Distortions, Endogenous Managerial Skills and Productivity Differences

(PRELIMINARY – DO NOT CIRCULATE)

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Abstract

We develop a span-of-control model where managerial skills are endogenous and the outcome of investments over the life cycle of managers. We calibrate this model to U.S plant-size data in order to quantify the effects of distortions that are plant specific and correlated with the size of production units (size-dependent policies). Our preliminary results indicate that these distortions can lead to large effects on plant productivity, as well as sharp reductions in the fraction of employment in large plants. Distortions also affect age-income profiles of managers as they reduce incentives to accumulate skills.

Key Words: Distortions, Size, Skill Investments, Productivity Differences.
JEL Classification: O40, E23.

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1 Introduction

Why are some countries so much richer than others? From development accounting exercises, the answer depends heavily on Total Factor Productivity (TFP) differences across countries (Klenow and Rodriguez-Clare, 1997; Hall and Jones, 1999; Caselli, 2005). Consequently, much work in the last decade or so has been devoted to understanding the determinants of these measured TFP differences. As part of this effort, a growing body of recent literature (Banerjee and Duflo 2005, Bartelsman, Haltiwanger and Scarpetta 2008, Buera, Kabowski and Shin 2010, Guner, Ventura and Xu 2008, Caselli and Gennaioli 2005, Hsieh and Klenow 2009, Restuccia and Rogerson 2008) studies the consequences of distortions that alter the efficient allocation of resources across production units, and show the extent to which these distortions can have large effects on aggregate productivity.

The exact nature of such distortions is the object of ongoing work. While some (Caselli and Gennaioli, 2005 and Buera and Shin, 2010) focus on imperfections in contract design or financial frictions as sources of misallocation, others (Hsieh and Klenow, 2009) recover the underlying distortions from observed allocations. They, as well as Bertelsman, Haltiwanger and Scarpetta (2008), follow Rogerson and Retuccia (2008) and model distortions as firm or plant-specific. Guner, Ventura and Xu (2008) focused on a particular form of these distortions: policies that only affect production units above or below a certain size (so-called size-dependent policies), and study the implications of such distortions on aggregate outcomes.

There is little doubt that the distortions that alter the efficient allocation of resources across productive units are likely to lead to misallocation of managerial talent. Managerial talent, however, can arguably be endogenous, and as such, it is a form of human capital that agents can choose to invest on. In an environment with no distortions, intrinsically more able individuals are likely to spend time and resources to improve their managerial human capital in order to operate larger units. In a distorted environment, in contrast, there could be little incentives for managers to undertake costly investments. If the distortions are firm specific and idiosyncratic, the returns to such investment can be risky. If distortions are size-dependent, investment on managerial skills can lead managers to low levels of investments relative to the distortion-free case. In sum, in order to understand how distortions and misallocation affect the aggregate economy, it is central to understand the interplay between agents' incentives to accumulate managerial skills, distortions and the resulting effects on productivity. This is the main objective of the current paper.

The connection between managerial investments, distortions and productivity has several implications that might be fruitful in the understanding of cross-country income differences. First, once we allow for investment in managerial quality, the underlying distortions that are necessary to generate observed TFP differences are likely to be small. Second, a model in which agents decide to invest in their managerial abilities will have implications for the size of production plants and for how managerial age-earnings profiles look like in distorted and undistorted economies, providing with a host of observations that can be used as a disciplining device in a calibration exercise. Finally, modeling managerial human capital investment links the literature on misallocation very naturally with the recent work on technology capital and its role in growth and development (McGrattan and Prescott, 2010 a-b).

In this paper we develop a life-cycle span-of-control model. Every period, a large number of finitely lived agents are born with some initially endowed levels of managerial skill. These agents are heterogeneous in terms of their initial endowment of managerial skills. The objective of each agent is to maximize lifetime utility from consumption. In the first period of their lives, agents make an irreversible decision to be either workers or managers. If an agent chooses to be a worker, her managerial skills are of no use and she earns the market wage in every period until retirement. If an agent chooses to be a manager, she can use her managerial skills to operate a plant by employing labor and capital to produce output and collect the net proceeds (after paying labor and capital) as managerial income. Moreover, managers invest resources in skill formation, and as a result managerial skills grow over the life cycle. This implies that a manager can grow the size of her production operation and managerial income by investing a part of her current income each period in skill formation. As managers age and accumulate managerial skills, the distribution of skills (and productivity of production units) evolves endogenously. At the same time, the model delivers predictions on the shape of age-earning profiles as well as the share of GDP that is invested in improving skills (a form of knowledge capital).

In this model, the evolution of managerial skills and hence plant size will depend not only on initially endowed skills, but also on skill investment decisions over the life cycle. These investment decisions will reflect the costs (resources that have to be spent rather than being consumed) and the benefits (the future awards associated to being endowed with better managerial skills). A central assumption in our model is that there are complementarities between skills and investments: managers born with high skills find it optimal to invest more in skills over their lifetime than managers born with low skills. This model property amplifies initial heterogeneity in skills, and leads to increasing dispersion with age in the size of production plants that managers can operate.

