Job Amenities in the Market for CEOs

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Abstract

We derive structural estimates of job amenities in the market for CEOs using a two-sided multidimensional matching model. Using matched CEO-firm data from Denmark, we estimate the model using maximum likelihood, accounting for CEO and firm fixed effects. We find that CEOs have preferences for two important amenities. The "legacy" amenity explains why there is low mobility in the CEO market and why outsider CEOs earn a wage premium over insider CEOs. The "empowerment" amenity explains why CEOs are willing to sacrifice significant pecuniary income to manage high equity firms. Counterfactuals illustrate how job amenities affect CEO assignment and compensation.

JEL subject classification: G30, M12, C78, C35, D31, J33

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Conflict-of-interest disclosure statement

Arnaud Dupuy
I have nothing to disclose
John Kennes
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Ran Sun Lyng
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Data availability:
We also wish to apply for an exemption from your data availability policy because our data are drawn from a restricted access data source. The data used in the paper are administrative Danish register data maintained by Statistics Denmark, which is kept in a secure server. The data can, however, be accessed remotely from within Danish universities and research institutions. Of course, we will provide all programs and instructions to any researcher who should wish to replicate the results from our paper.

Your work is going to fill a large part of your life, and the only way to be truly satisfied is to do what you believe is great work. And the only way to do great work is to love what you do.

— Steve Jobs, Co-Founder of Apple

1 Introduction

The job of a CEO is rewarding and difficult. CEOs are generally highly paid, and many achieve great respect and admiration in society. However, the job also involves long hours and many sources of stress. On this account, there is evidence that many CEOs suffer from burnout, premature aging, and even early death.[1] These observations raise important questions: do CEOs value non-pecuniary compensation in the form of job amenities? and if they do, to what extent differences in the value of amenities at different firms drive the assignment of CEOs to firms and shape the CEOs wage distribution? There is an emergent literature that shows CEOs' objectives go beyond just maximizing the NPV of their income[2]. While these emergent studies put forward important job amenities CEOs value, for example, working for a prestige firm, they fail to identify how amenities affect sorting and CEO wage distribution. In this paper, we apply a two-sided multidimensional matching model and derive structural estimates of important job amenities in the market for CEOs. We then use counterfactual policy experiments to show that these job amenities are an important driver of CEO compensation and assignment.

A baseline model of perfect competition is a key starting point in the analysis of the CEO market (Gabaix and Landier [2008] and Tervio [2008]). In the simplest setting, the competitive model predicts that the most productive firms should be matched to the most talented CEOs. Therefore, given the tremendous increase in firm size over recent decades, the competitive model provides an important explanation of the rise in CEO pay. While these results are compelling, competitive market analyses also predict that firms demand general CEO skills (see, for example, Murphy and Zabojnik [2004, 2007], Frydman [2019], Custódio et al. [2013]). This, however, is at odds with the observations that there is very little mobility of CEOs across sectors and firms (Graham et al. [2020], Cziraki and Jenter [2020]).[3] Our estimates show that CEOs have a preference for staying

[1] See, for example, Sirén et al. [2018] and Borgschulte et al. [2021]

[2] See, for example, Malmendier and Tate [2009], Focke et al. [2017], Yonker [2017], Edmans et al. [2021], Cziraki and Jenter [2020]

[3] Murphy and Zabojnik [2004, 2007], Frydman [2019], Custódio et al. [2013] predict that firms demand general CEO skills, that are transferable across firms and industries. So if only CEO skills would matter,

in the industry where they have experience. Our result can explain the puzzle in the literature. We show that the low mobility in the CEO market is not simply because CEOs are more productive in their industry, but more importantly because they prefer to stay there. We interpret this result as the "legacy effect": CEOs are willing to trade off a large amount of pecuniary pay for building a legacy in their industry. This result can also explain why outsider CEO hires earn a wage premium over insider CEO hires. As insider CEOs can be compensated by the "legacy" amenity, they accept less pecuniary compensation.

The theory of corporate governance offers further influential explanations for how CEOs should be compensated. One key idea of corporate governance theory is that firms institute different levels of oversight to their CEOs to balance the interests of the firm's many stakeholders. In accordance with Jensen [1986]'s 'control hypothesis', a firm faces higher levels of monitoring when it uses high levels of debt financing.[4] In contrast, firms with high equity value can to some extent shield CEOs from market scrutiny. CEOs of high equity firms do not have to work under constant pressure to meet debt obligations, suffers less intensity of monitoring, and less stress. From these considerations, we hypothesize that a CEO gets a positive amenity value from managing a firm with a high equity position, where she has more discretion in her job, and is more likely to feel empowered. This paper finds empirical support for this hypothesis. We indeed show that CEOs are willing to give up part of their salary to manage firms with high equity positions, suggesting that CEOs derive amenities from an empowered management position.

Before going into the discussion of our model, it is important to define amenities. We define amenities as the form of compensation CEOs derive from certain firm characteristics. For example, an amenity can be the enjoyment of managing a firm within an industry where the CEO has experience. We observe the form of amenities in the data. For example, we observe that a CEO manages a large firm. She could derive amenities from this because of the prestige that comes with the job. But we do not observe how much CEOs value certain amenity. Amenities are typically not taxed, because the value of amenities is highly subjective and unobservable. This is contrasted by the CEO's pecuniary compensation, which includes all sources of compensation for which it

one would expect a relatively high mobility of CEOs across firms the CEO market. in contrast to the low mobility observed in the data (Graham et al. [2020]).

[4]There are also higher risks of hostile takeover and replacement of CEOs associated with high levels of debt financing. Furthermore, the conflicts of interests between debt holders and equity holders can create investment distortions that directly affect a firm's profitability. CEOs will face oversights from the board of directors and external debt holders.

is straightforward to calculate a monetary value, such as base wage, perks, for example, a company provided car, tax-free salary, anniversary and severance pay, the value of stock options, remuneration for board work, fees in connection with consulting work, lectures and the like. It captures the CEOs' total wage income. An important difference between pecuniary compensations and amenities is that pecuniary compensations are typically taxed as the CEO's personal income.[5] Because we do not observe the value of amenities, we will infer it using a competitive market model.

Our modelling framework is simple. To draw our inferences of how different CEOs value the amenities of different firms, we consider a competitive model of the market for CEOs. In this model, CEOs are allowed to have different skills that are valued differently by different firms and have preferences over the amenities offered by different firms. The model allows agents from both sides of the market to differ along multidimensional attributes. This means, for example, that CEOs can be distinguished using several traits, such as age, education, wealth, marital status, etc; and firms can also be distinguished using multiple characteristics, such as number of employees, imports, exports, etc. Additionally, the model allows for unobserved heterogeneity on both sides of the market. The key identifying assumption is 'additive separability' of the unobserved heterogeneity of the two sides, which was first proposed by Choo and Siow [2006], and is developed more formally for a broader range of applications by Galichon and Salanié [2021] and Chiappori et al. [2017], and is further developed to allow continuous agent types by Dupuy and Galichon [2014]. From this theoretical model, we follow Dupuy and Galichon [2022] and apply a maximum likelihood estimation (MLE) technique. Going beyond Dupuy and Galichon [2022], we take into account CEOs' management style and firms' culture by including CEO and firm fixed effects in the model estimation. We apply an initial procedure that estimates the two high dimensional fixed effects, following the work of Postel-Vinay and Robin [2006] inspired by Abowd et al. [1999]. Our methodology allows us to separately identify the value of firm productivity (CEO skills) and job amenities (CEO preferences) by fitting three features of our data simultaneously: i) the observed assignment of CEOs to firms, ii) observed wages and iii) observed firm productivity.[6]

The modelling framework does not imply efficient CEO-firm assignment. This is

[5]Following this definition, fringe benefits, for example, a company provided car, extra insurance, are taxed. So it is part of pecuniary compensation, not amenities.

[6]A method of identifying job amenities in random matching markets between labor and firms is developed by Sorkin [2018]. Sorkin [2018] finds a key role for amenities in worker compensation. Boyd et al. [2013] use a competitive matching model to infer that teachers enjoy an amenity (accept lower wages) when managing 'easier' classrooms, which they find are found in suburban rather than inner-city communities.

because CEOs pay taxes on pecuniary income, but not on amenities. Our methodology can account for frictions on transfers through taxation. This is of importance because 'neutrality' is a fundamental principle of optimal taxation (Furman [2008]). If a tax system is not neutral, economic inefficiencies emerge because resources are not directed at their ideal uses. In our model, in which we assume a competitive market, the fact that amenities are untaxed induces distortions in the market for CEOs: with high taxation, CEOs choose firms they enjoy working for rather than firms they are most productive at. As a result, the social welfare can be expressed as a weighted sum of total amenities and total pecuniary compensation, the weight on the latter part decreasing as taxation increases.[7] CEOs are typically in the top of the income distribution, therefore face high taxes. When we account for amenities, the tax system is decidedly not neutral. And this non-neutrality can only be inferred, because the amenity valuations we identify cannot be directly observed in practice.[8] It is important to note that taxation has implications on equilibrium assignment (which CEO is matched to which firm), but not on our estimates of firm productivity and amenities since we explicitly account for it.

Explicitly accounting for amenities in a multidimensional matching model is important for several reasons. First, ignoring amenities, the estimates of productivity parameters in an otherwise similar multidimensional matching model would be biased. To see this, note that, the equilibrium matching is increasing in both productivity and amenities, whereas the equilibrium wages are increasing in productivity but decreasing in amenities. As a result, when fitting matching data, one would attribute the positive effect of amenities to productivity, leading to an upward bias in productivity estimates. And when fitting wage data, one would attribute the negative effect of amenities to productivity, leading to a downward bias. There are, however, no reasons to expect the two sources of bias to offset each other. Second, as taxation increases, equilibrium matching and wages tend to reflect more amenities than productivity, see Dupuy et al. [2020]. Therefore, when ignoring amenities, i) the aforementioned biases in productivity estimates are likely to be larger in markets with high taxation (similarly, since CEOs are typically in a high tax category, this bias in productivity estimates can be nontrivial in the market for CEOs); and ii) comparing productivity estimates across markets with different levels of taxation would be difficult to do, as the differences that should be attributed to different levels of

[7] In a competitive CEO/firm matching model, if all forms of compensation are taxed at the same rate (tax neutrality), the equilibrium assignment of CEOs to firms will generally be efficient (Gabaix and Landier [2008]). The only possible distortion of taxes in this case is on the extensive margin (who enters/leaves the CEO market).

[8] The matching distortion of taxation is studied in Dupuy et al. [2020]

taxation would be wrongly interpreted as differences in productivity.

Denmark offers high-quality data for the purposes of our study for several reasons. First, in order to infer amenities, we need an accurate measure of pecuniary compensation. The Danish personal income data is third-party reported to the tax office.[9] The Danish income and wealth information is considered of very high quality and widely used in academic research.[10] As mentioned before, our measure of CEOs' wage includes a comprehensive list of sources of income, with, for instance, fringe benefits such as a company provided car, and the expected value of incentive payments such as stock options. Moreover, the Danish registered data also provides information on various CEO characteristics, such as the CEOs' age, education, gender, marital status, number of children, age of each child, net wealth, bank debt, tax value of property, bank deposit, financial investments in stocks, market value of bonds, investments in foreign financial markets, previous work experience, payout in private pension schemes.

Second, Statistics Denmark provides the link between workers and employers, and detailed measures on firm equity, profitability and performance.[11] The matched CEO-firm data made it possible for us to infer the values of non-pecuniary forms of income (amenities) using a method of inference that was developed by Dupuy et al. [2020] and Dupuy and Galichon [2022].

Third, our data contains the entire Danish population of CEOs and firms for the year 2011. Taking into account considerations of the institutional environment in Denmark, where there is a large number of small and medium-sized firms with owner CEOs, we choose to focus on the CEOs of large firms (more than 250 employees). Denmark has one of the highest tax rates in the world. The Danish CEOs pay a marginal income tax rate of 56 percent. In this high tax environment, if amenities are important, there is likely to be a high level of distortion of the matching of CEOs to firms. Our tools of inference explicitly account for these distortions.

Fourth, the boundary of the CEO market is well defined in Denmark. Danish CEOs receive lower pay compared to the US and EU average, which is compounded by the fact that Denmark has one of the world's highest taxes. That Danish CEO talent rarely

[9]Pay slip information is reported by employers. Assets and liabilities are reported by banks. The value of securities is reported by financial institutions, such as mutual funds and investment banks.

[10]See, for example, Kleven et al. [2011], Boserup et al. [2016], Leth-Petersen [2010] and Chetty et al. [2014]. For a more detailed description of the data, see Section 4 and Appendix B.

[11]Following the Danish Financial Statement Act, introduced in 1981 by the Danish business authority, all firms in Denmark have to submit annual reports, that consist of a management's review, an income statement/statement of profit or loss and other comprehensive income, a balance sheet, a statement of changes in equity, and a cash flow statement.

leaves Denmark can be attributed to a strong attachment to Danish culture and work-life balance. CEOs in Denmark might receive a lower paycheck, but they are compensated by quality state-funded education, good public services, free health care, and a comprehensive social safety net from working in this country, which they (and their family) cannot get working elsewhere. That Non-Danes do not enter the Danish CEO market can be attributed to the difficulty of the Danish language and other cultural barriers. Therefore, while the Danish economy is small, the CEO market should be well approximated by a closed market.

In the model estimation, we find that CEOs are willing to trade off salaries for many forms of job amenities. This is in line with the finding of Focke et al. [2017], Yonker [2017], Edmans et al. [2021], Cziraki and Jenter [2020],[12] suggesting that CEOs' objectives are more than just maximizing the NPV of their incomes. Job amenities are important forms of compensation in the CEO market. We offer estimates on how much CEOs value different amenities in terms of their wage income.

Given our estimates that CEOs place high amenity values on certain important firm characteristics, it is of interest to determine how CEO assignment and pay will change if the characteristics of firms (the form of amenities) in our sample were to change. We develop four counterfactual experiments that help illustrate how amenities shape the CEO market. The first two experiments directly manipulate the importance of two key amenities - the amenity for working in own sector firms (the legacy amenity) and the amenity for managing higher equity firms (the empowerment amenity). The second two experiments are aimed at understanding how industry and trade policies might impact the CEO market. The first considers the effects of an industry policy that causes a sector shift from a declining sector to an expanding sector. The second considers the effects of a trade war that shuts down the firms' exports.

The counterfactual experiments give the following results. First, we find that shutting down the amenity for how CEOs enjoy working in the same sector (which we call the CEO's value of building legacy) leads to considerable mobility of CEOs across firms and also large increases in CEO salaries. Our structural estimates suggest that, absent the legacy amenity, the CEOs will increasingly trade on their general skills by moving to whatever industry offers the best salary. Second, if we set the equity of all large firms in the CEO market to the 95th/5th percentile firm type, we find that CEOs' salaries fall/rise

[12]Focke et al. [2017] show that CEOs accept lower pay when working for a more prestigious company, and Yonker [2017] shows that CEOs accept lower pay and are less likely to leave when working for firms in their home state.

by a large amount with virtually no change in the assignment of CEOs to firms. Therefore, our structural estimates suggest that CEOs will trade off concerns for more empowerment (for example, taking the same job, but with less stress) with lower wages, but that such effects will not have an impact on the overall allocation of CEOs. Third, if we shut down the low productivity industry in favor of creating firms in the high productivity industry, we find some mobility of CEOs across all industries. Our estimates suggest that there will then be a larger set of CEOs who are primarily concerned with salary and the application of their general skills, because firms in their own industry have disappeared. Fourth, if we shut down firms' exports, we do not find much mobility of CEOs. Our structural estimates suggest that this is due to the continued importance of the amenity for own industry firms in attracting CEOs to firms, which is not changed if there is a trade shock that affects only the amount of exports by each firm.

