The Effects of Economic Distortions on Firm Dynamics

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Abstract

On the one hand, the misallocation literature has mainly analyzed the effect of distortions on output and productivity. On the other hand, since Hsieh and Klenow (2014), a discussion about why firm dynamics over life cycle differ across countries emerges in the literature. On the basis of these two ideas, this paper examines the role of economic distortions on firm dynamics for a broad set of countries. For that, the Enterprise Surveys of the World Bank 2006-2017 are used. We find several countries for which there is a clear negative relationship between the evolution of how economic distortions are perceived by firms over time and the average employment profile. We then construct a model capturing the effect of economic distortions on firms life cycle. The model suggests that higher distortions over time lead to a reduction in employment profile ratio and to a higher share of small firms.

Keywords: Average Employment, ESWB, Economic Distortions, Life Cycle

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Contents

1 Introduction

The misallocation literature has mostly focused on analyzing the effect of economic distortions on average firm size, aggregate output and productivity, e.g. Restuccia and Rogerson (2008), Hsieh and Klenow (2009), and Bah and Fang (2015). In this paper, we broaden this scope by studying the effect that economic distortions have on firms employment profile over their life cycle. Our research is motivated by the empirical literature that observes sizeable differences across countries on firm dynamics. We examine the role of economic distortions on firms life cycle for a broad set of countries. In particular, we study whether there is any relationship between the evolution of how economic distortions are perceived by firms over their life cycle and the average employment profile shown by the firm.

Hence, we address two questions in this paper: (i) Are the different types of obstacles perceived differently by firms of different ages?, and (ii) Do they have any effect on firm dynamics? We compute firm growth in terms of employment levels over time for a large number of countries using the Enterprise Surveys of the World Bank 2006-2017 (hereinafter referred to as ESWB). They are a collection of establishment-level data[1] and the dataset contains standardized information about employment. Besides, the ESWB gather information regarding the business environment. This dataset has several advantages. First, the surveys use standardized survey instruments and a uniform sampling methodology to minimize measurement error and to yield data that are comparable across countries (World Bank's Enterprise Survey, "Understanding the Sampling Methodology"). Second, the questionnaire is implemented across all geographic regions and cover small, medium, and large companies. And third, the ESWB provide the weights to be able to make population estimations. Nevertheless, it has some limitations that should be taken into account. First, this is not census data, as in Hsieh and Klenow (2014). Another limitation is that the surveys are done mostly in World Bank client countries and hence most high-income countries are not covered by the surveys (US, Canada, Western European countries, Japan, etc). And finally, the number of observations per country is relatively small.

We start by documenting the average firm age and the share of employment of the small plants for each country and comparing them with the results obtained in previous works. We show that there is a positive correlation between GDP per capita and (i) Total Factor Productivity, a widely recognized fact in the literature, (ii) average establishment size, after excluding small countries. In addition, we observe a more mature firm distribution in more developed countries as in Alam (2017). We then focus on economic distortions which are perceived by firms as obstacles to growth. Several obstacles are grouped into five main categories: Limited Access to Finance, Weak Infrastructure, Red Tape, Tax, and Weak Law and Order. We show that high economic distortions are consistently associated with a lower GDP per capita as in Bah and Fang (2015).

[1] We use the terms *firm* or *plant* as synonyms of establishment in this paper. Many authors do that. See, among others, Kalemli-Ozcan and Sorensen (2012), Caunedo and Yurdagul (2017), and Bento and Restuccia (2017).

We then broaden the analysis of the obstacles to study their evolution over time. Considering firms with less than 5 and more than 20 years, we observe that (i) Limited Access to Finance and Weak Infrastructure display a decreasing evolution on how they are perceived by firms, (ii) the perception of Red Tape, Tax, and Weak Law and Order increases over time. The latter is the economic distortion group for which the increase is the highest as time goes by.

We analyze firms life cycle using synthetic cohorts instead of using cross-section data. We start by presenting evidence from the cross-sectional relationship between the mean number of employees working in a plant and firm age. Subsequently, to eliminate cohort effect, we create a synthetic employment profile. We cannot use the same approach as in Hsieh and Klenow (2014). Given that the ESWB permit us to compute employment growth for survived plants, we proceed as follows:

(i) Calculating the average employment of the initial cohort,

(ii) Obtaining the employment growth by plant, and

(iii) Using it to compute the synthetic average employment profile.

We observe that (i) the synthetic life cycle of firm employment is above the cross-section one, as in Hsieh and Klenow (2014), and (ii) in general firms grow as they age.

In order to evaluate the relationship between the evolution of how economic distortions are perceived by firms over time and the average employment profile, we compute two ratios. The first one corresponds to economic distortions; the second one, to the synthetic employment profile. We do not find any correlation between the synthetic employment profile and the perception of economic distortions **for a broad set of countries**. Nevertheless, we find several countries for which this correlation is clearly negative. That is, countries showing a higher perception of distortions over time display flatter profiles compared to countries which report a lower perception of distortions as firms age.

We next build an overlapping generations model that describes a life-cycle occupational choice economy à la Lucas with no uncertainty to examine the role of economic distortions on firms life cycle. Every period, a large number of finitely-lived households are born. These individuals are born with an initial endowment of managerial talent, which exogenously grows over its life cycle. The aim of each agent is to maximize the lifetime utility from consumption. In the first period of their lives, households must decide to work as employees or to be entrepreneurs. If an individual chooses to be an entrepreneur, she/he runs a firm employing labor and capital to produce output. We consider that firms may suffer higher economic distortions in the second period, relative to the first period. Furthermore, no matter the agent is employee or entrepreneur, she/he must decide how much to consume and save every period.

We calibrate the model to match firm characteristics observed in the US economy. For that, the 2010 US Economic Census is used. We assume for these purposes that the US economy is free of distortions. In addition, we force our economy to replicate the employment profile ratio observed in Turkey 2013. The model matches the data fairly well.

We then proceed to introduce distortions only in the second period to obtain the employment profile ratio observed in each country-survey. Introducing them leads to a reduction in employment profile ratio and average firm size, an increase in the number of entrepreneurs, and to a higher share of small firms. Besides, it seems firms' perception about how obstacles affect on their performance could be capturing the size of economic distortions suffered by firms.

We contribute to the empirical literature on the study of plants life cycle differences across countries, which is relatively limited due to the lack of comparable data until recently. This paper aims to empirically document how the business environment affects the life cycle of plants for a large number of countries. Hsieh and Klenow (2014) study the life cycle of plants only for three economies, the United States, India and Mexico. They argue that firm dynamics may differ across countries depending on their development level. Alam (2017) use firm-level data from the ESWB for a sample of 100 countries to conclude that poorer countries grow at a slower rate than richer countries. He performs the analysis using cross-section data. In this paper, we broaden the analysis to a dynamic perspective and we use synthetic cohorts instead of cross-section data. Bah and Fang (2015) simulate a model to quantify the impact of the business environment on aggregate output and productivity for eighteen Sub-Saharan African countries. Here, we focus on the impact of the business environment on firms employment profile over their life cycle.

The model differs in several aspects from the ones used by Bah and Fang (2015) and Guner et al. (2017). On the one hand, Bah and Fang (2015) work only with two periods. In the first period, the agent can only be a worker but has the option of becoming a manager in the second period. In our economy however, we consider three periods and each individual chooses whether to be a worker or an entrepreneur over the first two periods at the beginning of the life cycle. This decision is irreversible. In addition, they incorporate financial frictions in their model. Here, we assume the financial market is perfect. On the other hand, Guner et al. (2017) work with a model in which managers can invest resources in skill formation and, as a consequence, managerial skills grow over the life cycle endogenously. In our model, the growth rate of managerial talent is exogenous. Besides, they focus on size-dependent distortions as a source of misallocation. That is, larger establishments face higher distortions than smaller ones. In our case, we work with distortions that affect plants differently by plant age. We consider that firms may suffer higher economic distortions in their second period, relative to their first period, and we analyze its effect on life cycle of firms.

The rest of the paper proceeds as follows. Section 2 discusses the related literature. Section 3 describes the data in detail and reports some descriptive statistics. Section 4 presents the empirical analysis and the main results. Section 5 provides a sketch of a theoretical overlapping generation model and shows the findings associated with the introduction of economic distortions. Finally, this paper concludes in Section 6.

2 Literature Review

Output per capita varies across countries. Development accounting finds that an important part of the differences comes from the differences in Total Factor Productivity (hereinafter, referred to as TFP).[2] There is some consensus that TFP is more important than physical or human capital in explaining income differences. Some authors try to explain differences in TFP levels across countries. Hall and Jones (1999) postulate that poor contract enforcement, severe impediments to trade, corrupt government officials, and government interference in production could lead to lower TFP. Restuccia and Rogerson (2008) emphasize that misallocation of resources across firms can have important effects on aggregate TFP. They show that policies that levy establishment-level taxes or subsidies to either output, capital or labor can lead to misallocation and hence to considerable decrease in output and TFP. Hsieh and Klenow (2009) provide quantitative evidence on the potential impact of resource misallocation on aggregate TFP. They use a model of monopolistic competition with heterogeneous firms producing different goods to show how the misallocation of capital and labor can lower aggregate TFP. They find that hypothetically moving to US efficiency would boost TFP by 30-50% in China and 40-59% in India. The latter two papers are of great relevance in the recent literature that pursue to measure and explain the static differences in allocative efficiency across firms.

Following these relevant works, there is a literature focused on analyzing the effects of economic distortions on the allocation of resources. The misallocation analysis comprises two main strands. First, examining its effects on the characteristics of the employment distribution by firm size. Second, analyzing the effects on aggregate productivity and output per worker. There is also some literature that study the effect of a higher (lower) level of development on low (high) level of economic distortions.

Recent papers analyze the effect of economic distortions on TFP or GDP using the ESWB data. García-Santana and Ramos (2015) claim that the size distribution of firms becomes a crucial object in understanding the aggregate productivity of a country. They observe a monotonic positive cross-country relationship between the average plant size and the level of GDP per worker. Hence, countries that allocate more resources to small plants are associated with lower levels of aggregate productivity. They also show that countries with a better business environment have on average a significantly lower share of labor allocated to small plants. They have a look on access to finance, taxes, cost of entry, easiness of exporting, rule of law, and corruption. Distortions related to the capacity of the economy to provide credit are the main drivers of their results. Bah and Fang (2015) focus on Sub-Saharan African countries and use data from the ESWB to evaluate the impact of crime, access to infrastructure, corruption, and red-tape regulation on establishments.[3] They

[2] See, for example, Klenow and Rodriguez-Clare (1997), Caselli (2005), and Hsieh and Klenow (2010). They try to answer the following question: "how much of the cross-country income variance can be attributed to differences in physical and human capital, and how much to differences in the efficiency with which capital is used?"

[3] The impact of crime, access to infrastructure, and corruption are all reported as a percentage of total sales lost for each plant. The impact of red-tape regulation is reported as the fraction of managers' time in dealing with various government regulations.

conclude that poor business environment is quite damaging to African development. Businesses lose large shares of their sales due to government regulations, poor infrastructure, crime and corruption. This leads to lower aggregate output and TFP. Simulating a model for eighteen Sub-Saharan African countries, they observe that financial development accounts for 39% and taxes accounts for 11% of the dispersion of output. Besides that, Ranasinghe and Restuccia (2018) document that crime[4] and lack of access to finance are two major obstacles to business operation in poor and developing countries. They conclude that weaker financial development[5] and rule of law have substantial negative effects on aggregate output.

Other papers examine the role of economic distortions on TFP and output using different databases. Moscoso Boedo and Mukoyama (2012) analyze the effects of entry regulations and firing costs using the World Bank's Doing Business dataset. They claim that entry costs lower productivity by keeping low-productivity firms in operation and making the establishment size inefficiently large. In addition, they postulate that firing costs also lower productivity by reducing the reallocation of labor from low-productivity firms to high-productivity firms. Midrigan and Xu (2014) use producer-level data from Korean manufacturing to examine the role of financial frictions in reducing aggregate productivity. They argue that financial frictions distort entry and technology adoption decisions and generate misallocation among existing producers.