Assuming that the U.S. economy is relatively free of distortions, we calibrate the model to match some aggregate and cross sectional features of the U.S. plant data. Then, we plan to compare the performance of the model relative to a number of moments of the data on plant size. Our preliminary results indicate that model can capture the critical features of U.S. plant size distribution, including the upper and lower tails, something difficult to generate with a standard span-of-control model. This is critical; on one hand, the upper tail of the size distribution accounts for the bulk of the employment and output in the economy. On the other hand, the lower tail of the size distribution accounts for the bulk of the plants in the economy.

Our framework provides a natural framework to analyze the effects of distortions (plant or firm-specific or size-dependent) on the plant size distribution, aggregate productivity and output. We plan to answer several questions within this framework. How large should distortions be in order to account for observed differences in plant size across countries? What are the implications for output and measured productivity? What are the implications of investments in managerial quality for the life-cycle earnings of managers? What is the contribution of such investments in assessing the effects of distortions on resource allocation for aggregate output and productivity?

Our preliminary results show that a parsimonious specification of our environment generates in equilibrium the observed distribution of plant sizes in the U.S., and the fraction of employment in both large and small plants. This is *not* a feature of the standard span-of-control model (see Guner et al, 2008). We subsequently find that size-dependent distortions lead to substantial effects on output and notions of productivity. Introducing distortions that reduce mean size by 15% relative to the benchmark economy lead to a reduction in aggregate output by about 7% and output per plant by 20%. Such a reduction leads to drastic drop in the share of employment in large plants (100 workers or more). The employment share of large plants drops from about 42.2% in the undistorted benchmark to about 26.5%

in the distorted case.

2 Model

Consider the following a life-cycle version of Lucas (1978) span-of-control model. Each period, an overlapping generation of heterogeneous agents are born into economy that lives for J periods. The objective of each agent is to maximize the present value of lifetime utility from consumption

$$\sum_{j=1}^{J} \beta^{j-1} \log(c_j), \tag{1}$$

where $\beta \in (0,1)$ and c_j is the consumption of an age-j agent.

Each agent is born with an initial endowment of managerial ability. We denote managerial ability by z, and assume that initial (age-1) abilities are drawn from an exogenous distribution with cdf $F(z)$ and density $f(z)$. Moreover every period until retirement age J_R, each agent is also endowed with one unit of time which she supplies in-elastically as a manager or as a worker. In the very first period of their lives, agents must choose either to be a worker or a manager. This decision is irreversible. A worker in-elastically supplies her endowed labor time to earn the market wage every period until retirement. The decision problem of a worker is to choose how much to consume and save every period.

A manager's problem, however, is more complicated. A manager has to decide how much labor and capital to employ every period, given factor prices. Every period, she also has to decide how much of his net income to allocate towards current consumption, savings and investments in skill accumulation.

We assume that each cohort is $1 + n$ bigger than the previous one. These demographic patterns are stationary so that age j agents are a fraction μ_j of the population at any point in time. The weights are normalized to add up to one, and obey the recursion, $\mu_{j+1} = \mu_j/(1+n)$.

There is a government that taxes labor income of workers and incomes (profits) of managers at a proportional rate τ. We assume that tax revenue is used to finance government consumption.

Technology There is a Lucas (1978) span-of-control technology. Each plant comprises of a manager with ability z along with inputs labor and capital,

$$y = Az^{1-\gamma}\left(k^{\alpha}n^{1-\alpha}\right)^{\gamma}$$

where γ is the span-of-control parameter and $\alpha\gamma$ is the share of capital. The term A is productivity term that is common to all establishments. Every manager can enhance her future skills by investing some of the plant's current proceeds in skill accumulation. The law of motion for managerial skills is given by

$$z^{'} = z + g\left(z, x\right) = z + z^{\theta_1}x^{\theta_2},$$

where z' is next period's ability and x denotes investment in skill accumulation. The skill accumulation technology described above satisfies two important properties. First, the technology shows complementarities between current ability and investments in next period's ability i.e. $g_{zx} > 0$. Second, $g\left(z, x\right) = 0$ if $x = 0$.