A clear limitation of our methodology is that it assumes agents are risk-neutral and does not model explicitly incentives as derived from the principal-agent problem (see Holmstrom and Milgrom [1987], Edmans and Gabaix [2011]). However, a key asset of our model is that it allows us to consider multidimensional attributes on both sides of the market which affect amenities and productivity. So the incentive mechanisms that are explicitly modelled in Edmans and Gabaix [2011] can essentially be captured in our estimates of amenities. By including variables such as firms' equity, CEO net wealth and interaction terms between CEO and firm attributes, we provide flexible reduced-form answers to questions which are raised by these issues. For instance, Edmans et al. [2009], Edmans and Gabaix [2011] find that if utility is multiplicative in cash and effort, exerting effort will be more costly to a wealthy manager. We find that wealthier CEOs get dis-amenities when managing firms that export more. Assuming firms that export more require more efforts, our estimates suggest that wealthier CEOs require a higher monetary compensation to manage such a firm compared to, ceteris paribus, less wealthy ones. Note that this is corroborated by our other finding that more indebted CEOs derive positive amenities, managing firms that export more. This could be reflecting that indebted CEOs are more willing to put in the effort, and can be compensated with less pay. Nonetheless, we do think considering agents' risk preferences and modelling the principal-agent problem explicitly in our framework would constitute an important avenue for future research.

The paper is organized as follows. In the next section, we present the model. In the third section, we derive the MLE for the model parameters given data on CEO-firm matches. In the fourth section, we describe the Danish CEO market and the data used

in our analysis. In the fifth section, we estimate the model and discuss the results. We consider counterfactual experiments in the sixth section, and we discuss how our analysis relates to the literature in the seventh section. The final section concludes.

2 Model

We consider a matching model, that is close in spirit to Dupuy et al. [2020]. The key assumptions are that CEOs match one-to-one to firms and that utility is transferable through earnings, albeit imperfectly, as the CEO earnings are subject to taxation.[13] In a significant departure from the existing literature on CEO pay (Edmans and Gabaix [2016]), our model takes into account the potential value of job amenities to CEOs.

2.1 Agents

CEOs, indexed by i, seek employment with firms, indexed by j. The CEOs and the firms are grouped into observable (to the analyst) types. The set of CEO types is $\mathcal{X}$ and the set of firm types is $\mathcal{Y}$. A CEO i is said to be of type $x_i \in \mathcal{X}$, whereas a firm j is said to be of type $y_i \in \mathcal{Y}$. The first assumption of our model concerns the distribution of observable agent types in the economy.

Assumption 1 *There is a continuous distribution of CEOs over $\mathcal{X}$, whose p.d.f. is denoted $f(x)$, and a continuous distribution of firms over $\mathcal{Y}$, whose p.d.f. is denoted $g(y)$. The market is large so that there is a large number of CEOs of any given observable type x and there is a large number of firms of any given observable type y. Firms and CEOs are in equal mass which we normalize to* 1.

2.2 Match values

The CEOs have preferences over different types of firms. Following Dupuy et al. [2020], these preferences are additively separable into two terms

$$\alpha(x, y) + \sigma_1 \varepsilon_i(y).$$

[13] Workers in the Danish labor market are subject to piece-wise linear taxation. CEOs of large firms (more than 249 employees) all earn wages that fall into the highest income tax bracket. Consequently, the observed market for CEOs can be seen as one where taxes are linear, as in Dupuy et al. [2020].

The first term $\alpha(x, y)$ represents the systematic job amenity for a CEO of type x when managing a firm of type y. The second term $\varepsilon_i(y)$ represents the idiosyncratic value of a CEO i's amenity of working for a firm of type y. And σ_1 is a scaling factor that captures the intensity of the unobserved heterogeneity. The smaller the sigma, the less the unobserved heterogeneity it is in the model, the closer the solution will be towards a deterministic model.
Similarly, firms' output is also additively separable into two terms

$$\gamma(x, y) + \sigma_2 \eta_j(x).$$

The first term $\gamma(x, y)$ is the systematic output for a firm of type y when managed by a CEO of type x. The second term $\eta_j(x)$ represents the idiosyncratic output of firm j when matched with a CEO of type x. σ_2 is a scaling factor that captures the intensity of the unobserved heterogeneity.

The distribution of the idiosyncratic shocks for both CEOs and firms is given by Assumption 2.

Assumption 2 *Idiosyncratic shocks $\varepsilon_i(y)$ and $\eta_j(x)$ follow Gumbel random processes à la Dupuy and Galichon [2014, 2022].*

The allocation of match values is as follows. Let us consider a firm j of observable type $y_j = y$ and a CEO i of observable type $x_i = x$. If they match with each other, the profits of firm j are given by

$$\gamma(x, y) - w(x, y) + \sigma_2 \eta_j(x),$$

where $w(x, y)$ is the gross earnings paid by a firm of type y when matched to a CEO of type x, whereas CEO i's utility[14] is given by

$$\alpha(x, y) + T(w(x, y)) + \sigma_1 \varepsilon_i(y),$$

where $T(w(x, y))$ is the net (after-tax) earnings of a CEO of type x when managing a firm of type y.[15] The function $T()$ is determined by the tax system of the market under

[14] One might think that each type of CEOs values monetary transfers differently. In this case, we could introduce a weight parameter on the transfers and allow that to differ for each type of CEOs. Note that, however, this model would be strictly equivalent to a model where there is a scaling factor on amenities that depends on CEOs' type x.

[15] Note that as in Dupuy and Galichon [2022], by the law of one price, equilibrium transfers only vary with observable types of CEOs and firms.

consideration and is known to all agents.

The tax systems in this model can be very general. We only need to impose the following assumption:

Assumption 3 *The function $T()$ is continuous and so that $\lim_{w\to-\infty} T(w) = -\infty$.*

2.3 Competitive market

The market is competitive, as specified in Assumption 4.

Assumption 4 *All agents participate*[16] *and are price takers (monopolistic competition) and utility/profits maximizers. CEOs know $\alpha(x,y)$, $\gamma(x,y)$, $T()$ and $\sigma_1\varepsilon_i(y)$, and firms know $\alpha(x,y)$, $\gamma(x,y)$, $T()$ and $\sigma_2\eta_j(x)$.*

It follows from Assumption 4 that a profit-maximizing firm j of type $y_j = y$ solves the following program

$$\max_{x\in\mathcal{X}} \gamma(x,y) - w(x,y) + \sigma_2\eta_j(x),$$

and a utility-maximizing CEO i of type $x_i = x$ solves

$$\max_{y\in\mathcal{Y}} \alpha(x,y) + T(w(x,y)) + \sigma_1\varepsilon_i(y).$$

Denote $\mu^F(x,y)$ as the density of firms of type y opting for a CEO of type x, i.e. so that x solves firms of type y's problem. Denote $\mu^C(x,y)$ as the density of CEOs of type x opting for firms of type y, i.e. so that y solves CEOs of type x's problem.[17] Each of these problems can be seen as a discrete choice problem and by an application of the Williams-Daly-Zachary theorem, one obtains the logit demand of firms of type y for CEOs of type x as

$$\mu^F(x|y) := \frac{\mu^F(x,y)}{g(y)} = \exp\left(\frac{\gamma(x,y) - w(x,y) - v(y)}{\sigma_2}\right), \tag{1}$$

where $v(y) = \sigma_2 \log\int_X \exp\left(\frac{\gamma(x',y)-w(x',y)}{\sigma_2}\right)dx'$. In the Gumbel framework, $v(y)$ can be interpreted as the expected indirect utility of a firm of type y.

[16]Because of the logit structure of the model, it can be shown (see, Dupuy and Galichon [2014] and Dupuy and Weber [2021]) that this model is equivalent to an otherwise similar model, where agents are allowed not to participate in which case their reservation utility is $-\infty$.

[17]Note that CEO and firms' preferences only depend on their potential partner's type. Once the desired type has been determined, they are indifferent between agents of the same type.

The logit demand of CEOs of type x for firms of type y is[18]

$$\mu^C(y|x) := \frac{\mu^C(x,y)}{f(x)} = \exp\left(\frac{\alpha(x,y) + T(w(x,y)) - u(x)}{\sigma_1}\right), \tag{2}$$

where $u(x) = \sigma_1 \log \int_Y \exp\left(\frac{\alpha(x,y')+T(w(x,y'))}{\sigma_1}\right) dy'$. In the Gumbel framework, $u(x)$ can be interpreted as the expected indirect utility of a CEO of type x.

Agents can then determine equilibrium by tâtonnement over wage using these demand functions[19].

2.4 Equilibrium

An equilibrium outcome is characterized by the following formal definition.

Definition 1 *An outcome (μ, w) is an equilibrium outcome if the gross wage $w(x,y)$ is so that $\mu^F(x,y) = \mu^C(x,y) = \mu(x,y)$ where $u(x)$ and $v(y)$ are solutions of the system*

$$\begin{aligned} \int_X \mu(x,y)\, dx &= g(y), \\ \int_Y \mu(x,y)\, dy &= f(x). \end{aligned}$$

Note that, under our standing assumptions, Theorem 1 in Galichon et al. [2019] applies, so that there exists a unique equilibrium outcome to our problem.[20]

In particular, rearranging equations (1) and (2) at equilibrium, one obtains

$$\alpha(x,y) + T(w(x,y)) = \tilde{u}(x) + \sigma_1 \log \mu(x,y) \tag{3}$$

$$\gamma(x,y) - w(x,y) = \tilde{v}(y) + \sigma_2 \log \mu(x,y) \tag{4}$$

where $\tilde{u}(x) = u(x) - \sigma_1 \log f(x)$ and $\tilde{v}(y) = v(y) - \sigma_2 \log g(y)$.[21]

[18] Here is the reason why we need continuity in function $T()$ in Assumption 3. Because discontinuity in $T()$ would create discontinuity in the logit demands of CEOs.

[19] Note that there is no $\varepsilon_i(y)$ and $\eta_j(x)$ in the demand function of CEOs and firms, which means that agents do not need to observe other agents' "idiosyncratic shocks" to form their own demands. Even if they had access to that information, they would not use it.

[20] Indeed, as long as the function $T()$ satisfies assumption 3, agents face a proper bargaining set in the sense of Definition 1 in Galichon et al. [2019].

[21] The $\tilde{u}(x)$ and $\tilde{v}(y)$ are the potentials. They are the Lagrange multipliers corresponding to the scarcity constraints of type x CEOs and type y firms. A higher $\tilde{u}(x)$, for example, shall imply a higher relative scarcity for type x CEOs, and therefore a greater prospect for utility extraction for this type of CEOs.

Solving equation (4) for $w(x,y)$ and plugging the solution into equation (3) gives

$$\alpha(x,y) + T(\gamma(x,y) - \tilde{v}(y) - \sigma_2 \log \mu(x,y)) = \tilde{u}(x) + \sigma_1 \log \mu(x,y). \quad (5)$$

This equation provides an implicit solution for the equilibrium matching $\mu(x,y)$ given the potentials $(\tilde{u}(x), \tilde{v}(y))$. To derive an explicit expression for this equation, we need to specify the tax system represented in function $T()$. In particular, the Danish tax system used in our empirical application is characterized by Assumption 5.

Assumption 5 *The tax system is such that the net wage $T(w(x,y))$ reads as*

$$T(w(x,y)) = (1-\tau) w(x,y) + \delta t_1,$$

where τ is the tax rate and δt_1 is a lump sum.[22]

Let $\mu(x,y)$ be the equilibrium matching under $T(w(x,y)) = (1-\tau) w(x,y) + \delta t_1$. Plugging this expression into equation (5) gives

$$\alpha(x,y) + (1-\tau)(\gamma(x,y) - \tilde{v}(y) - \sigma_2 \log \mu(x,y)) + \delta t_1 = \tilde{u}(x) + \sigma_1 \log \mu(x,y)$$

which solves for $\mu(x,y)$ as

$$\begin{aligned} \log \mu(x,y) &= \\ M\left(\tilde{u}^t(x), \tilde{v}(y)\right) &:= \frac{\alpha(x,y) - \tilde{u}(x) + (1-\tau)(\gamma(x,y) - \tilde{v}(y)) + \delta t_1}{\sigma_1 + (1-\tau)\sigma_2}. \end{aligned} \quad (6)$$

As a by product, note that plugging this result into equation (4) and solving for the equilibrium gross wage $w(x,y)$ as a function of the potentials $(\tilde{u}(x), \tilde{v}(y))$ gives

$$w(x,y) = \frac{\sigma_1}{\sigma_1 + (1-\tau)\sigma_2}(\gamma(x,y) - \tilde{v}(y)) - \frac{\sigma_2}{\sigma_1 + (1-\tau)\sigma_2}(\alpha(x,y) - \tilde{u}(x) + \delta t_1). \quad (7)$$

2.5 Computing equilibrium matching and wages

We use the Iterative Proportional Fitting Procedure (IPFP) algorithm to find the equilibrium matching, given parameters $\alpha(x,y)$, $\gamma(x,y)$, τ, σ_1 and σ_2 and data $f(x)$ and $g(y)$. The algorithm works as follows.

[22] This formula can be derived as the net earnings of CEOs subject to a tax system with two income brackets, i.e. $[0, t_1]$ and $]t_1, \infty[$ where the tax rates on each interval is respectively τ_0 and τ, where $\delta = \tau - \tau_0$. In practice, all CEOs of large firms in Denmark pay top tax, which means their gross earnings are larger than t_1. Their net earnings are then indeed $T(w(x,y)) = (1-\tau) w(x,y) + \delta t_1$.

Algorithm 1 *Given parameters* $\alpha(x,y)$, $\gamma(x,y)$, τ, σ_1 *and* σ_2 *and data* $f(x)$ *and* $g(y)$,

1. Initialization: $t=1$, let $\tilde{u}^{t-1}(x)=0$ for all $x\in\mathcal{X}$.

2. At each iteration t, solve

$$\int_x M\left(\tilde{u}^t(x),\tilde{v}(y)\right)dx = g(y)$$

for $\tilde{v}(y)$ for all y given $\left(\tilde{u}^t(x)\right)_{x\in\mathcal{X}}$. Call this solution $\tilde{v}^t(y)$. Then solve

$$\int_y M\left(\tilde{u}(x),\tilde{v}^t(y)\right)dy = f(x)$$

for $\tilde{u}(x)$ for all $x\neq x_0$ given $\left(\tilde{v}^t(y)\right)_{y\in\mathcal{Y}}$ and call this solution $\tilde{u}^{t+1}(x)$.

3. Set $t=t+1$ and repeat this algorithm from 2, until $\max_{y\in\mathcal{Y}}|\tilde{v}^t(y)-\tilde{v}^{t-1}(y)|<\epsilon$ and $\max_{x\in\mathcal{X}}|\tilde{u}^{t+1}(x)-\tilde{u}^t(x)|<\epsilon$, where ϵ is a tolerance parameter, in which case go to 4.

