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Earnings Inequality and the Global Division of Labor: Evidence from the Executive Labor Market

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Abstract

Many industrialized economies have seen a rapid rise in top income inequality and in the globalization of production since the 1980s. In this paper I propose an open economy model of executive pay to study how offshoring affects the pay level and incentives of top earners. The model introduces a simple principal-agent problem into a heterogeneous firm talent assignment model and endogenizes pay levels and the sensitivity of pay to performance in general equilibrium. Using unique data of manager-firm matches including executives from stock market listed firms across the U.S. and Europe, I quantify the model predictions empirically. Overall, I find that between 2000 and 2014 offshoring has increased executive pay levels, raised earnings inequality across executives and increased the sensitivity of pay to firm performance.

JEL Classification: *D2,F1,F2,J3,L2*
Keywords: Offshoring; Earnings Structure, Inequality; Incentives; Executive Compensation

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1 Introduction

Past decades have witnessed a sharp increase in top income inequality, particularly within industrialized economies. Simultaneously, various technological and institutional developments in the world economy have led to a deeper international fragmentation of production across national borders. While some manufacturing and service tasks are now frequently done offshore, other more knowledge- and headquarter-intensive tasks continue to be undertaken domestically within industrialized economies.[1]

In this paper, I study the effects of offshoring on the compensation level, dispersion and performance sensitivity of executives, the occupational group at the top of the corporate hierarchy. To guide the empirical analysis, I develop a stylized general equilibrium model of executive pay that allows to analyze how international integration affects pay levels, pay-performance sensitivities and inequality. The model predicts that international integration raises competition for top talents and thus leads to an increase in the level and dispersion of executive pay and higher pay-performance sensitivities. I quantify these effects using a unique panel dataset of matched director-firm level data in combination with industry-level information on offshoring.

Executive pay is typically not only determined on the labor market but pay contracts are also designed to solve agency problems at the management level within firms. This differentiates executive compensation from pay in other occupations as a substantial part of the payment is paid in equity with fluctuating market value. The model reflects this feature of executive pay by introducing a stylized principal agent model into a general equilibrium talent assignment model with a monopolistically competitive market. Specifically, I introduce the agency problem from Edmans et al. (2009) into a general equilibrium assignment framework with monopolistic competition. Agents have multiplicative preferences over leisure and the consumption of differentiated varieties. The stylized contracting problem then allows to focus on the division of pay into fixed and performance-sensitive components disregarding the optimal level of pay. The latter then is determined in general equilibrium. I show that there is a unique equilibrium, where only firms with non-negative expected profits enter the market, labor markets clear and product demand is endogenized given the multiplicative preferences and incomes. The level and the sensitivity of pay are therefore simultaneously determined

[1] For example, improvements in information and communication technologies have reduced the costs of knowledge transfer across countries to levels that are comparable to the costs of knowledge transfers within national borders (see e.g. Baldwin (2016)). Furthermore, political and economic reforms in labor abundant economies such as China, India, and Eastern Europe have liberalized economic activity and reduced the costs of transport. See Baldwin and Lopez-Gonzalez (2015), Hummels et al. (2001), Johnson and Noguera (2012) or Timmer et al. (2014) among others for evidence on the increasing international fragmentation of production.

by the product market, the labor market and the agency conflict inside firms. While the most skilled agents in the economy are matched with the largest firms and earn the highest salaries, less skilled agents specialize in production activities leading to a positive association between talent, executive pay and firm size. Also the dollar value of incentive compensation increases with firm size while the executives' ownership shares decrease with firm size.

Similar to Antràs et al. (2006), I then extend the framework towards a two-country model where countries differ in their distributions of talent and agents can match across countries (offshoring). More talented managers have a comparative advantage in managing larger firms and benefit relatively more from the increased supply of Southern agents. Furthermore, this type of international integration raises global product demand. Both effects of globalization increase the skill premium of managers in the North. In contrast to Antràs et al. (2006), managers receive only a fraction of their remuneration as cash salary while the remainder is paid in equity. Thus, globalization affects the incentives that managers face as their compensation packages become more sensitive to performance.

The model delivers the following key insights. First, offshoring increases the level of total executive pay in the Northern economy. Second, offshoring raises inequality of pay both among executives across different firms and between executives and workers. Third, offshoring increases the dollar elasticity of equity of Northern managers such that executive compensation becomes more sensitive to firm performance and managers face steeper incentives.

To study these predictions empirically, I construct matched director-firm data, covering executive boards in public companies that are listed among one of the major stock indices in the U.S. and Europe. The data comprise the labor market for top executives between 2000 and 2014. Using information on trade flows from international input-output tables at the country-industry level, I link the compensation of executives to their exposure to intermediate goods trade (offshoring). In order to isolate changes in offshoring that are exogenous to executive compensation and uncorrelated with potential unobservable supply and demand shocks, I follow Hummels et al. (2014) and exploit variation in the global supply of exported intermediate inputs in the rest of the world to instrument for the offshoring intensity.[2] This variation in the world supply of inputs captures changes in the comparative advantages of sourcing countries over time that might arise from changes in production prices, production variety or product quality. Consistent with the presented theory, I find that the rise in the global division

[2] The world export supply is the total supply of an input from origin countries to the world market net of the supply to and from the importing country under consideration.

of labor has affected top earnings in various ways. The estimated magnitudes of the instrumental variable regressions suggest that the sample mean rise in offshoring between 2000 and 2014 has increased the level of executive pay by between 4.5 and 7.2%. This increase in the executive pay premium varies substantially across firm size with larger firms paying a higher premium. I find only mild effects of offshoring on within-firm inequality, consistent with recent evidence from Song et al. (2015) for the U.S. labor market. With respect to the incentives that managers face, I find that offshoring is associated with a 13.0% rise in stock prices and a 10.3% rise in enterprise value during the sample period. This has contributed to both, a 11.5% larger value of executives' stocks and a 9.6% higher wealth delta, the dollar wealth change per realized percentage stock return.

The paper covers a question at the intersection between labor economics, organizational economics and international trade and thus relates to various strands of the literature. First, I contribute to the literature that considers CEO pay in talent assignment models. The talent assignment models by Gabaix and Landier (2008), Edmans et al. (2009), Falato and Kadyrzhanova (2012), Baranchuk et al. (2011) and Terviö (2008) study the relation between CEO pay and the product market. These models either consider an exogenous mass of firms or an exogenous demand level in the economy and are well suited to explain the cross-section of CEO pay levels or CEO pay-performance sensitivities. However, since product demand and/or the mass of firms in the economy are exogenous, these models deliver only limited information about responses of executive pay to aggregate shocks in the economy. By introducing the assignment and principal-agent problem into a general equilibrium framework, my model makes predictions how the cross-section of CEO pay contracts responds to economic integration based on comparative statics.

Second, the paper relates to a literature in international trade that studies how offshoring is organized. Antràs et al. (2006) and Antràs et al. (2008) propose a hierarchical assignment theory based on Garicano (2000), where heterogeneous workers form hierarchical teams across borders. They model offshoring as the opportunity of agents in industrialized countries to match with agents from other countries that differ in skill endowments. Offshoring increases the match quality and consequently also the skill premium for Northern top managers. In my model, globalization comprises a similar comparative statics exercise: agents from a skill-abundant country can form matches with agents from a skill-scarce country. However, this type of international integration also affects the pay-performance elasticity and product demand, here. In that spirit, Gumpert (2014) argues that falling communication costs increase the leverage of managerial knowledge leading to a larger wage premium on knowledge in multinational headquarters. Marin et al. (2015) investigate how offshoring affects decentralization, as an alternative incentive device, in a small open economy model.

Third, the paper relates to theoretical and empirical studies that analyze the effects of offshoring and other types of trade integration on various labor market outcomes. Grossman and Rossi-Hansberg (2008) propose a theory of global production and investigate how falling offshoring costs affect factor prices. They show that one might expect a widening of the wage gap between managers and production workers if production jobs are also the most offshorable ones.[3] Feenstra and Hanson (1999) estimate the influence of trade in tasks and technological advancements on the wage gap between high and low skilled U.S. workers between 1979 and 1990. They argue that offshoring explains about 40 percent of the increase in relative wages. Becker et al. (2013) find that offshoring shifted the wage bill towards more non-routine and more interactive tasks in German multinationals. Also Hummels et al. (2014) and Baumgarten et al. (2013) find for Denmark, respectively Germany, that wage effects of offshoring vary across occupational task characteristics. Offshoring has the largest positive wage effect on tasks that require communication and language, followed by social sciences and maths. Notably, all these skills are categorical for managerial occupations. Cuñat and Guadalupe (2009, 2005) show empirically that tougher import competition increases the performance elasticity of executive pay.

Fourth, the paper is related to other studies on top income inequality and macroeconomic developments. Atkinson et al. (2011) and Alvaredo et al. (2013) document a general trend of increasing top 1% income shares for many industrialized countries since the 1980s or even earlier with the exception of the Great Recession period (see Piketty and Saez (2013)). As executives account for roughly one third of the top 1% in the U.S. income distribution (see Bakija et al. (2008)), their incomes comprise a relevant fraction of the top income inequality. Lustig et al. (2011) and Frydman and Papanikolaou (2016) develop models of executive pay inequality where inequality changes as a result of technological change. Monte (2011) develops a talent assignment model of final goods trade and technological change and parameterizes it to the U.S. While these models focus on inequality in pay levels, they do not account for agency problems and performance compensation.

The remainder of the paper is organized as follows. Section 2 develops the theory, section 3 presents the empirical analysis and section 4 concludes.