2.1 Decisions

Consider a stationary environment with constant factor prices r and w. Let a denote assets. The problem of a manager of age-j is given by

$$V_j(z, a) = \max_{x,a'}\{\log(c) + \beta V_{j+1}(z', a')\} \tag{2}$$

subject to

$$c + x + a' = (1-\tau)\pi(z; r, w) + (1+r)a \qquad \forall 1 \leq j < J_R - 1 \tag{3}$$

$$c + a' = (1+r)a \qquad \forall j \geq J_R \tag{4}$$

and

$$z^{'} = z + g\left(z, x\right) \qquad \forall j < J_R - 1, \tag{5}$$

with

$$V_{J+1}(z, a) = \begin{cases} 0 \text{ if } a \geq 0 \\ -\infty, \text{ otherwise} \end{cases}.$$

Given her state, (z, a) a j-years old manager decides how much to save, a', and how much to invest to enhance her skills. Up to the retirement age J_R, a manager's income consists of her managerial profits and her assets, while after age J_R her only source of income is from her assets. We assume that agents (managers as well as workers) can lend or borrow at the interest rate r as long as they do not die in debt.

Since there are no borrowing constraints, factor demands and per period profits of a manager only depend on her ability z. Managerial income for a manager with ability z is given by

$$\pi(z;r,w) = \max_{n,k}(Az^{1-\gamma}\left(k^{\alpha}n^{1-\alpha}\right)^{\gamma} - wn - (r+\delta)k),$$

where w and r are the rental prices for labor and capital services respectively and δ is the depreciation rate. Factor demands are given by

$$k(z;r,w) = (A(1-\alpha)\gamma)^{\frac{1}{1-\gamma}}\left(\frac{\alpha}{1-\alpha}\right)^{\frac{1-\gamma(1-\alpha)}{1-\gamma}}\left(\frac{1}{r+\delta}\right)^{\frac{1-\gamma(1-\alpha)}{1-\gamma}}\left(\frac{1}{w}\right)^{\frac{\gamma(1-\alpha)}{1-\gamma}} z, \tag{6}$$

and

$$n(z;r,w) = (A(1-\alpha)\gamma)^{\frac{1}{1-\gamma}}\left(\frac{\alpha}{1-\alpha}\right)^{\frac{\alpha\gamma}{1-\gamma}}\left(\frac{1}{r+\delta}\right)^{\frac{\alpha\gamma}{1-\gamma}}\left(\frac{1}{w}\right)^{\frac{1-\alpha\gamma}{1-\gamma}} z, \tag{7}$$

Substituting these into the profit function, one can show that profits are a linear function of z

$$\pi(z;r,w) = A(1-\gamma)\left(A(1-\alpha)\gamma\right)^{\frac{\gamma}{1-\gamma}}\left(\frac{\alpha}{1-\alpha}\right)^{\frac{\alpha\gamma}{1-\gamma}}\left(\frac{1}{r+\delta}\right)^{\frac{\alpha\gamma}{1-\gamma}}\left(\frac{1}{w}\right)^{\frac{\gamma(1-\alpha)}{1-\gamma}} z. \tag{8}$$

The dynamic programming problem of a manager is characterized by two conditions. The solution for a' is characterized by the standard Euler equation for asset accumulation

$$\frac{1}{C_j} = \beta(1+r)\frac{1}{C_{j+1}}.$$

The optimality condition for x given by

$$(1+r) = \beta(1-\tau)\pi_z\left(r,w\right)g_x(z_j,x_j).$$

The left-hand side of the above equation is next period's gain in utility from one unit of current savings. The manager can also use this one unit as an investment on her skills. The term $g_x(z_j,x_j)$ on the right-hand side are the additional skills generated next period from an additional unit of investment in the current period. The term $(1-\tau)\pi_z\left(r,w\right)$ is the additional profit generated from an additional unit of managerial skills, which is decreasing in τ. Hence the right-hand side is the gain in utility by the j-period old manager from investing one unit of the current consumption good in skill accumulation. To get a unique interior optimum g_{xx} must be negative. This implies that the marginal benefit of investing in skill accumulation is monotonically decreasing in the level of skill investment while the marginal cost is constant.

The manager's problem generates decision rules for savings $a' = a_j^m(z, a, r, w)$, investment in managerial skills, $x = x_j\ (z, a, r, w)$, as well as the associated factor demands given by $k = k(z, r, w)$ and $n = n(z, r, w)$.

The problem of an age-j worker is simpler and is given by

$$W_j(a) = \max_{a'}\{\log(c) + \beta W_{j+1}(a')\}$$

subject to

$$c + a' = (1 - \tau)w + (1 + r)a \qquad \forall 1 \le j < J_R - 1 \tag{9}$$

and

$$c + a' = (1 + r)a \qquad \forall j \ge J_R, \tag{10}$$

with

$$W_{J+1}(a) = \begin{cases} 0 \text{ if } a \ge 0 \\ -\infty,\ \text{otherwise} \end{cases}.$$

Let the associated savings decision of a worker be $a' = a_j^w(a, r, w)$. Like managers, workers can borrow and lend without any constraint as long as they do not die with negative assets.