4. Compute the equilibrium wages using the solution for the potentials $(\tilde{u}(x),\tilde{v}(y))$ into equation (7) to obtain

$$w(x,y)=\frac{\sigma_1}{\sigma_1+(1-\tau)\sigma_2}\left(\gamma(x,y)-\tilde{v}(y)\right)-\frac{\sigma_2}{\sigma_1+(1-\tau)\sigma_2}\left(\alpha(x,y)-\tilde{u}(x)\right)+\tilde{c} \tag{8}$$

where $\tilde{u}(x)$ and $\tilde{v}(y)$ are derived from the IPFP above, and

$$\tilde{c}=c-\frac{\sigma_2}{\sigma_1+(1-\tau)\sigma_2}\delta t_1$$

where c is a constant reflecting the normalization $\tilde{u}(x_0)=0$.

3 Maximum Likelihood Estimation

The model described in the previous section can be estimated using maximum likelihood. In this section, we provide a sketch of the estimation procedure, starting by discussing the data that are required to estimate the model. We then discuss the parametric specification. And finally, we present the log likelihood function given the parameterization.

3.1 The structure of available data

We consider the context of an analyst having access to a sample of matches between CEOs and firms where the following information is available:

1. a list of CEOs whose identity is indexed by $i = 1, ..., N$,
2. a list of firms whose identity is indexed by $j = 1, ..., N$,
3. the matching assignment, that is which CEO is matched to which firm. A matching $(\hat{\mu}_{ij})_{i,j} = 1$ if CEO i is matched with firm j, and 0 otherwise. Follow the convention that $\hat{\mu}_{ij} = 1(i = j)$, where $1()$ is the indicator function, with a slight abuse of notation $\hat{\mu}_{ii} = \hat{\mu}(x_i, y_i)$,
4. for each CEO i, a vector of (observable) attributes $x_i \in \mathcal{X}$, and his/her gross wage which is denoted by $\hat{w}_{ii}$ and is assumed to be a noisy measure of $w(x_i, y_i)$, where the noise follows a known (up to parameters) centered distribution,
5. for each firm j, a vector of (observable) attributes $y_j \in \mathcal{Y}$, and the firms' output which is denoted by $\hat{\Gamma}_j$ and is assumed to be a noisy measure of $\gamma(x_i, y_i)$, where the noise follows a known (up to parameters) centered distribution,
6. the top income threshold t_1 specified in the tax system under consideration, and the tax rates τ_0 and τ applied to the two income brackets $[t_0, t_1]$[23] and $[t_1, \infty]$, respectively, where $\tau_0 \geq 0$ and $\tau \geq \tau_0$.[24]

A more detailed description of the data is presented in Section 4.

3.2 Parametric specification

3.2.1 Defining job amenities and productivity

We parameterize the value of job amenities and productivity[25] such that the match value functions of CEOs and firms are linear in parameters:

[23] t_0 is the amount of tax-free allowances.

[24] Note that this tax system is characterized by the Danish tax system.

[25] With discrete agent types, one may be able to have fully nonparametric estimator as in Choo and Siow [2006]. Dupuy and Galichon [2014] explains the need for a parametric estimation when considering continuous variables, and we refer the interested readers to this reference.

$$\alpha(x, y; A) = \sum_{k=1}^{K} A_k \times \varphi_k(x, y),$$

and

$$\gamma(x, y; \Gamma) = \sum_{k=1}^{K} \Gamma_k \times \varphi_k(x, y),$$

where $\varphi_k(x, y)$ are basis functions.

In particular, defining the basis functions as (bi)linear in x and y gives,

$$\alpha(x, y; A) = \sum_{l} A_{l,1} y^{(l)} + \sum_{k,l} A_{kl,2} x^{(k)} y^{(l)},$$

and

$$\gamma(x, y; \Gamma) = \sum_{k=1} \Gamma_{k,1} x^{(k)} + \sum_{k,l} \Gamma_{kl,2} x^{(k)} y^{(l)}.$$

Note that in this specification, even though the match value functions are linear in parameters, we keep the way we measure firm and CEO types very flexible.[26] Moreover, we also include interaction terms between firm and CEO characteristics to estimate the match-specific effects on job amenities and productivity. Previous literature has mainly focused on the complementarities between firm size and CEO talent (see, for example, Rosen [1982] and Gabaix and Landier [2008]). Our advantage is that we have a multidimensional matching model that allows us to explore many other complementarities that are potentially important in the matching process.

3.2.2 Latent variable specification of earnings and productivity

Let us further construct a latent wage structure. Let $\hat{w}_i$ be the observed wage for CEO i. $\hat{w}_i$ is equal to the predicted wage for that CEO at the firm he is matched to in the data, i.e. $w_{ii} = w(x_i, y_i)$, with an additive measurement error e_i^W which is assumed to follow a centered Gaussian distribution with variance s^2. Hence,

$$\hat{w}_i = w(x_i, y_i) + e_i^W$$

where $w(x_i, y_i)$ is given by equation (8) and $e_i^W \rightsquigarrow N(0, s^2)$.

Note that while the parameters of the model can be estimated using a single cross-

[26] In our main specification, we have 41 parameters in total, where k is 16 and l is 23, plus two constants. x (the types of CEOs) and y (the types of firms) can enter the linear function in very flexible ways.

section of data, we have access to a panel data of matched CEOs and firms. We therefore propose to account for CEOs' and firms' fixed-effects in our analysis.We estimate these fixed-effects using a window of 5 years of data before the year of the cross-section selected for the main analysis. Note that the identification of workers' and firms' fixed-effects requires a large share of the firms to be "connected" through the mobility of workers across firms. This is generally obtained by having a large propensity of workers to move AND a large number of workers per firm. In our case, the mobility of CEOs across firms is relatively low[27] and there is only one CEO per firm. This creates a challenge for the identification of the two sets of fixed-effects. We remedy this issue by 1) including all managers (CEOs, COOs, CFOs etc.) into this part of the analysis which helps connecting more firms together and 2) adopt a parametric specification of the firms fixed-effects proposed by Postel-Vinay and Robin [2006] in which one specifies the firm's fixed-effect as being a linear function of some average characteristic of the firm over time (i.e. we experiment with mean productivity and the average of the principal component from a Principal Component Analysis on all accounting attributes of the firms) over the window of data selected. We then adopt the within-estimator method to estimate the coefficients for the firms fixed-effects and compute the CEOs fixed-effects using the de-meaned variables, the difference between the de-meaned (log) wages and the de-meaned predicted wages. We herewith augment the latent wage equation to include estimates of CEO fixed-effects denoted by $\hat{f}_i$, and firm fixed-effects denoted by $\hat{g}_i$, and obtain

$$\hat{w}_i = w\left(x_i, y_i\right) + \hat{f}_i + \hat{g}_i + e_i^W.$$

Similarly, using the observed measure of firm productivity, i.e. $\hat{\gamma}_i$, we adopt a latent productivity structure. For firm i, the observed productivity $\hat{\gamma}_i$ is equal to the value specified in the model, i.e. $\gamma_{ii} = \gamma(x_i, y_i; \Gamma)$, with an additive measurement error e_i^P which is also assumed to follow a centered Gaussian distribution with variance t^2. Hence,

$$\hat{\gamma}_i = \gamma(x_i, y_i; \Gamma) + \sum_l \Gamma_{l,1} y^{(l)} + e_i^P$$

where $e_i^P \rightsquigarrow N\left(0, t^2\right)$.

It is important to note that since we observe productivity in the data, we are able to measure the direct effects of firms' attributes on productivity, i.e. $\sum_l \Gamma_{l,1} y^{(l)}$. We

[27]From 2006 to 2011, only 30% CEOs changed firms in Denmark, taking into account CEOs from all small, medium, and large firms.

estimate these effects in the third term of our likelihood function.[28]

3.3 Maximum likelihood

Let $\lambda = (A, \Gamma, \sigma_1, \sigma_2, s^2, c, t^2)$ be the parameters of the model. Under the parametric structure described in the previous section, the log-likelihood of observing a match $\hat{\mu}_{ii}$ with transfer $\hat{w}_i$ and productivity $\hat{\gamma}_i$ can be decomposed into 3 terms.

The first term is the log-likelihood of observing the match $\hat{\mu}_{ii}$ and simply reads as $\log \hat{\mu}_{ii}$. The second term is the log-likelihood of observing the transfer $\hat{w}_i$ and reads as $-\left(\frac{\hat{w}_i - w_{ii}}{2s^2}\right)^2 - \frac{1}{2}\log s^2$. And the third term is the log-likelihood of observing the productivity $\hat{\gamma}_i$ and reads as $-\left(\frac{\hat{\gamma}_i - \gamma_{ii}}{2t^2}\right)^2 - \frac{1}{2}\log t^2$.

So the log-likelihood of observing the data $(\hat{\mu}_{ii}, \hat{w}_i, \hat{\gamma}_i)_{i=1}^N$ can be written as

$$\begin{aligned}
\log L(\lambda) &= \log L_1(\lambda) + \log L_2(\lambda) + \log L_3(\lambda) \\
&= \sum_{i=1}^{N} \log \hat{\mu}_{ii} - \sum_{i=1}^{N} \left(\frac{\hat{w}_i - w_{ii}}{2s^2}\right)^2 - \frac{N}{2}\log s^2 - \sum_{i=1}^{N} \left(\frac{\hat{\gamma}_i - \gamma_{ii}}{2t^2}\right)^2 - \frac{N}{2}\log t^2.
\end{aligned}$$

3.4 Identification

In this section, we highlight the identification of amenities and productivity presented in Section 2 and 3.[29]

Note that equilibrium matching (see equation 6) is increasing in both amenities α and productivity γ. However, equilibrium wages (see equation 7) is increasing in productivity γ, but decreasing in amenities α. This result is in fact very intuitive: in the model, for a CEO of type x and a firm of type y, higher amenities $\alpha(x, y)$ lead to higher matching probability $\mu(x, y)$ but lower wages $w(x, y)$, whereas higher productivity $\gamma(x, y)$ leads to both higher matching probability $\mu(x, y)$ and higher wages $w(x, y)$. The fact that we observe data on matching and wages allows us to separately identify the (pre-transfer) value of a match for each partner. This has great implications in our study. It means that we can separately identify *CEOs' preferences* that increase amenities α and *CEOs' skills* that increase productivity γ.

[28] Since we do not observe the value of amenities in the data, the direct effects of CEOs' characteristics on amenities are not identified.

[29] We refer the interested readers to Dupuy and Galichon [2022] for more details and proofs.

However, note that rewriting equations (3) and (4) gives

$$\alpha(x,y) = \tilde{u}(x) - T(w(x,y)) + \sigma_1 \log \mu(x,y) \quad (9)$$

$$\gamma(x,y) = \tilde{v}(y) + w(x,y) + \sigma_2 \log \mu(x,y). \quad (10)$$

The identification of $\alpha(x,y)$ and $\gamma(x,y)$ depends on equilibrium matching $\mu(x,y)$ and equilibrium wages $w(x,y)$. Furthermore, $\alpha(x,y)$ is identified up to an endogenous function of $\tilde{u}(x)$, and $\gamma(x,y)$ is identified up to an endogenous function of $\tilde{v}(y)$. Hence, adding a term $a(x)$, i.e. a firm fixed effect that is valued the same by all CEOs, to the specification of amenities or a term $b(y)$, i.e. a CEO fixed effect that is valued the same by all firms, to the specification of productivity would not affect equilibrium matching nor equilibrium wages. To see this, note that in algorithm 1, these terms would be "absorbed" in the endogenous functions $\tilde{u}(x)$ and $\tilde{v}(y)$ respectively, leaving the equilibrium matching and wages unchanged. One can only recover amenities up to a function of x and productivity up to a function of y.

Note also that we observe a wide range of firm characteristics in the data, and firm characteristics are the things that provide amenities to the CEOs. We select several attributes to be included in our model estimation, i.e. firms' equity, fixed assets, the value of import, the value of export, net investment, and the size of the firm, using likelihood-ratio tests[30], as those attributes appear to be associated with the most important forms of amenities valued by the CEOs. There might still be other forms of amenities we cannot observe, for example, a nice office with an ocean view. We address this concern in the following ways. First and foremost, since our specification of the basis functions is very rich, the systematic part of amenity and productivity stays fully flexible. We have experimented with various specifications (including different CEO and firm characteristics, and allowing different degrees of unobserved heterogeneity to affect sorting), and our main results are robust across all these specifications.[31] Secondly, the magnitude of the scaling parameters σ_1 and σ_2 indicates the amount of heterogeneity necessary to rationalize the data.[32] Hence, the effects of unobserved attributes should manifest itself in estimation results when we vary the value of these parameters. This means that if omitted firm and CEO characteristics are important to the value of amenities and productivity, we should

[30] More details can be found in Section 5.1.

[31] More details can be found in Section 5.1. We also report results from some of these robustness checks in the Appendix.

[32] As it is described in Section 5.1, we use a grid search to find the set of σ parameters that maximize our likelihood function.

see significant changes in our estimation results when we set σ_1 and σ_2 to different values. We have experimented by using different values of these parameters, our main results presented in Section 5 are robust across all these specifications.

4 Data and Empirical Issues

In this section, we describe the Danish CEO labor market and corporate governance practice, some features of the tax system and our matched CEO-firm data.

4.1 The CEO labor market and corporate governance practice in Denmark

CEO plays an important role in firm performance (Bertrand and Schoar [2003]). In a competitive labor market, firms are willing to offer generous compensation packages in order to attract the best candidates. In the US, CEO compensation triggers frequent national debates. A question business outlets like to ask every year is: how many executives made more than a million dollars this year? In Denmark, top executives receive lower pay. According to a CNBC report on CEO compensation[33], total pay of top executives in Denmark is about 75% of the European average. It is further below that of big economies like Germany, Britain and Switzerland, where stricter corporate governance mechanisms apply. This pay gap is compounded by the fact that Denmark has one of the world's highest taxes. Similar to other countries[34], there is low mobility in the Danish CEO market. Taking into account all small, medium and large firms, only 29% of CEOs changed firms from 2006 to 2011 in Denmark.

The Danish labor market is characterized as "flexicurity", which is a mix of a flexible labor market and a generous social security system, maintained by active labor market policies.[35] Labor market participation is averaged 70% for the past two decades, according to Statistics Denmark. According to OECD report,[36] Denmark has one of the highest earning quality and the highest level of job turnover rates among OECD countries. Unemployment duration is typically short. And the report ranks Denmark at the top on the quality of working environment.

[33]CNBC (2013) executive compensation report: Lower CEO Pay and Better Results in Europe?
[34]According to Cziraki and Jenter [2020], more than 80% of new CEOs are insiders.
[35]For a detailed discussion on the Danish "flexicurity" model, see Andersen and Svarer [2007]
[36]OECD Job Strategy, OECD 2018

There are a large number of small and medium-sized companies in Denmark. Limited companies are the most typical forms of business. There are private limited companies and public limited companies. Private limited companies are required to have at least one manager, but do not need a board representation. It is a popular ownership structure for small- and mid-sized companies. It is often used as an easy way to set up new Danish subsidiaries for foreign companies. Public limited companies, on the other hand, require a two-tier board system and are subject to many other regulatory restrictions. For a detailed overview of the legislative framework, see Danish Companies Act.[37] Typically, a public limited company has three managing directors, one of them being the CEO. But the CEO cannot act as the chairman of the board. Many of the Danish firms are privately held. There are only a small amount of listed firms. The average size of firms in Denmark is small relative to the other European countries.