Nevertheless, there has been little theoretical work trying to explain why firm dynamics differ across countries. Hsieh and Klenow (2014) examine the relevance of plant-specific productivity growth over firms life cycle in order to understand the differences in aggregate manufacturing TFP between three countries: the United States, India and Mexico. The evidence over time suggests that India and Mexico exhibit flatter employment-age profiles compared to the US.[6] They find that the dominant reason behind the slower employment growth with age in India and Mexico is the slower life cycle productivity growth. They consider a General Equilibrium (GE) model with monopolistic competitors whose productivity varies over their life cycle (first, exogenously; then, endogenously). They conclude that a certain type of misallocation, particularly misallocation that harms large establishments, can discourage investments that promote plant productivity, resulting in lower productivity of the average plant in poor countries.

Using firm-level data from the ESWB for a sample of 100 countries, Alam (2017) carries out a **cross-section analysis** to show that the results obtained by Hsieh and Klenow (2014) can be generalized. He observes that in general firms grow as they age, and establishments in poorer countries grow at a slower rate than those in richer countries do. Furthermore, he concludes that the growth rate of establishments explains approximately 16 percent of GDP per capita variations.

[4] Defined as theft, robbery, vandalism or arson on the establishment's premises.

[5] For financial market development they use data on whether an establishment is able to obtain a loan and whether it is financed through internal or external sources.

[6] A more exhaustive discussion of this paper will be presented later on, in the empirical analysis part.

3 Data: Enterprise Surveys of the World Bank

In order to carry out the analysis, the ESWB following the global methodology from 2006 to 2017 are used.[7] They are a collection of plant-level surveys with the aim to be representative of a country's non-agricultural formal private economy.[8] The sampling unit of the Enterprise Surveys is the establishment.[9] The ESWB collect data from manufacturing and retail/wholesale service sectors in every region of the world, and they are designed to survey firms with five or more permanent full-time employees.[10] In addition, the ESWB gather information regarding the business environment, including infrastructure, trade, finance, regulations, taxes and business licensing, corruption, crime and informality, innovation, labor, and perceptions about obstacles to doing business, allowing researchers to analyze how firms and the economy are affected by them.

As stated before, the main advantage of the database is that given the method of stratification used by the World Bank, based on establishment size, business sector and geographic region within a country, data is comparable across countries and years. Besides, García-Santana and Ramos (2015) perform an external validation of the ESWB data, comparing it to the Penn World Table 7.0 (PWT), a widely used aggregate dataset. The comparison speaks in favor of the quality of employment data of the Enterprise Surveys. Similarly, Bento and Restuccia (2017) show that for the particular case of India, their estimate of the elasticity of aggregate productivity to changes in firm-level distortions using the ESWB, is very close to the estimate obtained by Hsieh and Klenow (2014) using census data.

The original dataset consists of 139 countries, most of them developing countries.[11] It contains data on 135,245 firms, for which $31,419$ (23.23%) are from Africa, $30,760$ (22.74%) from Latin America and the Caribbean region, $29,047$ (21.48%) from Eastern European and Central Asia, $17,317$ (12.8%) from South Asia, $17,089$ (12.64%) from East Asia and Pacific region, and $9,613$ (7.11%) from Middle East and North Africa. With respect to the type of sector interviewed, $74,568$ (55.14%) correspond to manufacturing establishments and the rest $60,677$ (44.86%) to service sector establishments. Even if the coverage is wide from this point of view, the number of observations per country is small. Typically 150 establishments are surveyed in small economies, 360 in medium-sized economies, and between 1200 and 1800 in large economies.

[7] Available at *www.enterprisesurveys.org*.

[8] Many authors use the ESWB dataset. See, among others, Djankov et al. (2010), Gennaioli et al. (2012), Ayyagari et al. (2014), García-Santana and Ramos (2015), Caunedo and Yurdagul (2017), and Alam (2017).

[9] According to the formal definition of the World Bank, "an establishment is a single physical location where business is conducted or where services or industrial operations are performed. A firm may have one or many establishments. For the purposes of the survey an establishment must make its own financial decisions and have books separate from that of the firm to be included in the survey". However, as stated before, note that we use the terms *firm* or *plant* as synonyms of establishment in this paper.

[10] People who work up to eight or more hours per day are considered as full-time employees.

[11] Some countries are surveyed twice or thrice, therefore the original database covers 241 country-surveys.

In our analysis, only complete interviews are considered. Furthemore, government or state ownership establishments are excluded. Given that some establishments do not want to provide all of their information, there is missing data in the Enterprise Surveys. We drop observations for which relevant information such as the number of full-time employees is missing or negative. With respect to the firm age, we do not consider firms which have neither negative age nor more than 110 years (see World Bank's Enterprise Surveys, "Indicator Descriptions", page 138). We postpone a detailed description of the sample selection criteria and the variables used to Appendix A.

The final sample consists of 231 country-year samples from 137 countries between years 2006 and 2017.[12] Table 1 in Appendix B reports some descriptive statistics about it. Columns (1) and (2) indicate the country and the year in which the survey was implemented, respectively. Column (3) corresponds to the number of establishments surveyed. Column (4) shows the average firm age for each country. Although the final sample used is not the same, the results are similar to the ones presented by Caunedo and Yurdagul (2017). Column (5) presents the share of employment of the small plants.[13] The latter is consistent with the results by García-Santana and Ramos (2015). Finally, column (6) provides the GDP per capita of each country for the last year available, 2014. We use the Penn World Table 9.0 dataset in order to obtain that information (see Appendix A).

The evidence shows a clearly positive and significant high correlation (0.82) between TFP and GDP per capita in natural logarithms,[14] a widely recognized fact in the literature. Nevertheless, there is no consensus on the sign of the relationship between employment size distribution and income per capita.[15] In our sample, the correlation between GDP per capita and average establishment size is very low (0.10) and not significant.[16] This can be due to two facts. First, the dataset is clearly unbalanced in favour of developing countries; most high-income countries are not covered by the surveys. Second, we consider all countries, no matter their size. Following Bento and Restuccia (2017), we exclude countries with less than 10 million inhabitants and we obtain a positive correlation (0.20) at 10% significance level. Besides, our data shows a positive correlation between average firm age and GDP per capita. In particular, the elasticity of average firm age with respect to GDP per capita is 0.26. This suggests that a more mature firm distribution can be found in more developed countries. This result is consistent with Alam (2017), who observes that high income countries have higher establishment mean age compared to low income countries.

[12] In the cleaning data process, we lose China and Brazil as countries, and the following 10 country-year surveys: Brazil 2009, China 2012, Croatia 2007, DRC 2006, El Salvador 2006, Guatemala 2006, Honduras 2006, Nicaragua 2006, Pakistan 2007, and Venezuela 2006.

[13] We use the definition of establishment size given by the Enterprise Surveys; establishment sizes are 5-19 employees (small), 20-99 employees (medium), and 100 or more employees (large).

[14] We use the natural logarithms of the variables to calculate the correlations. The data for TFP is drawn from the Penn World Table 9.0.

[15] For a discussion, see, for example, Hsieh and Olken (2014), and Bento and Restuccia (2017).

[16] Alfaro et al. (2009) find a significant negative correlation. This results differs from Caunedo and Yurdagul (2017) who obtain a positive and significant correlation.

We focus on economic distortions which are perceived by firms as obstacles to growth. The question on obstacles is the same for all firms surveyed: "Is X No Obstable (assigned the numerical value 1),[17] Minor Obstable (2), Moderate Obstable (3), Major Obstacle (4), or a Very Severe Obstacle (5) to the current operations of this establishment?". Following Kalemli-Ozcan and Sorensen (2012),[18] we average the answers into five different groups: i) Limited Access to Finance; ii) Weak Infrastructure. This is the average of answers to the question stated above where X is "Electricity", "Transportation", and "Access to Land"; iii) Red Tape. It is the average of answers to the question where X is "Business Licensing and Permits", "Customs and Trade Regulations", and "Labor Regulations"; iv) Tax. This is the average of answers to the question where X is "Tax Rates" and "Tax Administration"; and v) Weak Law and Order. This is the average of answers to the question where X is "Corruption", "Functioning of the Courts", "Crime, Theft and Disorder", "Practices of Competitors in the Informal Sector", and "Political Instability".

They are coded in such a way the higher the average value, the worst the business environment. We find a negative and significant correlation between GDP per capita and the different groups. The correlation is stronger for Limited Access to Finance (-0.51) and Weak Infrastructure (-0.52) than for Red Tape (-0.27), Tax (-0.25) and Weak Law and Order (-0.27). The results are consistent with Bah and Fang (2015), who also find the highest correlation values for the financial development and the access to infrastructure. Table 2 shows the Top 5 of the obstacles perceived as the biggest ones affecting the operation of the establishment by firm age. Column (1) considers firms with less than 5 years. Column (2) and (3) present the case for firms with more than 20 and 40 years, respectively. We observe that Access to Finance and Electricity show a downward tendency as firms age at the expense of Practices of Competitors in the Informal Sector and Political Instability, which are perceived as the biggest obstacle by more firms as time goes by.

Table 2. Top 5 of the Biggest Obstacles by firm age.

Top 5 Biggest Obstacles affecting the operation of the establishment	(1) Firm age<5		(2) Firm age>20		(3) Firm age>40	
	# of firms	% of firms	# of firms	% of firms	# of firms	% of firms
Access to Finance	1,078	17.62	3,965	13.11	961	11.77
Electricity	1,006	16.45	3,363	11.12	796	9.75
Tax Rates	720	11.77	3,244	10.73	868	10.63
Competitors Informal Sector	628	10.27	4,176	13.81	1,201	14.71
Political Instability	524	8.57	3,919	12.96	1,051	12.88

[17] The original dataset uses a five-point answer scale from 0 to 4. We rescale this to 1-5.

[18] In their analysis, they use the Productivity and Investment Climate Survey of the World Bank instead of the ESWB. However, the Enterprise Surveys allow us to use a very similar grouping criteria.

4 Empirical Analysis

4.1 Business Environment over Time

We broaden the analysis of the obstacles to study their evolution over time. In particular, we ask whether the different types of obstacles are perceived differently by firms of different ages. For that, we consider firms with less than 5 years and firms with more than 20 years.[19] A large number of establishments fail during the first years due to different causes. Nevertheless, plants suffer from obstacles over their entire life cycle. We are interested in examining how the different distortions affect at different stages of the life cycle.

The ESWB report the perception of the firms about obstacles to doing business, which are grouped as discussed in previous part. Each obstacle takes values from 1 to 5, where 1 indicates the plant perceives it as no obstacle and 5 reflects the obstacle is considered to be very severe. We average the value by country-survey. The results are shown in Table 3, which presents the evolution of the main groups over time.[20] Limited Access to Finance shows a downward trend as firms age. On average, the perception of this obstacle decreases over time from 2.72 to 2.54. Weak Infrastructure also follows the same tendency, although the trend is not so obvious. In that case, the average value is about 2.39 for firms with less than five years, while it decreases slightly to 2.36 as firms age. These features are consistent with the ones presented in Table 2, in which we show that Access to Finance and Electricity are perceived as the biggest obstacle by fewer firms as time goes by. On the other hand, Red Tape, Tax, and Weak Law and Order exhibit the opposite tendency. The ratio of Red Tape increases from 2.01 to 2.04. The increase is higher for Tax, and even higher for Weak Law and Order, which increases from 2.41 to 2.49.

Table 3. Economic Distortions. Evolution over time.

	FINANCE	WEAK INFR	RED TAPE	TAX	WEAK LAW
Firms <5 years	2,7265	2,3910	2,0181	2,5901	2,4140
Firms >20 years	2,5494	2,3661	2,0434	2,6521	2,4890
Observations	223	217	213	222	199

Note: several establishments do not answer the question about obstacles. As a consequence, the number of observations differ across the groups considered.

As shown in Table 3, Weak Law and Order is the economic distortion group for which the increase is the highest as time goes by. Thus, it is appropriate to have a look in detail for some particular distortions grouped there. Table 4 presents the case for (i) Practices of Competitors in the Informal Sector, (ii) Political Instability, and (iii) Corruption. All of them show a clear tendency to increase the value of the distortion's perception as firms age. This is in line with the feature discussed in Table 2 regarding the Practices of Competitors in the Informal Sector and Political Instability.

