} \theta_w \left(w_f l_f + w_i l_i\right) - \frac{\kappa \left(l_i\right)^{1+\rho}}{1+\rho} - T\left(\theta_w w_f l_f\right) \tag{10}$$

subject to $l_i + l_f = 1$ and $l_s \geq 0$ for $s = i, f$. We assume non-confiscatory taxes. That is, $T'() < 1$ at every point. A worker will supply a positive amount of labor in the informal market $l_i \in [0, 1]$ up to the point where the optimality condition holds:

$$\theta_w w_i - \kappa l_i^{\rho} = 0 \tag{11}$$

Equation 11 is the standard condition equalizing the marginal benefit of working, which in our quasi-linear environment is labor market income from the informal sector, with the marginal dis-utility of working. For the case of constant marginal tax-transfer rates[13], equation 11 implies that hours worked are monotonically increasing in ability.

Definition of Equilibrium

An equilibrium with taxes consist of an allocation and a wage w such that

- $i(\theta) = 1$ whenever $\Pi(\theta_e) > W(\theta_w)$
- If $i(\theta) = 1$, the allocation for θ solves problem 3, given taxes and prices.
- If $i(\theta) = 0$, the allocation for θ solves problem 10, given taxes and prices.
- The allocation is feasible.
- The government budget is balanced,

$$\int_{\Theta} \left\{ \Big(T_c\big(\pi(\theta_e)\big) + T_n\big(w n_f(\theta_e)\big) \Big) i(\theta) + T_p\big(w \theta_w l\left(\theta\right)\big)\left(1 - i\left(\theta\right)\right) \right\} dF\left(\theta\right) \tag{12}$$

3.3 Planner's Problem

In the discussion above, we introduced corporate, payroll and labor income taxes as arbitrary functions of profits, formal payroll and labor income respectively. Our key assumption about the information structure is that individuals privately observe their productivity θ vector and also privately decide about how much to work (in case they become a worker) or how much to hire (in case they become an entrepreneur). We assume that the choice

[13] Bhandari, Evans, Golosov, and Sargent (2013) show that a constant marginal tax-transfer function is a good approximation for the case of the United States.

to become an entrepreneur or a worker is observable to the planner and thus the taxation authority can taylor the tax code accordingly.

As is standard in the optimal taxation literature, we will solve the dual problem. The planner will choose an allocation facing the same informational constraints as the tax authority in the decentralized equilibrium. The planner will choose the allocation that maximize some notion of social welfare, by taking into account the physical constraints and the incentive compatibility conditions associated with such allocations. Finally, an optimal tax policy will be backed out from the chosen allocations.

Implementable allocations

Recall an allocation in this economy is described by specifying consumption, as well as entrepreneurial choice, in case of becoming a worker hours worked in the formal and informal market, and formal and informal labor hired by entrepreneurs:

$$\{c(\theta), i(\theta), l_f(\theta), l_i(\theta), n_f(\theta), n_i(\theta), z(\theta)\}_{\theta\in\Theta}$$

To state the dual planner's problem, we need to restrict the available allocations the planner can choose from. In addition to the feasibility conditions, we call an allocation *implementable* if there exist payroll, corporate and personal income tax functions $T_n(\cdot), T_c(\cdot)$ and $T_p(\cdot)$ and wages w_f, w_i such that the allocation toghether with those tax functions and wages are a tax equilibrium.

The planner's proposed allocation constitutes a direct mechanism for the agent. For that mechanism to be incentive compatible, it requires that every agents weakly prefers the corresponding allocation assigned to his/her type θ over the allocations available *for other* types $\theta \in \Theta$. However the agent must keep in mind that when pretending to be a different type, he/she has to be consistent with the choices *observable* for the planner: effective hours in the formal labor market and *declared* sales.

