

# Macroeconomic Implications of Size-Dependent Policies\*

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November 2007

## Abstract

Government policies that impose restrictions on the size of large establishments or firms, or promote small ones, are widespread across countries. In this paper, we develop a framework to systematically study policies of this class. We study a simple growth model with an endogenous size distribution of production units. We parameterize this model to account for the size distribution of establishments and for the large share of employment in large establishments. Then, we ask: quantitatively, how costly are policies that distort the size of production units? What is the impact of these policies on productivity measures, the equilibrium number of establishments and their size distribution? We find that these effects are potentially large: policies that reduce the average size of establishments by 20% lead to reductions in output and output per establishment up to 8.1% and 25.6% respectively, as well as large increases in the number of establishments (23.5%).

KEYWORDS: Size Distortions, Establishment Size, Productivity Differences.

JEL Classification: O40, E23.

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\*We thank Mark Bilts, Lee Branstetter, Jeffrey Campbell, Francesco Caselli, Yongsung Chang, Jeremy Greenwood, Barry Ickes, Timothy Kehoe, Peter Klenow, Rodolfo Manuelli, Mark Melitz, José Víctor Ríos-Rull, Andrés Rodríguez-Clare, Richard Rogerson, Esteban Rossi-Hansberg, B. Ravikumar, John Taylor, Michelle Tertilt and seminar participants at Southern California, Rochester, the Macro Lunch at Wharton, Stanford, Iowa, Federal Reserve Bank of Philadelphia, CEMFI, the Cornell-PSU Macro Conference, the 2004 NBER Summer Institute (Macroeconomics and Productivity), 2005 SED Meetings, 2005 Midwest Macro Meetings, 2005 ITAM Summer Camp in Macroeconomics and CEPR-ESSIM Conference in Tarragona. Alejandro Riaño provided excellent research assistance. All errors are ours.

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# 1 Introduction

Government policies that impose restrictions on the size of large establishments or firms, or promote small ones, are widespread across countries. These policies emerge in multiple forms: different countries implement policies that either restrict the operations of large production units, or subsidize small ones, or try to do both. As we elaborate below, in developed countries such policies range from the restrictions on the size of retail stores in Japan, to employment protection legislation that only affect firms that are larger than a certain size in Italy.

In this paper we develop a simple framework to systematically evaluate policy distortions that depend on establishment size. We refer to these as *size-dependent policies*. In our model economy, there is a single representative household that makes consumption and savings decisions. The household is comprised of a large number of members who differ in terms of their endowment of managerial skills. Production requires three inputs: capital, labor and managerial services. As a result of the underlying heterogeneity, individuals sort themselves between managers and workers. Furthermore, since those who become managers are heterogeneous in terms of their skills, establishments of different sizes coexist in equilibrium.

We analyze two different types of policies: those that restrict production of large establishments and those that encourage production by small ones. In each scenario, we ask: quantitatively, how costly are policies that distort the size of production units? What is the impact of these policies on productivity? How do these policies affect the size distribution of establishments?

Our strategy to draw quantitative implications from size-dependent policies is to first restrict model parameters, in the absence of any distortion on size, in order to reproduce aggregate and cross-sectional observations of the U.S. This allows us to infer from data key model parameters: the degree of returns to scale at the establishment level, the aggregate capital share and parameters governing the distribution of (unobserved) managerial ability. In particular, we select these model parameters to generate a benchmark economy in which both size distribution of establishments as well as employment shares by large establishments are in line with the U.S. data.

We subsequently introduce government policies that depend on the size of establishments. We model these policies as taxes or subsidies on input use that become affective above or below particular levels of input use.<sup>1</sup> Given that in the model large and small production units coexist in equilibrium, different establishments will be affected differently by the policies; some will expand, some will contract, and new ones will emerge. In all the experiments we consider, distortions always result in an increase in the equilibrium number of establishments and a decline in the average estab-

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<sup>1</sup>Therefore, while we use the capital demand or the number of employees of an establishment as a measure of its size for our size-dependent policies, we always use the standard definition of size (i.e. the number of employees), when we refer explicitly to the size of an establishment.

lishment size. We use this property of the model to impose a natural discipline to the quantitative exercises we carry out. In each of our experiments, we impose implicit taxes or subsidies on our benchmark economy that reduce the average establishment size by the same amount, and select conservatively this reduction in line with available evidence from O.E.C.D. countries. According to European Commission (1996) the average production unit in European Union has about 23% less employees than the ones in the U.S., while the gap between the U.S. and Japan is of about 40%.<sup>2</sup> There are obviously several factors that contribute to cross-country differences in the size of establishments; these factors go well beyond the differences in the type of government policies we consider.<sup>3</sup> Hence our results should be viewed as answering the following question: How costly are size-dependent policies that generate differences in average establishment size that are similar to those observed among developed economies?

We find that the consequences of the policies we study can be substantial. When establishment size is reduced by 20% via taxes on capital use, output falls by about 8.1% across steady states. These effects on output are systematically accompanied by sharp increases in the equilibrium number of establishments, while standard measures of productivity non-trivially drop. For this case, the number of establishments goes up by 23.5%, and average output per establishment drops by about 25.6%. Finally, size-dependent policies generate sizeable effects on the size distribution of establishments. We find a substantial redistribution of output from large to small establishments: output accounted for by establishments at the top 20% drops from about 75.4% to 68.5%. These effects occur not only under restrictions on large establishments via taxes on capital or labor use, but also with subsidies to small ones.

We also find non-trivial welfare effects from these policies. When the reduction in average size is obtained via implicit taxes on capital use by large establishments we find that the welfare cost is relatively high. A reduction in average size by 20% leads to welfare costs (in consumption equivalents) up to 1.5% (including transitions across steady states). Meanwhile when the same reduction in average size is accomplished via implicit taxes on labor use, the welfare cost is relatively small. Thus, our analysis indicates that while different size-dependent policies can have similar effects on productivity measures, quantitatively, their potential effects on welfare depend critically on how a given average reduction in size is achieved.

Overall, our findings indicate that size-dependent policies can lead to sizeable effects on output, productivity and other observables. Quantitatively, they can account for a sizeable portion of the output and productivity variation among developed countries; i.e. U.S. versus Europe/Japan (see

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<sup>2</sup>The unit of observation in European data is an enterprise, which can have more than one production unit and thus it falls somewhere between a firm and a plant. As a result, the reported difference in average size between the U.S. and the E.U. is a lower bound. The observations reported above are based on comparisons between enterprises with paid employees.

<sup>3</sup>See Kumar, Rajan, and Zingales (1999) for a recent review.

below). Our results also indicate that these policies are unlikely to generate the bulk of the large differences in output per-worker and productivity across poor and rich countries documented by Klenow and Rodriguez-Clare (1997), Hall and Jones (1999) and Caselli (2004) among others.

**Background** Several observations make the study of size-dependent policies of special interest. First, large establishments account for a disproportionate fraction of output and employment in industrialized countries. In the case of the U.S., an economy for which the policies we study are largely absent, establishments with more than 100 workers correspond to 2.6% of the total number of establishments but account for 44.9% of total employment.<sup>4</sup> This concentration of employment in large establishments holds for the economy as a whole, for the manufacturing sector, as well as for the different sectors in the service area. Thus, it is natural to conjecture that policies that restrict the *size* of establishments are costly in terms of output and will impact productivity measures. This conjecture is supported by Nicoletti and Scarpetta (2005), who document strong effects of reduced regulation on output and productivity growth for O.E.C.D. countries.

Second, the size distribution of establishments differs significantly across countries of comparable levels of development and available evidence suggests a central role for policy differences. Differences among the U.S., the E.U. and Japan are noteworthy: small and medium size establishments play a significant role in Japan, but are much less significant in the U.S. with the E.U. being somewhere in the middle (European Commission (1996)). Surprisingly, the differences within the E.U. are also large. While small establishments account for the bulk of employment in Italy, larger establishments play a more important role in other countries, like Sweden and the U.K.<sup>5</sup> Davis and Henrekson (1999) and Henrekson and Johansson (1999) argue that the economic policy environment plays a key role in the prevalence of large establishments in Sweden. They point out, among other things, the role of labor regulations that affect all establishments in Sweden but only the larger ones in other countries, like Italy.

Finally, restrictions on size in the retail sector might be of special importance. In the first place, there is evidence of substantial productivity growth in services, and in the retail sector in particular. According to Basu, Fernald, Oulton, and Srinivasan (2003), productivity growth in wholesale and retail trade between 1995 and 2000 was the second highest among all sectors in the U.S., second only to information technology producing sectors. In the second place, the low productivity level of the retail sector, and its sluggish growth in Europe and Japan relative to the U.S., has been attributed to severe size and entry regulations in the sector; see for example Lewis (2004). In this

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<sup>4</sup>Source: our calculations using tabulated data from the U.S. Economic Census (1997). Available at <http://www.census.gov/epcd/www/ec97stat.htm>.

<sup>5</sup>Establishments with 1 to 9 and more than 250 workers accounted for 45.8% and 21.5% of employment in Italy in 1991, while the same numbers were 29.2% and 44.5% in Sweden in 1992, and 15.4 and 50.2% in U.K. in 1993 — European Commission (1996).

regard, the experience of the restricted Japanese retail sector is illustrative. Japanese retailing is characterized by (i) a relatively large number of stores per capita, (ii) a large concentration of employment and hours worked in small establishments, and (iii) low productivity.<sup>6</sup>

**Related Literature** This paper is connected to the growing macroeconomic literature that analyzes the relationship between distortions (like entry and exit barriers, barriers to technology adoption, limited contractual enforcement, etc.) and differences in economic performance. Bergoeing, Kehoe, Kehoe, and Soto (2002), Blanchard and Giavazzi (2003), Burstein and Monge (2005), Caselli and Gennaioli (2002), Castro, Clementi, and MacDonald (2006), Chu (2002), Erosa and Hidalgo (2005), Gollin (1995), Herrendorf and Teixeira (2004), Hsieh and Klenow (2007), Lagos (2004), Nicoletti and Scarpetta (2005), Schmitz (2001), Parente and Prescott (2000), Restuccia (2004), Restuccia and Rogerson (2007), among others, are examples of papers in this group.

Gollin (1995), and specially Restuccia and Rogerson (2007), are particularly close to the current paper, as they share our emphasis on policies that hinge on firm or establishment size. Gollin (1995) uses a span-of-control model to study the differential tax treatment of small vs large firms in Ghana. Restuccia and Rogerson (2007) argue that policies that affect the allocation of resources across production establishments via idiosyncratic distortions (e.g. distortions that are *establishment specific* that can vary with size) can have quantitatively important consequences for output and productivity. They conduct their analysis in a model with entry and exit like Hopenhayn and Rogerson (1993) and Veracierto (2001), but with no stochastic evolution of productivity for an establishment after entry and exogenous exit. One key difference between our paper and theirs is that our analysis systematically associates size-dependent policies, both restrictions on size as well as subsidies to small units, to increases in the number of establishments. In Restuccia and Rogerson (2007) this outcome does not necessarily occur.

## 1.1 Size-Dependent Policies in Practice

How do size dependent policies actually work? We document here key examples of policies that affect or restrict the size of firms or establishments across countries. We focus on policies prevailing in developed economies, and concentrate on three cases: regulation of the retail sector in Japan and France, employment protection in Italy, and subsidies for small and medium size enterprises in Korea.<sup>7</sup>

Regulation of the retail sector in Japan is among the most discussed size-dependent policies in

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<sup>6</sup>See Flath (2003), Guner, Ventura, and Yi (2007), Guner, Ventura, and Yi (2006) and McKinsey Global Institute (2000) for a documentation of these facts.

