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Rules and Regulations, Managerial Time and Economic Development

M. Nazım Tamkoç
Gustavo Ventura

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Abstract

This paper documents that senior plant managers in less-developed countries spend more time dealing with government rules and regulations than their counterparts in richer countries. These facts are interpreted through the lens of a span-of-control growth model, in which top managers run heterogeneous production plants, employing middle managers as well as production workers. The model implies that increasing the time burden on top management leads to equilibrium changes in wages, occupational sorting, the size distribution of production plants and ultimately, to a reduction in aggregate output. These consequences hold even when the time burden is symmetric across all plants. Quantitative results show that increasing the burden on managers' time from the levels observed in Denmark to the higher levels observed in poorer countries have substantial consequences. Imposing the average time spent on regulations in Argentina reduces aggregate output by about 1/3 and mean plant size by more than 5 employees. Results contribute to rationalizing differences in plant size and output across countries via a channel hitherto unexplored in the literature.

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Rules and Regulations, Managerial Time and Economic Development

M. Nazım Tamkoç and Gustavo Ventura[†][*]

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[†]Corresponding author: Gustavo Ventura. Email: gustavo.ventura@asu.edu

1 Introduction

It has long been argued that the business environment in less-developed countries involves more rules, regulations and red tape than in richer ones, hindering the development of private businesses as in developed economies and ultimately contributing to lower living standards. One aspect of excessive or inefficient rules and regulations that can be particularly detrimental is when they divert time from productive activities. Simple examples abound. In Denmark, for instance, it takes on average one hundred and thirty two hours to pay taxes per year, four days to register business property, and sixty four days to deal with a building permit. In Mexico, the corresponding figures are strikingly higher: two hundred and eighty eight hours, sixty five days and ninety nine days, respectively.[1] Similar examples can be documented for economies at similar levels of development.

In this paper, we focus with high resolution on the diversion of time from productive activities of managers caused by rules and regulations. For ease of exposition, we refer to this phenomenon as the time burden on managers, or simply as the *time tax*. We first extensively document the incidence of this implicit tax across countries. We then interpret the data via the lens of a growth model, in which the span of control of managers is distorted by a time tax, and quantify its consequences.

Our empirical analysis leverages data from the World Bank Enterprise Survey, where a common set of questions are asked to representative samples of establishments in different countries. In this data, we focus on the time tax on senior or top management, defined as the fraction of their time devoted to deal with rules and regulations. In this data, the average time tax of rich countries like Denmark, the Netherlands and Sweden averages about 6-7%, while for Türkiye, Mexico and Argentina can be three times as large, at around 15-20%. Using this data, we document that senior management in richer countries systematically devote less time to deal with government rules and regulations than their counterparts in less developed countries. We find that this relationship holds after controlling for a host of plant characteristics, holds in manufacturing and services, and holds after controlling for two-digit industry characteristics. Our estimates imply that a 20% decline in GDP per working-age adult is associated with a decline in the net fraction of time available to managers (one minus the time tax) of about 1.7 percentage

[1] Source: Doing Business Report, 2016. See also Loayza *et al.* (2010) and Djankov *et al.* (2002).

points. We also find that larger establishments tend to be more exposed to a time tax than smaller ones. Nonetheless, we find that the differences in the burden between small and large establishments vary by country, and are on average small.

What would be the implications of changes in a time tax? Consider the standard Lucas (1978) span-of-control model with only labor an input. In this setup, introducing a time tax that is uniform across all plants, is akin to a reduction in aggregate productivity. An increase in the time tax would just lead to a reduction in aggregate output, with no effects on the size distribution of plants in equilibrium. Yet, it is natural to surmise that the effects of a higher time tax would be more nuanced. For instance, note that the data refers to time taxes on *top managers*, suggesting that the analysis should consider more than one layer of managers, and hence, permit that not all managers be directly affected by a time tax. If so, indirect effects across heterogenous production units are likely to emerge, that would affect output and plant size.

To explore the quantitative consequences of the time tax across countries, we develop a growth model in which top managers run production units employing capital, raw (production) labor and managerial services from middle managers. In the model, a representative household accumulates capital and optimally allocates heterogeneous household members to different occupations: top management, middle management or production work. Production requires completing a continuum of imperfectly substitutable tasks. Each task requires production labor and capital. The total number of production tasks is bounded by the ability of a top manager, who can hire the services of middle managers to complement his/her ability and thus, enhance his/her span of control.

In equilibrium, more able top managers run larger production units and work with more employees (workers and middle managers). In this context, we introduce a time tax that reduces the endowment of productive time of top managers. As a result of the presence of a time tax, top managers reduce their demand for labor and managerial services, leading to changes in prices and a change in the equilibrium assignment of individuals to different occupations. This results in more top managers, fewer production workers, with an undetermined effect on middle managers. Therefore, the introduction of time tax, even if it is fully proportional to all plants, results in a lower average plant size. Output declines due to the lower available time of top managers, the changes in the occupational assignment, as well as the changes in capital formation across steady states.

Findings We parameterize the model environment in order to match observations of the Danish economy (one of the richest in our sample), which is characterized by a low time tax on average and around the predicted regression line connecting output per working-age adult and the time endowment of managers (net of the time tax). Our economy reproduces properties of the size distribution of production plants (services and manufacturing), including the concentration of production at the top, in conjunction with the average number of managers per plant. We also force the model to be consistent with observations on time taxes at large plants (plants with 100+ workers) via the specification of a two-parameter function determining the time tax at the plant level; one parameter governs the 'level' of the tax and another how it varies with respect to the ability of the top manager – a 'curvature' parameter. We then conduct several experiments where we vary the model parameter governing the level of the time tax, how the time tax varies with plant size and the effects associated with varying the structure of the time tax according to data.

Our findings show that changes in the parameter governing the level of taxes can lead to large effects on output and size statistics. Increasing the level parameter from the benchmark (Danish) level of 5% to a level of 15% (i.e. to levels observed in middle-income economies such as Argentina, Türkiye or Mexico), leads to a large long-run drop in output in excess of one third. It also determines a reduction in average plant size, from the benchmark level of about 13.1 employees to about 8, with a resulting increase in the average tax across all plants from about 6.4% to 15.8%. These effects are concomitant with a drastic reallocation of production, away from larger plants. Our findings show that the employment share at large plants (more than 100 employees) drops about 18 percentage points from the benchmark case.

We then apply our model to make inferences about individual countries. First, we calibrate the level parameter of the time-tax function of different countries to reproduce the average level of the time tax in selected countries. For the average level of the time tax in Argentina in 2006, we find that our model implies a reduction in output of about 32.8%, relative to the benchmark case. Meanwhile, for Türkiye in 2013 the predicted reduction in output is larger – 40.6%. The corresponding effects on mean size are a reduction in mean size to about 8 and 7 employees for Argentina and Türkiye, respectively.

We also ask what the implied gains in output for each country would be if the structure of the time tax in Denmark is imposed. Our results imply large output gains. For Argentina, our results imply a gain of about 51%, while for Türkiye – an initially more distorted economy – the implied gain in output is larger, about 79%. From these exercises, we conclude that observed variation in the average time burden on top managers can go a long way in generating sizeable effects on aggregate output and size statistics in line with observations. Furthermore, a reduction of the time tax to levels in line with rich countries can be a key force in closing the associated output gaps, without relying on large shares of reproducible factors.

Related Literature Our paper is connected to several, interconnected strands of literature. First, it is directly connected to the span-of-control model first developed in Poschke (2018). Tamkoç (2023) extends this model to allow for the coexistence of top and middle managers, and uses it to quantify the amplification of size-dependent distortions with a production structure with a varying number of managers. It also naturally connects with papers that follow the seminal work of Garicano (2000) and Garicano & Rossi-Hansberg (2006). Examples include Caliendo & Rossi-Hansberg (2012), Caicedo *et al.* (2019), Gumpert *et al.* (2022), Santamaría (2022), Mariscal (2018) and Lopez & Torres (2020), among others.

Our work is related to a growing body of work that emphasizes the role of managers and the constraints that they face in economic development, and the resulting implications for the size of production plants and productivity. Our emphasis of the time tax on top managers in data connects our paper with the empirical literature on managerial practices and performance; see Bloom & Van Reenen (2007), Bloom & Van Reenen (2010), Bloom *et al.* (2013), Bloom *et al.* (2019) and others. Bloom *et al.* (2019) in particular quantifies the role of planning for Brexit on the time allocation of top managers in the UK. Recent examples of papers that emphasize the role of managers in economic development and quantify the importance of features of the environment include Akcigit *et al.* (2021), Alder (2016), Chen *et al.* (2023), Esfahani (2022), Guner *et al.* (2018), Hjort *et al.* (2022) and

Grobovšek (2020) among others.

Finally, our paper is related to work that connects differences in plant size across as the result of misallocation induced by size-dependent distortions. Bento & Restuccia (2021) and Bento & Restuccia (2017) document plan-size differences across countries, and relate these differences to distortions that are size dependent. Garcia-Santana & Pijoan-Mas (2014), Guner *et al.* (2008), Gourio & Roys (2014) and others show how particular policies can lead to size differences and lower output. Unlike these papers, we show how variation in time taxes in line with data, even when time taxes are *not* size dependent, can lead to output and size differences that are substantial. Hence, we contribute by providing a new, quantitatively relevant rationale to the observed differences in plant size across countries.

2 The Time Tax Across Countries

Our primary data source is the World Bank Enterprise Surveys (WBES). This is an establishment level survey over a representative sample of an economy's non-agricultural and non-financial private sector. From establishment characteristics to government relations, a wide range of topics is covered through face-to-face interviews with business owners and top managers. It follows stratified sampling methodology along sectors of activity, establishment size and location with a common questionnaire for all countries. Formal establishments with at least 5 full-time permanent workers are included in all WBES.[2] We also use other data on aggregate variables, such as real GDP per working-age adult (PPP) and employment numbers that are from World Development Indicators (WDI).[3] We subsequently use plant-size distribution data from economic censuses for some countries.

The key question we focus in the WBES dataset asks the following: *"In a typical week over the last year, what percentage of total senior management's time was spent on dealing with requirements imposed by government regulations?"* In this question, senior manage-

[2]Raw establishment level data is publicly available at www.enterprisesurveys.org

[3]The employment data for Antigua and Barbuda and St. Kitts and Nevis are not available. Therefore, we assume the employment and population ratio in these countries is 0.53 which is the average employment to population ratio in our sample.

ment refers to managers, directors, and officers above direct supervisors of production or sales workers. We interpret the answer to this question as the time tax on managerial activities since it refers to time spent dealing on red tape and bureaucracy that would otherwise spent on business matters according to WBES questionnaire manual.[4]

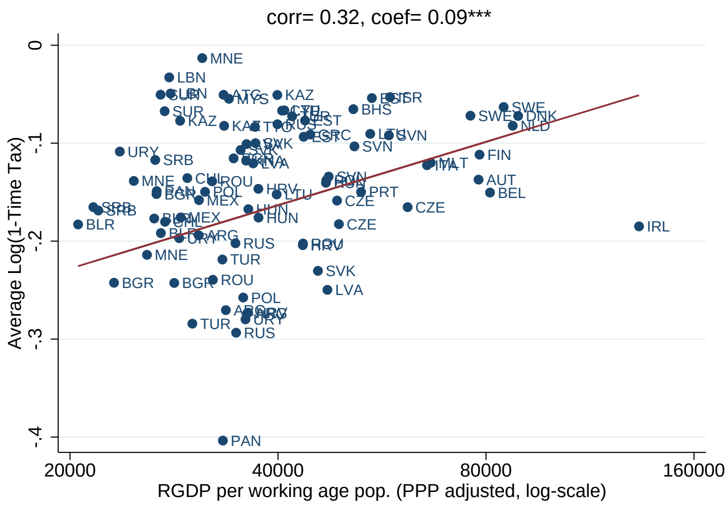
Our selection criteria is that a country is included in the analysis if it ever had a GDP working-age adult (ages 15-64) above $25,000 in PPP terms (2017) dollars during the years in which the survey was conducted. Using GDP per working-age adult allows to adjust for the non-trivial differences in demographics of the countries considered. As a result, there are 42 countries in our sample, which mostly consists of middle income and high-income countries. Although there are multiple rounds of WBES in most countries in our sample, we treat them as repeated cross-section data. Hence, a country appears more than once in our data if it satisfies the selection criteria. After we drop observations with missing values or "Don't Know" for the answer to the question of interest, the total value of annual sales and the number of permanent full-time workers, we have 42,751 establishments in our final sample. Table A.1 provides the list of countries and survey years.