When an agent of type θ pretends to be of type θ' he/she must adjust his/her choices. If the planner assigned type θ' to be a worker, this is $i(\theta') = 0$, then the agent must provide $\frac{\theta'_w}{\theta_w} l_f(\theta')$ hours, to satisfy the planner's effective hours demand. On the other hand, if the planner assigned type θ' to be an entrepreneur, choices are still constrained but there is more freedom. The agent is forced to use $n_f(\theta')$ hours of formal workers, but is free to hire any amount of informal hours as long as he/she *declares* the expected amount of sales by the planner, which is $\theta'\big(n_f(\theta') + n_i(\theta')\big)^\alpha - z(\theta')$. Hence, if the choice of informal hours is $\check{n}_i$ the corresponding choice of profit hiding is:

$$\check{z}(\check{n}_i, \theta'; \theta) = z(\theta') - y(\theta') + \theta\big(n_f(\theta') + \check{n}_i\big)^\alpha, \tag{13}$$

where $y(\theta') = \theta'\big(n_f(\theta') + n_i(\theta')\big)^\alpha$. Recall the agent always has access to the informal labor market. The problem for a type θ agent pretending to be an entrepreneur of type θ' is:

$$\check{\Pi}(\theta'; \theta) = \max_{\check{n}_i} \theta\big(n_f(\theta') + \check{n}_i\big)^\alpha - w_i\check{n}_i - \frac{\delta\check{n}_i^{1+\gamma}}{1+\gamma} - \beta\frac{\check{z}(\check{n}_i, \theta'; \theta)^{1+\sigma}}{1+\sigma} \tag{14}$$

A direct mechanism defines an utility allocation for each agent of type θ:

$$U(\theta) = c(\theta) - \big(1 - i(\theta)\big)\frac{\kappa l_i(\theta)^{1+\rho}}{1+\rho}.$$

Hence an allocation is incentive compatible if $\forall\theta, \theta' \in \Theta$

$$U(\theta) \geq c(\theta') - \big(1 - i(\theta')\big)\left(w_i\big(\theta'_w l_i(\theta'_w) - \theta_w l_i(\theta_w)\big) + \frac{\kappa}{1+\rho}\left(1 - \frac{\theta'_w}{\theta_w}\big(1 - l_i(\theta')\big)\right)^{1+\rho}\right)$$
$$+ i(\theta')\left[\check{\Pi}(\theta'; \theta) - y(\theta') + w_i n_i(\theta') + \frac{\delta n_i(\theta')^{1+\gamma}}{1+\gamma} + \beta\frac{z(\theta')^{1+\sigma}}{1+\sigma}\right], \tag{15}$$

where the last term contains the extra consumption obtained from operating at a different scale and input mix from the planner's suggested one.

We assume that the government's objective is given by

$$\int_{\Theta} W\big(U(\theta)\big) f(\theta) d\theta \tag{16}$$

where $W(\cdot)$ is an increasing and concave function and $U(\theta)$ is the utility of an individual of type θ defined above. A special case that gives us analytical tractability is the Rawlsian objective given by

$$\min_{\theta \in \Theta} U(\theta)$$

An allocation is said to be constrained efficient if it maximizes (16) while satisfying (15) and (2).

Simplifications. In order to simplify the optimization problem involving the efficient allocation, we make fourth observations: First, if two individuals have the same labor productivity and the allocations prescribes them that they become worker, incentive compatibility implies that they should receive the same utility. The same holds for entrepreneurs. It can also be inferred that all the workers with the same productivity and all entrepreneurs with the same productivity must have the same allocation. Thus we can define allocation in terms of the occupational choice $\{c_w(\theta_w), l_f(\theta_w), c_e(\theta_e), n_f(\theta_e), n_i(\theta_e), z(\theta_e), i(\theta)\}$ together with the utility profiles $\{U_e(\theta_e), U_w(\theta_e)\}$. We can thus write the incentive constraints as

$$\begin{aligned}
U_e(\theta_e) &\geq c_e(\theta'_e) + \left(\check{\Pi}(\theta'_e, \theta_e) - y(\theta'_e) + w_i n_i(\theta'_e) + \frac{\delta n_i(\theta'_e)^{1+\gamma}}{1+\gamma} + \frac{\beta z(\theta'_e)^{1+\sigma}}{1+\sigma}\right), i(\theta) = i(\theta') = 1 \\
U_e(\theta_e) &\geq c_w(\theta'_w) - \left(w_i(\theta'_w - \theta_w) + \frac{\kappa}{1+\rho}\left(1 - \frac{\theta'_w}{\theta_w}\big(1 - l_i(\theta')\big)\right)^{1+\rho}\right), i(\theta) = 1, i(\theta') = 0 \\
U_w(\theta_w) &\geq c_w(\theta'_w) - \left(w_i(\theta'_w - \theta_w) + \frac{\kappa}{1+\rho}\left(1 - \frac{\theta'_w}{\theta_w}\big(1 - l_i(\theta')\big)\right)^{1+\rho}\right), i(\theta) = i(\theta') = 0 \\
U_w(\theta_w) &\geq c_e(\theta'_e) + \left(\check{\Pi}(\theta'_e, \theta_e) - y(\theta'_e) + w_i n_i(\theta'_e) + \frac{\delta n_i(\theta'_e)^{1+\gamma}}{1+\gamma} + \frac{\beta z(\theta'_e)^{1+\sigma}}{1+\sigma}\right), i(\theta) = 0, i(\theta') = 1
\end{aligned}$$