[3] To the extent that offshoring is associated with reductions in consumer prices, production workers may still benefit from increases in real wages.

2 A Model of Executive Pay and Offshoring

This section proposes a theory that introduces the stylized principal-agent problem from Edmans et al. (2009) into a talent assignment model with heterogeneous firms. Agents differ in their managerial talents and form teams that consist of an executive and production workers to produce output. Agency problems at the management level rationalize that executive pay comprises cash and equity. The model links the cross-section of executive pay levels and pay-performance sensitivities to basic utility, technology and endowment parameters in general equilibrium. In subsection 2.4, I extend the model towards a two-country setting. Countries have different support in their talent distributions: while talents in the North are distributed between 0 and 1, talents in the South are distributed between 0 and $\alpha < 1$. Firms can now arise from matching agents across countries and output is consumed globally. I use this model to study potential implications of international integration on the executive earnings inequality.

2.1 Basic Setup: The Closed Economy

Preferences and Endowments The economy is populated by a mass of agents normalized to 1. Agents differ in their level of management skills but they are equal in the skills that they provide as production workers. Management skills are uniformly distributed between 0 and 1. All agents have multiplicative preferences over consumption and leisure and maximize their expected utility $U = E\left[u \cdot g\left(e\right)\right]$, where u is a standard c.e.s. consumption aggregator and $g\left(e\right)$ reflects the agent's *leisure,* i.e. the (inverse) cost of effort. The corresponding indirect utility V is given by

$$V\left(s,e\right) = E\left[\frac{w\left(s\right)}{P} g\left(e\right)\right], \tag{1}$$

where $w\left(s\right)$ is the nominal income of an agent with skill level s and P is the c.e.s. price index in the economy such that $\frac{w(s)}{P}$ will be the individual's real income. Notably, this multiplicative form of the indirect utility function implies that the utility gains from leisure are increasing with the level of compensation (both are complements). Agents' effort is a binary variable $e \in \{\underline{e}, \overline{e}\}$ and normalized to $\overline{e} = 0 > \underline{e}$>-1. The leisure function is given by

$$g\left(e\right) = \begin{cases} 1 & if\ e = \overline{e} \\ \frac{1}{1+\Lambda \underline{e}} & if\ e = \underline{e}, \quad \Lambda \in [0,1) \end{cases}, \tag{2}$$

which implies that low effort ($\underline{e}$) will increase the agent's utility by a fraction $\Lambda \left|\underline{e}\right|$.

On the technological side, the economy is endowed with a mass of potential production technologies whose quality is denoted by z. Technologies are also uniformly distributed on the unit interval. Similar to Chaney (2008), this mass of production technologies comprises the mass of potential entrants into the market.[4]

Production and Firms Firms are active on a monopolistically competitive market such that agents spend $x_j = X\left(p_j/P\right)^{1-\sigma}$ on each variety j. Here, $\sigma > 1$ is the constant elasticity of substitution and X is the aggregate consumption expenditure in the economy (the nominal GDP). Firms originate from the matching of a manager to a production technology and a hired team of production workers in proportion to the firm output.[5] The productivity of each firm is determined by the quality of the production technology z and the skill level s of the manager, where I make the assumption that management skills and production technologies complement each other regarding the production of output. In particular, the unit costs of production for a firm with a technology z and a manager with skill s are given by

$$\varphi\left(z,s\right) = \frac{w}{z^{1-\mu}s^{\mu}}, \tag{3}$$

where w is the production labor wage that I will use as the numéraire such that $w = 1$. The parameter $0 < \mu < 1$ measures the influence of management skills on firm productivity. Given the c.e.s. demand, firms charge a constant markup over their unit costs of production and obtain a profit of $\pi\left(z,s\right)$ per variety:

$$\pi\left(z,s\right) = M\left(z^{1-\mu}s^{\mu}\right)^{\sigma-1}. \tag{4}$$

The term $M \equiv \frac{1}{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} XP^{\sigma-1}$ captures the "size" of the market from the perspective of an individual variety. Markets are "large" if the elasticity of substitution is low and the aggregate expenditure level X or the price index P are large.

Agency Problem Since the objective of the model is to introduce a motive for incentive payments into a general equilibrium and provide empirically testable predictions, I introduce a very parsimonious agency problem. Executive compensation is restricted

[4]This implies that the number of available (however, bad) technologies is sufficient to accommodate any number of managers in equilibrium. Like in Chaney (2008), I assume that all production technologies are owned by some mutual fund (the principal) that maximizes the individual profits of each firm.

[5]The occupational choice between production work and managerial work will be endogenized later, when an equilibrium is determined. Unlike in Melitz (2003), where the production labor supply is fixed and similar to Wu (2011) and Monte (2011), the allocation of agents into production worker jobs and management jobs endogenously pins down the supply of production labor.

to comprise cash and equity and a contract will characterize how the the income of a manager is split into a cash payment and equity ownership. Due to the risk-neutrality of agents, there will be a continuum of incentive-compatible contracts and I will follow Edmans et al. (2009) and define the optimal contract as the incentive-compatible contract that minimizes the variable component of compensation as this would be strictly optimal under any nonzero risk aversion. Agents are subject to limited liability and obtain an (expected) equilibrium pay of $r(s)$ which will be endogenized later in general equilibrium. For now, I treat the expected pay $r(s)$ as exogenous. Production work does not entail any agency frictions since effort of production workers is assumed to be perfectly contractable such that $g = 1$ for all agents that become production workers. Management is however subject to agency frictions since agents are subject to limited liability and managerial effort is unobservable. I model this unobservability of effort in the following manner: executives elicit effort to find projects for the firm. Each project corresponds to one variety and a firm produces a continuum of varieties equal to $(1 + \eta)(1 + e)$, where $\eta \geq -1$ is stochastic noise with mean 0 such that the expected mass of projects when the executive elicits high effort is 1. Each variety generates a profit stream of $\pi(z, s)$. That way, low effort $e = \underline{e}$ reduces firm value by a fraction $\underline{e}$ and the effect of effort changes firm value proportionally. Hence, the model captures decisions that can be "rolled-out" across the firm rather than decisions that have effects independent of firm size. I assume that the value gains from high effort exceed the managers' disutility such that it is optimal to elicit effort $e = \overline{e}$. An executive's realized income $w(s)$ can be split up into a fixed cash salary $f \geq 0$ and a share v of the firm's equity

$$w(s) = f + v(1 + \eta)(1 + e)\pi.$$

2.2 Equilibrium in the Closed Economy

Consider an independent economy where agents that are employed as executives match with technologies and other agents employed as workers. In equilibrium the following conditions hold. First, firms offer the optimal amount of cash f and equity share v such that the manager elicits high effort $(e = 0)$ and the contract pays the manager's expected wage $r(s)$. Second, due to the complementarity of management talent and production technologies, there will be a positive assignment of managers and technologies such that the upper tails of the talent and the technology distribution match and $s = z$ for each matched pair (s, z). Third, agents choose the occupation (executive or production worker) based on their expected compensation given their level of skill s such that an agent chooses to become a manager if and only if $r(s) \geq 1$. Fourth, only firms that make non-negative expected profits will enter the market. Fifth, labor markets clear. The aggregate demand for production labor corresponds to the aggregate supply of workers and the aggregate demand for executives equals the aggregate supply of executives. Equivalently, the aggregate income of agents is spent on goods produced by the firms in the economy.

I will discuss each property of the equilibrium successively and characterize the unique equilibrium for the economy.

Incentive Pay in Partial Equilibrium Suppose a manager with skill s expects a level of compensation $r(s)$. The optimal allocation of executive pay into cash and equity will pay a fraction Λ of the expected compensation in shares and the remainder in cash:

$$\begin{aligned} r(s)\Lambda &= v^{*}\pi(s,z) \\ r(s)(1-\Lambda) &= f^{*}. \end{aligned} \tag{5}$$

The manager's realized compensation $w(s)$ can then be stated as

$$w(s) = r(s)(1+\Lambda\theta),$$

where θ is the realized return on equity. A manager's realized compensation will be particularly high if his expect compensation $r(s)$ is large or his effort costs Λ are high. Furthermore, the realized compensation will also be particularly large if the realized return θ is high.

Assignment and Expected Level of Compensation Consider the expected surplus of a firm with manager s and technology z:

$$E\left[(1+\eta)(1+e)\pi(z,s)\right] = M\left(z^{1-\mu}s^{\mu}\right)^{\sigma-1}.$$

The expected surplus must cover the compensation of the manager and the profits that accrue to the technology z. The skill-technology complementarity which drives the incentive to positive assortative assignment is given by the positive cross derivative of the surplus $\left(\partial^{2}M\left(z^{1-\mu}s^{\mu}\right)^{\sigma-1}/\partial s\partial z > 0\right)$. This complementarity between production technologies and management skills in combination with a competitive labor market creates an incentive for better firms (higher z) to hire better managers leading to a positive assortative assignment.[6]

[6]The positive assortative assignment of managers to firms is an essential factor in the CEO assignment literature: see for example Gabaix and Landier (2008), Terviö (2008), Edmans et al. (2009),

An individual firm is assumed to be too small to affect the aggregate market conditions such that each firm takes the expected wage function $r(s)$ as given. I make use of a standard assignment equation which equates the expected marginal cost of a manager with skill s with the expected marginal benefit of this manager. As the optimal manager with ability s balances the marginal benefit of a higher skill level with the marginal increase in expected managerial compensation:

$$\frac{\partial E\left[(1+\eta)(1+e)\pi(z,s)\right]}{\partial s}_{|z=z(s)} = r'(s)\,. \tag{6}$$

Positive assignments will imply that the measures of the upper tails of the skill and technology distributions are of equal size such that $z = s$. Furthermore, the marginal manager in the economy (I denote his skill level by s_c) must be indifferent between a management or a production work occupation such that $r(s_c) = 1$. To determine the expected compensation function I integrate (6) over the skill distribution and set $r(s_c) = 1$. The expected compensation of a manager can be stated as

$$r(s) = \mu M\left(s^{\sigma-1} - s_c^{\sigma-1}\right) + 1, \tag{7}$$

where s_c is the skill level of the marginal manager in the economy that runs the least productive firm in the market and earns a wage that is equal to the production worker wage rate. Intuitively, the level of expected compensation that a manager will receive in equilibrium increases with the size of the market M, the importance of management skills in the production process μ and the level of the manager's skill s relative to the skill-level of the marginal manager in the economy s_c. Since both, the marginal skill level and the size of the market will be determined in general equilibrium, the expected compensation stated in equation (7) can be seen as the partial equilibrium form of expected executive pay and the term $\mu M\left(s^{\sigma-1} - s_c^{\sigma-1}\right)$ comprises the skill premium of managers.