[19] We also perform the analysis considering firms with less than 8 years to be consistent with the analysis of the employment profile of plants (see next section). The results for Table 3 and 4 are qualitatively the same.

[20] Recall that we are interested in the evolution of the average value rather than in the value itself.

On average, Corruption is also perceived to affect more to firms with more than 20 years. The average value increases from 2.68 to 2.73.

Table 4. Weak Law and Order. Evolution over time.

	Practices of Competitors in the Informal Sector	Political Instability	Corruption
Firms <5 years	2,5216	2,6079	2,6895
Firms >20 years	2,6078	2,6502	2,7331
Observations	215	219	216

Note: several establishments do not answer the question about obstacles. As a consequence, the number of observations differ across the obstacles considered.

4.2 Employment Profile of Plants

In this section, we analyze firms life cycle for a large number of countries. Instead of focusing on cross-section data, we carry out the analysis using synthetic employment life cycle.

We begin by presenting evidence from the cross-sectional relationship between average employment per surviving plant and firm age. We define average employment as the mean number of employees working in a plant. We consider the sample establishments into seven age groups: 0-8, 8-12, 12-16, 16-20, 20-24, 24-28 and 28-32. We normalize the average employment of plants at each age to the average employment of young plants. We suppose that young plants are those under 8 years old.[21] The blue and green lines in Figure 1 show the mean profile for a broad set of countries using the mentioned cross-section approach.[22] According to the blue line, the average operating plant by age 32 is approximately three times larger than the average plant under the age of 8.

As Hsieh and Klenow argue, "the relationship between plant employment and firm age in the cross-section conflates size differences between cohorts at birth with employment growth of a cohort over its life cycle". Therefore, we want to eliminate cohort effect and measure the life cycle of a cohort of plants. According to the World Bank, obtaining panel data, i.e. interviews with the same firms across multiple years, is a priority in current Enterprise Surveys. However, this is not the case yet. As a consequence, we need to create a synthetic employment profile.

Hsieh and Klenow (2014) compare the average employment of operating establishments of each cohort in $year$ with the average employment of surviving plants from the same cohort in $year + x$. They do this for all the cohorts grouped into x-year age bins. In order to impute the life cycle from the change in average plant employment from $year$ to $year + x$ for each cohort, they assume the employment growth and the exit rate[23] over the life cycle to be the same for each cohort.

[21] Several authors argue firms with less than 10 years to be considered as *young firm* (see, for example, Haltiwanger et al. (2013)).

[22] The blue line considers 209 country-surveys, whereas the green line presents only the mean profile of 111 country-surveys, those which are represented also by synthetic cohorts. More details provided in the text.

[23] The number of firms that ceased operations during that period divided by the total number of firms that operated during the same period.

Nonetheless, we use a different approach to create synthetic employment profiles. There is one major justification for that. Note that we cannot apply the approach mentioned for all ESWB countries. Given that the method requires two different years to calculate the change in average plant employment, only those countries which are surveyed twice or thrice could be taken into consideration. Hence, we need to apply a different procedure. We want to consider all ESWB countries, no matter how many times and when have been surveyed.

We proceed from the fact that the ESWB allow us to calculate employment growth for those establishments which have survived. As exposed in Appendix A, there are two variables that enable us to do so: permanent full-time employees end of last complete fiscal year (variable $l1$) and permanent full-time employees three complete fiscal years ago (variable $l2$). We make three important assumptions, (i) every cohort experiences the same employment growth over its life cycle, (ii) employment growth is computed only for those firms that have survived, and (iii) employment growth is based on permanent full-time employees, given that there is no data for temporary workers three years before the last fiscal year. We first compute the average employment of the initial cohort. Then, we calculate the employment growth by plant and use it to compute the synthetic average employment over its life cycle.[24] The red line in Figure 1 presents the mean average plant employment as plants age calculated in this manner for a broad set of countries.[25] The evidence over time suggests that by age 32, average plant employment is almost four times higher compared to average employment at birth.

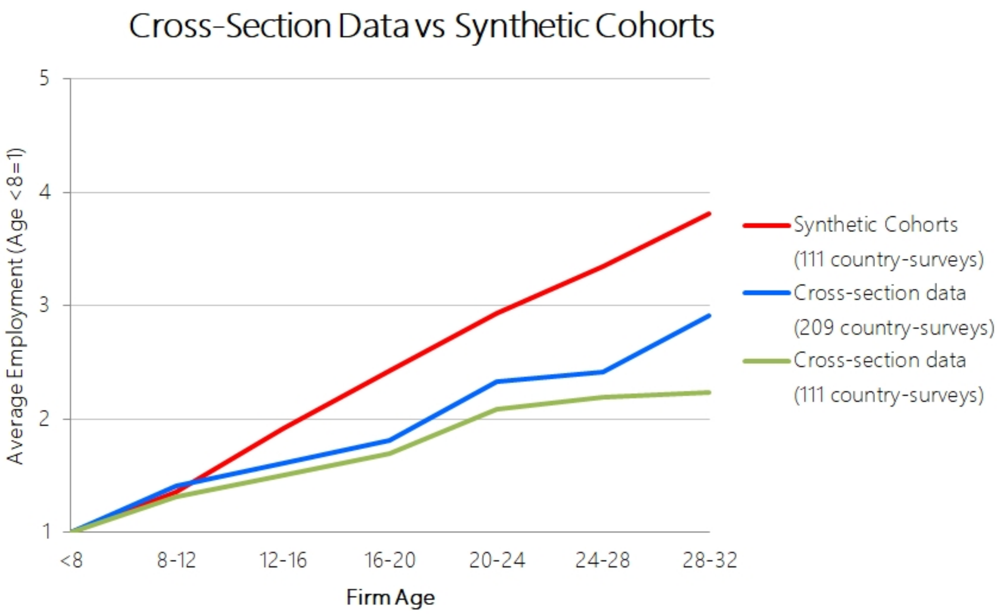

Figure 1. Cross-Section Data vs Synthetic Cohorts.

[24] See Appendix C for an illustrative example.

[25] In the process to obtain synthetic employment profiles, we drop observations for which we get negative employment values. As a result, fewer country-surveys are represented with synthetic cohorts compared to cross-section data. Besides, we find some countries for which the synthetic employment profile presents some anomalies. We correct them imposing to the anomalous cohort the average employment growth of the remaining cohorts.

We underline two facts from Figure 1. First, the synthetic line (red line) is above the cross-section lines (blue and green lines). This is consistent with the results presented in Figure I (blue and green lines) and IV (red line) by Hsieh and Klenow (2014). They find that for the US, the evidence over time suggests that average plant employment increases by a factor of 10 from birth to plant age 35; the cross-sectional evidence shows less than an eightfold raise. In India, the evidence over time suggests that by firm age 35, plant size in terms of employment levels is only 40 percent higher compared to average size at birth; India's cross-sectional data indicates a slightly smaller increase in plant size. In Mexico, the evidence over time is similar to what the cross-section implies; 25-year-old establishments are approximately twice the size of younger plants, and employment levels stay unchanged after plant age 25. Second, as in Alam (2017),[26] we can argue that in general firms grow as they age, considering both cross-section data and synthetic cohorts.

4.3 Business Environment and Employment Profile of Plants

We are interested in examining whether there is any relationship between the evolution of how economic distortions are perceived by firms over their life cycle and the average employment profile shown by the firm. In section 4.1, we conclude that there are in sum two contrasting tendencies. Whereas Limited Access to Finance and Weak Infrastructure display a decreasing evolution on how they are perceived by firms, on average, the perception of Red Tape, Tax, and Weak Law and Order increases over time. We want to assess the effect of the obstacles on the employment profile. Thus, we focus on the latter three distortion groups, which are the ones perceived as affecting more with the passage of time.

To evaluate the relationship mentioned for a broad set of countries, we compute two ratios. On the one hand, we calculate the ratio regarding the economic distortions. For that, we divide the average value provided by the firms with more than 20 years by the average value of the firms with less than 5 years by country-survey. This ratio captures the evolution of perceptions on obstacles for each country-survey. When the ratio takes a value higher than one, it means that on average the country perceives the obstacle to be increasing on its relevance. If the ratio is less than the unity, the country views the obstacle as less damaging over time. On the other hand, we compute the ratio corresponding to the synthetic employment profile. We divide the average employment of plants with more than 20 years by the average employment of young plants. Hence, the higher the value of this ratio, the steeper the synthetic employment profile.

We do not find any correlation between these two ratios. In other words, we do not find any correlation between the synthetic employment profile and the perception of economic distortions for a broad set of countries. However, we observe that there are several countries for which this correlation is clearly negative.

[26] Although he finds that establishments in some countries do not grow as they age (for example, in Georgia), and in some countries, they do not consistently grow as they age (for instance, in Senegal), he concludes that plants in general grow as they age. Recall that Alam performs the analysis using cross-section data. Thus, his conclusion is based on the blue line.

We identify nine countries where the perception of Tax, Red Tape, and Weak Law and Order is higher over time: Bahamas 2010, Cambodia 2016, Cameroon 2016, Costa Rica 2010, El Salvador 2016, Fyr Macedonia 2013, Guyana 2010, Malawi 2014, and Mexico 2010. On the other hand, we consider seven countries that show the opposite tendency: Bosnia and Herzegovina 2009, Cape Verde 2009, Chile 2006, Pakistan 2013, Russia 2009, Turkey 2013, and Vanuatu 2009. Table 5 reports the ratios for those countries. Note that the value of the ratio is higher than one in all cases for the nine countries, and less than the unity in all cases for the seven countries. There is little evidence in the literature about the evolution of the economic distortions over time. Nonetheless, Bah and Fang (2015), in their analysis of eighteen Sub-Saharan countries, find that Cape Verde has very low costs on gifts to government officials. In addition, they classify Cape Verde as a country with high level of capital intermediation.

Table 5. Ratio of Tax, Red Tape, and Weak Law and Order.

Higher perception of distortions	Tax ratio	Red Tape ratio	Weak Law ratio
Bahamas 2010	1.2563	1.0418	1.2027
Cambodia 2016	1.1308	1.1061	1.1476
Cameroon 2016	1.2462	1.2777	1.4659
Costa Rica 2010	1.6276	1.0187	1.3127
El Salvador 2016	1.2206	1.0394	1.0118
Fyr Macedonia 2013	1.0505	1.1406	1.3155
Guyana 2010	1.0757	1.3518	1.2383
Malawi 2014	1.0295	1.0684	1.2444
Mexico 2010	1.3893	1.2830	1.0403

Lower perception of distortions	Tax ratio	Red Tape ratio	Weak Law ratio
Bosnia and Herzegovina 2009	0.9138	0.9208	0.9263
Cape Verde 2009	0.8029	0.8479	0.8500
Chile 2006	0.7412	0.8623	0.8504
Pakistan 2013	0.9366	0.7933	0.8776
Russia 2009	0.8593	0.8377	0.8423
Turkey 2013	0.5624	0.8966	0.6424
Vanuatu 2009	0.9977	0.6628	0.9258

Next, we focus on the synthetic employment profile presented by those countries. Clearly, we observe that there is a negative relationship between the ratio and the profile.[27] That is, countries showing a higher perception of distortions over time display flatter profiles compared to the countries which report a lower perception of distortions as firms age. This idea is illustrated in Figure 2. On the one hand, Chile and Vanuatu have a lower perception of economic distortions by age and present an upward synthetic employment profile. On the other hand, the perception of economic distortions is higher as time goes by in Guyana and El Salvador, and the synthetic employment profile is flatter. Note that the profile is very similar in Guyana and Chile from birth to firm age 20. However, it is only from that moment on that Chile continues growing (it reports that obstacles are less damaging over time), while Guyana's employment growth is stagnating (the perception of distortions is higher over time).