The objective of each agent born every period is to maximize lifetime utility by choosing to be a worker or a manager. Let z^* be the ability level at which a 1-year old agent is indifferent between being a manager and a worker. This threshold level of z is given by (as agents are born with no assets)

$$V_1(z^*, 0) = W_1(0).$$

2.2 Equilibrium

As we mentioned above, member of each new generation is endowed with managerial ability levels distributed with distribution with cdf $F(z)$ and density $f(z)$ on $[\underline{z}, z^{\max}]$ After the age-1, distribution of managerial abilities is endogenous since it depends on investment decisions of managers over their life-cycle.

Let managerial abilities take values in set $Z = [\underline{z}, \overline{z}]$ with the endogenous upper bound $\overline{z}$. Similarly, let $A = [0, \overline{a}]$ denote the possible asset levels. Let $\psi_j(a, z)$ be the mass of age-j agents with assets a and skill level z. Given $\psi_j(a, z)$, let

$$\widetilde{f}_j(z) = \int \psi_j(a, z) da,$$

be skill distribution for age-j agents. Note that $\widetilde{f}_1(z) = f_1(z)$ by construction.

Since the decision to become a manager is irreversible, each period those agents whose ability is above z^* work as manager and others work as workers. Then, in a stationary equilibrium with given prices, (r, w), labor, capital and goods market must clear. The labor market equilibrium condition can be written as

$$\sum_{j=1}^{J_R-1} \mu_j \int_{z^*}^{\overline{z}} n(z, r, w) \widetilde{f}_j(z) dz = F(z^*) \sum_{i=1}^{J_R-1} \mu_j \tag{11}$$

where μ_j is the total mass of cohorts of age i. The left-hand side is the labor demand from $J_R - 1$ different cohorts of managers. A manager with ability level z demands $n(z, r, w)$ units of labor and there are $\widetilde{f}_j(z)$ of these agents. The right-hand side is the fraction of each cohort employed as workers times the total mass of all non-retired cohorts in the economy.

In the capital market demand for savings is not only generated by managers renting physical capital. There is an additional demand for savings from managers borrowing funds from the capital market to invest in skill accumulation. The capital market equilibrium condition can be written as

$$\begin{aligned}\sum_{j=1}^{J_R-1} \mu_j \int_{z^*}^{\overline{z}} k(z, r, w) \widetilde{f}_j(z) dz \quad = \quad & \sum_{j=1}^{J-1} \mu_j \int_{z}^{z^*} a_j^w(a) \psi_j(z, a) dz da \\ & + \sum_{j=1}^{J-1} \mu_j \int_{z^*}^{\overline{z}} \int_A a_j^m(z, a, r, w) \psi_j(z, a) dz da \\ & - \sum_{j=1}^{J_R-2} \mu_j \int_{z^*}^{\overline{z}} \int_A x_j(z, a, r, w) \psi_j(z, a) dz da \end{aligned} \tag{12}$$

The left-hand-side of the equation 12 above is the capital demand from $R - 1$ different cohorts of managers. The first two terms on the right-hand-side are the supply of savings from $J - 1$ different cohorts of managers and workers. The third term is the demand for skills investments from $J_R - 2$ different cohorts of managers (a manger will stop investing in his skills the period right before his retirement).

The goods market equilibrium condition requires that the sum of undepreciated capital stock and aggregate output produced in all plants in the economy is equal to the sum of aggregate consumption and savings across all cohorts, and skill investments by all managers across all cohorts. Finally, total tax collections must cover government consumption:

$$G = w\tau \; F(z^*) \sum_{j=1}^{J_R-1} \mu_j + \tau \sum_{j=1}^{J_R-1} \mu_j \int_{z^*}^{\overline{z}} \pi(z, r, w) \widetilde{f}_j(z) dz$$

where the first term is tax collection from workers, and the second term is tax collection from managers.

2.3 Size-Dependent Distortions

Consider now an economy in which managers face size-dependent distortions. We model these distortions as dependent on the ability level of the manager, as the size of production that a manager can operate is (strictly) increasing in her ability.

At age 1, each potential manager with ability levels z makes a draw from a distribution of $D(\tau_d)$ with support $[0,\tau_d^{\max}(z)]$. Once a manager is attached to a particular tax (distortion) τ_d, each period her after-tax profits are reduced by a factor $(1 - \tau - \tau_d)$, where τ is the tax rate in the benchmark economy. Note that $\tau_d^{\max}(z)$, maximum tax level for a manager depends on her ability level z. In particular, we assume that

$$\tau_d^{\max}(z) = \max(1 - \tau, \kappa \frac{z}{z^{\max}}),$$

where $\kappa > 0$ and we limit $\tau_d^{\max}(z)$ to be less than $1 - \tau$ to make sure total taxes imposed on managers are not higher than 1.

We note that this formulation delivers size-dependent (manager- specific) distortions in a simple, parsimonious way. If z is low, $\kappa \frac{z}{\overline{z}}$ is small (for a given κ), and managers are more likely to draw a low tax (distortion) level. As z increases and approaches to $z^{\max}$, a manager is more likely to draw high levels of taxes. A high level of taxes affects decisions over the life cycle. Higher tax rates reduce investments in skills, and lead to lower managerial productivity.