Zero Earnings Cutoff Only firms with non-negative expected earnings will enter into the market. The marginal firm that employs the marginal manager with skill s_c will just break even such that $Ms_c^{\sigma-1} - 1 = 0$. Replacing M and rearranging terms

Baranchuk et al. (2011) or Monte (2011). Furthermore, consider the following intuitive argument to see why a positive assortative assignment arises in equilibrium. Suppose there were two technology-skill matches (z_1, s_2) and (z_2, s_1) that form firms in equilibrium with $z_1 < z_2$ and $s_1 < s_2$. The aggregate surplus could be increased by making the manager with skill s_1 the head of the firm with production technology z_1 and the other manager with skill s_2 the head of the firm with z_2 instead. Since any competitive equilibrium is efficient, this is a contradiction.

yields the zero earnings cutoff condition $X(s_c)$:

$$X = s_c^{1-\sigma} - s_c. \tag{8}$$

The zero earnings cutoff condition $X(s_c)$ is negatively sloped since a larger nominal GDP translates into higher firm revenues. In order to restore zero earnings in the marginal firm, the cutoff skill level s_c must be smaller to reduce the productivity of the marginal firm in the economy.

Labor Market Clearing In contrast to the classical Melitz (2003) model with heterogeneous firms, production worker supply is endogenous here, since the mass of production workers depends on the mass of managers. Labor market clearing requires that the aggregate demand for production workers equals the aggregate supply of production workers (s_c) for any given amount of executives (i.e. firms). A firm needs $1/\varphi_j$ units of labor per unit of output and produces q_j units of output such that its demand for production workers can be written in terms of prices since $q_j = x_j/p_j = XP^{\sigma-1}p_j^{-\sigma}$ and $1/\varphi_j = \frac{\sigma-1}{\sigma}p_j$. Expected demand for production labor by firm j is thus given by:

$$\frac{q_j}{\varphi_j} = \frac{\sigma-1}{\sigma}XP^{\sigma-1}p_j^{1-\sigma}.$$

Integrating production labor demand for the individual firm over all active firms of the economy yields the labor market clearing condition $X(s_c)$:

$$X = \frac{\sigma}{\sigma-1}s_c. \tag{9}$$

Since the production wage rate is the numéraire, equation (9) can also be seen as the income approach of GDP measurement. In the aggregate, GDP comprises wages paid to workers equal to s_c and the compensation paid to managers equal to $\frac{1}{\sigma-1}s_c$. The labor market clearing curve is upward sloping since a larger s_c translates to a higher supply of production labor which must be absorbed by firms producing a higher level of output.

2.3 Characterization of the Equilibrium

Clearing of the labor markets and the zero earnings cutoff uniquely determine the marginal managerial skill level s_c and the nominal GDP X in the economy. The following Proposition describes the equilibrium solution.

Proposition 1. *There exists a unique equilibrium in the closed economy such that labor markets clear, no firms with negative expected earnings enter the market, the matching of managers and technologies is stable and firms provide optimal incentives for managers. This equilibrium has the following properties:*
i) the least skilled manager has a skill level

$$s_c = \left(\frac{2\sigma - 1}{\sigma - 1}\right)^{-1/\sigma},$$

ii) the GDP level in the economy is equal to

$$X = \frac{\sigma}{\sigma - 1}\left(\frac{2\sigma - 1}{\sigma - 1}\right)^{-1/\sigma},$$

iii) the expected compensation level of a manager with skill s is equal to

$$r(s) = \mu\left(\left(\frac{s}{s_c}\right)^{\sigma-1} - 1\right) + 1,$$

iv) higher skilled managers run larger firms but own a smaller fraction of the firms' equity

$$v^* = \left(\mu + \frac{1-\mu}{Ms^{\sigma-1}}\right)\Lambda,$$

v) however their value of equity is larger:

$$v^*\pi(s) = \left(\mu M s^{\sigma-1} + 1 - \mu\right)\Lambda.$$

Proof. See Appendix. □

In general equilibrium, executives receive an additional "skill premium" of $\mu\left(\left({}^{s}/_{s_c}\right)^{\sigma-1} - 1\right)$ in addition to the worker salary. The size of that premium increases with the importance of management in the production process μ, the executive's skill s and the elasticity of substitution σ. In partial equilibrium assignment models of executive pay (i.e. models with an exogenous mass and distribution of firms) the equilibrium pay level is typically increasing with the size of a "reference firm" in the economy and the aggregate market size (see Gabaix and Landier (2008)). My general equilibrium framework also nests this feature, however the mass of active firms and the size of the market are endogenized here. The pay premium increases when the skill of the marginal executive in the economy is relatively small. This translates to a relatively large market size M and also to relatively high expected profits for the median firm with skill level ${}^{(1+s_c)}/_{2}$.

Given the optimal contract, the realized compensation $w(s)$ is not indexed to the market as the contract rewards executives for high firm-specific returns θ. Consequently, the empirical observation of "pay-for-luck" (e.g. Bertrand and Mullainathan (2001)) is not necessarily inconsistent with optimal CEO pay. Equivalently to Edmans et al. (2009), the contract pays a fraction Λ of the executive's expected compensation $r(s)$ in equity. Thus, the realized executive pay responds to idiosyncratic firm shocks.

The performance-pay sensitivity can be measured as the change of an executive's dollar value of compensation as a response to the firm's realized return. This empirical proxy can be derived from the deltas of the executives' stock option grants and increases proportionally with the expected compensation $r(s)$ in equilibrium:

$$\frac{\partial w(s)}{\partial \theta} = \Lambda \left[\mu \left(\left(\frac{s}{s_c} \right)^{\sigma-1} - 1 \right) + 1 \right] \approx \frac{\triangle \ \$ \text{ Compensation}}{\triangle \ \ln \text{Firm Profits}}.$$

Partial equilibrium models of executive pay are well suited to explain the cross-section of CEO pay levels or CEO pay-performance sensitivities. However, as these models take product demand and/or the mass of firms in the economy as exogenously given, they deliver only limited information about responses of executive pay to aggregate shocks in the economy. By introducing the assignment and principal-agent problem into a general equilibrium framework, my model makes predictions how the cross-section of CEO pay contracts responds to economic integration based on comparative statics.

2.4 Equilibrium in the Open Economy

Suppose that the economy discussed in the previous subsections (I will call it the *North*) integrates with another economy (the *South*). The size of the South is denoted by L, meaning that there is a mass of L agents living in the South and also a mass of L potential production technologies originating from the South. However, the Southern economy is more scarcely endowed with managerial talent and high-quality technologies such that s and z are uniformly distributed between 0 and $\alpha < 1$ in the South. In an open economy equilibrium, agents can match across countries and form international teams. Furthermore, goods are sold on a single integrated market. The distribution of management skills and production technologies in the open economy is given by the sum of the distributions in the South and in the North. Namely, densities of skill level s or technology quality z are given by

$$\tau(i) = \begin{cases} \frac{L+\alpha}{\alpha} & if\ 0 < i \leq \alpha \\ 1 & if\ \alpha < i < 1, \end{cases}$$

where $i \in \{s, z\}$. Notably, τ is not a probability distribution as it integrates to the total size of the world market $1 + L$. The equilibrium construction parallels the closed economy case with three caveats. First, the labor market adjusts to the larger supply of relatively low skilled agents in the world economy. Second, the derivation of the expected compensation $r(s)$ needs to be adjusted to the altered distribution of skills in the open economy. Third, if some Southern agents become managers, the zero cutoff earnings condition adjusts as well. For the remainder of the subsection I will discuss two different cases. In one case, the North integrates with a skill scarce South such that all Southern agents will be employed as production workers ($\alpha < s_c$). In the other case, the Northern economy integrates with another relatively skill abundant economy such that some Southern agents become employed as managers ($s_c \leq \alpha$).

2.4.1 Equilibrium with Low-Skill Integration

Suppose that the Southern economy is relatively skill scarce such that all Southern agents will be employed as production workers in equilibrium ($\alpha < s_c$). Integration raises the supply of production workers from s_c to $s_c + L$ such that the labor market clears for aggregate expenditure levels of

$$X = \frac{\sigma}{\sigma - 1}(s_c + L). \tag{10}$$

The new labor market clearing curve $X(s_c)$ is above the curve in the closed economy. For each value of s_c, the supply of production labor is now larger due to the additional agents from the South. In order to keep the labor market in equilibrium, the nominal GDP must be larger to accommodate these additional Southern agents. As there are only firms managed by Northern managers, the zero cutoff earnings condition remains unaffected by globalization. The following Proposition describes the equilibrium solution in the world economy with low-skill integration.