The Danish corporate governance system is shaped by the Danish Public Companies Act from 1973. Denmark adopts a "two-tier" board system, a supervisory board whose responsibility is to monitor and control the managing directors, and a board of managing directors who are responsible for day-to-day operations. The supervisory board has the decision power for extraordinary matters. A unique feature of the Danish system is that managing directors are allowed to be on both tiers of the board.[38] More recently, the danish parliament has introduced the Danish Companies Act (DCA) which came into force in March 2010. This act establishes the corporate governance regime for both private and public limited liability companies. Similar to the German type corporate governance system, employees have representation on the board, and managers are monitored by stakeholders of the firm, i.e. banks, large shareholders and closely related firms.

4.2 The Danish tax system

Denmark has one of the highest tax rates in the world. According to Statistics Denmark, the average annual income in Denmark was 282,647 DKK in 2011 (approximately $52,827 at the average exchange rate for the corresponding year). The average Dane pays a total amount of 45 percent in income taxes.

The Danish tax system is progressive. Employees, including executives and registered executive management, are fully liable for taxes on their personal income and their re-

[37]Danish Act on Public and Private Limited Companies (the Danish Companies Act) In Danish: *lov om aktie- og anpartsselskaber (selskabsloven)*. It contains rules on Danish company incorporation, share capital, governing bodies, annual general meetings, auditing and management's liability.

[38]Discussion on the Danish Corporate Governance system, see Rose [2006], Thomsen [2016]

muneration. Each person pays a mandatory labor market contribution, that is 8% of the gross salary prior to any deductions. Taxation on personal income is then calculated on the amount after deduction of all relevant costs spent on obtaining and securing the income. On the remaining amount, each person has to pay an 8% contribution to the health care system, a municipal tax which averages to 24.9% depends on which municipality a person lives in, and a 0.73% church tax. For income below the top tax threshold, 389,900 (2011-level),[39] each person pays a bottom-tax of 3.67%. For income above the top tax threshold, each person pays a top-tax of 15%. All employees over 18 years of age have an annual personal allowance of 42,900 DKK that is tax exempted. The unused amount can be transferred to the spouse. Employees also have an employment allowance of the lower value between 4.25% of labor income and 13,600 DKK. The top marginal tax rate for labor income is 56% and the bottom tax rate is 40.9%.[40]

Capital incomes are also taxed. Negative net capital income, i.e. mortgage payments, below DKK 50,000 a year for singles (100,000 DKK for married couples) can receive a tax deduction at 33.5%. Whereas positive net capital income, i.e. yields from bonds and bank deposits, is taxed at the personal income tax rate. But for the first 40,000 DKK (80,000 DKK for married couples) positive net capital income, it is taxed at 37.3% irregardless of the individual's personal tax rate. Share income and dividends are taxed at 27% on gains up to 48,600 DKK (2011-level), and at 42% on anything exceeding this amount.

Any cash remuneration, i.e. cash bonuses, fringe benefits, shares and options, severance pay, termination package, warrants, are all taxed at the personal income tax rate. Taxation on remuneration in forms of options and warrants can be deferred until they are exercised. Under certain conditions, employee shares can be taxed at capital income tax rate.[41]

The Danish tax authority (SKAT) collects information on personal income, as well as

[39]There was a tax reform in 2010. This reform aims at reducing marginal taxes on labor income. In particular, the bottom tax rate is reduced by 1.5 percentage point; the middle tax is abolished; and the top tax threshold is increased. The tax ceiling is reduced from 59% to 51.5%. However, taxation on personal income has been increased in this reform. Among others, taxation on fringe benefits, i.e. company paid multimedia (PC, telephone, broadband internet, newspapers), company car, employee shares and bonds, has been increased. Capital income tax is also adjusted. For more information on the tax reform, see *Danish Tax Reform 2010* by the Danish Ministry of Taxation and *Centrale beløbsgrænser i skattelovgivningen 2010-2017* by the Danish Ministry of Taxation.

[40]The Danish Ministry of Taxation, *Marginalskatteprocenter 1993-2021*

[41]For a detailed discussion on the law regarding the Danish executive remuneration, see "The Executive Remuneration Review: Denmark" by Michael Møller Nielsen, Helene Lønningdal and Lund Elmer Sandager. The Law Reviews, 16th November 2020.

individuals' financial and real asset holdings, and liabilities.[42] This information is third-party reported, rather than self-reported. Labor income is directly reported to the tax office by employers at the end of each month. At the end of each year, banks report the assets and liabilities of their customers. Financial institutions (i.e., mutual funds, investment banks) report the value of securities held by their clients. The land and real estate registry reports the value of land and property owned by individuals and businesses. The tax authority uses this information to compute labor income tax, wealth tax and generate pre-populated tax returns. The Danish income and wealth information is considered of a very high quality. Kleven et al. [2011] did a field experiment in Denmark where they randomly selected some tax filers to be thoroughly audited. Their results show that the tax evasion rate is close to zero for income subject to third-party reporting. The Danish income and wealth data is widely used in academic research to study a variety of topics: intergenerational wealth mobility (Boserup et al. [2016]), intertemporal consumption under credit constraints (Leth-Petersen [2010]), and retirement savings (Chetty et al. [2014]). Furthermore, the data is not censored or top-coded, which is an advantage as CEOs are likely to be at the top of the wealth distribution. Statistics Denmark then organizes and anonymizes the raw data and makes it available to researchers.

Firms in Denmark are subject to taxation on all income and are allowed deductions on certain business related expenses. The corporate income tax rate was 25% in 2011. There is no payroll tax in Denmark.[43] The Danish Financial Statement Act, introduced in 1981 by the Danish business authority, requires all firms in Denmark to submit annual reports, which consist of a management's review, an income statement/statement of profit or loss and other comprehensive income, a balance sheet, a statement of changes in equity, and a cash flow statement.

4.3 Data and Sample

We exploit the administrative register-based data from Statistics Denmark that contains the entire Danish population of CEOs for the year 2011. In Appendix B, we provide a detailed description of our data sources, how we merge the data sets and variable definitions. To follow our model assumption, we aim to select a competitive market

[42]Pension contributions are not reported as part of wealth data in 2011, as pensions are not subject to wealth taxation. This is not a major issue in our analysis. Because, first of all, there are strict limits on the amount that can be invested in tax-preferred pension accounts. Secondly, compared to base salary, bonus and other pecuniary benefits, pension is typically a small fraction of income for CEOs.

[43]Some exceptions apply for companies carrying out specific VAT exempted activities.

where preference heterogeneity is an important feature. Considering the institutional environment in Denmark where there are a large number of small and medium-sized firms with owner CEOs, we choose to focus on the CEOs of large firms (more than 250 employees). Another reason for selecting this type of CEOs is that the yearly salaries of the large-firm CEOs are all above the cutoff for the top marginal tax bracket. Therefore, a linear approximation of taxation on CEOs' wages is justified.

In order to infer amenity value in equilibrium, we need an accurate measure of the CEOs' pecuniary pay, not only his base salary, but also his entire remuneration package. This is a key advantage of using the Danish administrative register data. Our data on CEOs' wage income is comprehensive, and is of very high accuracy. CEO wage measures his total taxable wage income, which includes perks, tax-free salary, anniversary and severance pay, the value of stock options, remuneration for board work, fees in connection with consulting work, lectures and the like. This payslip information is directly reported by his employer, not self-reported, as mentioned earlier in Section 4.2.

For each CEO, we have information on his age, education, gender, marital status, number of children, age of each child, net wealth, bank debt, tax value of property, bank deposit, financial investments in stocks, market value of bonds, investments in foreign financial markets, previous work experience, payout in private pension schemes.

We then match the CEOs with his firms using a register that provides the key between workers and firms.[44] We have information on firms' number of employees, number of branches, shares of female employees, net investment, sector, value of exports, value of imports, equity value, value of fixed assets, ownership structure, Selling, General and Administrative Expenses (SG&A), total salary expenses.

Our sample contains 295 CEO-firm matches. The majority of firms in our sample are public limited firms (87%), some are private limited firms (5%), and some are cooperatives (2.4%). Our data is at CEO-firm level. One observation is defined as a match between one CEO and one firm, with detailed CEO and firm characteristics. Table 6 presents summary statistics for the variables used to estimate our model. We discuss model specification later in Section 5.1.

In our sample, the average CEO is 52 years old, has 16 years of schooling, owns 3.29 million DKK in net wealth, 1.41 million DKK in bank debt, and has a yearly salary of 2.64 million DKK. 87% of the CEOs are married. 94% of them are male. And 78% of the CEOs

[44]For a person who works as CEO for more than one firm, we select his match as the firm that has the highest gross profit. There are only 2 individuals who work as CEO for multiple firms. Dropping them does not affect our estimates.

manage firms in the same industry where they worked 5 years ago. It is worth noting that danish CEOs have a similar social backgrounds, but a slightly different educational profile compared to the ones from North America and other European countries. In our sample, around 65% of CEOs have a colleague degree. This is consistent with the finding of Ellersgaard et al. [2013] that university degrees do not appear to be the most essential selection criteria for becoming an executive in Denmark. Most Danish CEOs do not have degrees from elite universities. And it is not common for a Danish CEO to have a PhD degree. Instead, many Danish CEOs obtained the executive positions through multiple years of work experience.[45]

Firms in our sample have on average 992 employees, 64.3 million DKK in net investment. The average total export value of goods and services (incl. sales of certain VAT-exempted products) in those firms is about 683 million DKK. Firms' total import value is about 386 million DKK. Firms have on average 858 million DKK in equity and fixed assets that are worth 981 million DKK. The average firm earns gross profits of 895 million DKK.

5 Estimation Results

5.1 Model specification

Preference heterogeneity is an important characteristic when describing the CEO labor market. CEOs have different skill sets and personality traits, which are desired by different types of firms. A market driven allocation of CEOs to firms can create economic surplus (Rosen [1981, 1982]). To estimate our two-sided matching model, we first need to determine which characteristics should be used to effectively distinguish between the agents on each side of the market. Rosen [1982], Gabaix and Landier [2008] relate firm size to CEO pay. Pan [2017] shows that CEOs with conglomerate work experience are matched with more diversifies firms and that CEOs with technical expertise are matched with R&D intensified firms. Kaplan et al. [2012], Kaplan and Sorensen [2021], Bertrand and Schoar [2003] provide empirical evidence that CEO personality traits are important for corporate actions and performance.

Following the guidance from the literature, we consider a list of potentially important

[45] Ellersgaard et al. [2013] show that about one third of the Danish CEOs have sales or marketing backgrounds from many firms, before becoming a CEO. Most Danish CEOs have education in the field of Business and Economics or Sciences and Engineering, not many from arts and humanities backgrounds.

attributes from both sides of the market to be included in our estimation. To distinguish CEOs, we consider CEOs' age, education, gender, marital status, number of children, age of each child, net wealth, bank debt, tax value of property, bank deposit, financial investments in stocks, market value of bonds, investments in foreign financial markets, previous industry experience, payout in private pension schemes. To differentiate firms, we use firms' number of employees, number of branches, shares of female employees, net investment, sector, value of exports, value of imports, equity value, value of fixed assets, ownership structure, Selling, General and Administrative Expenses (SG&A), total salary expenses.

We start with the most restricted model, including only CEOs' age, age squared, years of schooling, firms' number of employees, net investment and no interaction terms. Then more CEO and firm characteristics are added to the model estimation. The goal is to test whether a less restricted model fits significantly better than a more restricted model. We use likelihood ratio (LR) tests to accomplish this goal, as we reply on gradient descent algorithm in our maximum likelihood estimation. Based on these likelihood-ratio tests[46], the set of attributes selected are: CEOs' age, marital status, gender, years of schooling, net wealth, bank debt; firms' number of employees, net investment, value of imports, exports, equity value, value of fixed assets. We present estimates of the direct effects of these variables on job amenities and productivity in Section 5.2.

We also include interaction terms between firm and CEO characteristics to estimate the match-specific effects on job amenities and productivity. Previous literature has mainly focused on the complementarities between firm size and CEO talent (see, for example, Rosen [1982], Gabaix and Landier [2008]). We, however, are able to explore other complementaries that are potentially important in the matching process, since we allow for a multidimensional matching model. Performing likelihood-ratio test on different specifications regarding the interaction terms, we allow net wealth, bank debt, and marital status from the CEO side to interact with number of employees, net investment and value of exports from the firm side. We present estimates of these interaction effects on job amenities and productivity in Section 5.2.

The measure of transfers is the CEO's total taxable wage income, which includes perks, anniversary and severance pay, the value of stock options, remuneration for board work, fees in connection with consulting work, lectures and the like. The measure of productivity is the firm's gross profit.

Additionally, matching might also depend on CEO and firm fixed effects. For exam-

[46] An example of our LR tests is shown in the Internet Appendix D section.

ple, CEOs' management styles, personality, communication skills and interpersonal skills are shown to matter for firm performance (Bertrand and Schoar [2003], Kaplan et al. [2012], Kaplan and Sorensen [2021]) and CEO pay (Graham et al. [2012]). Firms' fixed effects, e.g. firms' branding, reputation and corporate culture, are important for CEO compensation (Graham et al. [2012]). So we account for the two high-dimensional fixed effects in our model estimation and counterfactual analysis, thereby allowing, to some extent, seemingly equivalent agents to earn (or pay) different levels of compensation. We assume those fixed effects are vertically differentiated, that is CEO i's fixed effect is valued the same across all firms, firm j' fixed effect is valued the same across all CEOs. Consequently, these fixed effects do not affect matching assignment in our setting.

The traditional AKM (Abowd et al. [1999]) method requires a large dataset, with many workers per firm and high enough mobility of workers across firms over time, as only workers who change firms contribute to connecting firms and hence the identification of firm fixed-effects. Since, by definition of our one-to-one matching market, we only observe one worker per firm each period, this limits drastically the scope for connectedness between firms. Moreover, CEO markets are well known to have low mobility.[47] This causes many firm fixed-effects to be unidentified. To circumvent this issue, we instead apply Postel-Vinay and Robin [2006] AKM method[48], where we use the first principal component from a Principal Component Analysis on firm characteristics, instead of firm dummies, to estimate firm fixed effects, and sweep out CEO fixed effects by within transformation (subtracting the mean of the variable grouped by each CEO for all observations). To create more mobilities, we use all top managers (CEO, CFO, COO, CTO, etc.) - firm matched data from 2006 to 2011[49].

Finally, we do a grid search to determine the value of σ_1 and σ_2 in the model.[50] Sigmas capture the degree of unobserved heterogeneity in the matching process. The pair of sigmas are chosen such that it maximizes the likelihood function for a given set of firm and CEO characteristics. The herewith selected values are $\sigma_1 = 0.5$ and $\sigma_2 = 0.25$, which maximizes the likelihood function in our main analysis. As a mean to test the robustness of our findings, we also report the results from other sigma specification, see

[47] As mentioned in footnote 27, from 2006 to 2011, only 30% of CEOs changed firms in Denmark, taking into account CEOs from all small, medium, and large firms.

[48] Postel-Vinay and Robin [2006] suggests to use firms' mean productivity instead of firm dummies to estimate firm fixed effects.

[49] 63% of top managers changed firms from 2006 to 2011, taking into account all small, medium and large firms.

[50] An example of the grid search is shown in Internet Appendix E. We performed grid search for several favored sets of firm and CEO characteristics, respectively.

Appendix Table 8. It is worth noting that for many pairs of σ_1 and σ_2 values, our model specification predicts observed wages very well, with R-Squared greater than 0.5. And for several pairs of σ_1 and σ_2 values, the model also fits the firm performance very well, with an R-Squared greater than 0.6. σ_1 and σ_2 are also set at 0.5 and 0.25 respectively in the counterfactual analyses.