We assume further that $D(\tau_d)$ is a uniform distribution. Hence, the mean value of additional taxes for a manager of type z is given by

$$E(\tau_d|z) = \frac{\kappa}{2}\frac{z}{z^{\max}},$$

which is increasing in z.

With this size-dependent distortions, the problem of a manager of age-j is given by

$$V_j(z, a, \tau_d) = \max_{x,a'}\{\log(c) + \beta V_{j+1}(z', a', \tau_d)\}$$

subject to

$$c + x + a' = (1 - \tau - \tau_d)\pi(z; r, w) + (1 + r)a \qquad \forall 1 \leq j < J_R - 1 \tag{13}$$

$$c + a' = (1 + r)a \qquad \forall j \geq J_R \tag{14}$$

and

$$z^{'} = g\left(z, x\right) \qquad \forall j < J_R - 1, \tag{15}$$

with

$$V_{J+1}(z, a, \tau_d) = \begin{cases} 0 \text{ if } a \geq 0 \\ -\infty, \text{ otherwise} \end{cases}.$$

3 Calibration

We assume that the U.S. economy to be distortion free and calibrate the benchmark model parameters to match some important aggregate and cross sectional features of the U.S. plant data. Before discussing the calibration strategy, it is worthwhile to emphasize important features of the U.S. plant size data collected from the 2004 U.S. Economic Census. The average size of an plant in the U.S. was 17.86. As many as 72.5% of plants in the economy employed less than 10 workers but accounted for only 15% of the total employment. Less than 2.7% of plants employed more than 100 employees but accounted for about 46% of total employment.

The exogenous skill distribution of new born agents in the model is assumed to follow a log normal distribution with parameters μ_z and σ_z. We let the model period correspond to 10 years. Each cohort of agents enter the model at age 20 and live until they are 80 years old. Agents retire at age 60. Hence, in the model agents live for 6 model periods, 4 as workers or managers and 2 as retirees. There are a total of 9 parameters listed in Tables 1. The product of two of these parameters, importance of capital (α) and returns to scale (γ), determine the share of capital in output. We determine the values of capital share in output and the depreciation rate from the data. A measure of capital consistent with the current model on business plants should include capital accounted for by the business sector. Similarly a measure of output consistent with our definition of capital should only include output accounted for by the business sector. The measure of capital and output discussed in Guner et.al. (2008) is consistent with the current plant size distribution model. Hence we adopt the value of capital output ratio, capital share and depreciation rate reported in Guner.et.al. (2008). These values are 2.325, 0.317, and 0.04 respectively. We choose the population growth rate in the model such that the annual population growth rate is 1.1%. We choose τ such that the ratio of government expenditure to GDP is about 20% in the model (consistent with the US data).

After calibrating the depreciation rate and the population growth rate, we have 7 more parameters to calibrate: importance of capital, returns to scale, discount factor, two parameters of the skill accumulation technology and the mean and variance of the skill distribution. Note that capital share in the model is given by $\gamma\alpha$, and since this value has to be equal to 3.17, a calibrated value for γ determines α as well. Hence we have indeed 6 parameters to determine: γ, β, θ_1,θ_2, μ_z and σ_z.

At the aggregate level, we want the benchmark model to replicate the capital output ratio in the U.S. economy. At the cross sectional level, the model implied distribution of plants should capture some of the important features of the U.S. plant size distribution discussed in the beginning of this section. We normalize the mean of the skill distribution to zero and jointly calibrate the 5 remaining parameters to match the following 5 moments of the U.S. plant size distribution: Mean plant size, fraction of plants with less than 10 workers, fraction of plants with more than 100 workers, fraction of the labor force employed in plants with 100 or more employees and the aggregate capital output ratio. These moments together with their model counterpart is given in Table 2.

The benchmark model is successful in replicating multiple features of the U.S. plant size distribution. The coefficient of variation of the plant size distribution implied by the skill accumulation model is 4.05 which is close to the corresponding value (3.98) in the data.

Indeed, the model is able to replicate the entire plant size distribution fairly well as illustrated in Figures 1 and 2. The success of the skill accumulation model in explaining the tail of the plant size distribution is quantitatively important because more than 45% of employment in the U.S. economy is accounted for by plants with over 100 employees.

In the model economy incomes of managers grows significantly by age. Figure 3 shows the age-income profiles of managers in the benchmark model. A manager who is in his 50s (age 4) earns about 5 times as much as a manager who is in his 20s (age 1). Interestingly, the US data also shows very steep age-income profiles for managers as illustrated in Figure 4.[1] Although the model is able to generate significant growth in managers' income over the life cycle, the fraction of resources that are invested for skill accumulation is relatively small, about 1.5% of GDP in the benchmark economy.