Proposition 2. *Suppose that $\alpha < s_c$. There exists a unique equilibrium in the open economy such that labor markets clear, no firms with negative expected earnings enter the market, the matching of managers and technologies is stable and firms provide optimal incentives for managers. Compared to the closed economy, the marginal skill level s_c is lower. More agents in the North become managers and all managers receive a larger expected compensation $r(s)$. All managers obtain a smaller fraction of the firms' equity v^*, however each manager's value of equity is larger.*

Proof. See Appendix. $\square$

Figure 1 depicts the equilibrium with low-skill integration. The upper graph illustrates the general equilibrium mechanics and the lower graph plots the expected compensation across the skill distribution. Globalization corresponds to a supply shock of production workers such that the labor market curve shifts upwards (LM^*). For the old marginal skill level, there are too few active firms in order to accommodate the additional production workers. Consequently, more firms enter the market and additional agents from the North become executives (s_c falls). Also the nominal GDP and the effective market size M increase. Due to the increase of the effective market size, firms bid up the expected compensation $r(s)$ for all managers. Furthermore, as the expected compensation level increases, executives also face stronger incentives (measured as change of an executive's dollar value of compensation as a response to the firm's realized return $\frac{\partial w(s)}{\partial \theta}$). Since $\frac{\partial w(s)}{\partial \theta}$ increases proportionally in $r(s)$, this rise in the pay-performance sensitivity is higher for managers of larger firms (i.e. managers with a higher s).

2.4.2 Equilibrium with High-Skill Integration

The equilibrium characterization is more involved when the Southern economy is more skill abundant such that some Southern agents will become managers in equilibrium ($s_c < \alpha$). These additional Southern managers imply that the price index is lower for any value of s_c as there are additional firms managed by Southern managers such that the mass of firms is larger ($1 - s_c + L(1 - {}^{s_c}/_{\alpha})$ instead of $1 - s_c$).

$$\begin{aligned} P^{HI} &= \frac{\sigma}{\sigma-1}\left(\frac{1}{\sigma}\right)^{1/1-\sigma}\left[1 - s_c^{\sigma} + \frac{L}{\alpha}\left(\alpha^{\sigma} - s_c^{\sigma}\right)\right]^{1/1-\sigma} \\ &< \\ P^{closed} &= \frac{\sigma}{\sigma-1}\left(\frac{1}{\sigma}\right)^{1/1-\sigma}\left[1 - s_c^{\sigma}\right]^{1/1-\sigma} = P^{LI} \end{aligned} \tag{11}$$

Using the new price index P^{HI}, the zero earnings cutoff condition $X(s_c)$ in the open economy can be stated as:

$$X = \left(1 + L\alpha^{\sigma-1}\right)s_c^{1-\sigma} - \left(1 + L\alpha^{-1}\right)s_c. \tag{12}$$

The curve for the zero earnings cutoff condition $X(s_c)$ in the open economy lies above the curve in the closed economy or the low-skill integration case. Since the identical cutoff skill level s_c implies that there will be a larger mass of firms in the open economy, the price level is lower for any value of s_c. Consequently, the zero earnings cutoff firm requires a higher level of aggregate expenditures for X to break even. This effect of high-skill integration thus contributes to lower executive pay levels in the North as the additional supply of Southern executives lowers the aggregate price level and thus reduces the effective market size M for any value of s_c.

Also the labor market clearing curve adjusts as globalization increases the supply of production workers to $\frac{L+\alpha}{\alpha}s_c$ for any given value of s_c. This leads to the new open economy version of the labor market clearing condition:

$$X = \frac{L+\alpha}{\alpha}\frac{\sigma}{\sigma-1}s_c. \tag{13}$$

Similar to the open economy with low-skill integration, the increase in the supply of Southern workers turns the labor market clearing curve upwards and therefore creates upward pressure on executive pay levels. Both equations (12) and (13) determine the marginal skill and the nominal GDP in equilibrium. The following Proposition describes the equilibrium solution in the world economy with high-skill integration.

Proposition 3. *Suppose that $\alpha \geq s_c$. There exists a unique equilibrium in the open economy such that labor markets clear, no firms with negative expected earnings enter the market, the matching of managers and technologies is stable and firms provide optimal incentives for managers. Compared to the closed economy, the marginal skill level is lower and given by*

$$s_c = \left[\left(\frac{\alpha+L}{\alpha+L\alpha^{\sigma}}\right)\frac{2\sigma-1}{\sigma-1}\right]^{-1/\sigma}.$$

More agents in the North become managers and all Northern managers receive a larger expected compensation

$$r(s) = \begin{cases} \mu\left(1+\frac{L}{\alpha}\right)\left(\left(\frac{s}{s_c}\right)^{\sigma-1}-1\right)+1 & if\ s_c < s < \alpha \\ \mu\left[\left(\left(\frac{s}{s_c}\right)^{\sigma-1}-1\right)+\frac{L}{\alpha}\left(\left(\frac{\alpha}{s_c}\right)^{\sigma-1}-1\right)\right]+1 & if\ s_c < \alpha < s. \end{cases}$$

All managers obtain a smaller fraction of the firms' equity v^*, however each manager's value of equity is larger.

Figure 2 depicts the equilibrium with low-skill integration. Again the upper graph illustrates the general equilibrium mechanics and the lower graph plots the expected compensation across the skill distribution. Integration corresponds to a supply shock of production workers such that the labor market curve turns upwards (LM^*). Furthermore, the price index falls as there are $\frac{\alpha-s_c}{\alpha}$ executives from the South managing new firms. This shifts the zero earnings curve upwards (ZE^*) as for any level of s_c, the marginal firm requires a larger expenditure level to break even. Since the South is more talent scarce, the labor supply effect increases such that more firms enter the market and additional agents from the North become executives (s_c falls). Also the nominal GDP and the effective market size M increase. Northern executives face stronger incentives ($\frac{\partial w(s)}{\partial \theta}$ rises) and expect a larger level of compensation $r(s)$. Since $\frac{\partial w(s)}{\partial \theta}$ increases proportionally in $r(s)$, the increase in pay-performance sensitivity is again higher for managers of larger firms.

2.5 Testable Predictions

The stylized model of executive pay gives rise to the following hypotheses that are empirically testable.

Prediction 1: More offshoring increases the average level of executive pay.

Prediction 2: More offshoring increases the executive earnings inequality across firms.

Prediction 3: More offshoring increases the earnings inequality between executives and production workers within firms.

Prediction 4: More offshoring increases the pay-performance sensitivity in executive pay.

3 Empirical Analysis

This section addresses the testable hypotheses with the help of a unique individual-level matched manager-firm panel dataset. The data combine information on individual manager's compensation with firm- and industry-level information. In order to isolate fluctuations in offshoring that are exogenous to the wage-setting policies within firms and uncorrelated with other unobserved supply or demand shocks, I will use fluctuations in the world supply of intermediate inputs as instrumental variables.

3.1 Data and Summary Statistics

3.1.1 Pay-, Firm- and Industry-Level Data

I use comprehensive individual-level data on executive pay for a broad cross-section of European and North American firms for the years 2000 to 2014. The data are provided by BoardEx, a business intelligence service company that collects details on remuneration and biographical information on business leaders across the world. BoardEx was established in 1999 and acquired by TheStreet, Inc. in 2014. It consolidates public domain information concerning the executives and senior managers of publicly quoted and large private companies across countries. The data include details on direct compensation, including fixed and variable components, and equity-linked compensation. They are based on public domain information including corporate announcements (such as annual or interim reports, press releases or company websites), regulatory news services or information releases from stock exchanges.

The individual manager-level data are matched with firm-level information from the FactSet database. FactSet provides detailed financial and fundamental data on public companies around the world. It includes public companies domiciled outside of the United States and also contains a complete coverage of U.S. companies that are filing with the Securities Exchange Commission (with the exception of closed end investment companies). The total universe of covered companies represents approximately 95% of global market capitalization. Since BoardEx covers managers in quoted companies across the world, FactSet allows to match firm information to most of the managers in the sample (I am able to match approximately 90% of the managers in BoardEx to FactSet entities).

In order to quantify an individual manager's exposure to globalization, I use data from the WIOD project (World Input Output Database). WIOD tracks the flow of intermediate and final goods and services across countries and industries. In its 2016 release, the data cover 43 countries and 56 sectors (based on ISIC Rev. 4) for the period 2000 to 2014. The industries cover all types of economic activity including agriculture, mining, construction, utilities, manufacturing industries and service industries. To obtain the offshoring indicator for an individual manager i who is employed at firm f in industry s and country c during year t, I use the value of imported intermediates relative to the value of total intermediate consumption in the country-industry-year cell.[7] One potential concern with the offshoring measure arises from the fact that offshoring is correlated with import competition at the output industry-level. As input-output tables suggest, a large fraction of inputs typically stems from the same downstream industry which implies a high correlation between both measures. Furthermore, previous literature has identified a causal impact of import competition on wages (Autor et al. (2013)) and in particular on executive compensation (Cuñat and Guadalupe (2005, 2009)). Therefore, it is appealing to isolate both effects. I disentangle the effects of offshoring from import

[7] In my model, firms hire production workers in proportion to the firms' output as the only variable factor of production and globalization raises the supply of workers. In the model, firms spend a fraction $\frac{L+s_c}{L+1}$ (for low-skilled integration) or $\frac{L}{L+\alpha}$ (for high-skilled integration) of their production labor wage bill on foreign production workers. These terms correspond to the empirical proxy for the global division of labor and are increasing in L.

competition by controlling for the degree of import penetration within downstream industries s in some empirical specifications. In order to control for the simultaneity bias when estimating the impact of integration on executive pay, I construct instruments for offshoring that are time varying and uncorrelated with the wage setting within the firms. Following Hummels et al. (2014) I construct the time varying country-industry supply shock in intermediate goods by adding international trade flows of all intermediate goods outside the country considered and weighted according to a time-invariant industry-specific input coefficient based on WIOD.