Figure 1 illustrates the main motivating fact of the paper: senior managers in richer countries tend to spend less time on dealing with government regulations. The vertical axis shows the mean of the logarithm of one minus the average time tax in a country at a survey year and the horizontal axis is the log of GDP per working age adult in a country at a survey year. The solid line represents the simple weighted regression line where the total employment is used to weight observations. The regression coefficient is positive and significant at 1% level and the correlation between the variables is 0.32. We interpret the variable of one minus the time tax as net time available for senior management after time devoted to deal with government regulations. The figure reveals some striking features of the data when richer countries are compared with their poorer counterparts. For example, establishments in Denmark report an average time tax of about 6.4%, while in Argentina in 2017 the tax on average is reported to be more than 3 times as large (21.6%). Similar figures hold for other countries around the same levels of development, such as Russia, Türkiye and Mexico. The estimated relationship implies that going from an output per

[4]The questionnaire manual prepared by WBES team is available online at WBES webpage.

working- age adult level of $80,000 to $40,000 is associated with an approximate decline in the time available to top managers of about 6.2 percentage points.

Figure 1: Relationship between the Time Tax and RGDP per Working Age Pop.



Notes: This figure shows the relationship between the log of 1 minus the time tax and RGDP per working age adult. Each dot represents a country at a survey year. The solid line is the simple weighted regression line where dependent variable is the log of one minus the time tax and the independent variable is the RGDP per working-age adult. The countries are weighted according to their employment sizes. Sources: WBES and WDI.

2.1 General Characterization

We now attempt a more general empirical characterization of the relationship between the (net) time available to managers and the level of development. We estimate the following relationship:

$$\log(1 - t_{i,c,t}) = \alpha + \beta \log GDP_{c,t} + F(i,c,t) + SFE_i + u_{i,c,t} \qquad (1)$$

where $1 - t_{i,c,t}$ stands for 1 minus the time tax at establishment i in country c at year t. $GDP_{c,t}$ stands for the log of RGDP per working-adult in country c at year t, SFE_i is a dummy variable associated to the two digit ISIC 3.1 sector, and $F(i,c,t)$ stands for a set of establishment level characteristics for establishment i in country c at year t. We control for the experience of the top manager (years), the number of permanent-full time workers, the age of the establishment (years), whether the establishment is a part of larger firm (multi-establishment dummy), the percentage owned by foreign nationals, the percentage of sales coming from exports, the gender of the top manager and whether the establishment has a bank loan or a line of credit. All OLS regressions use Huber-White robust standard errors and the standard errors are clustered at the country, survey year, region, sector and size level. Moreover, survey weights are adjusted such that sum of weights in a country at a survey year represents the total employment.

Table 1 presents our baseline estimation. The coefficients in the first nine columns are obtained via OLS regressions whereas the last column shows the marginal effects from a TOBIT regression. Our pooled regression results strongly confirm the view that level of development is negatively associated with the time tax. Note that our specification allows us to interpret the coefficient of interest β as the elasticity between the net time available to managers with respect to level of development (GDP per working age adult). The OLS estimates of the regression coefficient are of around 0.085, implying that halving GDP per working-age adult is associated with a decline in the net time available to managers of about 5.9 percentage points – $0.059 \sim -0.085 \times \log(1/2)$.

The regression analysis also reveals more findings. The senior managers of bigger establishments spend more time dealing with government regulations compared to the senior managers at small establishments, as the third row in Table 1 shows. This relationship is, however, small in magnitude; we investigate the issue in more detail below. Likewise, the time tax for older establishments is higher when compared to that for younger establishments. Interestingly, as the share of foreign nationals increase in the ownership of the establishment, senior management spend less time dealing with government regulations. In the appendix, we show that the positive and significant relationship between the net time available to top managers and the level of development persist even if we estimate the regressions in manufacturing and services sectors separately – see Table B.2 and B.3. These results show that the relationship between the incidence of the time tax is stronger in the manufacturing sector, even when controlling for two-digit sectors within manufacturing or services.

Plant Size and the Incidence of the Time Tax We now investigate in detail the relationship between the incidence of the time tax and establishment size. Our findings discussed above showed a relative small size-dependency in the time tax across establishment across countries in the sample; i.e. managers in larger establishments are more exposed to time taxes than those in smaller establishments. We first illustrate this in detail in two representative middle income countries in the data, Argentina and Türkiye, compared to a prototypical rich country (Denmark) with a low incidence of the time tax.

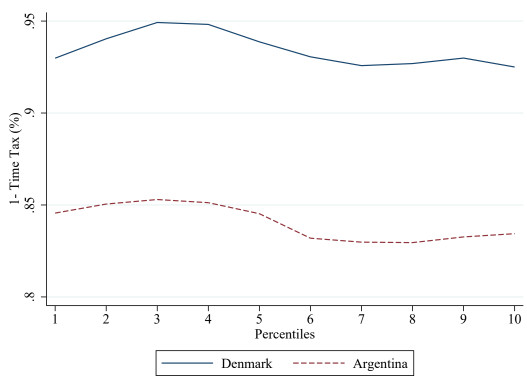


Figure 2: ARG vs DNK

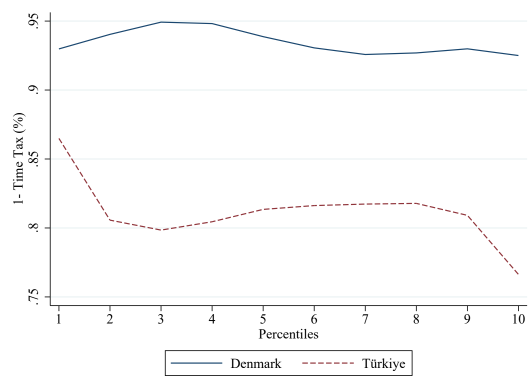


Figure 3: TUR vs DNK

Note: These figures present the level of the net time available to top managers across percentiles of the establishment size distribution. The left panel compares Argentina with Denmark, whereas the right panel compares Türkiye with Denmark.

As illustrated in Figure (2), the net time available to top managers in Argentina is essentially a mirror image of the Denmark's case, but at a much lower level. A difference of about ten percentage points emerges between Argentina and Denmark at all size levels. Managers in large establishments in Denmark are a bit more heavily taxed than at smaller establishments, and the same pattern holds for Argentina. The case of Türkiye in Figure (3) is somewhat different. While large differences on average exist in relation to Denmark, top managers at larger establishments in Türkiye are more heavily taxed than those at the bottom relative to Denmark. Thus, we would expect a stronger relationship between the net time available to top managers and size in Türkiye relative to Denmark or Argentina. All this suggests that the size effects uncovered earlier are due to within-country effects rather than across-country effects.

To examine the relationship between the net time available to top managers and size in a more systematic way, we estimate a version of equation (2) for each country/year in our sample:

$$\log(1 - t_i) = A_0 + B_1 \log(n_i) + F(i) + SFE_i + u_i \tag{2}$$

where n_i stands for the size of establishment i in each country/year.

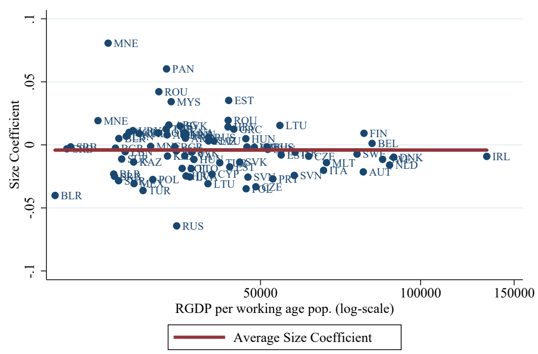


Figure 4: Size Coeff. and Development

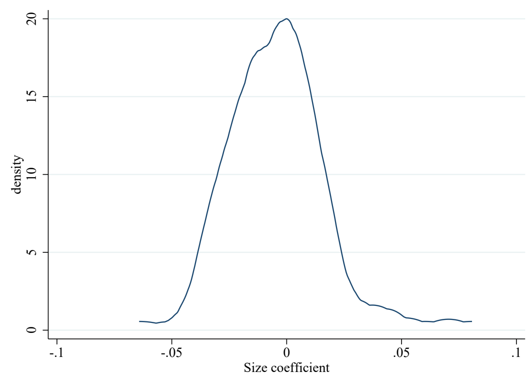


Figure 5: Size Coeff. Density

Note: These figures present properties of the coefficient B_1 associated to plant size. The left panel shows how it varies with the level of development, whereas the right panel illustrates its empirical density.

How does the coefficient B_1 vary with the level of development? Figure (4) shows that the country-specific coefficient is on average the same across levels of output per working-age adult. Regressing the coefficient B_1 against GDP per working-age adult implies a statistically significant coefficient of about zero. In fact, the average value of B_1 is marginally negative, but quite close to zero. The right panel shows the empirical density associated to all estimated coefficients. It shows a distribution that is effectively centered around zero. The mean value is about -0.0042 and the median is about 0.0051.

Robustness In order to check the robustness of our results, we perform additional estimations that are presented in the Appendix C. First, we restrict our sample to only the latest round of surveys whenever multiple rounds are available. By doing so, we deal with the multiple representation of poorer countries and year effects in the baseline sample. Second, we repeat all estimations with country-sector fixed effects in the baseline sample, and without any fixed effects both in the baseline sample and in the restricted sample. All of the robustness estimations strongly show that the managers in richer countries spend a fewer fraction of their time on dealing with government regulations. In particular, the estimates with country fixed effects show a much stronger relationship between the time tax and development.

3 Model Economy

We present below a growth model with an endogenous degree of span of control to capture key margins for the problem at hand. The model follows closely Tamkoç (2023), which in turn extends the span-of control setup in Poschke (2018) to allow for a production structure with top and middle managers.

Our model has three key important features. First, it has production layers within a production plant, and thus, distinguishes between top ('senior') managers, regular managers and workers. This feature is added in order to make sense of the nature of questions asked in the data. Second, the model leads to a size distribution of plants in equilibrium, which we later match to actual plant-size distribution data. Finally, the model has a non-trivial role for a time tax on top managerial time. The model implies that even a time burden that is symmetric across all managers has implications for the size of plants and aggregate output in equilibrium.

3.1 Environment

There is a single household with measure one of household members. Each household member is endowed with a unit of time and managerial ability, $z \in [0, \bar{z}]$, with cdf, $G(z)$ and density $g(z)$. Differences in managerial ability are the only source of heterogeneity in the model. The household discounts the future at a rate of $\beta \in (0, 1)$ and has preferences over streams of a single consumption good, $\{C_t\}_0^\infty$, that are valued according to

$$\sum_{t=0}^{\infty} \beta^t \log(C_t) \tag{3}$$

The household assigns its members to three occupations. Each household member supplies one unit of time inelastically and becomes either a production worker, a middle manager or a top manager according to his/her ability level. Production workers earn a wage W regardless of their ability, whereas a middle manager with ability z_m earns $P_m z_m$, where P_m is the price of efficiency units in middle management.

Technology Top managers operate production plants where the single final good of the economy is produced. The final good is produced using the output from differentiated tasks (activities) indexed by j. For each activity, top managers rent capital, k_j, from the household and hire production workers, n_j. The number of activities that a top manager can run is bounded by her ability level, z, and the amount of middle managers hired, z_m.

Let $M(z, z_m)$ be the number of activities that a top manager with ability z can perform with z_m efficiency units of middle managers. The number of activities that a top manager can perform increases with the abilities of the top manager and the middle managers; i.e. M is strictly increasing in each of its arguments. We assume that M is continuous and twice differentiable, and that the ability of a top manager and middle managers are complementary, i.e. $\frac{\partial M^2(z,z_m)}{\partial z\ \partial z_m} > 0$. Finally, we focus on a case where M is convex in the ability of the top manager and $M(0, z_m) > 0$. These assumptions fully pin down the occupational assignment of the household members, as we illustrate below.

The final output of a plant that performs $M(z, z_m)$ activities is given by

$$y = \left[\left(\int_0^{M(z,z_m)} \left(n_j^{\alpha} k_j^{1-\alpha} \right)^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}} \right]^{\gamma} \tag{4}$$

where $\gamma \in (0, 1)$ stands for a span-of-control parameter in the spirit of Lucas (1978), and $\sigma > 1$ is the elasticity of substitution between the output of different activities (intermediate goods). $\alpha \in (0, 1)$ is the importance of capital in the production of intermediate goods. Capital depreciates at the rate $\delta \in [0, 1]$.

A Plant's Problem Each period, a top manager with ability z chooses the number of workers and the amount of capital for each activity as well as efficiency units of middle management in order to maximize:

$$\pi(z) = \max_{\{n_j,k_j\}_j,z_m} \left[\left(\int_0^{M(z,z_m)} \left(n_j^{\alpha} k_j^{1-\alpha}\right)^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}} \right]^{\gamma} - \int_0^{M(z,z_m)} W n_j dj - \int_0^{M(z,z_m)} R k_j dj - P_m z_m \tag{5}$$

where R denotes the rental rate of capital services. Top managers can increase their span-of-control by hiring more middle manager services. Because of the complementary in abilities of top managers and middle management, more able top managers hire more middle management services and spend more on them than top managers of lower ability. In the Appendix, we present the first-order conditions for this problem.