<sup>7</sup>For a more detailed discussion of these policies and their counterparts in developing countries, see Guner et al. (2007).

developed countries. The origins of the regulations of large retail stores goes back to 1937, with the first "Department Store Law" enacted in reaction to complaints from small shop owners due to the expansion of large department stores. This law was eliminated in 1947 under the American administration, but was brought back under the same name in 1956. This law stipulated a special procedure in order to get a license for the expansion of certain existing retail businesses, or the opening of new ones, beyond 1,500 square meters.

In 1974 the famous Large Scale Retail Store Law was introduced and remained in affect until 2000. This law and its modifications expanded the scope of the original legislation to cover the entire retail sector, and essentially specified an application process to get a license for retail stores above a certain size. Since 1979, Type-1 stores were those larger than 1,500 sq. mts (3,000 sq. meters in large cities), while Type-2 stores covered a group of a substantially small size: between 500 sq. meters 1,500 sq. meters. Applications for stores of Type-1 were made to the Ministry of Trade and Industry (MITI), while applications for Type-2 were dealt at the local level. Starting in 1982, the very first step in the MITI process called for a consensus of interested parties, including those potentially affected by the opening (small, traditional stores). Not surprisingly, this "consensus" stage often led to the abandonment of the plans altogether.

By the mid-eighties, as a result of the law and the norms issued by the MITI governing its implementation, the process of obtaining approval for a new store at the Type-1 level was a long and costly one. It required a minimum of seven different stages, and a maximum of 16. At many of these stages, the plans for the proposed new store could be stopped, or business plans could be forced to change by those negatively affected. As a result, the number of applications of the first type fell from about 399 in 1974 to about 157 in 1986; for Type-2 stores, the number of applications fell from 1029 in 1979 to about 369 in 1986.<sup>8</sup>

In 2000, the Large Scale Retail Location Law replaced the 1974 law. The new law requires the approval for stores larger than 1000 sq. meters (an even *smaller* limit than the previous law) and leaves all legislations to the local authorities. While the protection of small retail is no longer an explicit objective of the legislation, the decision criteria now takes into account environmental factors (noise, congestion, etc.) McKinsey Global Institute (2000) raises serious concerns about the restrictiveness of the new law, and the lack of incentives for local governments to move to a more competitive environment.

Interestingly, Japan is not unique among the high income countries in regulating the retail sector. In 1973, the French Parliament approved the "*Loi d'Orientation du Commerce et de l'Artisanat*" or the Loi Royer with the explicit objective of protecting owners of small retail shops

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<sup>8</sup>Source: Larke (1994). To put these figures in perspective, it is worth emphasizing that the size of the Japanese population is of about 120 million, and that the Japanese economy grew at an annualized rate of about 3.6% from 1974 to 1985.

against the 'disordered' growth of new forms of distribution. Under the Loi Royer, any new store larger than 1,500 sq. meters (1000 sq. meters in cities with less than 40,000 people) requires the approval of a regional zoning committee created after the law. The same rules also apply to the expansion of existing stores, and the conversion of existing buildings into retail space. Interestingly, like in Japan under the Large Scale Retail Store Law, directly affected parties (owners of small retail shops and craftsmen) are represented in these committees.<sup>9</sup> Bertrand and Kramarz (2002) argue that the application process is a costly one, and show that a non-trivial fraction of proposals were effectively rejected by the regional committees. The mean approval rate across French departments from 1975 to 1998 was 42 percent, and projects for relatively large stores faced a lower probability of acceptance than small ones.

Employment protection legislation in several developed countries contains provisions that depend on the size of firms and/or establishments. This is present in many aspects of the prevailing provisions (e.g. rules regarding fixed term contracts, redundancy procedures, pre-notification periods, severance payments and requirements for collective dismissals) for countries like Italy, Germany, France and Spain.<sup>10</sup> The case of employment protection legislation in Italy is interesting to describe in detail, as it clearly shows how the policy provisions that depend on size actually operate.<sup>11</sup> In a nutshell, firms with more than 15 employees face employment protection legislation that differs in many ways with the legislation faced by smaller firms. Within the Italian institutional setting, five type of regulations depend on firm's size: employment protection, mandatory quotas on hiring, firm level rights to organize union related institutions, firm safety standards and collective dismissal rules.

The key institutional constraint is about individual dismissal rules (Article 18 of the labor code). Individual dismissals must be supported by a just cause, and workers have the right to appeal firm initiated dismissals. Whenever a judge rules a dismissal unfair, workers are entitled to a compensation that hinges on firms size. Firms employing less than 15 employees must compensate the (unfairly) dismissed worker and pay a severance payment ranging from 2.5 to 6 months. Firms employing 15 workers or more, must *rehire* the worker and pay a compensation for the foregone wages from the dismissal's date to the date of the ruling.

Government policies that support small and medium size enterprises (SMEs), either firms or establishments, are very common, if not universal, both in developing and developed countries. The particular attention to SMEs is perhaps justified by their sheer number: they represent, for example, between 96% and 99% of the total number of enterprises in the whole economy and between 60

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<sup>9</sup>According to Bertrand and Kramarz (2002), the law has become more strict in recent years, with a reduction in the threshold levels and with a stronger majority requirement for the approval of a project.

<sup>10</sup>See Bertola, Boeri, and Cazes (1999) for an extensive documentation.

<sup>11</sup>We follow Garibaldi, Pacelli, and Borgarello (2003) in the description of the Italian institutional setting.

to 70% of total manufacturing employment in most O.E.C.D. countries.<sup>12</sup> Furthermore, SMEs are arguably responsible for the bulk of new businesses and gross job creation.

Policies that affect SMEs can be grouped in two categories. The first group consists of policies that promote entrepreneurship and reduce entry costs. The second group encompasses size-dependent policies that provide *special provisions* for SMEs. Korea provides an illustrative example for the wide range of policies in this second group. First, there exists large financial subsidies benefiting SMEs. The Korean Credit Guarantee Fund (KCGF) and the Korea Technology Credit Guarantee Fund (KOTEC) provide credit guarantees to SMEs that are otherwise ineligible for regular bank loans. Furthermore, all commercial, regional, and foreign banks are required to allocate a certain proportion of their loans to SMEs; see Kim (2004). Second, SMEs enjoy special tax treatments. Newly created SMEs receive a 50% reduction of income and property tax payments up to five years and are exempt from registration and transaction taxes for two years. There is also a special 20% tax credit to small firms in the manufacturing sector. SMEs are also allowed to deduct 50% more for depreciation than larger firms; see O.E.C.D. (2002) and Kim (2004). Policies that are similar to Korean SME policies are quite widespread across countries. Indeed, financial subsidies to and special tax treatment of SMEs are very common. Both developed and developing countries provide special financing arrangements to SMEs, either in the form of loan grantees or interest rate subsidies.<sup>13</sup> In similar fashion, most O.E.C.D. countries have lower corporate tax rates for SMEs.<sup>14</sup>

The rest of the paper is organized as follows. Section 2 introduces the model economy we investigate. Section 3 discusses our choice of parameter values. Section 4 presents the findings from our experiments when size is affected via restrictions on capital use. Section 5 studies restrictions on size that depend on labor use. Section 6 analyzes restrictions on capital and labor use that generate cross-country differences in average establishment size. Section 7 investigates size-dependent subsidies. Section 8 concludes.

## 2 Theoretical Framework

We now describe a simple one-sector aggregative model with an endogenously determined size distribution of establishments. The model is based upon the Lucas (1978) span-of-control framework. We first present the model economy in the absence of any government policy, and subsequently we introduce size-dependent policies of different types.

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<sup>12</sup>See O.E.C.D. (2002). SMEs are usually defined enterprises with less than 250 employees, although the U.S. definition is less than 500.

<sup>13</sup>For an example of these policies in Japan, see Ministry of Economy, Trade and Industry (2004).

<sup>14</sup>These countries include Belgium, Canada, France, Germany, Ireland, Japan, Korea, Luxembourg, Mexico, the Netherlands, Portugal, Spain, the UK, and the U.S. Several countries also provide tax incentives for investment, like tax credits and more generous depreciation allowances, that are specific to SMEs. See O.E.C.D. (2002).

There is a single representative household in the economy. The household comprises at time  $t$  a continuum of members of total size  $L_t$ , who value only consumption. The size of the household (population) grows at the constant rate ( $g_L$ ). The household is infinitely lived and maximizes

$$\sum_{t=0}^{\infty} \beta^t L_t \log(C_t/L_t), \quad (1)$$

where  $\beta \in (0, 1)$  and  $C_t$  denotes total household consumption at date  $t$ .<sup>15</sup>

**Endowments** Each household member is endowed with  $z$  units of managerial ability. These efficiency units are distributed with support in  $Z = [0, \bar{z}]$ , with cdf  $F(z)$  and density  $f(z)$ , which are invariant with respect to population growth. Each household member has one unit of time which he/she supplies inelastically. Depending upon type, each household member can be a *worker* or a *manager*. We describe below this occupation decision and the associated incomes in detail. The household is also endowed with initial capital stock  $K_0$ .

**Production** Production requires managerial input ( $z$ ), capital ( $k$ ), and labor ( $n$ ). The output of a manager of type  $z \in Z$  is given by

$$y = z^{1-\gamma} A(g(k, n))^\gamma,$$

where  $g(., .) = k^\nu n^{1-\nu}$  and  $0 < \nu < 1$ . The parameter  $\gamma$  governs returns to scale at the establishment level (usually referred to as the span-of-control parameter), and satisfies  $0 < \gamma < 1$ . The term  $A$  is common to all production units, and accounts for exogenous productivity growth at the constant rate  $g_A$  (i.e.  $A_{t+1}/A_t = 1 + g_A$ ). A manager with ability  $z$  maximizes profits taking input prices as given and obtains  $\pi(z, W, R)$ , which is the solution to

$$\max_{n, k} [z^{1-\gamma} A(g(k, n))^\gamma - Wn - Rk],$$

where  $W$  and  $R$  are the rental prices for labor and capital services respectively.

Two first order conditions associated with this problem are

$$Az^{1-\gamma} \gamma (1 - \nu) (k^\nu n^{1-\nu})^{\gamma-1} (k^\nu n^{-\nu}) = W, \quad (2)$$

for labor and

$$Az^{1-\gamma} \gamma \nu (k^\nu n^{1-\nu})^{\gamma-1} (k^{\nu-1} n^{1-\nu}) = R, \quad (3)$$

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<sup>15</sup>We introduce population growth so the model has standard balanced-growth properties, and thus can be better mapped to data; see section 3.

for capital services. Then, for any  $z$ , capital to labor ratio,  $k/n$ , is given by

$$h \equiv \frac{k}{n} = \frac{\nu}{1 - \nu} \frac{W}{R}. \quad (4)$$

Therefore in a competitive equilibrium all establishments choose the same capital to labor ratio, regardless of their size.

**The Household Problem** The problem of the household is to choose sequences of consumption, the fractions of household members who work as managers or workers, and the amount of capital to carry over to the next period.

If a household member becomes a worker, her efficiency units are transformed into 1 unit of labor and her income is then given by  $W$ . If instead she becomes a manager, her contribution to household's income is given by  $\pi(z, W, R)$ . Note that there exists a unique threshold  $\hat{z}$  such that those individuals with efficiency units below this threshold become workers, and those with efficiency units above it become managers. This follows from the fact that the function  $\pi(\cdot, W, R)$  is strictly increasing in the first argument under diminishing returns to capital and labor jointly.