5.2 Estimation results

We apply the estimation strategy described in Section 3 to estimate the parameters of the model in the Danish CEO labor market in 2011. Overall, our estimation strategy describes the Danish CEO labor market well, with an R-Squared of 0.52 on observed wages, and an R-Squared of 0.85 on firm productivity. Table 1 presents the model estimates for both the direct and the interaction effects of CEOs' and firms' characteristics on job amenities (Alpha estimates) and productivity (Gamma estimates)[51]. Both wage and productivity are measured in millions of Danish kroner.[52] In order to directly compare the relative importance of each coefficient and to facilitate comparison with other studies, all coefficients are standardized coefficients. It can be interpreted as the effect of one standard deviation change in a variable of interest on the value of job amenities and productivity.

5.2.1 Job Amenities Estimates

For job amenities, we find that CEOs derive substantial amenities from managing a firm in their own industry, and are willing to give up 1.56 million DKK in pay to do so (significant at 1% level), suggesting that CEOs stay in their own industry because of their preferences. Malmendier and Tate [2009] shows that CEOs have become the faces of their corporations, starring in ad campaigns, making regular appearances in magazines and on prime-time TV shows. This evidence shows that CEOs have become superstars. The government takes them as experts of their industries, and involves them in policy

[51] Alpha and Gamma estimates corresponds to the parametric specification in our basis function:

$$\alpha(x, y; A) = \sum_l A_{l,1} y^{(l)} + \sum_{k,l} A_{kl,2} x^{(k)} y^{(l)},$$

and

$$\gamma(x, y; \Gamma) = \sum_{k=1} \Gamma_{k,1} x^{(k)} + \sum_{k,l} \Gamma_{kl,2} x^{(k)} y^{(l)}.$$

[52] In 2011, 1 USD = 5.36 DKK at the average exchange rate

discussions. Ellersgaard et al. [2013] studies the top Danish CEOs and shows that the "salespeople" type CEOs, who have many career changes, get less publicity. This type of CEOs also tends to manage firms that are less profitable and less prestigious. So we interpret the positive effect of "CEO industry experience" on job amenity as **the legacy effect**: CEOs are willing to trade off a large amount of salary for building a legacy in their own industry. This legacy effect can explain why there is low mobility in the CEO market. Cziraki and Jenter [2020] show that there is a discrepancy in the literature: standard frictionless model, for example Murphy and Zabojnik [2004], Frydman [2019], predicts that firms demand general CEOs skills, instead of firm- and industry- specific ones.[53] So if only CEOs' skills matter, there should be lots of mobility in the CEO market. But this is not the case, not in our sample, nor in other countries. Our legacy result can bridge this discrepancy in the literature. Our result shows that there is low mobility because CEOs prefer to stay in their own industry, not simply because of their skills. This result could also explain why outsider CEOs earn a wage premium over insider CEOs, which is consistent with the finding of Murphy and Zabojnik [2007].

Additionally, CEOs derive amenities from managing a firm with high equity value. A one standard deviation increase in firms' equity value increases the average amount that CEOs enjoy working for such firms by 0.66 million DKK. Firms with high equity value can to some extent shield CEOs from market scrutiny because these firms use less debt financing (Jensen [1986]). CEOs don't have to work under constant pressure to meet debt obligations, and suffer less intensity of monitoring and less stress.[54] As a result, CEOs have more discretion in their jobs and feel empowered. This empowerment result can also be related to the feeling of "fairness" mentioned in Edmans et al. [2021], where they argue that CEOs should not feel underpaid relative to their peers, and in relation to shareholder returns. CEOs perceive a good pay as a recognition of their efforts and as a signal that they have done a good job. Our empowerment result offers a mechanism for a similar feeling of "fairness". This "fairness" comes from the trust of shareholders, who believe the CEOs will do a good job, and make the right decisions to balance the interests of shareholders and outside investors. Thus, give CEOs more discretion and impose less

[53] This result is consistent with examples in real life, for example, Steve Jobs' once asked John Scully "Do you want to sell sugar water for the rest of your life or come with me and change the world?". Because Scully was a successful CEO for Pepsi, not because he has insights into Apple or the high-tech industry. There is empirical evidence on this as well. Kaplan et al. [2012], Kaplan and Sorensen [2021] use survey data and show that firms value CEOs' leadership skills and certain personality traits rather than their analytical skills and industry specific knowledge.

[54] Malmendier et al. [2019], Borgschulte et al. [2021] show that CEOs experience shorter life expectancy and poorer health from increased monitoring and industry distress.

oversight on them.

Furthermore, we find that CEOs on average prefer managing firms with lower value of fixed assets. Fixed effects refer to long-term tangible assets, for example property or equipment, that a firm owns instead of leases. They are not easily convertible to cash. This could mean that firms with large fixed assets tend to be less liquid and less flexible. CEOs need to be compensated by 0.62 million DKK on average when managing a firm whose value of fixed assets is one standard deviation above the mean.[55]

Finally, the interaction between firm characteristics (export value) and CEO characteristics (CEO personal wealth) suggests that CEOs' personal wealth correlates with their incentives to work. We find that wealthier CEOs get dis-amenities when managing firms that export more. Assuming firms that export more require more efforts, our estimates suggest that wealthier CEOs require a higher monetary compensation to manage such a firm compared to, ceteris paribus, less wealthy ones. Note that this is corroborated by our other finding that more indebted CEOs derive positive amenities, managing firms that export more. This could reflect that indebted CEOs are more willing to put in the effort, and can be compensated with less pay. This is consistent with Edmans et al. [2009], Edmans and Gabaix [2011], who show that if utility is multiplicative in cash and effort, exerting effort will be more costly to a wealthy manager.

5.2.2 Firm Productivity Estimates

For firm productivity, while we find strong evidence that CEOs derive large amenities from managing a firm in their own industry, there are mixed results on whether CEOs' industry-specific skills have a positive impact on firm productivity. In our main analysis (Table 1), we find that CEOs' industry-specific skills do not increase productivity. But in some other specifications, for example, in robustness checks Table 8, 9, 10, CEOs' industry-specific skills seem to increase their productivity. Existing literature also shows mixed evidence on this subject.[56] Some shows that firms demand general CEO skills, not firm- or industry - specific ones (Murphy and Zabojnik [2004], Frydman [2019]), and that outsider CEOs earn a wage premium over insider CEOs (Murphy and Zabojnik [2007]). Both suggest that CEO's industry-specific skills (valuable only within the industry) should not increase

[55]Some studies find that larger fixed assets are associated with higher amounts of debt, see Yan [2006]. In this respect, this result is largely consistent with the positive effect of managing high equity firms on job amenities.

[56]This is consistent with the mixed findings shown in studies that examining the relationship between experience-based, firm-specific human capital and compensation, see, for example, Altonji and Shakotko [1987]; Goldsmith and Veum [2002]; Slaughter et al. [2007].

firm productivity. Whereas, Frank and Obloj [2014] argues that firm-specific human capital can create agency costs that outweigh the benefits from productivity gain. They document a lower performance for managers with high firm-specific skills. Additionally, Hamori and Koyuncu [2015] finds that CEOs with job-specific experience in the same or related industry have lower post-succession performance than those without prior CEO experience.

Our results also show that firm productivity is hump-shaped over CEOs' life-cycle. This is consistent with the results from the human capital model of Becker [1964], Ben-Porath [1967], Mincer [1974], and the finding of Bennedsen et al. [2020], that predicts a flattening off and eventual decline of productivity as workers approach retirement. At early ages, productivity increases with CEOs' experience. On average, productivity increases by 0.44 million DKK when CEOs have 1 more year of experience. Starting at age 57, productivity decreases with CEOs' experience.

Moreover, we find that CEOs' personal wealth is positively correlated with firm productivity. The interaction term between CEO and firm characteristics suggest that CEOs' ability to manage personal wealth is positively correlated with productivity. With a CEO whose net wealth is one standard deviation above the mean, the same increase in export value increases productivity by 543 million DKK = 538 million DKK + 5 million DKK. But with a CEO who has bank debt one standard deviation above average, the same increase in exports value only increases productivity by 523 million DKK = 538 million DKK - 15 million DKK.

Last but not the least, we find that firm size, net investment, value of imports, exports are all important determinants of productivity.

These estimates will later be used to simulate the market under counterfactual policy experiments in Section 6.

6 Counterfactual Experiments

We carry out four sets of counterfactual experiments. The first experiment aims at quantifying the importance of job amenities in terms of experience - that is CEOs prefer to manage firms in the sector where they have experience - to the sorting of CEOs to firms. The second experiment aims at quantifying the importance of job amenities in terms of oversight to the sorting of CEOs to firms. The third experiment gives some insights in how CEOs reallocate and what are the equilibrium wage gains/losses under a potential sectoral shift from a declining sector to an expanding sector. Finally, in the

Table 1: Effect of CEOs' and firms' characteristics on job amenities and productivity (in Millions DKK)

	Main effects	Number of employees	Net investment (in DKK)	Import (in DKK)	Export (in DKK)	Equity (in DKK)	Fixed assets (in DKK)
Job Amenities (Alpha)							
Main effects		-0.08	**0.40**	-0.09	0.64	**0.66**	**-0.62**
		(0.12)	**(0.15)**	(0.09)	(0.41)	**(0.13)**	**(0.12)**
Age (in years)							
Age$\hat{2}$							
Years of schooling (in years)							
Net wealth (in DKK)		-0.03	**0.57**		**-0.99**		
		(0.09)	**(0.17)**		**(0.12)**		
Bank debt (in DKK)		-0.10	-0.15		**3.24**		
		(0.14)	(0.17)		**(0.32)**		
Gender (1 male/0 female)							
Marital status (1 Married)		-0.06	**-0.66**		-0.18		
		(0.15)	**(0.16)**		(0.40)		
CEO industry experience	**1.56**						
	(0.08)						
Productivity (Gamma)							
Main effects		**590.14**	**503.76**	**363.98**	**538.32**	380.40	395.51
		(78.69)	**(94.53)**	**(124.13)**	**(141.40)**	(319.32)	(344.25)
Age (in years)	**3.91**						
	(1.32)						
Age$\hat{2}$	**-3.83**						
	(1.34)						
Years of schooling (in years)	0.25						
	(0.15)						
Net wealth (in DKK)	0.18	-0.13	**-2.63**		**4.74**		
	(0.30)	(0.51)	**(0.74)**		**(0.54)**		
Bank debt (in DKK)	**-2.10**	0.39	0.49		**-14.62**		
	(0.39)	(0.66)	(0.67)		**(1.42)**		
Gender (1 male/0 female)	1.07						
	(0.77)						
Marital status (1 Married)	0.45	0.12	**1.32**		3.43		
	(0.65)	(0.63)	**(0.65)**		(2.04)		
CEO industry experience	0.29						
	(0.31)						
Productivity constant	**812.23**						
	(59.00)						
Salary constant	**14.63**						
	(1.15)						

Notes: This table reports the estimates of the effect of CEO and firm characteristics on job amenities and firm productivity. wages and productivity are measured in millions of Danish kroner. In 2021, 1 DKK = 0.16 USD at the average exchange rate. All covariates, except for CEO industry experience, are standardized to have a standard deviation of 1. Standard errors are in parentheses, calculated from the Hessian of the likelihood. The R-squared on wage is 0.52 whereas the R-squared on productivity is 0.85. The value of the objective function at convergence of this specification is 5544.98. The smaller the value of the objective function, the higher the likelihood, the better the fit of the model.

fourth experiment, we mimic a trade war and shed light on the new equilibrium matching between CEOs and firms following this trade war.

6.1 Legacy (Industry specific experience) amenity

In our estimation, we find that CEOs derive a large amenity (1.56 million DKK) from managing a firm in the sector for which they have experience, which we call the legacy amenity. In order to substantiate the importance of this amenity to the sorting of CEOs to firms, we answer the following question: suppose the amenity value of managing a firm within a CEO's preferred sector is equalized across all firms, what would be the new equilibrium assignment and wages? This question is relevant because once we remove the job amenity from managing a firm in a particular sector, CEOs can no longer be compensated through this amenity channel, they have to either be compensated by pecuniary pay or find a firm offering more of the remaining amenities.

First, we compute the equilibrium matching when the legacy amenity parameter is set to 0 for all potential matches between CEOs and firms. Table 2A presents the result of this experiment. Removing this amenity from all firms creates considerable reshuffling in CEOs assignments. More than half (54.53%) of the CEOs switch firms. This reshuffling comes from both high productivity and low productivity firms. In this new equilibrium, CEOs' wages also increase to 1,331 million DKK, compared to the equilibrium wage of 838 million DKK from the model estimation. This corresponds to a 58.83% increase in CEOs wages. We conclude that the CEOs market adjust to the disappearance of the legacy amenity by both an important reshuffling of who manages which firm and a dramatic increase in pay.

We then repeat the computation, but this time, setting the legacy amenity parameter to 1 for all potential matches between CEOs and firms. Table 2B presents the result of this experiment. We again observe the same pattern in terms of the equilibrium assignment, but as expected we now observe a dramatic drop in the equilibrium wages of 555 million DKK = 838 million DKK - 283 million DKK. This corresponds to a 66.23% decrease. In this case, CEOs can be compensated through amenities, therefore requires a lower pecuniary compensation.

This experiment confirms our finding that CEOs derive an economically important amenity from managing a firm in the sector where he has experience. This amenity can to a large extent explain the relative low mobility of CEOs across firms/sectors, and should be considered as an important form of CEO compensation.

Table 2A: Eliminate CEO's alma-mater industries AM = 0

Changes in CEO assignments	Percentage of CEOs who switched firms	
All firms	54.53%	
Low productivity firms	54.34%	
High productivity firms	54.72%	
Changes in CEO wages	Counterfactual sample	Main sample
Variance of CEO wages	2.45	2.48
Mean of CEO wages (millions DKK)	1331.3	838.02
Changes in CEO amenities	Counterfactual sample	Main sample
Number of CEOs in their own industry	0.00	230.34

Notes: This Table reports results from a counterfactual experiment where we shut down the legacy amenity (CEOs can no longer derive amenity from working in his own industry, or any other industry). We show how (1) CEO assignment, (2) the variation of CEO wages and (3) mean of CEO wages were to change under this counterfactual scenario. This table also reports the number of CEOs who work in their own industries before and after the experiment. Low productivity firms are those whose gross profits are below the median, whereas high productivity firms refer to those whose gross profits are above the median.

Table 2B: All firms are in CEO's alma mater industries AM = 1

Changes in CEO assignments	Percentage of CEOs who switched firms	
All firms	54.53%	
Low productivity firms	54.34%	
High productivity firms	54.72%	
Changes in CEO wages	Counterfactual sample	Main sample
Variance of CEO wages	2.45	2.48
Mean of CEO wages (millions DKK)	282.77	838.02
Changes in CEO amenities	Counterfactual sample	Main sample
Number of CEOs in their own industry	295.00	230.34

Notes: This Table reports results from a counterfactual experiment where we let CEOs derive legacy amenity from all industries, not only from his own industry. We show how (1) CEO assignment, (2) the variation of CEO wages and (3) mean of CEO wages were to change under this counterfactual scenario. This table also reports the number of CEOs who work in their own industries before and after the experiment. Low productivity firms are those whose gross profits are below the median, whereas high productivity firms refer to those whose gross profits are above the median.