The Household's Problem The representative household owns the capital stock that it rents to production plants. At any date t, the household selects consumption and next period's capital as well the occupation of their household members. The latter is done by choosing two thresholds $z^*_{1,t}$ and $z^*_{2,t}$, taking prices R_t, W_t and $P_{m,t}$ as given. It follows that the flow of income accruing to the household is

$$I(z^*_{1,t}, z^*_{2,t}; R_t, W_t, P_{m,t}) \equiv \int_0^{z^*_{1,t}} W dG(z) + \int_{z^*_{1,t}}^{z^*_{2,t}} p_{m,t} z dG(z) + \int_{z^*_{2,t}}^{\infty} \pi(z) dG(z) + R_t K_t. \tag{6}$$

Thus, at any date, the household's budget constraint is

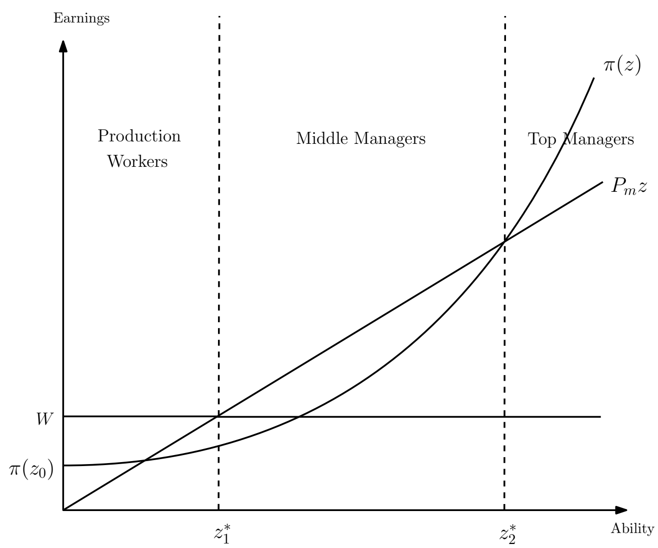
$$C_t + K_{t+1} = I(z^*_{1,t}, z^*_{2,t}; R_t, W_t, P_{m,t}) + (1-\delta) K_t \tag{7}$$

Formally, the problem of the household is to maximize (3), subject to (7) and $K_0 > 0$, by selecting sequences $\{C_t, K_{t+1}, z^*_{1,t}, z^*_{2,t}\}_0^{\infty}$.

The solution to the household problem involves a standard Euler equation characterizing the choice of consumption and capital, as well as the first-order conditions characterizing the occupational choices. We present these choices in detail in the Appendix. In Figure (6) we illustrate the assignment of household members to different occupations. Household members with abilities greater than $z^*_{2,t}$ become top managers and run plants whereas the household members whose abilities are lower than $z^*_{1,t}$ become workers. The remaining household members with abilities between $z^*_{1,t}$ and $z^*_{2,t}$ work as middle managers. Workers earn W regardless of their managerial ability level whereas middle managers earn according to a linear function of their ability, $P_{m,t}z$. The rents (profits) of those who become top managers are also increasing in their ability and convex under the assumption of convexity of function M in the ability of the top manager.

The first threshold, $z^*_{1,t}$ exists and is unique because the earnings of production workers are constant at W, and the middle managers' income increases proportionally with their ability. The profits of top managers and the earnings of the middle managers can intersect at most twice due to the assumptions on the function M. As long as W is higher than the first intersection of the profit and the middle managers' earning functions, $z^*_{2,t}$ is uniquely determined and greater than $z^*_{1,t}$. Henceforth, the two thresholds fully define the sets that span all occupational choices.

Figure 6: Occupational Choice



Note: This figure illustrates the occupational choices for household members; production workers, middle managers and top managers.

3.2 A Time Tax

We introduce a *time tax* in the economy as a tax $\tau(z)$ on the time endowment of top managers. Thus, $1-\tau(z)$ is the available time for a top manager of ability z. Altogether, this implies that the function M that bounds the number of activities that can be carried out inside the plant is now corrected by the presence of the time tax:

$$M(z, z_m) \;\rightarrow\; M(z(1-\tau(z)), z_m) \tag{8}$$

We note that since the ability of the top manager determines the size of the plant's operations, this formulation is a simple yet flexible one that permits to accommodate time taxes that are potentially *size dependent*. A case in which all top managers are hit by the same time tax is simply $\tau(z) = \bar{\tau}$ for all z.

3.3 Competitive Equilibrium

In competitive equilibrium, the representative household and top managers make optimal decisions and markets clear. Market clearing in the market for production workers and middle managers requires

$$\int_0^{\hat{z}^*_{1,t}} g(z)dz = G(\hat{z}^*_{1,t}) = \int_{\hat{z}^*_{2,t}}^{\bar{z}} \hat{n}(z)g(z)dz \tag{9}$$

$$\int_{\hat{z}^*_{1,t}}^{\hat{z}^*_{2,t}} zg(z)dz = \int_{\hat{z}^*_{2,t}}^{\bar{z}} \hat{z}_m(z)g(z)dz \tag{10}$$

where $\hat{n}(z)$ stands for the equilibrium demand for production labor by a top manager with ability z, $\hat{z}_m(z)$ stands for the middle-manager services demanded by top manager with ability z, while a 'hat' over a variable denotes its equilibrium value. Market clearing for capital services requires:

$$\hat{K}_t = \int_{\hat{z}^*_{2,t}}^{\bar{z}} \hat{k}(z)g(z)dz \tag{11}$$

where $\hat{k}(z)$ is the capital demanded by top manager with ability z. The solution of the household problem dictates indifference conditions for occupation assignments. It implies two indifference conditions that hold in equilibrium:

$$\hat{W}_t = \hat{P}_{m,t}\hat{z}^*_{1,t}, \text{ and } \hat{P}_{m,t}\hat{z}^*_{2,t} = \pi(\hat{z}^*_{2,t}). \tag{12}$$

That is, the marginal middle manager at equilibrium prices is indifferent with the production work option at $\hat{W}_t$, and the marginal top manager is indifferent with regard to his/her compensation as a middle manager.
In equilibrium, aggregate output at t, $\hat{Y}_t$, is given by

$$\hat{Y}_t = \int_{\hat{z}^*_{2,t}}^{\bar{z}} \left[\left(\int_0^{M(z(1-\tau(z),\hat{z}_m(z))} \left(\hat{n}_j(z)^\alpha \hat{k}_j(z)^{1-\alpha} \right)^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}} \right]^\gamma dG(z)$$

Altogether, equilibrium in the goods market implies the familiar condition in a one-sector growth model:

$$\hat{C}_t + \hat{K}_{t+1} = \hat{Y}_t + (1-\delta)\hat{K}_t \tag{13}$$

We can then define a competitive equilibrium. Given a time tax rule, $\tau(z)$, a competitive equilibrium are sequences $\{\hat{C}_t, \hat{K}_{t+1}, \hat{W}_t, \hat{P}_{m,t}, \hat{R}_t, \hat{z}^*_{1,t}, \hat{z}^*_{2,t}\}_0^\infty$ such that (i) Given $\{\hat{W}_t, \hat{P}_{m,t}, \hat{R}_t\}_0^\infty$, the sequences $\{\hat{C}_t, \hat{K}_{t+1}, \hat{z}^*_{1,t}, \hat{z}^*_{2,t}\}_0^\infty$ solve the household problem; (ii) Given $\{\hat{W}_t, \hat{P}_{m,t}, \hat{R}_t\}_0^\infty$, factor demands solve the problem of each top manager at all t; (iii) Markets clear for all t; i.e. conditions 11, 10 and 9 hold for all t.

In the appendix, we show simple but important properties of competitive equilibria that we summarize in the proposition below.

Proposition 1 (*Equilibrium Properties*)**.** *In any competitive equilibrium,*

1. *The capital to labor ratio is the same for all activities and for all plants;*

2. *The capital to output ratio is the same for all plants;*

3. *Further, in a steady state, the aggregate capital to output ratio is equal to*

$$\frac{\hat{K}}{\hat{Y}} = \gamma \, \frac{1-\alpha}{1/\beta - 1 + \delta}. \tag{14}$$

The first two conditions follow from simple algebra implied by the optimization problem of plants and the corresponding first-order conditions. We note that these conditions hold for all plants, regardless of the ability of the top manager and the structure of a time tax.

The last condition follows from the fact that in steady state, allocations and prices are constant, as well as the thresholds $\hat{z}_1^*$ and $\hat{z}_2^*$. The Euler equation for the intertemporal choice of capital and consumption dictates the steady-state value of the rental price of capital,

$$\hat{R} = \frac{1}{\beta} - 1 + \delta.$$

Since the capital to output ratio is the same for all plants, it is also the aggregate capital to output ratio. This ratio depends only on the rental price of capital, which in steady state equals the value above.

Two simple, yet important comments are in order. First, just four parameters pindown the capital-output ratio in steady state; α, β, γ and δ. Note also that as the span of control parameter γ approaches 1, the capital to output ratio becomes the *same* as the one in the standard one-sector growth model, under a Cobb Douglas technology with capital share $1 - \alpha$.

Second, all steady states induced by different configurations of a time tax will share the same rental price of capital (same interest rate), the same capital to output ratio and the same aggregate share of payments to capital. Thus, changes in the time tax are equivalent to changes in Total Factor Productivity (TFP) in the standard one-sector growth model with a Cobb-Douglas technology. In such model, as is well known, the steady-state capital to output ratio is invariant to changes in TFP.

Model Statistics It is worth defining model statistics related to the size of production plants that can be used later on to map our model to data. Note first that total paid employees in the economy, production workers plus middle managers, amount to the fraction of agents who are not top managers. Thus,

$$\text{Total Employees} = G(\hat{z}_2^*) \tag{15}$$

Since there is one top manager per plant, it immediately follows that mean plant size, total employees per plant, is given by

$$\text{Mean Size} = \frac{G(\hat{z}_2^*)}{1 - G(\hat{z}_2^*)} \tag{16}$$

Economy wide, how many managers per plant are there? Since there are $G(\hat{z}_1^*)$ production workers, there are $1 - G(\hat{z}_1^*)$ middle managers and top managers. Hence, total managers per plant is given by

$$\text{Managers per Plant} = \frac{1 - G(\hat{z}_1^*)}{1 - G(\hat{z}_2^*)} \tag{17}$$

Meanwhile, middle managers per plant are given by

$$\text{Middle Managers per Plant} = \frac{G(\hat{z}_2^*) - G(\hat{z}_1^*)}{1 - G(\hat{z}_2^*)} \tag{18}$$

4 Parameter Values

We now discuss the choice of parameter values for our economy, under the assumption that the model period is one year. We focus on stationary equilibria, and aim at reproducing aggregate and plant-size properties of a rich economy in our data, in line with observations of time taxes on top managers. We map our economy to Denmark, one of the richest economies in our sample, with observations on the time tax around the valued predicted by the estimated relationship presented in Figure (1).

We start by specifying the function mapping the ability of a top manager to time taxes. We use the average time tax function, popularized by Benabou (2002), and used in the development context recently by Guner *et al.* (2018) and others. Specifically, the distortion for a manager of ability z, $1 - \tau(z)$, obeys

$$1 - \tau(z) = (1 - \tau_0) z^{-\tau_1} \tag{19}$$

In this formulation, τ_0 controls the 'level' of the time tax, and τ_1 the curvature of the time tax with respect to the manager's productivity. Note that if $\tau_1 = 0$, all managers face the same tax and their effective time endowment becomes $1 - \tau_0$. If, however, $\tau_1 > 0$, top managers with higher abilities face higher time taxes. In other words, since higher ability managers run larger operations, τ_1 changes the size dependency of the time tax.

We select τ_0 and τ_1, in conjunction with other parameters, to reproduce for Denmark's average time tax, and the time tax on large plants (more than 100 employees).

Endowments and Technology We assume that the distribution of abilities is log normal: $\ln(z) \sim N(0, \sigma_z^2)$. In terms of the function M, we assume it takes the form

$$M(z, z_m) = \bar{M}^{h(z,z_m)}, \quad h(z, z_m) \equiv (1 - \tau(z))\ z\ (1 + \phi z_m^\theta) \tag{20}$$

where $\bar{M} > 1$ is a level parameter, $\phi \geq 0$ governs the efficiency of middle management, and $\theta \in (0, 1)$ determines the degree of diminishing returns of middle management. When $\phi = 0$, top managers do not demand any middle managerial services, so there are only production workers and top managers in equilibrium. This particular functional form implies that larger plants have more managers but the share of managers among all workers is smaller in larger plants compared to smaller plants. Tamkoç (2023) discusses this observation in detail. Put differently, the number of workers per manager increases with plant size. Since the elasticity of M with respect to the ability of the top manager increases with the middle management efficiency units, top managers with higher ability can and choose to perform more activities with extra units of middle management compared to top managers with lower ability.