Table 1 provides summary statistics for the variables.

- Table 1 here -

3.1.2 Sampling and Bias

BoardEx uses various sources to collect information on executive pay. Information sources can be i) the sampled firm itself via annual reports or the company website, ii) regulatory entities that publish official company information and press releases, iii) stock exchanges, and iv) commercial other third party data providers providing bibliographical information. These information are offered to subscribers for a fee. The decision whether a firm is sampled in the BoardEx data is based on the firm's listing in a major stock market index. The data appendix provides a list of the sampled stock indices.

In particular, the data providers focus on public stock index listed companies and to a lesser extend on private companies such that executives of large public firms are largely overrepresented in the sample. Furthermore, since pay disclosure requirements differ across countries, executives employed by firms located in these countries (e.g. the U.S. and the U.K.) are overrepresented as well. In order to address these biases, I will focus on within-firm or within-individual pay variation over time as a response to changes in the market environment. Over the sample period (2000 - 2014) the average firm is sampled 6.6 times and the average director is sampled 4.2 times.

3.2 Results

3.2.1 The Cross-Section of Executive Pay

Due to the positive assignment implied by the complementarity between talent and firm size, the model predicts that directors of larger firms should in equilibrium receive a higher level of total and equity compensation, have a larger dollar-stock return sensitivity and own a smaller fraction of the firm. In order to establish that the theoretical model captures these stylized features of executive pay in the cross-section of firms, I regress size quartile dummies on the total level of annual compensation, the (estimated) value of equity-linked compensation, the wealth delta, the executive-employee pay gap and the executive ownership share in the firm. I include a set of region-year and industry dummies and control for the type of the director position (CEO, executive director, senior management position) throughout all estimations.

- Table 2 here -

Table 2 reports regression results based on the pooled cross-section of executives in the sample. The estimated correlations generally confirm the predicted model features in the data, although the estimations do not allow for a causal interpretation, here. Firm size quartile dummies are based on the mean enterprise value (i.e. the market value of equity plus total debt) over the whole sample period. The smallest quartile is the omitted category throughout all columns. In column (1), I regress the size dummies on the total annual compensation (in logs). Working for a top 25% firm is associated with a 10.5 times higher pay level[8], working for a top 25-50% firm is associated with 4.8 times higher pay level and working for a top 50-75% firm is associated with a 1.7 times higher pay level compared to directors employed by firms in the lowest size quartile. Column (2) shows that these pay-difference associations are quantitatively similar for equity-linked compensation: factor 14.3 for top 25%, 5.9 for top 25-50%, 1.7 for top 50-75%. Since the stylized agency problem in the model implies that each executive obtains on average a constant fraction Λ of his compensation in equity, the theory would predict identical coefficients for both, equity and total compensation.

Column (3) shows how the cross-section of managerial incentives, measured by the wealth delta (in logs), vary with firm size. The wealth delta approximates by how many dollars an executive's wealth changes as a response to a 1% change in firm value and is therefore a proxy of $\frac{\partial w(s)}{\partial \theta} \approx \frac{\triangle \text{ \$ Compensation}}{\triangle \text{ ln Firm Profits}}$ in the model. Deltas are calculated from all current and previous share and option grants using a Black-Scholes formula. In a top 25% firm, director wealth is 9.4 times more elastic compared to the wealth elasticity in the lowest quartile. Similar to the level of executive pay, wealth elasticity scales up with firm size. It is 3.7 times larger in a top 25-50% firm and 1.2 times larger in a top 50-75% firm compared to the wealth elasticity of executives working for firms in the lowest size quartile.

Column (4) reports correlations for the within-firm executive-employee pay ratio (in logs). Within-firm executive-employee pay ratios are obtained by dividing the total

[8] $(\exp(2.444) - 1) \times 100\% \approx 1052\%$

compensation of a director by the total labor expenses per employee of the employing firm. The correlates suggest that within-firm pay inequality generally increases with firm size. The pay gap is 11.7 times higher in a top 25% firm compared to one of the smallest 25% firms. This is consistent with recent empirical evidence from Mueller et al. (2017) who analyze within-firm inequality and find that inequality within firms across hierarchical occupation layers increases with various measures of firm size.

Lastly, column (5) shows how ownership shares vary with firm size. The model predicts that ownership shares v^* should be smaller in larger firms. I approximate ownership shares by dividing an executive's wealth by the market capitalization of the firm and winsorize ownership shares at the top 1% to exclude unreasonably large approximations. In the top 25% firms, director ownership shares are 4.6% smaller, in top 25-50% firms ownership shares are 3.9% smaller and in top 50-75% firms ownership shares are 2.9% smaller compared to the bottom 25%.

3.2.2 Offshoring, Earnings Inequality and the Level of Executive Pay

According to Propositions 2 and 3, offshoring should raise the average compensation level of managers in the North. To investigate this prediction empirically, I regress the total compensation (in logs) on a country-industry measure of offshoring and a set of control variables. The globalization of production is measured by the fraction of intermediate inputs that are imported from other countries in the country-industry-year cell. The corresponding measure in the model would be $\frac{L+s_c}{L+1}$ (for low-skilled integration) or $\frac{L}{L+\alpha}$ (for high-skilled integration) as these are the fractions of the production labor wage bill spent on foreign production workers. Both terms are increasing in L. All specifications include a set of region-specific year fix effects (regions are North America and Europe). Columns (1) to (3) additionally include firm fix effects to absorb time-invariant factors at the firm-, country- or industry-level. In columns (4) and (5) I include director fix effects instead. These absorb all time-invariant individual characteristics such as talent or experience.

Offshoring might be an endogenous regressor in these empirical specifications. First, higher wages in industrialized countries simultaneously affect the amount of conducted offshoring. Second, endogeneity might also arise from unobservable demand or productivity shocks that affect the share of imported intermediates and labor market outcomes and are not captured by the control variables. These could be for instance technological factors such as developments in information or communication technologies that affect offshoring and the productivity of managers alike.[9] In order to address these concerns,

[9]See for example Antràs et al. (2008), Bloom et al. (2014), and Bloom et al. (2012) for empirical evidence and theoretical models on the relation between I.C.T. and international production.

I instrument offshoring with the "world export supply" of inputs.[10] A valid instrument should be correlated with trade in intermediates but conditionally uncorrelated with changes in firm productivity and executive compensation. The variable "world export supply" is the total value of intermediate goods that is produced in the world (excluding the country under consideration) and exported to other countries (again excluding the country under consideration) in the same year. These inputs are weighted according to input coefficients for each output industry in the country under consideration.[11] The instrument captures developments of comparative advantages of the input supplying countries, weighted according to the historical relevance of those inputs for the output industries of a firm where a given manager is employed. These shifts in input specific comparative advantages should only have an impact on the compensation of executives through the offshoring channel to be a valid instrument.

- Table 3 here -

Table 3 reports the results. The upper panel A reports the ordinary least squares estimates, the lower panel B the instrumental variable results. All standard errors are corrected for clustering at the country-industry level. Notably, the coefficient magnitudes of the IV regressions are larger than the OLS estimates. One explanation for the larger magnitude of the IV estimates can be that the treatment effects of offshoring are not constant across managers. While the OLS estimator identifies the *average* effect of offshoring on executive pay across the managers within the sample, the IV approach identifies local treatment effects: since executive pay adjusts heterogeneously to international integration according to the theory, the model predicts a larger treatment effect for more talented agents which are employed by larger firms. Consequently, changes in the world export supply (the IV) have larger effects on the compensation of that subgroup.[12] Therefore, I consider both estimators to be informative. On the one hand, the OLS might suffer from endogeneity biases but identifies the average effect of offshoring. On the other hand, the IV controls for endogeneity but identifies a treatment effect for those managers who are affected by changes in the international supply of intermediates.

In columns (1) to (3), I regress executive pay on offshoring, firm fix effects and region-year fix effects. Throughout these columns I subsequently add additional control variables. Column (2) includes industry output, imports and exports (all in logs) and

[10]This idea is based on Hummels et al. (2014) and Baumgarten et al. (2013) who also instrument offshoring with the world export supply of inputs.

[11]I use time-invariant input coefficients for the year 2000, the first year of the sample period.

[12]When exploring pay inequality later, the difference in magnitudes between OLS and IV becomes smaller. The OLS-IV magnitude differences in this study are comparable to those in Hummels et al. (2014).

column (3) additionally includes assets (in logs), a multinational dummy and leverage as firm-level controls. Offshoring is positive and significant at the 1-5% level in the OLS estimates and at the 5-10% level in the IV estimates. Taking the IV coefficients at face value would imply that the mean rise in offshoring throughout the sample period between 2000 and 2014[13] has contributed to an increase in executive pay of about 4.5-7.2%. Furthermore, executive pay is positively associated with industry output. The estimated correlations imply a positive output-pay elasticity of 0.19-0.34.