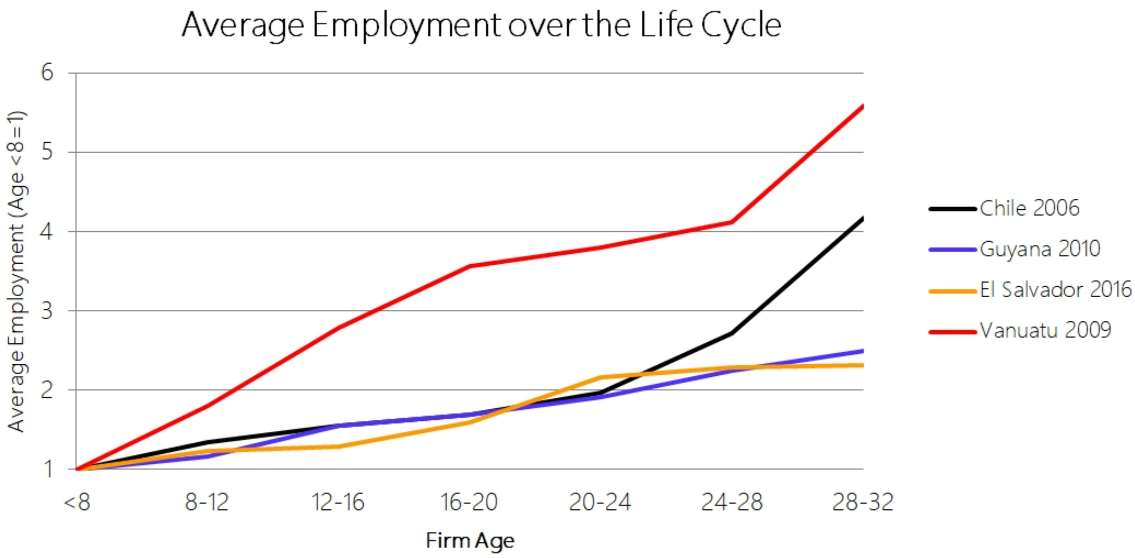

Figure 2. Average Employment over the Life Cycle. Chile, Guyana, El Salvador and Vanuatu.

Note: average employment is the mean number of employees working in a plant.

Overall, these results suggest that higher distortions over firms life cycle have negative effects on the employment profile over time. We present a parsimonious model able to capture the effect of economic distortions on firms life cycle in the next section.

[27] Here, as an illustrative example, we present the employment profile for only four countries. Table 6 in Appendix C reports the synthetic employment profile for each country considered in Table 5.

5 Model

This model describes a life-cycle occupational choice economy à la Lucas (1978) with no uncertainty. The economy is populated by overlapping generations of households that live a finite horizon lifetime as in Bah and Fang (2015) or Guner et al. (2017). Time is discrete. There is no population growth and, without loss of generality, we normalize the size of population at each period of time to 1. That is, at each period t a large number of finitely-lived households of measure one are born. Households live for 3 periods. All households are born with an initial endowment of managerial talent, z, where z is a random component drawn from an exogenous stationary distribution with cdf $F(z)$ and density $f(z)$ on $[0, z^{\max}]$. This initial endowment of managerial skill z grows over its life cycle. Since there are no bequests, households' initial wealth is assumed to be zero. Households decide, at the beginning of their life, whether to work as employees during their active lifetime period or become entrepreneurs. This decision is irreversible. Hence, over their first two periods, households work or run a firm. During their retirement period, all households live only on their savings. From the production side, a single final output good is produced by heterogeneous producers that have access to a diminishing returns to scale technology.

5.1 Decisions

On the one hand, if an individual chooses to be an entrepreneur, she/he has access to a technology to produce output. Let factor prices be denoted by r and w for capital and labor services, respectively. Thus, given factor prices, the entrepreneur decides how much labor and capital to employ every period. Besides, she/he must solve the problem of how much of her/his income would be allocated towards current consumption and savings. On the other hand, the decision problem of a worker is to decide on how much to consume and save every period.

Entrepreneurs As in Lucas (1978), we assume that all entrepreneurs' technology exhibits diminishing returns to scale with respect to private input factors (also known as the 'span-of-control' technology). Each entrepreneur produces the same single final consumption good y using the following technology:

$$y_z = Az^{(1-\gamma)} \left(n_z^{(1-\alpha)} k_z^{\alpha} \right)^{\gamma}, \tag{1}$$

where $\gamma < 1$ denotes the span-of-control, A is the productivity term that is common to all establishments, and k_z and n_z denote the amount of capital and labor demanded by an entrepreneur with managerial talent z, respectively.

Profits of an entrepreneur with ability z at date t are given by

$$\max_{\{k_z, n_z\}} \pi_z = \left[(1-\tau) Az^{(1-\gamma)} \left(n_z^{(1-\alpha)} k_z^{\alpha} \right)^{\gamma} - (r+\delta) k_z - w n_z \right],$$

where τ captures the possibility to face higher economic distortions in the second period, relative to the first period. Therefore, we consider $\tau = 0$ in the first period, but $\tau > 0$ for the second period.

Solving the entrepreneurs' maximization problem we obtain the standard first order conditions:

$$w = (1-\tau)(1-\alpha)\gamma \frac{y_z}{n_z}, \tag{2}$$

and

$$r + \delta = (1-\tau)\alpha\gamma \frac{y_z}{k_z}. \tag{3}$$

Therefore, the optimal demand for k_z and n_z in terms of factors' prices, technology level, managerial talent and parameters can be obtained by solving the previous first order conditions (2) and (3), taking into account (1):

$$k_z = zk_y[(1-\tau)A]^{\frac{1}{1-\gamma}} \left(\frac{1}{r+\delta}\right)^{\frac{1-(1-\alpha)\gamma}{1-\gamma}} \left(\frac{1}{w}\right)^{\frac{(1-\alpha)\gamma}{1-\gamma}}, \tag{4}$$

$$n_z = zn_y[(1-\tau)A]^{\frac{1}{1-\gamma}} \left(\frac{1}{r+\delta}\right)^{\frac{\alpha\gamma}{1-\gamma}} \left(\frac{1}{w}\right)^{\frac{1-\alpha\gamma}{1-\gamma}}, \tag{5}$$

and

$$y_z = zy_y(1-\tau)^{\frac{\gamma}{1-\gamma}} A^{\frac{1}{1-\gamma}} \left[\left(\frac{1}{r+\delta}\right)^{\frac{\alpha}{(1-\gamma)}} \left(\frac{1}{w}\right)^{\frac{(1-\alpha)}{(1-\gamma)}}\right]^{\gamma}, \tag{6}$$

where the parameters k_y, n_y and y_y are defined as follows:

$$k_y \equiv \gamma^{\frac{1}{1-\gamma}} \alpha^{\frac{1-(1-\alpha)\gamma}{1-\gamma}} (1-\alpha)^{\frac{(1-\alpha)\gamma}{1-\gamma}},$$

$$n_y \equiv \gamma^{\frac{1}{1-\gamma}} \alpha^{\frac{\alpha\gamma}{1-\gamma}} (1-\alpha)^{\frac{1-\alpha\gamma}{1-\gamma}},$$

and

$$y_y \equiv \left[\gamma^{\frac{1}{(1-\gamma)}} \alpha^{\frac{\alpha}{(1-\gamma)}} (1-\alpha)^{\frac{(1-\alpha)}{(1-\gamma)}}\right]^{\gamma}.$$

Substituting these into the profit function, the maximum profits can be written as follows[28]:

$$\pi_z = (1-\tau)(1-\gamma)y_z = z[(1-\tau)A]^{\frac{1}{1-\gamma}} \Pi(r,w), \tag{7}$$

where

$$\Pi(r,w) = (1-\gamma)\left[\gamma^{\frac{1}{(1-\gamma)}} \alpha^{\frac{\alpha}{(1-\gamma)}} (1-\alpha)^{\frac{(1-\alpha)}{(1-\gamma)}} \left(\frac{1}{r+\delta}\right)^{\frac{\alpha}{(1-\gamma)}} \left(\frac{1}{w}\right)^{\frac{(1-\alpha)}{(1-\gamma)}}\right]^{\gamma}.$$

[28] We can show that this can be obtained as follows:

$$\pi_z = (1-\tau)y_z - (r+\delta)k_z - wn_z = (1-\tau)y_z - (1-\tau)\alpha\gamma\frac{y_z}{k_z}k_z - (1-\tau)(1-\alpha)\gamma\frac{y_z}{n_z}n_z$$

$$(1-\tau)y_z - (1-\tau)\alpha\gamma y_z - (1-\tau)(1-\alpha)\gamma y_z = (1-\tau)(1-\alpha\gamma-\gamma+\alpha\gamma)y_z = (1-\tau)(1-\gamma)y_z$$

The remaining proofs are presented in Appendix D.

Once the entrepreneur decides how much labor and capital to employ every period, she/he must solve the problem of how much of her/his income would be allocated towards current consumption and savings. Entrepreneurs' budget constraints are given by

$$c_1 + s_1 = \pi_z, \tag{8}$$

$$c_2 + s_2 = \pi_{z'} + (1+r)s_1, \tag{9}$$

$$c_3 = (1+r)s_2, \tag{10}$$

and the law of motion for their skills is given by the following expression

$$z' = (1+g)z \tag{11}$$

We assume that the utility function at each period is given by

$$u(c_j) = \ln(c_j).$$

Thus, the problem of an entrepreneur, can be written as follows:

$$\begin{aligned} V^e(z) &= \max \sum_{j=1}^{3} \beta^{j-1} \ln(c_j) = \ln(c_1) + \beta \ln(c_2) + \beta^2 \ln(c_3) \\ & \quad s.t. \;\; \text{Equations (8), (9), (10), (11)} \end{aligned}$$

where $\beta \in (0,1)$ is the discount factor.

Workers They decide how much to consume and save every period. All workers will receive the same equilibrium wage rate, independently of their initial skills' endowment. The problem faced by each worker is completely homogeneous and it can be written as follows:

$$\begin{aligned} V^w &= \max \sum_{j=1}^{3} \beta^{j-1} \ln(c_j) \\ s.t. \quad c_1 + s_1 &= w, \\ c_2 + s_2 &= w + (1+r)s_1, \\ c_3 &= (1+r)s_2, \end{aligned}$$

where the intertemporal budget constraint is given by

$$c_1 + \frac{c_2}{(1+r)} + \frac{c_3}{(1+r)^2} = w\left[1 + \frac{1}{(1+r)}\right] \tag{12}$$

Occupational Choice Let z^* be the managerial talent at which a 1-year old agent is indifferent between being an entrepreneur and a worker. That is, there is a threshold z^* below which all households are workers and above which all households are entrepreneurs. This threshold value z^* is determined such that:

$$V^e(z^*) = V^w$$

where $V^e(z)$ is an increasing function of z.

Government We assume that the costs faced by the entrepreneurs due to economic distortions in the second period are captured by the government, which uses them for consumption. Therefore, the government budget constraint can be written as follows:

$$G = \tau \int_{z^*}^{z^{\max}} y(z, r, w, \tau) f_2(z) dz$$

5.2 Stationary Equilibrium

We present now a stationary equilibrium for an economy along a balanced growth path. We assume an exogenous, and constant, distribution of initial endowment of the random component of managerial skills z. For a given distribution of initial endowment of managerial skills and no population growth, we can obtain the aggregates of labor, capital and final consumption good.

In equilibrium, prices (r,w) will be determined such that labor, capital and goods markets clear. In particular, in the labor market we have that:

$$N = \sum_{j=1}^{2} \mu_j \int_{z^*}^{z^{\max}} n(z, r, w, \tau) f_j(z) dz = F(z^*) \sum_{j=1}^{2} \mu_j$$

where N is the endogenous stationary equilibrium level of workers and μ_j denotes the mass of cohort j. Furthermore, $f_j(z)$ denotes the density function for z, $F(z)$ the cumulative distribution function for initial managerial skill z and $n(z, r, w, \tau)$ denotes the amount of labor hired by each entrepreneur taking into account her/his managerial skill level. Consequently, the left hand side is the aggregate labor demand and the right hand side is the aggregate labor supply.