4 Effects of Size-Dependent Distortions

We now consider size-dependent establishment specific taxes as we outlined above. In particular, we select the parameter κ such that average establishment size is reduced by 15% (from about 17 to 14) in the new stationary equilibrium. At the same time, we reduce common tax rate on profits and wages to collect the same overall tax revenue as in the benchmark economy.[2] Hence, we shift part of the tax burden from a proportional to a size-dependent (progressive) format. In other words, the total amount of resources that are extracted from regular taxation and managerial specific taxes is *constant* across steady states.

The results of this experiments are shown in Table 3. It is important to note total amount of taxes collected in this size-dependent manner is quite small (about 3.7% of GDP). With size-dependent distortions, aggregate output drops by about 7%. With additional taxes on large establishments, resources are shifted from large to small establishments. As a result, while number of establishments increase, output per establishment declines by about 20%. The share of employment in large establishments declines significantly, from about 42.2 % to about 27.5%. Managers spend fewer resources to enhance their skills and as a result,

[1]The data for Figure is from 2009 American Community Survey (ACS), as tabulated by IPUMS. The occupational can be found at http://usa.ipums.org/usa/volii/c2ssoccup.shtml, with codes 1 to 43 defined as managers. The fraction of managers in this sample is about 8.9%. Figure reports quadratic equations fit to total income data by age.

[2]The value of κ is 1.85. The tax rate τ is reduced from its benchmark value of 0.244 to 0.21 to collect the same level of revenue.

age-income profiles become flatter (Figure 3).

[To be continued]

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Table 1: Parameter Values

Parameter	Value
Population Growth Rate (n)	0.011
Depreciation Rate (δ)	0.04
Importance of Capital (ν)	0.404
Returns to Scale (γ)	0.785
Mean Log-managerial Ability (μ_z)	0
Dispersion in Log-managerial Ability (σ_z)	2.3
Discount Factor (β)	0.944
Skill accumulation technology (θ_1)	0.96
Skill accumulation technology (θ_2)	0.40

Table 2: Targets

Statistic	Data	Model
Mean Size	17.86	17.07
Capital Output Ratio	2.325	2.349
Fraction of Small (0-9 workers) establishments	0.725	0.720
Fraction of Large (100+ workers) establishments	0.0263	0.0248
Share of Employment in Large (100+ workers) establishments	0.462	0.422

Table 3: Size-Dependent Distortions

Statistic	Benchmark	15% Reduction in Average Size
Aggregate Output	100.00	93
Output per Establishment	100.00	80
Number of Establishments	100.00	116
Investment in Skills (% of GDP)	1.49	0.97
Share of Employment in Large (100+ workers) establishments	0.422	0.265

