Three Essays on Portuguese Economic Growth, Firm Formation, and Productivity

by

Andre Regateiro

A dissertation submitted in partial fulfilment of the
requirements for the degree of Doctor of Philosophy

at

School of Information Systems and Management H. John Heinz III College Carnegie Mellon University

Advisory Comitee:

Lee Branstetter (Chair)
Serguey Braguisky
Miguel Torres Preto

June 16th, 2014

0.1 Acknowledgements

This work would not have been possible without the efforts of a number of deeply committed faculty advisors. **Rui Baptista** provided the initial motivation for the study of the Portuguese economy, and together with **Francisco Lima** gained access to excellent data that served as the basis for the entire thesis. **Miguel Torres Preto** provided excellent support in the final stages of this thesis.

I am specially thankful to **Serguey Braguinsky** and **Lee Branstetter**, they became my main mentors:

Serguey Braguisky shared my enthusiasm for the subject matter and patiently walk me through the all the steps of research. His broad knowledge in econometrics and modelling inspired me to look further at each step.

Lee Branstetter pushed me to look for the important answers, the things that matter most. By doing so **Lee** raised both the quality and the impact of this research. It is because of him that I wish to pursue these subjects for the next couple of years.

Given the impact of their contribution it is only fair to equally blame them for any errors or omissions.

While working on this thesis I meet and married **Andreia**. I couldnt have asked for a better outcome for these years.

Contents

List of Figures

List of Tables

0.2 Introduction

Portugal is in deep economic trouble. It has been so for years, but the world only recently took notice. This thesis uses detailed micro-data to look into Portugal's economy and points to several causes to its malaise. Portuguese small and shrinking firms are extremely unproductive, public policies trying to protect workers and small firms are aggravating the problem. These policies backfire terribly, small firms do not create more jobs, and protecting jobs leads to lower wages and massive welfare losses. Each chapter in this thesis looks deeply into each one of these problems.

The first chapter of revisits the discussion of the relationship between firm size and job creation and the relationship between firm size and firm growth. We find that the relationship between firm size and firm growth is mediated by the industry conditions: In declining or low-growth industries smaller firms grow faster than larger ones but that relationship reverses for faster growing industries. This effect seems to be caused by a greater ability of larger firms to adapt to the economic climate. Small firms are always job creators. Large firms switch from job destroyers to job creators as industry conditions improve. We also find that adapting firm growth to industry growth has a positive impact on firm survival. Overall the results of this chapter find very little support for the proposition that small firms create more jobs. Public polices favouring small firms should be reevaluated.

The second chapter again uses the extensive matched employer-employee data set to document an unusual feature of the Portuguese economy. For decades, the entire Portuguese firm size distribution has been shifting to the left. We argue in this paper that Portugal's shrinking firms are linked to the country's anaemic growth and low productivity. We show that the shift in the Portuguese firm size distribution is not reflected in other advanced industrial economies for which we have been able to obtain comparable data. Careful attempts to account for expanding data coverage, a structural shift from manufacturing to services, and aggressive efforts to "demonopolize" the Portuguese economy leave more than half of this shift unexplained by these factors. So, what does explain this shift? We argue that Portugal's uniquely strong protections for regular workers have played an important role. Drawing upon an emerging literature that attributes much of the productivity gap between advanced nations and developing nations to the misallocation of resources across firms in developing countries, we develop a theoretical model that shows how Portugal's labor market institutions could prevent more productive firms from reaching their optimal size, thereby constraining GDP per capita. Calibration exercises based on this model quantify the degree of labor market distortion consistent with the recent shifts in the Portuguese firm size distribution. These calibration exercises suggest quite substantial growth effects could arise if the distortions were lessened or abolished altogether.

The third chapter takes a closer look at actual the productivity levels of Portuguese industries. It does so by leveraging the comprehensive matched employer employee data set with the detailed cross country analysis of the KLEMS project. This allows for a detailed comparison of Portugal and other KLEMS countries. The results are staggering. Portuguese firms are unproductive, incredibly unproductive. Portuguese firms in the beginning of our data window have a very large productivity gap to other countries. From 1985 to 1995 that gap was reduced but since 1995 there is no sign of progress and in some industries the productivity gap actually widens.

Comparing Portugal with its european neighbours in a detailed growth accounting exercise shows that Portuguese firms are able to produce much less given the same level of inputs. Total Factor Productivity (TFP) since 1995 has been mostly negative. Even when using the same composition of labour Portuguese firms are unable to match other countries. This result strongly reinforces the findings of chapter 2. The misallocation of capital and labour into small firms is causing massive productivity losses.

The economic problems of Portugal are now easier to understand, if not to solve.

Chapter 1

Revisiting Firms Size and Job Creation

1.1 Introduction

Policy makers typically focus on Small and Medium Enterprises (SMEs) as the engines of economic growth and job creation. Examples of this can be seen in practically every job related legislation of most countries.

The United States government, trough the Small Business Administration, guarantees loans to SMEs that in 2008 reached 84 Billion dollars. The European Union published a charter for SMEs during the review of the Lisbon Strategy in 2004.[1] A lot of these policies were implemented in response to earlier studies of the job creation responsibilities of smaller firms.

Past studies have dealt with two related but distinct questions: what is the relationship between firm size and firm growth and what is the relationship between firm size and job creation.

The first question asks how the growth rate of firms is affected by their size. The second one adds the Firm Size Distribution (FSD) into the equation and asks: Given the current FSD and the growth rate of different-sized firms what firm size category generates most jobs? Two main fields in economics have looked into the consequences of firm size. The Industrial Organization (IO) literature tries to answer the first question. The main interest of this literature is to discover the fundamental rules that govern the growth process of firms. This has been done through several theoretical and empirical research efforts. The Public Policy literature tries to answer the second question. Its main concern is to provide policy guidelines as to maximise employment growth. This has been done mostly trough empirical investigations of the relationship between firm size and job creation.

The two questions differ if the Firm Size Distribution is not symmetric. It may be the case that small firms grow faster than larger ones, but if larger firms have a higher share of total employment it might compensate for their lower growth. This distinction in approach does not seem to have been completely appreciated in the previous literature.

When analysing the previous studies on the relationship between firm size and job creation we can get a glimpse that the relationship can be dependent on overall industry condition. Most of the literature finds that

[1] http://ec.europa.eu/enterprise/policies/sme/best-practices/charter/

small firms grow faster and most of the literature analyses declining industries, particularly manufacturing. The main contribution of this paper is to show that in fact industry conditions mediate the relationship between firm size and job creation. It will show that in declining or low growth industries smaller firms are responsible for most job creation but that in growing industries it is the larger firms that contribute most to job creation. We will also analyse the reasons behind this difference and conclude that larger firms choose to adapt to the economic climate while smaller firms do not. We also find that adapting firm growth to industry growth improves the survival probabilities of firms of all size.

The remainder of this section will analyse the two previously identified strands of literature that have tackled these issues. Section 2 will present the database used. Section 3 will present the methodology used, our contributions to it and the results it provides. Section 4 will test the robustness of the results. Section 5 will look deeper into the causes of differentiated growth. Section 6 will conclude and provide a discussion of the results.

1.1.1 Job Creation Literature

The field started getting attention with a series of studies performed by Birch (1979, 1981, 1987). In these reports Birch establishes that firms in the US manufacturing sector with less than 20 workers were responsible for 66% of net new job creation.

The most compelling fact about these results is the disproportionability between the extremely small share of under 20 worker companies in total employment (about 5%) and its impact on net job creation (about 66%).

A series of studies followed these initial reports.

Kirchhoff and Phillips (1988) found that US firms with less them 100 workers are major sources of job creation.

Davis et al. (1996, 1998) criticised these early reports of the importance of small firms in job creation. They show that the methodology followed by Birch is prone to data misinterpretation, statistical bias and was based on poor data quality. Another problem is identified by Davis et al. (1998) as the regression to the mean fallacy. To account for it the authors propose a new procedure to measure growth rate that is more robust to the fallacy, the so-called average size methodology. The authors test their new procedure on the Longitudinal Research Database, covering US manufacturing firms from 1972 to 1998, and find that job creation rates for different-sized firms are very similar

In contrast, Davidsson et al. (1998) do a comparison of the base size and the average size methodology but do not find relevant differences in the results. They report that smaller (less than 200 employees) Swedish establishments are disproportionally responsible for net job growth. A detailed account of the different methodologies, the regression fallacy as identified by previous research, their solution, and other methods is given in section 3. The notion that accounting methodology does matter is not yet fully appreciated in the research efforts in this area.

The studies by Davis et al. (1996, 1998) became seminal in the labor literature and several studies using similar methodologies surfaced in the following years. Blanchflower and Burgess (1996) used a 1980, 1984 and 1990 survey of UK manufacturing plants and found that small plants grew faster in this period than larger ones. As a major drawback the survey only included firms with more than 25 workers so the smallest plants were left out of the analysis.

Broersma and Gautier (1997) studied the Dutch manufacturing sector from 1979 to 1991 and found that small firms are responsible for a larger share of job creation, destruction and net than larger firms. This study also finds that job persistence increases with firm size and interestingly is not affected by the business cycle. The authors also note a positive correlation between net job creation and total industry job growth for small firms and a negative correlation for larger firms, and come to the conclusion that small firms are more elastic in their hiring practices. This result is not generalizable as it is done analyzing only one industry and not taking firms with less than 10 workers into account.

Picot and Dupuy (1998) used the same method as Davis et al. (1998) and found that smaller firms in Canada actually grow faster than larger ones. They also control for the wage differential between firm sizes and still they find that value (measured by wage-bill) in small firms grows faster than in larger ones . The authors do a comparison between net job creation rates by firm size using different methodologies and find that, even when using average size, smaller firms grow faster than larger ones. This study also finds a small number of companies in each size category are responsible for most of the job creation and destruction. Interestingly when analyzing two consecutive 3 year periods they find that the firms that expand rapidly in one period are mostly displaced in the following period as growth leaders.

This result falls in line with what is found in most of the so called gazelles literature[2]. This literature seems to find that the job creation, destruction and overall growth are very concentrated in a small share of firms.

Baldwin (1998) again analyses the Canadian economy but focuses only on the manufacturing industry and finds that small firms were responsible for most of the net job creation. However, when measuring jobs by their wage value small firms no longer dominate. And when measuring job creation by productivity small firms are actually lagging behind larger ones.

Heshmati (2001) using the average size methodology finds that smaller firms in Sweden were responsible for a larger share of net job growth.

Wagner (1995) finds that smaller firms in germany have higher shares of job creation and job destruction, but that these seem to even out leading to no consistent relationship between firm size and growth. Similarly,Hohti (2000) finds that although smaller firms in Finland have larger shares of job creation and job destruction, net job growth has little relationship with firm size.

Davidsson et al. (1998) do a comparison of the base size and the average size methodology and do not find relevant differences in the results. They find that smaller (less than 200 employees) Swedish establishments are disproportionally responsible for net job growth.

Barnes and Haskel (2002) revisit the 1980 to 1990 period in the UK manufacturing previously analyzed by Blanchflower and Burgess (1996) with higher detailed data and still find that small firms create a disproportional share of employment.

Neumark et al. (2011) use a firm database of the whole Californian economy from 1992 to 2004 to compare base and average size methodology. They find that the results indicationg that small firms grow faster hold up even when using average year. They also compare their work to Davis et al. (1998), using only manufacturing, and find similar results. In the manufacturing sector in California small firms do not grow faster than larger ones.

Overall the literature seems to imply that the relationship between firm size and firm growth is either

[2] See Henrekson and Johansson (2010) for a survey.

negative or inexistent.

1.1.2 Data characteristics

There are several characteristics of the literature on the link between firm size and firm growth that are important to mark down. Table 1.1 compares the previous empirical results and their characteristics.

Coverage The initial papers in this area only looked into manufacturing industries. As the importance is this sector is diminishing fast among develop nations a serious study that informs policy policy needs to cover the entire economy.

Unit of Analysis Most papers in this type of empirical literature only have access to plant or establishment level data with no link to firm for multi establishment firms. Since most policy decisions are based on firm and not establishment size this can lead to a disconnect between research and public policy.

Also relevant is the fact that looking at only firm or establishment level data hides away job creation and destruction inside the firm/establishment. Only the net result of job creation and job destruction inside the firm is known.

Methodology The notion that accounting methodology matters is not yet fully appreciated in the research efforts in this area. In section 3 we will go trough the methodologies used by previous research and their shortcomings. These shortcomings are not completely understood and they have a tremendous impact in the resulting outcomes and policy implications.

A new methodology (dynamic sizing) which solves all of the mentioned shortcomings is introduced.

Separation of flows Net job growth is the result of 4 different types of job flows:

- Job creation trough firm Entry.
- Job creation trough firm Expansion.
- Job destruction trough firm Exit.
- Job destruction trough firm Contraction.

Most papers tend to bundle job creation and job destruction in only two categories, but these flows have different causes and need to be considered separately so that the policy implications derived can be truly informed.

The most striking example is that most of the studies that show a disproportional responsibility of small firms as job creators do not separate firm entry from firm expansion. This leads them to overreaching policy implications because, as we will see, this result comes mostly from the firm entry patterns.

Picot and Dupuy (1998) Separates firm entry from expansion and contraction but does not unbundle firm exit. Under a public policy perspective it is valuable to separate contraction from firm exit.

Table 1.1: Previous literature on firm size and job creation

Study	Region	Coverage	Unit of analysis	Duration	Methodology	Flow Sepa-ration	Firm move-ments	Job qual-ity
Wagner (1995)	Germany	Manufacturing	Establishment	15 years	Average size	No	No	No
Davis et al. (1996)	US	Manufacturing	Establishment	15 years	Average size	No	No	No
Blanchflower and Burgess (1996)*	UK	Whole economy	Establishment	10 years	Terminal size	No	No	No
Broersma and Gautier (1997)**	Netherlands	Manufacturing	Firm	13 years	Average size	No	No	No
Picot and Dupuy (1998)	Canada	Whole economy	Firm	14 years	Average size	No	No	Yes
Davidsson et al. (1998)	Sweden	Whole economy	Establishment	5 years	Base size	No	No	No
Baldwin (1998)	Canada	Manufacturing	Establishment	19 years	Average size	No	No	Yes
Hohti (2000)***	Finland	Manufacturing	Establishment	14 years	Average size	No	No	Yes
Heshmati (2001)	Sweden	Whole economy	Firm	5 years	Terminal size	No	No	No
Barnes and Haskel (2002)	UK	Manufacturing	Establishment	11 years	Terminal size	No	No	No
Baptista et al. (2008)	Portugal	Whole economy	Firm	17 years	Average size	No	No	No
Neumark et al. (2011)	California	Whole economy	Firm	12 years	Average size	No	No	No

*Only for firms with more than 25 workers
**Only for firms with more than 10 workers
***Only for firms with more than 5 workers

Firm dynamic movements As a lot of firms change legal status, and are involved in firm dynamic movements like mergers, acquisitions, divestitures and spin offs. It is important to be able to differentiate between entering or exiting firms and the ones that just look like it in the database.

No previous research has taken these movements into consideration. A worker tracking procedure, presented in section 3, will allow us to overcome this limitation.

Reporting To allow for comparisons between studies size categories should also be reported in quantile terms. This will allows for comparisons of economies that have different firm size distributions. We recommend using quartiles.

If firms sizes are categorized within quantiles these should be updated in every period to allow for the distribution of firms to change over time.

Duration The patterns of job flows are complex and seem to follow reasonably long time trends. Because of this it is important to have access to a database covering a sufficiently long time period that allows to differentiate between transitory movements and long term trends.

Job Quality An important aspect often overlooked when making policy decisions is that in fact the jobs created by smaller firms have shorter duration and pay less. An informed policy on supporting any firm size category should take this into consideration.

1.1.3 Firm Growth Literature

Firm growth literature, typically from the Industrial Organization field, has also done considerable inroads in the connection between firm size and growth. One of the most important strands of this literature is the one based on on Gibrat's law:

Let E_t denote the size of a firm in time t and ε_t denote the firms growth rate according to:

$$\varepsilon_t = \frac{E_t - E_{t-1}}{E_{t-1}}$$

Gibrat's law states that firm size in time t is given by:

$$E_t = (1 + \varepsilon_t)E_{t-1}$$

Where ε_t is given by from a normal distribution with mean μ and variance σ^2. And so :

$$E_t = E_0(1 + \varepsilon_1)(1 + \varepsilon_2)(1 + \varepsilon_3)\dots(1 + \varepsilon_t)$$

Taking the logs:

$$log(E_t) = log(E_0) + log(1 + \varepsilon_1) + log(1 + \varepsilon_2) + log(1 + \varepsilon_3)\dots log(1 + \varepsilon_t)$$

If the time period is relatively small we can approximate $log(1 + \varepsilon_t) \approx \varepsilon_t$ and obtain:

$$log(E_t) = log(E_0) + \varepsilon_1 + \varepsilon_2 + \varepsilon_3 \dots \varepsilon_t$$

As $t \to \infty$, $log(E_t)$ becomes zero and we can approximate E_t with a normal distribution with mean $t\mu$ and variance $t\sigma^2$

This result states that firm's growth is independent of size. This result seems to be fragile from the start as it it actually saying that it is just as likely that a firm with 2 workers will double in size as that a firm with 100 workers will double in size.

Mansfield (1962) proposed three different interpretations of Gibrats Law:

- The law will hold for all firms, including the ones that exit.
- The law will hold for all continuing firms, excluding the ones that exit.
- The law will hold only for sizes above a given threshold representing the minimum efficiency level.

The last interpretation can be combined with the first two ones, and these interpretations do not define how or if entry is counted. A test of Gibrats law seems to require eight different interpretations resulting of the combinations of considering or not entry, exit and a minimum threshold. When considering entry and exit one still has to define how to count the growth rate of entering and exiting firms.

It is important to note, as Sutton (1997) did, that Gibrats law is not inconsistent with a agent maximizing approach. The law merely states that the probability that a firms captures some new opportunity is equal across firm sizes in a per employee manner. A useful mental construct is to think that each employee in a firm has the same change of capturing an opportunity independent of the the size of the firm.

This result has been thoroughly tested by previous literature, most of which found weak support for the hypothesis. Sutton (1997) and Audretsch et al. (2004) provide surveys on the empirical work done.

A different trend in theory of industry structure is the selection hypothesis presented by Jovanovic (1982). In this seminal paper the author presents a model in which each firm is founded with a different efficiency level that makes firms heterogeneous. Initially firms have no knowledge of their efficiency level but as time goes by they get signals as to what that efficiency can be. As time passes firms make the decision to exit or not the market. This model leads to the outcome that mostly efficient firms stay in the industry and grow while less efficient firms realize their condition and exit. The major drawback of this model is the inflexibility of the efficiency parameter that leads to such strange results as existing firms that never exit the market.

Following the selection hypothesis Hopenhayn (1992) presents a model were efficiency is no longer fixed but subject to random shocks. In every period there is firm entry and exit and no firm is guaranteed to never exit. A specific equilibrium is analyzed were the entry and exit of firms in every period maintain the same industry structure. Although some insights can be obtained from these model there does not seem to be a strong empirical support for this type of equilibrium.

Cabral and Mata (2003) found that the Portuguese firm size distribution is right-skewed and evolves over time to something close to a lognormal distribution. The authors test for selection by comparing the size distribution of entrants in 1991 and 1983 survivors and find that selection accounts for very little of this evolution. They propose a model using financial constrains on the entrepreneurial team. However, Braguinsky and Ohyama (2011) use the same data to show that the evolution of the firm size distribution observed is actually the one that could be expected from a noisy selection model.

1.2 Data

The data from this paper comes from *Quadros de Pessoal*. A portuguese matched employer employee dataset that covers the full formal private sector of Portugal from 1986 to 2007. The data contains detailed information on workers, firms and establishments. The detail of the information allows for the separation of job flows, measures of job quality and the tracing of firm dynamic movements.

1.2.1 Firm Size Definitions

Although there is no definitive consensus on what constitutes a small or medium enterprise some organisms have converged into a common definition. The EU, OECD[3] and World Bank[4] generally consider that Small and Medium enterprises are the ones that have less them 250 employees. In the USA the SME definition usually refers to an upper limit of 500 employees although that number can reach 1500 employees in some cases [5].

The European Commission established guidelines to define firm size across the 27 EU member states.[6]

Table 1.2: European Union Limits on the Size Definition of Firms

	Limit
Micro	10
Small	50
Medium	250
Large	>250

Using this definition we can compare the firm size distribution of Portugal, the European Union and US.

Table 1.3: Firm size distribution comparison

	2005 Employment share by Firm Size			
	Micro	Small	Medium	Large
Portugal[1]	28.4	27.6	20.5	23.4
EU-27[2]	29.6	20.6	16.8	32.9
US[3]	11.5	17.8	16.2	54.5

1 - *Quadros de Pessoal*
2 - *Eurostat*
3 - *US Census - Business Dynamics Statistics*

The EU definition seems to work well for Portugal dividing the number of Jobs into 4 relatively even categories. Table 1.17 shows the evolution of the firm size distribution in Portugal from 1985 to 2007. The definition also works reasonably well at the European level.

[3]http://stats.oecd.org/glossary/detail.asp?ID=3123
[4]http://go.worldbank.org/329G6YML20
[5]http://www.sba.gov/contractingopportunities/officials/size/table/index.html
[6]http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/sme-definition/index_en.htm

The US however has more than 54% of firms classified as Large and so this definition does not seem appropriate to categorize US firms. Table 1.18 shows the evolution of the firm size distribution in the US from 1977 to 2005 using this measure. When referring to SMEs in Portugal we will consider that SMEs refer to the two smallest size categories.

To make reasonable comparisons between countries with such different firm size distributions we need to start thinking into categorizing firm sizes according to quantiles. Using quantiles instead of static sizes also provides a better picture of evolving firm size distributions. As we will see in 1986 firms with less than 10 workers accounted for 15.6% of jobs, in 2003 that number was 28.6%. Certainly the notion of small firm should refer to the smaller firms in the economy and not to firms under a static limit.

Observing table 1.3 it is possible to infer that the Portuguese economy does not differ much from the remaining European Union. Portugal has a higher percentage of workers in the two smallest size categories compared with the European Union average.

In table 1.17 we can see the evolution of firm size distribution in Portugal. A distinct trend is evident, the share of employment by Micro firms increased at the expense of Large firms.

In the same time period the number of employees grew from 1.8 to 3 million but the average firm size shrank from 18 to 9 employees.

1.2.2 Firm dynamics

Another important issue that previous literature has encountered but has not solved is the fact that firms do not evolve in a static way. Firms do not just go trough entry, activity and exit. Firms merge and acquire each other, they divest into smaller firms and launch spinoffs. Our database does not identify M&A, divestitures or spinoffs but since we can track employees we can construct a metric of how many workers in a starting firm came from an existing firm. This metric shows how similar a new firm (a firm with a new identifying number) is to a previously existent firm. If the percentage of shared workers between the old and new firm is high enough we can be reasonably sure that there is a strong link between these firms. We chose as a cutoff point the 50% of common employees to say if a new firm is linked to a previous firm. These rules for firm dynamics only apply to firms with 10 or more workers. Applying the 50% rule to smaller firms might lead to a lot of false positives. Figure 1.1 shows the 5 firm movement possibilities.

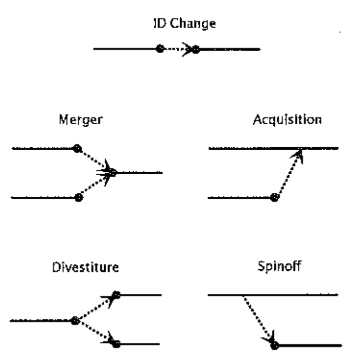


Figure 1.1: Possible firm dynamics

Each of the 5 movements is identified in a specific manner:

Firm identifier change A common problem found in both our database and previous literature is simply that firms change identifiers. If a firms changes its legal statues it will be assigned a new firm identifier, and so in our database it will appear as both a entry and exit of a firm. This might also appear as a result of ownership change.

We identify and correct this situation if: More than 50% of an exiting firm workers go on to work in the same starting firm next year. We do not count these workers as either having lost or gained their jobs.

During our period of analysis 6,683 firms changed ID according to our identification procedure. These ID changes account for 85,929 job transfers that were previously counted as jobs creations and destructions.

Mergers If a firm merges or acquires another it will show positive employment growth, but that growth however does not represent new job creation. On the other hand it is important not to count the acquired firm as have exited the market and destroyed jobs.

Mergers are identified by two or more firms exiting the market and one new firm entry. If all of the original firms have at least 50% of their employees in the new company we do not count them as job creating or destructing.

During our period of analysis 1,968 firms went trough mergers, accounting for 27,819 job changes.

Acquisitions If a firm disappears and 50% or more of its workers are employed in the same company the next year, we consider that the firm was acquired. We do not count the number of workers that are employed in the next company as having exited or entered a firm. The workers that are not employed by the acquiring firm are counted as exits.

During our period of analysis 5,267 firms went trough mergers, accounting for 123,289 job changes.

Divestitures Divestures are identified as the opposite movement of mergers. In this case if one firm disappears and two firms are created each having at least 50% of their personnel from the original company we consider that a divesture took place and do not count the job movements.

During our period of analysis 2,081 firms went trough divestitures, accounting for 10,728 job changes.

Spinoffs We identify spin offs if a firm is created with 50% of more of employes from a single previous firm we consider a spinoff happened and do not count these movements either.

During our period of analysis 2,239 firms went trough spinoffs, accounting for 61,357 job changes.

The main reason to account for firm dynamics in our analysis is to provide an unbiased estimate of job creation by firm size. If a large firm went trough divestiture into two medium sized ones it would count a large firm exit and two medium firms entry although no job creation or destruction took place.

Table 1.4 shows the net impact on job creation trough firm size. It represents the error encored if these movements were not considered.

Table 1.4: Net job changes by firm dynamic movement

Firm Size	ID	Merger	Sum Acquisition	Divestiture	Spin off	Total
Micro	0	-2,241	-489	3,791	666	1,727
Small	-649	4,476	17,614	-5,787	-6,970	15,654
Medium	-354	-949	3,638	1,426	-2,523	3,761
Large	-121	-1,289	-21,314	516	8,591	-13,617
Total	-1,124	-3	-551	-54	-236	-1,968

1.3 Analysis

Measuring the job creation rate of different sized firms is not a straightforward task. Early studies were filled with statistical and data interpretation fallacies as reported by Davis et al. (1998).

The most natural way to think about the share of firm size in job creation is to divide firms into size categories and count how many jobs each category created over the last period.

$$X_t = E_t - E_{t-1}$$

This change in the number of jobs (X_t) is them attributed to the specific size category. Base size classification assigns the change in jobs to the category they belonged in period $t-1$. Terminal size classification assigns the change in jobs to the category they belonged in period t.

Davis et al. (1996) called attention to the Regression to the Mean problem.

> *"On average firms classified as large in the base year are more likely to have experienced a recent transitory increase in employment. Since transitory movements reverse themselves, firms that are large in the base year are relatively likely to contract."* (Davis et al., 1998, pag. 67)

This, the authors state, leads base size methodology to favor smaller size categories

Friedman (1992) seems to have pioneered this reasoning by using firm size as an example of the regression to the mean fallacy:

> *"For example, 'everyone knows' that job creation comes mainly from small firms. That proposition may be true but the evidence offered for it that I have seen classifies firms by size in an initial year and traces subsequent levels of employment (...) I have yet to see what the data show if firms are classified by their terminal size, or by their average size over a period."* (Friedman, 1992, pag. 2131)

Although the point seems to have some validity, the explanation is not satisfactory as the reverse logic can be applied to the case were firms have a contraction movement that should statistically be followed by an expansion movement. This two effects should cancel each other out if firm expansion and contraction were equiprobable. There is no strong reason to expect that larger firms are more affected by transitory contraction movements when compared to smaller firms. Even if this was true this effect, by itself, does not lead to a bias in accounting as it is simply describing the process of growth. If larger firms do actually tend to contract because of regression to the mean them this should be incorporated in the accounting procedure.

Testing for the regression to the mean is quite straightforward. We find a -0.0098 correlation between consecutive year growth. That value, although negative, seems too small to claim that a regression to the mean effect is taking place. There seem to be only slight evidence of a regression to the mean effect. Other studies have also found no or positive correlations between consecutive period growth.

There actually is a bias present when using base year methodology, but it is not caused by regression to the mean. Regression to the mean simply exacerbates the problem.

The bias actually arises when a firm changes size category from one period to the next. If we categorize the firm based on its size on period $t-1$, the so-called base year classification, we are counting all of the firms that grew into a larger category as being part of the smaller category. The opposite effect happens when a firm contracts, now the contracting firm is counted as being part of the larger category. Both of these effects lead to a Bias favoring the smaller categories when using base year. In the first case by assigning job creation to the smaller category and in the second by assigning job destruction to the larger category.

If we categorize the firms based on its size in year t, the terminal year classification, the reverse effects take place and the Bias now favors larger categories.

Table 1.5 shows the Bias direction.

Table 1.5: Bias direction when firms change size category

	Expansion	Contraction
Base year	Assigns expansion to smaller category	Assigns contraction to larger category
Terminal year	Assigns expansion to larger category	Assigns contraction lo smaller category

So any time a firm crosses a size limit it will cause a bias. Even if regression to the mean was completely inexistent we would still have bias in base and terminal year classification. Regression to the mean, if it were present, would worsen the problem by adding noise to the data and so cause more limit crossing. Other sources of noise also worsen the bias, like data entry errors. Also the more limits, or size classifications there are, the more firm crossings will appear and cause a larger bias.