Formally the household problem is to select  $\{C_t, K_{t+1}, \hat{z}_t\}_0^\infty$  to maximize (1) subject to

$$C_t + K_{t+1} = I_t(\hat{z}_t, W_t, R_t)L_t + R_tK_t + K_t(1 - \delta),$$

and

$$K_0 > 0.$$

The per-capita income from managerial and labor services,  $I_t(\hat{z}_t, W_t, R_t)$ , is given by

$$W_t F(\hat{z}_t) + \int_{\hat{z}_t}^{\bar{z}} \pi(z, W_t, R_t) f(z) dz.$$

The solution to the household problem is then characterized by two First Order Conditions:

$$\frac{1}{(C_t/L_t)} = \beta(1 + R_{t+1} - \delta) \frac{1}{(C_{t+1}/L_{t+1})}, \quad (5)$$

and

$$W_t = \pi(\hat{z}_t, W_t, R_t). \quad (6)$$

Condition (5) is the standard Euler equation for capital accumulation. Condition (6) states that the household member with marginal ability  $\hat{z}_t$  at  $t$  must receive the same compensation as a manager than as a worker (i.e. be indifferent).

**Equilibrium** In equilibrium, the markets for capital and labor services, as well as the market for goods must clear. Let  $k(z, W, R)$  and  $n(z, W, R)$  be the demands for capital and labor services of a manager of ability  $z$ . Market clearing in the market for labor services requires

$$N_t^* = L_t \int_{\hat{z}_t^*}^{\bar{z}} n(z, W_t^*, R_t^*) f(z) dz, \quad (7)$$

where an  $(*)$  over a variable denotes its equilibrium value, and  $N_t^*$ , aggregate labor supply at  $t$ , is given by

$$N_t^* \equiv L_t F(\hat{z}_t^*). \quad (8)$$

Market clearing in the market for capital services requires

$$K_t^* = L_t \int_{\hat{z}_t^*}^{\bar{z}} k(z, W_t^*, R_t^*) f(z) dz. \quad (9)$$

Let  $y_t(z, W_t, R_t)$  be the supply of goods by managers with ability  $z$ . Then, market clearing in the market for goods is given by

$$L_t \int_{\hat{z}_t^*}^{\bar{z}} y(z, W_t^*, R_t^*) f(z) dz = C_t^* + K_{t+1}^* - K_t^* + \delta K_t^*. \quad (10)$$

It is now possible to define a competitive equilibrium. A competitive equilibrium is a collection of sequences  $\{C_t^*, K_{t+1}^*, \hat{z}_t^*, W_t^*, R_t^*\}_0^\infty$ , such that (i) given  $\{W_t^*, R_t^*\}_0^\infty$ , the sequences  $\{C_t^*, K_{t+1}^*, \hat{z}_t^*\}_0^\infty$  solve the household problem; (ii) the markets for capital and labor services clear for all  $t$  (equations (7) and (9) hold); (iii) the market for goods clears for all  $t$  (equation (10) holds).

Along a competitive *balanced growth path*, the rental rate of capital services is constant. Per-capita consumption and output, wages and managerial profits all grow at the common rate  $1 + g \equiv (1 + g_A)^{1/(1-\gamma\nu)}$ , and the threshold  $\hat{z}^*$  is constant. Aggregate output, consumption and capital grow at the rate  $(1 + g_L)(1 + g)$ .

Before we introduce size-dependent policies, two features of benchmark economy are important to note here. First, the competitive equilibrium is unique, and coincides with the Social Planner solution in the absence of distortions. This implies that *any* policy affecting size will be distorting.<sup>16</sup> Our analysis can thus be viewed as a natural benchmark to analyze the consequences of policies of this type: what effects are to be expected on a host of variables in equilibrium, and what the magnitude of such effects will be.

Second, the fact that the standard Euler equation for capital accumulation applies in this model implies that the rental rate for capital services is constant across steady states. This suggests a

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<sup>16</sup>Of course, this does not imply that size regulations are always inefficient. They would be efficient, for example, if large establishments generate negative externalities.

simple and natural procedure to compute steady state equilibria. We first normalize variables to remove the effects of secular growth, and then guess a value of the normalized steady-state capital stock. Second, given the guess for the capital stock, we calculate equilibrium factor prices from equations (7) and (9). Note that for any given set of prices  $(W, R)$ , we can solve the profit maximization problem of a given manager and find  $k(z, W, R)$ ,  $n(z, W, R)$  and  $\pi(z, W, R)$ . This determines  $\hat{z}$  from equation (6) for any  $(W, R)$ . The managerial ability of the marginal manager  $\hat{z}$  can then be used to calculate demand and supply of labor from equations (7) and (8) as well as the demand for capital from the left hand side of equation (9). We iterate on  $(W, R)$  until both markets clear and find the equilibrium prices for a given aggregate capital stock. Third, if the resulting rental rate for capital services differs from  $((1 + g)/\beta - 1 + \delta)$ , we update the guess for aggregate capital stock and go back to the first step and repeat the same procedure until we find a steady state equilibrium. This procedure, which also applies when government policies are introduced, is the one we use to calculate all the steady state statistics we report in the paper.<sup>17</sup>

## 2.1 Size-Dependent Policies

Our representation of policies is meant to capture government policies which affect the size of establishments via implicit taxes or subsidies on input use. Our analysis thus provides bounds for the effects of size-dependent policies that directly tax/subsidize output.

We discuss in this section the case of *restrictions* on size, which we model as implicit taxes that are applied only to the input units above an exogenously set level. The central idea is that if an establishment wants to expand the use of an input beyond a given level, it faces a marginal cost of using the input in question that is larger than its price.

We focus first on restrictions imposed on the use of capital; the case of restrictions on labor use is similar and we analyze it later. We posit that the total cost associated to capital use beyond a pre-determined level  $\underline{k}$ , i.e. for  $k > \underline{k}$ , is given by

$$R\underline{k} + R(1 + \tau)(k - \underline{k}),$$

for some  $\tau \in (0, 1)$ . If  $k \leq \underline{k}$ , then the total cost of capital use is just  $Rk$ . Note that this resembles a progressive tax, in which there are two implicit marginal tax rates, 0 and  $\tau$ . If  $k > \underline{k}$ , the production unit pays  $R\underline{k}$  for the first  $\underline{k}$  units used, plus an amount that is proportional to the difference between  $k$  and  $\underline{k}$ .

This modeling of restrictions implies that the total cost associated to capital use is continuous in  $k$ . As a result, the function  $\pi(\cdot)$  summarizing managerial rents, and establishment's demand

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<sup>17</sup>Note that due to productivity growth, the stationary version of the model dictates that the Euler equation for capital (equation 5) includes the term  $(1 + g)$ .

functions for capital and labor are continuous. In particular, for any establishment with demand for capital services that is *larger* than  $\underline{k}$ , the marginal cost of capital is given by  $R(1 + \tau)$  since

$$\begin{aligned}\pi(z, W, R) &= \max_{k, n} [z^{1-\gamma} A(g(k, n))^\gamma - Wn - R\underline{k} - R(1 + \tau)(k - \underline{k})] \\ &= \max_{k, n} [z^{1-\gamma} A(g(k, n))^\gamma - Wn - R(1 + \tau)k + R\tau\underline{k}].\end{aligned}$$

Profit maximization dictates that there are potentially three types of establishments. Unconstrained ones are small establishments that choose  $k(z, W, R; \underline{k}, \tau) \leq \underline{k}$ . Thus, for these establishments the marginal product of capital equals the rental rate  $R$ . On the other extreme, are those whose managers have relatively high levels of  $z$ , and thus choose  $k(z, W, R; \underline{k}, \tau) > \underline{k}$ . For these units, the marginal product of capital is *higher* than the rental rate. Finally, there is an intermediate group of establishments for which the marginal product of capital is between  $R$  and  $R(1 + \tau)$ . For these,  $k(z, W, R; \underline{k}, \tau) = \underline{k}$ . Since the demand for capital services is continuous and increasing in managerial ability, this ordering is mapped into levels of managerial ability. Hence, there exist thresholds  $z^-$  and  $z^+$  so that: (i) unconstrained establishments are those with  $z \in [\hat{z}, z^-]$ ; (ii) establishments in the intermediate group are those for which  $z \in [z^-, z^+]$ ; (iii) the largest establishments have  $z > z^+$ .

How are the critical values  $z^-$  and  $z^+$  determined? Note that equations (2), (3) and (4) imply that the size of an establishment is given by

$$n(z, W, R) = \Omega z R^{-\frac{\gamma\nu}{1-\gamma}} W^{\frac{\gamma\nu-1}{1-\gamma}}, \quad (11)$$

where  $\Omega$  is a constant. Therefore, demand for capital by a manager of type  $z$  can be written as

$$k(z, W, R) = hn(z, W, R) = \Phi z R^{\frac{\gamma(1-\nu)-1}{1-\gamma}} W^{\frac{\gamma(\nu-1)}{1-\gamma}}, \quad (12)$$

where  $\Phi$  is another constant. Then, given any  $\underline{k} > 0$ , there exists a value of  $z$  which satisfies equation (12), and it is given by

$$z = \Phi^{-1} \underline{k} R^{\frac{1-\gamma(1-\nu)}{1-\gamma}} W^{\frac{\gamma(1-\nu)}{1-\gamma}}. \quad (13)$$

Therefore, there are two values of  $z$ ,  $z^-$  and  $z^+$  with  $z^- < z^+$ , which satisfy equation (13) for  $R$  and  $R(1 + \tau)$ . Finally, for all establishments between  $z^-$  and  $z^+$ , the optimal choice of  $n$  is given by the following version of equation (2)

$$Az^{1-\gamma} \gamma (1 - \nu) (\underline{k}^\nu n^{1-\nu})^{\gamma-1} (\underline{k}^\nu n^{-\nu}) = W.$$

Since the optimal choice for  $n$  is increasing in  $z$ , capital output ratio,  $k/n$ , is decreasing in this region.

Figure 1 illustrates the determination of  $\hat{z}$ ,  $z^-$  and  $z^+$ . The managerial ability of the marginal manager  $\hat{z}$  is simply determined by the intersection of  $W$  (the value of being a worker) and profits. With size-dependent policies, the profit function consists of three segments:  $\pi(z, W, R)$ , the profits of unrestricted establishments,  $\pi(z, W, R; \underline{k}, \tau)$ , the profits of establishments who choose  $\underline{k}$ , and  $\pi(z, W, R(1 + \tau))$ , the profits of large establishments. The thresholds  $z^-$  and  $z^+$  are determined by the intersection of capital demand under  $R$  and  $R(1 + \tau)$  with  $\underline{k}$  as shown in the middle panel. It is important to remember here that an implication of the model without distortions is that all establishments choose the same capital to labor ratio, regardless of their size. The reason for this is the assumption of homogeneity of the function  $g(k, n)$ , and the fact that all establishments face the same prices for capital and labor services. With restrictions on capital use, the capital to labor ratio is a weakly decreasing function of managerial ability, as shown in the bottom panel of Figure 1. When restrictions are imposed on the use of labor services the opposite is true (see section 5).