Calibration We first exogenously set to usual estimates the discount factor β, the depreciation rate of capital, δ, and the aggregate share of capital, $(1 - \alpha)\gamma$, to 0.95, 0.055 and 0.33 respectively. Note that the importance of capital in the production of differentiated inputs, α, is determined after the span-of-control parameter γ is set using $(1 - \alpha)\gamma = 0.33$. We set the value of the elasticity of substitution between activities (intermediate goods), σ, to 6.6, in line with the middle (robust) estimates of Broda & Weinstein (2006), Table IV.

We then proceed to calibrate the standard deviation of log ability σ_z^2, the span-of-control parameter γ, and the parameters $\bar{M}$, ϕ and θ to reproduce jointly five observations for the Danish economy in 2016. We target the mean plant size (13.1 employees), the number of managers per plant (1.3), the fraction of plants at the bottom 1-9 employees and 10-19 employees (86.4% and 6.6%), and the employment share at (large) plants with more than 100 employees (61.7%).

To compute plant-size statistics, we focus on 2016 data and consider all plants with at least 1 worker in all sectors while calculating the moments of plant size distribution. We use general enterprise statistics from Statistics Denmark to calculate the mean size and plant-size statistics. We use auxiliary data from ILO and Eurostat to compute the number of managers per plant.

Tables 2 and 3 show the resulting parameter values and performance of the model respectively. Figures 7 and 8 show the performance of the model in terms of the fraction of plants and employment shares at different bins of the plant-size distribution.

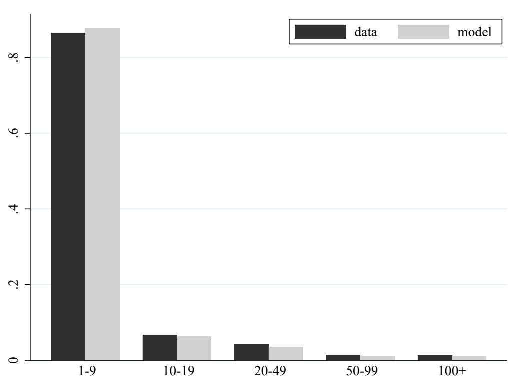


Figure 7: Fraction of Plants

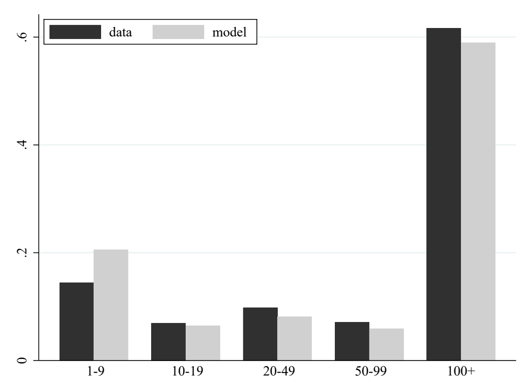


Figure 8: Employment Shares

Note: These figures present properties of the plant size distribution in terms of model and in the Danish data. The left panel shows fractions of plants at different bins of the plant-size distribution, whereas the right panel displays the corresponding shares of total employment.

A few comments are in order. First, our choices imply an aggregate capital to output ratio of around 3.1 in steady state, in line with standard estimates. Second, as it is well known, employment is highly concentrated in large production plants. Plants with more that 100 workers constitute about 1% of the total number of plants, but they account for a disproportionate share of employment – about 61.7%. Our parsimonious model – via the complementary role of middle managers – can generate the high levels of employment concentration at the top. We note that our model matches well the distribution of employment by size in data, beyond targeted values, as Figures 7, 8 and Table 3 show. All this occurs with a standard log-normal distribution of managerial ability. Finally, our benchmark parameterization successfully matches the properties of the time tax in Denmark, with a low average value and with a higher incidence for top managers at large plants. Our choices result in values for the level parameter τ_0 of 0.054, and a size-dependency parameter of 0.015. These parameters determine the observed time taxes for Denmark; of 6.4% on average and a time tax for plants with 100+ workers of about 7.1%.

Implications We now contrast the implications of our model with data that we have not targeted. First, we check the implications of our parameterization for inequality, and contrast the implied value of earnings dispersion among managers in the model against data. We use Danish data from EU-SILC, and focus on full time, paid managers for the year 2016 (the same year of our plant-size data). We define the earnings of (all) managers to be cash plus noncash income from the main job, and drop observations of those who report less than 30 hours of work per week. The data implies a variance of log managers' income of about 0.83. Our calibrated model lines very well against this observation, and implies a variance of log-income of all managers of 0.83 as well.

We also check a theoretical prediction of the model against data. Our model implies that the elasticity of output (value added) with respect to employment is 1. This is implied by our analysis in the appendix. We use the data from the World Bank Enterprise Survey for Denmark in 2019, and construct a notion of value added at the plant level (sales minus purchases of intermediate inputs), and estimate a corresponding elasticity from this data. Again, our model is in line with data, as the elasticity is estimated (significantly) at 1.01.

5 Findings

In this section, we present and discuss the central quantitative results of the paper. We first explore the implied responses of our model economy to variations in the level of the time tax, and then evaluate the implications for specific countries. We then quantify the importance of changes in the size dependency of the time taxes.

5.1 Changes in the Time Tax: Levels

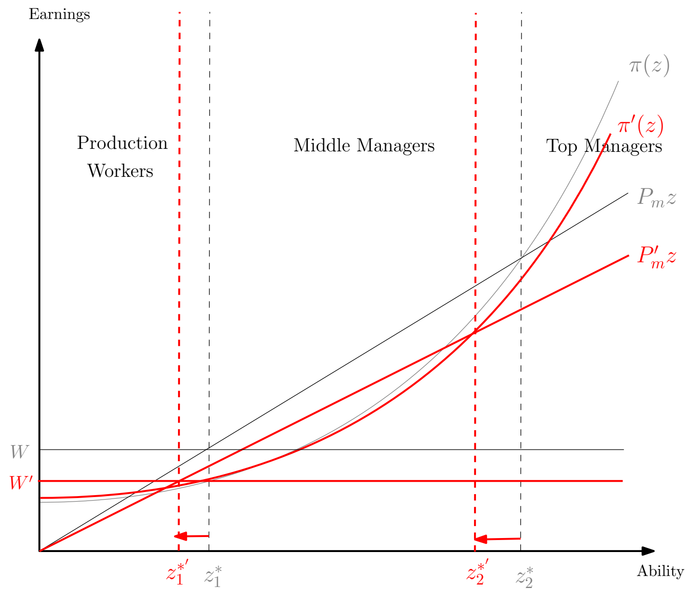
We now evaluate the consequences associated to changing the level of the time tax across steady states. In Table 4 we present the consequences of varying the 'level' of time tax (τ_0) on a host of variables. Note that the benchmark economy (Denmark) is characterized by a relatively low value of τ_0 (0.054), which in conjunction with the calibrated value of τ_1 (0.015), implies an average time tax of 6.4%. As τ_0 increases, the time tax increases on all managers and output declines. Quantitatively, the decline is substantial; a rise from the benchmark level of τ_0 to a value of 0.15 implies a decline in output of nearly one third (33.5%) with a resulting average time tax of about 16.6%. This high value is well within the empirical range for middle income countries, as we showed in section 2 and discuss in more detail below.

The increase in τ_0 leads to an equilibrium reallocation of output and employment from larger to smaller plants, with a resulting reduction in mean size of more than four employees on average as τ_0 reaches 0.15. The share of employment at large plants drops from the baseline value to 45.8% (about eighteen percentage points), with a concomitant increase in the share of employment accounted for by small plants, as Table 4 illustrates.

Why do these equilibrium effects take place? As the time tax increases, the number of feasible activities within a given plant becomes lower and thus, output and managerial rents drop at fixed prices in conjunction with a reduction in the demand for labor and capital services. But, given the properties of the function M, which features increasing returns to top managerial ability, the drop in the demand of inputs is disproportionately larger in larger plants (run by more able top managers). This leads to equilibrium changes in occupational choices and thus, the size of production plants in equilibrium. Figure 9 illustrates these effects. The figure illustrates that the reduction in managerial rents takes place alongside an equilibrium reduction in the wage rate for production workers and the price of middle management efficiency units. This results in a decline in the equilibrium thresholds $\hat{z}_1^*$ and $\hat{z}_2^*$, which determines a reduction in the number of production workers, an increase in the number of top managers, and ambiguous effects on the number of middle managers. Altogether, this implies the reduction in mean size that the findings in Table 4 show.

The large effects on output driven by changes in the time tax are also connected to

Figure 9: Equilibrium Effects of Changes in the Time Tax.



Notes: This figure illustrates the effects of an increase in the time tax on occupational choices.

the changes in capital formation across steady states, with no effects on capital-output ratios as we elaborated earlier. Across steady states, the rental rate of capital is constant as τ_0 changes. Hence, as the demand for capital services drops upon an increase in the time tax, the aggregate stock of capital decreases in the new steady state as the rate of return has to be constant across steady-state equilibria.

Number and Quality of Managers Our results also show, via composition effects, a decline in the quality of management for both top managers and for middle managers across steady states. Table 4 shows a corresponding decline in the number of managers per plant. We find that the number of managers per plant decline from the benchmark value of 1.3 to 1.1 as the level of the time tax increases from the benchmark value to $\tau_0 = 0.15$. Here, we note that while the total number of managers (top and middle) increases, the number of plants increases as well.

The relatively small movements in the number of managers per plant masks the substantial changes in the organization of production induced by the increase in the level of the time tax. In the benchmark economy, the bulk of managers are concentrated at large plants. While plants with 50-99 employees have only 2.5 managers on average, plants with more than 100 employees have 21.9 managers on average as Table 4 shows. This drastically changes with increases in the level of the time tax. At $\tau_0 = 0.15$, the number of managers at large plants (100+) becomes 14.4 – a drop of more than 7 managers on average – while number of managers at plants with 50-99 employees changes only to 2.3. These findings underlie the substantial changes in output that we find across steady states as the level of time taxes increases.[5]

Overall, it is worth relating our results to properties of standard span-of-control models. In a standard model along the lines of Lucas (1978), changes in the level of the time tax are akin to a change in aggregate productivity, common to all plants. Hence, under a Cobb-Douglas technology, these changes simply result in a drop in aggregate output, with no effects on occupational choices and plant size. In contrast, the mechanism in our environment implies effects beyond standard ones on output. It determines a reduction in plant size and a reallocation of employment and output towards smaller plants, providing an alternative rationale for differences in plant size across countries.

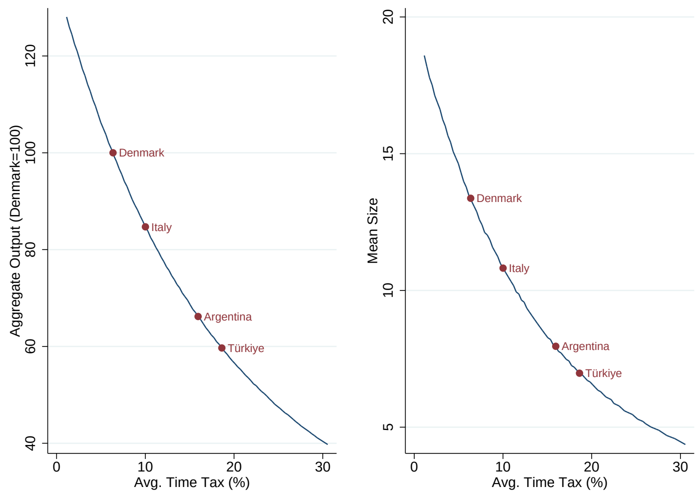
Country-specific Effects In Figure 10 we associate observed levels of the average time tax, with changes in output and mean size driven by changes in τ_0. To construct the figure, we vary τ_0 from its benchmark value to reproduce exactly the value of average time taxes in the data. We show the implied values of output and mean size in steady state alongside the average time tax. For illustrative purposes, we consider four countries; Italy, Argentina and Türkiye, keeping the benchmark case of Denmark in the figure. Note that for Denmark, by construction, we match the mean size observed in the data.

The figure highlights the substantial effects predicted by the model when the time tax varies. A shift from time-tax levels observed in Denmark to Italy implies a fall in output of more than 10%, and a corresponding reduction of about 1/3 for the case of Argentina. For output, the model naturally falls short of accounting for the actual differences in output per working-age adult. Note that relative to Denmark in 2019, corresponding actual values are 73.8%, 34.5% and 37.3%, for Italy, Argentina and Türkiye, respectively.