This realization re-conciliates several pieces of literature in firm growth. Several previous researchers (eg. Carree and Klomp (1996); Davidsson et al. (1998)) oposed the results by Davis et al. (1998) by showing that they could not find evidence of regression to the mean. This, the authors claimed, meant that there should be no bias in using base year. We can now see that in fact the bias exists, and as we will show it is substantial. But the bias is not caused by regression to the mean, it is cause by the favoring of some size categories over another when firms cross size limits. Seeing the data classified by terminal or average size would not help Friedman test for the regression to the mean bias.

The initial reports by Birch used the base year classification, and found strong support for the claim that small firms create most jobs.

Davis et al. (1998), following Friedman (1992), proposed using the Average Size Classification as a way to reduce bias. (Which they actually termed as Current size, but we will follow Friedman terminology). In this classification a firm is categorized based on the average size of the firm between the two time periods. Average firm size methodology is equivalent to attributing the change in size to which ever category has gained or lost most during the period. If a firm goes from 45 to 60 workers when using 49 as the size limit, average size (55.5) will attribute 15 jobs created to the larger size category. If a firm goes from 40 to 55 workers, average size (47.5) will attribute 15 jobs created to the smaller size category. The advantage of using average size over base or terminal size is that the bias is not constantly favoring any of the size classes. Although this reduces the bias and leads to more trustwordy classification the Bias is not eliminated and it is not possible to immediately say if the Bias is favoring smaller or larger size categories.

The solution to this problem is the Dynamic Size classification and it categorizes employment gains or losses according to the instant size of the firm. So for example if a firms in our database grows from 40 to 55 employees the dynamic size methodology would count a 9 employee gain to small firm category and and a 6 employee gain to the medium firm category. This methodology allows for a completely unbiased account of the job creation responsibility of each size category. Dynamic sizing has now been chosen by the US Bureau of labor statistics as its official classification (see Butani (2006)). Table 1.6 shows the results of the 4 previous methodologies on our database.

Table 1.6: Total Net Job Creation by firm size

	Firm Size				
	Q1	Q2	Q3	Q4	Total
Base	783,701	206,807	56,110	-117,782	928,836
Terminal	-271,625	437,890	358,039	404,532	928,836
Average	252,448	327,494	220,219	128,675	928,836
Dynamic	260,900	322,095	214,964	130,877	928,836

Source: Quadros de Pessoal

We can see that the type of classification used can have a big effect on the outcome. Also noteworthy is the fact that the average size methodology presents quite a similar result pattern to the dynamic size classification. The base or terminal year classification should be avoided in any future research.

Okolie (2004) compares the base, terminal and average methodologies for the US non farm economy in a 4 month time frame and finds the same result pattern.

1.3.1 Econometric analysis

Regression analysis does not suffer from the methodological problems identified previously because firms do not have to be assigned to size categories. In a sense each firm size is its own category. As a drawback the methodology used is more complex.

Let E_t denote the size of a firm in time t. The relationship between firm size and growth can be modeled as:

$$E_t = \beta_0 + \beta_1 E_{t-1} + \epsilon$$

Testing for Gibrats law amounts to testing if β_1 is equal to one. In that way a change in previous year size has a proportional effect on current year size. A β_1 smaller than 1 implies that smaller firms grow faster than larger ones.

Since Gibrat Law states that "the probability of given proportional change in size during a specified period is the same for all firms in a given industry" (Mansfield, 1962) we can also include industry controls, leading to:

$$E_t = \beta_0 + \beta_1 E_{t-1} + I + \epsilon$$

This specification is similar to Hall (1988); Evans (1987), except that it does not employ a logarithmic transform on firm size. The log specification is useful when testing if firm size has an impact on firm growth as it is just testing if the β_1 coefficient is equal to one. However since the focus of this paper goes beyond simply testing fo Gibrat's Law logs were not used. The particular reasons logs were not used is that they assign decreasing impact on employment changes. For example they imply that 10 firms adding 2 workers has a greater growth rate impact than if all workers entered in the same firm.

Table 1.7 presents the estimation results. The first column does not include industry controls while columns 2 trough 4 do. Columns 3 and 4 include a second order component on previous firm size. The results show that the relationship between firm size and growth is complex. The simple correlations between firm sizes in column 1 suggests that small firms grow faster them larger ones. The 0.977 coefficient of columns 1 and 2 indicates that a 1 employee increase in size leads to only a 0.977 increase in subsequent year size, meaning that for every additional employee firms grow approximately 2% slower. When assuming a second oder relationship between firm size and growth, as in column 3, the results indicate that larger firms grow faster. Now adding an employees has an approximate 2% increase in growth. The second order effect only inverts the relationship at a firm size of over 9000 workers capturing only a minuscule number of firms in our sample (the 99% percentile on firm size is 107). Columns 1 trough 3 answer the economic question of the relationship between firm size and firm growth. The answer seems to be that larger firms actually grow faster. Column 4 answers the policy question of what firms create more jobs, again the answer seems to favor larger firms.

One of the problems we face is that we can only observe surviving firms. If Gibrats law is correct size will have no influence on growth, but it might still influence exit. There are two main reasons for this. The first one is that smaller firms carry a lot less market power and so are more vulnerable. A second reason is that smaller firms simply cannot adjust their labor force down as easily as larger firms. A 100 person firm can loose 60% of their personnel and still operate while a 10 person firm can not operate only with 4 employees and will probably have to exit the market. So we have to realize that the size changes we are observing in firms is the change in size of surviving firms.

Econometrically we can solve this by two methods. We can assume that this is a truncated sample, that is, we do not observe firms with less than 1 worker. In that case we can run a truncated version of the previous equation with left truncation at 0. in this case we observe firm size when its greater than 1 and do not observe it otherwise.

$$E_t = \begin{cases} E_t^* & \text{if } E_t^* > 0 \\ - & \text{if } E_t^* \leq 0 \end{cases}$$

Where E_t^* represents the latent size variable only observable when size is greater than 1. This specification

Table 1.7: Estimation results

VARIABLES	(1) ols1 E_t	(2) ols2 E_t	(3) ols3 E_t	(4) ols4 E_t
E_{t-1}	0.977***	0.977***	1.022***	1.018***
	(0.000161)	(0.000164)	(0.000282)	(0.000527)
Age_{t-1}		0.00258***	-0.0183***	-0.274***
		(0.000935)	(0.000932)	(0.0117)
IEG_t		0.0810***	0.0797***	11.04***
		(0.00664)	(0.00658)	(0.147)
E^2_{t-1}			-5.21e-06***	-3.24e-06***
			(2.68e-08)	(4.00e-08)
Constant	0.436***	-0.258***	-0.190**	-46.17***
	(0.0144)	(0.0829)	(0.0821)	(2.862)
Industry Dummies		X	X	X
Observations	1,926,562	1,926,562	1,926,562	1,926,562
R-squared	0.950	0.950	0.951	0.958

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

assumes that firms choose their next period size and that if that firm size ever falls below 1 they exit the market. In effect it is assuming that the firm growth and exit decision are the same.

We can also assume that exit is a distinct choice made by the firm. Since firm can select to exit the market the data base presents only the firms that selected to continue. Lets assume that in each period firms receive a random shock X_{it}. The nature of this shock is exogenous to the model and represents growth or profit opportunities or threats. This exogenous shock will influence both the growth and exit decisions.

$$X \sim N(0, \sigma^2)$$

$$E_{ti} = \beta_0 + \beta_1 E_{it-1} + I + X_{it} + \epsilon_e$$

$$S_{ti} = \delta_0 + \delta_1 E_{it-1} + \delta_2 E^2_{it-1} + I + X_{it} + \epsilon_s$$

The change in firm size will only be observed for firms that choose not to exit. This two part model has a selection equation given by:

$$S_t = \begin{cases} 1 & \text{if } S^*_t > 0 \\ 0 & \text{if } S^*_t \leq 0 \end{cases}$$

And an outcome equation given by:

$$E_t = \begin{cases} E^*_t & \text{if } S^*_t > 0 \\ - & \text{if } S^*_t \leq 0 \end{cases}$$

Where S_t^* represents the latent survival equation equations for witch we only observe 2 outcomes. E_t^* now represents the latent size variable only observable when size is greater than 1. This model is a generalization of the truncated model.

If the random shock was perfectly observed this model could be easily solved as a two step procedure using Maximum Likelihood Estimation. Since these shocks are not observable they are going to be integrated into the equations respective error terms. And so we will get a correlation between ϵ_e and ϵ_s.

In that case an appropriate econometric procedure is to use a two step Heckman selection model. To use it we only have to make the extra assumption that the correlation between the error terms can be linearly decomposed as:

$$\epsilon_e = \delta\epsilon_s + \xi$$

In this case in the first step we specify a Probit on the survival probability:

$$S = \Phi(\delta_0 + \delta_1 E_{t-1} + \delta_2 E_{t-1}^2 + Age_t + I)$$

This first step assumes that the survival of the firm is dependent on the size of the firm in a possibly non linear way. The inverse mills ratio resulting from this first step can then be included in the original regression to control for the sample survival selection. Table 1.8 shows the Probit estimation results. The size of the firm has a positive influence on its survival probability.

Table 1.8: Probit on Survival Probability

VARIABLES	(1) Probit survival
E_{t-1}	0.00643***
	(6.56e-05)
E_{t-1}^2	-3.58e-07***
	(4.43e-09)
Age_{t-1}	0.0112***
	(0.000102)
GDP_t	0.0535***
	(0.000768)
Constant	0.770***
	(0.00598)
Observations	2,198,292

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.9 shows the results for the second stage regression for several models. All of them use the same first stage selection equation.

The results from this procedure are very similar to the standard regression. Again wen considering a second order effect of size we can tell that larger firms grow faster.

Table 1.9: Selection model results

VARIABLES	(1) heck1 E_t	(2) heck2 E_t	(3) heck3 E_t
E_{t-1}	0.976***	0.976***	1.023***
	(0.000166)	(0.000173)	(0.000302)
Age_{t-1}		-0.0221***	-3.73e-05
		(0.00134)	(0.00132)
IEG_t		0.0333***	0.116***
		(0.00688)	(0.00682)
E_{t-1}^2			-5.35e-06***
			(2.83e-08)
Constant	1.741***	2.909***	-2.598***
	(0.0521)	(0.146)	(0.146)
Industry Dummies		X	X
Observations	2,198,292	2,198,292	2,198,292

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The inverse mills ratio is significant in all of the equations, this means that there is in fact a correlation between ϵ_e and ϵ_s and that the sample selection model is necessary. The results, however, are very similar to the ones with a regular OLS. Previous research has also found that accounting for selection has only a minor influence on the results (see Hall (1988); Mata (1994)).

Some previous literature uses a different methodology to account for firm exit, it assigns a -100% growth rate to exiting firms. In our case that would amount to setting $E_t = 0$ for exiting firms. It is hard to interpret what the result of this procedure mean. First it is confounding growth with exit. Second assining a -100% will always lower the β_1 coefficient. This happens because the procedure adds observations that correspond to the lowest possible growth for all exiting firms, therefore decreasing the relationship between firm size and growth.

1.3.2 Size, Growth and Macroeconomic Condition

Davis and Haltiwanger (1991) found that there was a correlation between the measures of job creation/destruction and the macroeconomic conditions. Not surprisingly the authors find that job creation falls and job destruction rises during an economic contraction. The authors do not report any difference in the job creation and job destruction across firm sizes with differing macroeconomic conditions.

As we will see the 4 job flows across firm size are differently impacted by macroeconomic and industry factors. But most striking in expanding or contracting industries smaller firms respond differently than larger firms. To do so we will need to include some measure of the macro condition. We have chosen to use Industry Employment Growth (IEG), defined as the change in total number of workers in a specific industry s:

$$IEG_{st} = \left(\frac{E_{st} - E_{st-1}}{E_{st} + E_{st-1}}\right) 100$$

This measure presents a symmetric view of industry growth, with growth bounded between -1 and 1.

To analyze the impact of industry macroeconomic conditions on the firms entry, exit and growth decisions we will first divide observations into growth quartiles. The growth quartiles groups firms into 4 bins with an average IEG of 0.1%, 3.0%, 5.3% and 73.3% respectively.

Table 1.10 shows how entry is mostly concentrated in smaller firms but the total entry by different growth quartiles does not present such a strong trend.

Table 1.10: Firm Entry by Growth and Size Quartiles

IEG quartiles	Size				
	Q1	Q2	Q3	Q4	Total
Q1	87,213	27,086	6,194	2,370	122,863
Q2	119,325	62,636	25,129	5,900	212,990
Q3	138,837	85,585	36,020	5,012	265,454
Q4	148,262	75,864	25,085	4,893	254,104
Total	493,637	251,171	92,428	18,175	855,411

Source: Quadros de Pessoal 1995-2006

Table 1.11: Firm Exit by Growth and Size Quartiles

IEG quartiles	Size				
	Q1	Q2	Q3	Q4	Total
1	110,901	60,159	37,210	35,724	243,994
2	123,211	66,434	38,528	22,779	250,952
3	136,924	74,326	35,646	13,846	260,742
4	99,828	53,394	30,403	21,872	205,497
Total	470,864	254,313	141,787	94,221	961,185

Source: Quadros de Pessoal 1995-2006

Table 1.11 shows that firm exit is again concentrated in smaller firms but is remarkably regular across growth quartiles.

Table 3.5 reports net change in employment by firms divided by industry growth quartiles. It shows a remarkable pattern of firm growth. Small firms create jobs in every growth quartile and increase the job creation with industry growth. Larger firms on the other hand destroy jobs in the lower growth quartiles and create jobs in the higher growth quartiles.

The relationship between firm size and job creation is dependent on the industry macroeconomic level. In negative or ow growth industries small firms create most jobs, in growing industries that function is taken

Table 1.12: Firm Net Job Growth (Expansion - Contraction)

IEG quartiles	Size				
	Q1	Q2	Q3	Q4	Total
Q1	2,076	2,839	-23,772	-70,566	-89,423
Q2	13,483	29,214	23,085	-992	64,790
Q3	43,222	43,651	28,990	54,084	169,947
Q4	53,640	77,905	90,835	132,391	354,771
Total	112,421	153,609	119,138	114,917	500,085

Source: Quadros de Pessoal 1995-2006

over by larger firms.

We can do the same analysis using an econometric approach. To do so we will add our IEG measure to the econometric framework presented before. To test for the hypothesis that the relationship between size and growth is dependent on industry growth, we will interact firm size with IEP. We can then test if the interaction coefficient between firm size and industry growth is significantly different from 0.

$$E_t = \beta_0 + \beta_1 E_{t-1} + \beta_2 E_{t-1} X IEG_t + Age_t + I + \epsilon$$

Table 1.13 shows the results of a regular OLS regression of the previous equation. The IEG coefficient can be interpreted as the effect of a 1% increase in industry growth. Once again column 4 weighs the regression by E_{t-1}.

Table 1.14 shows the results using the previously described sample selection correction. Again the sample selection correction yields similar results to the survival only sample.

The relationship between firm size, firm growth and industry macro economic is significant in every model consirered. Its magnitude can be viewed by looking at the marginal effects of previous firm size given by, for example, column 2 of tables 1.13 and 1.14:

$$\frac{\partial E_t}{\partial E_{t-1}} = 0.95 + 0.017 IEG_t$$

With a 0% industry growth small firms grow 5% faster than larger firms. With a 6% industry growth large firms now grow 5% faster than smaller firms. Gibrat's law seems to correspond to an approximate 3% industry growth. Using other model specifications achieves the same results.

The results are also robust to the introduction of overall economic growth. Table 1.15 includes annual GDP growth for Portugal in the same period. The GDP coefficient interpretation is similar to the IEG, but the GDP measure has a reduced variability. Column 4 includes both GDP and IEG interactions.

GDP growth has smaller impact on firm growth because of both a smaller coefficient and smaller variability. When including both measures of growth the IEG stays relatively unchanged.

Table 1.13: Macro economic response

VARIABLES	(1) olsi1 E_t	(2) olsi2 E_t	(3) olsi3 E_t	(4) olsi4 E_t
E_{t-1}	0.951***	0.950***	0.969***	0.934***
	(0.000173)	(0.000176)	(0.000325)	(0.000571)
$E_{t-1}XIEG_t$	0.0169***	0.0171***	0.0157***	0.0211***
	(4.75e-05)	(4.77e-05)	(5.14e-05)	(6.27e-05)
IEG_t	-0.129***	-0.136***	-0.120***	-4.629***
	(0.00525)	(0.00646)	(0.00646)	(0.150)
Age_{t-1}		-0.0132***	-0.0197***	-0.256***
		(0.000906)	(0.000910)	(0.0114)
E_{t-1}^2			-1.94e-06***	3.93e-07***
			(2.83e-08)	(4.04e-08)
Constant	0.630***	0.643***	0.598***	23.71***
	(0.0244)	(0.0803)	(0.0802)	(2.789)
Industry dummies		X	X	X
Observations	1,926,562	1,926,562	1,926,562	1,926,562
R-squared	0.953	0.953	0.953	0.960

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.14: Macro economic response (with sample selection correction)

VARIABLES	(1) heckI1 E_t	(2) heckI2 E_t	(3) heckI3 E_t
E_{t-1}	0.951***	0.950***	0.970***
	(0.000175)	(0.000178)	(0.000341)
$E_{t-1}XIEG_t$	0.0169***	0.0170***	0.0157***
	(4.76e-05)	(4.78e-05)	(5.18e-05)
IEG_t	-0.127***	-0.145***	-0.0997***
	(0.00532)	(0.00667)	(0.00670)
Age_{t-1}		-0.0178***	-0.00980***
		(0.00126)	(0.00127)
E_{t-1}^2			-2.02e-06***
			(2.93e-08)
Constant	0.520***	1.234***	-0.711***
	(0.0574)	(0.138)	(0.141)
Industry Dummies		X	X
Observations	2,198,292	2,198,292	2,198,292

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.15: Macro economic response (with sample selection correction)

VARIABLES	(1) heckIg1 E_t	(2) heckIg2 E_t	(3) heckIg3 E_t	(4) heckIg4 E_t
E_{t-1}	1.002***	1.002***	1.041***	0.998***
	(0.000345)	(0.000365)	(0.000427)	(0.000427)
$E_{t-1}XGDP_t$	-0.00942***	-0.00931***	-0.00661***	-0.0124***
	(0.000108)	(0.000114)	(0.000114)	(0.000109)
GDP_t	0.0611***	-0.0564***	0.326***	0.314***
	(0.0105)	(0.0129)	(0.0130)	(0.0130)
Age_{t-1}		-0.0286***	0.0121***	0.00180
		(0.00152)	(0.00153)	(0.00145)
E^2_{t-1}			-5.18e-06***	-1.41e-06***
			(3.00e-08)	(3.09e-08)
$E_{t-1}XIEG_t$				0.0167***
				(5.36e-05)
IEG_t				-0.143***
				(0.00701)
Constant	1.482***	3.912***	-4.370***	-2.642***
	(0.0701)	(0.181)	(0.186)	(0.178)
Industry Dummies		X	X	X
Observations	2,198,292	2,198,292	2,198,292	2,198,292

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

1.3.3 Measurement error

One of the problems previous studies have faced is measurement errors. In large datasets it is quite common for errors or discrepancies to show up. In this section we will check if measurement errors could be driving our results.

We will follow the methodology proposed by Hall (1988). By assumption we will consider that there are no consistent measurement errors, i.e. firms that are constantly under or over reported. We will instead consider that measurement errors are independent of firm and can occur at any time. That being the case we will use an Instrumental variable approach and use E_{t-2} as the instrument. Aside from measurement error, the only effect that E_{t-2} has on E_t is trough E_{t-1}.

Table 1.16 reproduces the regression of table 1.13 but instrumenting E_{t-2} for E_{t-1}. The results are very similar and we can be quite secure that non consistent measurement errors are not driving our results.

Table 1.16: Macro economic response (with sample selection and measurement error correction)

	(1)	(2)	(3)	(4)
	iv1	iv2	iv3	iv4
VARIABLES	E_t	E_t	E_t	E_t
E_{t-1}	0.937***	0.936***	0.957***	0.920***
	(0.000240)	(0.000244)	(0.000463)	(0.000733)
$E_{t-1}XIEG_t$	0.0213***	0.0214***	0.0198***	0.0312***
	(6.63e-05)	(6.66e-05)	(7.27e-05)	(9.42e-05)
IEG_t	-0.210***	-0.208***	-0.217***	-4.565***
	(0.00705)	(0.00855)	(0.00836)	(0.124)
Age_{t-1}		-0.0113***	-0.0175***	0.229***
		(0.00123)	(0.00123)	(0.0138)
E_{t-1}^2			-2.02e-06***	-2.88e-07***
			(3.85e-08)	(4.95e-08)
Constant	0.901***	0.889***	1.787***	0
	(0.0335)	(0.114)	(0.0886)	(0)
Observations	1,269,364	1,269,364	1,269,364	1,269,364
R-squared	0.950	0.950	0.950	0.949

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

1.4 Discussion

The finding that the relationship between firm size and firm growth depends on the macroeconomic conditions has severe implications.

The first one concerns the public policy implications of the result. It now is apparent that small firms only create most jobs when industries are not going trough some at least modest growth. This casts an even greater doubt on public policies that emphasize the job creation aspects of small firms. Is supporting small firms the same as supporting low growing industries at the expense of faster growing industries? The public policy implication need to carefully tough trough.

The second implication is for economic theory. None of the surveyed theories of job growth seems to be able to accommodate differentiated growth according to macro conditions.

The pattern we observe seems to signal that larger firms are more flexible. They destroyed jobs on bad economic conditions and create them in good ones. They seem to have an easier time adjusting to whatever climate they are inserted in. This seem to push for the insertion of adjustment costs in the standard growth theories.

1.5 Apendix

Table 1.17: Portuguese Firm Size Distribution

Year	Micro %	Small %	Medium %	Large %	Total %
1986	15.6	23.8	24.0	36.7	100.0
1987	15.9	24.2	24.1	35.9	100.0
1988	17.0	25.3	24.7	33.0	100.0
1989	17.5	25.2	24.1	33.2	100.0
1990	17.5	25.5	24.7	32.2	100.0
1991	18.3	25.9	24.7	31.2	100.0
1992	19.2	26.6	24.8	29.5	100.0
1993	20.5	27.0	24.3	28.2	100.0
1994	22.9	27.4	23.1	26.6	100.0
1995	23.5	26.8	23.1	26.6	100.0
1996	24.2	26.8	22.7	26.3	100.0
1997	24.8	27.0	22.7	25.5	100.0
1998	25.2	27.0	22.4	25.3	100.0
1999	25.7	27.3	21.9	25.0	100.0
2000	26.7	27.6	21.6	24.1	100.0
2001	26.7	28.0	21.4	23.9	100.0
2002	28.4	29.0	20.0	22.6	100.0
2003	28.6	28.0	20.6	22.8	100.0
2004	28.3	27.5	20.9	23.3	100.0
2005	28.4	27.6	20.5	23.4	100.0
2006	28.1	27.5	20.8	23.6	100.0
2007	27.8	27.6	20.9	23.8	100.0
Total	23.9	26.9	22.4	26.8	100.0

Source: *Quadros de Pessoal*

Table 1.18: US Firm Size Distribution

Year	Micro %	Small %	Medium %	Large %	Total %
1977	13.8	18.5	15.0	52.6	100.0
1978	13.7	19.1	15.8	51.4	100.0
1979	13.3	19.3	16.1	51.4	100.0
1980	12.7	18.7	16.0	52.6	100.0
1981	13.0	18.8	15.3	52.9	100.0
1982	13.0	18.6	15.2	53.1	100.0
1983	13.6	18.9	15.4	52.1	100.0
1984	13.6	19.1	15.8	51.5	100.0
1985	13.3	19.1	16.4	51.2	100.0
1986	13.2	19.4	16.7	50.7	100.0
1987	13.3	19.3	16.7	50.7	100.0
1988	13.0	19.2	16.4	51.4	100.0
1989	12.6	19.0	16.3	52.0	100.0
1990	12.6	19.0	16.3	52.1	100.0
1991	12.7	18.9	15.9	52.5	100.0
1992	12.8	18.8	16.0	52.5	100.0
1993	12.8	18.6	16.0	52.5	100.0
1994	12.7	18.6	16.2	52.5	100.0
1995	12.5	18.6	16.2	52.7	100.0
1996	12.4	18.5	16.2	53.0	100.0
1997	12.2	18.3	16.2	53.3	100.0
1998	11.8	18.1	16.1	54.0	100.0
1999	11.6	17.9	15.9	54.6	100.0
2000	11.2	17.8	16.0	54.9	100.0
2001	11.1	17.7	16.0	55.2	100.0
2002	11.5	17.9	15.9	54.7	100.0
2003	11.5	18.0	16.3	54.2	100.0
2004	11.6	18.1	16.4	53.9	100.0
2005	11.5	17.8	16.2	54.5	100.0
Total	12.5	18.5	16.1	52.9	100.0

Source: *US Census - Business Dynamic Statistics*

Table 1.19: Portuguese Quartile Size Limit

Year		Mean	
	Q25	Q50	Q75
1986	18	98	587
1987	18	91	553
1988	16	81	490
1989	16	78	478
1991	15	69	397
1992	14	64	349
1993	12	57	310
1994	10	47	263
1995	10	48	277
1996	10	47	279
1997	9	43	253
1998	9	42	254
1999	9	40	239
2000	8	36	216
2002	8	31	197
2003	8	32	193
2004	8	33	200
2005	8	34	202
2006	8	35	210
2007	8	35	215
2008	8	37	232
Total	10	45	267

Source: *Quadros de Pessoal*

Chapter 2

The Incredible Shrinking Portuguese Firm

2.1 Introduction

Using Portugal's comprehensive and highly detailed matched employer-employee data base we document a 20-plus year trend in which the firm size distribution systematically shifted to the left. The average firm size declined by almost 50 percent between 1986 and 2009 but firm sizes at all positions of the firm size distribution were affected: the size of the median firm fell by 25 percent over the same period, the size of the firm at the 75th percentile fell by 40 percent and the size of the firm at the 90th percentile fell by more than 50 percent (see Table 1 below). This kind of shift is not found in other advanced industrial economies where we have been able to obtain similar data, such as the U.S. or Denmark. In these countries, the tendency has been for the firm size distribution to shift modestly to the right.[1] Although Portugal's matched employer-employee data base has been used in past research, to our knowledge, ours is the first paper to document this surprising change.[2]

An emerging literature in development economics finds that the largest part of the productivity gap between developed and developing countries can be attributed to the inefficient allocation of resources across firms in the latter countries.[3] Whereas well developed factor and product markets and a high level of competitive intensity ensure that the most productive factors are allocated to the most productive enterprises in developed countries, this often fails to happen to the same degree in developing countries. Our paper builds on this literature, and shows that this problem not only exists in developing Asia, Africa, or Latin America, but also in the countries of the Western European periphery.

We argue that a particularly important cause of this misallocation (and the shrinking firm size) has been

[1] In a recent working paper Choi and Spletzer (2011) document a decline in the average size of the U.S. establishments in the 2000s, from about 17 to 16 workers. The decline in the average firm size in Portugal, however, is of a different order of magnitude, it continued throughout the 1980s and the 1990s (when many U.S. establishments grew in size), and the size decline in Portugal applies to the entire firm size distribution. We therefore believe that recent trends in the U.S. and in Portugal are fundamentally different.

[2] Important studies using these data include Blanchard and Portugal (2001) and Cabral and Mata (2003).

[3] This literature is surveyed in Jones (2011). Important recent contributions include Hsieh and Klenow (2009), Restuccia and Rogerson (2008), and Chari (2011).

Portugal's uniquely restrictive and very complicated labor market practices, rooted deeply in the country's history (see Braguinsky, Branstetter, and Regateiro (2011) for details). After the collapse of a right-wing dictatorship in 1974, it became nearly impossible for private employers to fire workers or to reduce nominal wages. These policies were slightly relaxed by more centrist governments in the 1980s, which is when our data window opens, and successive Portuguese governments began granting exemptions for smaller firms from various tax and administrative rules and social policies that larger enterprises were constrained to follow.[4] Still, there are ample reasons to believe that government interventions in the labor market continued to distort the allocation of labor across firms. In particular, it remains very difficult for enterprises – especially those with over 20 employees – to fire workers for cause or to lay-off workers even in difficult economic circumstances. It is also all but impossible for firms to reduce employees' nominal wages, even when the firms face very adverse circumstances. Legally mandated severance payments are quite high, even by European standards, and Portuguese courts have been consistently characterized by a pro-worker orientation. OECD rankings of member states on the basis of labor market protections consistently placed Portugal at the very top through the mid 1990s. At that point, it was ranked second after Turkey.

Another dimension of distortion revolves around the increasing extent to which the Portuguese legal, tax, and administrative regime discriminates against larger enterprises. Appendix C lists a large number of policies which only apply to firms above a certain size. These policies span virtually the entire spectrum of public regulation of enterprise from compliance with accounting rules, to minimum wage requirements, to tax policy. It is common for European countries with elaborate labor laws and protections to exempt the smallest firms from many policy requirements and mandates. In other countries, these exemptions are often granted to all enterprises below a certain threshold, and this could be associated with a "bulge" in the firm size distribution just below the common threshold at which many of these requirements hold.[5] In Portugal, we find no "bulge" in the firm size distribution, probably because there is no common threshold but rather a large number of different thresholds that are connected to different policies. However, it is clear that, as Portuguese enterprises grow in size, they confront a steadily growing set of rules, regulations, and mandates that increasingly drive a wedge between the value of employees to the firm and the cost of employing workers while maintaining compliance with all relevant laws. The absence of a single clear threshold does not eliminate the possibility that firm growth is deterred by a gradual accretion of increasing mandates and costs.