We now briefly describe the modified household problem under restrictions on size. Resources taxed via restrictions on size are returned to the representative household in a lump-sum form. Formally, the household's budget constraint now equals

$$C_t + K_{t+1} = I_t(\hat{z}_t, W_t, R_t; \underline{k}, \tau)L_t + R_t K_t + K_t(1 - \delta) + X_t,$$

where  $X_t$  stands for lump-sum transfers which are taken as given by the household. In equilibrium, they equal

$$X_t^* = L_t \tau R_t^* \int_{z^{+*}}^{\hat{z}} (k(z, \cdot) - \underline{k}) f(z) dz.$$

## 2.2 Returns to Scale

It is important to emphasize at this point the importance of the curvature parameter  $\gamma$  governing returns to scale (or managerial *span-of-control*) for the current analysis. We note that there is some uncertainty and debate with respect to the empirical value of this parameter at the establishment level. Basu and Fernald (1997) for instance, estimate values that range from 0.8 to 1, but argue that there is an upward bias in estimates from aggregated data.

The parameter  $\gamma$  plays two critical roles in the current analysis. First, it determines how sensitive establishment size and output are to changes in factor prices. To see this note that equation (11) implies

$$\log(n) = \log(z) + \log(\Omega) - \frac{\gamma\nu}{1 - \gamma} \log(R) - \frac{1 - \gamma\nu}{1 - \gamma} \log(W).$$

Hence, the way establishment size reacts to changes in factor prices depends on  $\gamma$ . In particular, as  $\gamma$  approaches 1, small changes in factor prices can have large effects on output. Therefore, the

aggregate effects of the reallocation of resources across production units thus hinges critically upon  $\gamma$ . This point was made forcefully by Atkeson, Khan, and Ohanian (1996). They analyze the link between firing costs and gross job flows within an industry evolution model, and argue, by contrasting manufacturing job flows from the U.S. with other O.E.C.D. countries, that a value on the low side of the above estimates is reasonable.

Second, since all individuals face the same wage rate as workers, the size of the smallest and the average establishment can differ significantly. They depend critically on the parameter governing span-of-control,  $\gamma$ . Indeed, given our assumptions regarding functional forms, it is possible to derive an explicit condition that determines  $\hat{z}$ , which is given by,

$$\hat{z} = \frac{\gamma}{1 - \gamma} (1 - \nu) \frac{\int_{\hat{z}}^{\hat{z}} f(z) dz}{\int_{\hat{z}}^{\hat{z}} z f(z) dz}. \quad (14)$$

This is one equation in one unknown, i.e.  $\hat{z}$ .<sup>18</sup>

It is immediate from equation (14) that as  $\gamma$  approaches 1,  $\hat{z}$  gets larger and at the limit there will be a single establishment in this economy, with the most talented manager hiring everyone else. Since there is one-to-one correspondence between managerial ability and establishment size, this equation also tells us that the smallest production unit, and therefore average size, depend on  $\gamma$  as well. Thus, given a distribution for managerial talent,  $\gamma$  is critical in determining the distribution of employment across establishments of different sizes. Finally, equation (14) also highlights the importance of the parameter  $\nu$ , which governs the importance of capital in production, in determining the size of smallest establishment in this economy.

### 3 Calibration

We calibrate parameters in order to match observations in steady state, both at the *aggregate* and at the *cross-section* level. To this end, we use data pertaining to the United States, which we take as a relatively distortion-free economy for the purposes of this paper.

As a first step in this process, we choose a model period of a year and proceed to adopt a notion of capital for measurement purposes. We assume that the stock of capital is comprised by business equipment and structures, business inventories and business land. From the NIPA data published by U.S. Department of Commerce (2005), Table 1.3.5, we take the flow of output consistent with this notion of capital, which is GDP accounted for by the business sector. For the period 1960-2000, the capital to output ratio associated to these choices averaged about 2.325.<sup>19</sup> For this period, output

<sup>18</sup>The derivation of equation (14) is achieved by first using equations (11) and (12) in the labor market clearing condition (7), and then using the resulting factor prices in the expression (6) for the marginal manager.

<sup>19</sup>The sources for the stock of business capital and structures is Lally (2002), Table 1. The sources for the stock of business land are the recently published series by the Bureau of Labor Statistics from their Multifactor

growth was about 3.67% at the annual level. Given a corresponding annual population growth rate of about 1.1%, the implied measure for the technical growth rate  $g$  is 2.55%.

We then measure the share of capital in total output and the depreciation rate. Using the methodology described in Cooley and Prescott (1995), the share of capital averaged about 0.317 for the period 1960-2000. Using depreciation data from NIPA (Table 5.2.5) consistent with the notion of the capital we adopt, the depreciation rate for this period averaged about 0.040. In our economy the share of capital equals  $\gamma\nu$ . We set the parameter  $\gamma$  governing returns to scale using the procedure we explain below. Then, given  $\gamma$ , we obtain the parameter  $\nu$  so that the model is consistent with the aggregate capital share.

We now proceed to calibrate  $\gamma$  and the parameters governing the distribution of managerial ability  $f(z)$ , which jointly determine the relative size of production units. The calibration strategy is guided by our discussion regarding the role of  $\gamma$  in the previous section. The span-of-control parameter  $\gamma$  together with  $f(z)$  determine the size distribution of establishments; they determine mean establishment size, the range of employment levels, as well as the share of total labor employed by establishments of different sizes. We choose to calibrate  $f(z)$  and  $\gamma$  so they are consistent with the data on the fraction of establishments at different employment levels, and the share of total employment accounted by large establishments.

We note that while most production establishments in the data are relatively small, there exist relatively few rather large establishments that account for a disproportionate fraction of employment and output. Establishments with 9 employees or less constitute 70.7% of the total number of establishments, yet they account for only 14.6% of total employment in the data we consider. Simultaneously, establishments with 100 employees or more constitute only about 2.6% of the total, but they account for 44.9% of employment. Put differently, the size distribution of establishments exhibits a remarkable degree of concentration.<sup>20</sup> In light of the issues we try to address in the paper, our parameterization is designed to capture these striking features of the data.

We use the data on establishments from the 1997 U.S. Economic Census. From this census we calculate the following targets using data on *all* sectors: (i) mean establishment size; (ii) the fraction of establishments over the number of employees (at tabulated values), and (iii) the share of total employment accounted for by large (those with more than 100 employees) establishments. We then select  $\gamma$  and  $f(z)$  to match these statistics. To this end, we assume that log-managerial ability is distributed according to a (truncated) normal distribution, with mean  $\mu$  and variance  $\sigma^2$ . We impose that this distribution accounts for the bulk of production units, with a total mass

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Productivity Program. We use the stocks of land reported as part of the productive capital stock. This is available at <ftp://ftp.bls.gov/pub/suppl/prod3.capital.zip>.

<sup>20</sup>This is a property shared with other well-known distributions in economics, such as the distribution of wealth.

of  $1 - f_{max}$ . To account for the remainder of the distribution of establishments, we select a top value for managerial ability,  $z_{max} > \bar{z}$  and its corresponding fraction,  $f_{max}$ . Thus, the distribution of managerial ability has two parts: the bulk on the bottom side is characterized by a log-normal distribution while at the very top is captured by an extreme value for managerial ability.<sup>21</sup> These few but highly talented managers allow us to generate the right amount of factor demand by large establishments, which is critical for the question we try to study.

Finally, given the above choices, we find the discount factor  $\beta$  in order to reproduce the aforementioned capital output ratio in steady state. There are in total seven parameters that we choose in order to reproduce observations. These are  $\gamma, \nu, \mu, \sigma, z_{max}, f_{max}$  and  $\beta$ . There are in total eight observations that the model is forced to match: the fraction of establishments corresponding at different levels of employees, the share of employment accounted for by establishments with more than 100 employees, mean size, the aggregate capital share and the aggregate capital to output ratio. Table 1 summarizes our choices. Table 2 lists the set of observations that constitute our targets, and shows the performance of the model in terms of them.<sup>22</sup>

### 3.1 Discussion

We note that it is not problematic for the model to reproduce the targets we impose. Figure 2 shows graphically the overall fit of the actual size distribution of establishments. Figure 3 shows that the model is also successful in reproducing the fraction of employment for the selected levels of employment, although that we *only* force the model to match the share of employment at the top. In the current calibration,  $f_{max}$  and  $z_{max}$  are selected to reproduce data on establishments with more than 100 employees. In the benchmark economy, the size of establishments with  $z_{max}$  is of about 294 employees. In the data, the average size of establishments with more than 100 employees is of about 300 workers. Hence, the calibrated model is able to capture the range of employment levels between the average establishment and the establishments at the top (i.e. establishments with more than 100 workers).

We also emphasize that our calibrated value for the returns-to-scale parameter ( $\gamma = 0.802$ ) is in the range of values used in recent studies. For instance, from the evidence presented in Basu and Fernald (1997), Chang (2000) uses a value equal to 0.8, whereas Veracierto (2001) obtains 0.83 when his economy is calibrated to U.S. observations. More recently, using only manufacturing data, Atkeson and Kehoe (2005) argue in favor of a value equal to 0.85.

In the model, about 94.5% of the labor force are workers while the remaining fraction are managers. Regarding the consistency of these values with data, it is worth noting that pinning down

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<sup>21</sup>Our approach bears close resemblance to the approach taken by Castaneda, Diaz-Gimenez, and Rios-Rull (2003) to calibrate earnings distribution for the U.S. economy.

<sup>22</sup>In all simulations we approximate  $f(z)$  by a discrete distribution with 5000 grid points.

an empirical value for the fraction of workers (managers) is difficult. From census data, it is possible to calculate a lower bound on the fraction of workers, as about 85.7% of the labor force performed non-managerial tasks in 2001.<sup>23</sup> Chang (2000), using PSID data, calculates a similar value for the fraction of workers (84%). Nevertheless, a more literal interpretation of the model economy, which we prefer, suggests that each establishment is run by one manager. This consideration suggests a lower bound on the fraction of managers, which can be obtained by dividing the number of active establishments in 1997 by the size of the work force in that year. This calculation leads to a fraction of workers in the population of about 95%. Note that the model generates a similar value (94.5%), which follows since the model reproduces number of workers per establishment (i.e. mean establishment size).

Finally, we note that the model implies that mean size is constant along the balanced growth path. We emphasize that this property is in conformity with available data. Using time-series data from the County Business Patterns, we find that average size is trendless despite productivity growth. For instance, mean size was 15.94 in 1969, 16.47 in 1980, 14.22 in 1985, 15.13 in 1990, 15.17 in 1995 and 16.13 in 2000. Note that we use a different source of data (Economic Census) for calculating the statistics on size that we report previously. As a result, our target in Table 2 differs slightly from these numbers.

## 4 Restrictions on Capital Use

We proceed by comparing steady states of our model economy without distortions with steady states of a distorted model economy. We report results for restrictions that kick-in at average capital use in the economy without restrictions. We report results for two scenarios, given by the values of the tax rate ( $\tau$ ) such that 10% and 20% reductions in average size across steady states is accomplished. Given the absence of empirical counterparts for implicit tax rates, this form of reporting findings provides a natural discipline for an assessment of the effects of the policies we study.<sup>24</sup> Furthermore, the reduction in average size of establishments that these distortions generate is well within differences we observe among industrialized countries.

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<sup>23</sup>Source: U.S. Census Bureau (2002), Table 588. This results from considering individuals under the occupation category “Executive, Administrative and Managerial”.