Similarly, the market for capital clears when the demand of capital per capita equals the supply of capital per capita. Hence,

$$K = \sum_{j=1}^{2} \mu_j \int_{z^*}^{z^{\max}} k(z, r, w, \tau) f_j(z) dz = \sum_{j=1}^{2} \mu_j \int_{z^*}^{z^{\max}} s_j(z) f_j(z) dz + F(z^*) \sum_{j=1}^{2} \mu_j s_j$$

By the Walras' Law, the market for the output clears.[29] The equilibrium for the output good can be written as follows:

$$\begin{aligned}
Y &= C + I + G, \\
Y &= \sum_{j=1}^{2} \mu_j \int_{z^*}^{z^{\max}} y(z, r, w, \tau) f_j(z) dz = \sum_{j=1}^{2} \mu_j y_j(r, w, \tau), \\
C &= F(z^*) \sum_{j=1}^{3} \mu_j c_j + \sum_{j=1}^{3} \mu_j \left[\int_{z^*}^{z^{\max}} c_j(z) f_j(z) dz \right], \\
I &= \delta K, \\
G &= \tau \int_{z^*}^{z^{\max}} y(z, r, w, \tau) f_2(z) dz
\end{aligned}$$

[29] See Appendix D for the proof.

5.3 Calibration

To examine the role of economic distortions on firms life cycle, we take the stance that countries are identical in every respect except for the level of distortions reflected in τ. This abstraction allows us to use our model framework to evaluate the effect on the employment profile arising from differences on economic distortions.

We assume a period in the model is 20 years. We set the value of β to obtain an annualized real rate of return of 4 percent. The aggregate productivity is normalized to one and we assume the depreciation rate to be 6% at the annual level. This value is quite standard in the literature. We assume the same value of the capital share as the reported in Guner et al. (2017). In particular, we consider a value of 0.3256. Taking into account the relationship between α, γ and the capital share,[30] we obtain the value for α, once the value of γ has been calibrated. We also assume that managerial talent follows a log normal distribution with 500 grid points. The mean of the log-normal distribution for initial skills is normalized to zero ($\mu_z = 0$). Table 7 summarizes the parameter values.

Table 7: Parameter Values (annualized)

Managerial talent growth rate (g)	0.0429
Depreciation Rate (δ)	0.06
Importance of Capital (α)	0.4553
Discount Factor (β)	0.967
Returns to Scale (γ)	0.715
Mean Log-managerial Talent (μ_z)	0
Dispersion in Log-managerial Talent (σ_z)	3.42
Aggregate Productivity (A)	1

Note: the calibrated values are β, g, γ and σ_z. See text for details.

Our calibration strategy is as follows. We assume that the US economy is free of distortions, and calibrate the benchmark model parameters to match characteristics observed in the US economy. For that purpose, we use the 2010 US Economic Census. The data shows that the average plant size is about 16.84 employees. Moreover, approximately 70.5% of establishments in the economy employ less than 10 workers, but account for only 14.79% of total employment. On the other hand, less than 2.5% of plants employ more than 100 employees but account for about 44% of total employment. We choose the standard deviation of the distribution (σ_z) and the value for the span-of-control parameter (γ) to match the share of establishments with less than 10 employees and the average plant size, respectively. The model matches the share of total employment and establishments by size in the data fairly well, as demonstrated in Figure 3.

[30] The importance of capital, α, the span-of-control parameter, γ, and the capital share are related as follows

$$\alpha = \frac{capital\ share}{\gamma}$$

Besides that, we force our economy to reproduce the employment profile ratio observed in Turkey 2013, which exhibits no increase on how economic distortions are perceived in the second period.[31] Furthermore, Turkey 2013 shows similar values on firm characteristics compared to the US. According to the 2010 US Economic Census, the average establishment size is about 16.84 employees, and the share of employment of the small plants is 14.79%. For Turkey 2013, the values are 16.60 and 14.80%, respectively (see Table 1 in Appendix B). Hence, we choose the growth rate of the managerial talent (g) to match the employment profile ratio[32] observed in Turkey 2013.[33] Table 8 shows the targeted moments together with their model counterparts.

Table 8: Empirical Targets: Model and Data

Target moments	Data	Model	Parameter
Share of small plants out of total	70.52	70.46	$\sigma_z = 3.42$
Real rate of return	0.04	0.0402	$\beta = 0.967$
Average establishment size	16.84	17.66	$\gamma = 0.715$
Employment profile ratio	2.3177	2.3177	$g = 1.3177$

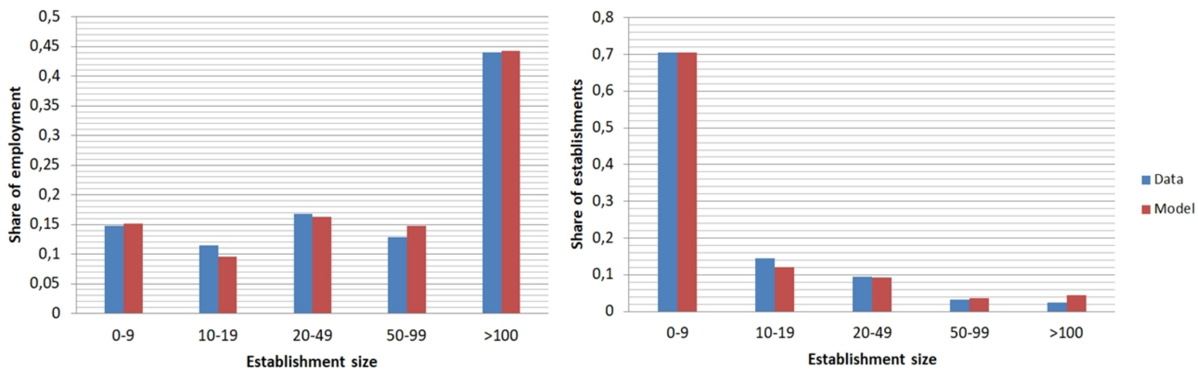

Figure 3. Share of employment and establishments by plant size: model vs data.

[31] Since the employment profile is obtained using the ESWB data, we do not consider the US employment profile ratio, which is obtained from census data.

[32] Employment profile ratio is defined as the ratio between average employment for firms above 20 years and under 20 years. More details will be provided in the next section.

[33] The calibrated value of g is 1.3177. The value of g reported in Table 7 corresponds to the annualized growth rate. Note that this is obtained from the following relationship

$$(1 + g\_annualized)^{20} = (1 + g)$$

5.4 Quantitative Analysis of Economic Distortions

In this section, we present and discuss the central quantitative findings of the model. We first compute the employment profile ratio for Bahamas, Cambodia, El Salvador and Malawi. We then infer from the calibrated model the size of economic distortions necessary to obtain flatter profiles. Subsequently, we quantify the importance of economic distortions on firm characteristics.

We focus our analysis on four country-surveys: Bahamas 2010, Cambodia 2016, El Salvador 2016, and Malawi 2014. As shown in previous part, they report higher perception of economic distortions as time goes by. In addition, the share of employment by small plants in those countries is close to the US value of 14.79%. We now compute the employment profile ratio for them. Given the properties of the model, we define it as the ratio between average employment for firms above 20 years and under 20 years. In the benchmark model, where we assume $\tau = 0$, the value for the employment profile ratio corresponds to Turkey 2013, and it takes the value of 2.3177. This means that average employment is more than twice for firms above 20 years (second period in our model) compared to firms under 20 years (first period in our model). Column 1 in Table 9 presents the ratios regarding employment profile for the countries mentioned. The synthetic employment profile is flatter in Bahamas 2010 than in Cambodia 2016. Furthermore, El Salvador 2016 and Malawi 2014 show very similar values for this ratio.

Next, we are interested in quantifying the size of economic distortions for old plants, relative to young plants, to obtain the employment profile ratio observed in each country-survey, i.e. the value of τ for each country-survey. In other words, we want to address this issue: what should be the value of τ to reduce the employment profile ratio from 2.3177 (observed in Turkey 2013) to 1.4577 (observed in Bahamas 2010)? The model suggests that when tax rate increases to 12.38%, the employment profile ratio reduces to almost 40% of its benchmark value, from 2.3177 to 1.4577. The results for the remaining countries are presented in Table 9. Thus, we should need a value of τ in the second period of 7.57%, 9.14% and 9.15% for Cambodia 2016, El Salvador 2016, and Malawi 2014, respectively.

Table 9. Employment Profile Ratio and Size of Distortion

Country-survey	Employment profile ratio	Size of Distortion
Bahamas 2010	1.4577	12.38%
Cambodia 2016	1.7583	7.57%
El Salvador 2016	1.6558	9.14%
Malawi 2014	1.6551	9.15%

As Table 10 demonstrates, economic distortions may affect some firms characteristics variables. Introducing economic distortions in the second period leads to a reduction in average firm size and employment profile ratio across steady states, an increase in the number of entrepreneurs, and to a higher share of small firms. These implications of the model are consistent with previous papers. García-Santana and Ramos (2015) conclude that establishments tend to be smaller in poorer countries and with a higher level of distortions.

Table 10. Effects of Economic Distortions on Firm characteristics

	Benchmark $\tau = 0$	Cambodia 2016 $\tau = 0.0757$	El Salvador 2016 $\tau = 0.0914$	Malawi 2014 $\tau = 0.0915$	Bahamas 2010 $\tau = 0.1238$
Share empl <10	15.09%	15.83%	16.01%	16.01%	16.20%
Share empl >100	44.28%	43.22%	42.84%	42.84%	42.66%
Share establ <10	70.46%	71.57%	71.71%	71.71%	72.14%
Fraction workers	94.64%	94.38%	94.38%	94.38%	94.24%
Average firm size	17.66	16.78	16.78	16.78	16.38
Empl. profile ratio	2.3177	1.7583	1.6558	1.6551	1.4577

Note: "Share empl <10" means the share of employment by plants with less than 10 employees. "Share empl >100" is the share of employment by plants with more than 100 employees. "Share establ <10" corresponds to the share of establishments with less than 10 employees.

It should be highlighted that we are working with heterogeneous tax rates. We are analyzing the consequences that old firms suffer higher economic distortions than young firms. In particular, we have considered the simplest case when firms only suffer economic distortions when they are old. Note that if we impose a homogeneous tax rate on both periods ($\tau_1 = \tau_2 = 0$ or $\tau_1 = \tau_2 > 0$), firm characteristics discussed in Table 10 would not be affected anymore. That is, when economic distortions do not affect firms differently by plant age, the employment profile is unchanged.

How do our findings relate to the data presented in Table 5? Bahamas 2010, Cambodia 2016, El Salvador 2016, and Malawi 2014 report that on average they perceive economic distortions to be more damaging over time. We average the ratios of Tax, Red Tape, and Weak Law and Order for each of them. This average value captures the mean increase in the perception of those obstacles. The results are presented in Table 11. We compare the size of distortion necessary to obtain the employment profile ratio observed in that country (predicted by the model) with the mean increase in the perception reported by the same country. We underline that these values do not differ significantly each other. Thus, it seems that firms' perception about how obstacles affect on their performance could be capturing the size of economic distortions suffered by firms.

Table 11. Size of Distortion vs Perception of Distortions

	Size of Distortion predicted by the model	Mean increase in the Perception of Distortions
Bahamas 2010	12.38%	16.69%
Cambodia 2016	7.57%	12.80%
El Salvador 2016	9.14%	9.06%
Malawi 2014	9.15%	11.41%

6 Concluding Remarks

We document that across a group of ESWB countries, there is a negative relationship between the synthetic employment profile and the perception of economic distortions over time. We find that while Limited Access to Finance and Weak Infrastructure are seen as less damaging over time, on average, the perception of Tax, Red Tape, and Weak Law and Order increases with the passage of time. We observe that nine countries, for which perception of these distortions increases over time, display flatter employment profiles compared to other seven ESWB countries, which report downward perception of distortions as plants age.

To analyze these facts, we develop a three-period overlapping generations model that describes a life-cycle occupational choice economy à la Lucas. In the first period of their lives, households must decide whether to be workers or entrepreneurs over the first two periods. We calibrate the model to match firm characteristics observed in the US economy and to replicate the employment profile ratio observed in Turkey 2013. We study the consequences of higher economic distortions for old plants, relative to young plants, on firm dynamics.