[5] To calculate these figures, we first calculate the mean efficiency level of a middle manager in each economy (i.e. under different levels of τ_0). With this information, we infer the number of middle managers at different size bins.

The model goes a long way in generating size differences in line with data. Mean plant size in data (model) amounts to 10.9 (10.8), 4.1 (8.0) and 4.0 (7.0) employees, for Italy, Argentina and Türkiye, respectively.

Figure 10: Equilibrium Effects of Changes in the Time Tax.



Notes: This figure illustrates the effects on aggregate output and mean size for Italy, Argentina and Türkiye, driven by changes in τ_0 that generate the observed levels of time-tax average taxation. The years considered for different countries are 2006, 2019 and 2013, for Argentina, Italy and Türkiye, respectively.

Implications for Measured TFP Our analysis has implications for inferences on Total Factor Productivity (TFP) as a source of cross-country income differences, and indicates that a substantial role of time taxes in measured differences. To see this, consider a naive observer who has data on our economy under different levels of the time tax. Under traditional assumptions, the observer postulates a Cobb-Douglas aggregate technology, with capital share a and without any adjustment for labor efficiency units.

With these assumptions, one can write output per person as

$$y = \text{TFP}^{\frac{1}{1-\alpha}} \upsilon^{\frac{a}{1-a}}, \tag{21}$$

where υ is the capital to output ratio. In our economy, this ratio is invariant to changes in the time tax across steady states. Thus, the equation above can be used to infer TFP differences. In our case, the capital share takes the standard value of 0.33. This implies that if observed output per person is lower by 33.5% as in Table 4 (from the benchmark to $\tau_0 = 0.15$), TFP is lower by about 23.9%. As we argued above, shifts in levels of time taxes of this magnitude are consistent with observations of middle-income countries like Argentina, Türkiye and others. Thus, from the lens of our model, we conclude that differences in time taxes can be an important source of differences in measured TFP across countries.

5.2 Changes in the Time Tax: Size Dependency

We now entertain the effects across steady states associated with changes in the curvature parameter τ_1, that governs the size dependency of the time tax. Note that increasing τ_1 tilts the function $\tau(.)$ counterclockwise, increasing the time tax for top managers running large plants while (potentially) reducing it at smaller plants.

Our results are summarized in Table 5, where we present results ranging from $\tau_1 = 0$ to $\tau_1 = 0.06$, covering a range of empirically plausible values as we discuss below. Note that increasing τ_1 from the benchmark value to a $\tau_1 = 0.06$, increases the mean time tax from 6.4% to about 9.0%, while increasing the tax for large plants from the benchmark value of 7.1% by more than 5 percentage points. An increase in τ_1 increases the time tax more heavily for those top managers running larger plants, who reduce their demand for labor and capital services. This determines, in equilibrium, a reduction in mean plant size, an increase (reduction) in the employment share of smaller (larger) plants, and a change in the organization of plants at the top as previously. Output declines, due to the reduction of output at top plants alongside a reallocation towards smaller plants, and the concomitant reduction of aggregate capital across steady states.

Quantitatively, the effects of changes in τ_1 across steady states can be substantial. Increasing size dependency from its benchmark value to $\tau_1 = 0.04$, implies an increase in the average time tax of one and a half percentage point, but it leads to decline of output of 12.7%, to a reduction in mean size of about 3.2 employees alongside a sharp reduction in the employment share of large plants of more than nine percentage points. The average number of managers at large plants drops by more than five, from the benchmark value of 21.9 to about 17.5.

Altogether, these findings indicate that the effects of changes in the level of size dependency can be important, even when taking into account that the first-order source of variation in the time tax across countries is in levels. We return later to this issue in the next section when we analyze the joint effects of levels and size dependency of time taxes for specific countries.

6 Discussion

We now provide a discussion on the quantitative findings emerging from our model. We first evaluate the implications of time taxes for differences in income across countries. We then assess the output gains for selected countries of adopting the structure of (low) time taxes of Denmark. Finally, we examine the implications of an alternative parameterization, with different values for the elasticity of substitution among tasks at the plant level (σ).

6.1 Cross-Country Income Differences

How important are time taxes in generating dispersion in output in our sample of countries? Our model can provide an answer to this question. We start by noting that while we consider a set of middle income and rich countries in our data, the observed differences in output per working-age adult are substantial. Note that the output gap between Denmark and the poorest economy in our data exceeds a factor of 3.5.

To answer this question, we reproduce the average time taxes for each country-year observation in our data via variations in the level parameter τ_0. We do so as the primary source of variation of time taxes in data is due to its levels, as we discussed in section 2. The resulting output disparities across economies highlight the effects of only varying the level of time taxes in line with data.

Figure 11 illustrates our findings. As the figure shows, the vast majority of economies is above the 45-degree line. Thus, save a few exceptions, the model naturally predicts less variation in output than it is observed in data. To quantify the contribution of variation in time taxes on output per adult, we compute a measure of dispersion in output in the model and in the data. We find that the model accounts for about 42.7% of the variance of log-output per adult in the data. Thus, our model implies that the observed burden of

Figure 11: Cross-Country Income Differences in the Model vs Data

Notes: This figure compares the model's prediction of aggregate output when it is disciplined to match each country's average time tax in the data using τ_0. Each dot represents a country-year and the solid line is the 45-degree line. We choose units so that he benchmark economy matches output in the data.

time taxes can go a long way in accounting for the observed disparities in output in our sample of middle income and rich countries.[6]

6.2 Output Gains from Benchmark Time Taxes

We now focus on a different, but related question to income differences across countries. What are the gains in output associated to adopting the benchmark economy (Denmark) time taxes?

We answer this question for three selected countries/years that we discussed earlier; Argentina, Türkiye, and Italy. We proceed as follows. We calibrate again our model for each country, where we impose its time taxes, both in terms of their level (τ_0) and their curvature (τ_1), and also force these economies to be consistent with their level of output relative to Denmark. The rest of parameters are from the benchmark's case. To match each country's relative output, we adjust the function M by the factor $\bar{M}^{-\lambda}$. Thus, a value of $\lambda > 0$, implies that all top managers in the economy can perform fewer tasks, and thus, output at the plant level and at the aggregate is lower. This is equivalent in our

[6]The variance of log output per working-age adult in the data is 0.136.

context to imposing different levels of exogenous, economy-wide productivity. We then impose the time-tax structure of Denmark to each of these cases.

Our results are displayed in Table 6, where the last row presents the counterfactual output levels associated to Danish time taxes. We first note how the productivity factor varies across countries, depending on the required values of τ_0, τ_1, and the output gap. Argentina and Türkiye in the years considered are similar in terms of the output gap relative to Denmark, while Türkiye has higher average time taxes with a stronger degree of size dependency. Thus, to match the observed gaps in output per adult, this dictates a larger adjustment factor λ for Argentina than for Türkiye, as the Table demonstrates. An equivalent reasoning explains the low adjustment factor for a richer economy like Italy.

The above considerations explain the larger gains in output for Türkiye than in Argentina from a shift to Danish time taxes, as well as a smaller gain for Italy. Our results imply that the steady-state output increase for a hypothetical Argentina is about 51% while it does by much more for Türkiye – about 79%. The output gain for Italy amounts to about 27.6%. Needless to say, these gains in output for middle income economies like Argentina or Türkiye, while sizeable, are far from enough to close the development gap. The output gap between a hypothetical Argentina (2006) and Denmark (2019) is a factor of 2.9, while the corresponding gap with Türkiye (2013) is a factor of about 2.7.

6.3 The Role of the Elasticity of Substitution

Our quantitative results rely on an external estimate of the elasticity of substitution between intermediate inputs in the production process, σ. We used the robust estimate, 6.6, from Broda & Weinstein (2006), but there is range of estimates presented therein, depending on how narrow the classification of goods is. Other authors have used lower values. Bento & Restuccia (2017) and Hsieh & Klenow (2009) used a much lower value of 3. Poschke (2018) uses a value of 4. Atkeson & Burstein (2010) use a value of 5.

It turns out that our findings are quite robust to the precise value of the elasticity parameter, once all internal model parameters are calibrated again. If we choose a value of $\sigma = 4$ and recalibrate internal parameters, the effects of increasing the level of time taxes via τ_0, from the Denmark values to $\tau_0 = 0.15$ determine a decline in output of 35.5% and a reduction in mean size of about 5.3 employees across steady states. Instead, choosing $\sigma = 8$ implies a decline in output of 34.1% and a reduction in mean size of about 5.7 employees. The corresponding effects in our baseline case displayed in Table 4 dictate a decline in output of about 33.5% and an decline in mean size of about 5.4 employees.

Equivalent results hold if we change the parameter controlling size dependency, τ_1. We conclude from these findings that uncertainty about the precise value of the substitution elasticity is not a concern in terms the predicted effects from changes in the time tax.

7 Concluding Remarks

We have documented in detail properties of the time burden on top managers associated to government regulations – the *time tax* – in a set of middle-income and rich countries. We find that the incidence of the time tax is substantially larger in poorer countries relative to their richer counterparts. This finding and others are robust to a number of controls, and in particular, hold for the manufacturing and service sectors separately.

We then developed a simple span-of-control growth model in order to quantify the role of time taxes in the macroeconomy. We calibrate this model to observations from Denmark, one of the richest economies in our data, featuring a low level of a time tax. Our findings indicate that variation in time taxes within a range consistent with the cross-country data leads to substantial effects on output and plant size in the long run. For instance, we find that increasing the time tax from Danish levels to a level consistent with values observed in Argentina in 2006, implies a drop in output of almost a third, and a reduction in mean plant size of more than 5 employees.

We conclude the paper with two comments. First, our analysis effectively leads to a simple theory of Total Factor Productivity (TFP) disciplined by observations on the time tax. It implies that variation in time taxes in line with data leads to a large variation in measured TFP, without effects on rates of return or capital-output ratios in the long run. Therefore, it contributes to rationalize the measured differences in TFP that the literature has extensively documented.

Second, our analysis takes the distribution of managerial ability as given. In particular, we have assumed throughout that the distribution of managerial abilities is invariant to time taxes. It is natural to conjecture that changes in time taxes would affect such distribution via complementary investments to foster managerial skills, as in Guner *et al.* (2018) and Esfahani (2022). Thus, the predicted effects on output and the size distribution of plants from changes in time taxes are arguably larger than those found in this paper. We leave this and other extensions for future work.

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Table 1: Relationship between the time tax and the level of development after controlling establishment characteristics

Dependent Variable: Log (1-Time Tax)	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS	(8) OLS	(9) OLS	(10) Tobit
Log RGDP per working age pop.	0.0985***	0.103***	0.0951***	0.0870***	0.0847***	0.0835***	0.0851***	0.0840***	0.0838***	0.107***
	(0.0123)	(0.0129)	(0.0121)	(0.0119)	(0.0120)	(0.0119)	(0.0118)	(0.0121)	(0.0121)	(0.00699)
Experience of the top manager-log		-0.0138*	-0.0123	-0.00373	-0.00305	-0.00277	-0.00222	-0.000116	-0.000249	0.000202
		(0.00699)	(0.00683)	(0.00709)	(0.00703)	(0.00702)	(0.00711)	(0.00747)	(0.00752)	(0.00292)
Number of workers-log			-0.0163***	-0.0137**	-0.0150**	-0.0160**	-0.0151**	-0.0164**	-0.0165**	-0.0163***
			(0.00461)	(0.00454)	(0.00478)	(0.00491)	(0.00505)	(0.00544)	(0.00615)	(0.00179)
Age of the establishment (as of 2020)-log				-0.0288***	-0.0296***	-0.0294***	-0.0294***	-0.0339***	-0.0339***	-0.0471***
				(0.00743)	(0.00771)	(0.00772)	(0.00772)	(0.00799)	(0.00811)	(0.00370)
Multi-establishment					0.0199	0.0149	0.0135	0.0137	0.0135	0.0210**
					(0.0139)	(0.0140)	(0.0140)	(0.0157)	(0.0158)	(0.00639)
Pct. owned by foreigns						0.0376*	0.0447**	0.0502**	0.0495**	0.0500***
						(0.0171)	(0.0162)	(0.0176)	(0.0182)	(0.0101)
Pct. of sales coming from exports							-0.0401	-0.0436	-0.0425	-0.0462***
							(0.0218)	(0.0229)	(0.0224)	(0.00943)
Female top manager								-0.0240	-0.0240	-0.0239***
								(0.0138)	(0.0139)	(0.00524)
Establishment has a bank loan/line of credit									0.000223	-0.00659
									(0.0128)	(0.00399)
Constant	-1.175***	-1.183***	-1.054***	-0.904***	-0.882***	-0.873***	-0.893***	-0.960***	-0.957***	-1.162***
	(0.130)	(0.131)	(0.122)	(0.122)	(0.125)	(0.125)	(0.125)	(0.134)	(0.134)	(0.146)
var(e.logoneminusj2)										0.118***
										(0.00103)
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num. of Obs.	42664	42156	42152	41890	41890	41649	41536	36137	35936	35936

Standard errors in parentheses

In OLS estimations,Huber-White robust standard errors are reported in parenthesis and they are clustered at country year, sampling region, sampling size and sampling sector level.