6.2 Empowerment (Firm equity) amenity

Another key job amenity identified in our empirical analysis is that CEOs enjoy managing firms with high equity value. Following Jensen [1986]'s 'control hypothesis', firm equity is commensurate with stakeholder oversight, such that firms with lower equity value are likely to experience more oversight. We consider two experiments where firm oversight is strengthened and weakened, respectively. We then compute the new equilibrium matching under these experiments.

In the first experiment, all firms are given high equity value, corresponding to the 95th percentile firm's equity, simulating a scenario where oversight is weakened for all firms. Table 3A presents the result of this experiment. Weakened oversight for all firms creates almost no reshuffling in CEO assignment, although it generates important changes in compensation. Under this new equilibrium, CEOs wages are reduced to 558 million DKK, compared to the equilibrium wage of 838 million DKK from the model estimation. This corresponds to a 33.41% drop.

In the second experiment, all firms are given low equity value, corresponding to the 5th percentile firm's equity, simulating a scenario where oversight is strengthened for all firms. Table 3B presents the result of this experiment. Strengthen oversight for all firms also creates no reshuffling in CEO assignment, yet average equilibrium wages increase to 960 million DKK, which corresponds to a 14.56% increase.

This experiment confirms our finding that CEOs enjoy managing firms with higher equity value and derive large amenity from it. It is also interesting to note that diminishing differences across firms in amenity in terms of oversight lead to low job mobility, but large fluctuations in CEO compensation, whereas equalizing amenity in terms of managing firms in their own industry lead to both high mobility across firms and significant changes in compensation.

This experiment also contributes to the debate about the determinants of executive pay, the "shareholder value" view versus the "rent extraction" view, see Edmans et al. [2017]. Our results suggest CEO compensation fall with weakened oversight, therefore providing evidence against the "rent extraction" view.

6.3 Sectoral shift from Construction to ICT

In the third policy experiment, we study how sectoral shifts from a declining sector to an expanding sector can induce a reallocation of CEOs and quantify the wage gains/losses at the new equilibrium.

Table 3A: Weaken oversight

Changes in CEO assignments	Percentage of CEOs who switched firms	
All firms	0.00%	
Low productivity firms	0.00%	
High productivity firms	0.00%	
Changes in CEO wages	Counterfactual sample	Main sample
Variance of CEO wages	6.24	2.48
Mean of CEO wages (millions DKK)	557.79	838.02
Changes in CEO amenities	Counterfactual sample	Main sample
Number of CEOs in their Alma Mater industry	230.34	230.34

Notes: This Table reports results from a counterfactual experiment where we decrease firms' oversight over CEOs by increasing the equity value of all firms to the 95th percentile of firm's equity value. We show how (1) CEO assignment, (2) the variation of CEO wages and (3) mean of CEO wages were to change under this counterfactual scenario. This table also reports the number of CEOs who work in their own industries before and after the experiment. Low productivity firms are those whose gross profits are below the median, whereas high productivity firms refer to those whose gross profits are above the median.

Table 3B: Strengthen oversight

Changes in CEO assignments	Percentage of CEOs who switched firms	
All firms	0.00%	
Low productivity firms	0.00%	
High productivity firms	0.00%	
Changes in CEO wages	Counterfactual sample	Main sample
Variance of CEO wages	6.24	2.48
Mean of CEO wages (millions DKK)	960.14	838.02
Changes in CEO amenities	Counterfactual sample	Main sample
Number of CEOs in their Alma Mater industry	230.34	230.34

Notes: This Table reports results from a counterfactual experiment where we increase firms' oversight over CEOs by decreasing the equity value of all firms to the 5th percentile of firm's equity value. We show how (1) CEO assignment, (2) the variation and (3) mean of CEO wages were to change under this counterfactual scenario. This table also reports the number of CEOs who work in their own industries before and after the experiment. Low productivity firms are those whose gross profits are below the median, whereas high productivity firms refer to those whose gross profits are above the median.

To create a sectoral shift, we replace one-to-one low productivity firms from the construction sector, by clones of randomly selected high productivity firms from the Information and Communication Technology (ICT) sector. This gives us a counterfactual distribution of firms $g^{C_1}(y)$ while the distribution of CEOs $f(x)$ stays unchanged.

We then use Algorithm 1, taking parameters $\alpha(x, y; A)$, $\gamma(x, y; \Gamma)$, τ, σ_1 and σ_2 from the model estimation, and counterfactual data $f(x)$ and $g^{C_1}(y)$ to derive the counterfactual equilibrium $\left(\mu^{C_1}, w^{C_1}\right)$.

Table 4 presents the result of this experiment. Sectoral shifts from declining to expanding sector triggered some mobility of CEOs across firms under the new equilibrium. 9.62% of CEOs switch their assignments. This reallocation comes from both high and low productivity firms. In addition, by artificially shutting down firms in manufacturing industry, we force some CEOs out of the sectors where they have past experience. Some CEOs can no longer benefit from the legacy amenity, and consequently, we observe an increase in CEOs wage compensation.

Table 4: Replacing one-to-one construction firms by a random draw of ICT firms

Changes in CEO assignments	Percentage of CEOs who switched firms	
All firms	9.62%	
Low productivity firms	9.18%	
High productivity firms	10.06%	
Changes in CEO wages	Counterfactual sample	Main sample
Variance of CEO wages	2.81	2.48
Mean of CEO wages (millions DKK)	863.75	838.02
Changes in CEO amenities	Counterfactual sample	Main sample
Number of CEOs in their own industry	217.66	230.34

Notes: This Table reports results from a counterfactual policy experiment where we replace each construction firm in our sample with a random draw of firm from the ICT industry. We show how (1) CEO assignment, (2) the variation of CEO wages and (3) mean of CEO wages were to change under this counterfactual scenario. This table also reports the number of CEOs who work in their own industries before and after the experiment. Low productivity firms are those whose gross profits are below the median, whereas high productivity firms refer to those whose gross profits are above the median.

6.4 Trade war

In the last policy experiment, we study how CEO-firm assignment changes under a trade war. To mimic a trade war, we replace the export value of all firms in our data with half of its actual value. This gives us a counterfactual distribution of firms $g^{C_2}(y)$. The distribution of CEOs $f(x)$ is again unchanged.

Using the IPFP algorithm together with the parameters $\alpha(x, y; A)$, $\gamma(x, y; \Gamma)$, τ, σ_1 and σ_2 from the model estimation, and counterfactual data $f(x)$ and $g^{C_2}(y)$, we compute the counterfactual equilibrium $\left(\mu^{C_2}, w^{C_2}\right)$ under trade war.

Table 5 presents the results of this experiment. This table clearly shows that trade war generates a little amount of reshuffling in CEO assignments. As a result, the mass of CEOs working in their own sector is virtually unaffected. The new equilibrium CEO wages decrease modestly by 64 million DKK, corresponding to a 7.64% drop from the predicted equilibrium wage from the model estimation.

Table 5: Trade war - exports are reduced by 50% for all firms

Changes in CEO assignments	Percentage of CEOs who switched firms	
All firms	1.39%	
Low productivity firms	1.40%	
High productivity firms	1.38%	
Changes in CEO wages	Counterfactual sample	Main sample
Variance of CEO wages	1.96	2.48
Mean of CEO wages (millions DKK)	773.87	838.02
Changes in CEO amenities	Counterfactual sample	Main sample
Number of CEOs in their own industry	230.36	230.34

Notes: This Table reports results from a counterfactual policy experiment where we simulate a trade war and replace the export value of all firms in our data with half of its actual value. We show how (1) CEO assignment, (2) the variation of CEO wages and (3) mean of CEO wages were to change under this counterfactual scenario. This table also reports the number of CEOs who work in their own industries before and after the experiment. Low productivity firms are those whose gross profits are below the median, whereas high productivity firms refer to those whose gross profits are above the median.

7 Related Literature

There are two main perspectives on CEO compensation, which Edmans and Gabaix [2016] call the 'rent extraction view' and the 'shareholder value view' (See also Edmans et al. [2017]). They define the shareholder value view as putting emphasis on two key aspects of the CEO market. First, when evaluating CEO compensation, this view emphasizes the need to take into account dimensions such as market forces and competitive equilibrium. Second, this view allows for a relatively wide view of firm contracts, which are generally concerned with maximizing shareholder value. In the influential rent extraction view, the key assumption is that boards controlling the firm might pursue objectives that are not in the interest of the shareholders (Bebchuk and Fried [2004]). Therefore, this view argues that external regulations that increase oversight over how these rents are extracted will generally be necessary to support the goals of shareholders and facilitate the sorts of market discipline that stakeholders can then impose on firm decisions. Positive developments in external regulations are necessary to make the hiring of CEOs by firms closer aligned to the shareholder value view.

Our method falls most naturally under the shareholder value view, because we assume that the hiring of CEOs is driven by market forces that seek to maximize shareholder value. However, we are able to empirically evaluate some important hypotheses that are central to the debate over which view of the CEO market is most accurate (Frydman and Jenter [2010], (Cziraki and Jenter [2020]). For example, we find that CEOs derive positive amenity value from managing firms with high equity value, which suggests that CEOs are paid more in firms with more stringent oversight (and not paid less as it might be predicted by the rent extraction view of the CEO market). Furthermore, we show that an amenity for firms in the CEOs own industry offers a simple market based argument for the low mobility of CEOs.

Several influential studies argue that the market for CEOs is well described by a matching market with perfect competition and no frictions (Tervio [2008], Gabaix and Landier [2008], Edmans et al. [2009]). While the basic models emphasize that the most talented CEOs should be matched with the largest firms, other influential studies also argue that firms' demand for managerial skills has shifted from firm-specific to general (and therefore transferable) skills (Murphy and Zabojnik [2004, 2007], Frydman [2019]). Our estimated matching model allows agents on both sides of the market to be differentiated using several characteristics instead of just a single one. For instance, we allow that the matching between CEOs and firms can depend on CEOs' age, marital status,

education, net wealth and firms' size, exports, net investment, capital structure, etc. Most importantly, we identify the job amenity channel in a framework with taxation on transfers. While our results are in line with the general findings of the two streams of literature pioneered by Gabaix and Landier [2008] and Murphy and Zabojnik [2004], in our estimated model, we can also determine and measure the importance of amenities in CEO compensations.

Several other CEO market analyses have allowed for multidimensional matching in the CEO labor market, see, for example, Pan [2017] and Chen et al. [2020]. These studies have not considered the problem of identifying the value of job amenities to the CEOs, nor the implications of taxes on earned income. The reason why these studies do not address these issues is due to differences in the underlying methods of inference. The previous models rely on the Maximum Score Estimation method developed by Fox [2007, 2010, 2018]. While these methods have a key advantage that they do not specify any structure on the error term, there is a trade-off in that the estimation results rely on the assumption of perfect transferable utility, which means that the market assignment of CEOs must be efficient. Of course, if tax neutrality is violated by the existence of untaxed amenities, market allocations will not be efficient. The methodology of Dupuy et al. [2020], which we apply, does not seek identification from the requirement that the market is efficient. Instead, identification follows from the assumption of separability, which means that the unobserved valuations of CEOs and firms are assumed to be uncorrelated. The importance of the separability assumption for the identification of latent variables in matching models is developed in several influential papers by Choo and Siow [2006], Galichon and Salanié [2021] and Chiappori et al. [2017].

Our estimation of the value of amenities for each CEO at each firm is related to the literature on compensating differentials (Rosen [1974]). Much of this literature follows a regression approach that seeks to identify the lower wage that a worker is willing to accept for any given amenity. Influential studies have found, for example, that workers are willing to accept lower wages in jobs with lower probability of death (Thaler and Rosen [1976]). Such studies typically seek to measure the value placed on an observed amenity such that it is possible to access valid controls where there are other jobs that are otherwise similar. The core challenge of which is that workers are not randomly assigned to jobs in the field (Hwang et al. [1992]). Some of these difficulties can be resolved by running controlled experiments. For example, Eriksson and Kristensen [2014] use a controlled experiment to show that there are trade-offs between wages and non-monetary rewards that could impact the sorting of workers to firms.

Our methods for analyzing compensating differentials related to amenities for different firm characteristics are more closely related to recent studies that seek to identify amenities from observations on the pattern of assignments and wages. Like Sorkin [2018], we also infer compensating differentials from assignments and wages. However, in the Sorkin [2018] model, there are search frictions and the workers can respond to new offers over time. In this case, he can apply a revealed preference argument to infer the amenities of each firm. In a competitive market, this is not the case, because CEOs are assigned according to what constitutes a 'stable allocation' (Refer to Gale and Shapley [1962], Roth [2002]). However, in such a market we are able to follow the methodology of Dupuy and Galichon [2022], Dupuy et al. [2020], which derives an identification strategy for the case of a perfectly competitive assignment of firms.

With regard to studying the employment, performance and compensations of managers using Danish data, there are several earlier studies by Eriksson [1999] and Lausten [2002]. These studies verify the hypothesis from the literature on tournaments, which suggests that poor performing managers will be replaced (Lazear and Oyer [2012]). Similar findings are found in other CEO/management markets (Kaplan [1997]). Verification of the tournament hypothesis also supports the shareholder valuation view of the CEO market. While we do not consider CEO turnover, the estimates from the study of turnover are consistent with our findings from a cross-section of CEOs and firms that the more productive firms pay more talented CEOs higher wages.

8 Conclusions

There is much evidence that CEOs are crucial for firm performance (Rosen [1981, 1982], Kaplan et al. [2012], Kaplan and Sorensen [2021], Bennedsen et al. [2020]). Moreover, to the extent that high performance firms are led by talented CEOs are essential to the profitable development of innovations and economic opportunities. It is a matter of public interest that the right CEOs are matched to the right firms. Therefore, a deeper understanding of the CEO market can offer valuable guidance, not only for general corporate strategies that impact who manages the firm, but also for public policies that impact CEO pay and assignment (Refer to Edmans and Gabaix [2016]). In order to measure how CEO compensation attracts CEOs to firms, we have argued that it is important to account for the amenities offered by each firm and to understand how CEOs value these amenities. Our estimates suggest that CEOs receive high amenity compensations for working at a firm in their own industry, which we interpret as a preference for building a

legacy in their industry. We also find that CEOs derive amenity value from working at a firm with high equity. Since high equity is associated with less shareholder oversight, this finding suggests that CEOs are willing to give up a considerable amount of salary to gain empowerment. Consequently, firms that offer these amenities are able to pay their CEOs lower wages than firms without these amenities.

To further illustrate the importance of amenities, we considered two counterfactual experiments that directly impacted the amenity for own industry firms and the amenity for firms with high equity. We find that eliminating the amenity for working at an own industry firm would push CEO salaries much higher, and that there would also be large changes in CEO assignments. Our counterfactual experiment also predicts that decreasing the equity of high equity firms will lead to large increases in CEO salaries, but will not change the overall CEO assignment. The first result suggests that the legacy (own industry) amenity is a strong incentive that holds CEOs to their current industry, and the latter result suggests that on average, CEOs react positively to the strong amenity incentive to manage higher equity firms over lower equity firms.

Previous research about the market for CEOs has not offered estimation results with regard to how CEOs value the amenities offered by different firms. As we have discussed in our review of the literature, this neglect is mainly due to methodological difficulties that have been recently resolved by Dupuy and Galichon [2022], which draws on some important results obtained by Choo and Siow [2006], Galichon and Salanié [2021], Dupuy and Galichon [2014] and Chiappori et al. [2017]. We are now able to estimate a model of the CEO market, which is close in both spirit and formalities as earlier works by Gabaix and Landier [2008] and Tervio [2008]), but which also allows us to consider CEO and firm fixed effects, introduce taxation, job amenities and multidimensional attributes of agents on both sides of the market. The application of these methods also requires that we have administrative matched CEO/firm data that measures the observable characteristics of each firm and CEO. Importantly, for our methods, it is important that we have accurate and comprehensive measures on CEOs pecuniary pay and firm profits. We obtain this information from the Danish tax authority. Our estimates square well with the relevant predictions of the 'shareholder value' view of the market for CEOs (Refer to Edmans and Gabaix [2016]). Furthermore, our findings help resolve some puzzling facts in the literature.