<sup>24</sup>Targeting reductions in average size does not necessarily imply that the effects on aggregates and productivity depend on the location of the distortion. Earlier versions of this paper showed this by contrasting the current case with the case of  $\underline{k}$  equal to 2/3 of mean capital use. What a lower (higher) value of  $\underline{k}$  simply does is to reduce (increase) the tax required to achieve a given reduction in size. Thus, as long as the targeted reduction in size can be achieved via a pair  $(\underline{k}, \tau)$ , what matters is the magnitude of the distortion measured by the reduction in average size, and not how such reduction is obtained (either via thresholds or via implicit taxes).

**Aggregates** Table 3 summarizes the main findings for aggregate variables. When restrictions on capital use lead to a reduction in average establishment size of 20% (10%) across steady states, aggregate output falls by about 8.1% (3.8%), aggregate capital falls by about 21.3% (11.2%) and aggregate consumption falls by about 5.2% (2.2%). When  $\tau$  increases, affected establishments either set their demand for capital services at  $\underline{k}$ , or demand capital services from a new, higher price  $R(1+\tau)$ . This process leads to a reduction in the total demand for capital services, a reduction in the capital to labor ratio in distorted establishments, and a reduction in the supply of the single good produced. In equilibrium, this process is accompanied by an increase in the number of small establishments as Table 3 shows, as well as an expansion of establishments not affected by the increase in the implicit tax ( $\tau$ ). Thus, aggregate output decreases despite the emergence of new, small establishments and the expansion of undistorted ones; this simply reflects the fact that large (distorted) ones account for a disproportionate share of total output.

We note that the increase in the number of small establishments is a simple and natural implication of our framework. Quantitatively, this increase in the number of small establishments is substantial, ranging from about 10.3% when mean size declines by 10% to about 23.5% when the reduction is 20%. Why does this phenomenon occur? The introduction of restrictions on large establishments leads to a reduction in the aggregate demand for labor, and thus to a new steady state with a *lower* wage rate. Provided that the rental rate on capital services is constant across steady states, the fall in wages increases the managerial rents associated to operating small, undistorted establishments. In addition, the fall in the wage rate reduces the benefits of being a worker. The net result is the reduction in the productivity threshold  $\hat{z}$ , and the non-trivial increase in the number of small establishments that Table 3 shows.

In our exercises, the ability of the marginal manager,  $\hat{z}$ , declines by 22% (11%) when restrictions on capital use lead to a reduction in average establishment size of 20% (10%). The decline in  $\hat{z}$  results in about 1.3% (0.6%) of the population switching to managerial work. As  $\hat{z}$  declines, so does the output produced by the marginal manager. The marginal manager produces 7% (3%) less when restrictions on capital use lead to a reduction in average establishment size of 20% (10%).

**Productivity** The distortions on size have systematically a direct and negative impact on productivity measures. We report in Table 3 several of them. The first one is simply average output per worker (non-managers). We also report the behavior of output per establishment, output per efficiency unit of labor (managers plus workers), as well as average managerial quality. These measures are defined as

$$\frac{\int_{\hat{z}^*} y(z, W^*, R^*) f(z) dz}{(1 - F(\hat{z}^*))},$$

$$\frac{\int_{\hat{z}^*} y(z, W^*, R^*) f(z) dz}{F(\hat{z}^*) + \int_{\hat{z}^*} z f(z) dz},$$

and

$$\frac{\int_{\hat{z}^*} z f(z) dz}{(1 - F(\hat{z}^*))},$$

respectively. For a reduction in mean size of 20% (10%) across steady states, output per worker drops by about 6.9% (3.3%). The reduction in output per establishment and average managerial quality are much more pronounced; the fall in these magnitudes for a reduction in mean size of 20% (10%) are of about 25.6% (12.8%) and of about 16.6% (8.0%), respectively.

Overall, the reductions in productivity measures reflect the negative consequences that size restrictions have on the allocation of the economy's fixed endowment of managerial talent, and the general equilibrium effects that ensue. Table 4 illustrates how distortions affect the allocation of managerial talent, by calculating the fraction of total output accounted for by managers at different quintiles of the distribution of managerial ability. In the benchmark economy without distortions only about 3.2% of the total output is produced by managers who constitute the bottom 20% of the managerial ability distribution, while about 75.4% of total output is produced by the top managers. What happens when we introduce the restrictions on size? Consider for instance the situation when average establishment size is reduced by 20%. In this case, the fraction of output accounted for by the top 20% of managers declines significantly, to about 68.5%. Meanwhile, output accounted for by less talented managers expands at the bottom of the distribution. Thus, restrictions on large establishments not only reduce average size and increase the number of establishments that operate in equilibrium, but also *redistribute* production from high ability to low ability managers.

With the distortions in the allocation of managerial talent illustrated in Table 4, total output as well as total demand for labor and capital decline and the general equilibrium effects on prices follow. We now concentrate in detail on the effects of the restrictions on one of the productivity measures, output per worker, to illustrate these general equilibrium effects. Why does this statistic drop across steady states? This is important to understand, as this is a statistic usually computed in productivity studies. In each establishment, physical output per worker equals

$$\frac{W^*}{(1 - \nu)\gamma},$$

*independently* of the presence of restrictions on size as we modelled them. Thus, absent general equilibrium effects, size restrictions applied to the use of capital do *not* affect output per worker, despite the emergence of establishments with relatively low output and the reduction in output in large, distorted ones. As a result, the fall in output per worker reported in Table 3 is also the fall in the wage rate across steady states associated to the restrictions on large establishments.

**TFP** An alternative, admittedly imperfect, measure of how the reallocation of managerial talent affects aggregate output are the implications of our analysis for Total Factor Productivity (TFP). We calculate this variable in two alternative ways. The first is consistent with cross-country studies (e.g. Klenow and Rodriguez-Clare (1997)); that is, TFP is the residual from an aggregate technology under a capital share  $\nu\gamma$  and a labor share  $1 - \nu\gamma$ , under the assumption that there are no distinctions between workers and managers in the labor force. Concretely, we calculate

$$TFP = \frac{Y/L}{(K/L)^{\nu\gamma}}.$$

For this measure, we find that these policies have effects on TFP of small magnitude; reducing size by 20% leads to a reduction in TFP of about 0.9%. Alternatively, we can separate workers and managers by their efficiency units and define aggregate labor as  $N + Z$ , where  $Z \equiv L \int_{z^*}^{\bar{z}} z f(z) dz$ . For this case, we have:

$$TFP = \frac{Y}{(K)^{\nu\gamma} (N + Z)^{(1-\nu\gamma)}},$$

and a 20% reduction in average size implies a reduction of about 2.6%.

Two comments are in order regarding these calculations. First, since distortions on capital use that reduce average size by 20% result in a 8.1% decline in output, a non-trivial portion of this decline can be viewed as accounted for by the aforementioned reallocation process. Second, it is important to bear in mind that in the one-sector model *without* an endogenous size distribution, a distortionary capital income tax would have no effect on TFP.

**Size Distribution** Table 5 shows that restrictions on capital use have large consequences on the size distribution of establishments. We note first that, albeit moderately, median establishment size *increases* as mean size declines across steady states. This occurs in spite of the emergence of small establishments at the bottom of the distribution. This phenomenon is accounted for by the expansion of existing undistorted establishments in response to the drop in wage rates across steady states. Overall, dispersion in the size of establishments, measured by the coefficient of variation, drops as Table 5 indicates. The drop in this statistic is substantial, ranging from 2.74 in the undistorted situation, to about 2.66 and 2.46 under reductions in mean size of about 10% and 20% respectively. Several forces influence this behavior. On the one hand, everything else constant, the emergence of new, small establishments tends to increase dispersion. On the other hand, the reduction in the size of distorted establishments reduces dispersion, while the increase in the size of undistorted ones has an uncertain effect. Overall, the effects that lead to a reduction in dispersion dominate, as the results show.

It is worth emphasizing the effects that restrictions have upon the mass of establishments at or above  $\underline{k}$ , the level where these restrictions kick-in. In the first place, note that the restrictions create a sizeable mass of establishments concentrated at  $\underline{k}$ ; the mass of establishments at this level jumps from theoretical level of zero in the undistorted case, to values of 4.2% to 7.9%. Both the contraction of some establishments, which now demand capital services at  $\underline{k}$ , and the expansion of undistorted ones account for this phenomenon. Second, the increase in the magnitude of the distortion does *not* change significantly the overall mass of distorted establishments (that is, those demanding  $k \geq \underline{k}$ ). This phenomenon can lead to an erroneous conclusion, such as that an increase in the severity of the restrictions does not matter. To see this, notice that the increase in the implicit tax rate leads to a significant decrease in the number of establishments strictly above  $\underline{k}$ . Quantitatively, this magnitude drops from the undistorted value of 15.4% to 11.0% when the reduction in mean size is of 10%, and to about 7.0% when the reduction is of 20%.

**Welfare** As we indicated earlier, consumption and output drop in a significant way across steady states. Our analysis then leads to potentially significant welfare gains (costs) from eliminating (introducing) policies that restrict capital use which lead to only moderate reductions in average size. Table 3 shows that in consumption equivalent terms, reducing size by 20% across steady states implies a welfare cost of about 1.5%. These welfare cost calculations *do* take into account transitional dynamics.<sup>25</sup> Welfare costs of this magnitude are sizeable by the standards of the applied general equilibrium literature.

## 4.1 Discussion

We now try to understand the findings in more detail. First, we ask: What are the consequences of taxing uniformly the use of capital across all units so that the *same* revenue is generated? This experiment naturally permits to disentangle the effects on aggregate capital forces akin to standard capital income taxation, from those stemming from treating production units of different size differently. We note first that average size is unaffected by this experiment since the common tax is now paid by all establishments. The fact that all establishments pay this tax also determines that the tax rates that solve this problem are much smaller than the marginal tax rates in the *size-dependent* case: 10.2% vs 34.4% and 5.9% vs 13.3%. More importantly, the output effects are substantially smaller. The marginal tax rate that generates the revenue corresponding to a 20% (10%) reduction in mean size now leads to a drop in output of about 4.4% (2.6%). The results then indicate that the effects of these policies on output and capital are non-trivially driven by the underlying “progressivity” of the implicit tax schedule; output losses under a proportional

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<sup>25</sup>From U.S. data, we calculate that this welfare cost amounts to about \$442 per person in 2005. Source: Economic Report of the President (2006), Personal Consumption Expenditures, Table B31.

tax amount only to about 54.3% and 67.5% of the output losses implied by the size-dependent restrictions on capital use.

Second, what is the quantitative importance of the decline in capital stock in generating the large effects on output and consumption? To answer this question, we look at the effects of restrictions on capital use using the implicit tax rates reported in Table 3, but when the aggregate capital stock is kept at its *benchmark* level.<sup>26</sup> Since the demand for capital services is reduced with distortions, when the supply of capital is fixed, the rental rate declines significantly. As a result, the effects of distortions are much less pronounced due to a cheaper rental rate for capital. We find that for a reduction in mean size of 20% (10%), aggregate output declines by about 0.87% (0.16%). That is, in the absence of capital accumulation and associated price adjustments the resulting effects on output are lower by several orders of magnitude. Not surprisingly, accounting for changes in the capital stock is crucial to assess the effects of restrictions on capital use; for aggregate such as output and capital, these restrictions act as a capital income tax.