Second, we can characterize the set of entrepreneurs by a cutoff $\theta_e^*(\theta_w)$ where

$$i(\theta) = \begin{cases} 1 & \theta_e \geq \theta_e^*(\theta_w) \\ 0 & \theta_e < \theta_e^*(\theta_w) \end{cases} \tag{17}$$

In words, for a given level of labor productivity, all the agents whose entrepreneurial productivity is high enough become workers and vice versa. We leave a formal proof of this result to Appendix.

Third, in any incentive compatible allocation $n_f(\theta_e)$, $z(\theta_e)$ and $n_i(\theta_e)$ must satisfy,

$$\alpha \theta_e \left(n_f(\theta_e) + n_i(\theta_e)\right)^{\alpha - 1} = w_i + \delta n_i(\theta_e)^{\gamma} + \beta z(\theta_e)^{\sigma} \tag{18}$$

Fourth and finally, we can replace the set of incentive constraint by their local counterparts which in turn greatly simplifies our analysis. These local incentive constraints in their envelope form are given by

$$U_e(\theta_e) = U(\underline{\theta}) + \int_{\underline{\theta}_e}^{\theta_e} \left(n_f(s) + n_i(s)\right)^{\alpha} \left[1 - \beta z(s)^{\sigma}\right] ds \tag{19}$$

$$U_w(\theta_w) = U(\underline{\theta}) + \int_{\underline{\theta}_w}^{\theta_w} \left(w_i + \kappa\big(1 - l_f(s)\big)^{\rho} \frac{l_f(s)}{s}\right) ds \tag{20}$$

together with

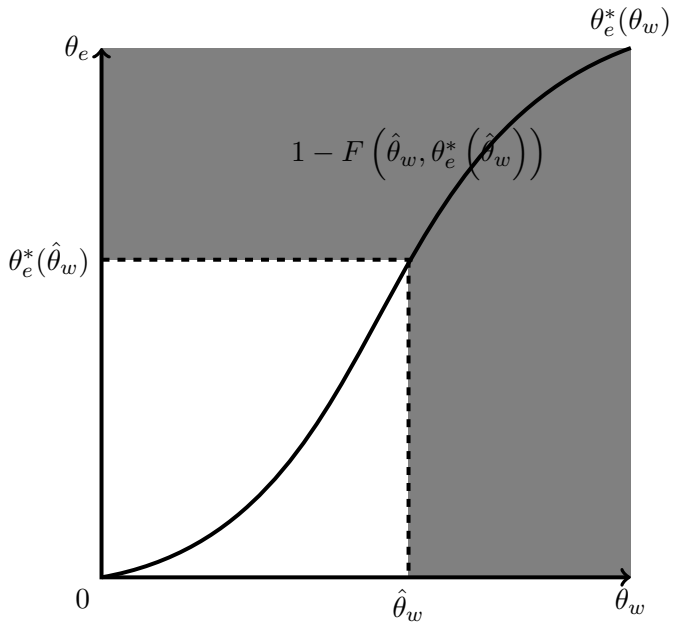
$$U_e\left(\theta_e^*\left(\theta_w\right)\right) = U_w\left(\theta_w\right), \forall \theta_w. \tag{21}$$

While the restriction to local incentive constraints are without loss of generality. In the appendix, we provide conditions on fundamentals that will lead to their sufficiency. Furthermore, later in our dynamic model, we use a numerical verification method to verify the validity of this approach.

Figure 7 below summarizes the results stated above. The occupational choice is characterized by the increasing function $\theta_e^*\left(\theta_w\right)$. The iso-utility curves are shown as well. Note that given $\theta_e^*\left(\theta_w\right)$, the distribution of workers and entrepreneurs are pinned down and our problem becomes a simple optimal taxation problem given these distributions. In turn, the optimal allocations among workers and entrepreneurs lead to a occupational choice frontier $\hat{\theta}_e\left(\theta_w\right)$. The planning problem, thus, can be thought of as a fixed point of this transformation.