We can point to several avenues for future research. First, it will be useful to assess how the market for CEOs might differ across international boundaries. There are several reasons why this research will be of interest. First, it would be of interest to learn whether

the qualitative conclusions of this paper can be supported in other markets. We argue that amenities are a driver of CEO assignments, and thus it is important that the estimated amenities have the correct sign with regard to theories that motivate why such attributes are considered to be amenities to the CEOs. The hypothesis that CEOs will assign a positive amenity to working at a high equity firm is an example. Another reason to study the CEO market in other countries is to determine if there are quantitative differences between these markets that could be measured by estimates that follow the procedures used in the present paper. For example, we might expect that the high taxation of CEO income in Denmark drives amenity compensation to be more important than in other countries with lower taxation. Furthermore, the value of amenities might also depend on differences in corporate governance practices and cultures across countries. For example, different practices and cultural norms might impact how CEOs value the amenity of empowerment, which is gained at high equity firms, or their value for legacy, which is derived from a career in a single industry, relative to pecuniary forms of compensation. Nevertheless, we believe that Denmark is a useful starting point for such inquiries, because the market is relatively closed with regard to other CEO markets even though Danish firms produce sophisticated products and services that are valued globally and have ready access to global sources of capital. In particular, Denmark is a small country with a difficult language. Therefore, almost all Danish firms are managed by Danish-born CEOs (Refer to Ellersgaard et al. [2013]). Furthermore, given that most Danish people put a high value on Danish work-life balance, culture, and ability to use their native language, there is very little mobility of CEO talent out of Denmark.

A second topic for further research is to look for natural experiments as a means to quantify how the key parameters of our model might change in response to changes in relevant external factors. For example, changes in taxation or the methods of corporate governance over time could easily impact how CEOs value different firm amenities. Furthermore, economic factors that affect some firms more directly than others, such as international trade and industrial policies, might lead to changes in the distribution of firm types that offer amenities that are valued by CEOs. To illustrate some relevant hypotheses with regard to the latter factors, we considered two counterfactual experiments. First, we used our estimated model to generate the hypothesis that a trade war will have a moderate negative impact on CEO wages but little effect on CEO assignment. Second, we used our estimated model to generate hypothesis with regard to industrial policy that replaces firms in a declining industry with firms in the expanding industry sector. In this case, we found that the impact of such a policy would cause large increases in CEO

wages and large changes in CEO assignments, because the legacy amenity is not valued by the displaced CEOs. Future work that investigates natural experiments relating to these sorts of hypothesis could be used to derive addition evidence that supports (or rejects) our general claim that amenities which are tied to key firm characteristics are an important source of CEO compensation.

A third topic for further research is to better integrate dynamic decision-making and longitudinal data into the analysis of the market for CEOs with taxes and non-pecuniary compensation. For example, an explicit dynamic model might be better suited for drawing inferences about the role that firing might play in incentivizing higher quality CEOs to accept the position of CEO at a firm. This conclusion would also require that we consider how different CEOs evaluate risks as well as their own talent. Furthermore, in a dynamic analysis, it becomes relevant to consider whether CEO and firm types might change over time. For example, given that we estimate that CEOs like some firm types more than others, we might expect that CEOs push firms under their command to become more like their most favored type of firm. In other words, there will be many challenges related to moving from our simple static model to more general dynamic models and data, but there are also opportunities to make additional progress with regard to understanding the role of amenities in the CEO market. Since we have shown that a simple static analysis delivers results that are both statistically and economically significant, the estimates from our basic model could serve as either a useful benchmark or foil for these more ambitious studies.

Overall, our findings demonstrate that amenities are important forms of compensation and are key drivers of assignment in the market for CEOs. These results point to a number of important considerations: CEOs objectives are much richer than just maximizing the NPV of their income; other than pecuniary compensations, a corporate board must evaluate amenities when attempting to attract or retain a CEO. For example, for a given level of pecuniary compensation, the board is likely to attract a better CEO applicant pool if the firm has high equity. And, the board should not underestimate the importance to the CEO of enjoying an opportunity to build a legacy within her industry. Our results also contribute to understanding the importance of these factors in a high tax country like Denmark.

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Appendix

A Tables

Table 6: Summary statistics of CEOs' and firms' characteristics - main sample

	Mean	Std
CEOs:		
Age (in years)	51.57	8.81
Years of schooling (in years)	15.74	2.47
Net wealth	3.29E+06	1.08E+07
Bank debt	1.41E+06	4.33E+06
Gender (1 male/0 female)	0.94	0.23
Marital status (1 Married)	0.87	0.34
Salary	2.64E+06	2.88E+06
Firms:		
Number of employees	991.84	2468.97
Net investment	6.43E+07	1.77E+08
Import	3.86E+08	1.07E+09
Export	6.83E+08	2.63E+09
Equity	8.58E+08	3.05E+09
Fixed assets	9.81E+08	3.09E+09
gross profit	8.95E+08	2.50E+09
N = 295		

B Data

B.1 Data Sources

CEO characteristics. We merge several administrative registers made available by Statistics Denmark to obtain the CEO-firm matches and a series of comprehensive information on the CEOs and firms.

To identify CEOs, we use the ISCO-08 classification code (International Standard Classification of Occupations).[57] We obtain a list of CEOs' Civil Personal Registration (CPR) Number[58] from this step. Using these CPR numbers, we add detailed information about the CEO from several other administrative registers. CEO characteristics include: demographic information such as age, gender, education, marital status, number of children, age of each child, from the Danish civil registration system (CPR Registeret); income and financial information, such as wage, perks, tax-free salary, anniversary and severance pay, the value of stock options, remuneration for board work, fees in connection with consulting work, lectures and the like, net wealth, bank debt, from the Danish tax authority (SKAT); and real estate information such as the size and tax value of each registered property from the real estate statistics register (Ejendomsstatistik Registeret).

CEO-Firm matches. We then match the CEOs with his firms using the register FIDA that provides the key between workers and firms. For a person who works as CEO for more than one firm, we select his match as the firm that has the highest gross profit. The firm identifier is the *Centrale Virksomhedsregister* (CVR) number assigned by the Central Business Register for all legal entities. Our data is at CEO-firm level. One observation is defined as a match between one CEO and one firm, with detailed CEO and firm characteristics.

Firm characteristics. Finally, we add firm level statistics using FIRM (Generel firmastatistik). This register covers active firms from all industries and sectors. It integrates information from three different types of reports: balance sheet, income statement and employment statistics.

[57] The Danish version of the ISCO-08 code is referred to as DISCO codes. we use a variable called disco08-alle-indk to identify CEOs for the year 2011. We double check the worker's primary job function using the variable pstill and assure the consistency of coding using DISCO code from two different registers.

[58] CPR number is a unique time-consistent personal identification number for all Danes and residents of Denmark. Statistics Denmark replace them by anonymized ID-numbers to ensure confidentiality

B.2 Variable Definition

Age: reports a CEO's age on 1st January 2011;
Marital status: Marital status = 1 indicates that a CEO is married (including separated couples) or the CEO is involved in a registered partnership, or the CEO has a cohabiting partner. Otherwise, Marital status = 0;
Gender: gender = 1 indicates that it is a male CEO. Gender = 0 indicates that it is a female CEO;
Education: reports a CEO's highest level of educational attainment. This variable is originally defined in categories based on the International Standard Classification of Education (ISCED). We then translated these categories into years of schooling. Primary education, 10 years of schooling; preparatory courses, 10 years of schooling; Upper secondary education, 11 years of schooling; High school and apprenticeship education, 12 years of schooling; Shorter cycle higher education, 14 years of schooling; vocational bachelor's education, 15 years of schooling; Bachelor's degree, 16 years of schooling; Master's degree, 18 years of schooling; PhD, 21 years of schooling.
Net wealth: is calculated as property value + the value of securities + savings and checking account balance - mortgage loans - bank debt - other debts. All these values are reported by third parties to the Danish tax authority as their prevailing market value at the end of the year. For example, banks report the assets and liabilities of their customers; financial institutions (i.e., mutual funds, investment banks) report the value of securities held by their clients. Land and real estate registry reports the value of land and property owned by individuals and businesses. This variable doesn't include cash, large durable (such as cars, boats, and private airplanes), non-corporate business assets, unlisted securities (i.e., bearer bonds, unlisted equities, and shares of housing cooperatives), assets held abroad (foreign real estate and foreign bank accounts), and inter-personal debts. See a detailed documentation of the Danish wealth data in Jakobsen et al. [2020];
Bank debt: debts to banks measured on 31st December. This variable includes debt to banks, pension funds, insurance and finance companies, credit card schemes and student debt administered by banks.
Wage: Total taxable wage income, include perks, tax-free salary, anniversary and severance pay, the value of stock options, remuneration for board work, fees in connection with consulting work, lectures and the like.

Number of employees: indicates the number of people employed in the company at the end of November. For employees, statistics Denmark require them to meet the following

requirements: during the year in question, the employee has received a salary corresponding to at least 80 hours of work; the employee was not registered as fully unemployed in the last week of November; and the employee has legal residence in Denmark at the end of the year.

Net investment: Total investment inflow minus total investment outflow, measured in Danish kroner.

Import: The company's total import value. All amounts are measured in kroner without VAT.

Export: Total export value of goods and services as well as sales of certain VAT-exempted products, measured in Danish kroner.

Equity: Equity at the end of the accounting year. This variable is calculated as total assets minus the sum of liabilities and other debt obligations.

Fixed assets: Total value of fixed assets. This variable includes assets that are intended for permanent ownership or operation of the company, i.e., buildings, machinery, patents, licenses and long-term investments of a financial nature, i.e., shares and bonds.

Productivity: the firm's gross profit. This variable is calculated as the turnover minus the consumption of goods minus the purchase of labor (wage) and subcontractors, measured in Danish kroner.

C Robustness Checks

C.1 Follow Dupuy et al. [2020], without CEO and Firm Fixed Effects

Table 7: Effect of CEOs' and firms' characteristics on job amenities and productivity (in Millions DKK)

	Main effects	Number of employees	Net investment (in DKK)	Import (in DKK)	Export (in DKK)	Equity (in DKK)	Fixed assets (in DKK)
Job Amenities (Alpha)							
Main effects		0.00	0.26	**-0.28**	0.57	**1.06**	**-0.86**
		(0.17)	(0.20)	**(0.13)**	(0.95)	**(0.29)**	**(0.22)**
Age (in years)							
Age^2							
Years of schooling (in years)							
Net wealth (in DKK)		0.03	0.08		**-0.74**		
		(0.28)	(0.25)		**(0.18)**		
Bank debt (in DKK)		-0.40	-0.33		**3.97**		
		(0.24)	(0.26)		**(0.47)**		
Gender (1 male/0 female)							
Marital status (1 Married)		-0.30	**-0.61**		-0.05		
		(0.22)	**(0.20)**		(0.92)		
CEO industry experience	**1.65**						
	(0.16)						
Productivity (Gamma)							
Main effects		**579.36**	**495.30**	**363.73**	**551.63**	371.65	370.71
		(76.46)	**(93.38)**	**(122.46)**	**(135.58)**	(309.79)	(327.38)
Age (in years)	**6.18**						
	(2.07)						
Age^2	**-6.49**						
	(2.12)						
Years of schooling (in years)	0.35						
	(0.24)						
Net wealth (in DKK)	**1.34**	-0.52	-0.43		**3.67**		
	(0.42)	(1.23)	(1.11)		**(0.79)**		
Bank debt (in DKK)	**-1.26**	1.74	1.27		**-17.91**		
	(0.55)	(1.07)	(1.12)		**(2.13)**		
Gender (1 male/0 female)	1.81						
	(1.10)						
Marital status (1 Married)	1.04	1.06	1.12		3.03		
	(1.03)	(0.97)	(0.88)		(4.04)		
CEO industry experience	0.72						
	(0.62)						
Productivity constant	**820.06**						
	(57.82)						
Salary constant	**16.49**						
	(0.37)						

Notes: This table reports the estimates of the effect of CEO and firm characteristics on job amenities and firm productivity. wages and productivity are measured in millions of Danish kroner. In 2021, 1 DKK = 0.16 USD at the average exchange rate. All covariates, except for alma mater, are standardized to have a standard deviation of 1. Standard errors are in parentheses. The R-squared on wage is 0.52 whereas the R-squared on productivity is 0.85. The value of the objective function at convergence of this specification is 5635.34. The smaller the value of the objective function, the higher the likelihood, the better the fit of the model.

C.2 Allow more unobserved heterogeneity in fitting productivity (sigma1 = 0.5, sigma2 = 0.35)

Table 8: Effect of CEOs' and firms' characteristics on job amenities and productivity (in Millions DKK)

	Main effects	Number of employees	Net investment (in DKK)	Import (in DKK)	Export (in DKK)	Equity (in DKK)	Fixed assets (in DKK)
Job Amenities (Alpha)							
Main effects		-0.07	**0.39**	-0.08	0.55	**0.66**	**-0.62**
		(0.13)	**(0.20)**	(0.09)	(0.41)	**(0.15)**	**(0.13)**
Age (in years)							
Age$\hat{2}$							
Years of schooling (in years)							
Net wealth (in DKK)		0.00	**0.58**		**-1.01**		
		(0.25)	**(0.24)**		**(0.14)**		
Bank debt (in DKK)		-0.10	-0.15		**3.23**		
		(0.26)	(0.24)		**(0.36)**		
Gender (1 male/0 female)							
Marital status (1 Married)		-0.07	**-0.66**		-0.09		
		(0.18)	**(0.18)**		(0.39)		
CEO industry experience	**1.57**						
	(0.09)						
Productivity (Gamma)							
Main effects		**590.21**	**503.78**	**363.93**	**538.14**	380.41	395.66
		(78.70)	**(94.53)**	**(124.14)**	**(141.41)**	(319.25)	(344.21)
Age (in years)	**4.07**						
	(1.60)						
Age$\hat{2}$	**-3.98**						
	(1.60)						
Years of schooling (in years)	0.25						
	(0.15)						
Net wealth (in DKK)	0.15	-0.28	**-2.69**		**4.84**		
	(0.31)	(1.09)	**(1.00)**		**(0.61)**		
Bank debt (in DKK)	**-2.09**	0.41	0.49		**-14.59**		
	(0.40)	(1.16)	(1.13)		**(1.61)**		
Gender (1 male/0 female)	1.04						
	(0.77)						
Marital status (1 Married)	0.38	0.16	**1.28***		3.04		
	(0.65)	(0.72)	**(0.68)**		(2.07)		
CEO industry experience	**0.56***						
	(0.34)						
Productivity constant	**812.16**						
	(59.00)						
Salary constant	**14.47**						
	(1.25)						

Notes: This table reports the estimates of the effect of CEO and firm characteristics on job amenities and firm productivity. wages and productivity are measured in millions of Danish kroner. In 2021, 1 DKK = 0.16 USD at the average exchange rate. All covariates, except for CEO industry experience, are standardized to have a standard deviation of 1. Standard errors are in parentheses, calculated from the Hessian of the likelihood. Bold indicates that the variable is significant at 1% level. * indicates that the variable is significant at 5% level. The R-squared on wage is 0.52 whereas the R-squared on productivity is 0.85. The value of the objective function at convergence of this specification is 5545.15. The smaller the value of the objective function, the higher the likelihood, the better the fit of the model.