Finally, how big are the distortions that we impose on the model economy in the quantitative exercises? Surprisingly, they are not large. First, note that in our experiments only about 15.4% of establishments are affected by size restrictions, and only about 11.0% and 7.0% of the establishments effectively pay the implicit tax on capital services in each case. Furthermore, the establishments that pay this tax, only pay a penalty on the amount of capital they rent above the threshold level,  $\underline{k}$ . Indeed, one can calculate in this economy the total value of tax payments as a percentage of total payments for capital services. This calculation gives an average tax rate on payments to capital equal to

$$\frac{\tau \int_{z^{+*}}^{\bar{z}} (k(z, W^*, R^*) - \underline{k}) f(z) dz}{\int_{\underline{z}^*}^{\bar{z}} k(z, W^*, R^*) f(z) dz}.$$

In our experiments this average tax rate turns out to be relatively small. It ranges from about 6.1% when the reduction in average size is 10%, to 11.3% when the reduction is 20%. To account for the significant effects on output in Table 3, note that while average tax rates are low, the implicit tax rate  $\tau$  affects the decisions at the margin of *large* establishments, which have substantial effects on input markets and lead to the changes in the capital accumulation we discussed above. Note that these establishments account for the bulk of output: in the undistorted economy, establishments above the median size are responsible for about 90% of total output, while establishments above the mean account for about 71%.

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<sup>26</sup>Formally, we compute equilibria when the representative household is endowed with the steady state capital stock in the absence of restrictions.

## 5 Restrictions on Labor Use

We now discuss the implications of size restrictions when they depend on the use of labor services beyond a threshold value. Table 6 summarizes the main results. In line with restrictions on capital use we set the threshold value,  $\underline{n}$ , to mean labor use in the economy without restrictions and again, we report results for implicit tax rates leading to reductions on average size of 10% and 20%.

We now discuss key aspects of these results, and relate them to previous case. First, when restrictions depend on the use of labor services, a given implicit tax rate can achieve a larger reduction in average size. To understand this, note that unlike the case of restrictions on capital use, restrictions on labor use have a first-order effect on the market for labor services. This follows since establishments substitute away from labor into capital, while total output produced declines. The result is a reduction in the equilibrium wage rate across steady states that is larger than when restrictions depend on capital use. Thus, by creating larger changes in the demand for labor services these policies provide larger incentives for the emergence of new, small establishments. This, together with the direct effects on large establishments, contributes to a larger reduction in mean size and size dispersion associated to a given implicit tax rate. The natural implication is that in order to achieve the average reductions in size that we target, lower implicit tax rates are needed, as Table 6 demonstrates. For instance, when the reduction in average size is 10%, the implicit tax rate equals 5.87% in the case of restrictions on labor use while it is about 13.35% for restrictions of capital use.

Second, note that output per worker falls by less than in the case when size restrictions depend on capital use. To understand this finding, it is key to bear in mind that for large establishments which pay the implicit tax, output per worker equals

$$\frac{W^* (1 + \tau)}{(1 - \nu)\gamma}.$$

Hence, for fixed wage rates, output per worker *goes up* for establishments that pay the implicit tax. There are then two opposing forces that operate as  $\tau$  increases across distorted and undistorted steady states. On the one hand, wage rates fall, reducing output per worker of establishments not paying the implicit tax. On the other hand, relatively large establishments also become high output per worker establishments due to the payment of the implicit tax. Put differently, large establishments appear to be more productive precisely because of the restrictions on their size.

Finally, we note that the effects on aggregate output in this case are much smaller. For a 20% (10%) reduction in mean size output falls 0.53% (0.11%) across steady states, while under restrictions to capital use the corresponding reduction is about 8.1% (3.8%). The simple yet important implication of this finding is that the quantitative effects on output and potentially

welfare of policies that restrict size depend crucially on how they are implemented. Our findings show that two alternative policies that imply the same reduction in size and have similar effects on productivity measures and the number of establishments, can have very different quantitative consequences on output and potential welfare. In the current case, the policies in question have little affect on the aggregate capital stock as distorted establishments become *more* capital intensive and thus, the net effects on aggregate capital are relatively small. In the case of restrictions on capital use, the opposite occurs. The policy implication that emerges is then clear; size-dependent policies that depend on capital use are costlier than alternative ones as they have a large effect on the economy’s capital stock in the long run.<sup>27</sup>

### 5.1 An Application: Restrictions on Labor Use in Italy

So far we have analyzed the consequences of size-dependent restrictions by purposefully focusing on abstract reductions in mean size, which are accomplished via implicit taxes. We study below an application of our model economy to the case of size-dependent restrictions of labor use in Italy, which offers a concrete and transparent example of these policies. As we document in the Introduction, a number of labor regulations kick-in at the level of 15 employees that are applied to firms and establishments in the whole economy. Not surprisingly, mean size in Italy is not only smaller than in the United States, but also smaller than in other E.U. countries; according to European Commission (1996), mean size of enterprises with salaried workers in Italy is just about 42% of the average of the EU-15 group.

We study the case in which if an establishment wants to expand input use beyond a limit, it faces implicit taxes on *all* input units (marginal and inframarginal). This is a more accurate representation of the policies in place than the benchmark cases we analyzed previously. If labor use is  $n > \underline{n}$ , the cost associated to labor services equals  $W(1 + \tau)n$ , while this cost equals  $Wn$  if  $n \leq \underline{n}$ . Therefore, labor costs are discontinuous at  $\underline{n}$ . There are then thresholds  $z^-$  and  $z^+$  that define three types of establishments as previously, with those with  $z \in [z^-, z^+]$  choosing  $\underline{n}$ . The difference with the previous analysis is that the discontinuity at  $\underline{n}$  implies that  $z^+$  is determined by

$$\pi(W, R, z; \underline{n}, \tau)_{n=\underline{n}} = \pi(W(1 + \tau), R, z; \underline{n}, \tau)$$

where  $\pi(w, R, z; \underline{n}, \tau)_{n=\underline{n}}$  are the managerial rents associated to  $n = \underline{n}$ . This indifference condition results in the existence of a set of inputs that will not be demanded,  $[\underline{n}, n^+]$ , where  $n^+$  is the demand for labor services associated to  $z^+$ . The interesting observational implication of this type of policy is a “gap” in the size distribution for establishments by employment (or by capital use).<sup>28</sup>

<sup>27</sup>This finding parallels the well-known result in macroeconomics and public finance that taxes on capital income are more distorting than taxes on labor income.

<sup>28</sup>Rauch (1991) obtains a similar result in a span-of-control framework with labor as an only input. In his model,

Table 7 presents the main results when  $\underline{n}$  equals 15 in the undistorted case. Since mean size in Italy is much lower than in our undistorted case (about 17.1 employees), we present results for an array of implicit tax rates (20%, 35%, 50% and 65%).<sup>29</sup> As the Table 7 demonstrates, the model implies large distortionary effects emerging from restricting labor use in this way. An implicit tax of 20% leads to a reduction of aggregate of output of about 1.5%, to a reduction in average size of about 28.7% (from 17.09 to 12.19 employees), and to a sizeable increase in the number of establishments (37.1%). These effects are of course magnified as the implicit tax rate increases, even though taxes we consider do not generate observed establishment size in Italy. It is worth noticing also that productivity measured as output per worker drops non-trivially again, despite the fact that distorted establishments have higher measured output per worker due to the implicit tax.

A way to put these results in perspective is to ask: what it would take in the familiar one-sector growth model to reduce aggregate output in the magnitudes shown in Table 7? Assuming that the capital share, depreciation and preference parameters are the same as here, tax rates on (net) capital income of about 4-5% and of about 12-13% are needed to generate the reductions in aggregate output emerging from the implicit tax rates of 20% and 35% in Table 7.

## 6 Cross-Country Differences in Size

Size-dependent restrictions on capital and labor use raise natural questions: how large must be the distortions to be able to generate the observed differences in size between developed economies? More generally, how do output and mean size vary with the level of these distortions? We answer these questions in Figure 4 a-b. In Figure 4a, we set  $\underline{k}$  to the mean capital demand in the benchmark economy and vary taxes on capital use above  $\underline{k}$  from 0 (benchmark economy) to 60%, and plot the effects on mean size and output. A tax rate of 43-44% generates the mean size observed in Europe (about 13.2 employees) and implies that output is reduced by about 10%. The welfare cost associated with such a tax rate is also substantial; taking into account transitions between steady states, the associated welfare cost amounts to about 2.3%. Note that the figure also shows an interesting, albeit expected, non-linearity. Output and mean size are relatively elastic to the tax rate for *low* values of it, while the opposite is true at high tax rates.

In Figure 4b, we set  $\underline{n}$  to average size in the benchmark economy and repeat the same exercise

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production units are either small and belong to the “informal” sector, or sufficiently large and part of the “formal” sector.

<sup>29</sup>Not surprisingly, we have verified that for a given reduction in size, this specification has stronger and more distorting effects than when the policies only affect marginal input use; for a given value of  $\hat{n}$ , a given implicit tax leads to larger increases in the number of establishments, as well as to larger reductions in output and productivity measures. Consequently, relative to the case when the policy affects only marginal units, *lower* implicit tax rates are needed to generate given the targeted reductions in average size.

with varying taxes on labor use. In contrast to taxes on capital, a 16%-17% tax on labor is all that it takes to reduce average establishment size from 17.09 workers to 13.2 workers. With taxes on labor use, output declines much less, only about 1%. As a result the welfare cost is also smaller, and amounts to only about 0.6% of consumption.

## 7 Size-Dependent Subsidies

We finally explore the consequences of subsidies to “small” units, a policy of widespread acceptance across countries. We concentrate on subsidies associated to the use of capital services. If an establishment uses  $k \leq \underline{k}$ , it faces a cost per unit  $R(1 - s)$ , whereas if it chooses  $k > \underline{k}$  it faces the rental rate  $R$ . Thus, this feature creates a discontinuity in the cost of capital use as in the previous case. That is, by expanding capital use beyond  $\underline{k}$ , the establishment gives up the subsidy. The observable implication is a “gap” in the size distribution; that is, values of employment and/or capital use not chosen by any establishment.

To conduct quantitative experiments, we assume that the subsidies are financed by a consumption tax. This allows us to isolate the allocative effects of the subsidies, as consumption taxes in the current environment do *not* affect capital accumulation or occupational choice. Results are presented in Table 8 for subsidies that kick-in at 1/4 of mean capital use. Again, and for comparison purposes, subsidy rates are found so as to generate reductions in average size of 10% and 20% respectively. The findings indicate that these policies have effects that differ in some ways from those emerging from restrictions on the size of large establishments. Quantitatively, the consequences of size-dependent subsidies can be viewed as large, despite the relatively small size of the rates and thresholds considered.

To understand how this policy operates, note that unlike all the cases studied previously, it increases directly the returns to operate small establishments. This in turn implies increases in the demand for capital and labor services by subsidized (small) establishments, as well as a reduction in the supply of labor. Across steady states, the subsidy policy leads to a higher wage rate and determines a lower output by large establishments not collecting any subsidy. The net result is a lower aggregate output and a roughly constant capital stock across steady states. Since keeping a constant capital stock in the presence of lower output is costly, consumption falls. Quantitatively, it is noteworthy that the effects created by a policy of relatively limited scope can lead to non-trivial welfare costs (of about 0.63% and 1.8%), as Table 8 demonstrates.

Note that unlike previous cases, output per worker *increases*. This is not surprising as the wage rate increase as well. But the behavior of this statistic is misleading in this case, as all other productivity measures drop. In quantitative terms, the drop in average managerial quality and output per establishment is substantial, in line with results obtained previously.