We develop a theoretical model that shows how strong protections for employees could shift the entire firm size distribution. The model builds on the intellectual foundations of Lucas (1978), in which the firm size distribution reflects an underlying distribution of managerial ability. Better managers, by definition, run bigger firms. We argue that the impact of employment protections can be represented as an effective tax on wages. By driving a wedge between the costs firms must pay for employees and their value to the firm, these protections lead firms to reduce their employment, lower demand for workers in the aggregate, and force some employees into the creation of low-productivity enterprises when these same employees would be better off working for more skilled managers. In effect, these protections distort and degrade the distribution of employees across managers of different quality. Not only is the entire firm size shifted to the left, but productivity in terms of national per capita output falls significantly.

[4]See Martins (2009) for an excellent description and detailed analysis of the impact of this relaxation of labor regulations for small firms.

[5]See Garicano et al. (2012), who find evidence of such a bulge in the French firm size distribution.

It turns out that even a system of labor protections that is uniformly applied across the firm size distribution has a disproportionate impact on larger, more productive enterprises. These enterprises are especially sensitive to labor protections and respond to them by reducing employment even more, in proportion to their size, than smaller, less productive enterprises. This pattern of response strengthens the (negative) impact of the labor protections on aggregate output per capita. A review of Portuguese economic history suggests that, as indicated above, the protections were not rigidly enforced for the smallest firms, but that the effective degree of protection was substantially higher for larger firms. We develop an extension of the model that accounts for this and show, both analytically and by means of a calibration exercise, that a policy regime that discriminates against large firms exacerbates the leftward shift in the firm size distribution.

The most closely related paper to ours is Garicano et al. (2012). These authors build a similar model to explain the sharp discontinuity at an employment size of 50 in French data. In contrast to them, there does not appear to be a single discontinuity at a particular employment size in the Portuguese data but rather a continuous and persistent shift in the firm size distribution to the left over time. Our model, like that of Garicano et al. (2012), represents the impact of labor market restrictions as functioning like a tax on wages. We use the model developed in this paper and calibration exercises to estimate the magnitude of policy distortions that are consistent with the observed shift in the Portuguese firm size distribution. We find that the implied effective tax on wages in Portugal is about twice as large as the tax rate implied by the French data in Garicano et al. (2012) and that the resulting loss of output is also significantly higher in Portugal that it is in France. Thus, our calibrations suggest that the relaxation of labor market protections could yield large productivity gains in Portugal.

Of course, labor regulations are not the only possible cause of the shift in the firm size distribution observed in the data. We examine how some of the shift in the firm size distribution may have been caused by other, "natural causes," such as expanding data coverage, structural change, or the efforts of Portuguese governments in the 1980s and 1990s to demonopolize sectors that had become excessively concentrated in the turbulent years of the 1970s and 1980s. For example, greater trade openness might have led to greater competition for larger manufacturing firms while demonopolization of the industries that had been nationalized could plausibly lead to shrinkage of the largest firms in these industries. Also, like nearly all industrialized nations, Portugal has witnessed a shift in labor from manufacturing, where firms have traditionally been larger, to services, where they have traditionally been smaller. Successive Portuguese governments made concerted efforts to bring small firms in the "informal economy" into the formal sector, and coverage of small firms in the official databases expanded over time. All of these factors could in principle affect the firm size distribution, and we examine the magnitude of their impact using our data. However, even generous allowances for all of these factors leaves most of the shift unexplained. The decline in Portuguese firm size thus appears to be a reflection of fundamental problems in Portugal's economy and economic policies. The calibration exercise we undertake in the paper suggests that the leftward shift in the firm size distribution induced by Portugal's labor market regulations could depress national output per capita by as much as one-fifth to one-third relative to a counterfactual equilibrium in which these regulations were removed.

The rest of the paper is organized as follows. Section 2 documents the shift in Portugal's firm size distribution, compares it to trends in other countries, and demonstrates that this shift is not an artifact of expanding data coverage or "natural causes," such as the shift from manufacturing to services. Section 3 presents a theoretical model where labor protections are first modeled as a uniform (linear) tax on labor and shows that it can generate the same broad level of shrinkage of firm size observed in our data. We also show that the burden of such a tax falls disproportionately on larger firms. The model is then extended to reflect the fact that labor protections have been relaxed for smaller firms but tightened for larger firms in Portugal over the past 20-25 years. We show that even a considerable reduction in the labor protections for smaller firms can be more than undone in terms of its effects on firm size and efficiency by simultaneously introducing a relatively small bias against larger firms. Section 4 presents a calibration exercise based on the model to estimate the implied implicit tax rate on labor and the effect on productivity (output per capita). We show that the model can account for the observed leftward shift in the firm size distribution, and that the implied effect on productivity of even a relatively modest tax is economically very significant. Section 5 concludes.

2.2 Firm Size Matters: Shifts in the Portuguese Firm Size Distribution, 1986-2009

Table 2.1 shows the evolution of firm size, measured by the total number of workers, of the Portuguese entire economy, by quartile, from the opening of our data window in 1986 through the most recent year for which we have complete data, 2009. The shift in the entire firm size distribution is immediately apparent. It also appears if we measure firm size by revenues rather than workers. If we plot data by decile, we see that firm size is declining at every decile, save the lowest.

We do not see a shift like this in other advanced industrial countries for which comparable data are easily available. The Business Dynamics Statistics database maintained by the U.S. Census Bureau allows users to examine changes in the distribution of U.S. firms by employment size category[6] of the U.S. Census Bureau. While the on-line database does not allow us to produce a table that looks exactly like Table 1, it is clear from the histogram one can produce with these data that the U.S. firm size distribution has shifted modestly to the right. Between the late 1986 and 2009, the number of firms in the smallest categories declined slightly, and the number of firms in most of the largest categories increased slightly. This looks nothing like the shift we see in Portugal.

Figure 2.1 illustrates the shift in the U.S. firm size distribution. Of course, the United States is not necessarily an ideal comparator for Portugal. Instead, one might want to look at another comparable European economy. Fortunately, similar data are also available for Denmark. In fact, the data for Denmark are more detailed and more comparable to that the Portuguese data than is the case for the U.S., allowing us to construct a table that is easily comparable to the one we created for Portugal.

Table 2.2 shows that the average firm size in Denmark has actually grown in the last 30 years. Not only that but all other percentiles of the data have either grown or remained constant. As in the U.S., it seems the firm size distribution in Denmark has shifted somewhat to the right. But even if there is a shift in the measured Portuguese firm size distribution that is not evident in the data for other industrial countries, it is still possible that the shift could be an artefact of the data or it could arise for reasons other than distortionary government policies.

[6] `http://www.ces.census.gov/index.php/bds`

2.2.1 Is the Shift an Artifact of Increasing Data Coverage?

An increase in database coverage could have caused an apparent shift in the Portuguese firm size distribution. Small firms could have been previously operating "under the radar" and not reporting their existence in order to escape paying taxes and social security contributions. As these, mostly small, firms move into the formal economy a decrease in the firm size distribution could appear in the data, even though the underlying real firm size distribution remained unchanged. Dell'Anno (2007) claims the informal economy has indeed decreased in Portugal, as depicted in Table 2.3 transcribed from that study.

To see how much of the leftward shift in the firm size distribution may be attributable to the decrease in the informal economy, we make use of the regulation that requires firms to disclose how long they have been operating, and the tenure of their employees at the time of their first formal registration. Table 2.4 reports the percentage of new firms (firms that are in the database for the first time) that report tenures of at least 3 years for at least one worker. It seems from these data that the database is indeed becoming more inclusive. Once we have identified using this procedure firms that had been operating in the informal economy before they became formally registered, we use a simple regression approach to correct our firm size distribution for the effects of increasing data coverage.

Specifically, we estimate recursively the following regression for firms identified as having entered from the informal economy:

$$E_{t-1} = E_t + \beta_1 FirmAge + \beta_2 IndustryControl.$$

The regression is estimated recursively for the previous 5 years or the maximum workers' tenure reported, whichever is smaller. The resulting coefficients are then employed to infer the size in the previous year, given the size in the current year, firm age, and industry.

Table 2.5 compares the original and corrected average firm size. Table 2.6 shows the decile decomposition of the corrected firm size. Figure 2.2 compares the 1987 original and corrected firm size density.

In line with the story that the size of the informal economy in Portugal has been getting smaller over the years (Dell'Anno (2007)), the correction procedure above seems to have a much greater impact in the early years than in the later ones. It turns out that of our original 8.83 drop in average firm size 2.01 or 22% can be explained by increased database coverage. If we consider the entire firm size distribution rather than a single moment, such as the mean, the impact on our measured shift appears limited, as the figures indicate.

2.2.2 Demonopolization in the 1980s

As mentioned in the introductory section, the opening of our data window broadly corresponds to the period in which Portuguese economic policy was shifting to the center, and earlier efforts to nationalize and monopolize certain critical sectors were reversed. This "denationalization" and "demonopolization" policy was concentrated in sectors such as electricity generation/distribution, railway management/operation, cable based telecom companies, gas and water distribution (with the establishment of regional monopolies), and regional transport, where earlier nationalization and monopolization efforts had been concentrated. Forcing the breakup of large companies into several smaller ones could, in principle, drive the measured firm size distribution to the left.

Unfortunately, our data, which have replaced firm names with identifier codes to maintain anonymity, do not allow us to easily identify exactly which enterprises were subject to this policy. However, we can show that even if we control for all significant firm breakups in our data over our sample period, this is insufficient to explain the shifts we see in the data. The procedure we follow below is to identify firm breakups through worker movements, which we can track quite easily. We identify any firm whose initial workforce is composed of over 50% of workers that worked together in another firm in the previous year as being created as a result of a breakup or divestiture. Obviously, this procedure captures not only government forced breakups but also voluntary ones. The procedure is applied to all firms with more than 50 workers, even though the conventional wisdom regarding the demonopolization and denationalization policies of the 1980s suggests that they were concentrated on much larger enterprises. Our procedure will thus capture many other kinds of breakups, including spinoffs that contained a high degree of worker movement from the parent to the new firm.

As a result of the procedure described above, we have identified 982 firms with more than 50 workers as having been created out of some kind of divestiture or breakup procedure. To measure the impact of firm breakups in the change in average firm size we can compare the current situation with a hypothetical world where these firms never went through a breakup. To do so we consider that only the parent firm survives and that its size is the sum of the sizes of all of its offspring.

Table 2.7 shows the results. Out of the remaining 6.9 average firm size reduction (after the correction for increased database coverage), breakups only explain 0.03 difference in average firm size or close to 0.13%. Other moments of the firm size distribution remain broadly unaffected as well. These can be seen in table 2.8. This particular aspect of recent Portuguese policy history does not explain the leftward shift in the firm size distribution.

2.2.3 The Switch to Services

Another factor contributing to decreases in firm size is the change in the structure of the Portuguese economy. Like all other advanced industrial economies, Portugal has seen a decline in the employment share of manufacturing, and a corresponding rise in the employment share of the service sector over our sample period. Table 2.9 shows this change. Firms in the service sector have historically been considerably smaller than firms in manufacturing as can be seen in Table 2.10. So the structural shift from manufacturing to services is yet another factor contributing to the decrease in firm size. To measure the impact of this change on Portugal's firm size distribution, we compare the observed decrease in size with the counterfactual of what would have happened if the change in employment shares had not occurred.

To get a similar counterfactual for the entire firm size distribution, we had to reshape the data base so as to make the industry structure in 2009 resemble the industry structure in 1986. To do so we resample each industry in 2009 with a sampling probability equal to the industry share in 1986. This allows us to answer the question *what would the firm size distribution look like if the industry structure had not changed?* Out of the 348,367 firms we had as active in 2009, we sample 186,280 (a sampling rate of about 53%). Figure 2.3 shows the corrected 1986 and 2009 firm size distributions. The next table shows the means and percentiles of the 1986 and 2009 firm size distributions after correcting for the 3 identified causes.

Year	Mean	P10	P25	P50	P75	P90
1986	15.71	1	2	4	9	23
2009	9.15	1	1	3	7	15

We also remind the reader that, while other countries like the United States and Denmark have also undergone a shift toward greater employment in services, they have not experienced the same leftward shift in the entire firm size distribution that we have seen in Portugal.

Several interesting conclusions emerge from this section. First, the entire firm size distribution in Portugal has shifted significantly to the left. Second, we do not see similar shifts in other Western countries for which we have comparable data. Third, the Portuguese shift cannot be plausibly ascribed to expanding data coverage or other "natural causes." While expanding data coverage and other factors can explain part of the shift that we observe, a great deal remains unexplained. To account for this large residual, we turn now to the consideration of a category of economic policies that Portugal has pursued to an extreme degree since the fall of the Salazar dictatorship in the 1970s: employment protection for workers.

2.3 Labor Protection

Labor protection is notoriously high in Portugal. The OECD index of Strictness of Overall Employment Protection[7] has listed Portugal as the country having the most protective labor laws in the entire sample from 1985 to 1996. Since 1996, it has ranked second overall (after Turkey), but it is the highest ranked Western European country by a considerable margin. In 2007 Denmark placed 20th and the US 29th out of the 29 OECD countries. Various aspects of Portugal's employment protection regime have been discussed in detail elsewhere (e.g., Blanchard and Portugal (2001) and Martins (2009)).

2.3.1 Labor Laws in Portugal

Dismissals of workers in Portugal has been tightly regulated for some time. Dismissal for cause has been one of the ways for firms to let go of workers. In 1969, according to Law 49408, fair reasons for dismissal included lack of specific competence on the part of the worker for her assigned function. Just cause also included violation of discipline and safety. In the event of a dismissal for cause, workers were entitled to compensantion equivalent to 1 week pay per year of employment. The 1974 revolution substantially changed Portuguese labor laws. The new constitution specified, in Article 53, - *"Workers are guaranteed job security, and dismissal without fair cause or for political or ideological reasons is prohibited."* The constitution also guaranteed workers the right to strike and forbade lockouts.

Following the adoption of the new constitution, a series of labor laws was passed that sought to embed the pro-labor orientation of the democracy movement into the structure of Portuguese labor law and practice. A detailed discussion of some of the major post-revolution labor laws is provided in Appendix B at the end of the paper. Without belaboring those details here, we can state without contradiction that the post-revolutionary state quickly erected and maintained a system of protections for permanent employees that was extensive and strong, even by contemporary Western European standards.

[7] www.oecd.org/employment/protection

With such strong employment protection, we would expect firms to be especially cautious when hiring workers, due to the difficulties involved in firing them later. Firms facing a tumultuous market might put off hiring workers that would be useful in the present but that would become costly to lay off if conditions deteriorated. These fears might lead to biases and mis-allocations of workers across firms. Could they also impact the firm size distribution and aggregate productivity?

In order to guide our thinking on these issues, we present a variation of the celebrated Lucas "span-of-control" model (Lucas (1978)), in which the size of a firm reflects the competence of its manager. We model labor protection costs as an implicit tax on labor, or a "wedge" driven between what it costs the firm to hire a worker and what the worker actually receives as his/her take-home wage. There is an important difference, however, between an actual and an implicit tax stemming from regulation. The difference is that while an actual tax (such as payroll tax) generates government revenue and thus does not, by itself, represent a deadweight loss, the implicit tax imposed by labor protection-related regulation generally yields no such revenue. For some detailed examples, the reader is referred to Appendices B and C. To bound the welfare costs of these distortions, we model the welfare losses as if they were imposed by a "tax" where revenues are completely dissipated, with no social benefit arising from efficient expenditure. Taking this view of the effective "tax" imposed by labor market distortions in Portugal suggests quite large losses in output per capita associated with the current regime.

2.3.2 Modeling the Firm Size Distribution in the Presence of Labor Protection

Following the Murphy et al. (1991) variation of the Lucas model, we assume that there is a distribution of ability x in the workforce, with the support of $[1, x_{max}]$ and the strictly positive density function $g(x)$. There is only one good in the economy which is produced by many firms. If a firm is organized by an entrepreneur with ability x, its profits are given by

$$\pi(x; w, T) = xh^{\alpha} - wTh,$$

where h is the aggregate human capital (ability) of all the workers employed by this entrepreneur, $0 < \alpha < 1$ is the parameter of the production function, w is the workers' wage, the price of good is normalized to be 1, and $T \geq 1$ is the gross tax on labor. As discussed immediately above, this "tax" is actually designed to represent a market distortion, or extra deadweight cost imposed on firms that does not generate any government revenues. Hence, T should perhaps be properly called a "wedge" that is driven by regulation and red tape between the outlay per worker the firm has to spend and the actual wage received by the worker. We continue to use the word "tax" to describe this situation below but it should be understood in the sense defined here.

The first order condition determines the optimal size of the firm given the ability of the entrepreneur, the wage and the gross tax rate (the "wedge") per efficiency unit of labor employed:

$$h(x; w, T) = \left(\frac{x\alpha}{wT}\right)^{\frac{1}{1-\alpha}}. \tag{2.1}$$

More able entrepreneurs obviously run larger firms and since there are increasing returns to ability in entrepreneurship, optimal firm size and hence profits π are a convex function of x, where π is given by:

$$\pi(x; w, T) = c x^{\frac{1}{1-\alpha}} (wT)^{-\frac{\alpha}{1-\alpha}},$$

where $c = \alpha^{\frac{\alpha}{1-\alpha}} - \alpha^{\frac{1}{1-\alpha}} > 0$.

Note also that given w, an increase in T lowers the optimal sizes of all firms. Of course, an increase in the tax will not leave wages unchanged, so we now turn to market equilibrium.

An individual becomes an entrepreneur when

$$\pi(x) > wx,$$

and a worker otherwise. Abler people become entrepreneurs in equilibrium and less able ones become workers. The ability (human capital) level that defines the cutoff between entrepreneurs and workers is denoted by z and is given by the indifference condition:

$$wz = z^{\frac{1}{1-\alpha}} (wT)^{-\frac{\alpha}{1-\alpha}} c,$$

or equivalently by:

$$z = \left(\frac{w}{c^{1-\alpha}}\right)^{\frac{1}{\alpha}} T. \tag{2.2}$$

Note that even though the labor cost is simply the product of w and T, which thus enter the firm's profit maximization problem in a completely symmetric way, the cutoff ability z of the "marginal entrepreneur is disproportionately affected by w (because $\alpha < 1$). This plays an important role in the equilibrium repercussions of a higher tax on entry (see the discussion after the proof of Proposition 1 below).

The demand for workers by entrepreneurs must equal the supply of workers:

$$\int_1^z x\, g(x)\, \mathrm{d}x = \int_z^{x_{max}} h(x)\, g(x)\, \mathrm{d}x. \tag{2.3}$$

The existence and uniqueness of the equilibrium pair (z, w) is a standard result in the Lucas "span-of-control" model and it is not affected by the presence of the labor tax, so we do not present it here. Figure 2.4 illustrates occupational choice.

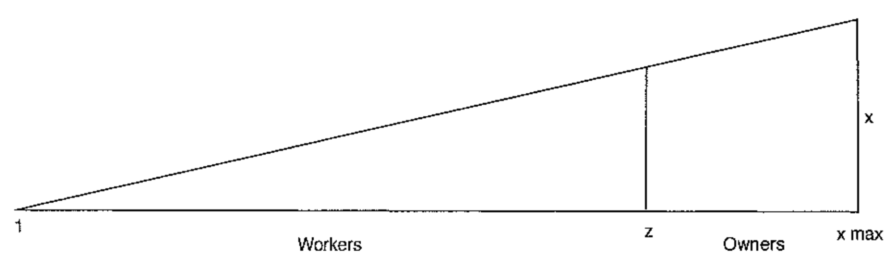


Figure 2.4: Occupational Choice

A rise in labor protection (an increase in labor tax, or the "wedge" between the firm's expenses on hiring a worker and the wage received by the worker) will have repercussions for both the equilibrium wage rate w and for the cutoff ability z. It might seem at first that since a higher tax reduces profits, this will induce marginal firms to exit, raising the cutoff ability required to be an entrepreneur. Such a conclusion, however, does not take into account the effect of the equilibrium adjustment of the wage rate. As it turns out, in equilibrium a higher T not only leads to smaller sizes of all existing firms, but also induces *entry* by entrepreneurs with ability below the cutoff z that prevailed in the previous equilibrium. More formally, we have

Proposition 1: *An increase in labor protection reduces the equilibrium wage and optimal sizes of all incumbent firms. It also induces entry of firms run by entrepreneurs in the lower tail of the entrepreneurial ability distribution.*

Proof: From the indifference condition (2.2) we have

$$(wT)^{-\frac{1}{1-\alpha}} = z^{-\frac{\alpha}{1-\alpha}} T^{-1} c^{-1}.$$

Substituting for the optimal size of the firm (2.1) in the equilibrium equation (2.3) and using the expression immediately above we obtain

$$cT \int_1^z x\, g(x)\, \mathrm{d}x = \alpha^{\frac{1}{1-\alpha}} z^{-\frac{\alpha}{1-\alpha}} \int_z^{x_{max}} x^{\frac{1}{1-\alpha}}\, g(x)\, \mathrm{d}x, \tag{2.4}$$

which implicitly determines equilibrium z as a function of T (and the parameters of the model). Straightforward differentiation shows that $\frac{dz}{dT} < 0$.

Next, rearranging and differentiating the indifference condition (2.2), we obtain

$$w'(T) = c^{-\frac{(1-\alpha)}{\alpha}} [-\alpha T^{-\alpha-1} z^{\alpha} + \alpha z^{\alpha-1} T^{-\alpha} \frac{dz}{dT}],$$

which is less than zero, because $\frac{dz}{dT} < 0$.

Finally, using equation (2.1) we can see that the optimal firm size is inversely proportional to the tax-inclusive wage rate wT for any x. Hence, the optimal size of all incumbent firms will change in the same direction in response to an increase in taxes. But if the direction of the change in the optimal size of incumbent firms is non-negative (that is, if they all increase or at least not decrease in size) in response to a higher tax on labor [8], the demand for hired human capital from incumbent firms will also increase or at least stay constant, while new entry will definitely increase this demand. The supply of human capital for hire, on the other hand, has to go down because z shifts to the left as shown above. Thus the new situation where all incumbent firms expand or at least do not decrease their optimal sizes cannot be an equilibrium, meaning that we must have $\frac{\partial h(x;T)}{\partial T} < 0$ for any x.

Intuitively, an increase in the labor "tax" leads to entry by more marginal firms because wage earnings for the marginal worker/entrepreneur go down by more than his/her profits as an entrepreneur. Thus, the worker with ability z who was indifferent between working for a wage and running his/her own firm before the tax increase now strictly prefers to run his/her own firm. To see this even more clearly, suppose that after an increase in taxes the wage was such that the worker with ability z in the previous equilibrium was still indifferent between working for pay and being an entrepreneur. From the cutoff ability condition (2.2) we can see that for z to remain unchanged, the wage w must fall less than in proportion to the increase in T

[8]In principle, this could happen if the incidence of tax falls more than 100 percent on the workers, so that $\frac{d(wT)}{dT} < 0$

(because $\alpha < 1$). This, in its turn, implies that the product wT must go up for all firms, so that all existing firms profits must go down, reducing the demand for labor compared to what it was before the tax increase. With the cutoff ability unchanged, the supply of labor is also unchanged, hence, the wage has to come down further and that induces the marginal worker to switch to entrepreneurship. An increase in labor protection, somewhat unexpectedly, pushes more workers into starting their own firms, and these newly created firms are less efficient than incumbent firms.

The effect of an increase in employment protection on the firm size distribution follows in a straightforward fashion from Proposition 1:

Corollary: *An increase in labor protections produces a leftward shift of the firm size distribution.*

Proof: Proposition 1 implies that all incumbent firms decrease in size, while there is entry by even smaller firms due to a decrease in the ability of the marginal entrepreneur z. The claim follows immediately.

Welfare, Output, and Productivity

Welfare in the model is given by economy-wide output:

$$Y = \int_{z(T)}^{x_{max}} xh(x;T)^{\alpha} g(x)\,\mathrm{d}x.$$

Totally differentiating with respect to T, we obtain

$$\frac{dY}{dT} = \alpha \int_{z}^{x_{max}} xh^{\alpha-1} \frac{\partial h}{\partial T} g(x)\,\mathrm{d}x - zh(z;T)^{\alpha} g(z) \frac{dz}{dT}. \tag{2.5}$$

Equation (2.5) shows that the effect of the tax on labor can be decomposed into two parts. The first part is the decrease in the output of incumbent firms, which are now producing at less than their optimal levels without tax. The second part is the additional output produced by former employees who now find it relatively more attractive to start their own firms. Total output and welfare decline because workers that leave employment to become entrepreneurs do not have the same level of ability as their previous employers and so are unable to compensate for the production loss taking place in the firms they left. [9]

In our model, higher taxes will lower aggregate output. Since we assume that population is fixed, this means that output per capita falls. We therefore use per capita output as our measure of the economy's aggregate productivity. This particular measure of productivity is helpful in linking our analysis to considerations of national welfare. References elsewhere in the text to the implications of our analysis for the "productivity" of the Portuguese economy are, therefore, meant to indicate per capita output. Our modeling assumptions – especially the assumption of diminishing returns to labor within firms – imply that the marginal product of labor within firms actually increases as taxes force firms to decrease employment. But, at the aggregate level, the ability of the economy to produce output with its labor endowment clearly declines because labor is shifted out of productive enterprises and into less productive ones.

This effect is substantially increased if we remember that T is actually not a pure revenue-generating tax but instead it is mostly deadweight loss stemming from various regulatory and bureaucratic costs. We believe this is a more realistic view of Portuguese reality. Labor market distortions drive a wedge between the price of labor to firms and the wages workers actually receive, but very little of that wedge can be rebated

[9] formally, the first term on the right-hand-side of expression (2.5) (which is negative) has a non-zero mass, while the second term (which is positive) is infinitesimally small (has mass zero).

to workers, firms or any other part of society through the expenditure of funds raised by a tax equivalent in size to that wedge. This reinterpretation of our tax-like effect corresponds to significant losses in output per capita.

Non-linear Effect of a Linear Tax

Even though we have so far assumed that the marginal "tax" rate on labor is constant and independent of firm size, it is important to note that the effect of increasing such a tax results in a more than proportional decrease in the optimal firm size. Formally, from the expression for the optimal size of the firm (2.1) we have

$$-\frac{\partial h}{\partial(wT)}\frac{wT}{h} = \frac{1}{1-\alpha} > 1,$$

so that the elasticity of the optimal firm size with respect to gross of tax wage is greater than 1. This, of course, is a consequence of increasing returns to entrepreneurial ability and it shows that labor protection has a disproportionately large impact on the size and output produced by the most efficient firms in the economy.

2.3.3 Biases against Large Firms in Portugal

So far in our modeling framework we have assumed that labor protection and regulation equally affects firms of all sizes. In pure theory, this assumption is enough to generate a leftward shift of the firm size distribution similar to the one observed in the data. A more realistic picture of Portuguese economic reality, however, is that of a playing field increasingly tilted especially against firms as they grow in size. Portugal is known for having strong government support systems for small firms. Small firms are typically viewed as important economic drivers, worthy of stronger support then larger firms. These incentives to be a small firm might hamper firm growth and exacerbate biases and mis-allocations of workers across firms. A particular aspect of government systems to promote small businesses is that small firms are partly or wholly exempted from labor regulations and requirements imposed on larger enterprises. Hence, such laws might create incentives for firms to remain below a certain size threshold and so decrease the average firm size. The impact of these types of thresholds has already been the subject of several past studies.

For example, in Portugal the impact of the threshold created by Law Decree 64-A/1989 was studied by Martins (2009). The study found that the threshold did not create a significant distortion in the worker flows of firms above and below the threshold. The study did find, however, that firms under the threshold gained sizable increases in performance. A similar law with a 15 worker threshold in Italy was analyzed by Schivardi and Torrini (2008). The authors found that the law created a concentration of firms under the threshold and that firms just below the threshold had a 2 percent lower probability of growth. Garibaldi et al. (2003) and Boeri and Jimeno (2005) found a similar effect when analyzing the same law.

Our analysis indicates that the government support system for small firms in Portugal has not created a concentration of firms under any particular threshold. This may reflect that many different laws with many different thresholds have been introduced over the past few decades (see Appendix C for the list of relevant laws and their brief description). Figure 2.5 shows the number of firms for each size category from 5 to 250 workers. The 5, 10, 20, 50, 100, and 250 worker thresholds are each highlighted by a vertical line, as each of these thresholds occurs in at least one Portuguese law. As can be seen, there is little indication that firms prefer to stay below any of these thresholds. We also checked if any of the specific thresholds had a discernible influence on the optimal firm size by estimating the probabilities that firms cross various thresholds in their growth (shrinkage) process. Figure 2.6 plots the probability of crossing size thresholds between 5 and 60. Firms can either grow above the threshold or shrink below it. The picture looks quite smooth, with no kinks at any particular threshold.