We find that introducing economic distortions only in the second period leads to a reduction in employment profile ratio and average firm size, an increase in the number of entrepreneurs, and to a higher share of small firms and a higher share of employment in small firms. For instance, when tax rate increases to 12.38% in the second period, the employment profile ratio reduces to almost 40% of its benchmark value, from 2.3177 to 1.4577. We then compare the size of distortion predicted by the model to match the observed employment profile ratio with the mean increase in the perception reported. It seems that firms' perception about how obstacles affect on their performance could be capturing the size of economic distortions suffered by firms.

Before concluding, we want to emphasize that there are many other relevant features that we do not study in this paper. We abstract the model in such a way that we can evaluate the effect on the employment profile arising from differences on economic distortions as firms age. Besides, it might be important to complement our research with an analysis that shows the relative role of the reduction of employment profile in shaping output. We leave this task for future work.

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8 Appendix

8.1 Appendix A: Data

In this section, we provide a detailed description of the cleaning data process and we present the variables used. Recall that we use the ESWB following the global methodology from 2006 to 2017. The original dataset consists of 135,245 observations, 241 country-surveys and 139 countries. The final sample consists of 102,509 observations, 231 country-surveys and 137 countries.

The variables we use from the ESWB are: the year in which the face-to-face interview begins (variable *a14y*), the year in which the establishment began operations (*b5*), permanent full-time employees end of last complete fiscal year (*l1*), permanent full-time employees three complete fiscal years ago (*l2*), temporary workers employed last fiscal year (*l6*), and average length of temporary employment (*l8*). In addition, we use the variable *b2c* to drop government/state ownership firms and *wt_ rs*, which is the re-scaled sampling weight. Data weighting is used to ensure a nationally representative sample for each economy.

Where available, we use the information from "DataDetails.xlsx" (provided by the World Bank) in order to recover observations for the variable *a14y*. We are not able to recover data for some country-surveys: China 2012, Brazil 2009, Croatia 2007, El Salvador 2006, Guatemala 2006, Honduras 2006, Nicaragua 2006, and Pakistan 2007. Note that variables *a14y* and *b5* are used to calculate firm age. Following explanations by the World Bank, we drop firms which have neither negative age nor more than 110 years ("Indicator Description", page 138).

To calculate total number of employees per establishment, we take into account both full-time and temporary employees. We use average length of temporary employment up to 12 months to calculate the number of temporary employees. We drop observations for which total number of employees is less than one, and several inconsistencies of the data regarding number of employees and size (for instance, we drop observations with total employees less than one hundred and size three).

With respect to the Penn World Table 9.0, the variables we use are: population in millions (the variable *pop*), the number of people engaged in millions (*emp*), the output-side real GDP at current PPPs (*cgdpo*), and the TFP level at current PPPs relative to the US (*ctfp*). The last available year is 2014. Note that for the following countries there is no data in the PWT 9.0: Afghanistan, DRC, Eritrea, Guyana, Kosovo, Micronesia, Papua New Guinea, Samoa, Solomon Islands, South Sudan, St. Kitts and Nevis, Timor-Leste, Vanuatu, and West Bank and Gaza.

8.2 Appendix B: Descriptive Statistics

Table 1. Descriptive statistics for the sample countries.

Country	Year	# of firms	Average establishment age	Share empl. by small plants	GDP pc 2014
Afghanistan	2008	408	8.55	0.156	
Afghanistan	2014	255	9.52	0.176	
Albania	2007	199	8.97	0.239	10873.18
Albania	2013	247	11.77	0.208	
Angola	2006	275	10.82	0.496	8476.77
Angola	2010	203	9.36	0.252	
Antigua and Barbuda	2010	134	18.14	0.297	15003.82
Argentina	2006	922	28.29	0.044	20007.17
Argentina	2010	942	27.19	0.092	
Argentina	2017	905	26.94	0.157	
Armenia	2009	255	11.17	0.081	9118.22
Armenia	2013	324	13.82	0.068	
Azerbaijan	2009	270	13.86	0.166	15798.9
Azerbaijan	2013	310	12.95	0.200	
Bahamas	2010	126	24.48	0.132	20910.82
Bangladesh	2007	599	14.48	0.030	2887.38
Bangladesh	2013	1,383	18.64	0.018	
Barbados	2010	111	16.43	0.276	9989.26
Belarus	2008	166	13.14	0.067	19889.71
Belarus	2013	279	11.95	0.178	
Belize	2010	147	18.29	0.280	7780.55
Benin	2009	115	13.28	0.237	2102.87
Benin	2016	136	15.87	0.095	
Bhutan	2009	231	14.52	0.213	6842.97
Bhutan	2015	223	14.35	0.305	
Bolivia	2006	547	20.06	0.163	5798.52
Bolivia	2010	274	26.41	0.084	
Bolivia	2017	309	18.42	0.205	
Bosnia and Herzegovina	2009	283	16.20	0.141	10025.99
Bosnia and Herzegovina	2013	332	17.53	0.168	
Botswana	2006	258	12.77	0.153	14886.24
Botswana	2010	253	15.75	0.086	
Bulgaria	2007	951	11.46	0.111	16768.45
Bulgaria	2009	250	12.67	0.214	
Bulgaria	2013	284	15.35	0.171	

Table 1. Descriptive statistics for the sample countries (continued).

Country	Year	# of firms	Average establishment age	Share empl. by small plants	GDP pc 2014
Burkina Faso	2009	323	12.77	0.128	1538.23
Burundi	2006	224	10.66	0.422	839.58
Burundi	2014	143	16.17	0.168	
Cambodia	2013	388	11.97	0.108	2983.80
Cambodia	2016	342	13.73	0.163	
Cameroon	2009	330	16.37	0.139	2680.79
Cameroon	2016	272	21.03	0.305	
Cape Verde	2009	111	20.88	0.250	6400.96
Central African Republic	2011	105	13.25	0.203	598.54
Chad	2009	113	15.71	0.189	1964.89
Chile	2006	938	26.38	0.039	21125.29
Chile	2010	979	24.32	0.024	
Colombia	2006	928	14.67	0.176	12710.09
Colombia	2010	917	16.56	0.147	
Congo	2009	69	13.04	0.112	4503.01
Costa Rica	2010	472	21.76	0.074	13356.4
Croatia	2013	327	16.29	0.252	20495.11
Czech Republic	2009	182	13.26	0.165	28953.47
Czech Republic	2013	223	17.41	0.172	
Côte d 'Ivoire	2009	335	10.38	0.256	3218.57
Côte d 'Ivoire	2016	277	16.97	0.171	
DRC	2010	315	16.00	0.149	
DRC	2013	446	11.18	0.308	
Djibouti	2013	164	17.85	0.185	3215.51
Dominica	2010	145	15.98	0.317	9064.77
Dominican Republic	2010	288	20.30	0.159	12630.63
Dominican Republic	2016	280	19.79	0.144	
Ecuador	2006	581	20.03	0.123	10921.67
Ecuador	2010	327	16.80	0.116	
Ecuador	2017	343	18.13	0.115	
Egypt	2013	2,316	18.36	0.129	10779.8
Egypt	2016	1,615	23.00	0.124	
El Salvador	2010	320	19.82	0.128	7964.29
El Salvador	2016	684	22.11	0.166	
Eritrea	2009	133	16.26	0.371	
Estonia	2009	237	12.76	0.228	25692.01

Table 1. Descriptive statistics for the sample countries (continued).

Country	Year	# of firms	Average establishment age	Share empl. by small plants	GDP pc 2014
Estonia	2013	246	15.49	0.240	
Ethiopia	2011	491	10.26	0.071	1489.08
Ethiopia	2015	722	13.47	0.119	
Fiji	2009	123	23.44	0.176	7111.90
Fyr Macedonia	2009	290	13.46	0.162	13123.57
Fyr Macedonia	2013	341	14.09	0.346	
Gabon	2009	115	12.95	0.183	13933.08
Gambia	2006	123	11.61	0.183	1860.82
Georgia	2008	279	10.13	0.087	10307.29
Georgia	2013	260	9.69	0.178	
Ghana	2007	167	18.24	0.115	3608.04
Ghana	2013	597	16.07	0.145	
Grenada	2010	139	23.38	0.286	10546.67
Guatemala	2010	553	23.94	0.051	6874.59
Guinea	2006	177	9.76	0.348	1573.13
Guinea	2016	92	9.89	0.542	
Guinea Bissau	2006	133	11.46	0.515	1256.59
Guyana	2010	146	23.87	0.054	
Honduras	2010	308	24.06	0.083	4317.88
Honduras	2016	296	21.83	0.121	
Hungary	2009	266	13.55	0.092	22629.34
Hungary	2013	230	14.73	0.263	
India	2014	8,780	16.41	0.063	5386.09
Indonesia	2009	1,330	15.18	0.256	9642.26
Indonesia	2015	1,280	19.15	0.290	
Iraq	2011	715	10.66	0.698	11923.02
Israel	2013	461	22.28	0.199	31242.38
Jamaica	2010	271	21.02	0.311	7198.10
Jordan	2013	487	16.69	0.147	11741.10
Kazakhstan	2009	436	9.83	0.073	23118.94
Kazakhstan	2013	514	11.55	0.149	
Kenya	2007	649	11.32	0.106	2956.06
Kenya	2013	671	20.27	0.095	
Kosovo	2009	233	11.95	0.354	
Kosovo	2013	174	15.67	0.167	

Table 1. Descriptive statistics for the sample countries (continued).

Country	Year	# of firms	Average establishment age	Share empl. by small plants	GDP pc 2014
Kyrgyz Republic	2009	210	15.45	0.139	5599.21
Kyrgyz Republic	2013	238	12.73	0.074	
Lao PDR	2009	349	12.42	0.258	5665.84
Lao PDR	2012	228	13.04	0.080	
Lao PDR	2016	330	13.84	0.502	
Latvia	2009	220	11.93	0.172	22171.79
Latvia	2013	253	13.83	0.245	
Lebanon	2013	476	22.10	0.205	14018.35
Lesotho	2009	112	14.07	0.034	2799.77
Lesotho	2016	128	14.25	0.114	
Liberia	2009	143	7.51	0.651	876.55
Liberia	2017	140	14.36	0.223	
Lithuania	2009	226	12.72	0.174	24980
Lithuania	2013	192	13.84	0.285	
Madagascar	2009	394	17.76	0.102	1236.85
Madagascar	2013	226	14.53	0.107	
Malawi	2009	128	14.72	0.071	971.42
Malawi	2014	389	18.73	0.119	
Malaysia	2015	760	16.36	0.020	21391.48
Mali	2007	196	13.33	0.249	1506.52
Mali	2010	250	11.69	0.354	
Mali	2016	128	19.22	0.205	
Mauritania	2006	212	11.65	0.393	3331.66
Mauritania	2014	103	16.96	0.076	
Mauritius	2009	326	15.25	0.123	17909.29
Mexico	2006	1,265	16.73	0.207	15424.44
Mexico	2010	1,328	20.42	0.048	
Micronesia	2009	60	17.22	0.300	
Moldova	2009	298	10.93	0.151	5354.64
Moldova	2013	308	12.32	0.236	
Mongolia	2009	339	11.61	0.097	10918.27
Mongolia	2013	325	10.92	0.159	
Montenegro	2009	100	10.97	0.387	16540.17
Montenegro	2013	134	14.66	0.293	
Morocco	2013	361	20.84	0.112	7251.31

Table 1. Descriptive statistics for the sample countries (continued).