Finally, it is worth noting that dispersion in establishment size, as measured by the coefficient of variation, systematically *increases* as we consider higher reductions in average size; this stands in contrast with the results in previous cases. To understand this, recall that subsidies lead to more small establishments in equilibrium, a “gap” in the size distribution, while relatively large establishments contract across steady states, albeit slightly. The net effect is that the distribution by size becomes more disperse.

## 8 Conclusion

We analyze government policies that target production establishments of different sizes. To this end, we develop model economies in which agents differ in terms of their managerial ability, and sort themselves into managers and workers. We calibrate these economies to reproduce aggregate and cross-sectional observations from the U.S. economy, and then introduce different government policies that depend on the size of production units via input use. In each of our experiments, we impose taxes or subsidies on our benchmark economy that reduce the average establishment size by the same amount, and select this reduction in line with available evidence from O.E.C.D. countries.

Although our emphasis has been on developed countries, size-dependent policies are widespread worldwide. It is then not difficult to imagine that these policies can be much costlier for developing countries. In the current paper we assume that the distribution of managerial talent is the same across countries. If educational attainment is an indicator of managerial abilities, this is not an unrealistic assumption for the set of countries we consider. For developing countries, on the other hand, lower educational attainment will limit the number of high ability managers. As a result, restrictions on the operations of these high ability managers can be particularly costly.

We conclude the paper by mentioning two important issues we abstracted from. The first one relates to the effects of sector-specific policies. A natural conjecture is that when managers can move across sectors, or more generally, can switch sectors *and* accumulate sector specific skills, the policies in question can be very costly in terms of productivity and welfare.

The second one relates to the interplay between restrictions on size and technical progress. If the emergence of new technologies allows the operation of larger establishments, as it seems to be the case in the retail sector, the policies we study are again likely to be more costly than in our current analysis. More generally, we know that technological change in the production of new equipment has been remarkable in the postwar United States. This has resulted in cheaper, more efficient equipment and triggered more investment in these capital goods. Greenwood, Hercowitz, and Krusell (1997) document that the relative price of equipment declined at an annual average rate of 3.2% between 1954 and 1990, and that such investment-specific technological progress accounts for about 60% of postwar growth in output per hour worked. Indeed, investment-specific technological

change has accelerated recently. Cummins and Violante (2002) estimate an aggregate index of investment specific technological change for the U.S. economy, and show that this index grows at an annual rate of 4% for the 1947-2000 period, *and* that its growth accelerates in the last two decades (about 6% in the 1990's). The consequence of this acceleration would be an increase in optimal size of establishments and thus, higher welfare costs associated to restrictions on size that depend on capital use.<sup>30</sup>

The full investigation of these issues requires more elaborated model economies than the simple one studied here. We leave these extensions for future work.

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<sup>30</sup>Greenwood and Yorukoglu (1997) study a model of adoption of new technologies when technical change is investment specific. In their model, as technical change accelerates optimal size increases as well.

**Table 1: Parameter Values**

Parameter	Value
Population Growth Rate ( $g_L$ )	0.0110
Productivity Growth Rate ( $g$ )	0.0255
Depreciation Rate ( $\delta$ )	0.040
Importance of Capital ( $\nu$ )	0.406
Returns to Scale ( $\gamma$ )	0.802
Mean Log-managerial Ability ( $\mu$ )	-0.367
Dispersion in Log-managerial Ability ( $\sigma$ )	2.302
Highest Managerial Ability Level ( $z_{max}$ )	3360.2
Mass Highest Managerial Ability Level ( $f_{max}$ )	0.00144
Discount Factor ( $\beta$ )	0.9357

**Table 2: Targets**

Statistic	Data	Model
Mean Size	17.09	17.11
Aggregate Capital Share	0.317	0.317
Capital Output Ratio	2.325	2.331
% of Establishments at		
0 - 9 employees	70.7	73.3
10 - 19 employees	14.0	13.4
20 - 49 employees	9.4	7.5
50 - 99 employees	3.2	3.2
100 + employees	2.6	2.6
Share of Employment at		
100 + employees	44.95	44.90

Note: This Table reports the performance of the model when parameters are selected to match the reported aggregate and cross-sectional features of the data.

**Table 3: Aggregate and Productivity Effects**

Statistic	Benchmark	10% Reduction in Average Size	20% Reduction in Average Size
Aggregate Output	100.00	96.14	91.87
Capital	100.00	88.79	78.65
Consumption	100.00	97.75	94.75
Output per Worker	100.00	96.73	93.09
Output per Establishment	100.00	87.20	74.39
Output per Efficiency Units	100.00	94.98	89.51
Average Managerial Quality	100.00	91.95	83.38
Number of Establishments	100.00	110.31	123.51
Implicit Tax (%)	-	13.35	34.36
Welfare Cost (%)	-	0.30	1.52

Note: This Table reports aggregate and productivity effects of restricting the size of large establishments via implicit taxes on the use of capital. The implicit tax  $\tau$  is found in order to generate a 10% and 20% reduction in the average size of establishments. The threshold  $\underline{k}$  equals mean capital use in the undistorted case.

**Table 4: Output Accounted for by Managers of Different Ability (%)**

Economy	Lowest 20%	Next 20%	Next 20%	Next 20%	Upper 20%
Benchmark	3.22	4.34	6.24	10.79	75.41
10% Reduction Average Size	3.59	4.83	7.03	12.16	72.39
20% Reduction Average Size	4.02	5.54	7.98	13.96	68.50

Note: This Table reports the fraction of output accounted for by managers at different quintiles of the distribution of managerial ability, with and without restrictions on capital use on large establishments. The implicit tax  $\tau$  is found in order to generate a 10% and 20% reduction in the average size of establishments. The threshold  $\underline{k}$  equals mean capital use in the undistorted case.

**Table 5: Size Distribution Effects**

Statistic	Benchmark	10% Reduction in Average Size	20% Reduction in Average Size
Mean Size	17.09	15.41	13.66
Median Size	5.25	5.32	5.38
Coefficient of Variation	2.74	2.66	2.46
% Distorted ( $k \geq \underline{k}$ )	15.43	15.20	14.92
% Distorted ( $k > \underline{k}$ )	15.43	10.98	7.03

Note: This Table reports the consequences on the distribution of establishment size, measured by the number of employees, associated to restricting the size of large establishments via implicit taxes on the use of capital. The implicit tax  $\tau$  is found in order to generate a 10% and 20% reduction in the average size of establishments. The threshold  $\underline{k}$  equals mean capital use in the undistorted case.

**Table 6: Size-Dependent Restrictions on Labor Use**

Statistic	Benchmark	10% Reduction in Average Size	20% Reduction in Average Size
Aggr. Output	100.00	99.89	99.47
Capital	100.00	99.89	99.47
Consumption	100.00	99.89	99.47
Output per Worker	100.00	97.52	94.74
Output per Establishment	100.00	90.59	94.74
Output per Efficiency Units	100.00	98.67	96.89
Average Managerial Quality	100.00	91.95	83.38
Number of Establishments	100.00	110.31	123.51
Median Size	5.25	5.33	5.38
Coefficient of Variation	2.74	2.67	2.53
Implicit Tax (%)	-	5.87	13.76
Welfare (%)	-	0.08	0.43

Note: This Table reports the consequences of restricting the size of large establishments via implicit taxes on the use of labor services. The implicit tax  $\tau$  is found in order to generate a 10% and 20% reduction in the average size of establishments. The threshold  $\underline{n}$  equals mean labor use in the undistorted case.

**Table 7: The “Italy” Case ( $\underline{n} = 15$ )**

Statistic	Benchmark	20% Tax	35% Tax	50% Tax	65% Tax
Aggr. Output	100.00	98.47	95.80	94.14	92.48
Mean Size	17.09	12.19	10.28	9.50	8.96
Output per Worker	100.00	92.84	89.20	87.14	85.78
Number of Establishments	100.00	137.07	160.40	172.15	181.56
Welfare (%)	-	1.28	3.63	5.15	6.18

Note: This Table reports the consequences of restricting the size of large establishments via implicit taxes on the use of labor services, when  $\underline{n} = 15$  as in the case of Italian size-dependent regulations. Differently from the cases analyzed before, if an establishment chooses labor services beyond  $\underline{n}$ , marginal and inframarginal units of labor are subject to the implicit tax.

**Table 8: Size-Dependent Subsidies**

Statistic	Benchmark	10% Reduction in Average Size	20% Reduction in Average Size
Aggr. Output	100.00	99.88	99.90
Capital	100.00	99.93	100.61
Consumption	100.00	99.35	98.32
Output per Worker	100.00	100.51	101.28
Output per Establishment	100.00	90.58	74.39
Average Managerial Quality	100.00	91.95	83.38
Number of Establishments	100.00	110.31	123.51
Median Size	5.25	4.40	4.14
Coefficient of Variation	2.74	2.86	2.98
% Distorted ( $k \leq \underline{k}$ )	39.27	68.38	77.45
% Distorted ( $k < \underline{k}$ )	39.27	33.62	26.79
Subsidy (%)	-	8.05	16.6
Welfare (%)	-	0.63	1.80

Note: This Table reports the consequences of subsidizing capital use in small establishments. The subsidy rate is found in order to generate a 10% and 20% reduction in the average size of establishments, and it is financed via a consumption tax. The threshold  $\underline{k}$  equals 1/4 mean capital use in the undistorted case.