One way in which firms could be responding to the laws is by changing the composition of their work force. For example, firms could hire more temporary workers above the thresholds to be able to maintain a flexible work force. To see if this pattern can indeed be found in the data, we have examined the percentage of temporary workers in the total number of workers below and above various thresholds but, once again, could not detect any significant variation. The same holds for part-time contracts. Wages and firm survival probabilities also do not seem to change significantly at the thresholds. Overall there is no strong evidence that any single particular threshold influenced by the laws impacts firm size in any significant manner. Our interpretation of these results is straightforward. The absence of "threshold effects" does not mean that the bias against larger firms has no effect. It instead stems from the wide range of different thresholds at which the various policies begin to bind. As productive firms in Portugal grow, they do not run into a solid wall of greater employment protection costs at some particular size. Instead, the growth momentum may be undermined by a gradual accumulation of costs that are individually small but collectively amount to a significant disincentive to growth. We model such a situation theoretically in the next subsection by introducing a degree of nonlinearity into the model with labor tax from the previous section.

2.3.4 Equilibrium With a Nonlinear Tax

The evolution of a labor protection regime over the past 20 years as described in the previous subsection can be summarized as accumulating barriers to firm growth amidst measures to exempt small firms from costly requirements and provide them with subsidies or other forms of financial support. Some telling evidence of the effects of such increased bias against larger firms can be seen in Figures 2.7 and 2.8. These two figures show the change in the probabilities of growing above a certain threshold or shrinking below it, respectively, for firms of different sizes that occurred over these 20 years. We can see that the probability of growing to the next level has diminished fairly substantially at all firm sizes. Portugal's firm size distribution has shifted to the left, in part, because enterprises do not have the same propensity to grow larger in the latter part of our time period that they had at the outset. We also see that the probability of a firm shrinking in the next period compared to the previous period has increased over time, and this increase is concentrated in the smaller size ranges.

To capture this reality, we recast the model in this section by introducing a nonlinear component to the implicit tax on labor of the previous model. Specifically, let the profit of the firm run by entrepreneur of ability x be given by

$$\pi(x; w, T(h)) = xh^{\alpha} - whT(h),$$

where $T(h)$ is now assumed to be an increasing function of the firm size h. For simplicity, we will assume that $T(h)$ has constant elasticity $\delta > 0$ with respect to h, $T(h) = \mu h^{\delta}$. Letting $\beta \equiv \delta + 1$, the profit function can be written as

$$\pi(x; w, \mu, \beta)) = xh^{\alpha} - w\mu h^{\beta}$$

The parameter $\mu > 1$ is the linear component of the gross tax on labor corresponding to T in our earlier linear tax model, while $\beta > 1$ reflects the convexity of the overall cost of hiring extra workers under the non-linear tax on labor. Taking the first-order condition, we can solve for the optimal firm size as before:

$$h(x; w, \mu, \beta) = \left(\frac{\alpha x}{\beta w \mu}\right)^{\frac{1}{\beta-\alpha}} \tag{2.6}$$

Clearly, *ceteris paribus* the optimal firm size is decreasing in both the linear and non-linear parameters of the tax.

The optimized profit is given by:

$$\pi(x; w, \mu, \beta) = x^{\frac{\beta}{\beta-\alpha}} (w\mu)^{-\frac{\alpha}{\beta-\alpha}} \left(\frac{\alpha}{\beta}\right)^{\frac{\alpha}{\beta-\alpha}} (1 - \frac{\alpha}{\beta})$$

As in the previous section, the cutoff ability of the marginal entrepreneur is determined by the indifference condition similar to equation (2.2), from which we obtain, after some manipulations,

$$z = (w\beta)^{\frac{\beta}{\alpha}} \frac{\mu}{\alpha} (\beta - \alpha)^{-\frac{\beta-\alpha}{\alpha}} \tag{2.7}$$

Finally, in equilibrium the demand and supply of labor must be equal, implying

$$\int_1^z x\, g(x)\, \mathrm{d}x = \int_z^{x_{max}} h(x)\, g(x)\, \mathrm{d}x. \tag{2.8}$$

We first establish

Lemma 1: *For any positive and finite μ and β there exists a unique market equilibrium with the nonlinear tax, that is, there is a unique pair (w^*, z^*) such that all individuals with ability less than or equal to z^* work in firms and receive wage w^* and all individuals with ability above z^* choose to run entrepreneurial firms.*

Proof: The indifference condition (2.7) together with increasing returns to ability in entrepreneurship establish the second part of the claim. It remains to show existence and uniqueness. Solving equation (2.7) for w in terms of z and substituting the resulting expression as well as the expression for the optimal size of the firm (2.6) into the market equilibrium condition (2.8), we obtain

$$\int_1^z x\, g(x)\, \mathrm{d}x = \left(\frac{\alpha}{\mu(\beta - \alpha)}\right)^{\frac{1}{\beta}} z^{-\frac{\alpha}{\beta(\beta-\alpha)}} \int_z^{x_{max}} x^{\frac{1}{\beta-\alpha}}\, g(x)\, \mathrm{d}x. \tag{2.9}$$

The left-hand side of the equation (2.9) is equal to zero when z tends to 1 and is monotonically increasing in z. The right-hand side is positive and finite when z tends to 1 and is monotonically decreasing in z, converging to zero as z approaches x_{max}. Thus, there must exist a unique z that satisfies equation (2.9), as claimed in the Lemma. The existence of the corresponding unique w^* follows from equation (2.7).

The equilibrium with the nonlinear tax has the same qualitative properties as the equilibrium with the linear tax studied in the previous section. More formally, we have

Proposition 2: *Assume that*

$$\beta < \frac{\alpha(1+\mu)}{\mu}. \tag{2.10}$$

Then an increase in either the linear component of the tax μ or the nonlinear component β (provided the above constraint is still met) reduces the equilibrium wage and the optimal size of all incumbent firms. It also induces new entry of firms run by entrepreneurs in the lower tail of the entrepreneurial ability distribution.

Proof: See Appendix.

Note that the parametric restriction (2.10) is only a sufficient but not a necessary condition and it is likely to be easily satisfied for reasonable parameter values.

Provided that (2.10) holds, all other results we obtained in the previous section also continue to hold. In particular, an increase in μ and/or β shifts the firm size distribution to the left and reduces total output and efficiency.

2.4 Calibrating the Model

Our theoretical analysis above has demonstrated that labor protection measures do indeed result in the reduction of optimal firm size and also in entry by marginal, less efficient firms in equilibrium. Taken together, these two effects produce a leftward shift in the firm size distribution broadly similar to the one observed in the data. In this section, we calibrate the model to see what kind of implicit tax rates need to be assumed in order to replicate the actual shift in firm size that happened in Portugal from 1986 to 2009. This calibration also allows us to estimate the implied loss in firm output and (net of tax) equilibrium wage as compared to the case of no tax.

We conduct three separate calibration exercises. In the first such exercise, we assume that all firms are affected equally by employing the linear tax model and ignoring any possible convexity. In the second exercise we only vary the degree of convexity of the implicit tax on hired labor. Finally, in the third exercise we vary both the linear and non-linear components at the same time. The third exercise gives us an extra degree of freedom, and we use it to see what kind of a simultaneous reduction in the linear component together with an increase in the convexity of the implicit tax on labor can still replicate the patterns observed in the data. This exercise seems to correspond most closely to the actual story of the evolution of labor protection in Portugal in the past couple of decades, where smaller firms had been gradually granted more exemptions from regulation while the bias against large firms had been increasing.

For the purpose of all our calibrations we fix the parameter of the production function $\alpha = 0.67$. This corresponds to a standard share of labor in national income. We assume that the human capital (ability) follows a power distribution [10], with probability density function given by $g(x) = a\,x^{a-1}$. We truncate the power law to the $[1, 10]$ interval and normalize both the linear component μ and the non-linear component β to be equal to one in 1986 where our data begin. We pick up the remaining free parameter ($a = 0.12$) to match the actual average firm size in that year (15.71 workers).

The second column in Table 2.11 shows that in order to match the decline of the average firm size similar to the one observed in the Portuguese data from 1986 to 2009 by increasing the linear component in the tax

[10] We also conducted our calibration exercises below assuming a Normal distribution of ability and the results were qualitatively very similar. In an earlier version we used a uniform distribution, which can also replicate the shift in the firm size observed in the data.

on labor alone, the tax rate in 2009 has to be set equal to 310 percent. Total output by all firms declines by 47 percent as a result, and average wages in the working population decrease by 63 percent. Thus, an increase in the linear component of the tax is indeed enough to produce the decline in the average firm size observed in the data. The implied tax rate seems, however, to be unrealistically high.

Table 2.11: Calibrating the model

Parameters: $\alpha = 0.67, supp(x) = [1, 10]$.

	No Tax	Linear Tax	Convex Tax	Both	Both
Linear Tax	1.00	3.10	1.00	0.90	0.80
Convex Tax	1.00	1.00	1.16	1.17	1.19
Average Firm Size	15.71	9.15	9.15	9.15	9.15
Cutoff Ability	6.46	4.51	4.51	4.51	4.51
Wage	1.85	0.68	1.21	1.27	1.33
Production	4.03	2.10	3.07	2.94	2.75

The third column in Table 2.11 shows the results when only the non-linear component of the tax is varied. The net marginal tax rate of 16 percent is sufficient to generate the pattern consistent with the data. This rate is somewhat higher than the 6-9 percent tax rate at size 50 calibrated by Garicano et al. (2012) using the French data but it does not seem unreasonably high. The implied loss of output is 23 percent, and the decline in equilibrium wage is now limited to 34 percent as compared to the benchmark case of no tax on labor. The difference in the impact on output and wages can be understood as follows. A convex labor tax falls predominantly on large firms. Therefore, it reduces their size by more than the size of smaller firms. This means that the same leftward shift in the firm size distribution (and the same decrease in the average firm size) happens now at a lower overall implicit tax rate, limiting the overall output and wage decline. Figure 2.9 shows the cutoff ability and the distribution of firm sizes under the no-tax, $T = 3.10$ and $\mu = 1, \beta = 1.16$ scenarios above. With the nonlinear tax, the optimal sizes of the firms run by entrepreneurs at the high end of the ability distribution are markedly lower than under a much higher linear tax. There are also many more entrepreneurial firms run by individuals towards the lower end of the part of the ability distribution from which entrepreneurial talent is drawn. Going beyond our current model, the long-term welfare repercussions of a convex "tax" can thus actually be more severe than those of a flat tax (for example, if largest firms are responsible for a disproportionally high share of investment or R&D activity in the economy and so on).

In the final two columns of Table 2.11 we examine what kind of an increase in the convexity of the tax can offset a possible decline in the linear component (which, as argued above, may have happened under gradual relaxation of labor regulations especially for small firms in Portugal) and still produce the decline in the average firm size observed in the data. In the fourth column we assume that over the period covered by our data the linear component was reduced by 10 percent (from 1 to 0.9). To match the observed decline in the average firm size over the same period the marginal tax rate now has to be set equal to 0.17 (as opposed to 0.16). The implied decline in output is 23 percent and the decline in equilibrium wage is 31 percent. In the last (fifth) column we let the decrease in the linear component be even larger (from 1 to 0.8), which requires the marginal tax to be increased to 19 percent in order to match the decrease in the average firm size observed in the data. The implied decline in output is 32 percent while the decline in equilibrium wage is 28 percent. We can thus see that even a rather large relaxation of labor protection targeting small firms is completely offset by "tilting" the playing field just a little bit more against larger firms. The overall effect of such policies is comparable in terms of its effects on the decrease in the average firm size to the effects of a very large increase in the linear net tax rate but it results in an even larger decline in the total output of all firms. In other words, even a relatively small bias against large firms in the labor protection policy can completely undo any positive effects of a reduction in labor protections for smaller firms and is actually equivalent to a sharp *increase* in the labor protection if applied equally to all firms.

2.5 Conclusion

This paper documents an important, unusual, and heretofore undocumented feature of the Portuguese economy. For at least two decades, the Portuguese firm size distribution has been shifting to the left. This shift is quite pronounced, does not appear to exist in other advanced industrial countries, and cannot be fully or even mostly explained by expanding data coverage or other "natural causes."

We believe Portugal's unusual and distinctive shifts in the firm size distribution reflect its unusual and distinctive labor market regime. As many observers and official indices have attested, Portugal's policy commitment to employment protections for regular workers in the formal sector is extreme, even by Western European standards. We present a model in which high levels of employment protection effectively operate as a tax on wages, and can produce a shift in the firm size distribution, relative to the distortion-free benchmark, that reflects, in some ways, what we have seen in Portugal.

An immediate implication of our model is that the same policy regime that shrinks firms also lowers aggregate productivity. Even a uniform tax tends to hit the most productive enterprises disproportionately hard, causing a degradation of the allocation of resources across enterprises. More resources are tied up in smaller, less protective enterprises and fewer resources are allocated to the most productive firms, relative to what we would see in a distortion-free economy. To the extent that the tax hits larger (and more productive) enterprises harder – a reasonable belief given the realities of Portugal's labor regime – the negative impact of resource allocation is exacerbated, the firm size distribution is driven even further to the left, and aggregate output declines even more.

We engage in some simple calibration exercises to quantify the level of policy distortion that is consistent with the shifts in the firm size distribution we observe in the data, then seek to measure the level of aggregate productivity gains that might result if these distortions were partly or completely eliminated. Our results strongly suggest that Portugal could achieve first-order productivity gains by moving to a less distorted labor market.

2.6 Proof of Proposition 2

Note that the equilibrium equation (2.9) in the main text can also be written as

$$\int_1^z x\, g(x)\,\mathrm{d}x = \left(\frac{\alpha}{\mu(\beta-\alpha)}\right)^{\frac{1}{\beta}} z^{\frac{1}{\beta}} \int_z^{x_{max}} \left(\frac{x}{z}\right)^{\frac{1}{\beta-\alpha}} g(x)\,\mathrm{d}x.$$

Totally differentiating (2.9) yields

$$\frac{dz}{d\mu} = -\frac{\frac{1}{\mu\beta}\Omega}{zg(z)\,(\Gamma z)^{-\frac{1}{\beta}} + \frac{\alpha}{\beta(\beta-\alpha)}z^{-1}\Omega + g(z)}, \tag{2.11}$$

$$\frac{dz}{d\beta} = -\frac{\frac{1}{\beta^2}\Omega\ln z + \frac{1}{(\beta-\alpha)^2}\Xi + \frac{1}{\beta(\beta-\alpha)}\Omega + \frac{1}{\beta^2}\Omega\ln\Gamma}{zg(z)\,(\Gamma z)^{-\frac{1}{\beta}} + \frac{\alpha}{\beta(\beta-\alpha)}z^{-1}\Omega + g(z)}, \tag{2.12}$$

where $\Omega \equiv \int_z^{x_{max}} \left(\frac{x}{z}\right)^{\frac{1}{\beta-\alpha}} g(x)\,\mathrm{d}x$, $\Xi \equiv \int_z^{x_{max}} \left(\frac{x}{z}\right)^{\frac{1}{\beta-\alpha}} \ln(\frac{x}{z})\, g(x)\,\mathrm{d}x$, and $\Gamma \equiv \frac{\alpha}{\mu(\beta-\alpha)}$.

Both the numerator and the denominator in the expression (2.11) contain only positive terms, hence, $\frac{dz}{d\mu}$ is always negative. The denominator in the expression (2.12) is the same; as for the numerator, all terms except the last one are positive. If $\ln\frac{\alpha}{\mu(\beta-\alpha)} > 0$ the the last term is also positive. Hence, the condition (2.10) in the main text is a sufficient (but not necessary) condition for $\frac{dz}{d\beta}$ to also be negative.

Next, taking the natural log of the equation (2.7) in the main text, we obtain

$$\ln w = \frac{\alpha}{\beta}\ln z + \frac{\alpha}{\beta}\ln\frac{\alpha}{\mu} + \frac{\beta-\alpha}{\beta}\ln(\beta-\alpha) - \ln\beta.$$

Obviously, w will be decreasing in μ and/or β if and only if $\ln w$ is so. Since z is decreasing in μ, the equilibrium wage is clearly a decreasing function of μ. Differentiating the expression above with respect to β we obtain, after some manipulations

$$\frac{d\ln w}{d\beta} = -\frac{\alpha}{\beta^2}\ln z + \frac{\alpha}{\beta}\frac{1}{z}\frac{dz}{d\beta} - \frac{\alpha}{\beta^2}\ln\frac{\alpha}{\mu(\beta-\alpha)}.$$

Under the condition (2.10) both the second and the third terms on the right-hand side of the expression above are negative, so that $\frac{d\ln w}{d\beta} < 0$.

The arguments that under the condition (2.10) the optimal sizes of all incumbent firms are decreasing in μ and β and that an increase in either μ or β shifts the firm size distribution to the left and reduces total output are exactly the same as in the proofs of Propositions 1 and the Corollary in the main text.

2.7 List of Major Laws Protecting Workers In Portugal

The following paragraphs identify and briefly describe some of the major laws imposing labor market regulations after the end of Portugal's dictatorship in the 1970s.

Law Decree 372-A/75 was the first major revision of labor law issued after the revolution, and lack of worker competence was removed from the list of reasons that would warrant a worker's dismissal. Only direct disobedience, worker conflicts, dereliction of duty, unjustified absences, or damage of company property or interests were considered as grounds for fair dismissal. Law Decree 841-C/76 added "unjustified decline in worker performance" as a justification for fair dismissal, and the definition has not changed since.

Law Decree 372-A/75 also allowed for dismissal for "economic reasons" – essentially weak financial performance on the part of the employing firm – but such a dismissal would have to be approved by the workers union through a lengthy procedure. Upon dismissal, the worker was entitled to compensation of one month's salary per year of tenure with a minimum compensation of 3 months' salary. Law Decree 64-A/89 removed this union-mediated procedure and instituted dismissal for economic, structural or technological reasons. The firm could lay off workers if it could prove that both following conditions held: that it was impossible to maintain the labor contract, e.g. by switching the worker to another position, and that no fixed term contract worker is employed in a similar position. If several workers were in the same position the firm could only dissmiss the one with least seniority. The company had to notify the worker 60 days before the dismissal date and the dismissed worker maintained the same 1 month compensation per year of tenure with a minimum of 3 months.

Law Decree 400/91 introduced "insufficient adaptation to new technologies or processes" as an additional reason for dismissal. This method could only be used if new technology or processes were introduced. The firm was required to provide job training for the worker to adjust to new technology or to a new position inside the firm. Only after providing training and enough time to adjust could the company claim this type of dismissal. The company would also have to prove that there was no other position for the worker inside the firm and it would have to maintain the same level of employment, i.e. it would have to hire some other worker. The dismissed worker was entitled to work 2 hours less per day during the training/adjustment period and had the same early warning and dismissal compensation conditions as before.

Another option available for firms is "collective dismissals," a simultaneous or near simultaneous cessation of the employment relationship of multiple employees. Law Decree 84/76 defined a collective dismissal as one involving at least two workers in a firm with less than 50 workers and at least five workers for larger firms . The firms can claim economic, structural, or technological conditions to justify the dismissals. The procedure required authorization from the labor ministry (which has evolved over time). Law Decree 64-A/89 changed the role of the labor ministry to that of a mediator between labor and firm, removing its authorization requirement. Given the time-intensive bureaucratic procedures involved, collective dismissals are very rare. In 2009, with the global economy in free fall and unemployment rising in Portugal, collective dismissal procedures were invoked in only 5779 separations (about 0.18% of total workers). Workers dismissed under collective dismissal procedures are entitled to the same dismissal compensation conditions noted above.

Fixed term contracts were freely available under Law Decree 49408, promulgated in 1969. Law Decree 781/76 limited the use of these contracts to 3 years, after which the firm would have to switch the worker to a full term contract (essentially employment for life) or else lay off the worker. Workers were not entitled to any compensation. Law Decree 64-A/89 limited the use of fixed term contracts to temporary worker replacement, temporary increases in activity, seasonal activity, and other temporary projects.

Under Law Decree 49408, issued in 1969, workers were entitled to 6, 12, 18 paid vacation days for tenures up to 2, 10, or more years. Law Decree 874/76 entitled every worker to at least 21 paid vacation days. In addition to the paid vacation days, workers receive a vacation subsidy equivalent to the wage of the vacation days. DL 99/2003 increased paid vacation days to 22, while entitling the worker up to 3 more days if he has no unjustified absences. Since 1974, Portugal has had 13 mandatory holidays, with certain regions adding an extra one. Law Decree 372/74 created a Christmas subsidy, equivalent to a month's salary, for public workers and pensioners. It also grants them a vacation subsidy equivalent to half a month's wage. DL 496/80 sets the vacation subsidy to equal a month's pay. Law Decree 88/96 extends the Christmas subsidy equivalent to 1 month salary for every worker.

Law Decree 409/71 limited working hours to a maximum 48 hours per week and 8 per day. The weekly limit was lowered to 44 hours per week by Law Decree 2/91 and to 40 hours per week by Law Decree 21/96. Law Decree 421/83 limited overtime to 160 hours per year and 2 hours per day, with a 50% pay premium for the first hour and 75% for all following hours.

A national minimum wage was created after the revolution (LD 217/74), with a very high initial value. At the time it represented 70% of the median wage in Portugal. Yearly updates have brought it closer to 50% of median wage.

Law Decree 519-C1/79 regulates the agreements that can be reached by negotiation between labor unions and firms or groups of firms. The agreements can and do expand the rights and protections of workers while most of the rights mentioned above cannot be removed. A particular detail of this legislation is that it allows the labor ministry to extend agreement reached between one firm and its workers to firms and workers in the same category of job. As a result some of these conventions extend to large parts of the working population.

2.8 List of Laws Supporting Small Firms and/or Penalizing Large Firms

This section lists and briefly describes provisions of Portugal's labor market regulation regime that effectively support small firms and/or discriminate against large ones. The legal history is complicated – some provisions were introduced, then revised or repealed, then replaced by similar provisions. Nevertheless, the general tendency has been to maintain a wide array of exemptions and de facto subsidies for smaller firms. Unless otherwise indicated, legal provisions discussed here remained in effect through the end of our data window.

- Law Decree 217/1974 - Firms with 5 or fewer workers were exempt from minimum wage laws, in effect until 1975.

- Law Decree 292/1975, Law Decree 49-B/1977 - Firms with 10 or fewer workers could ask the labor ministry authorization to pay bellow the minimum wage if it stated the minimum wage was unsustainable, in effect until 1978.

- Law Decree 113/1978, Law Decree 440/1979 - Firms with 5 or fewer workers were exempt from minimum wage laws, in effect through 1987.

- Law Decree 69-A/1987, Law Decree 411/1987 - Firms with 5 or fewer workers were subject to a minimum wage about 12.5% lower then remaining firms. Firms between 6 and 50 workers could ask the labor ministry authorization to pay bellow the minimum wage if it proved its labour costs would rise too much following the increase in minimum wage, in effect until 1991.

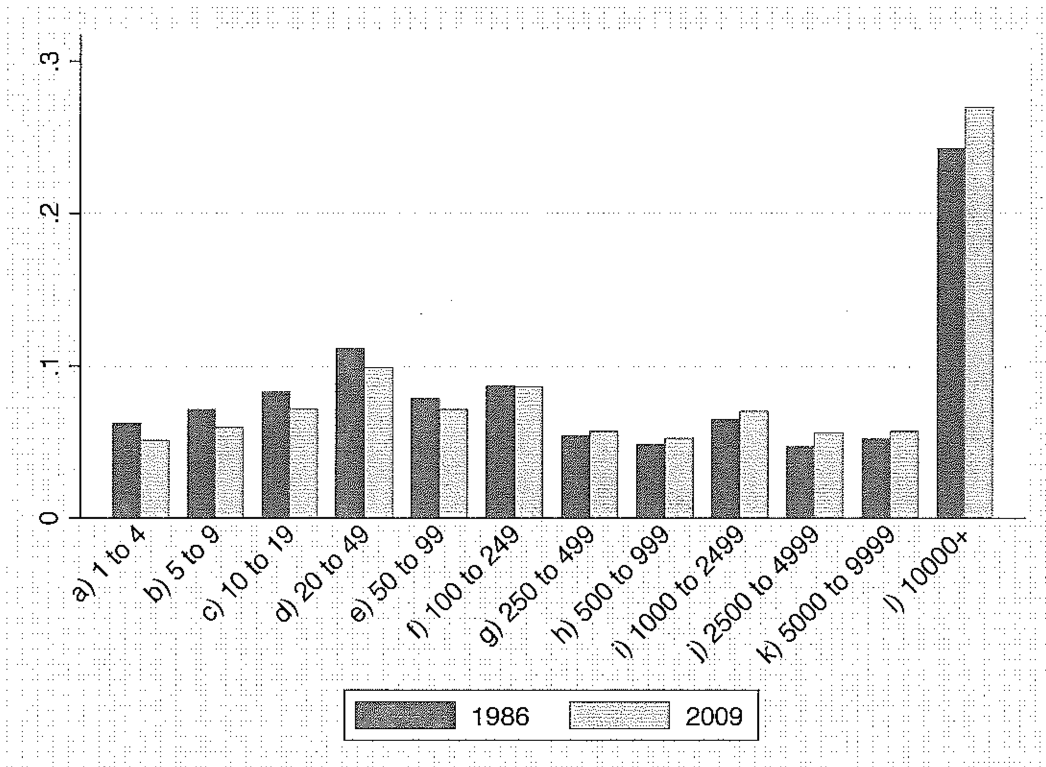
- Law Decree 194/1980, Law Decree 132/1983 - These laws provided extensive opportunities for firms under 20 workers (50 workers after 1983) to deduct the costs associated with a wide range of investments from their taxable income, potentially generating a substantial reduction in tax liabilities for firms small enough to take advantage of its provisions.

- Law Decree 141/1985, Law Decree 9/1992 - Firms with over 100 (50 after 1992) workers were required to present detailed monthly reports to the government describing the wages and benefits provided to all employees.
- Law Decree 64-A/1989 - Firms under 20 workers were allowed greater freedom to dismiss workers for cause. This legal provision, in effect until 2003, was studied extensively by Martins (2009), who found that it had a statistically and economically significant effect on the relative growth of smaller firms.
- Law Decree 298/1992, Law Decree 211/1998, Law Decree 171/1999 - These laws created a special line of credit for firms with fewer than 250 workers, lowering the costs of capital for these enterprises.
- Law Decree 26/1994, Law Decree 109/2000 - Under these laws, firms with over 50 workers were required to maintain an internal worker health protection system; smaller firms were exempted from this requirement.
- Law Decree 39-B/1994, Law Decree 160/1995 - Firms under 20 workers were entitled to a 95% income tax deduction. This provision was in effect until 1997.
- Law Decree 39-B/1994, Law Decree 121/1995, Law Decree 200/1996, Law Decree 42/1998 - These laws allowed firms under 20 workers to deduct several separate categories of operational costs from taxable income. Their provisions remained in effect until 2001.
- Law Decree 34/1996, Ordinance 255/2002 - Firms under 50 workers have access to workers whose wages are subsidized by public funds. These firms collect a subsidy equivalent to the minimum wage during the first year if they hire a young or unemployed worker. This support is subject to availability of funds, which varied over the years.
- Law Decree 116/1999 - Progressively higher fines for violations of labor law were set at employment size thresholds of 5, 50, and 200 workers.
- Law 12-A/2000 - Priority was given to firms under 50 workers in the disbursement of European Structural Funds for worker training.
- Law Decree 106/2001 - Firms over 10 workers were required to file monthly reports to the government on wages paid to employees.
- Law Decree 99/2003 - Firms under 50 workers were exempted from legal requirements to inform union leaders concerning various categories of firm information.
- Law Decree 99/2003 - Firms under 10 workers were allowed considerably greater freedom to dismiss workers for cause, even as firms from 10-20 workers were required to follow the procedures that had been imposed on larger enterprises.
- Law Decree 99/2003 - This law instituted several modest advantages for firms under 10 workers, including changes in information presentation deadlines, and reductions in mandatory days off and vacation time.

- Law Decree 99/2003 - Firms under 50 workers were allowed to deny leaves of absence to their workers under certain conditions.
- Law Decree 99/2003 - Firms under 50 workers and 10 workers were given higher limits on permissable overtime work for their employees.
- Law Decree 40/2005 - Firms under 250 workers were allowed to tax deduct patent request and maintenance costs from their taxable income.