Figure 1: Size Distribution of Establishments, Model and Data

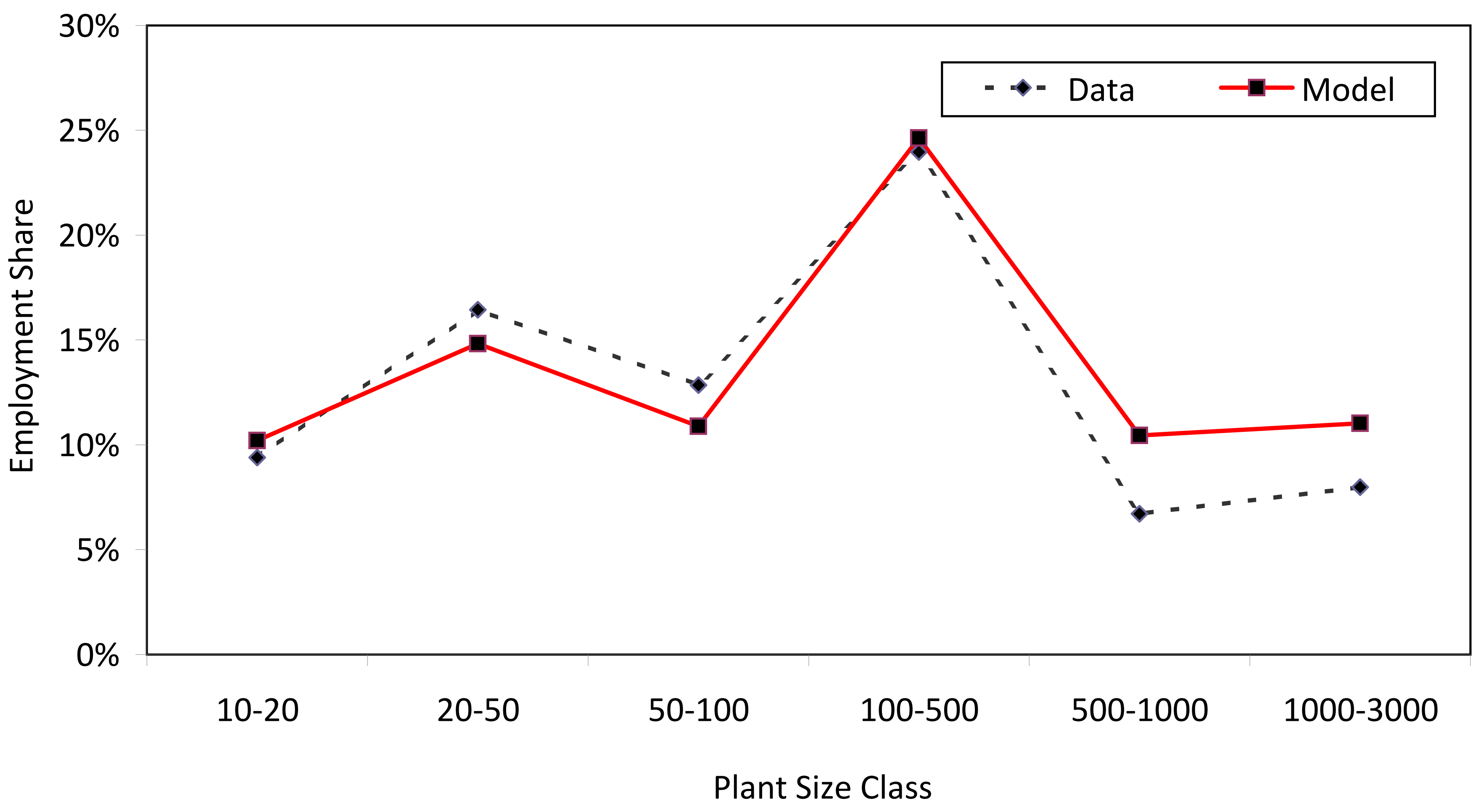

Figure 2 --- Employment Distribtion, Model and the Data