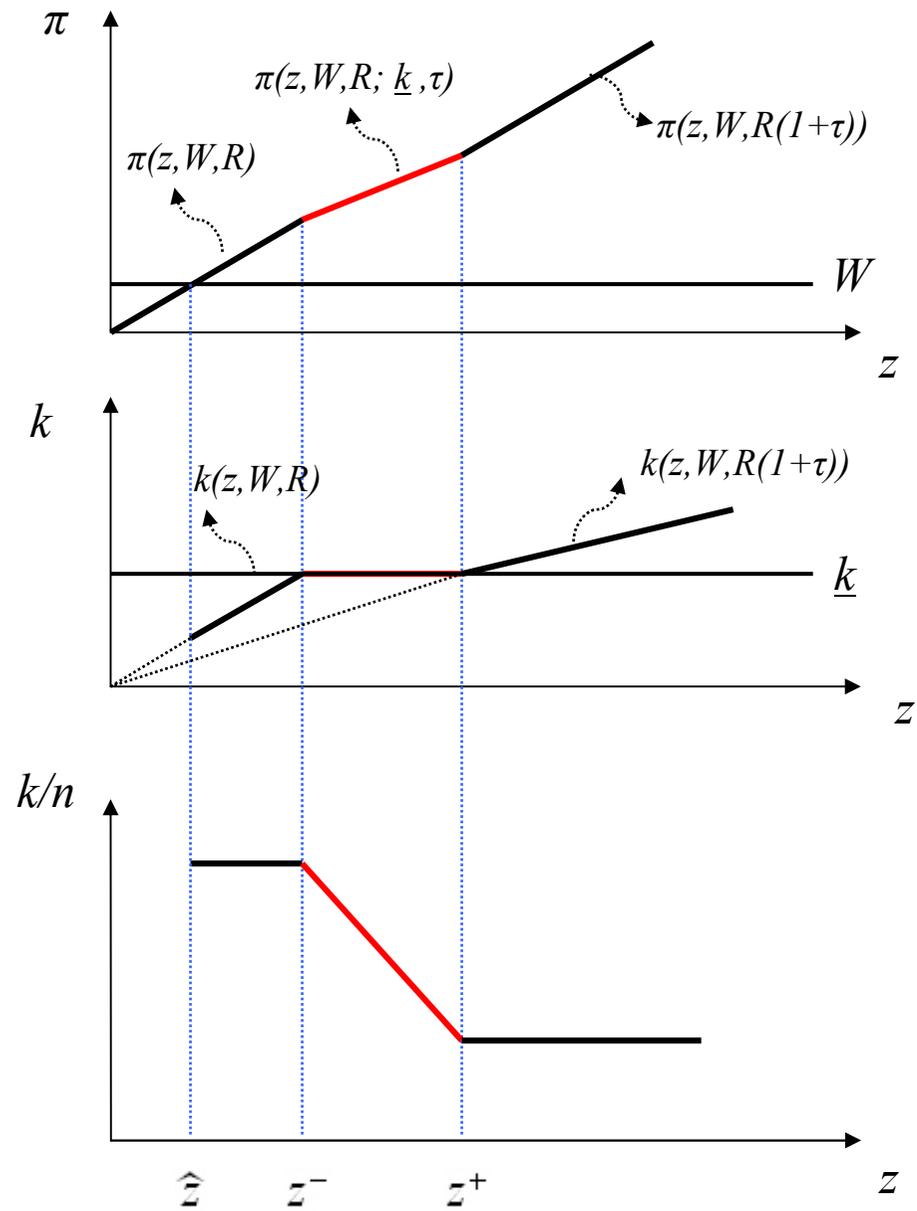
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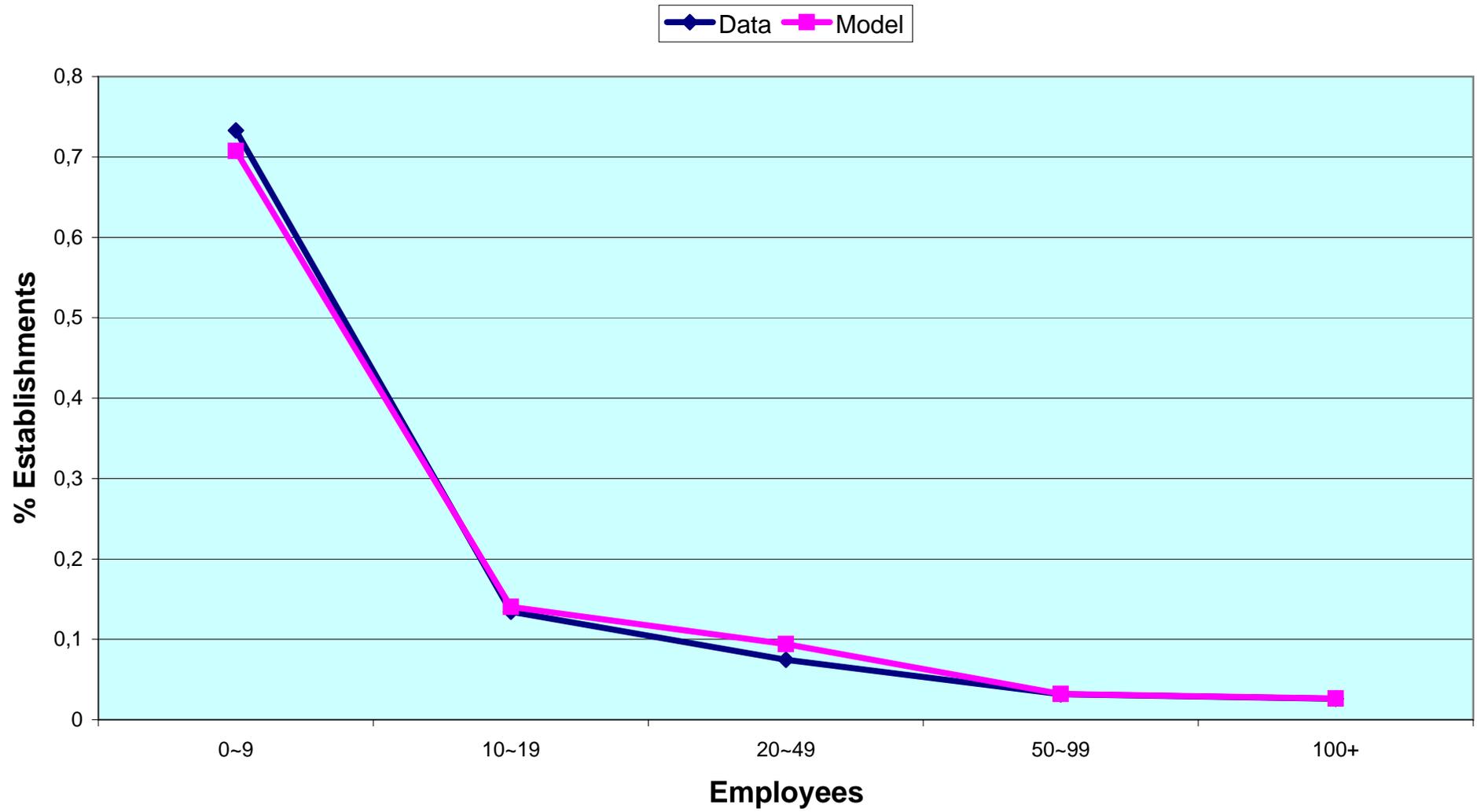
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**Figure 1 --- The Effects of Restrictions on Size**



**Figure 2 --- Size Distribution of Establishments**



### Figure 3 --- Employment Shares

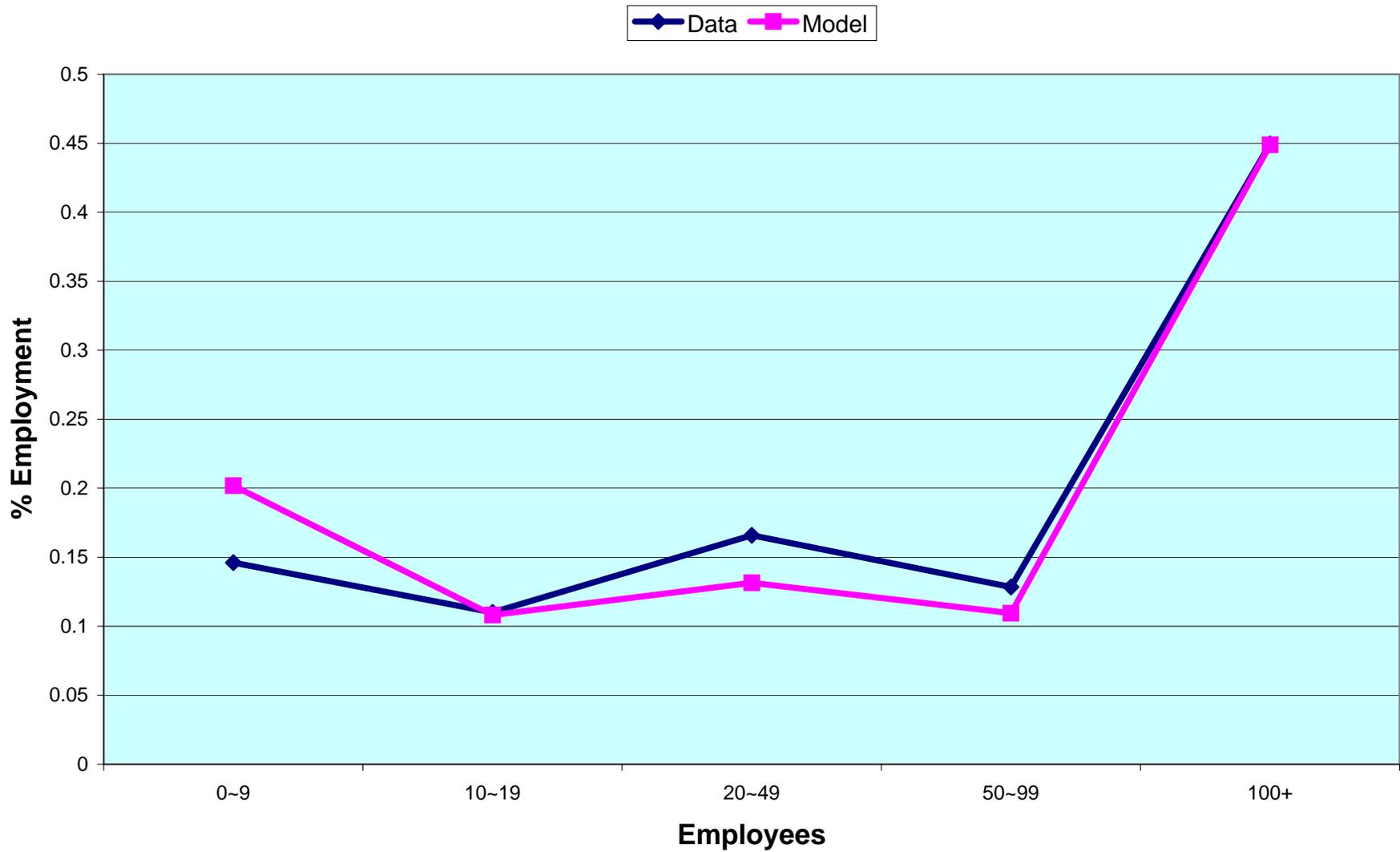


Figure 4a: Restrictions on Capital Use

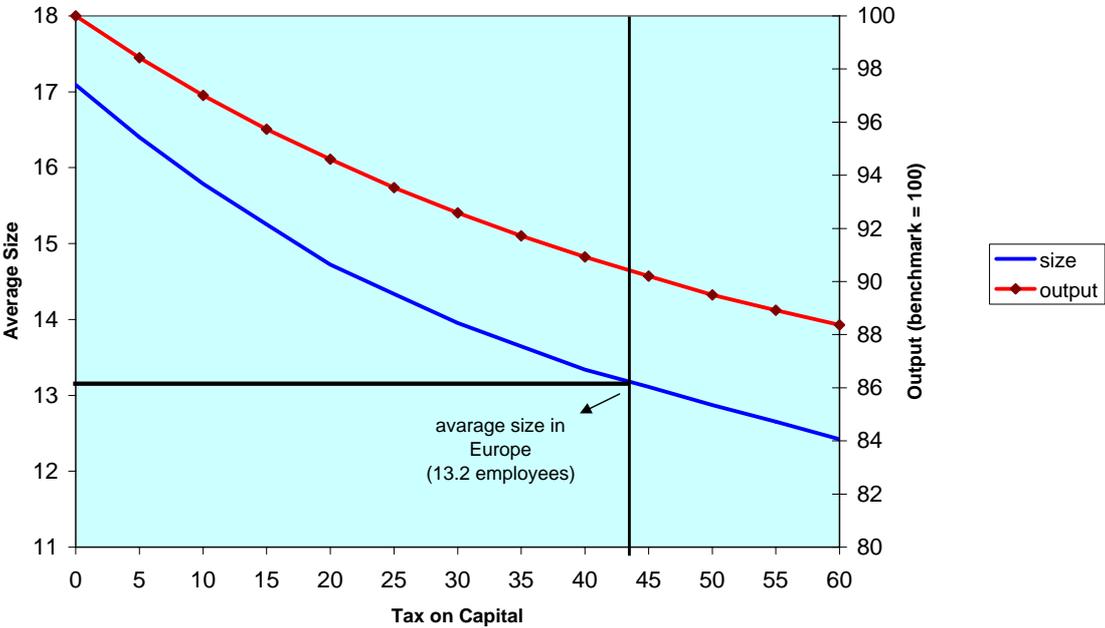


Figure 4b: Restrictions on Labor Use