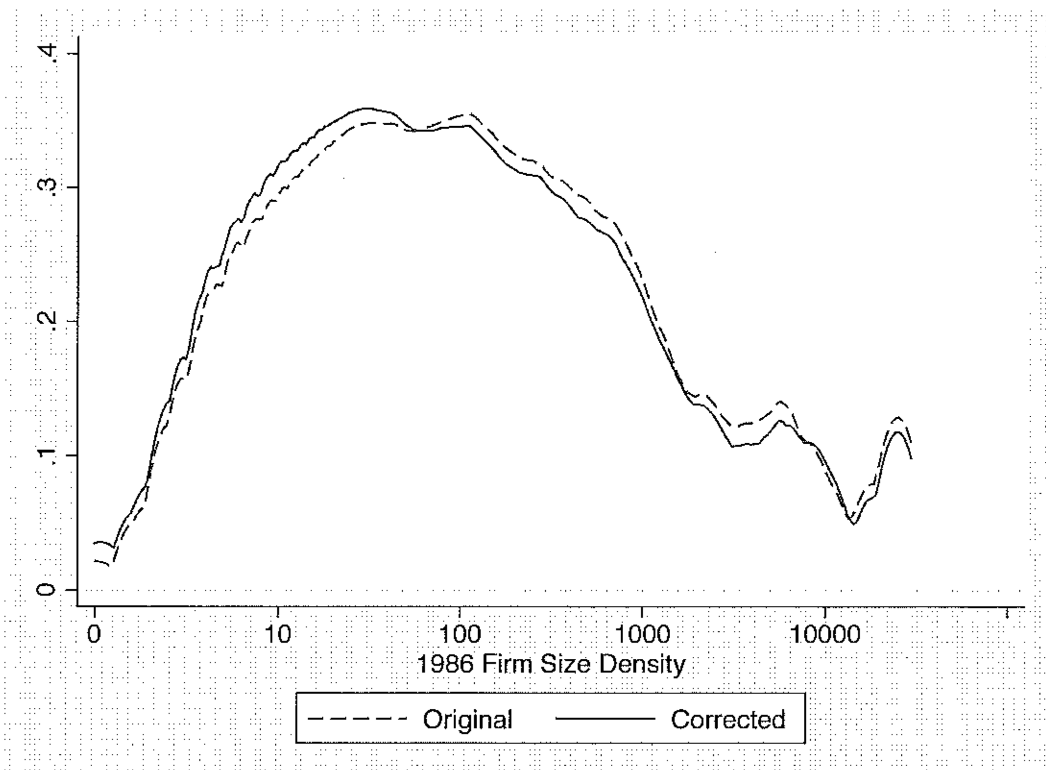
2.9 Figures

Figure 2.1: Changes in the US Firm Size Distribution, 1986-2009



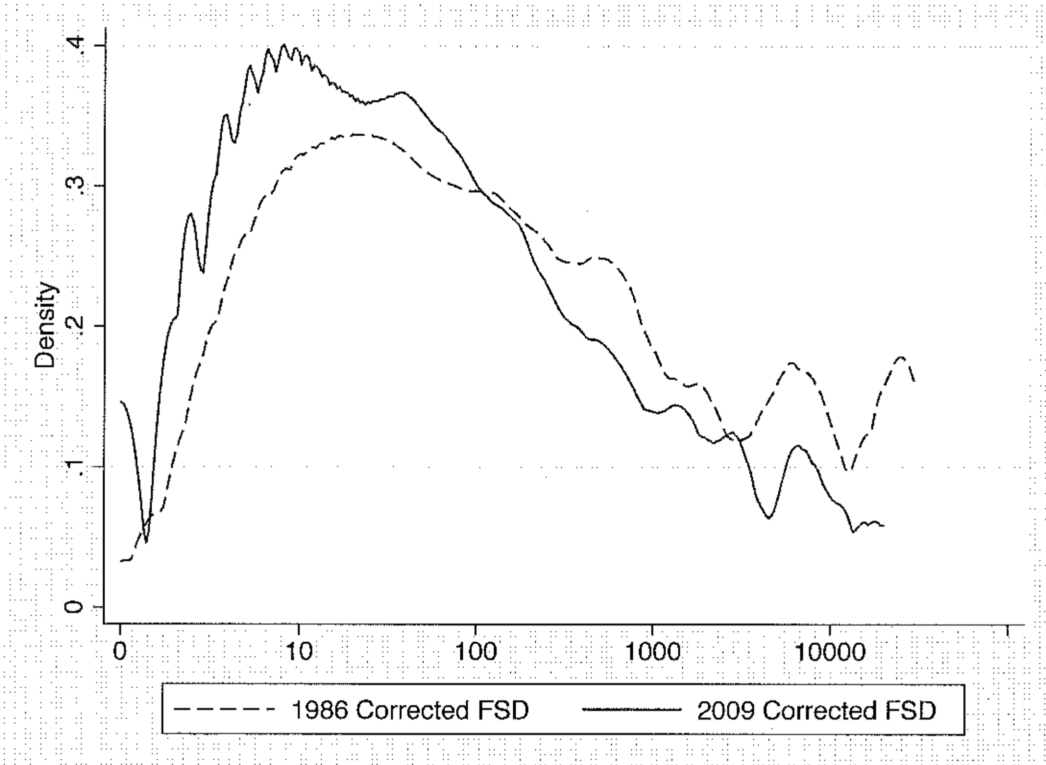
Source: U.S. Census Bureau

Figure 2.2: 1986 Original and Corrected Firm Size Distribution
The firm size distribution in Portugal weighted by number of employees:
Original data and the data corrected for the increase in data coverage, 1986.



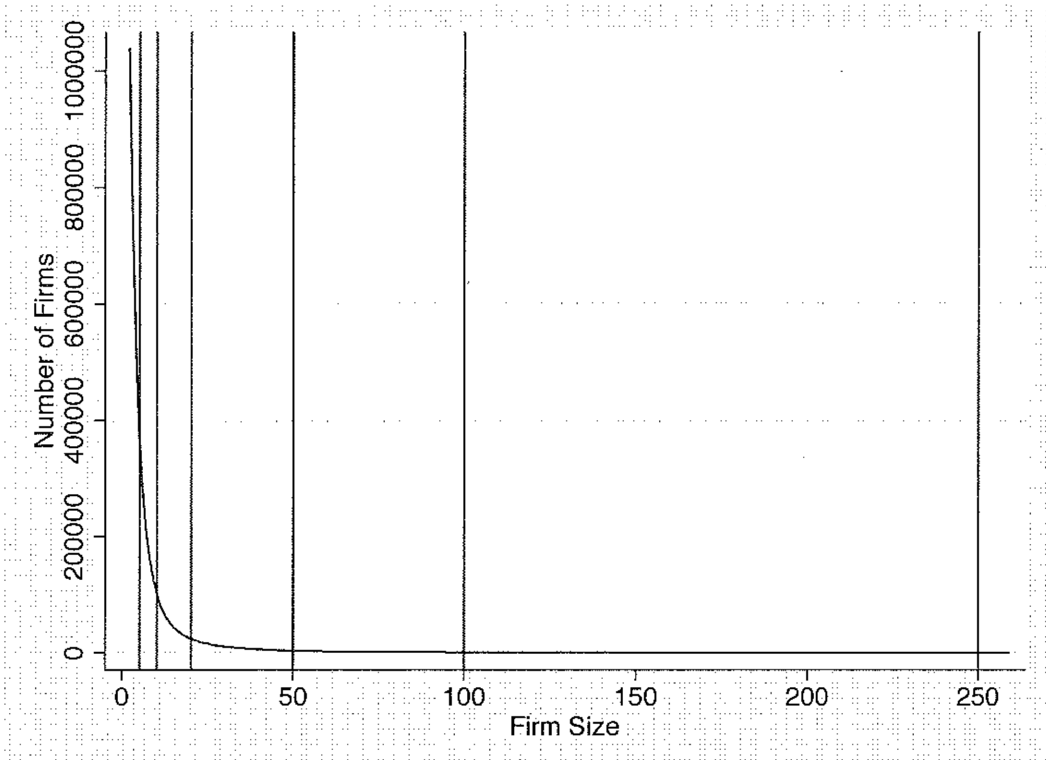
Source: Authors' calculations based on *Quadros de Pessoal* (Portuguese matched employer-employee dataset).

Figure 2.3: 1986 and 2009 Portuguese Firm Size Distributions corrected for increase in data coverage, demonopolization and change in industry structure. Weighed by number of employees



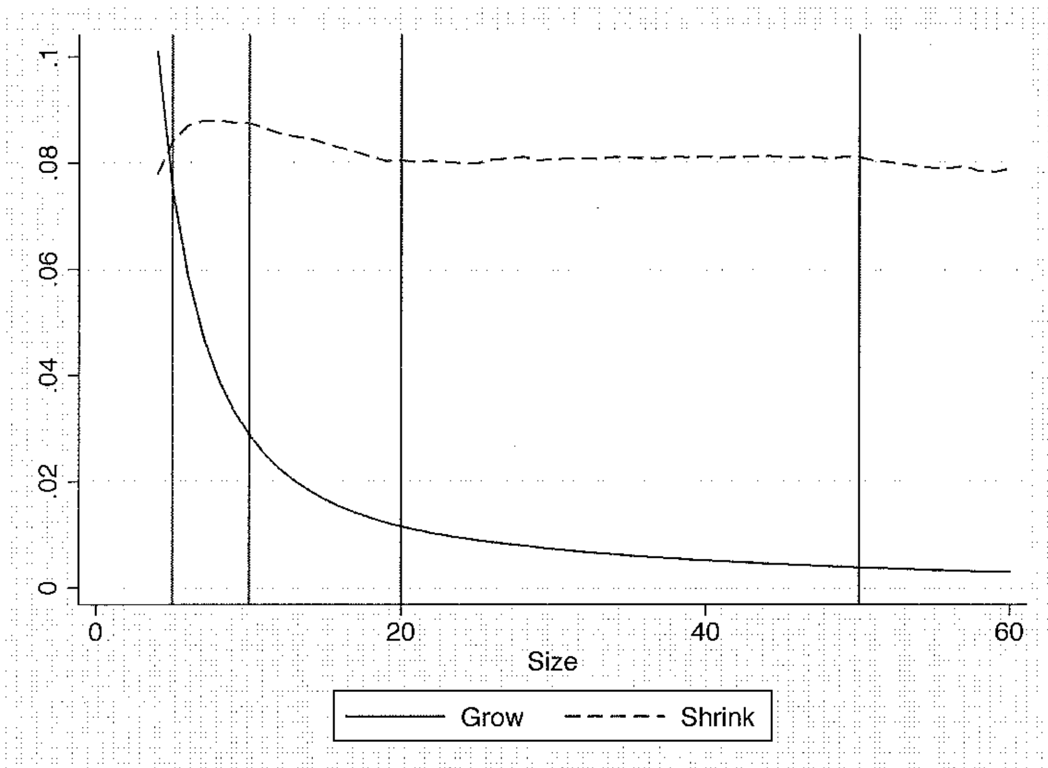
Source: Authors' calculations based on *Quadros de Pessoal* (Portuguese matched employer-employee dataset).

Figure 2.5: Number of firms by firm size
Number of firms in different size categories. Some thresholds affected by labor protection laws and government support for small firms highlighted in red.



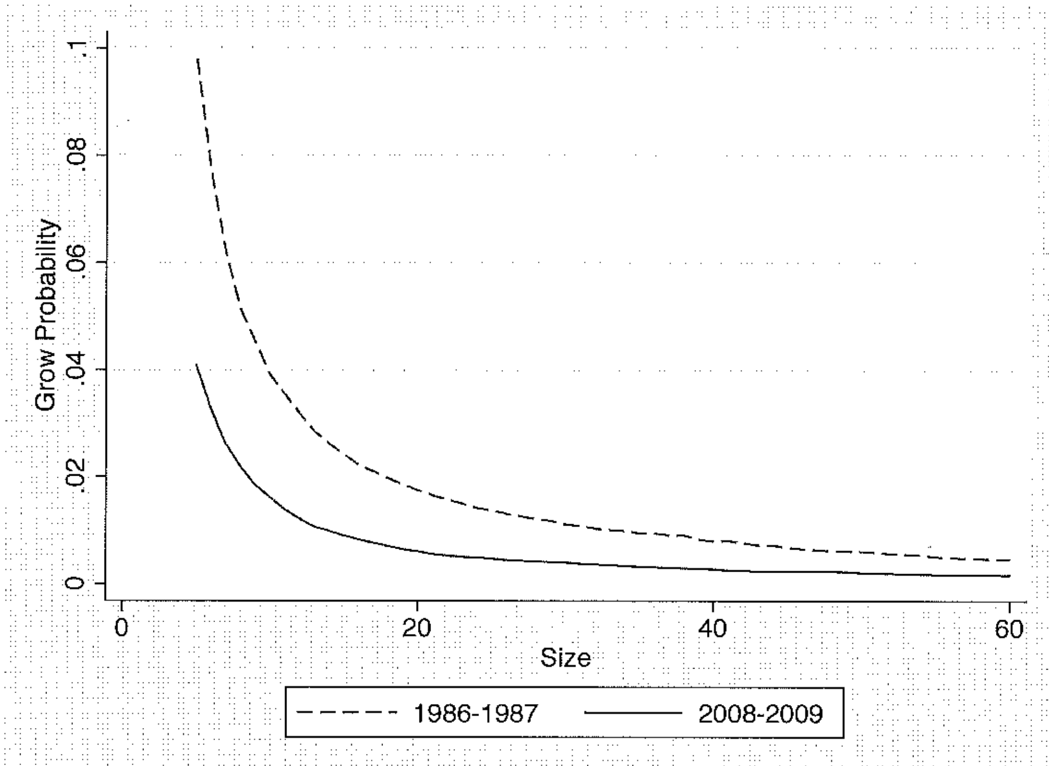
Source: Authors' calculations based on *Quadros de Pessoal* (Portuguese matched employer-employee dataset).

Figure 2.6: Threshold Crossing Probabilities
The probabilities of any given firm crossing specific size thresholds (either grow above or shrink below) for firm sizes between sizes 5 and 60.



Source: Authors' calculations based on *Quadros de Pessoal* (Portuguese matched employer-employee dataset).

Figure 2.7: The probability of a firm growing above a given threshold, 1986 to 1987 and 2008 to 2009.

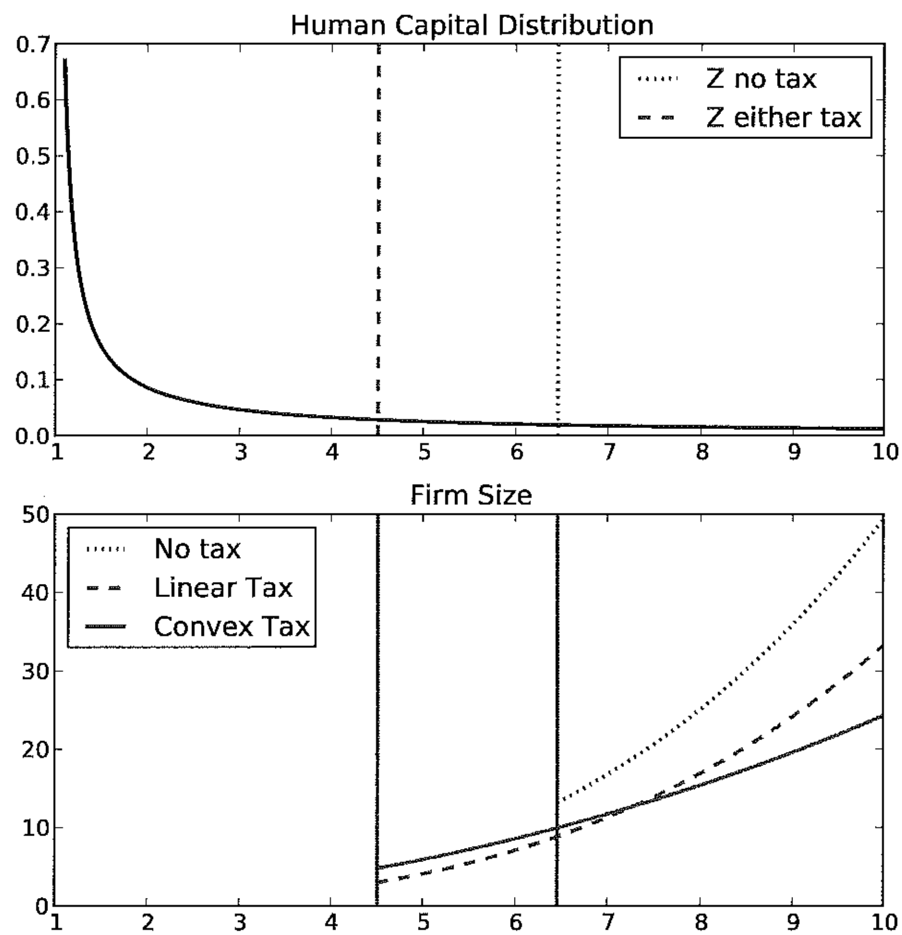


Source: Authors' calculations based on *Quadros de Pessoal* (Portuguese matched employer-employee dataset).

Figure 2.8: The probability of a firm shrinking below a given threshold, 1986 to 1987 and 2008 to 2009.

Source: Authors' calculations based on *Quadros de Pessoal* (Portuguese matched employer-employee dataset).

Figure 2.9: Calibration with Linear and Non-Linear Tax



Firm sizes with no tax, linear tax $T = 3.10$ and Convex Tax $\beta = 1.16$
The parameter of the production function $\alpha = 0.67$, x power distributed on the interval $[1, 10]$

2.10 Tables

Table 2.1: Portuguese Firm Size

Average firm size and firm sizes at various percentiles of the firm size distribution, 1986-2009.

Year	Mean	P10	P25	P50	P75	P90
1986	17.72	1	2	4	10	26
1987	17.44	1	2	4	10	26
1988	16.27	1	2	4	10	25
1989	15.87	1	2	4	9	24
1990	15.75	1	2	4	9	24
1991	15.07	1	2	4	9	24
1992	14.27	1	2	4	9	23
1993	13.36	1	2	4	8	21
1994	12.02	1	2	4	8	19
1995	11.63	1	2	4	7	18
1996	11.31	1	2	3	7	17
1997	11.00	1	2	3	7	17
1998	10.78	1	2	3	7	16
1999	10.56	1	2	3	7	16
2000	10.05	1	2	3	7	15
2001	10.04	1	2	3	7	15
2002	9.41	1	2	3	7	15
2003	9.29	1	2	3	6	14
2004	9.26	1	2	3	6	14
2005	9.01	1	1	3	6	14
2006	9.01	1	1	3	6	14
2007	9.03	1	1	3	6	14
2008	9.11	1	1	3	6	14
2009	8.89	1	1	3	6	13

Source: Authors' calculations based on *Quadros de Pessoal* (Portuguese matched employer-employee dataset).

Table 2.2: The Danish Firm Size Distribution

Average firm size and firm sizes at various percentiles of the firm size distribution, 1980-2007.

Year	Mean	P10	P25	P50	P75	P90
1980	11.03	1	1	3	7	16
1981	10.90	1	1	3	7	16
1982	11.35	1	1	3	7	16
1983	11.39	1	1	3	7	16
1984	11.60	1	1	3	7	17
1985	12.43	1	1	3	7	18
1986	13.08	1	1	3	8	19
1987	13.11	1	1	3	8	19
1988	13.07	1	1	3	8	19
1989	13.20	1	1	3	8	19
1990	13.21	1	1	3	8	19
1991	13.44	1	1	3	8	19
1992	13.32	1	1	3	8	19
1993	12.91	1	1	3	8	19
1994	13.49	1	1	3	8	20
1995	14.12	1	1	3	8	20
1996	13.83	1	2	3	9	20
1997	14.26	1	2	4	9	21
1998	14.66	1	2	4	9	21
1999	14.69	1	2	4	9	21
2000	14.78	1	2	4	9	21
2001	14.76	1	2	4	9	21
2002	14.66	1	2	4	9	21
2003	14.26	1	2	3	9	21
2004	14.01	1	2	3	9	20
2005	13.84	1	2	3	9	20
2006	13.90	1	2	3	9	21
2007	13.70	1	2	3	9	21

Source: Summary statistics from the Danish matched employer-employee database were kindly provided by Michael Dahl.

Table 2.3: Portuguese Shadow Economy size estimated by MIMIC model.

Years	77/79	80/82	83/85	86/88	89/91	92/94	95/97	98/00	01/03	04
	28.8%	26.4%	27.7%	24/6%	20.2%	21.9%	21.4%	18.5%	17.9%	17.6%

Source: Dell'Anno (2007)

Table 2.4: Fraction of new firms reporting at least 3 year tenures

Year	Mean
1987	0.35
1988	0.27
1989	0.23
1991	0.24
1992	0.24
1993	0.22
1994	0.24
1995	0.19
1996	0.17
1997	0.16
1998	0.15
1999	0.14
2000	0.18
2002	0.16
2003	0.15
2004	0.15
2005	0.24
2006	0.14
2007	0.11
2008	0.09
2009	0.08

Source: Authors' calculations based on *Quadros de Pessoal* (Portuguese matched employer-employee dataset).

Table 2.5: Average firm size after correcting for the increase in data coverage and reduction of the informal economy in Portugal

Year	Original Size	Corrected Size
1986	17.72	15.71
1987	17.44	15.27
1988	16.27	14.95
1989	15.87	15.18
1990	15.75	13.99
1991	15.07	13.42
1992	14.27	12.70
1993	13.36	11.99
1994	12.02	11.08
1995	11.63	10.75
1996	11.31	10.47
1997	11.00	10.28
1998	10.78	10.07
1999	10.56	9.85
2000	10.05	9.59
2001	10.04	9.26
2002	9.41	9.01
2003	9.29	8.79
2004	9.26	8.69
2005	9.01	8.55
2006	9.01	8.60
2007	9.03	8.69
2008	9.11	8.84
2009	8.89	8.89

Source: Authors' calculations based on *Quadros de Pessoal* (Portuguese matched employer-employee dataset).

Table 2.6: Corrected Firm Size

Firm sizes at various percentiles of the firm size distribution corrected for the increase in data coverage and reduction of the informal economy in Portugal.

Year	P10	P25	P50	P75	P90
1986	1	2	4	9	23
1987	1	2	4	9	23
1988	1	2	4	9	23
1989	1	2	4	9	23
1990	1	2	4	8	21
1991	1	2	4	8	21
1992	1	2	4	8	20
1993	1	2	4	8	19
1994	1	2	3	7	17
1995	1	2	3	7	16
1996	1	2	3	7	16
1997	1	2	3	7	16
1998	1	2	3	7	15
1999	1	2	3	6	15
2000	1	2	3	6	15
2001	1	1	3	6	14
2002	1	1	3	6	14
2003	1	1	3	6	14
2004	1	1	3	6	13
2005	1	1	3	6	13
2006	1	1	3	6	13
2007	1	1	3	6	13
2008	1	1	3	6	13
2009	1	1	3	6	13

Source: Authors' calculations based on *Quadros de Pessoal* (Portuguese matched employer-employee dataset).

Table 2.7: Average firm size after correcting for "denationalization" and "demonopolization".

	Firm Size	Corrected
1986	15.710	15.710
1987	15.269	15.269
1988	14.954	14.955
1989	15.178	15.178
1990	13.988	13.988
1991	13.422	13.422
1992	12.698	12.698
1993	11.991	11.991
1994	11.079	11.079
1995	10.749	10.749
1996	10.472	10.474
1997	10.282	10.282
1998	10.069	10.069
1999	9.845	9.845
2000	9.593	9.593
2001	9.255	9.255
2002	9.011	9.011
2003	8.792	8.792
2004	8.689	8.690
2005	8.551	8.552
2006	8.586	8.597
2007	8.686	8.687
2008	8.838	8.840
2009	8.845	8.870

Source: Authors' calculations based on *Quadros de Pessoal* (Portuguese matched employer-employee dataset).

Table 2.8: Corrected Firm Size

Firm sizes at various percentiles after correcting for "denationalization" and "demonopolization"

Year	P10	P25	P50	P75	P90
1986	1	2	4	9	23
1987	1	2	4	9	23
1988	1	2	4	9	23
1989	1	2	4	9	23
1990	1	2	4	8	21
1991	1	2	4	8	21
1992	1	2	4	8	20
1993	1	2	4	8	19
1994	1	2	3	7	17
1995	1	2	3	7	16
1996	1	2	3	7	16
1997	1	2	3	7	16
1998	1	2	3	7	15
1999	1	2	3	6	15
2000	1	2	3	6	15
2001	1	1	3	6	14
2002	1	1	3	6	14
2003	1	1	3	6	14
2004	1	1	3	6	13
2005	1	1	3	6	13
2006	1	1	3	6	13
2007	1	1	3	6	13
2008	1	1	3	6	13
2009	1	1	3	6	13

Source: Authors' calculations based on *Quadros de Pessoal* (Portuguese matched employer-employee dataset).

Table 2.9: Employment shares by industry in Portugal, 1986-2008

Year	Agriculture, Forestry Fishing	Manufacturing	Retail Wholesale	Construction	Transport, Electric, Gas	Services
1986	2.8	40.3	7.3	17.9	8.0	23.7
1987	2.6	39.9	7.1	17.9	7.8	24.6
1988	2.7	38.8	7.2	18.1	7.4	25.7
1989	2.8	39.2	7.7	18.7	7.3	24.3
1990	2.7	37.3	7.5	18.1	6.8	27.6
1991	2.5	36.6	7.9	18.6	6.9	27.5
1992	2.5	35.8	8.1	19.6	6.8	27.3
1993	2.4	34.5	8.2	20.2	6.6	28.1
1994	2.4	34.1	8.6	22.4	6.4	26.2
1995	2.3	33.3	8.5	17.8	6.2	32.0
1996	2.3	31.8	8.6	17.7	6.0	33.6
1997	2.3	31.0	9.0	17.9	5.8	33.9
1998	2.3	30.2	9.2	17.8	5.8	34.6
1999	2.2	29.6	9.3	18.3	5.8	34.7
2000	2.2	28.5	10.2	18.6	5.8	34.7
2001	2.1	26.3	11.5	17.9	5.6	36.5
2002	2.2	24.7	11.8	18.1	5.5	37.7
2003	2.1	24.5	11.4	18.4	5.5	38.2
2004	2.1	24.3	11.6	18.6	5.4	37.9
2005	2.5	24.1	12.1	19.2	5.6	36.5
2006	2.5	23.3	12.2	19.3	5.6	37.1
2007	2.4	22.4	12.6	19.5	5.5	37.7
2008	2.4	22.2	12.6	19.9	5.7	37.3
2009	2.4	21.2	11.9	20.1	5.8	38.6

Source: Authors' calculations based on *Quadros de Pessoal* (Portuguese matched employer-employee dataset).

Table 2.10: Average Firm Size by industry, 1986-2008

Year	Agriculture, Forestry Fishing	Manufacturing	Retail Wholesale	Construction	Transport, Electric, Gas	Services
1986	11.4	33.6	17.0	8.7	60.2	10.2
1987	11.1	33.0	16.9	8.5	58.3	10.0
1988	10.1	30.8	15.6	8.1	51.7	11.0
1989	9.8	30.1	15.0	8.0	48.3	12.1
1990	9.6	29.8	14.6	8.1	47.3	10.0
1991	8.9	28.5	13.7	7.9	44.4	9.8
1992	8.3	26.9	12.6	7.7	40.4	9.3
1993	7.8	25.3	11.9	7.4	36.1	9.1
1994	7.1	22.7	10.9	6.9	30.0	8.8
1995	6.7	22.1	10.5	6.7	27.8	8.4
1996	6.6	21.7	10.4	6.6	25.7	8.3
1997	6.4	20.6	10.0	6.7	24.4	8.4
1998	6.4	20.1	9.2	6.6	22.8	8.4
1999	6.2	19.6	8.6	6.7	21.4	8.2
2000	5.9	18.7	8.1	6.6	18.1	8.4
2001	6.0	18.3	8.6	6.6	16.5	7.9
2002	5.7	17.2	8.2	6.4	13.9	8.1
2003	5.6	16.9	7.9	6.3	12.9	8.0
2004	5.4	16.9	8.1	6.3	12.4	7.8
2005	4.1	16.5	8.1	6.2	12.1	8.0
2006	4.2	16.2	8.2	6.2	11.8	8.2
2007	4.3	16.4	8.3	6.3	11.6	8.5
2008	4.4	16.5	8.2	6.4	11.8	9.2
2009	4.4	15.8	7.9	6.3	11.7	9.1

Source: Authors' calculations based on *Quadros de Pessoal* (Portuguese matched employer-employee dataset).

Chapter 3

Portuguese Industry Productivity

3.1 Introduction

This paper takes a close look at the productivity levels of Portuguese industries. It does so by leveraging the comprehensive matched employer employee data set with the detailed cross country analysis of the KLEMS project (O'Mahony and Timmer (2009)). The results are staggering! Portuguese firms are extremely unproductive when compared with other countries. Not only are industry level productivities very low in Portugal but we can also find evidence that Portugal allocates a disproportional amount of resources into the lowest productivity industries. This misallocation severely compounds the productivity problem.

Several previous studies have pointed to low educational achievements as the root cause of the low productivity levels in Portugal. This is undoubtedly so, but when comparing Portugal with its european neighbours we see that Portuguese firms are able to produce much less given the same level of inputs. Even when using the same composition of labour, Portuguese firms are unable to match other countries. These results are verified with a growth decomposition approach. With this approach we are able to decompose the overall economic growth into its components. We can see that most of the growth in production over the last 30 years was achieved by Capital deepening and Labour quality increases, while the overall Total Factor Productivity (FTP) component has severely under-performed other KLEMS countries. In the most recent years of our data the TFP component has actually been mostly negative indicating that with the same level of inputs Portuguese industries are actually achieving less production.

Previous research (Braguinsky et al. (2011)) has shown that portuguese firms are becoming smaller and less productive. The results in this paper allow us to quantify this effect at the macro level and compare Portugal with other countries. The results are quite bad, disguised by an increase in the worker population and increasing capital and educational levels, productivity levels in Portugal have actually performed dismally. This happens at the same time as we witness a strong shift in the Portuguese firm size distribution. The two factors seem related, the shift in Portuguese economy to smaller and less productive firms has big macro productivity impacts.

A recent trend in economic research has looked into misallocation as the cause of the differences in production across countries.

Banerjee and Duflo (2005) point to a level of heterogeneity of rates of return to the same factor within a single economy that dwarfs the cross-country heterogeneity. The authors show that the marginal product of capital differs widely among firms in India, potentially reducing overall output.