The estimated effects in columns (1) to (3) absorb firm fix effects and therefore do not net out pay increases from attracting better talented managers or reorganizing the composition of the management within the firm. Consequently, I replace the firm fix effects with director fix effects in columns (4) and (5) to estimate how the offshoring exposure of an individual executive affects his pay. Bertrand and Schoar (2003) find that a large extent of the heterogeneity in firm decisions and organizational practices can be explained by the presence of individual director fixed effect. Consequently, including these director fix effects allow to capture how offshoring affects an individual executive's pay after controlling for changes in the composition of the executive team.[14] The estimated coefficients are substantially smaller compared to the estimations with firm fix effects, both in terms of size and statistical significance. The IV coefficients suggest that the mean rise in offshoring throughout the sample period has lead to an individual pay increase of about 2.9-3.5%.

Next, I want to explore if offshoring affects pay levels heterogeneously between the executives from different firms. I regress the total or equity-linked compensation (in logs) on interactions of the four size quartile dummies with the offshoring measure, controlling for industry output, imports and exports (in logs), region-year fixed effects and director fixed effects.

- Table 4 here -

Table 4 reports the results. In columns (1) and (2), the dependent variable is the total annual level of compensation. Column (2) additionally includes the firm-level controls assets, the MNE dummy and leverage. Instrumental variables are constructed by interacting the time-invariant size quartile dummies with the world export supply variable. Both, the OLS and the IV estimates suggest that globalization affects managers differently across firms. Throughout all estimations in (1) and (2), managers of top 25%

[13]The sample mean increased by 2.8 percentage points (>26%) from 10.53% to 13.32% of imported intermediates.

[14]For example Marin et al. (2015) find that headquarters reorganize when firms import a larger fraction of intermediate inputs.

firms receive the highest globalization-induced earnings premium. According to the IV estimates in column (2), a director working for a top 25% firm obtains an earnings premium of 8.1% due to the mean rise in offshoring throughout the sample period (significant at the 1% level). This earnings premium equals 7.6% for directors in a top 25-50% firm (significant at the 1% level) and 4.0% for directors in a top 50-75% firm (significant at the 5% level). These effects are less pronounced when considering the equity-linked compensation in column (4). Here, I find significantly negative earnings responses for directors working for the smallest 25% of firms. Positive equity-linked earnings premiums in larger firms turn out statistically insignificant from zero. Figure 3 plots these estimated effects of an average sample period increase in offshoring on total executive pay (in blue) and on equity-linked pay (in red).

- Table 5 here -

Table 5 reports results on the effects of offshoring on earnings inequality between managers and workers within firms. The dependent variable "within-firm pay inequality" is the log difference between director compensation and the labor expenditure per employee within the firm. In a recent study, Song et al. (2015) document for the U.S. that a substantial part of the rise in overall earnings dispersion is accounted for by increasing wage dispersion across firms and only to a small extend by increasing within-firm inequality. Similarly, I find only mild effects of offshoring on the pay gap between executives and workers within firms. If anything, offshoring has only a negative effect on within-firm earnings inequality for the smallest 25% of firms. After controlling for industry imports, exports and output, firm assets, MNE status, and leverage as well as director and region-year fixed effects in column (2), offshoring has a significantly negative effect on within-firm inequality for the smallest firms in the sample.

3.2.3 Offshoring and Incentives: Pay and Wealth Sensitivity

Propositions 2 and 3 also suggest that globalization increases the monetary incentives that executive face, measured as the dollar value change of an executive's compensation (or wealth, since the model is static) as a response to the firm's realized return. In the model, this effect on incentives is driven by scaling up the value of the firm. Globalization increases demand and matching the supply of production workers and thus increases firm size and value for the largest firms such that the directors' equity ownership becomes more valuable and the dollar-return elasticity rises. Table 6 first reports results on the effect of offshoring on firm valuation.

- Table 6 here -

I regress the (log) stock price or the (log) enterprise value (market capitalization plus total value of debt) on offshoring, the usual controls and firm fixed effects. Overall, stock prices react more elastic on offshoring than enterprise values. Nevertheless, both measures of firm valuation increase when production becomes more international. According to the IV estimates in columns (2) and (4), the sample mean increase in offshoring between 2000 and 2014 is associated with a 13.0% rise in stock prices and a 10.3% rise in enterprise value. In order to see what this implies for the monetary incentives that executives face, I regress offshoring on the stock wealth (in logs) and on the approximated wealth delta (in logs). Results are presented in Table 7.

- Table 7 here -

Overall, I find that offshoring has a positive effect on equity wealth and pay-performance sensitivity. Taking the estimated coefficients in columns (2) and (4) at face value implies that the sample mean increase in offshoring between 2000 and 2014 raised the value of executive wealth by 11.5% and the wealth delta by 9.6%.

4 Conclusion

In this paper I incorporate a stylized principal-agent model into a general equilibrium theory of talent assignments. Extending the model towards a 2-country version where agents can match internationally allows to derive predictions on the effect of the global division of labor on executive pay. I test these predictions with data on executives across U.S. and European firms. I find that offshoring of production leads to higher executive pay and higher pay inequality across executives. Furthermore, offshoring contributes to a stronger pay-performance sensitivity.

Figure 1: The Effects of a Low-Skill Integration

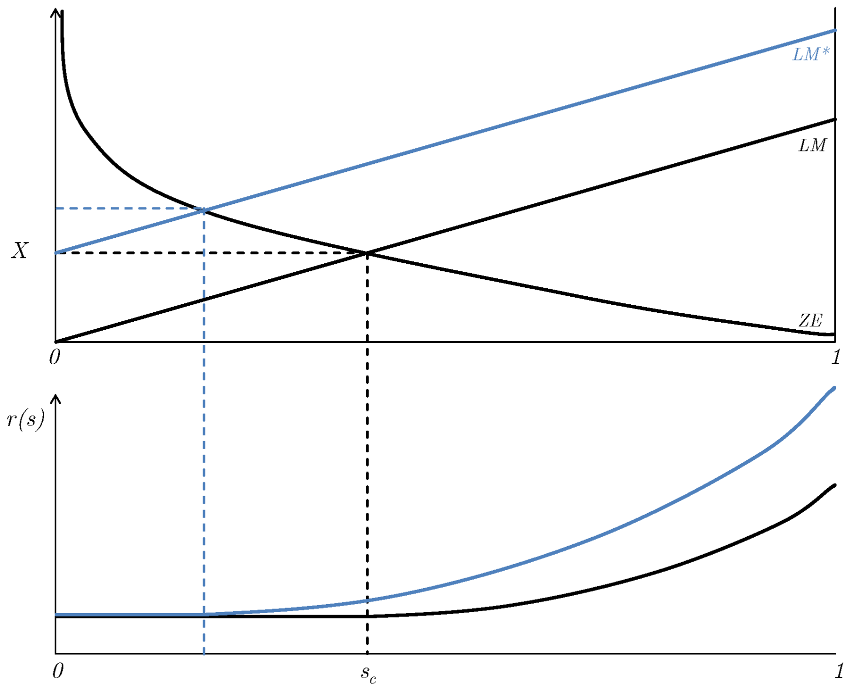


Figure 2: The Effects of a High-Skill Integration

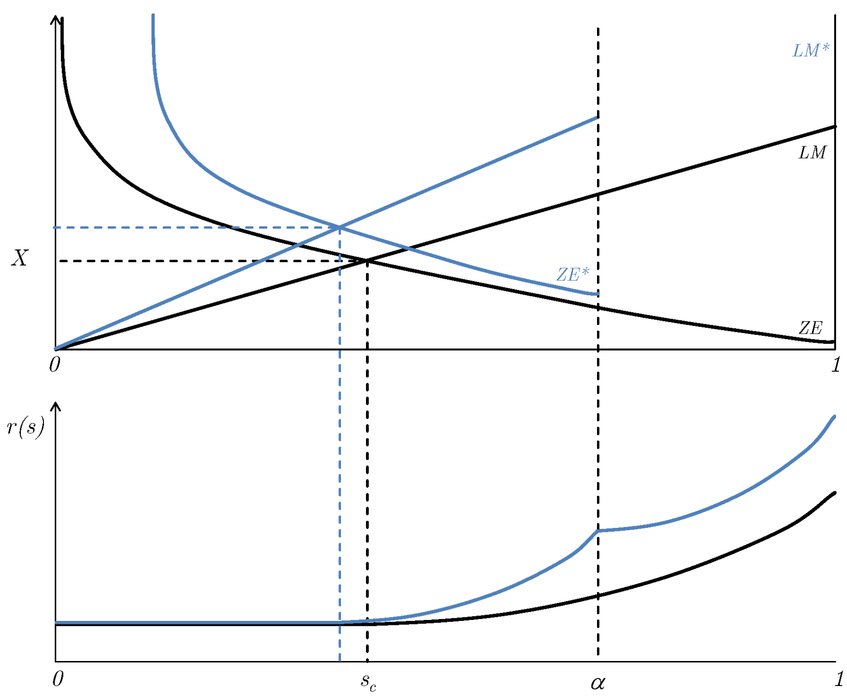


Table 1: Selected Summary Statistics

Variable	Obs.	Mean	Std. Dev.	25th pct.	Median	75th pct.
			director-year level			
Total Pay (in Thd. USD)	110,359	3,115	10,199	266	947	3,026
Equity Pay (in Thd. USD)	79,391	3,374	1,1410	248	1,055	3,258
Wealth Delta (in Thd. USD per %)	103,216	399	7,676	7	38	153
Ownership (Share)	103,185	0.03	0.10	0.00	0.00	0.02
			firm-year level			
Total Assets (in Mio. USD)	22,656	21,744	150,443	53	341	2778
MNE (Dummy)	22,661	0.49	0.50	0	0	1
Leverage (Share)	22,648	0.30	0.31	0.01	0.25	0.46
Enterprise Value (in Mio. USD)	22,401	10,236	45,452	42	333	3,104
			country/industry-year level			
Offshoring (Share)	1,652	0.26	0.17	0.13	0.22	0.36
Imports (in Mio. USD)	1,652	11,911	18,915	1,606	4,569	14,439
Exports (in Mio. USD)	1,652	12,071	20,954	1,290	5,054	14,274
Output (in Mio. USD)	1,652	71,317	114,707	13,689	32,448	80,819
World Export Supply (in Mio. USD)	1,652	293,968	196,267	157,127	233,780	381,691