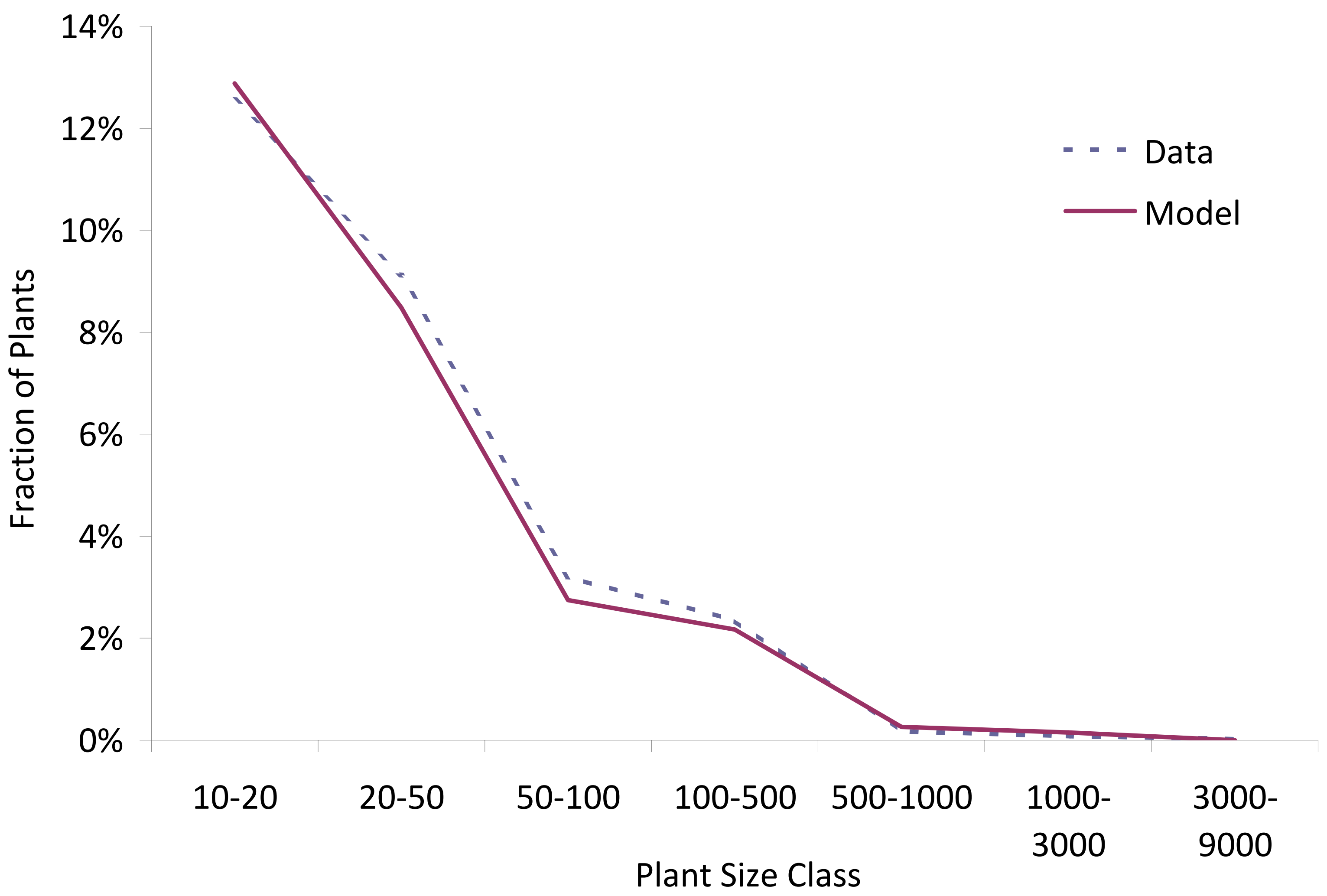

Figure 3: Age-Income Profiles of Managers

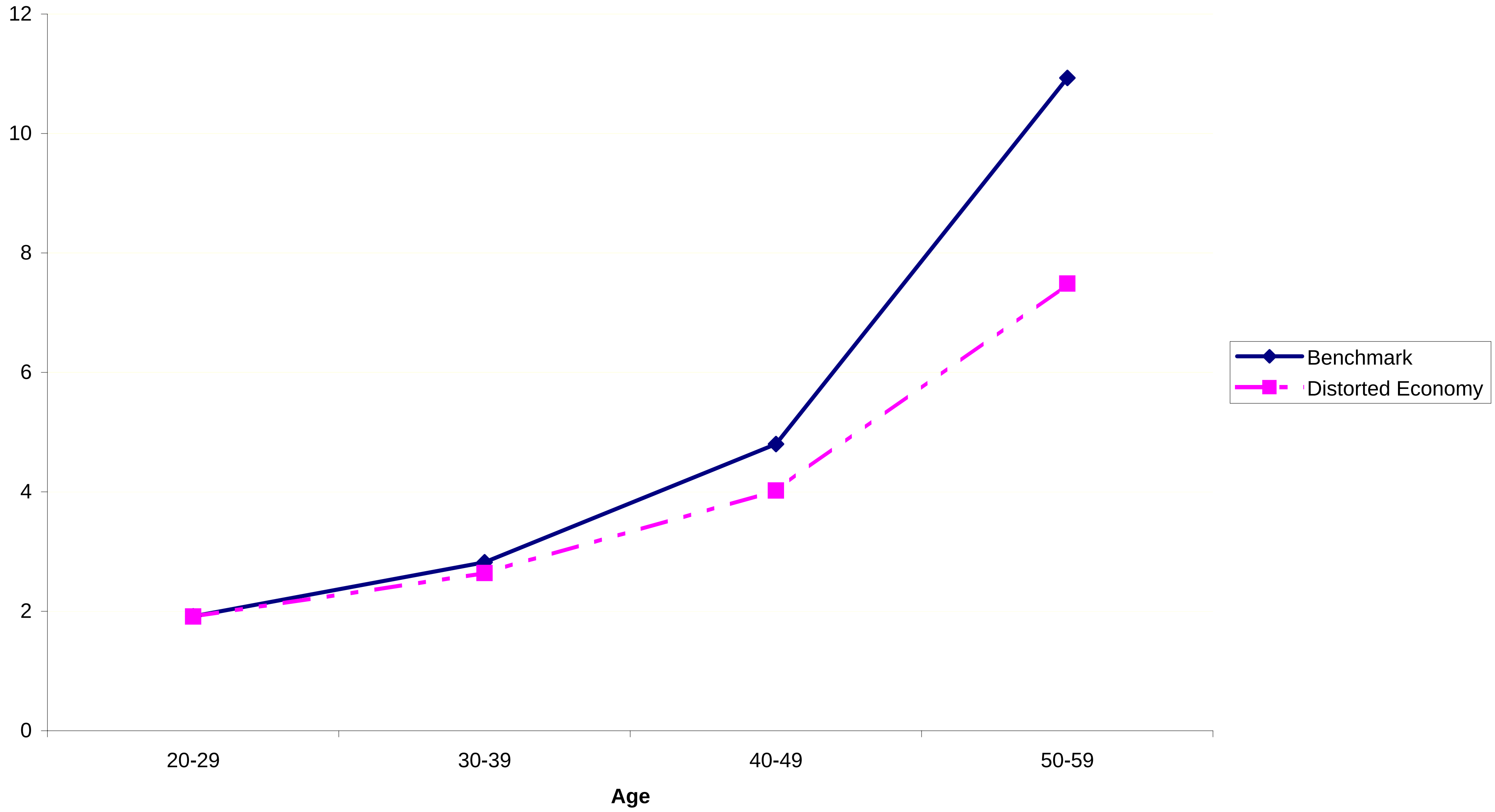

Figure 4: Age-Income Profiles, Managers and Non-Managers