Picking up on this, Hsieh and Klenow (2009) compare the productivity distributions of India, China and the US. The productivity distributions in India and China appear to be quite more dispersed than in the US. Particularly India and China allocate a larger share of resources into low productivity firms. The study proposes using the US productivity distribution in China and India as a counterfactual to identify economic loss due to misallocation. The authors claim that if these countries equalised their distribution to the US they could achieve TFP gains of 30%-50% in China and 40%-60% in India.

Restuccia and Rogerson (2008) propose a model of heterogeneous firms to identify the economic loss due to misallocation of resources across firms. The authors calibrate the model with US data and show that policies that create distortions on the prices faced by individual firms, while maintaining the same average price, can cause a 30% to 50% decrease in output and TFP.

Braguinsky et al. (2011) look into the continuous left shift in the Portuguese firm size distribution and argue that it is evidence of severe misallocation of resources into the smaller and less productive firms. The authors argue that the restrictive Portuguese labour protection laws and favouring of smaller firms are causing the shift.

This paper takes a closer look into a different but related aspect of misallocation of resources in Portugal. According to the completed KLEMS data, Portuguese firms are misallocated into the lowest productivity industries when compared to most remaining KLEMS countries. This misallocation severely compounds the low portuguese firm productivity.

Even more troubling we are able to verify that some industries have a disproportionally large impact on portuguese productivity. And in these industries Portuguese productivity is not closing the gap with remaining countries, it is widening.

The following section describes the data sources used.

3.2 KLEMS

The EU KLEMS database project was created to collect comparable input, output and productivity measures at the industry level for 25 individual EU member states plus the US, South Korea and Japan from 1970 to 2005. The input measures include various categories of capital (K), labour (L), energy (E), material (M) and service(S) inputs. Capital input is measured through the perpetual inventory method. Labour costs includes full wages plus all other costs of employing labour that are borne by the employer. Prices for all countries are converted to USD thorough Purchasing Power Parity (PPP) indexes. Importantly, the measures allow for quite a detailed picture of the industry as data on capital is desegregated between ICT, transport, residential and non residential structures and transport investments. Data on Labour measures hours worked and worker compensation and is desegregated into educational achievement level, age and gender. The variables are organised around the growth accounting methodology, a major advantage of which is that it is rooted in neoclassical production theory. It provides a clear conceptual framework within which the interaction between variables can be analysed in an consistent way.

Given the difficulties with collecting data in a comparable way, several countries are not covered with enough Labour detail to allow for a full growth decomposition. These are: Cyprus, Estonia, Ireland, Latvia, Lithuania, Luxembourg, Malta, Sweden and Portugal.

Since the release of the KLEMS data several papers have taken advantage of its coverage and completeness to study different questions: Michaels et al. (2010) find that industries with faster ICT growth shifted demand from middle-educated workers to highly educated workers contributing to the polarisation of workers out of the middle and into lower and higher skill levels. Jorgenson and Timmer (2011) revisits the Kaldor (1957) stylised facts and find that although service sectors have overwhelmingly dominated economic activity in KLEMS countries there is substantial productivity heterogeneity among them. Some service sectors are very productive while others lag behind.

Inklaar and Timmer (2009) use the detailed industry level data to show that since 1970 patterns of productivity convergence across industries in different countries have differed. Productivity in market services converged across countries but there was no convergence in manufacturing.

Van Ark et al. (2008) note that the productivity convergence between Europe and the US in the 1973 to 1995 period stopped and then reversed in the 1995 to 2006 period. The authors attribute this reversal to the faster emergence of the knowledge economy in the US. The paper focus particularly on the lack of productivity in the European market service industries that failed to adapt ICTs at the level seen in their US counterparts.

Given the interest that researchers have demonstrated for the data, several countries have started to collect and release KLEMS comparable data, these include Canada, Argentina, Australia, China, India, Japan and Korea. Cross country efforts are underway to release KLEMS data for Latin America and Asia.

"Quadros de Pessoal" allows us to measure, at the industry level, hours worked and compensation for the educational, age and gender groups used in the remaining KLEMS countries. Portugal can then be removed from the list of countries ignored when using KLEMS data.

3.2.1 Measures

Data in KLEMS is available for several industries. The industries presented in this paper are in Apendix A. These can be further disagregated into smaller categories but the country coverage is not complete. The KLEMS industry codes are based on SIC Rev 1 that is similar to European NACE 1 codes that are the base for the CAE2+ codes present in "Quadros" starting in 1995. For the period 1985-1994 Portugal used an incompatible industry code CAE1. A conversion table between CAE1 and CAE2+ was created by statistically matching the conversion used by firms that changed their code between 1994 and 1995. Firms using CAE1 codes were then assigned to the CAE2+ code that the majority of firms in the CAE1 code chose in the transition.

KLEMS Labour data is divided by:

- Academic Achievement
  - High Skill - College or University Graduate
  - Medium Skill - Typically Upper Secondary School Graduate
  - Low Skill - All others
- Age
  - A29 - Under 29
  - A49 - Between 30 and 49
  - A50 - 50 or over
- Gender

This leads to 18 different labour groups ($3 \times 3 \times 2$) per industry. For each group KLEMS has total hours worked and total compensation.

Data for Portugal in KLEMS is missing detailed labour information but contains total hours worked and total labour compensation at the industry level for some of the years. These values compare very well with the ones available in "Quadros" with the main exception of two areas: Agriculture and Public Services (including Education and Health). In the remaining areas the error is bounded at 6% and the variation is very similar. The difference is probably due to the missing 'contractors' from "Quadros" data witch is particularly relevant in Agricultural industries. Since "Quadros" covers mostly the privately owned industries it considerably under-samples Public Services data. To maintain comparability between countries, KLEMS values were used when available instead of the ones present in "Quadros". Data from "Quadros" in these cases was used to determine what percent of total hours and total labour compensation was allocated to each of the 18 labour groups. This means for example that the shares of workers that are considered High Skill in Agriculture and Public Services are the ones from the subsample we have access to.

Values for all other industries, including their distribution into Age, Gender and Skill groups was retrieved from "Quadros".

3.2.2 Hours worked

KLEMS data allows us to measure not only number of workers but most importantly how many hours they work. Figure 3.2 plots the number of hours worked in all KLEMS countries in 2005. Portuguese workers work slightly above the average annual working hours.

The situation was similar in 1985, the beginning of our data window. Portuguese workers then also worked slightly above average annual hours.

It is interesting to note that most countries significantly decreased annual working hours, the only exception being South Korea. In Portugal this decreased was mostly achieved though mandatory legislation that progressively limited weekly working hours to 44 in 1991 and 40 hours in 1996. This can be seen in figure 3.3. The two vertical lines represent the beginning of implementation of both laws.

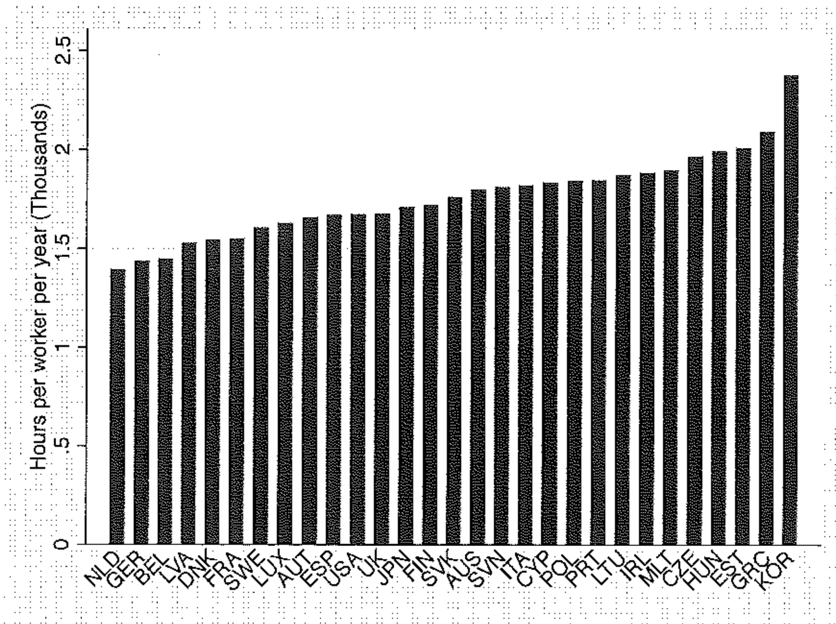


Figure 3.1: Annual working Hours in 2005

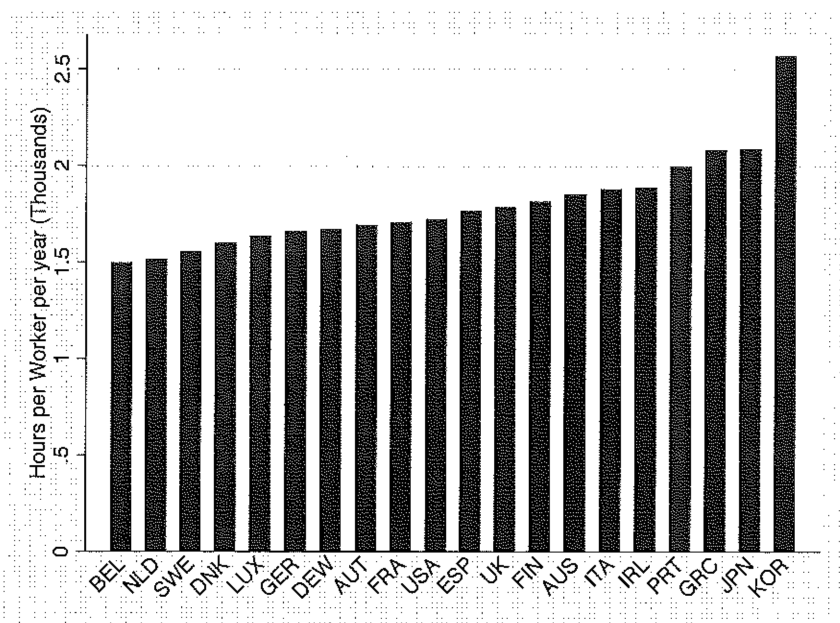


Figure 3.2: Annual working Hours in 1985

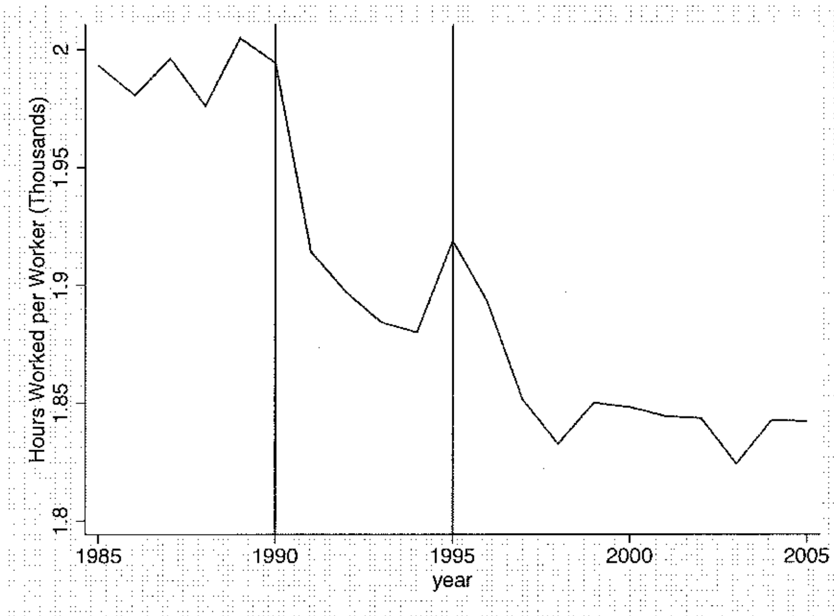


Figure 3.3: Annual working Hours in Portugal. Vertical lines represent the effect date of laws limiting work hour per week.

3.2.3 Educational Achievement

KLEMS data measures educational achievement in a mostly comparable data across countries. High Skill on all countries is always considered as having graduated from a Higher Education Institution. The split between Low Skill and Medium skill is more nuanced. In most countries the Medium skill is considered as having finished upper Secondary School. This was the measure used for "Quadros" data. There is however some variation in this metric across countries. Most notably Italian data considers Medium skill graduates of lower secondary school.

One of the most striking and often mentioned themes regarding the Portuguese economy is the shockingly low qualification of its work force.

Figure 3.4 compares the share of workers by Educational Achievement across countries in 2005. High Skill refers to workers that have graduated from a Higher Education Institution across countries in 2005. Portugal ranks at the bottom of the listing but not that much removed from the average of the remaining European countries. However, the share of Low Skilled workers in Portugal is shockingly high. It stands at almost 3 times the european average. In 2005 around 75% of workers in Portugal had not graduated upper secondary school. Portugal has the lowest percentage of workers who have finished upper secondary but not graduated from college. In most other countries this group forms the bulk of the workforce.

Despite the dismal standing of Portugal in 2005 enormous achievements have been accomplished since 1985. Figure 3.5 plots the evolution of the share of working hours by skill normalised to 1 in 1985. Portugal stands out in KLEMS countries as the country whose High Skill and Medium skill groups most grew. The share of High Skill workers in Portugal in 2005 is almost 5 times the 1995 share. The medium skill share more than doubled.

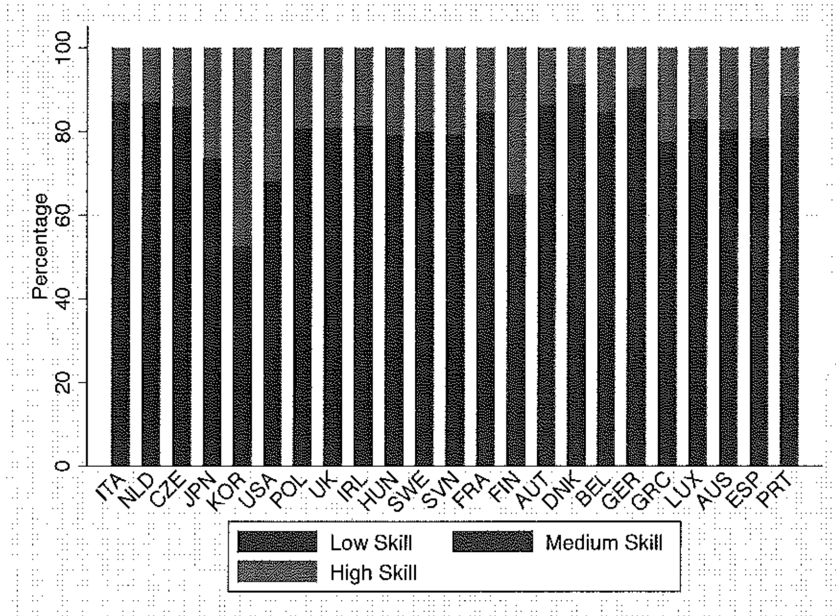


Figure 3.4: Composition of workers by Educational Achievement in 2005

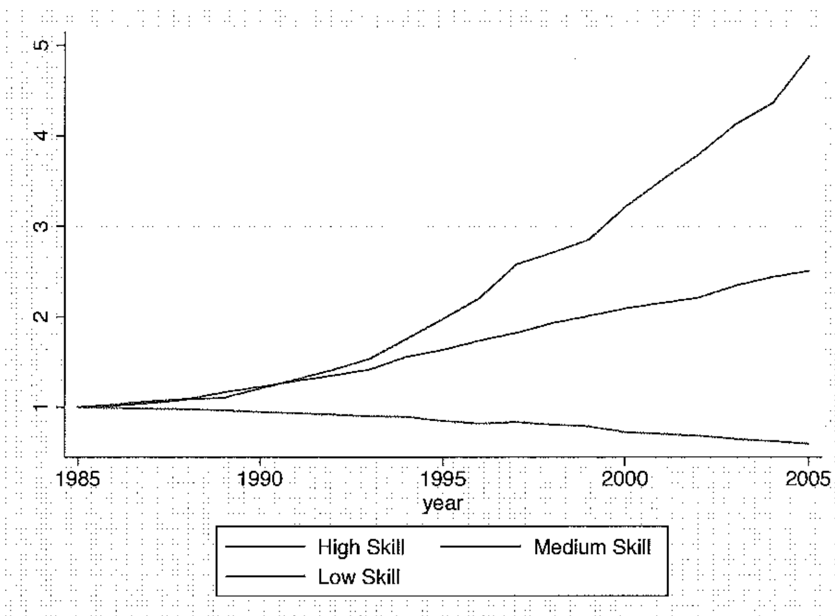


Figure 3.5: Evolution in Skill composition in Portugal (1985 = 1)

It could be expected that the scarcity of Medium and High Skill workers would increase their wage and the abundance of low skilled workers would decrease their wage. However when comparing the wages in Portugal for these 3 skill groups in Appendix A we get no evidence of such an effect. Wages in Portugal are consistently low across skill groups.

3.3 Productivity

The detailed KLEMS data allows us to detail the productivity in KLEMS countries. A simple measure of productivity is GDP per hour worked. Figure 3.6 shows this measure for 2005 and figure 3.7 for 1985. In both cases Portugal has a distinctive gap with core european countries.

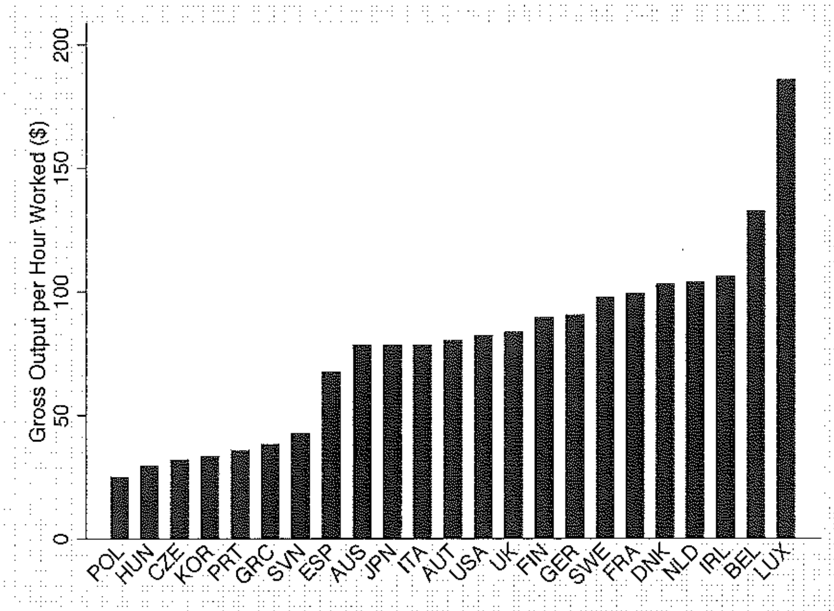


Figure 3.6: Gross Output per hour in 2005

Since KLEMS has detailed data on Intermediates inputs, we can remove these from GDP and measure Value Added per hour. Figure 3.8 shows this measure for 2005 and figure 3.9 for 1985. Again Portugal presents a distinctive gap with core european countries.

KLEMS allows us to decompose this productivity measure by industry. Table 3.1 shows that decomposition for the large industry groups present in KLEMS. Portuguese productivity in Agriculture is just dismal, even when compared with remaining periphery countries in Europe. Productivity levels in Construction, Hotels and Restaurants, Manufacturing and Wholesale And Retail are also extremely low in Portugal.

KLEMS and Quadros allow for a detailed look inside manufacturing. Table 3.2 compares the same countries in several manufacturing industries.

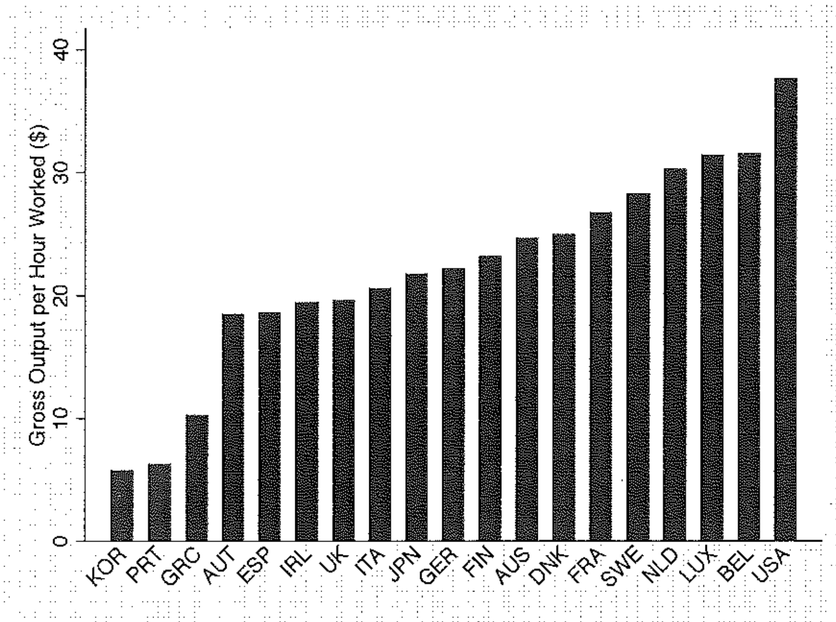


Figure 3.7: Gross Output per hour in 1985

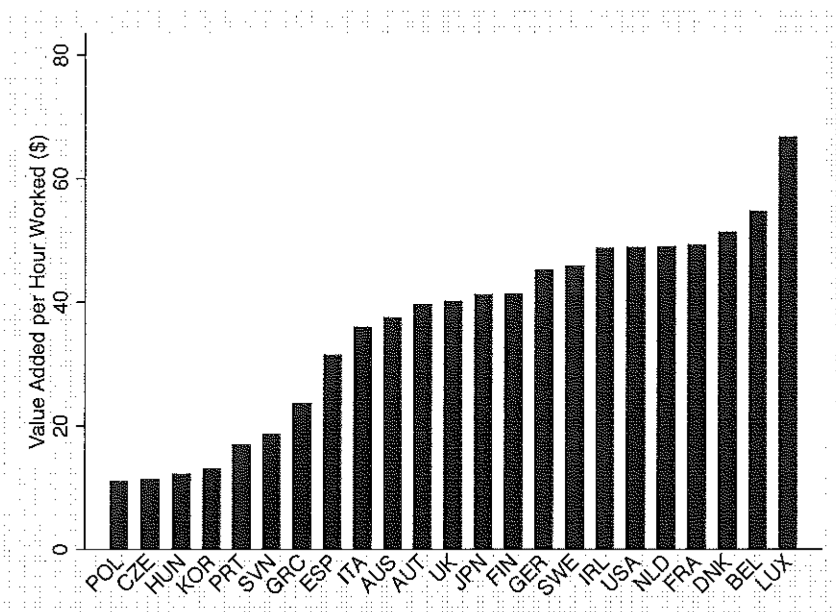


Figure 3.8: Value Added per hour in 2005

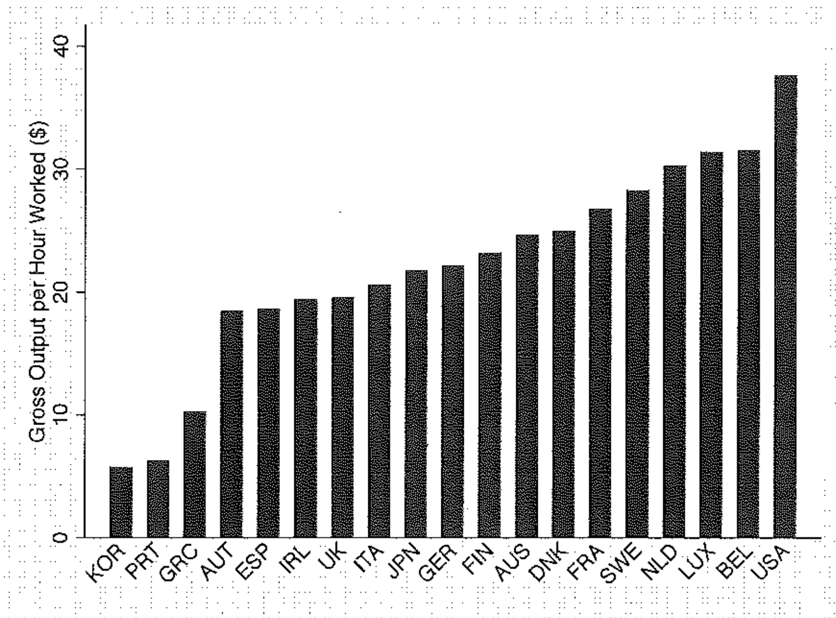


Figure 3.9: Value Added per hour in 1985

Table 3.1: Value Added ($) per hour worked in 2005

	PRT	ESP	ITA	GRC	IRL	FRA	GER	USA
Agriculture	3.78	17.41	14.06	10.69	21.02	20.82	14.67	28.64
Community	18.71	26.91	27.20	21.35	25.78	42.30	41.11	22.90
Construction	10.40	26.76	29.26	19.37	33.45	37.29	28.25	32.67
Education	30.91	35.27	38.45	21.58	35.72	49.74	35.90	38.88
Financial	50.48	61.39	69.99	48.75	93.37	87.54	81.63	81.66
Health	22.31	29.63	36.98	27.89	43.61	38.08	33.09	40.94
Hotels and Restaurants	9.96	32.65	21.05	28.55	17.04	29.49	17.06	18.57
Households	5.54	9.95	6.06	7.63	8.52	16.32	14.27	9.43
Manufacturing	14.12	30.97	34.25	18.48	80.15	47.01	51.49	64.81
Public Administration	23.82	27.61	48.46	24.18	38.27	44.55	38.38	56.00
Transportation	28.93	37.93	41.10	29.87	40.85	50.37	44.98	52.17
Wholesale and Retail	12.19	21.12	26.70	19.50	38.06	37.78	31.43	32.30
Whole Economy	16.96	31.44	35.93	23.64	48.68	49.25	45.21	48.81

Table 3.2: Manufacturing Value Added ($) per hour worked in 2005

	PRT	ESP	ITA	GRC	IRL	FRA	GER	USA
Apparel	6.12	14.14	20.56	12.94	25.52	44.82	39.13	24.73
Basic Metals	29.83	42.80	44.72	29.42	57.09	61.68	56.69	71.64
Chemicals	33.10	50.34	60.99	18.01	250.22	116.46	88.53	126.23
Computing machin	36.33	35.84	28.60	7.76	99.30	11.51	112.52	52.56
Electrical machi	17.97	35.41	38.14	50.98	84.69	46.00	55.04	65.30
Fabricated Metal	10.69	27.48	30.78	13.49	25.75	39.71	43.52	49.90
Food Products	16.97	28.09	33.27	17.62	65.78	39.63	31.01	63.57
Leather Products	9.01	16.60	28.23	10.22	56.68	30.00	34.38	35.07
Machinery	15.76	29.90	37.17	9.09	34.42	46.84	54.83	63.63
Manufacturing NE	16.01	35.90	31.46	23.38	40.18	47.08	58.22	75.78
Medical Instrume	19.64	26.35	33.61	16.21	47.81	52.16	53.58	83.29
Motor Vehicles	21.89	38.21	35.26	17.23	30.17	56.34	70.26	50.80
Other Minerals	17.17	36.29	39.00	28.51	37.90	49.64	43.49	60.34
Printing	20.82	36.24	35.60	23.42	144.80	44.76	47.22	60.08
Pulp, Paper	35.24	42.93	41.91	18.29	38.71	49.50	41.69	70.27
Radio, TV and Te	19.32	19.27	41.64	68.16	96.57	48.92	53.50	67.41
Recycling	9.09	19.01	.	11.17	.	31.04	33.71	44.57
Rubber and Plast	17.50	35.23	34.61	16.49	28.48	39.45	45.71	51.66
Textiles	12.45	17.92	28.21	13.29	22.26	31.77	35.09	33.85
Tobacco	94.94	62.35	24.23	20.69	208.47	98.29	75.54	142.07
Wood and Cork	9.50	17.13	22.54	7.09	26.55	30.22	32.55	31.02
Total	22.35	31.78	34.53	20.64	71.07	48.37	52.68	63.04

3.3.1 Productivity Convergence

Despite dismal productivity values in 2005, Portugal actually was able to improve its competitive position to most countries. Figure 3.10 measures Portuguese productivity as a percentage of the productivity of several countries. Up until 1995 Portugal was able to converge to the productivity levels of other countries, but that evolution stopped thereafter. This pattern had been noted at the macro level by Blanchard (2007).

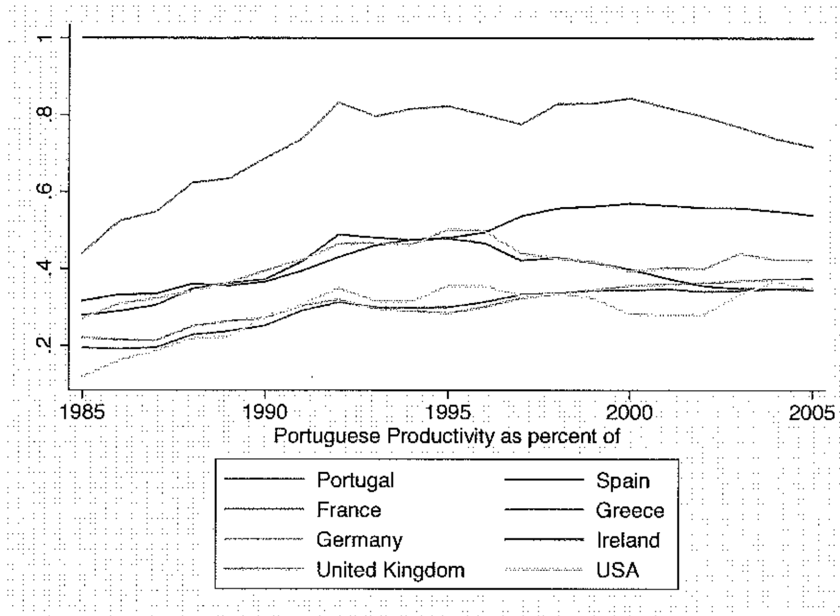


Figure 3.10: Portuguese Productivity Convergence

3.3.2 Growth Decomposition

Assuming a Cobb-Douglas production function with constant returns to scale and efficient input markets, Total Growth can be totally decomposed into the inputs of production according to:

$$\Delta Y = s_K \Delta K + s_L \Delta L + s_E \Delta E + s_M \Delta M + s_S \Delta S + \Delta TFP$$

Were s_K indicates the share of capital in total costs and similarly for other inputs. Cost shares are calculated as the geometric mean between time t and $t-1$. Capital was further decomposed into ICT and non-ICT capital and Labour was divided into the 18 labour categories present in KLEMS. The part of growth unexplained by the previous exercise will be assumed to be total factor productivity growth (TFP), that is, the gain (or loss) in production that is not accounted by the change in inputs.