In Tobit estimations, average marginal effects are reported

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: Benchmark Parameter Values.

Parameter	Description	Value
	Exogenous	
β	Discount Factor	0.95
δ	Depreciation Rate	0.055
μ	Mean of ability distribution	0
$(1-\alpha)\gamma$	Capital Share	0.33
	Calibrated	
σ_z^2	Variance of ability distribution	0.144
ϕ	Efficiency of middle management	0.60
θ	Diminishing returns on middle management	0.009
γ	Span-of-control parameter	0.71
$\bar{M}$	Level parameter	57.9
τ_0	Level of time tax	0.054
τ_1	Size dependency of time tax	0.015

Note: This table shows the parameter values of our benchmark calibration. The top panel displays the exogenously set parameters, whereas the bottom panel presents the parameter values that are found in order to reproduce data.

Table 3: Benchmark Model Performance

	Data	Model
Mean size	13.3	13.4
Managers per plant	1.3	1.33
Fraction of plants (%)		
1-9	86.5	87.8
10-19	6.6	6.3
Employment share large plants (100+, %)	61.7	58.9
Average time tax	6.4	6.4
Average time tax 100+	7.1	7.1

Note: Table entries summarize the performance of the benchmark model in terms of empirical targets.

Table 4: Changes in the Level of the Time Tax

	$\tau_0 = 0.0$	Benchmark $\tau_0 = 0.054$	$\tau_0 = 0.10$	$\tau_0 = 0.15$
Mean Size	18.6	13.4	10.3	8.0
Output	128.1	100.0	81.6	66.5
Capital-Output Ratio	3.1	3.1	3.1	3.1
Employment Share (Small Plants) (%)	20.3	27.1	34.1	42.6
Employment Share (Large Plants) (%)	67.7	58.9	50.4	40.8
Managers per Plant	1.5	1.3	1.2	1.1
Number of Managers (Large Plants)	27.6	21.9	17.8	14.4
Top Managers Mean Ability	104.9	100.0	96.0	91.7
Middle Manager Mean Ability	105.1	100.0	96.1	92.2
Time Tax (Mean, %)	1.1	6.4	10.9	15.8
Time Tax (Large Plants, %)	1.9	7.1	11.7	16.6

Note: This table presents the quantitative experiments with different values of the level parameter of the tax function, τ_0. In this exercises, all the parameters except τ_0 are held constant at the benchmark values. Aggregate output at the benchmark is normalized to 100. Large Plants are plants with 100 employees or more. Small plants are those with 1-19 employees.

Table 5: Changes in the Size Dependency of the Time Tax

	$\tau_1 = 0.0$	Benchmark $\tau_1 = 0.015$	$\tau_1 = 0.04$	$\tau_1 = 0.06$
Mean Size	15.9	13.4	10.2	8.6
Output	108.7	100.0	87.3	79.4
Capital-Output Ratio	3.1	3.1	3.1	3.1
Employment Share (Small Plants) (%)	23.2	27.1	34.5	40.6
Employment Share (Large Plants, %)	64.0	58.9	49.6	42.5
Managers per Plant	1.4	1.3	1.2	1.2
Number of Managers (Large Plants)	25.4	21.9	17.5	12.8
Top Managers Mean Ability	102.8	100.0	96.2	93.4
Middle Managers Mean Ability	102.9	100.0	95.9	93.0
Time Tax (Mean, %)	5.4	6.4	7.9	9.0
Time Tax (Large Plants, %)	5.4	7.1	10.2	12.5

Note: This table presents the quantitative experiments with different values of the curvature parameter of the tax function, τ_1, that defines the degree of size dependency of time taxes. In this exercises, all the parameters except τ_1 are held constant at the benchmark values. Aggregate output at the benchmark is normalized to 100. Large plants are plants with 100 employees or more. Small plants are those with 1-19 employees.

Table 6: Output Gains from Reducing Time Taxes

Parameter	DNK (2019)	ARG (2006)		ITA (2019)		TUR (2013)	
τ_0	0.053	0.151		0.073		0.159	
τ_1	0.015	0.015		0.044		0.056	
λ	0	-0.843		-0.078		-0.521	
Statistic	Model	Data	Model	Data	Model	Data	Model
Time Tax (Mean, %)	6.3	16.0	16.0	10.0	10.0	18.7	18.7
Time Tax (100+, %)	7.1	16.8	16.8	12.6	12.6	21.9	22.0
Output	100.0	34.5	34.5	73.8	74.5	37.3	37.3
Output (DK Time Tax)	100.0	-	52.2	-	94.2	-	66.8

Note: This table presents the parameterization of the economies of Argentina, Italy and Türkiye to reproduce the time tax in each case, in conjunction with their output level relative to the benchmark. The benchmark case (Denmark) is reproduced for illustration. The last row shows the output level when the Danish time taxes are imposed in each case. See text for details.

Appendix

A List of Countries

Table A.1: Survey Years and the Number of Observations in WBES

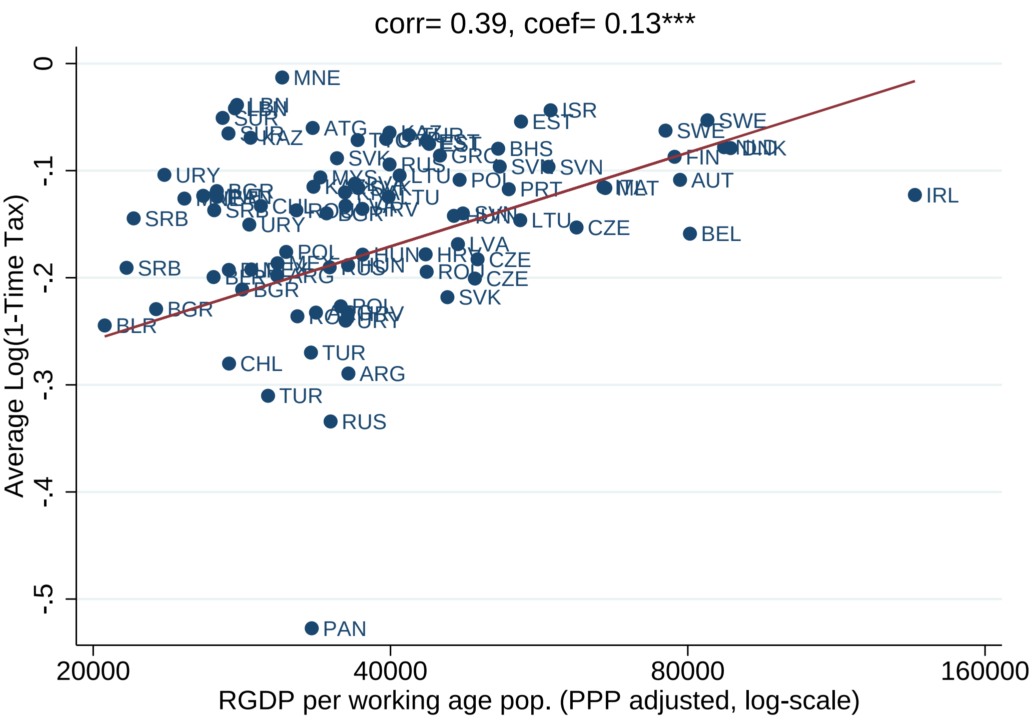
Country	Survey Year(s)	Number of Observations
Antigua and Barbuda	2010	134
Argentina	2006, 2010, 2017	2718
Austria	2021	572
Bahamas, The	2010	121
Belarus	2008, 2013, 2018	963
Belgium	2020	576
Bulgaria	2007, 2009, 2013, 2019	1953
Chile	2006, 2010	1845
Croatia	2007, 2013, 2019	1249
Cyprus	2019	189
Czech Republic	2009, 2013, 2019	855
Denmark	2020	931
Estonia	2009, 2013, 2019	797
Finland	2020	738
Greece	2018	580
Hungary	2009, 2013, 2019	1162
Ireland	2020	585
Israel	2013	426
Italy	2019	671
Kazakhstan	2009, 2013, 2019	1817
Latvia	2009, 2013, 2019	735
Lebanon	2013, 2019	984
Lithuania	2009, 2013, 2019	746
Malaysia	2015	797
Malta	2019	226
Mexico	2009, 2010	2679

Table A.1: Survey Years and the Number of Observations in WBES

Country	Survey Year(s)	Number of Observations
Montenegro	2009, 2013, 2019	271
Netherlands	2020	794
Panama	2006, 2010	631
Poland	2009, 2013, 2019	1093
Portugal	2019	822
Romania	2009, 2013, 2019	1456
Russian Federation	2009, 2012, 2019	4469
Serbia	2009, 2013, 2019	913
Slovak Republic	2009, 2013, 2019	714
Slovenia	2009, 2013, 2019	862
St. Kitts and Nevis	2010	128
Suriname	2010, 2018	307
Sweden	2020	1114
Trinidad and Tobago	2010	330
Türkiye	2008, 2013, 2019	3209
Uruguay	2006, 2010, 2017	1220

B Time Tax on Manufacturing and Services Sectors

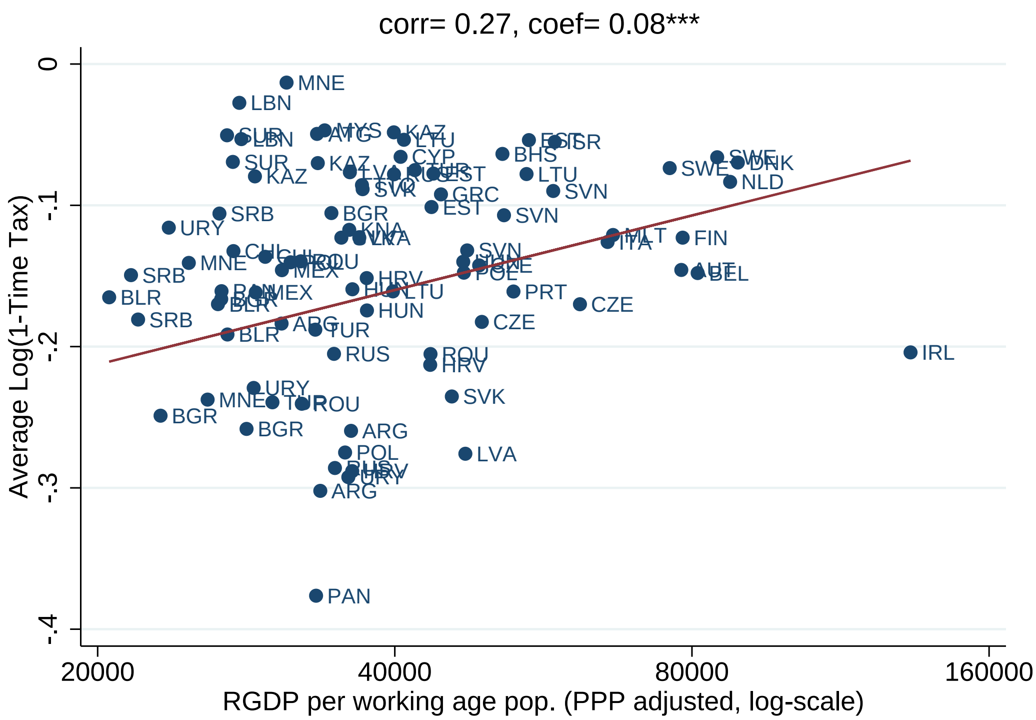
Figure B.1: Time Tax in Manufacturing Sector



Sources: WBES and WDI

Notes: This figure shows the relationship between the log of 1 minus the time tax and RGDP per working age adult in manufacturing sector. Each dot represents a country at a survey year. Solid line is the simple weighted regression line where dependent variable is the average time tax and the independent variable is the RGDP per working age adult. The countries are weighted according to their employment sizes.

Figure B.2: Time Tax in Services Sector



Sources: WBES and WDI

Notes: This figure shows the relationship between the log of 1 minus the time tax and RGDP per working age adult in services sector. Each dot represents a country at a survey year. Solid line is the simple weighted regression line where dependent variable is the average time tax and the independent variable is the RGDP per capita. The countries are weighted according to their employment sizes.