C.3 With CEO and Firm Fixed Effects (FEs are estimated using mover CEOs in the past 5 years) (sigma1 = 0.5, sigma2 = 0.25 as in main result)

Table 9: Effect of CEOs' and firms' characteristics on job amenities and productivity (in Millions DKK)

	Main effects	Number of employees	Net investment (in DKK)	Import (in DKK)	Export (in DKK)	Equity (in DKK)	Fixed assets (in DKK)
Job Amenities (Alpha)							
Main effects		0.03	-0.16	-0.18	**0.58***	**0.80**	**-0.39***
		(0.16)	(0.20)	(0.12)	**(0.34)**	**(0.24)**	**(0.20)**
Age (in years)							
Age$\hat{2}$							
Years of schooling (in years)							
Net wealth (in DKK)		-0.03	0.12		**-0.57**		
		(0.28)	(0.23)		**(0.16)**		
Bank debt (in DKK)		0.32	**-0.87**		**2.99**		
		(0.23)	**(0.23)**		**(0.43)**		
Gender (1 male/0 female)							
Marital status (1 Married)		-0.11	0.17		-0.51		
		(0.19)	(0.21)		(0.36)		
CEO industry experience	**1.46**						
	(0.11)						
Productivity (Gamma)							
Main effects		**462.78**	**303.39**	131.87	**291.99**	154.69	206.94
		(106.93)	**(134.62)**	(173.36)	**(109.41)**	(239.01)	(199.46)
Age (in years)	**12.38**						
	(1.85)						
Age$\hat{2}$	**-9.00**						
	(1.88)						
Years of schooling (in years)	**0.81**						
	(0.21)						
Net wealth (in DKK)	0.08	-0.25	-0.70		**2.93**		
	(0.41)	(1.21)	(1.02)		**(0.72)**		
Bank debt (in DKK)	**-1.93**	-1.53	**3.78**		**-13.45**		
	(0.52)	(1.03)	**(1.00)**		**(1.93)**		
Gender (1 male/0 female)	-0.10						
	(0.99)						
Marital status (1 Married)	1.25	0.28	**-3.05**		**6.13**		
	(0.79)	(0.84)	**(0.83)**		**(1.65)**		
CEO industry experience	**0.98**						
	(0.47)						
Productivity constant	**792.53**						
	(82.44)						
Salary constant	**31.67**						
	(1.59)						

Notes: This table reports the estimates of the effect of CEO and firm characteristics on job amenities and firm productivity. wages and productivity are measured in millions of Danish kroner. In 2021, 1 DKK = 0.16 USD at the average exchange rate. All covariates, except for CEO industry experience, are standardized to have a standard deviation of 1. Standard errors are in parentheses, calculated from the Hessian of the likelihood. The R-squared on wage is 0.57 whereas the R-squared on productivity is 0.67. The value of the objective function at convergence of this specification is 5738.79. The smaller the value of the objective function, the higher the likelihood, the better the fit of the model.

C.4 With CEO and Firm Fixed Effects (FEs are estimated using mover CEOs in the past 5 years) (sigma1 = 0.5, sigma2 = 0.35)

Table 10: Effect of CEOs' and firms' characteristics on job amenities and productivity (in Millions DKK)

	Main effects	Number of employees	Net investment (in DKK)	Import (in DKK)	Export (in DKK)	Equity (in DKK)	Fixed assets (in DKK)
Job Amenities (Alpha)							
Main effects		-0.06	0.14	-0.19	0.57	**0.80**	**-0.45**
		(0.17)	(0.21)	(0.12)	(0.39)	**(0.26)**	**(0.21)**
Age (in years)							
Age$\hat{2}$							
Years of schooling (in years)							
Net wealth (in DKK)		-0.15	0.35		**-0.72**		
		(0.28)	(0.24)		**(0.16)**		
Bank debt (in DKK)		0.11	**-0.58**		**2.99**		
		(0.21)	**(0.23)**		**(0.42)**		
Gender (1 male/0 female)							
Marital status (1 Married)		-0.06	-0.10		-0.49		
		(0.21)	(0.21)		(0.38)		
CEO industry experience	**1.42**						
	(0.11)						
Productivity (Gamma)							
Main effects		**459.03**	**297.41**	124.84	**284.34**	147.95	201.54
		(108.31)	**(136.92)**	(175.09)	**(107.98)**	(247.90)	(208.65)
Age (in years)	**11.20**						
	(1.77)						
Age$\hat{2}$	**-7.99**						
	(1.79)						
Years of schooling (in years)	**0.84**						
	(0.21)						
Net wealth (in DKK)	-0.31	0.32	-1.73		**3.58**		
	(0.39)	(1.22)	(1.08)		**(0.68)**		
Bank debt (in DKK)	**-2.22**	-0.56	**2.46**		**-13.46**		
	(0.50)	(0.95)	**(1.00)**		**(1.88)**		
Gender (1 male/0 female)	-0.12						
	(0.95)						
Marital status (1 Married)	0.81	0.08	**-1.84**		**5.88**		
	(0.75)	(0.89)	**(0.85)**		**(1.73)**		
CEO industry experience	**1.40**						
	(0.48)						
Productivity constant	**791.84**						
	(83.94)						
Salary constant	**31.46**						
	(1.52)						

Notes: This table reports the estimates of the effect of CEO and firm characteristics on job amenities and firm productivity. wages and productivity are measured in millions of Danish kroner. In 2021, 1 DKK = 0.16 USD at the average exchange rate. All covariates, except for CEO industry experience, are standardized to have a standard deviation of 1. Standard errors are in parentheses, calculated from the Hessian of the likelihood. The R-squared on wage is 0.57 whereas the R-squared on productivity is 0.66. The value of the objective function at convergence of this specification is 5741.42. The smaller the value of the objective function, the higher the likelihood, the better the fit of the model.

Internet Appendix

D Likelihood Ratio Tests

Variable Selection

CEO_Cont	age	age^2	year of schooling	net wealth	bank debt	
CEO_Cat	gender	marital status				
Firm_Cont	no- branches / no. employees	net investment	import	export	equity	fixed assets
Firm_Cat with AM	CEO's industry 5 years ago and firm's industry					
lions DKK **Wage**	wage include pension and monetary benefits					
lions DKK **Productivity**	gross profit					

Model	LR test result	prob > chi2	LR test statistics	Num_para	sigma1	sigma2	minus_loglike	minus_Fval	r_sq_wage	r_sq_prod	first order	#iterations	exitflag	Interaction variables
	Group 1 (Nested)													
1	most restrictive model			35	0.5	0.5	2007.80	1665.80	0.6019	0.6157	0.0126	166	5	net wealth, marital status, no. branches, net investment, export
2			-7.6	41	0.5	0.5	2011.60	1652.20	0.6856	0.6179	0.00963	210	5	net wealth, bank debt, marital status, no. branches, net investment, export
3			-18	47	0.5	0.5	2016.80	1674.60	0.6923	0.5594	0.0617	257	5	age, net wealth, bank debt, marital status, no. branches, net investment, export
4			-26	47	0.5	0.5	2020.80	1662.80	0.6069	0.6234	0.0374	273	5	age, schooling, net wealth, marital status, no. branches, net investment, export
5			-31.2	47	0.5	0.5	2023.40	1711.70	0.7204	0.0252	0.0761	220	5	net wealth, bank debt, marital status, no. branches, net investment, export, equity
6			-42.6	55	0.5	0.5	2029.10	1701.40	0.702	0.2377	0.296	280	5	age, net wealth, bank debt, marital status, no. branches, net investment, export, equity
7			-47.8	55	0.5	0.5	2031.70	1652.30	0.6487	0.6158	0.0422	325	5	age, schooling, net wealth, marital status, no. branches, net investment, export, equity
8			-52	55	0.5	0.5	2033.80	1682.00	0.627	0.5565	0.0612	268	5	age, schooling, net wealth, marital status, no. branches, net investment, import, export
9			-52.2	55	0.5	0.5	2033.90	1652.60	0.6481	0.6157	0.0773	351	5	age, schooling, net wealth, marital status, no. branches, net investment, export, fixed assets
10			-81	63	0.5	0.5	2048.30	1667.00	0.6667	0.5616	0.523	479	5	age, schooling, net wealth, marital status, no. branches, net investment, export, equity, fixed assets
11			-55.4	63	0.5	0.5	2035.50	1703.40	0.649	0.2616	0.223	320	5	age, schooling, net wealth, gender, marital status, no. branches, net investment, export, equity
12			-97.2	73	0.5	0.5	2056.40	1687.50	0.7617	0.0793	0.14	381	5	age, schooling, net wealth, bank debt, marital status, no. branches, net investment, export, equity, fixed assets

In group 1, Model 1 is the most restricted model. Model 1 fits better than other more complicated models.

	Group 2 (Nested)	Num_para	sigma1	sigma2	minus_loglike	minus_Fval	r_sq_wage	r_sq_prod	first order	#iterations	exitflag	Interaction variables
1	most restrictive model	41	0.5	0.5	2007.30	1651.60	0.6823	0.6151	0.0404	217	5	net wealth, bank debt, marital status, no. branches, net investment, import
2		73	0.5	0.5	2055.70	1682.30	0.7587	0.1891	0.316	316	5	age, schooling, net wealth, bank debt, marital status, no. branches, net investment, import, equity, fixed assets

In group 2, Model 1 is the most restricted model. According to log likelihood value, Model 1 fits better than other more complicated models.

	Group 3 (Nested)	Num_para	sigma1	sigma2	minus_loglike	minus_Fval	r_sq_wage	r_sq_prod	first order	#iterations	exitflag	Interaction variables
1	most restrictive model	25	0.5	0.5	1998	1699.8	0.5435	0.5549	0.0617	93	5	net wealth, export
2		25	0.5	0.5	1993.8	1674.3	0.5438	0.6157	0.0565	106	5	net wealth, no. employees
3		27	0.5	0.5	1994.3	1663.5	0.6091	0.6351	1.37E-07	202	1	net wealth, bank debt, no. employees
4		29	0.5	0.5	1997.7	1665.5	0.6127	0.616	0.013	121	5	age, net wealth, bank debt, no. employees *t_stats complex number
5		29	0.5	0.5	1999.5	1662.3	0.6175	0.6345	1.33E-06	221	5	education, net wealth, bank debt, no. employees
6		31	0.5	0.5	1999.5	1663.2	0.6255	0.6156	0.0353	138	5	net wealth, bank debt, no. employees, net investment
7		31	0.5	0.5	1998	1689.9	0.6116	0.5561	6.17E-02	124	5	net wealth, bank debt, no. employees, export *not a good fit
8		35	0.5	0.5	2010.5	1661.9	0.6321	0.6166	0.02	180	5	net wealth, bank debt, no. employees, investment, export
9		41	0.5	0.5	2012	1725.6	0.6344	0.0705	0.127	139	5	net wealth, bank debt, gender, no. employees, investment, export
10		41	0.5	0.5	2029.90	1632.90	0.7031	0.7353	0.0186	195	5	net wealth, bank debt, marital status, no. employees, net investment, export
11		41	0.5	0.5	2030.00	1717.70	0.7023	0.0188			5	net wealth, bank debt, marital status, no. employees, net investment, export
12		43	0.5	0.5	2030.30	1629.20	0.7055	0.7521	0.031	197	5	net wealth, bank debt, marital status, no. employees, net investment, export
13		43	0.5	0.5	2031.2	1636.7	0.7095	0.7075	0.151	207	5	net wealth, bank debt, marital status, no. employees, net investment, export
14		49	0.5	0.5	2046.7	1667.5	0.7113	0.6801	0.0786	218	5	net wealth, bank debt, marital status, no. employees, net investment, export, total assets
		36	0.5	0.5								net wealth, no. children, no. employees, net investment, export

E Grid Search to Determine Sigmas

200 observations, Specification 12

sigma 1	sigma 2	minus_Fval	r_sq_wage	r_sq_prod	first order	#iterations
0.25	0.25	2.54E+03	-1.4068	0.5306	3.13E+03	9
0.25	0.5	2.5317E+03	-2.2385	0.4468	121	7
0.25	0.75					
0.25	1	2.58E+03	-3.9231	0.2694	1.56E+03	4
0.5	0.25					
0.5	0.5	2.34E+03	-0.4918	0.6995	220	25
0.5	0.75	2.33E+03	-0.7083	0.684	358	21
0.5	1					
0.75	0.25	2.36E+03	-1.4722	0.64	247	31
0.75	0.5	2.23E+03	-0.117	0.7706	148	36
0.75	0.75	2.42E+03	-1.7844	0.6052	187	24
0.75	1	2.43E+03	-1.7631	0.6968	271	24
1	0.25	2.08E+03	0.5891	0.848	0.00353	140
1	0.5	2.07E+03	0.6122	0.8535	0.00332	143
1	0.75	2.69E+03	-12.6021	0.7117	58.4	24
1	1	2.69E+03	-24.3494	0.5027	47.8	26

200 observations, Specification 11

sigma 1	sigma 2	minus_Fval	r_sq_wage	r_sq_prod	first order	#iterations
0.25	0.25	2.60E+03	-1.3039	-0.572	237	1
0.25	0.5	2.60E+03	-1.3028	-0.572	241	1
0.25	0.75	2.60E+03	-1.3022	-0.572	241	1
0.25	1	2.60E+03	-1.3017	-0.572	243	1
0.5	0.25	2.69E+03	-5.7034	-2.2416	228	3
0.5	0.5	2.69E+03	-5.7026	-2.2436	235	3
0.5	0.75	2.69E+03	-5.5997	-2.2064	204	3
0.5	1	2.69E+03	-5.5949	-2.2058	201	3
0.75	0.25	2.30E+03	0.4286	0.0192	**0.00273**	32
0.75	0.5	2.89E+03	-12.5247	-4.1522	245	7
0.75	0.75	2.89E+03	-12.5048	-4.1522	245	7
0.75	1	2.89E+03	-12.4884	-4.1522	248	7
1	0.25	2.30E+03	0.4286	0.0192	**2.95E-05**	34
1	0.5	2.30E+03	0.4286	0.0192	**0.0106**	30
1	0.75	2.30E+03	0.4286	0.0192	**0.0119**	29
1	1	2.30E+03	0.4286	0.0192	**0.00505**	30

200 observations, Specification 13

sigma1	sigma2	minus_Fval	r_sq_wage	r_sq_prod	first order	#iterations
0.25	0.25					
0.25	0.5	1700.9	0.7129	0.0582	0.363	365
0.25	0.75	1702.6	0.7127	0.0214	0.0872	306
0.25	1					
0.5	0.25	1691.1	0.6472	0.4249	0.431	354
0.5	0.5	1693.1	0.6631	0.362	0.512	373
0.5	0.75	1698.1	0.6937	0.1921	0.323	339
0.5	1	1702	0.7064	0.0696	0.375	292
0.75	0.25	1700.6	0.6947	0.1484	0.533	348
0.75	0.5	1703.6	0.7009	0.0497	0.69	297
0.75	0.75	1703.4	0.7002	0.0566	0.235	309
0.75	1	1696	0.6683	0.3126	0.884	369
1	0.25					