The results are present in tables 3.3, 3.4 and 3.5.

Table 3.3 presents the decomposition shares of Labour, ICT and non-ICT Capital, Energy and Materials Intermediate Inputs Labour refers to to totality of labour services presented in tables 3.4 and 3.5. The values presented are the average yearly decomposition of growth. So for example in table 3.3 Portugal growth averaged 3.37 percent from 1985 to 2005, Non ICT Capital accounted for 0.58 percentage points of the growth average and so on. Important contributors to growth in Portugal in this period were Intermediate Materials with 1.26 percentile points and Intermediate Services with 0.89. These are probably the result of a transition to a more modern economy where the decision between buy or build tilts towards buy. TFP is on average negative for this period in Portugal, a situation that is only matched by Japan.

Figure 3.11 shows the evolution of Growth and TFP for the overall Portuguese economy from 1985 to 2005. TFP has been negative in Portugal since 1998 meaning that using the same number of inputs is

Table 3.3: Growth Decomposition 1995 to 2005

Country	Growth	Capital Non-ICT	Capital ICT	Energy	Materials	Services	Labour	TFP
AUT	3.02	0.29	0.20	0.17	0.82	0.77	0.19	0.58
BEL	2.76	0.35	0.31	0.15	0.75	0.88	0.15	0.17
CZE	4.31	0.53	0.23	0.06	2.35	1.00	0.09	0.05
DNK	2.50	0.19	0.41	0.03	0.54	0.92	0.15	0.28
ESP	3.66	0.62	0.19	0.15	1.07	0.91	0.24	0.49
FIN	2.85	0.26	0.21	0.15	0.69	0.48	0.20	0.88
GER	1.79	0.42	0.19	-0.09	0.57	0.57	0.01	0.14
HUN	5.94	0.12	0.11	0.01	3.20	0.96	0.21	1.33
ITA	2.37	0.30	0.11	0.05	0.58	0.87	0.09	0.36
JPN	2.13	0.71	0.20	0.05	0.46	0.57	0.19	-0.05
KOR	7.53	0.64	0.08	0.44	3.15	1.28	0.34	1.60
NLD	2.85	0.28	0.23	0.08	0.61	0.92	0.15	0.58
PRT	3.37	0.58	0.26	0.08	1.26	0.89	0.38	-0.07
UK	2.85	0.31	0.32	0.15	0.60	0.83	0.25	0.39
USA	2.89	0.42	0.30	-0.03	0.45	0.71	0.16	0.88
Total	3.30	0.40	0.23	0.11	1.03	0.83	0.19	0.51

achieving less output ever since[1].

Tables 3.4 and 3.5 while informative do not provide a simple way to compare countries. To simplify the presentation table 3.6 presents the same labour information aggregated into its constituent groups. That is: Male represents the gains in production from the sum of all labour groups that are Male, and similarly for Female, High Skill, etc.

Table 3.6 replicates the Labour column of table 3.3, it measures the total contribution of Labour to growth. The following columns decompose this change into the Labour categories. I.E for Portugal growth in female working hours were responsible for 0.33 percentage points of the 0.38 points of the total labour contribution for growth. Obviously these contributions are orthogonal to the other labour contributions but it can be easily seen that the increase of women in the labour force was tremendous and its contribution to growth was the largest of any of the countries analysed. The skill composition is harder to analyse. The rise in the number of working hours by High Skill individuals actually contributed less to growth than the rise of medium skill group. Both of these contribution were counterbalanced by the decrease in the Low Skilled group. Regarding age the 29 to 49 range was responsible for most of the growth.

3.3.3 Industry Decomposition

Focusing only on Portugal we can show the results of the same exercise at an industry level. Tables 3.7 and 3.8 show the results of this exercise. Column **share** shows the share of the industry in total output.

There is considerable variation in average TFP per industry: Telecommunications (code 64), Manufacturing of Electrical and Transport equipment (codes 30t33 and 34t35) show robust TFP growth but account for only 2% of output each. Mining (code C) also shows robust TFP growth but accounts for only a residual amount of output.

[1]For Portugal, strong TFP and Productivity growth in the 1956 to 1995 period had been noted by Duarte and Restuccia (2007) and Teixeira and Fortuna (2004) showed robust TFP growth in the 1960 to 2001 period.

Table 3.4: Detailed Growth Decomposition 1995 to 2005, part 1

	High Skill Under 29 Female	High Skill Under 29 Male	High Skill 30 to 49 Female	High Skill 30 to 49 Male	High Skill 50 and over Female	High Skill 50 and over Male	Medium Skill Under 29 Female	Medium Skill Under 29 Male	Medium Skill 30 to 49 Female
AUT	0.01	0.00	0.05	0.06	0.01	0.02	-0.06	-0.05	0.08
BEL	0.01	0.01	0.04	0.06	0.01	0.02	-0.00	0.02	0.10
CZE	0.01	0.01	0.01	0.01	0.01	0.03	-0.03	-0.04	-0.00
DNK	0.01	0.00	0.04	0.03	0.01	0.02	-0.00	-0.02	0.06
ESP	0.02	0.01	0.09	0.06	0.02	0.01	0.02	0.02	0.08
FIN	-0.01	-0.01	0.09	0.06	0.07	0.10	-0.02	-0.02	0.01
GER	0.00	0.00	0.01	0.01	0.01	0.02	-0.02	-0.02	-0.02
HUN	0.04	0.02	0.03	0.04	0.06	0.06	-0.05	-0.07	-0.02
ITA	0.01	0.00	0.06	0.02	0.00	-0.00	0.02	-0.03	0.08
JPN	0.01	-0.01	0.03	0.10	0.01	0.09	-0.03	-0.03	0.04
KOR	0.07	0.00	0.09	0.22	0.01	0.04	-0.09	-0.07	0.06
NLD	0.01	0.01	0.04	0.04	0.02	0.04	-0.05	-0.08	0.09
PRT	0.03	0.02	0.07	0.06	0.01	0.02	0.04	0.06	0.09
UK	0.02	0.02	0.07	0.09	0.02	0.04	-0.03	-0.03	0.06
USA	0.00	-0.03	0.07	0.06	0.02	0.05	-0.04	-0.08	0.03
Total	0.02	0.00	0.06	0.07	0.02	0.04	-0.02	-0.03	0.05

Table 3.5: Detailed Growth Decomposition 1995 to 2005, part 2

Country	Medium Skill	Medium Skill	Medium Skill	Low Skill	Low Skill	Low Skill	Low Skill	Low Skill	Low Skill
Country	30 to 49	50 and over	50 and over	Under 29	Under 29	30 to 49	30 to 49	50 and over	50 and over
Country	Male	Female	Male	Female	Male	Female	Male	Female	Male
AUT	0.12	0.02	0.04	-0.04	-0.03	-0.02	-0.03	-0.01	-0.02
BEL	0.12	0.03	0.04	-0.04	-0.08	-0.04	-0.12	0.00	-0.04
CZE	0.03	0.03	0.05	-0.00	-0.00	-0.02	-0.01	0.00	-0.00
DNK	0.04	0.06	0.10	-0.02	-0.03	-0.06	-0.03	-0.02	-0.04
ESP	0.14	0.02	0.04	-0.03	-0.05	-0.01	-0.14	-0.01	-0.12
FIN	0.08	0.05	0.07	-0.02	-0.03	-0.11	-0.11	-0.02	-0.01
GER	-0.01	0.02	0.02	-0.01	-0.01	-0.01	0.02	0.00	0.01
HUN	-0.01	0.08	0.09	-0.01	-0.01	-0.04	-0.00	0.02	-0.01
ITA	-0.06	-0.01	-0.01	-0.00	-0.00	-0.02	-0.02	-0.00	-0.00
JPN	0.02	0.04	0.13	-0.00	-0.01	-0.04	-0.13	-0.02	-0.05
KOR	0.04	0.01	0.07	-0.03	-0.06	-0.02	-0.16	0.01	0.02
NLD	-0.02	0.05	0.08	-0.01	-0.01	-0.00	-0.05	-0.00	-0.01
PRT	0.13	0.01	0.03	-0.06	-0.16	0.00	-0.10	0.02	-0.05
UK	0.10	0.04	0.10	-0.02	-0.05	-0.06	-0.09	-0.01	-0.05
USA	0.09	0.01	0.02	-0.00	-0.01	-0.01	-0.02	-0.01	-0.02
Total	0.06	0.03	0.06	-0.02	-0.04	-0.03	-0.07	-0.01	-0.03

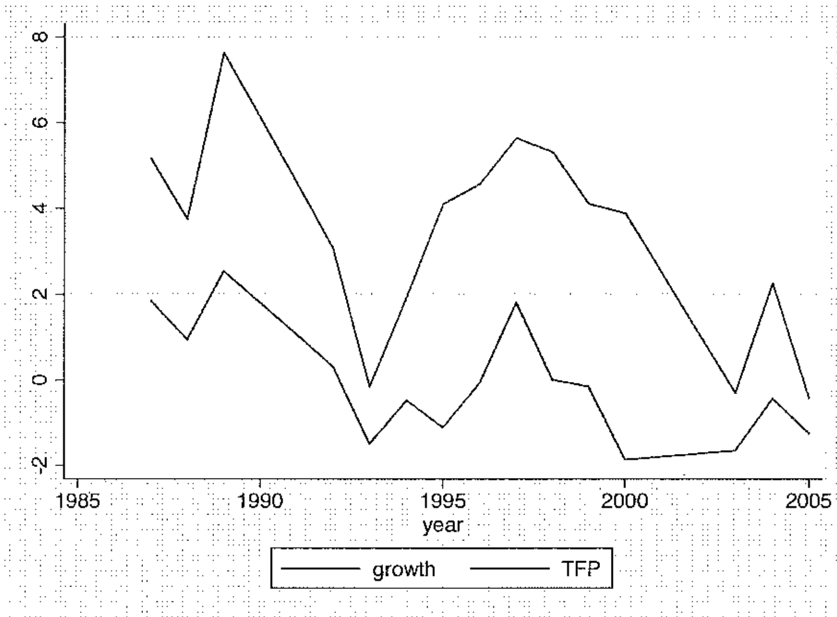


Figure 3.11: Growth and TFP for the overall Portuguese economy from 1985 to 2005

Table 3.6: Growth Decomposition 1995 to 2005, Labour Categories

	Labour	**Female**	**Male**	**High Skill**	**Medium Skill**	**Low Skill**	**Under 29**	**30 to 49**	**50+**
AUT	0.19	0.09	0.10	0.20	0.16	-0.18	-0.16	0.28	0.07
BEL	0.15	0.16	-0.00	0.16	0.33	-0.34	-0.09	0.17	0.07
CZE	0.09	0.03	0.06	0.12	0.02	-0.05	-0.04	0.02	0.11
DNK	0.15	0.10	0.05	0.12	0.28	-0.25	-0.05	0.06	0.14
ESP	0.24	0.22	0.02	0.27	0.36	-0.38	0.02	0.29	-0.07
FIN	0.20	0.14	0.06	0.35	0.17	-0.33	-0.12	0.05	0.26
GER	0.01	0.07	-0.06	0.08	-0.09	0.02	-0.04	-0.03	0.08
HUN	0.21	0.11	0.09	0.24	0.03	-0.07	-0.05	-0.02	0.28
ITA	0.09	0.18	-0.09	0.14	-0.02	-0.04	0.02	0.09	-0.02
JPN	0.19	0.08	0.11	0.27	0.17	-0.25	-0.05	0.04	0.20
KOR	0.34	0.15	0.19	0.55	0.06	-0.28	-0.14	0.29	0.19
NLD	0.15	0.19	-0.04	0.20	0.03	-0.08	-0.13	0.10	0.18
PRT	0.38	0.33	0.05	0.32	0.49	-0.43	-0.04	0.34	0.07
UK	0.25	0.17	0.08	0.34	0.20	-0.29	-0.08	0.17	0.16
USA	0.16	0.13	0.03	0.23	0.00	-0.07	-0.17	0.23	0.10
Total	0.19	0.15	0.04	0.25	0.16	-0.21	-0.08	0.15	0.12

Table 3.8 shows that Public Administration, Education and Health actually gained quite a lot from the High Skilled group. The high skilled group outpaced every other input.

Table 3.7: Industry Growth Decomposition for Portugal, part 1

Industry	Share	Growth	Non-ICT	ICT Capital	Energy	Materials	Services	Labour	TFP
Food Products	0.06	1.94	0.21	0.02	-0.09	1.55	0.43	0.11	-0.29
Textiles	0.07	0.19	-0.04	0.00	-0.15	0.87	-0.10	0.12	-0.52
Wood Products	0.01	2.29	-0.03	0.00	-0.20	1.56	0.39	0.13	0.43
Pulp and Paper	0.02	1.68	0.30	0.03	-0.27	1.64	0.14	0.27	-0.42
Chemicals	0.04	2.38	-0.18	0.03	0.24	1.32	0.15	0.08	0.74
Non-Metalic Minerals	0.02	4.09	0.49	0.03	-0.26	2.62	0.36	0.15	0.69
Metal Products	0.03	3.56	-0.05	0.04	0.15	2.81	0.10	0.15	0.36
Machinery	0.01	0.96	-0.06	0.01	-0.11	1.53	0.01	0.26	-0.69
Electrical Equipment	0.02	7.24	0.35	0.15	-0.08	4.93	0.35	0.08	1.46
Transport Equipment	0.02	6.76	0.32	0.02	-0.04	5.22	0.18	0.05	1.01
Other Manufacturing	0.01	4.35	0.56	0.06	-0.28	3.39	0.38	0.13	0.12
Motor Vehicles Sale	0.03	3.33	0.99	0.17	-2.55	0.45	4.04	0.28	-0.06
Wholesale	0.06	3.48	1.17	0.18	0.48	0.80	0.83	0.45	-0.44
Retail	0.03	3.74	0.17	0.27	0.12	0.77	1.06	0.36	0.99
Transport	0.04	3.03	0.26	0.05	0.38	0.11	1.87	0.30	0.06
Telecom	0.02	8.76	1.25	1.64	-0.03	0.83	2.96	0.11	2.01
Agriculture	0.04	0.36	-0.00	0.00	-0.04	0.34	0.24	0.24	-0.42
Mining	0.00	3.54	-0.69	0.02	0.07	1.28	0.28	0.14	2.44
Electricity, Gas and Water supply	0.03	4.68	1.79	0.04	1.71	0.44	0.69	0.06	-0.04
Construction	0.09	4.11	0.15	0.00	0.12	3.10	0.21	0.22	0.32
Hotels and Restaurants	0.04	2.10	0.76	0.13	0.01	1.22	0.61	0.15	-0.79
Financial	0.14	5.10	1.90	0.78	0.06	0.33	1.73	0.10	0.20
Public Services	0.15	3.16	0.36	0.55	0.25	0.34	1.16	0.74	-0.24
Whole Economy	1.01	3.37	0.58	0.26	0.08	1.26	0.89	0.38	-0.07

Table 3.8: Industry Growth Decomposition for Portugal, part 2

Industry	Share	Growth	Female	Male	High Skill	Medium Skill	Low Skill	Under 29	30 to 49	50 and over
Food Products	0.06	1.94	0.08	0.03	0.10	0.15	-0.13	-0.02	0.10	0.03
Textiles	0.07	0.19	0.12	0.00	0.05	0.25	-0.17	-0.28	0.34	0.06
Wood Products	0.01	2.29	0.07	0.07	0.08	0.21	-0.16	-0.13	0.21	0.05
Pulp and Paper	0.02	1.68	0.18	0.09	0.23	0.34	-0.30	-0.04	0.23	0.08
Chemicals	0.04	2.38	0.06	0.01	0.07	0.14	-0.13	0.00	0.04	0.04
Non-Metalic Minerals	0.02	4.09	0.12	0.03	0.10	0.26	-0.21	-0.11	0.21	0.06
Metal Products	0.03	3.56	0.08	0.08	0.07	0.32	-0.24	-0.13	0.16	0.13
Machinery	0.01	0.96	0.12	0.14	0.24	0.48	-0.47	-0.04	0.24	0.05
Electrical Equipment	0.02	7.24	0.12	-0.03	0.13	0.26	-0.31	0.01	0.05	0.02
Transport Equipment	0.02	6.76	0.19	-0.14	0.06	0.23	-0.24	0.07	-0.02	-0.00
Other Manufacturing	0.01	4.35	0.16	-0.03	0.08	0.24	-0.19	-0.18	0.27	0.04
Motor Vehicles Sale	0.03	3.33	0.19	0.09	0.16	0.57	-0.45	-0.08	0.31	0.05
Wholesale	0.06	3.48	0.28	0.17	0.35	0.64	-0.54	-0.07	0.49	0.03
Retail	0.03	3.74	0.63	-0.27	0.31	1.25	-1.21	0.04	0.33	-0.02
Transport	0.04	3.03	0.21	0.10	0.14	0.66	-0.50	0.05	0.14	0.11
Telecom	0.02	8.76	0.03	0.08	0.37	0.32	-0.58	0.05	0.07	-0.02
Agriculture	0.04	0.36	0.50	-0.26	0.31	0.47	-0.54	-0.35	0.74	-0.15
Mining	0.00	3.54	0.06	0.08	0.03	0.26	-0.14	-0.22	0.28	0.09
Electricity, Gas and Water supply	0.03	4.68	0.04	0.01	0.12	0.06	-0.13	-0.04	0.02	0.07
Construction	0.09	4.11	0.08	0.14	0.15	0.28	-0.22	-0.18	0.37	0.03
Hotels and Restaurants	0.04	2.10	0.26	-0.12	0.08	0.49	-0.42	-0.09	0.18	0.06
Financial	0.14	5.10	0.22	-0.13	0.33	-0.06	-0.17	0.10	-0.03	0.02
Public Services	0.15	3.16	0.68	0.06	1.04	0.31	-0.62	-0.20	0.89	0.06
Whole Economy	1.01	3.37	0.33	0.05	0.32	0.49	-0.43	-0.04	0.34	0.07

3.4 Input Allocation

The very low productivity in some of the Portuguese industries is compounded by the fact that these industries seem to have a larger share of employment than in other countries. Figure 3.12 shows this relationship. The vertical axis plots the ratio in allocation of capital and labour between Portugal and the remaining KLEMS countries. The horizontal axis plots the average labour productivity of each industry in all KLEMS countries. Portugal allocates a considerable amount of Capital and Labour to the lowest productivity industries at the expense of the more productive ones. Leather products, apparel and textiles are allocated more than double of the resources in Portugal than in other KLEMS countries and have a very low productivity level. This allocation comes at the expense of the more productive industries, Portugal under-allocates resources in 27 out of the top 30 most productive industries.

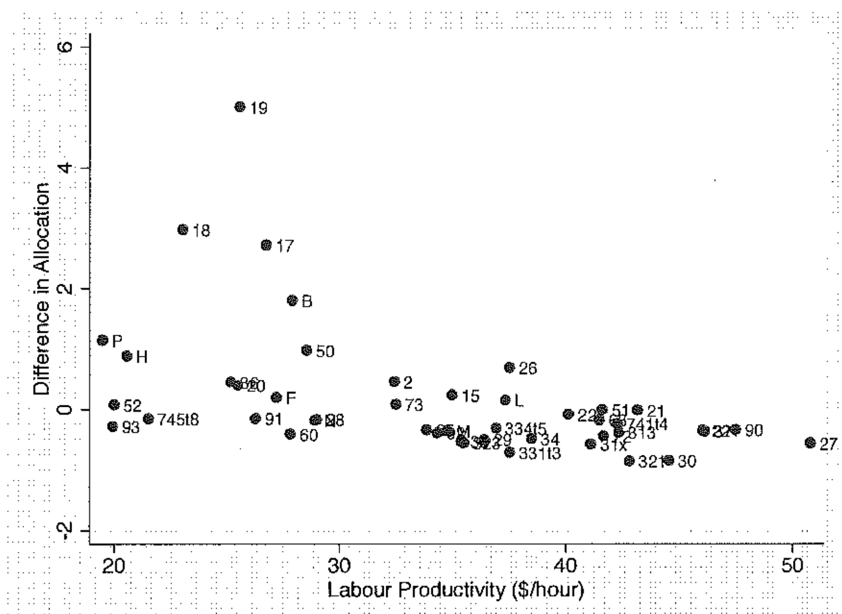


Figure 3.12: Difference in allocation of Portuguese labour and capital inputs and average industry productivity

Figure 3.13 points to an explanation to this misallocation. The vertical axis plots the ratio in allocation of Capital and Labour between Portugal and the remaining KLEMS countries. The horizontal axis plots the average share of high-skill workers in each industry. The industries are divided between tradables and non-tradables. In both cases there is a clear inverse relationship between the Portuguese allocation and the industry use of high skill workers. Given Portugal very low educational levels it is not surprising that firms chose to operate in industries that require few High Skill workers. However, this effect is greatly magnified when talking about industries whose product is easily tradable. In these cases Portuguese firms at a great disadvantage in both domestic and foreign markets. When the product is tradable Portuguese firms have to compete with other firms that don't share the same shortage of High Skill workers. In the non tradable case this does not happen.

To measure the impact of this allocation of factors across industries in Portugal we conduct a simple

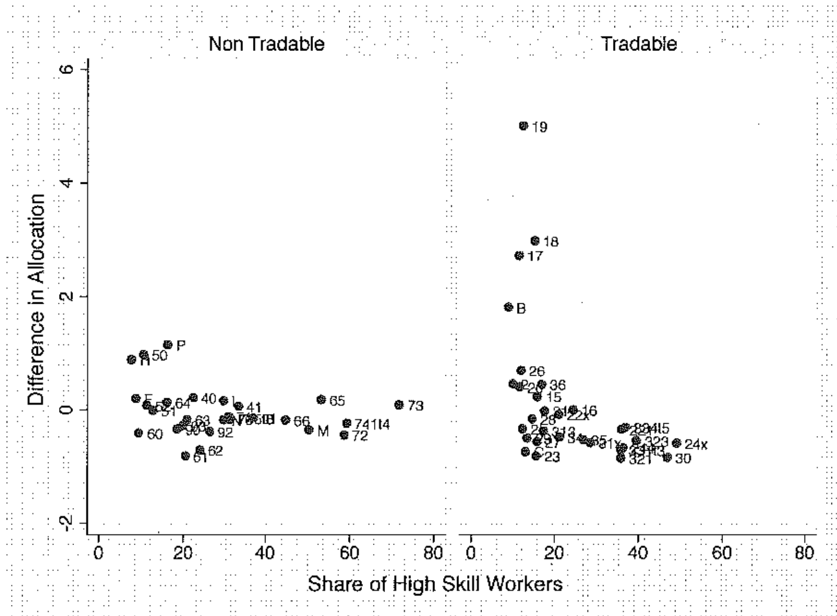


Figure 3.13: Difference in allocation of Portuguese labour and capital inputs and use of High Skill workers in the industry

exercise: Using the Portuguese industry productivity we calculate the economy-wide aggregated productivity if the allocation of labour across industries were the same as in other countries. The results are present in table 3.9.

The second column of table 3.9 shows the estimated portuguese productivity under different labour allocations shares. In every allocation the overall productivity of the Portuguese increases, this growth is represented in column 2. This result implies that the allocative efficiency in Portugal is the worse out of all of the compared countries

The third column compares this new estimated productivity with the productivity of the country being compared. For each country it shows how much of the difference between Portuguese productivity and the country being compared would be gaped. This measure is only available for countries with a higher productivity than Portugal. Differences in resource allocation across industries explain up to 50% of the overall difference in productivity between Portugal and Austria or the United Kingdom.

The results in this section point to the fact that low academic achievement not only lowers productivity within industries but also lowers overall productivity by pushing more resources into unproductive industries. The impact of this second effect is much stronger than previously expected.

3.5 How does each industry contribute to country productivity?

The previous sections show that Portugal has low industry level productivity figures but also that the country allocates more inputs to lower productivity industries. But those two measures when taken alone do not allow for a quantification of the impact of that particular industry on overall productivity. The typical way

Table 3.9: Estimated Portuguese productivity under labour allocations of other countries

Country	New Productivity	Growth In Productivity	Closed Gap
PRT	16.96	1.00	
AUS	27.43	1.62	0.50
AUT	25.24	1.49	0.37
BEL	25.15	1.48	0.22
CZE	24.27	1.43	
DNK	27.53	1.62	0.31
ESP	22.00	1.30	0.35
FIN	26.90	1.59	0.41
FRA	25.21	1.49	0.26
GER	26.08	1.54	0.32
GRC	19.55	1.15	0.39
HUN	22.86	1.35	
IRL	23.97	1.41	0.22
ITA	19.32	1.14	0.13
JPN	23.65	1.39	0.28
KOR	29.63	1.75	
LUX	29.43	1.74	0.25
NLD	24.50	1.44	0.24
POL	23.01	1.36	
SWE	28.40	1.67	0.40
UK	27.51	1.62	0.46
USA	27.63	1.63	0.34

to think about these issues is to look at productivity levels weighed by output shares.

$$P = \alpha_{o1}P_1 + \alpha_{o1}P_2 + \ldots + \alpha_{oi}P_i$$

Were P represents the productivity of the overall economy and P_i measures the productivity of a specific industry weighed by its share of output α_{oi}. There are two problems with this naive decomposition. First it is not guaranteed to be a complete and full decomposition. There is no reason to believe that the left hand side will equal the right hand side. Because the naive method uses output share it overstates the impact of the most productive industries on total productivity. Using input shares would have the opposite effect, the less productive industries would be given disproportional weight.

The second problem is the interpretation of the share coefficients. We would like the coefficients to reflect the impact changes in productivity would have on overall productivity e.g. if industry X productivity was raised by 10% what would happen to overall productivity, all other things being equal? None of the above methods answer that question, the rest of this section is dedicated to finding a measure that does.

Ideally we would like to create industry shares (α_i) that decompose the overall country productivity (P) as the sum of the productivity of each industry (P_i):

$$P = \alpha_1 P_1 + \alpha_2 P_2 + \ldots + \alpha_i P_i$$

These industry shares can be interpreted as the combination of the industry productivity and its share of inputs and outputs. In a full decomposition the sum of share must equal 1.

$$\sum_{1}^{n} \alpha_n = 1$$

But since we have more industries than restrictions on the decomposition equation we would get a multitude of valid decompositions. A solution to this issue is to decompose each industry (i) on its own while comparing it to all other remaining industries (o). The decomposition becomes:

$$P = \alpha_i P_i + \alpha_o P_o$$

$$\alpha_i + \alpha_o = 1$$

In witch P_o is the productivity of all industries other than P_i measured as the sum of production of all other industries over the sum of inputs of all other industries.

The share of industry i contribution to total productivity is then easily calculated as:

$$\alpha_i = \frac{P - P_o}{P_i - P_o}$$

This leads to a unique and full decomposition were the sum of the shares of all industries adds up to 1. We can use any measure of productivity like labour productivity or TFP. We choose to use labour productivity to avoid having to deal with the negative TFP results we obtained for Portugal and other countries. The results of this exercise for labour productivity are present in table 3.10 for a selection of countries and industries.

The numbers in each column can be interpreted as the percentage contribution of each industry productivity to the overall productivity of the country.

The importance of Portuguese agriculture jumps out of the table. It is responsible 11.7% of overall productivity score. It scores at more than twice the value of the closest countries Spain and Italy and seven times more important than agriculture in the UK. The construction sector also seems to have a higher than average importance in Portugal and is particularly important in Spain.

The leather products, apparel and textiles sectors that caused concern in the previews chapters because of their low productivity and high allocations do in fact represent a much higher share of productivity in Portugal than in other countries but only have a combined 5.6% effect in Portuguese productivity.

An attempt to improve productivity in Portugal should pay special attention to those industries that are most responsible for its composition, particularly Agriculture, Construction, Hotels, Restaurants and Wholesale and Retail Trade. These industries are responsible for over half of the overall portuguese productivity score. Raising the productivity of this group of industries by 10% would raise economy-wide productivity levels by 5%.

Agriculture

Agriculture represents the largest contributor to Portuguese overall productivity score. Figure 3.14 shows the Productivity of Portuguese Agriculture as a percentage of several other countries. Unlike the overall economy there is no convergence in Portuguese productivity.

Figure 3.15 shows the evolution of Agricultural TFP in several countries with the 1985 normalised as 1.