Table 2: The Cross-Section of Executive Pay

	ln Total pay	ln Equity pay	ln Wealth delta	ln Pay gap	Ownership share
Highest company value quartile	2.444***	2.729***	2.342***	2.543***	-0.0481***
	(0.0525)	(0.0676)	(0.0930)	(0.0798)	(0.00399)
2nd highest company value quartile	1.766***	1.938***	1.548***	1.814***	-0.0402***
	(0.0467)	(0.0618)	(0.0649)	(0.0638)	(0.00469)
3nd highest company value quartile	0.996***	0.993***	0.776***	1.010***	-0.0294***
	(0.0434)	(0.0721)	(0.0643)	(0.0568)	(0.00471)
CEO dummy	0.670***	0.821***	0.602***	0.628***	0.0171***
	(0.0400)	(0.0303)	(0.0289)	(0.0251)	(0.00306)
Executive dummy	0.373***	0.461***	1.159***	0.196***	0.0329***
	(0.0451)	(0.0369)	(0.0438)	(0.0663)	(0.00595)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	113,194	80,600	101,724	71,394	107,385
R-squared	0.677	0.617	0.548	0.691	0.076
Number of firms	0	0	0	0	0
Country-industry clusters	364	364	364	364	364

Notes: Company value quartile dummies measure the average 2000-2014 size quartile of the firm based on the sum of market capitalization and debt. For more details on the dependent variables see the Data Appendix. All estimations include a set of 2-digit ISIC Rev. 4, year and region (U.S. and Europe) fixed effects. Standard errors are cluster-robust at the country-industry level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 3: Offshoring and Executive Pay Levels

	ln Total pay				
	(1)	(2)	(3)	(4)	(5)
			Panel A: OLS		
Offshoring	0.609**	0.838***	0.684***	0.295	0.198
	(0.269)	(0.264)	(0.233)	(0.235)	(0.234)
ln Industry output		0.266***	0.188***	0.112***	0.0843**
		(0.0813)	(0.0699)	(0.0367)	(0.0342)
ln Industry exports		0.0203	0.0147	0.00818	0.00504
		(0.0268)	(0.0254)	(0.0200)	(0.0198)
ln Industry imports		-0.0409	-0.0569	-0.0141	-0.00870
		(0.0508)	(0.0388)	(0.0250)	(0.0260)
ln Assets			0.273***		0.226***
			(0.0149)		(0.0176)
MNE			-0.0246		-0.0259
			(0.0197)		(0.0221)
Leverage			-0.171***		-0.147***
			(0.0396)		(0.0384)
			Panel B: IV		
Offshoring	2.059*	2.490**	1.581**	1.240*	1.040
	(1.083)	(1.015)	(0.759)	(0.674)	(0.716)
ln Industry output		0.335***	0.226***	0.173***	0.138***
		(0.0816)	(0.0721)	(0.0521)	(0.0526)
ln Industry exports		0.0345	0.0224	0.0125	0.00884
		(0.0279)	(0.0267)	(0.0216)	(0.0213)
ln Industry imports		-0.115**	-0.0971**	-0.0467	-0.0377
		(0.0572)	(0.0483)	(0.0330)	(0.0342)
ln Assets			0.272***		0.225***
			(0.0147)		(0.0177)
MNE			-0.0241		-0.0266
			(0.0199)		(0.0223)
Leverage			-0.170***		-0.145***
			(0.0398)		(0.0384)
First stage: World Export Supply	0.000000154***	0.000000135***	0.000000135***	0.000000208***	0.000000208***
	(2.77e-08)	(2.26e-08)	(2.26e-08)	(2.36e-08)	(2.36e-08)
First stage F-statistic	30.93	35.92	35.75	77.94	77.7
Number of firms	3,813	3,812	3,812	3,666	3,665
Number of directors	26,354	26,344	26,336	20,467	20,453
Country-industry clusters	318	318	318	312	312
Observations	110,359	110,247	110,179	104,379	104,305
Firm fixed effects	Yes	Yes	Yes	No	No
Director fixed effects	No	No	No	Yes	Yes
Region-year fixed effects	Yes	Yes	Yes	Yes	Yes

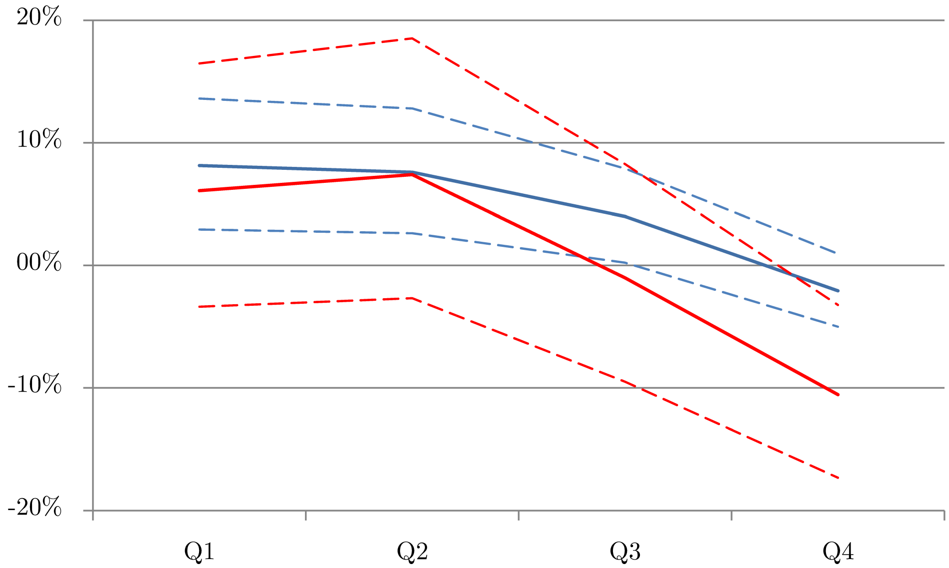
Notes: For more details on the variables see the Data Appendix. Reported F-statistics are Kleibergen-Paap rank statistics. All estimations include a set of firm or director and region-year (U.S. and Europe) fixed effects. Standard errors are cluster-robust at the country-industry level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4: Offshoring and Executive Earnings Inequality

	ln Total pay	ln Total pay	ln Equity pay
	(1)	(2)	(3)
		Panel A: OLS	
Offshoring x Size Q1	1.271***	0.564*	0.420
	(0.341)	(0.310)	(0.490)
Offshoring x Size Q2	0.769**	0.611**	0.721
	(0.337)	(0.309)	(0.443)
Offshoring x Size Q3	0.0575	0.183	-0.626
	(0.293)	(0.291)	(0.552)
Offshoring x Size Q4	-1.383***	-0.646**	-1.681***
	(0.281)	(0.275)	(0.529)
		Panel B: IV	
Offshoring x Size Q1	3.944***	2.803***	2.117
	(0.904)	(0.898)	(1.699)
Offshoring x Size Q2	3.160***	2.622***	2.557
	(0.866)	(0.860)	(1.791)
Offshoring x Size Q3	1.625**	1.402**	-0.366
	(0.677)	(0.671)	(1.628)
Offshoring x Size Q4	-1.376**	-0.750	-3.992***
	(0.634)	(0.553)	(1.431)
First stages: World Export Supply x Qx			
W.E.S. x Qx $>$ 0 and significant at $<$ 1%?	Yes	Yes	Yes
First stage F-statistics	14.55	14.48	10.28
Number of firms	3,633	3,632	2,862
Number of directors	20,307	20,296	15,216
Country-industry clusters	311	311	242
Observations	103,682	103,621	72,170
Industry controls	Yes	Yes	Yes
Firm controls	No	Yes	Yes
Director fixed effects	Yes	Yes	Yes
Region-year fixed effects	Yes	Yes	Yes

Notes: Q1 (Q4) corresponds to the largest (smallest) size quartile. Firm controls are assets (in logs), a MNE dummy and leverage. Industry controls are exports, imports and output (all in logs). For more details on the variables see the Data Appendix. Reported F-statistics are Kleibergen-Paap rank statistics based on all four first stages. All estimations include a set of firm or director and region-year (U.S. and Europe) fixed effects. Standard errors are cluster-robust at the country-industry level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Figure 3: Heterogeneous Effects across Firms



Notes: The figure plots the estimated percentage change of the sample average increase in offshoring during 2000 - 2014 on executive pay. Total (equity) pay changes are drawn in blue (red). The dashed lines correspond on the 95% confidence intervals. Estimates are based on the IV regressions from columns (2) and (3) in Table 4.