In what follows, we describe in more detail the critical properties of the occupational choice frontier as well as its implication for optimal taxes.

Figure 7: Occupational choice



3.4 Rawlsian Planner

4 Calibration

5 Conclusion

In this paper, we develop a theory of optimal taxation in an economy with an informal sector. An important challenge in any empirical work regarding informality is the data, since by definition informal activities are not observed by the authorities. We overcome this

limitation by combining multiple sources of information including the Economic Census of Peru, administrative tax records from tax authorities, and a nationally representative household survey, to obtain a unique characterization of the informal economy in Peru.

We incorporate the main empirical features that we observe in the data, in a general equilibrium model with informality. In our model, entrepreneurs hire formal and informal workers and do not pay payroll taxes on their informal workforce. On the other hand, workers do not pay taxes on their income generated in the informal economy. We consider an additional dimension of informality acknowledging the fact that entrepreneurs can hide part of their production to avoid corporate taxes.

The calibration exercise allows us to discipline the parameters of the model. We replicate the main features of the economy in Peru and are able to quantify the welfare gains from imposing an optimal tax scheme in this economy.

6 Appendix 1. Model solution with constant marginal tax rates

The solution to the entrepreneur problem when marginal tax rates are constant is given by equations 7 - 9:

$$n_i + n_f = \frac{\alpha\theta_e}{w_f + T_p'}$$

$$n_i = \left(\frac{T_n'(1 - T_c')}{\delta}\right)^{\frac{1}{\gamma}}$$

$$z = \left(\frac{T_c'}{\beta}\right)^{1/\sigma}$$

And thus, plugging these equations into 3 we obtain an expression for $\Pi(\theta_e; w_f, w_i)$.

The solution to the problem of the worker is given by:

$$l_i = \min\{\left(\frac{\theta_w w_i}{\kappa}\right)^{\frac{1}{\rho}}, 1\} \tag{22}$$

$$l_f = 1 - \min\{\left(\frac{\theta_w w_i}{\kappa}\right)^{\frac{1}{\rho}}, 1\} \tag{23}$$

And the value of the problem is given by plugging these equations into 10 to obtain $V(\theta_w; w_f, w_i)$.

Entrepreneurial decision is given by

$$i(\theta_e, \theta_w; w_i, w_f) = \mathbb{1}\{\Pi(\theta_e; w_f, w_i) > V(\theta_w; w_f, w_i)\} \tag{24}$$

Wages are found by the market clearing conditions

$$\int_\Theta n_i(\theta_e) i(\theta_e, \theta_w; w_f, w_i) dF(\Theta) = \int_\Theta \theta_w l_i(\theta_w, w_i)(1 - i(\theta_e, \theta_w; w_i, w_f)) dF(\Theta) \tag{25}$$

$$\int_\Theta n_f(\theta_e) i(\theta_e, \theta_w; w_f, w_i) dF(\Theta) = \int_\Theta \theta_w l_f(\theta_w, w_i)(1 - i(\theta_e, \theta_w; w_i, w_f)) dF(\Theta) \tag{26}$$

References

Bhandari, A., Evans, D., Golosov, M., & Sargent, T. J. (2013). *Taxes, debts, and redistributions with aggregate shocks* (Tech. Rep.). National Bureau of Economic Research.

Gomez, E. (2016). Latin america's informal economy. *Briefing*(589.783).

Levy, S. (2010). *Good intentions, bad outcomes: Social policy, informality, and economic growth in mexico*. Brookings Institution Press.

Meghir, C., Narita, R., & Robin, J.-M. (2015). Wages and informality in developing countries. *American Economic Review*, *105*(4), 1509–46.

Mirrlees, J. A. (1971). An exploration in the theory of optimum income taxation. *The Review of Economic Studies*, *38*(2), 175-208.

Perry, G. (2007). *Informality: Exit and exclusion*. World Bank Publications.

Ramsey, F. (1927). A contribution to the theory of taxation. *The Economic Journal*, *37*(145), 47-61.

Stantcheva, S. (2017). Optimal taxation and human capital policies over the life cycle. *Journal of Political Economy*, *125*(6).

Ulyssea, G. (2017). Firms, informality and development: Theory and evidence from brazil.