Table B.2: Manufacturing: Relationship between the time tax and the level of development after controlling establishment characteristics

Dependent Variable: Log (1-Time Tax)	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS	(8) OLS	(9) OLS	(10) Tobit
Log RGDP per working age pop.	0.126***	0.128***	0.124***	0.124***	0.125***	0.123***	0.124***	0.131***	0.132***	0.163***
	(0.0173)	(0.0175)	(0.0176)	(0.0185)	(0.0193)	(0.0189)	(0.0186)	(0.0196)	(0.0195)	(0.00985)
Experience of the top manager-log		-0.0136	-0.0140	-0.0168	-0.0172	-0.0161	-0.0161	-0.0117	-0.0108	-0.0132**
		(0.00858)	(0.00848)	(0.00903)	(0.00903)	(0.00892)	(0.00899)	(0.00820)	(0.00824)	(0.00400)
Number of workers-log			-0.0118**	-0.0130**	-0.0122**	-0.0131**	-0.0127**	-0.0145*	-0.0126*	-0.00964***
			(0.00403)	(0.00457)	(0.00464)	(0.00471)	(0.00491)	(0.00564)	(0.00606)	(0.00240)
Age of the establishment (as of 2020)-log				0.00273	0.00289	0.00308	0.00324	-0.00253	-0.00200	-0.0156**
				(0.0115)	(0.0117)	(0.0118)	(0.0119)	(0.0128)	(0.0127)	(0.00482)
Multi-establishment					-0.0105	-0.0155	-0.0164	-0.0328	-0.0344	-0.0368***
					(0.0242)	(0.0251)	(0.0252)	(0.0347)	(0.0350)	(0.00872)
Pct. owned by foreigns						0.0436*	0.0454*	0.0649**	0.0595**	0.0615***
						(0.0187)	(0.0187)	(0.0202)	(0.0213)	(0.0138)
Pct. of sales coming from exports							-0.0103	-0.0144	-0.00921	-0.0182
							(0.0241)	(0.0252)	(0.0254)	(0.0103)
Female top manager								-0.0467	-0.0485	-0.0467***
								(0.0325)	(0.0322)	(0.00757)
Establishment has a bank loan/line of credit									-0.0269	-0.0348***
									(0.0140)	(0.00549)
Constant	-1.456***	-1.440***	-1.356***	-1.359***	-1.365***	-1.348***	-1.363***	-1.524***	-1.519***	-1.818***
	(0.182)	(0.182)	(0.188)	(0.205)	(0.213)	(0.209)	(0.206)	(0.225)	(0.223)	(0.142)
var(e.logoneminusj2)										0.121***
										(0.00146)
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num. of Obs.	24551	24248	24245	24079	24079	23966	23918	19061	18953	18953

Standard errors in parentheses

In OLS estimations,Huber-White robust standard errors are reported in parenthesis and they are clustered at country year, sampling region, sampling size and sampling sector level.

In Tobit estimations, average marginal effects are reported

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B.3: Services: Relationship between the time tax and the level of development after controlling establishment characteristics

Dependent Variable: Log (1-Time Tax)	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS	(8) OLS	(9) OLS	(10) Tobit
Log RGDP per working age pop.	0.0877***	0.0931***	0.0823***	0.0700***	0.0647***	0.0641***	0.0642***	0.0628***	0.0624***	0.0808***
	(0.0156)	(0.0169)	(0.0153)	(0.0148)	(0.0144)	(0.0144)	(0.0143)	(0.0146)	(0.0146)	(0.0101)
Experience of the top manager-log		-0.0136	-0.0106	0.00466	0.00581	0.00572	0.00704	0.00620	0.00581	0.00842*
		(0.00975)	(0.00940)	(0.00969)	(0.00953)	(0.00954)	(0.00971)	(0.00979)	(0.00987)	(0.00429)
Number of workers-log			-0.0195**	-0.0151*	-0.0174*	-0.0185*	-0.0183*	-0.0187*	-0.0194*	-0.0211***
			(0.00721)	(0.00684)	(0.00715)	(0.00730)	(0.00732)	(0.00732)	(0.00822)	(0.00267)
Age of the establishment (as of 2020)-log				-0.0463***	-0.0486***	-0.0483***	-0.0480***	-0.0485***	-0.0488***	-0.0630***
				(0.00948)	(0.00975)	(0.00977)	(0.00978)	(0.00980)	(0.0101)	(0.00555)
Multi-establishment					0.0409**	0.0361*	0.0350*	0.0351*	0.0348*	0.0490***
					(0.0154)	(0.0148)	(0.0147)	(0.0149)	(0.0149)	(0.00938)
Pct. owned by foreigns						0.0338	0.0436	0.0434	0.0433	0.0408**
						(0.0247)	(0.0234)	(0.0236)	(0.0243)	(0.0147)
Pct. of sales coming from exports							-0.0783*	-0.0792*	-0.0791*	-0.0779***
							(0.0364)	(0.0367)	(0.0365)	(0.0162)
Female top manager								-0.0178	-0.0171	-0.0184*
								(0.0143)	(0.0146)	(0.00752)
Establishment has a bank loan/line of credit									0.0108	0.00362
									(0.0168)	(0.00582)
Constant	-1.022***	-1.032***	-0.877***	-0.697***	-0.634***	-0.625***	-0.632***	-0.612***	-0.614***	-0.768
	(0.163)	(0.165)	(0.148)	(0.144)	(0.142)	(0.143)	(0.143)	(0.145)	(0.146)	(0.412)
var(e.logoneminusj2)										0.117***
										(0.00149)
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num. of Obs.	18113	17908	17907	17811	17811	17683	17618	17076	16983	16983

Standard errors in parentheses

In OLS estimations,Huber-White robust standard errors are reported in parenthesis and they are clustered at country year, sampling region, sampling size and sampling sector level.

In Tobit estimations, average marginal effects are reported

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

C Robustness

Table C.4: Baseline Regression using restricted sample

Dependent Variable: Log (1-Time Tax)	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS	(8) OLS	(9) OLS	(10) Tobit
Log RGDP per working age pop.	0.0463***	0.0511***	0.0469***	0.0437**	0.0448**	0.0437**	0.0483**	0.0485**	0.0490**	0.0560***
	(0.0135)	(0.0139)	(0.0141)	(0.0141)	(0.0148)	(0.0148)	(0.0154)	(0.0154)	(0.0154)	(0.00627)
Experience of the top manager-log		-0.0102	-0.00855	0.00457	0.00409	0.00425	0.00453	0.00349	0.00370	0.00398
		(0.00661)	(0.00679)	(0.00761)	(0.00755)	(0.00755)	(0.00761)	(0.00801)	(0.00804)	(0.00324)
Number of workers-log			-0.0113*	-0.00850	-0.00750	-0.00903	-0.00766	-0.00799	-0.00681	-0.00117
			(0.00508)	(0.00522)	(0.00485)	(0.00475)	(0.00482)	(0.00491)	(0.00514)	(0.00207)
Age of the establishment (as of 2020)-log				-0.0262***	-0.0256**	-0.0258**	-0.0258**	-0.0259**	-0.0257**	-0.0339***
				(0.00765)	(0.00810)	(0.00812)	(0.00815)	(0.00809)	(0.00807)	(0.00328)
Multi-establishment					-0.0105	-0.0150	-0.0166	-0.0171	-0.0181	-0.0276***
					(0.0203)	(0.0209)	(0.0211)	(0.0213)	(0.0213)	(0.00633)
Pct. owned by foreigns						0.0403*	0.0477**	0.0482**	0.0470*	0.0496***
						(0.0187)	(0.0184)	(0.0186)	(0.0191)	(0.0116)
Pct. of sales coming from exports							-0.0479	-0.0485	-0.0458	-0.0421***
							(0.0249)	(0.0249)	(0.0252)	(0.0109)
Female top manager								-0.0187	-0.0200	-0.0198***
								(0.0176)	(0.0174)	(0.00532)
Establishment has a bank loan/line of credit									-0.0167	-0.0268***
									(0.00900)	(0.00406)
Constant	-0.633***	-0.652***	-0.539***	-0.459**	-0.478**	-0.456**	-0.476**	-0.471**	-0.471**	-0.546
	(0.154)	(0.153)	(0.162)	(0.163)	(0.177)	(0.176)	(0.179)	(0.178)	(0.177)	(0.995)
var(e.logoneminusj2)										0.0746***
										(0.000857)
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num. of Obs.	22818	22539	22537	22445	22445	22321	22258	22243	22117	22117

Standard errors in parentheses

In OLS estimations,Huber-White robust standard errors are reported in parenthesis and they are clustered at country year, sampling region, sampling size and sampling sector level.

In Tobit estimations, average marginal effects are reported

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.5: Baseline Regression with Country and Sector FE's using initial sample

Dependent Variable: Log (1-Time Tax)	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS	(8) OLS	(9) OLS	(10) Tobit
Log RGDP per working age pop.	0.324***	0.320***	0.299***	0.269***	0.270***	0.271***	0.266***	0.299***	0.300***	0.483***
	(0.0526)	(0.0535)	(0.0512)	(0.0496)	(0.0496)	(0.0498)	(0.0503)	(0.0529)	(0.0539)	(0.0212)
Experience of the top manager-log		-0.0101	-0.00846	-0.00428	-0.00370	-0.00343	-0.00322	-0.00127	-0.00142	-0.00376
		(0.00825)	(0.00805)	(0.00799)	(0.00792)	(0.00789)	(0.00794)	(0.00839)	(0.00836)	(0.00302)
Number of workers-log			-0.0131**	-0.0119**	-0.0127**	-0.0139***	-0.0127**	-0.0140**	-0.0141**	-0.0115***
			(0.00409)	(0.00406)	(0.00416)	(0.00423)	(0.00434)	(0.00462)	(0.00526)	(0.00183)
Age of the establishment (as of 2020)-log				-0.0170*	-0.0171*	-0.0165*	-0.0168*	-0.0195*	-0.0193*	-0.0236***
				(0.00814)	(0.00819)	(0.00817)	(0.00818)	(0.00841)	(0.00837)	(0.00389)
Multi-establishment					0.0124	0.00723	0.00593	0.00408	0.00402	0.00581
					(0.0128)	(0.0131)	(0.0132)	(0.0144)	(0.0145)	(0.00665)
Pct. owned by foreigns						0.0446**	0.0515**	0.0557**	0.0551**	0.0575***
						(0.0172)	(0.0166)	(0.0180)	(0.0187)	(0.0100)
Pct. of sales coming from exports							-0.0471*	-0.0519*	-0.0512*	-0.0675***
							(0.0213)	(0.0224)	(0.0224)	(0.00955)
Female top manager								-0.0267	-0.0265	-0.0300***
								(0.0142)	(0.0143)	(0.00523)
Establishment has a bank loan/line of credit									0.000791	-0.00901*
									(0.0116)	(0.00403)
Constant	-3.333***	-3.275***	-3.026***	-2.674***	-2.679***	-2.697***	-2.641***	-3.071***	-3.083***	1.487
	(0.543)	(0.548)	(0.523)	(0.509)	(0.509)	(0.512)	(0.517)	(0.539)	(0.551)	(2.620)
var(e.logoneminusj2)										0.113***
										(0.000986)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observation	42664	42156	42152	41890	41890	41649	41536	36137	35936	35936

Standard errors in parentheses

In OLS estimations,Huber-White robust standard errors are reported in parenthesis and they are clustered at country year, sampling region, sampling size and sampling sector level.

In Tobit estimations, average marginal effects are reported

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.6: Baseline Regression without fixed effects using restricted sample

Dependent Variable: Log (1-Time Tax)	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS	(8) OLS	(9) OLS	(10) Tobit
Log RGDP per working age pop.	0.0429**	0.0489**	0.0436**	0.0381*	0.0388*	0.0375*	0.0436*	0.0434*	0.0439**	0.0476***
	(0.0156)	(0.0158)	(0.0159)	(0.0156)	(0.0166)	(0.0164)	(0.0170)	(0.0169)	(0.0169)	(0.00612)
Experience of the top manager-log		-0.0134	-0.0110	0.00290	0.00249	0.00268	0.00305	0.00180	0.00211	0.00305
		(0.00699)	(0.00724)	(0.00842)	(0.00829)	(0.00828)	(0.00834)	(0.00876)	(0.00878)	(0.00321)
Number of workers-log			-0.0142*	-0.0112	-0.0105	-0.0121*	-0.0101	-0.0106	-0.00939	-0.00396
			(0.00569)	(0.00576)	(0.00548)	(0.00543)	(0.00550)	(0.00563)	(0.00589)	(0.00203)
Age of the establishment (as of 2020)-log				-0.0275***	-0.0271***	-0.0272***	-0.0268***	-0.0269***	-0.0268***	-0.0322***
				(0.00752)	(0.00792)	(0.00795)	(0.00795)	(0.00786)	(0.00781)	(0.00321)
Multi-establishment					-0.00798	-0.0127	-0.0146	-0.0147	-0.0158	-0.0240***
					(0.0224)	(0.0231)	(0.0233)	(0.0233)	(0.0233)	(0.00628)
Pct. owned by foreigns						0.0418	0.0520*	0.0529*	0.0518*	0.0535***
						(0.0214)	(0.0208)	(0.0211)	(0.0217)	(0.0117)
Pct. of sales coming from exports							-0.0620**	-0.0626**	-0.0590**	-0.0466***
							(0.0227)	(0.0228)	(0.0229)	(0.0105)
Female top manager								-0.0214	-0.0228	-0.0211***
								(0.0180)	(0.0177)	(0.00527)
Establishment has a bank loan/line of credit									-0.0181	-0.0280***
									(0.00972)	(0.00407)
Constant	-0.582***	-0.610***	-0.523**	-0.433*	-0.441*	-0.425*	-0.493**	-0.483**	-0.485**	-0.488***
	(0.170)	(0.169)	(0.170)	(0.168)	(0.180)	(0.178)	(0.184)	(0.182)	(0.182)	(0.0658)
var(e.logoneminusj2)										0.0764***
										(0.000877)
Sector FE	22844	22565	22563	22471	22471	22347	22284	22269	22143	22143

Standard errors in parentheses

In OLS estimations,Huber-White robust standard errors are reported in parenthesis and they are clustered at country year, sampling region, sampling size and sampling sector level.