Country	Year	# of firms	Average establishment age	Share empl. by small plants	GDP pc 2014
Mozambique	2007	137	16.43	0.081	1211.41
Myanmar	2014	568	13.74	0.153	5567.86
Myanmar	2016	547	16.37	0.207	
Namibia	2006	243	13.84	0.287	11060.93
Namibia	2014	466	10.20	0.291	
Nepal	2009	317	11.65	0.440	2577.68
Nepal	2013	467	14.25	0.446	
Nicaragua	2010	301	24.73	0.118	4494.65
Nicaragua	2016	315	23.19	0.295	
Niger	2009	104	17.07	0.338	868.03
Niger	2017	106	16.28	0.107	
Nigeria	2007	1,882	9.63	0.354	5499.23
Nigeria	2014	1,212	15.49	0.376	
Pakistan	2013	794	21.88	0.017	4797.64
Panama	2006	533	24.13	0.155	19792.23
Panama	2010	309	16.84	0.209	
Papua New Guinea	2015	63	27.99	0.013	
Paraguay	2006	549	21.49	0.134	8168.83
Paraguay	2010	312	20.98	0.077	
Paraguay	2017	312	23.09	0.088	
Peru	2006	596	18.78	0.035	10846.83
Peru	2010	931	16.33	0.065	
Peru	2017	898	22.80	0.070	
Philippines	2009	1,189	17.46	0.068	6603.00
Philippines	2015	1,159	20.23	0.123	
Poland	2009	310	17.03	0.197	24278.27
Poland	2013	424	19.08	0.144	
Romania	2009	407	12.54	0.233	20018.53
Romania	2013	494	15.18	0.235	
Russia	2009	816	14.23	0.039	23768.19
Russia	2012	3,445	10.72	0.083	
Rwanda	2006	150	12.10	0.058	1626.87
Rwanda	2011	199	9.67	0.155	
Samoa	2009	87	19.83	0.140	
Senegal	2007	136	14.57	0.143	2309.26

Table 1. **Descriptive statistics for the sample countries (continued).**

Country	Year	# of firms	Average establishment age	Share empl. by small plants	GDP pc 2014
Senegal	2014	472	17.08	0.119	
Serbia	2009	314	16.58	0.134	13391.78
Serbia	2013	308	15.33	0.287	
Sierra Leone	2009	69	15.98	0.688	1353.07
Sierra Leone	2017	126	18.76	0.494	
Slovak Republic	2009	185	12.62	0.233	24944.41
Slovak Republic	2013	239	16.26	0.154	
Slovenia	2009	230	17.64	0.118	27475.21
Slovenia	2013	227	20.39	0.357	
Solomon Islands	2015	125	19.69	0.081	
South Africa	2007	345	19.75	0.026	11962.84
South Sudan	2014	401	6.56	0.457	
Sri Lanka	2011	496	23.18	0.168	10729.67
St Kitts and Nevis	2010	133	19.22	0.196	
St Lucia	2010	150	15.29	0.255	10338.26
St Vicent and Grenadines	2010	133	21.14	0.302	8547.66
Sudan	2014	587	13.38	0.217	3681.51
Suriname	2010	151	22.27	0.160	14463.2
Swaziland	2006	195	13.49	0.122	7537.61
Swaziland	2016	103	17.72	0.209	
Sweden	2014	500	28.72	0.109	42117.17
Tajikistan	2008	280	14.06	0.065	3183.63
Tajikistan	2013	239	11.87	0.121	
Tanzania	2006	352	12.54	0.211	2309.12
Tanzania	2013	458	13.63	0.250	
Thailand	2016	854	19.36	0.139	13586.9
Timor-Leste	2009	111	6.29	0.183	
Timor-Leste	2015	120	10.99	0.260	
Togo	2009	117	11.97	0.323	1445.99
Togo	2016	135	14.77	0.080	
Tonga	2009	136	12.90	0.784	
Trinidad and Tobago	2010	342	20.66	0.324	30984.51
Tunisia	2013	564	20.74	0.103	10535.24
Turkey	2008	791	17.49	0.076	19521.83
Turkey	2013	1,062	16.60	0.148	

Table 1. Descriptive statistics for the sample countries (continued).

Country	Year	# of firms	Average establishment age	Share empl. by small plants	GDP pc 2014
Uganda	2006	502	12.71	0.168	1852.91
Uganda	2013	540	10.61	0.299	
Ukraine	2008	673	14.91	0.108	10256.68
Ukraine	2013	165	14.06	0.178	
Uruguay	2006	531	27.18	0.227	19573.12
Uruguay	2010	532	23.41	0.178	
Uruguay	2017	292	26.40	0.131	
Uzbekistan	2008	292	13.54	0.325	8363.78
Uzbekistan	2013	260	10.24	0.217	
Vanuatu	2009	102	18.32	0.234	
Venezuela	2010	249	19.50	0.240	15117.76
Vietnam	2009	857	9.93	0.055	5411.61
Vietnam	2015	763	10.73	0.048	
West Bank and Gaza	2013	323	18.63	0.596	
Yemen	2010	418	15.45	0.306	3491.15
Yemen	2013	326	24.04	0.331	
Zambia	2007	115	21.67	0.045	3576.25
Zambia	2013	640	14.79	0.251	
Zimbabwe	2011	521	32.64	0.091	1902.23
Zimbabwe	2016	512	22.03	0.187	

Sources: Enterprise Surveys of the World Bank and Penn World Table 9.0

Note: only data for last year available is reported for GDP per capita. Note that in order to calculate correlations, where necessary, we average the values for the different years by country (for firm age and share of employment).

8.3 Appendix C: Empirical Analysis

Illustrative Example. Synthetic Employment Profile.

Year	Synthetic Cohort
$Empl_{0-4}^{year}$	$Empl_{0-4}^{synthetic} = Empl_{0-4}^{year}$
$(Empl_{4-6} - Empl_{0-4}) = g_1$	$Empl_{4-6}^{synthetic} = Empl_{0-4}^{synthetic}(1+g_1)$
$(Empl_{6-8} - Empl_{4-6}) = g_2$	$Empl_{6-8}^{synthetic} = Empl_{4-6}^{synthetic}(1+g_2)$
$(Empl_{8-10} - Empl_{6-8}) = g_3$	$Empl_{8-10}^{synthetic} = Empl_{6-8}^{synthetic}(1+g_3)$
...	...

Note: $Empl_{0-4}^{year}$ indicates the mean number of employees working in a plant between 0 and 4 years at $year$.
g_i is the average growth among survived plants at the year they have been surveyed.

Table 6. Synthetic Employment Profile.

Higher perception of distortions							
Firm age	0-8	8-12	12-16	16-20	20-24	24-28	28-32
Bahamas 2010	1	1.17	0.71	0.86	1.05	1.45	1.59
Cambodia 2016	1	1.39	1.54	1.77	1.99	2.43	2.90
Cameroon 2016	1	1.15	1.51	2.38	2.36	1.56	1.65
Costa Rica 2010	1	1.10	1.12	0.83	1.03	2.54	2.66
El Salvador 2016	1	1.24	1.29	1.59	2.16	2.29	2.31
Fyr Macedonia 2013	1	1.80	1.66	1.85	2.11	2.54	2.93
Guyana 2010	1	1.17	1.55	1.70	1.92	2.24	2.50
Malawi 2014	1	1.22	1.34	1.35	1.63	1.36	2.32
Mexico 2010	1	0.84	0.90	1.62	1.87	1.99	1.97
Lower perception of distortions							
Firm age	0-8	8-12	12-16	16-20	20-24	24-28	28-32
Bosnia and Herzegovina 2009	1	1.53	2.96	4.05	5.80	7.33	7.57
Cape Verde 2009	1	1.38	1.51	2.16	3.65	3.48	3.78
Chile 2006	1	1.35	1.55	1.68	1.97	2.71	4.18
Pakistan 2013	1	1.44	1.91	1.77	3.09	4.21	4.54
Russia 2009	1	1.77	3.41	3.98	4.56	5.13	5.71
Turkey 2013	1	1.17	1.45	1.96	2.49	2.86	3.61
Vanuatu 2009	1	1.80	2.79	3.56	3.80	4.12	5.59

8.4 Appendix D: Proofs

Entrepreneurs' profit maximization

$$\max_{\{k_z,n_z\}} \left[(1-\tau)Az^{(1-\gamma)}\left(n_z^{(1-\alpha)}k_z^{\alpha}\right)^{\gamma} - (r+\delta)k_z - wn_z\right]$$

$$\rightarrow \frac{\partial \pi_z}{\partial n_z} = \gamma\left(n_z^{(1-\alpha)}k_z^{\alpha}\right)^{\gamma-1}(1-\tau)Az^{(1-\gamma)}(1-\alpha)n_z^{-\alpha}k_z^{\alpha} - w = 0$$

$$\gamma(1-\alpha)(1-\tau)Az^{(1-\gamma)}\left(n_z^{(1-\alpha)}\right)^{\gamma-1}n_z^{-\alpha}\left(k_z^{\alpha}\right)^{\gamma-1}k_z^{\alpha} = w$$

$$\gamma(1-\alpha)(1-\tau)Az^{(1-\gamma)}n_z^{(1-\alpha)\gamma-(1-\alpha)-\alpha}k_z^{\alpha\gamma-\alpha+\alpha} = w$$

$$\gamma(1-\alpha)(1-\tau)\frac{Az^{(1-\gamma)}\left(n_z^{(1-\alpha)}k_z^{\alpha}\right)^{\gamma}}{n_z} = w$$

$$(1-\tau)(1-\alpha)\gamma\frac{y_z}{n_z} = w \tag{2}$$

$$\rightarrow \frac{\partial \pi_z}{\partial k_z} = \gamma\left(n_z^{(1-\alpha)}k_z^{\alpha}\right)^{\gamma-1}(1-\tau)Az^{(1-\gamma)}n_z^{(1-\alpha)}\alpha k_z^{\alpha-1} - (r+\delta) = 0$$

$$\gamma\alpha(1-\tau)Az^{(1-\gamma)}\left(n_z^{(1-\alpha)}\right)^{\gamma-1}n_z^{(1-\alpha)}\left(k_z^{\alpha}\right)^{\gamma-1}k_z^{\alpha-1} = r+\delta$$

$$\gamma\alpha(1-\tau)Az^{(1-\gamma)}n_z^{(1-\alpha)\gamma-(1-\alpha)+(1-\alpha)}k_z^{\alpha\gamma-\alpha+\alpha-1} = r+\delta$$

$$\gamma\alpha(1-\tau)\frac{Az^{(1-\gamma)}\left(n_z^{(1-\alpha)}k_z^{\alpha}\right)^{\gamma}}{k_z} = r+\delta$$

$$(1-\tau)\alpha\gamma\frac{y_z}{k_z} = r+\delta \tag{3}$$

From (2),

$$n_z = \left(\frac{\gamma(1-\alpha)(1-\tau)Az^{(1-\gamma)}k_z^{\alpha\gamma}}{w}\right)^{\frac{1}{1-(1-\alpha)\gamma}}$$

From (3),

$$k_z = \left(\frac{\gamma\alpha(1-\tau)Az^{(1-\gamma)}n_z^{(1-\alpha)\gamma}}{r+\delta}\right)^{\frac{1}{1-\alpha\gamma}}$$