Table 3.10: Contribution of industries to overall productivity (%)

	Portugal	Spain	France	Italy	Germany	UK	USA
Agriculture	11.7	5.3	5.1	5.3	2.6	1.7	3.0
Air transport	0.2	0.2	0.3	0.2	0.1	0.3	0.7
Apparel	2.6	0.7	0.2	1.2	0.1	0.2	0.3
Basic Metals	0.2	0.6	0.4	0.5	0.8	0.3	0.4
Chemicals	0.3	0.6	0.4	0.8	0.8	0.5	0.2
Computers	0.5	0.9	1.8	2.8	1.6	2.3	1.6
Construction	11.2	13.6	7.6	7.5	6.3	8.0	7.1
Education	3.9	4.3	5.4	4.6	5.7	6.5	7.0
Fabricated Metal	1.7	2.1	1.9	2.9	2.1	1.4	1.0
Financial	1.0	1.2	1.7	1.3	1.9	2.2	2.8
Fishing	0.4	0.4	0.1	0.3	0.0	0.1	0.0
Food Products	2.3	2.3	2.3	2.0	2.5	1.7	1.2
Forestry	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Health	4.9	5.8	10.9	5.6	9.9	9.3	9.0
Hotels and Restaurants	7.5	7.4	3.8	6.6	4.3	5.1	5.9
Households	2.4	2.8	1.7	5.6	1.1	0.3	0.6
Insurance	0.2	0.3	0.6	0.1	0.6	0.7	1.8
Land Transport	2.1	3.1	2.8	3.0	2.1	2.9	2.3
Leather Products	1.2	0.3	0.1	0.7	0.1	0.0	0.0
Legal, technical	1.8	3.2	4.0	2.7	5.7	6.1	4.7
Machinery	0.9	1.2	1.3	2.5	2.8	1.1	1.1
Manufacturing NEC	0.3	0.3	0.4	0.4	0.4	0.6	0.6
Membership organisations	0.5	0.3	0.4	0.2	1.1	0.6	4.1
Mining	0.3	0.2	0.1	0.2	0.3	0.3	0.5
Motor Vehicles	0.5	1.1	0.9	0.6	2.0	0.7	0.7
Other Minerals	1.3	1.1	0.5	1.0	0.7	0.5	0.4
Consulting	2.8	3.2	6.9	5.6	4.0	7.0	4.7
Other electrical	0.4	0.4	0.5	0.8	1.2	0.5	0.4
Pharmaceuticals	0.1	0.3	0.2	0.4	0.3	0.2	0.5
Post and Telecom	0.8	1.3	1.5	1.2	1.0	1.9	1.0
Printing	0.5	0.6	0.5	0.5	0.5	0.6	0.4
Public Administration	6.7	6.8	8.4	4.9	7.1	5.3	7.8
Publishing	0.2	0.3	0.4	0.2	0.5	0.6	0.5
Pulp, Paper	0.2	0.3	0.3	0.3	0.5	0.3	0.4
Real Estate	0.4	1.1	1.1	0.4	1.1	1.5	1.5
Recreational	0.8	2.2	2.3	0.9	2.1	3.0	1.6
Recycling	0.7	0.6	0.4	.	0.4	0.4	0.6
Renting of machinery	0.2	0.3	0.3	0.2	0.2	0.6	0.6
R&D	0.1	0.1	0.9	0.2	0.5	0.4	0.6
Retail trade	9.1	9.9	7.2	8.3	7.6	8.8	9.3
Rubber and Plastics	0.5	0.6	0.8	0.8	1.1	0.8	0.7
Sale of motor vehicles	3.0	2.2	2.2	2.6	2.7	2.6	2.2
Scientific instruments	0.1	0.2	0.4	0.4	0.7	0.4	0.5
Sewage and refus	0.2	0.3	0.4	2.2	0.3	0.3	0.1
Supporting and a	0.8	1.2	1.5	2.3	2.5	1.5	0.5
Telecommunication	0.1	0.1	0.1	0.2	0.2	0.1	0.2
Textiles	1.8	0.6	0.3	1.0	0.3	0.3	0.3
Wholesale trade	6.7	3.9	4.2	5.2	4.6	4.6	5.1
Wood and Cork	1.1	0.6	0.4	0.7	0.5	0.4	0.6

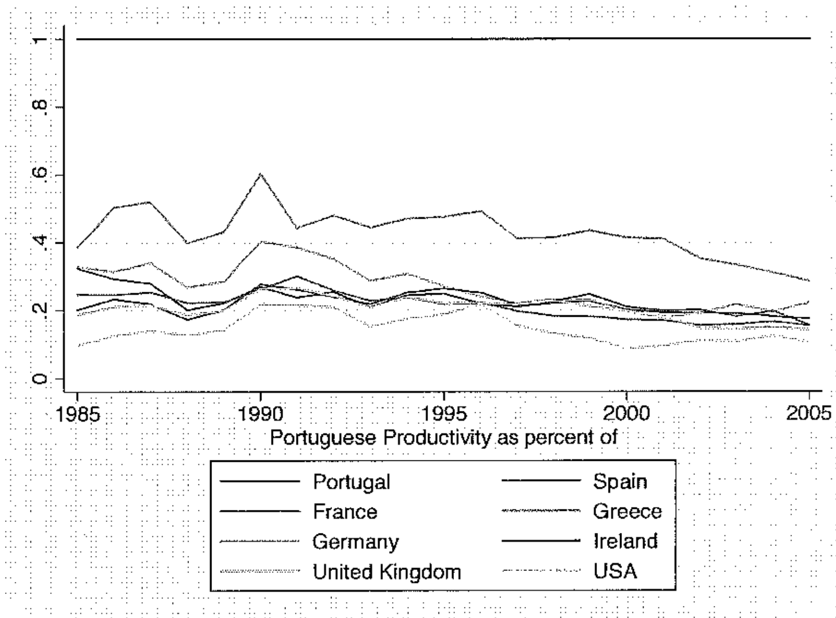


Figure 3.14: Convergence in Labour Productivity in Agriculture

Portuguese TFP productivity grew at the same rate as several other countries up until 1995 and actually decreases after that.

Construction

Construction is also a large contributor to Portuguese overall productivity score. Figure 3.16 shows the productivity of Portuguese construction sector as a percentage of several other countries. Around 1990 where Portuguese construction was actually more productive than in Spain and Greece. But the Portugal lost that edge and in recent years is gradually loosing ground to other countries.

Figure 3.17 shows the evolution of Construction TFP in several countries. Here we can see some initial gains in TFP in Portugal that have been lost in the most recent times. Portugal TFP in the end of the data window is only slightly higher then in 1985.

3.6 Why has productivity stagnated?

Up until now we have been able to trace the portuguese productivity from 1985 onwards. But the questions still remains, why has productivity stagnated?

Blanchard (2007) was the first study to point to the low levels of productivity in Portugal. Without access to detailed industry level data the author was only able to call attention to Portuguese lack of competitiveness and the implications that would have in a monetary union.

Braguinsky et al. (2011) was the first effort to provide an explanation as to why productivity levels are so low in Portugal. The overprotective labour and small firm favouring laws were allowing a massive number of small and unproductive firms to keep operating in Portugal.

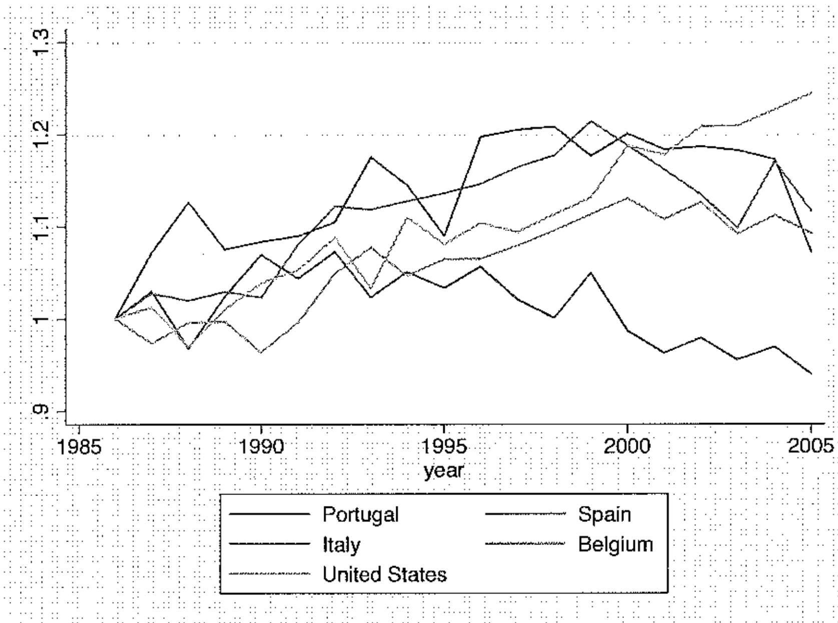


Figure 3.15: TFP evolution in Agriculture

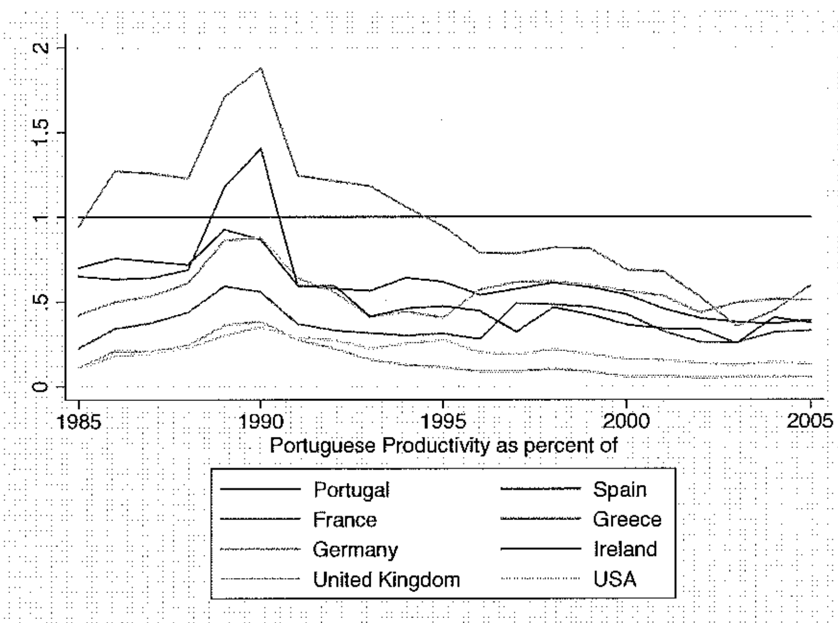


Figure 3.16: Convergence in Labour Productivity in Construction

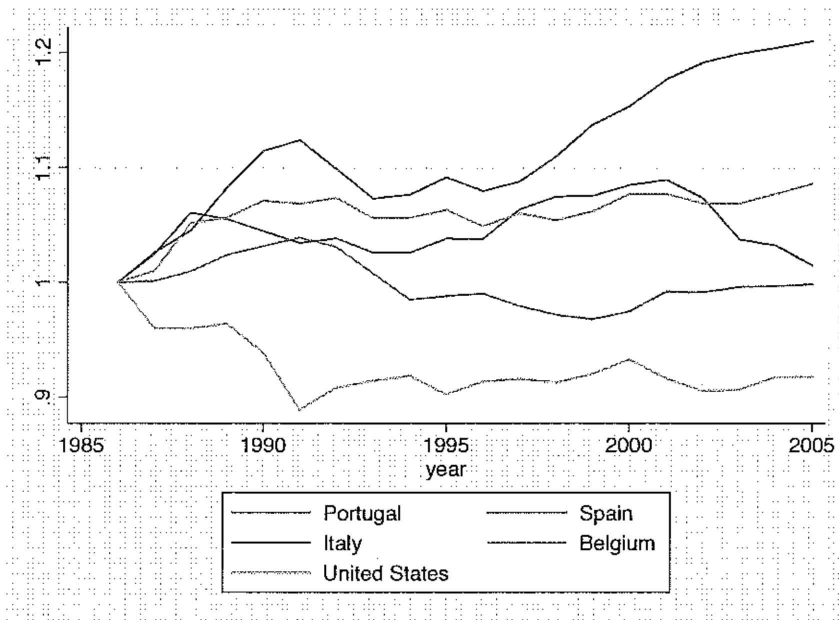


Figure 3.17: TFP evolution in Construction

Bloom and Reenen (2011) examine the relationship between Human Resource Management and productivity in a sample of firms from several countries. The authors find that in Portugal there is a left tail of firms that have very low scoring Human Resources practices but that nonetheless continue in operation. This evidence is supportive of the small firm effect in productivity.

Reis (2013) proposes another explanation to the low productivity levels. Portugal, having joined the European Monetary Union, was able to borrow at much lower costs and so large capital inflows flooded the inexperienced Portuguese financial sector. These capital flows were then directed into the "low productive non-tradable sector". According to the author these flows diverted inputs from the most productive areas into the less productive ones causing the slump in productivity.

Given our availability of detailed data we can compare how these theories hold up.

The first thing to notice is that the non-tradable sector was already in decline well before Portugal joined the EMU. Figure 3.18 plots the capital and labour shares of non-tradables in Portugal. The shares have consistently been going down since 1985. There does not seem to be a worsening of that trend starting in 2000.

Figure 3.18: Capital and Labour Shares of all Non-Tradable industries in Portugal

We do in fact observe that the rise non-tradables are responsible for most of the decline in productivity but it is hard to blame the financial sector or the entry into the EMU for that trend.

The explanation proposed by Braguinsky et al. (2011) suggests that the shrinking of firms is responsible for the decline in productivity. If that is the case we would expect that industries were firms shrank the most would have the worse productivity changes. That is in fact the case, figure 3.19 shows the relationship between firm size and the evolution of TFP in portuguese industries. TFP grew most in the industries that suffered less from a decrease in average firm size.

Figure 3.19: Evolution of TFP and change in average firm size on Portuguese industries

The industry level data seems to support the proposition of chapter 2 that small firms are sapping the industry productivity.

3.7 Conclusion

Filling in the Labour missing information in the KLEMS data has allowed us to get a detailed look into the Portuguese economy. The results are terrifying. Productivity in Portugal is very low when compared to other countries. Not only are industry level productivities very low but we can also find evidence that Portugal allocates a disproportional about of resources into the lower productivity industries.

Growth decomposition analysis shows that despite a growth in capital and labour, associated with a very large skill upgrade the overall total factor productivity in the economy is still very depressed. Previous research has shown that portuguese firms are becoming smaller and less productive. This happens at the same time as the drop in productivity measured here.

We are able to identify a small number of industries that are disproportionally responsible for the overall portuguese productivity. And in these industries we find no productivity convergence and actually see some divergence. These results help explain the low Portuguese productivity levels mentioned in Reis (2013) and Blanchard (2007). We can also see that at least some of that decrease is due to the decrease in firm size studied in chapter 2.

Appendix A

Table 11: Industry Codes

TOTAL INDUSTRIES	TOT
Food products, beverages and tobacco	15t16
Textiles, textile products, leather and footwear	17t19
Wood and products of wood and cork	20
Pulp, paper, paper products, printing and publishing	21t22
Chemicals	23t25
Other non-metallic mineral products	26
Basic metals and fabricated metal products	27t28
Machinery, nec	29
Electrical and optical equipment	30t33
Transport equipment	34t35
Manufacturing nec; recycling	36t37
Sale, maintenance and repair of motor vehicles and motorcycles	50
Wholesale trade and commission trade	51
Retail trade	52
Transport and storage	60t63
Post and telecommunications	64
Agriculture, hunting, forestry and fishing	AtB
Mining and quarrying	C
Electricity, gas and water supply	E
Construction	F
Hotels and restaurants	H
Finantial	JtK
Public Admin, Education and Health	LtQ

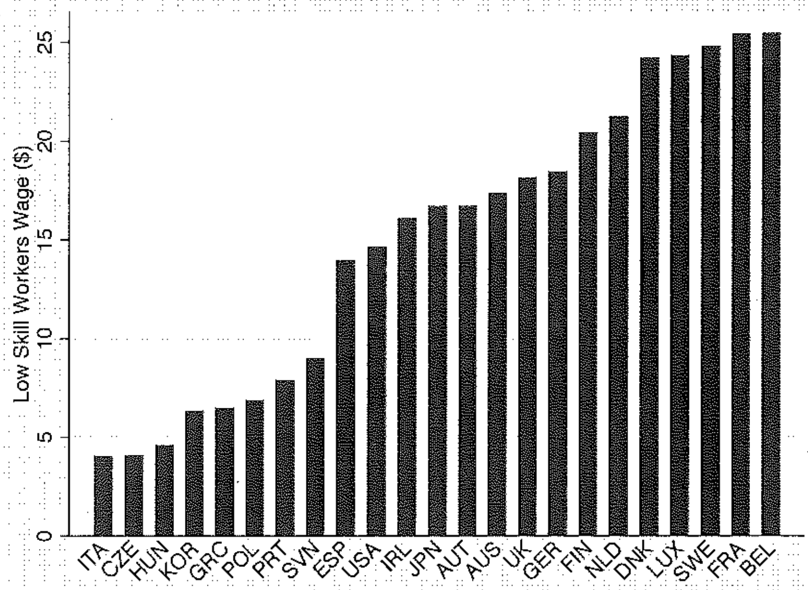


Figure 20: Hourly Wage of Low Skill workers in 2005

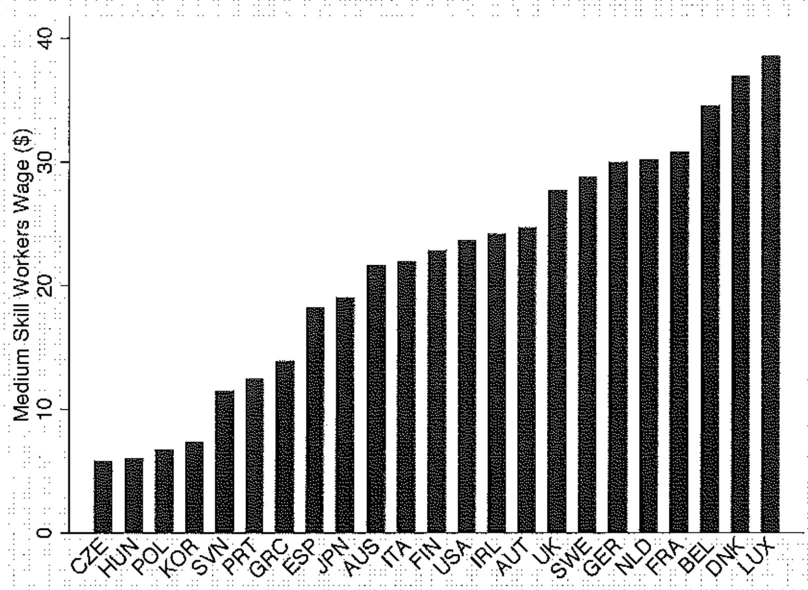


Figure 21: Hourly Wage of Medium Skill workers in 2005

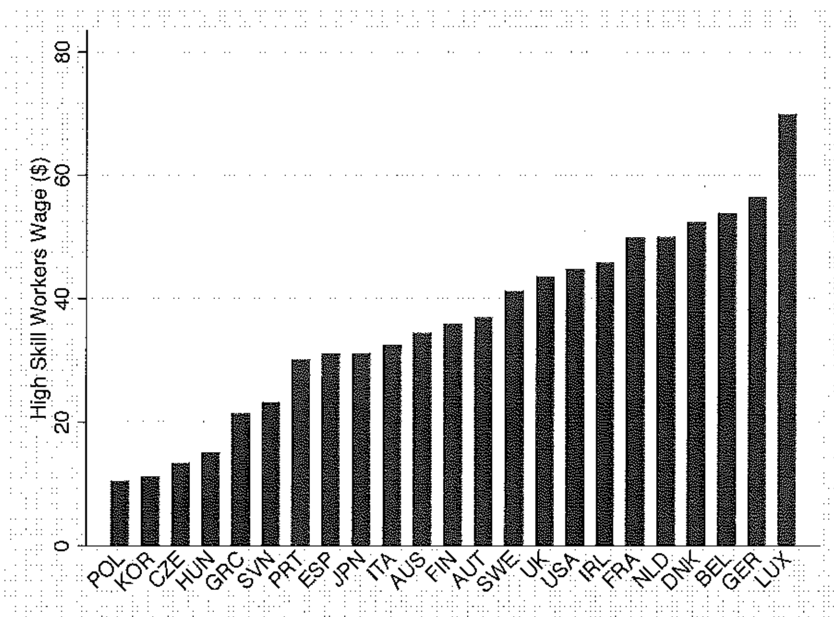


Figure 22: Hourly Wage of High Skill workers in 2005

Bibliography

David B Audretsch, Luuk Klomp, Enrico Santarelli, and A Roy Thurik. Gibrat's law: are the services different? *Review of Industrial Organization*, 24(3):301–324, 2004.

John R Baldwin. Were small producers the engines of growth in the canadian manufacturing sector in the 1980s? *Small business economics*, 10(4):349–364, 1998.

Abhijit V Banerjee and Esther Duflo. Growth theory through the lens of development economics. *Handbook of economic growth*, 1:473–552, 2005.

Rui Baptista, Vítor Escária, and Paulo Madruga. Entrepreneurship, regional development and job creation: the case of portugal. *Small Business Economics*, 30(1):49–58, 2008.

Matthew Barnes and Jonathan Haskel. Job creation, job destruction and the contribution of small businesses: Evidence for uk manufacturing. *U of London Queen Mary Economics Working Paper*, (461), 2002.

David GW Birch. The job generation process. 1979.

David GW Birch. Job creation in america: How our smallest companies put the most people to work. *University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship*, 1987.

David L Birch. Who creates jobs. *Public Interest*, (65):3–14, 1981.

O. Blanchard. Adjustment within the euro. the difficult case of portugal. *Portuguese Economic Journal*, 6 (1):pp. 1–21, 2007.

O. Blanchard and P. Portugal. What hides behind an unemployment rate: Comparing portuguese and us labor markets. *American Economic Review*, 91(1):pp. 187–207, 2001.

David G Blanchflower and Simon M Burgess. Job creation and job destruction in great britain in the 1980s. *Indus. & Lab. Rel. Rev.*, 50:17, 1996.

Nicholas Bloom and John Van Reenen. Human resource management and productivity. *Handbook of labor economics*, 4:1697–1767, 2011.

T. Boeri and J.F. Jimeno. The effects of employment protection: Learning from variable enforcement. *European Economic Review*, 49(8):pp. 2057–2077, 2005.

Serguey Braguinsky and Atsushi Ohyama. Noisy selection model and the evolution of firm size and within-firm earnings distributions: a unified approach. *Small Business Economics*, 37(1):59–72, 2011.

Serguey Braguinsky, Lee G Branstetter, and Andre Regateiro. The incredible shrinking portuguese firm. Technical report, National Bureau of Economic Research, 2011.

Lourens Broersma and Pieter Gautier. Job creation and job destruction by small firms: An empirical investigation for the dutch manufacturing sector. *Small Business Economics*, 9(3):211–224, 1997.

Shail J Butani. Business employment dynamics: tabulations by employer size. *Monthly Lab. Rev.*, 129:3, 2006.

L.M.B. Cabral and J. Mata. On the evolution of the firm size distribution: Facts and theory. *American Economic Review*, 93(4):pp. 1075–1090, 2003.

Martin Carree and Luuk Klomp. Small business and job creation: a comment. *Small Business Economics*, 8(4):317–322, 1996.

AV Chari. Identifying the aggregate productivity effects of entry and output restrictions: An empirical analysis of license reform in india. *American Economic Journal: Economic Policy*, 3(2):pp. 66–96, 2011.

E. Choi and J. Spletzer. The declining average size of establishments: Evidence and explanations. *BLS Working Paper No. 452*, 2011.

Per Davidsson, Leif Lindmark, and Christer Olofsson. The extent of overestimation of small firm job creation–an empirical examination of the regression bias. *Small Business Economics*, 11(1):87–100, 1998.

Steve J Davis and John Haltiwanger. Gross job creation, gross job destruction and employment reallocation. Technical report, National Bureau of Economic Research, 1991.

Steven J Davis, John Haltiwanger, and Scott Schuh. Small business and job creation: Dissecting the myth and reassessing the facts. *Small business economics*, 8(4):297–315, 1996.

Steven J Davis, John C Haltiwanger, and Scott Schuh. Job creation and destruction. *MIT Press Books*, 1, 1998.

R. Dell'Anno. The shadow economy in Portugal: An analysis with the MIMIC approach. *Journal of Applied Economics*, 10(2):pp. 253–277, 2007.

Margarida Duarte and Diego Restuccia. The structural transformation and aggregate productivity in portugal. *Portuguese Economic Journal*, 6(1):23–46, 2007.

David S Evans. The relationship between firm growth, size, and age: Estimates for 100 manufacturing industries. *The journal of industrial economics*, pages 567–581, 1987.

Milton Friedman. Do old fallacies ever die?, 1992.

P. Garibaldi, L. Pacelli, and A. Borgarello. Employment Protection Legislation and the Size of Firms. *IZA Discussion Papers*, 2003.

L. Garicano, C. LeLarge, and J. Van Reenen. Firm size distortions and the productivity distribution: Evidence from france. *Working Paper, London School of Economics*, 2012.

Bronwyn H Hall. The relationship between firm size and firm growth in the us manufacturing sector, 1988.

Magnus Henrekson and Dan Johansson. Gazelles as job creators: a survey and interpretation of the evidence. *Small Business Economics*, 35(2):227–244, 2010.

Almas Heshmati. On the growth of micro and small firms: evidence from sweden. *Small business economics*, 17(3):213–228, 2001.

Satu Hohti. Job flows and job quality by establishment size in the finnish manufacturing sector 1980–94. *Small Business Economics*, 15(4):265–281, 2000.

Hugo A Hopenhayn. Entry, exit, and firm dynamics in long run equilibrium. *Econometrica: Journal of the Econometric Society*, pages 1127–1150, 1992.

C.T. Hsieh and P.J. Klenow. Misallocation and Manufacturing TFP in China and India. *Quarterly Journal of Economics*, 124(4):pp. 1403–1448, 2009.

Robert Inklaar and Marcel P Timmer. Productivity convergence across industries and countries: the importance of theory-based measurement. *Macroeconomic Dynamics*, 13(S2):218–240, 2009.

C.I. Jones. Misallocation, economic growth, and input-output economics. Technical report, National Bureau of Economic Research, 2011.

Dale W Jorgenson and Marcel P Timmer. Structural change in advanced nations: A new set of stylised facts*. *The Scandinavian Journal of Economics*, 113(1):1–29, 2011.

Boyan Jovanovic. Selection and the evolution of industry. *Econometrica: Journal of the Econometric Society*, pages 649–670, 1982.

Nicholas Kaldor. A model of economic growth. *The economic journal*, pages 591–624, 1957.

Bruce A Kirchhoff and Bruce D Phillips. The effect of firm formation and growth on job creation in the united states. *Journal of Business Venturing*, 3(4):261–272, 1988.

R.E. Lucas. On the size distribution of business firms. *The Bell Journal of Economics*, 9(2):pp. 508–523, 1978.

Edwin Mansfield. Entry, gibrat's law, innovation, and the growth of firms. *The American Economic Review*, pages 1023–1051, 1962.

P.S. Martins. Dismissals for Cause: The Difference That Just Eight Paragraphs Can Make. *Journal of Labor Economics*, 27(2):pp. 257–279, 2009.

Jose Mata. Firm growth during infancy. *Small Business Economics*, 6(1):27–39, 1994.

Guy Michaels, Ashwini Natraj, and John Van Reenen. Has ict polarized skill demand? evidence from eleven countries over 25 years. *Review of Economics and Statistics*, (0), 2010.

K.M. Murphy, A. Shleifer, and R.W. Vishny. The allocation of talent: implications for growth. *The Quarterly Journal of Economics*, 106(2):pp. 503–530, 1991.

David Neumark, Brandon Wall, and Junfu Zhang. Do small businesses create more jobs? new evidence for the united states from the national establishment time series. *The Review of Economics and Statistics*, 93 (1):16–29, 2011.

Cordelia Okolie. Why size class methodology matters in analyses of net and gross job flows. *Monthly Lab. Rev.*, 127:3, 2004.

Mary O'Mahony and Marcel P Timmer. Output, input and productivity measures at the industry level: The eu klems database*. *The Economic Journal*, 119(538):F374–F403, 2009.

Garnett Picot and Richard Dupuy. Job creation by company size class: The magnitude, concentration and persistence of job gains and losses in canada. *Small Business Economics*, 10(2):117–139, 1998.

Ricardo Reis. The portuguese slump and crash and the euro crisis. Technical report, National Bureau of Economic Research, 2013.

Diego Restuccia and Richard Rogerson. Policy distortions and aggregate productivity with heterogeneous establishments. *Review of Economic Dynamics*, 11(4):707–720, 2008.

F. Schivardi and R. Torrini. Identifying the effects of firing restrictions through size-contingent differences in regulation. *Labour Economics*, 15(3):pp. 482–511, 2008.

John Sutton. Gibrat's legacy. *Journal of economic literature*, pages 40–59, 1997.

Aurora AC Teixeira and Natércia Fortuna. Human capital, innovation capability and economic growth in portugal, 1960-2001. *Portuguese Economic Journal*, 3(3):205–225, 2004.

Bart Van Ark, Mary O'Mahony, and Marcel P Timmer. The productivity gap between europe and the united states: trends and causes. *The Journal of Economic Perspectives*, pages 25–44, 2008.

Joachim Wagner. Firm size and job creation in germany. *Small business economics*, 7(6):469–474, 1995.