In Tobit estimations, average marginal effects are reported

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.7: Baseline Regression without fixed effects using initial sample

Dependent Variable: Log (1-Time Tax)	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS	(8) OLS	(9) OLS	(10) Tobit
Log RGDP per working age pop.	0.0927***	0.0982***	0.0887***	0.0797***	0.0772***	0.0761***	0.0787***	0.0826***	0.0824***	0.102***
	(0.0116)	(0.0122)	(0.0116)	(0.0118)	(0.0119)	(0.0119)	(0.0118)	(0.0126)	(0.0125)	(0.00694)
Experience of the top manager-log		-0.0167**	-0.0140*	-0.00687	-0.00576	-0.00543	-0.00488	-0.00234	-0.00248	-0.00170
		(0.00640)	(0.00622)	(0.00686)	(0.00678)	(0.00675)	(0.00686)	(0.00715)	(0.00723)	(0.00291)
Number of workers-log			-0.0192***	-0.0173***	-0.0189***	-0.0199***	-0.0185***	-0.0195***	-0.0196**	-0.0195***
			(0.00449)	(0.00463)	(0.00486)	(0.00498)	(0.00524)	(0.00561)	(0.00628)	(0.00175)
Age of the establishment (as of 2020)-log				-0.0235***	-0.0251***	-0.0250***	-0.0245***	-0.0308***	-0.0308***	-0.0397***
				(0.00708)	(0.00733)	(0.00735)	(0.00731)	(0.00750)	(0.00755)	(0.00365)
Multi-establishment					0.0280	0.0231	0.0215	0.0220	0.0218	0.0318***
					(0.0151)	(0.0150)	(0.0151)	(0.0167)	(0.0168)	(0.00636)
Pct. owned by foreigns						0.0376*	0.0459**	0.0504**	0.0496**	0.0481***
						(0.0164)	(0.0152)	(0.0167)	(0.0173)	(0.0101)
Pct. of sales coming from exports							-0.0509*	-0.0518*	-0.0506*	-0.0453***
							(0.0219)	(0.0231)	(0.0222)	(0.00909)
Female top manager								-0.0219	-0.0221	-0.0187***
								(0.0167)	(0.0168)	(0.00514)
Establishment has a bank loan/line of credit									-0.000633	-0.00680
									(0.0133)	(0.00399)
Constant	-1.145***	-1.158***	-1.012***	-0.871***	-0.841***	-0.829***	-0.860***	-0.885***	-0.882***	-1.023***
	(0.126)	(0.126)	(0.120)	(0.124)	(0.127)	(0.127)	(0.126)	(0.133)	(0.133)	(0.0746)
var(e.logoneminusj2)										0.120***
										(0.00105)
Sector FE	42753	42244	42240	41977	41977	41735	41622	36210	36007	36007

Standard errors in parentheses

In OLS estimations,Huber-White robust standard errors are reported in parenthesis and they are clustered at country year, sampling region, sampling size and sampling sector level.

In Tobit estimations, average marginal effects are reported

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

D The Plant Problem, the Household Problem, and Equilibrium Properties

D.1 Solving the Plant's Problem

Consider a top manager with ability z. Let X be the aggregate of differentiated tasks (inputs): $X \equiv \left(\int_0^{M(z,z_m)} \left(n_j^\alpha k_j^{1-\alpha}\right)^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}}$. The choices of production workers, middle manager services and capital services for this manager are found by solving the following FOCs associated to problem (5) with respect to k_j, n_j and z_m:

$$\gamma X^{\gamma-1} \left(\int_0^{M(z,z_m)} \left(n_j^\alpha k_j^{1-\alpha}\right)^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{1}{\sigma-1}} \left(n_j^\alpha k_j^{1-\alpha}\right)^{\frac{-1}{\sigma}} (1-\alpha) n_j^\alpha k_j^{-\alpha} - R = 0, \quad \forall j \tag{D.1}$$

$$\gamma X^{\gamma-1} \left(\int_0^{M(z,z_m)} \left(n_j^\alpha k_j^{1-\alpha}\right)^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{1}{\sigma-1}} \left(n_j^\alpha k_j^{1-\alpha}\right)^{\frac{-1}{\sigma}} (\alpha) n_j^{\alpha-1} k_j^{1-\alpha} - W = 0, \quad \forall j \tag{D.2}$$

$$\frac{\partial M(z,z_m)}{\partial z_m} \left(\gamma X^{\gamma-1} \frac{\sigma}{\sigma-1} \left(\int_0^{M(z,z_m)} \left(n_j^\alpha k_j^{1-\alpha}\right)^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{1}{\sigma-1}} \left(n_j^\alpha k_j^{1-\alpha}\right)^{\frac{\sigma-1}{\sigma}} - W n_j - R k_j \right) - P_m = 0 \tag{D.3}$$

D.2 Solving The Household's Problem

The household chooses sequences $\{C_t, K_{t+1}, z_{1,t}^*, z_{2,t}^*\}_0^\infty$ to maximize her preferences represented by (3). Let λ_t be the Lagrange multiplier associated the budget constraint. Then the first-order conditions of the household's problem for all t follow, with respect to $C_t, K_{t+1}, z_{1,t}^*$ and $z_{2,t}^*$, respectively:

$$\beta^t \frac{1}{C_t} = \lambda_t \tag{D.4}$$

$$\lambda_{t+1}(1-\delta+R_{t+1})=\lambda_t \tag{D.5}$$

$$P_{m,t}z^*_{1,t}=W_t \tag{D.6}$$

$$\pi(z_2)=P_{m,t}z^*_{2,t} \tag{D.7}$$

Combining (D.4) and (D.5) provides the familiar intertemporal Euler equation of the household:

$$\frac{C_{t+1}}{C_t}=\beta\left(1-\delta+R_{t+1}\right) \tag{D.8}$$

Equation (D.6) requires households with ability $z^*_{1,t}$ to be indifferent between becoming a production worker and a middle manager. Similarly, Equation (D.7) requires household members with ability $z^*_{2,t}$ to be indifferent between becoming a middle manager and a top manager. Altogether, Equations (D.6), (D.7) and (D.8) characterizes the household's solution.

D.3 Equilibrium Properties

We now show basic properties of the equilibrium, with special focus on the steady state of the model economy.

We first divide Eq (D.1) by Eq (D.2) and call capital-labor ratio within an activity G:

$$\frac{k_j}{n_j}=\left(\frac{1-\alpha}{\alpha}\right)\frac{W}{R}\equiv G \tag{D.9}$$

It follows that capital-labor ratio is the same across activities, and depends only on the share parameter α in the production technology and the ratio of rental prices for labor and capital. Rewrite now Eq (D.1) using the capital-labor ratio, G:

$$\gamma\left[\left(\int_0^{M(z,z_m)}\left(n_jG^{1-\alpha}\right)^{\frac{\sigma-1}{\sigma}}dj\right)^{\frac{\sigma}{\sigma-1}}\right]^{\gamma-1}\left(\int_0^{M(z,z_m)}\left(n_jG^{1-\alpha}\right)^{\frac{\sigma-1}{\sigma}}dj\right)^{\frac{1}{\sigma-1}}\left(n_jG^{1-\alpha}\right)^{\frac{-1}{\sigma}}\alpha G^{1-\alpha}=W,\quad\forall j \tag{D.10}$$

Note that the first two terms in (D.10) are just functions of the ability of the top manager z, and thus, the same for any activity j. Then, $n_j = n_s = n, \quad \forall j, s \in [0, M(z, z_m)]$. Since G is a constant, similar argument holds for capital as well: $k_j = k_s = k, \quad \forall j, s \in [0, M(z, z_m)]$. It follows that Eq (D.10) can be rewritten after dropping the subscript j as follows:

$$\gamma\left[nG^{1-\alpha}M(z,z_m)^{\frac{\sigma}{1-\sigma}}\right]^{\gamma-1}\left(n^{\frac{\sigma-1}{\sigma}}G^{\frac{(1-\alpha)(\sigma-1)}{\sigma}}M(z,z_m)\right)^{\frac{1}{\sigma-1}}\left(nG^{1-\alpha}\right)^{\frac{-1}{\sigma}}\alpha G^{1-\alpha}=W \tag{D.11}$$

Therefore, after replacing G by its components, the (constant) amount of labor per each activity, n, is given by

$$n=\left[\gamma\left(\frac{\alpha}{W}\right)^{1-(1-\alpha)\gamma}\left(\frac{1-\alpha}{R}\right)^{(1-\alpha)\gamma}\right]^{\frac{1}{1-\gamma}}M(z,z_m)^{\frac{1-\sigma(1-\gamma)}{(\sigma-1)(1-\gamma)}} \tag{D.12}$$

Similarly, the amount of capital per each activity, k, is given by

$$k=\left[\gamma\left(\frac{\alpha}{W}\right)^{\alpha\gamma}\left(\frac{1-\alpha}{R}\right)^{1-\alpha\gamma}\right]^{\frac{1}{1-\gamma}}M(z,z_m)^{\frac{1-\sigma(1-\gamma)}{(\sigma-1)(1-\gamma)}} \tag{D.13}$$

Now using equations (D.12) and (D.13), we obtain the total labor, $n(z)$, total capital, $k(z)$, and output $y(z)$ of a top manager with ability z. It follows that

$$n(z) = \int_0^{M(z,z_m)} n\,dj = nM(z,z_m) \tag{D.14}$$

$$= \left[\gamma\left(\frac{\alpha}{W}\right)^{1-(1-\alpha)\gamma}\left(\frac{1-\alpha}{R}\right)^{(1-\alpha)\gamma}\right]^{\frac{1}{1-\gamma}}M(z,z_m)^{\frac{\gamma}{(\sigma-1)(1-\gamma)}} \tag{D.15}$$

$$k(z)=\left[\gamma\left(\frac{\alpha}{W}\right)^{\alpha\gamma}\left(\frac{1-\alpha}{R}\right)^{1-\alpha\gamma}\right]^{\frac{1}{1-\gamma}}M(z,z_m)^{\frac{\gamma}{(\sigma-1)(1-\gamma)}} \tag{D.16}$$

$$y(z)=\left[\gamma\left(\frac{\alpha}{W}\right)^{\alpha}\left(\frac{1-\alpha}{R}\right)^{1-\alpha}\right]^{\frac{\gamma}{1-\gamma}}M(z,z_m)^{\frac{\gamma}{(\sigma-1)(1-\gamma)}} \tag{D.17}$$

Altogether, the above imply an important property of the competitive equilibrium: the capital-output ratio for a plant run by any top manager is independent of his/her ability. It is given by

$$\frac{k(z)}{y(z)}=\gamma\frac{1-\alpha}{R} \tag{D.18}$$

Since the above holds for all plants, it is also the capital-output ratio in the aggregate.

Steady States In stationary equilibrium, since consumption growth is constant, the rental rate of capital is given by $\hat{R}=1/\beta-1+\delta$. It immediately follows that the aggregate capital output ratio in steady state is given by

$$\frac{K}{Y}=\gamma\ \frac{1-\alpha}{1/\beta-1+\delta}. \tag{D.19}$$

Note that as the span-of-control $\gamma\rightarrow 1$, the capital to output ratio becomes the *same* than in the standard one-sector growth model under a Cobb Douglas technology with capital share $1-\alpha$. This also implies that the aggregate capital share in steady state is simply $\gamma(1-\alpha)$.