Optimal demand for $\mathbf{k}_z$

$$k_z = \left(\frac{\gamma\alpha(1-\tau)Az^{(1-\gamma)} \left(\frac{\gamma(1-\alpha)(1-\tau)Az^{(1-\gamma)}k_z^{\alpha\gamma}}{w}\right)^{\frac{(1-\alpha)\gamma}{1-(1-\alpha)\gamma}}}{r+\delta} \right)^{\frac{1}{1-\alpha\gamma}}$$

$$\begin{aligned} k_z &= \gamma^{\frac{1}{1-\alpha\gamma}+\frac{(1-\alpha)\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} \alpha^{\frac{1}{1-\alpha\gamma}} (1-\tau)^{\frac{1}{1-\alpha\gamma}+\frac{(1-\alpha)\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} A^{\frac{1}{1-\alpha\gamma}+\frac{(1-\alpha)\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} \cdot \\ &\cdot z^{\frac{1-\gamma}{1-\alpha\gamma}+\frac{(1-\gamma)(1-\alpha)\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} (1-\alpha)^{\frac{(1-\alpha)\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} k_z^{\frac{\alpha\gamma(1-\alpha)\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} \left(\frac{1}{r+\delta}\right)^{\frac{1}{1-\alpha\gamma}} \left(\frac{1}{w}\right)^{\frac{(1-\alpha)\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} \end{aligned}$$

$$\begin{aligned} k_z &= \gamma^{\frac{1-(1-\alpha)\gamma+(1-\alpha)\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} \alpha^{\frac{1}{1-\alpha\gamma}} (1-\tau)^{\frac{1-(1-\alpha)\gamma+(1-\alpha)\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} A^{\frac{1-(1-\alpha)\gamma+(1-\alpha)\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} z^{\frac{(1-\gamma)[1-(1-\alpha)\gamma+(1-\alpha)\gamma]}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} \cdot \\ &\cdot (1-\alpha)^{\frac{(1-\alpha)\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} k_z^{\frac{\alpha\gamma(1-\alpha)\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} \left(\frac{1}{r+\delta}\right)^{\frac{1}{1-\alpha\gamma}} \left(\frac{1}{w}\right)^{\frac{(1-\alpha)\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} \end{aligned}$$

$$\rightarrow k_z^{\frac{[1-(1-\alpha)\gamma](1-\alpha\gamma)-\alpha\gamma(1-\alpha)\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} = k_z^{\frac{1-\alpha\gamma-\gamma+\alpha\gamma^2+\alpha\gamma-\alpha^2\gamma^2-\alpha\gamma^2+\alpha^2\gamma^2}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} = k_z^{\frac{1-\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}}$$

$$k_z = \gamma^{\frac{1}{1-\gamma}} \alpha^{\frac{1-(1-\alpha)\gamma}{1-\gamma}} (1-\tau)^{\frac{1}{1-\gamma}} A^{\frac{1}{1-\gamma}} z (1-\alpha)^{\frac{(1-\alpha)\gamma}{1-\gamma}} \left(\frac{1}{r+\delta}\right)^{\frac{1-(1-\alpha)\gamma}{1-\gamma}} \left(\frac{1}{w}\right)^{\frac{(1-\alpha)\gamma}{1-\gamma}}$$

$$k_z = z\gamma^{\frac{1}{1-\gamma}} \alpha^{\frac{1-(1-\alpha)\gamma}{1-\gamma}} (1-\alpha)^{\frac{(1-\alpha)\gamma}{1-\gamma}} [(1-\tau)A]^{\frac{1}{1-\gamma}} \left(\frac{1}{r+\delta}\right)^{\frac{1-(1-\alpha)\gamma}{1-\gamma}} \left(\frac{1}{w}\right)^{\frac{(1-\alpha)\gamma}{1-\gamma}} \tag{4}$$

Optimal demand for $\mathbf{n}_z$

$$n_z = \left(\frac{\gamma(1-\alpha)(1-\tau)Az^{(1-\gamma)} \left(\frac{\gamma\alpha(1-\tau)Az^{(1-\gamma)}n_z^{(1-\alpha)\gamma}}{r+\delta}\right)^{\frac{\alpha\gamma}{1-\alpha\gamma}}}{w} \right)^{\frac{1}{1-(1-\alpha)\gamma}}$$

$$\begin{aligned} n_z &= \gamma^{\frac{1}{1-(1-\alpha)\gamma}+\frac{\alpha\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} (1-\alpha)^{\frac{1}{1-(1-\alpha)\gamma}} (1-\tau)^{\frac{1}{1-(1-\alpha)\gamma}+\frac{\alpha\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} A^{\frac{1}{1-(1-\alpha)\gamma}+\frac{\alpha\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} \cdot \\ &\cdot z^{\frac{1-\gamma}{1-(1-\alpha)\gamma}+\frac{(1-\gamma)\alpha\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} \alpha^{\frac{\alpha\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} n_z^{\frac{(1-\alpha)\gamma\alpha\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} \left(\frac{1}{r+\delta}\right)^{\frac{\alpha\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} \left(\frac{1}{w}\right)^{\frac{1}{1-(1-\alpha)\gamma}} \end{aligned}$$

$$\begin{aligned} n_z &= \gamma^{\frac{1-\alpha\gamma+\alpha\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} (1-\alpha)^{\frac{1}{1-(1-\alpha)\gamma}} (1-\tau)^{\frac{1-\alpha\gamma+\alpha\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} A^{\frac{1-\alpha\gamma+\alpha\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} z^{\frac{(1-\gamma)(1-\alpha\gamma+\alpha\gamma)}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} \cdot \\ &\cdot \alpha^{\frac{\alpha\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} n_z^{\frac{(1-\alpha)\gamma\alpha\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} \left(\frac{1}{r+\delta}\right)^{\frac{\alpha\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} \left(\frac{1}{w}\right)^{\frac{1}{1-(1-\alpha)\gamma}} \end{aligned}$$

$$\rightarrow n_z^{\frac{[1-(1-\alpha)\gamma](1-\alpha\gamma)-(1-\alpha)\gamma\alpha\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} = n_z^{\frac{1-\alpha\gamma-\gamma+\alpha\gamma^2+\alpha\gamma-\alpha^2\gamma^2-\alpha\gamma^2+\alpha^2\gamma^2}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}} = n_z^{\frac{1-\gamma}{[1-(1-\alpha)\gamma](1-\alpha\gamma)}}$$

$$n_z = \gamma^{\frac{1}{1-\gamma}} (1-\alpha)^{\frac{1-\alpha\gamma}{1-\gamma}} (1-\tau)^{\frac{1}{1-\gamma}} A^{\frac{1}{1-\gamma}} z \alpha^{\frac{\alpha\gamma}{1-\gamma}} \left(\frac{1}{r+\delta}\right)^{\frac{\alpha\gamma}{1-\gamma}} \left(\frac{1}{w}\right)^{\frac{1-\alpha\gamma}{1-\gamma}}$$

$$n_z = z\gamma^{\frac{1}{1-\gamma}} \alpha^{\frac{\alpha\gamma}{1-\gamma}} (1-\alpha)^{\frac{1-\alpha\gamma}{1-\gamma}} [(1-\tau)A]^{\frac{1}{1-\gamma}} \left(\frac{1}{r+\delta}\right)^{\frac{\alpha\gamma}{1-\gamma}} \left(\frac{1}{w}\right)^{\frac{1-\alpha\gamma}{1-\gamma}} \tag{5}$$

Optimal income $\mathbf{y}_z$

$$y_z = Az^{(1-\gamma)}\left(n_z^{(1-\alpha)}k_z^{\alpha}\right)^{\gamma} =$$

$$= Az^{(1-\gamma)}\left[z^{1-\alpha}\gamma^{\frac{1-\alpha}{1-\gamma}}\alpha^{\frac{(1-\alpha)\alpha\gamma}{1-\gamma}}(1-\alpha)^{\frac{(1-\alpha\gamma)(1-\alpha)}{1-\gamma}}[(1-\tau)A]^{\frac{1-\alpha}{1-\gamma}}\left(\frac{1}{r+\delta}\right)^{\frac{(1-\alpha)\alpha\gamma}{1-\gamma}}\left(\frac{1}{w}\right)^{\frac{(1-\alpha\gamma)(1-\alpha)}{1-\gamma}}\right]^{\gamma}\cdot$$

$$\cdot\left[z^{\alpha}\gamma^{\frac{\alpha}{1-\gamma}}\alpha^{\frac{[1-(1-\alpha)\gamma]\alpha}{1-\gamma}}(1-\alpha)^{\frac{(1-\alpha)\gamma\alpha}{1-\gamma}}[(1-\tau)A]^{\frac{\alpha}{1-\gamma}}\left(\frac{1}{r+\delta}\right)^{\frac{[1-(1-\alpha)\gamma]\alpha}{1-\gamma}}\left(\frac{1}{w}\right)^{\frac{(1-\alpha)\gamma\alpha}{1-\gamma}}\right]^{\gamma} =$$

$$= Az^{(1-\gamma)}\left[z\gamma^{\frac{1}{1-\gamma}}\alpha^{\frac{\alpha\gamma-\alpha^2\gamma+\alpha-\alpha\gamma+\alpha^2\gamma}{1-\gamma}}(1-\alpha)^{\frac{1-\alpha-\alpha\gamma+\alpha^2\gamma+\alpha\gamma-\alpha^2\gamma}{1-\gamma}}[(1-\tau)A]^{\frac{1}{1-\gamma}}\right]^{\gamma}\cdot$$

$$\cdot\left[\left(\frac{1}{r+\delta}\right)^{\frac{\alpha\gamma-\alpha^2\gamma+\alpha-\alpha\gamma+\alpha^2\gamma}{1-\gamma}}\left(\frac{1}{w}\right)^{\frac{1-\alpha-\alpha\gamma+\alpha^2\gamma+\alpha\gamma-\alpha^2\gamma}{1-\gamma}}\right]^{\gamma} =$$

$$= A^{\frac{1}{1-\gamma}}z\left[\gamma^{\frac{1}{1-\gamma}}(1-\tau)^{\frac{1}{1-\gamma}}\alpha^{\frac{\alpha}{1-\gamma}}(1-\alpha)^{\frac{1-\alpha}{1-\gamma}}\left(\frac{1}{r+\delta}\right)^{\frac{\alpha}{1-\gamma}}\left(\frac{1}{w}\right)^{\frac{1-\alpha}{1-\gamma}}\right]^{\gamma} \tag{6}$$

Intertemporal budget constraint

$$\begin{aligned} c_1 + s_1 &= w, \\ c_2 + s_2 &= w + (1+r)s_1, \\ c_3 &= (1+r)s_2, \end{aligned}$$

$$\begin{aligned} c_2 + s_2 &= w + (1+r)(w - c_1) \\ s_2 &= w + (1+r)(w - c_1) - c_2 \\ c_3 &= (1+r)\left[w + (1+r)w - (1+r)c_1 - c_2\right] \end{aligned}$$

$$\begin{aligned} c_3 + (1+r)^2 c_1 + (1+r)c_2 &= (1+r)w + (1+r)^2 w \\ c_1 + \frac{c_2}{(1+r)} + \frac{c_3}{(1+r)^2} &= \frac{w}{(1+r)} + w \end{aligned}$$

$$c_1 + \frac{c_2}{(1+r)} + \frac{c_3}{(1+r)^2} = w\left[1 + \frac{1}{(1+r)}\right] \tag{12}$$

Walras' Law

$$C + I + G =$$

$$F(z^*) \cdot [c_1^w \mu_1 + c_2^w \mu_2 + c_3^w \mu_3] + \mu_1 \int_{z^*}^{z^{\max}} c_1(z) f_1 dz + \mu_2 \int_{z^*}^{z^{\max}} c_2(z) f_2 dz + \mu_3 \int_{z^*}^{z^{\max}} c_3(z) f_3 dz +$$

$$+K - (1-\delta)K + \tau \int_{z^*}^{z^{\max}} y(z, r, w, \tau) f_2(z) dz =$$

$$= F(z^*) \cdot \{(w - s_1)\mu_1 + [w + (1+r)s_1 - s_2]\mu_2 + [(1+r)s_2]\mu_3\} + \mu_1 \int_{z^*}^{z^{\max}} \{[y_1 - wn_z - (r+\delta)k_z] - s_1\} f_1 dz$$

$$+\mu_2 \int_{z^*}^{z^{\max}} \{[(1+\tau)y_2 - wn_z - (r+\delta)k_z] + (1+r)s_1 - s_2\} f_2 dz + \mu_3 \int_{z^*}^{z^{\max}} [(1+r)s_2] f_3 dz +$$

$$+K - (1-\delta)K + \tau \int_{z^*}^{z^{\max}} y_2 f_2(z) dz$$

Note that $\mu_1 = \mu_2 = \mu_3 = 1$. Then, it is easy to see that the wage bill of employees and entrepreneurs will cancel out, as well as the savings. Besides, remember that the costs faced by the entrepreneurs as a consequence of the economic distortions in the second period are captured entirely by the government, i.e. they also cancel out. Hence, we have that:

$$F(z^*) \cdot [r(s_1 + s_2)] + \int_{z^*}^{z^{\max}} [y_1 - (r+\delta)k_z] f_1 dz + \int_{z^*}^{z^{\max}} [y_2 - (r+\delta)k_z + rs_1] f_2 dz + \int_{z^*}^{z^{\max}} [rs_2] f_3 dz + \delta K$$

$$= \int_{z^*}^{z^{\max}} y_1 f_1 dz + \int_{z^*}^{z^{\max}} y_2 f_2 dz = Y$$