Table 5: Offshoring and Earnings Inequality between Executives and Workers

	Within-Firm Pay Inequality	
	(1)	(2)
	Panel A: OLS	
Offshoring x Size Q1	1.164***	0.318
	(0.430)	(0.408)
Offshoring x Size Q2	0.280	-0.00529
	(0.348)	(0.325)
Offshoring x Size Q3	-0.359	-0.287
	(0.402)	(0.426)
Offshoring x Size Q4	-2.001***	-1.293***
	(0.396)	(0.404)
	Panel B: IV	
Offshoring x Size Q1	2.662***	1.387
	(0.944)	(1.052)
Offshoring x Size Q2	1.323	0.674
	(0.921)	(1.058)
Offshoring x Size Q3	-0.106	-0.438
	(1.202)	(1.431)
Offshoring x Size Q4	-3.119***	-2.563**
	(0.881)	(1.109)
First stages: World Export Supply x Qx		
W.E.S. x Qx $>$ 0 and significant at $<$ 1%?	Yes	Yes
First stage F-statistics	36.59	36.73
Number of firms	2,786	2,786
Number of directors	12,965	12,962
Country-industry clusters	287	287
Observations	64,324	64,309
Industry controls	Yes	Yes
Firm controls	No	Yes
Director fixed effects	Yes	Yes
Region-year fixed effects	Yes	Yes

Notes: Q1 (Q4) corresponds to the largest (smallest) size quartile. Firm controls are assets (in logs), a MNE dummy and leverage. Industry controls are exports, imports and output (all in logs). For more details on the variables see the Data Appendix. Reported F-statistics are Kleibergen-Paap rank statistics based on all four first stages. All estimations include a set of director and region-year (U.S. and Europe) fixed effects. Standard errors are cluster-robust at the country-industry level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 6: Offshoring and Firm Valuation

	ln Stock Price		ln Enterprise Value	
	(1)	(2)	(3)	(4)
	Panel A: OLS			
Offshoring	1.807***	1.612***	0.715	0.500
	(0.512)	(0.532)	(0.612)	(0.380)
ln Industry output		0.0984		0.329***
		(0.154)		(0.102)
ln Industry exports		0.0401		-0.0267
		(0.0444)		(0.0334)
ln Industry imports		0.160		0.233**
		(0.106)		(0.108)
	Panel B: IV			
Offshoring	4.080**	4.366*	3.505**	3.504**
	(1.895)	(2.479)	(1.591)	(1.547)
ln Industry output		0.258		0.505***
		(0.163)		(0.113)
ln Industry exports		0.0699		0.00570
		(0.0490)		(0.0350)
ln Industry imports		0.00832		0.0684
		(0.161)		(0.0932)
First stage: World Export Supply	0.000000238***	0.0000002***	0.000000239***	0.000000201***
	(1.96e-08)	(2.25e-08)	(1.96e-08)	(2.26e-08)
First stage F-statistic	148.19	78.74	149.38	79.08
Number of firms	3,374	3,372	3,349	3,347
Country-industry clusters	305	305	303	303
Observations	22,170	22,131	21,781	21,743
Firm fixed effects	Yes	Yes	Yes	No
Region-year fixed effects	Yes	Yes	Yes	Yes

Notes: For more details on the variables see the Data Appendix. Reported F-statistics are Kleibergen-Paap rank statistics. All estimations include a set of firm and region-year (U.S. and Europe) fixed effects. Standard errors are cluster-robust at the country-industry level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 7: Offshoring and Pay Sensitivity

	ln Wealth in Shares		ln Wealth Delta	
	(1)	(2)	(3)	(4)
		Panel A: OLS		
Offshoring	1.272**	0.504	0.975*	0.690*
	(0.623)	(0.480)	(0.504)	(0.393)
ln Industry output	0.392**	0.0237	0.285**	0.0989*
	(0.165)	(0.0746)	(0.144)	(0.0573)
ln Industry exports	-0.0291	0.00760	-0.00808	0.0238
	(0.0606)	(0.0507)	(0.0573)	(0.0364)
ln Industry imports	-0.0995	0.0102	-0.0805	-0.0118
	(0.117)	(0.0605)	(0.105)	(0.0531)
ln Assets	0.414***	0.350***	0.347***	0.305***
	(0.0347)	(0.0244)	(0.0221)	(0.0226)
MNE	-0.114***	-0.114***	-0.0492	-0.0530*
	(0.0390)	(0.0400)	(0.0301)	(0.0306)
Leverage	-0.545***	-0.483***	-0.555***	-0.499***
	(0.101)	(0.0764)	(0.0670)	(0.0588)
		Panel B: IV		
Offshoring	6.916**	3.901**	5.323**	3.286*
	(3.377)	(1.973)	(2.689)	(1.723)
ln Industry output	0.635***	0.236	0.460**	0.263**
	(0.207)	(0.151)	(0.179)	(0.119)
ln Industry exports	0.0146	0.0241	0.0273	0.0380
	(0.0757)	(0.0568)	(0.0696)	(0.0388)
ln Industry imports	-0.354***	-0.108	-0.270**	-0.100*
	(0.134)	(0.0786)	(0.110)	(0.0598)
ln Assets	0.408***	0.347***	0.342***	0.302***
	(0.0359)	(0.0243)	(0.0229)	(0.0229)
MNE	-0.115***	-0.123***	-0.0490	-0.0567*
	(0.0393)	(0.0405)	(0.0304)	(0.0306)
Leverage	-0.534***	-0.475***	-0.545***	-0.493***
	(0.102)	(0.0759)	(0.0679)	(0.0581)
First stage: World Export Supply	0.00000013***	0.000000198***	0.00000013***	0.000000203***
	(2.31e-08)	(2.53e-08)	(2.27e-08)	(2.49e-08)
First stage F-statistic	31.76	61.57	32.43	66.26
Number of firms	3,662	3,538	3,705	3,583
Number of directors	22,886	17,715	24,345	18,865
Country-industry clusters	289	284	305	299
Observations	95,505	90,344	101,672	96,198
Firm fixed effects	Yes	No	Yes	No
Director fixed effects	No	Yes	No	Yes
Region-year fixed effects	Yes	Yes	Yes	Yes

Notes: For more details on the variables see the Data Appendix. Reported F-statistics are Kleibergen-Paap rank statistics. All estimations include a set of firm or director and region-year (U.S. and Europe) fixed effects. Standard errors are cluster-robust at the country-industry level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

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Mathematical Appendix

Closed Economy Equilibrium (Proposition 1)

The following proof illustrates the equilibrium characterization in the closed economy case.

Incentive Pay The optimal contract gives the agent his expected wage $E[w \mid e=0] = r$.

$$\begin{aligned} E[w \mid e=0] &= f + v\pi = r \\ E[w \mid e=\underline{e}] &= f + v(1+\underline{e})\pi = f + v\pi + \underline{e}v\pi = r + \underline{e}v\pi. \end{aligned}$$

The contract is incentive compatible and the agent chooses $e=0$ iff:

$$E\left[\frac{w}{P}g(0) \mid e=0\right] \geq E\left[\frac{w}{P}g(\underline{e}) \mid e=\underline{e}\right],$$

this implies

$$\begin{aligned} r &\geq \frac{r+\underline{e}v\pi}{1+\Lambda\underline{e}} \\ &\Leftrightarrow \\ \Lambda r &\geq v\pi. \end{aligned}$$

Hence, the agent receives the lowest possible incentive compatible amount of equity that will pay him the fraction Λ of his compensation in equity. The salary f^* is chosen to ensure that expected pay is r:

$$f^* = r - v^*\pi = r(1-\Lambda).$$

Assignment and Expected Pay To determine the expected compensation $r(s)$, I make use of a standard assignment equation that equates the expected marginal cost of a manager with skill s with the expected marginal benefit of this manager:

$$\frac{\partial E[(1+\eta)(1+e)\pi(z,s)]}{\partial s}_{|z=z(s)} = r'(s)$$

as in Gabaix and Landier (2008) or Monte (2011).

The l.h.s. of this equation can be stated as follows:

$$\begin{aligned}
\frac{\partial E\left[(1+\eta)(1+e)\pi(z,s)\right]}{\partial s} &= \frac{\partial M\left(\frac{z^{1-\mu}s^{\mu}}{w}\right)^{\sigma-1}}{\partial s} \\
&= M\left(z^{1-\mu}\right)^{\sigma-1}\frac{\partial s^{\mu(\sigma-1)}}{\partial s} \\
&= M\left(s^{(1-\mu)(\sigma-1)}\right)\frac{\partial s^{\mu(\sigma-1)}}{\partial s} \\
&= \mu(\sigma-1)Mw^{1-\sigma}\left(s^{(\sigma-2)}\right).
\end{aligned}$$

Next, I take the integral from s_c to s and fix $r(s_c)=1$ to obtain $r(s)$:

$$\begin{aligned}
\int_{s_c}^{s}\mu(\sigma-1)M\left(t^{(\sigma-2)}\right)dt &= \mu(\sigma-1)M\int_{s_c}^{s}\left(t^{(\sigma-2)}\right)dt \\
&= \mu(\sigma-1)M\left\|\frac{1}{\sigma-1}s^{\sigma-1}\right\|_{s_c}^{s} \\
&= \mu M\left(s^{\sigma-1}-s_c^{\sigma-1}\right)+1.
\end{aligned}$$

Cutoff Skill and Nominal GDP Setting the labor market clearing and the zero earnings cutoff condition equal gives the marginal skill level s_c:

$$\begin{aligned}
s_c^{1-\sigma}-s_c &= \frac{\sigma}{\sigma-1}s_c \\
s_c &= \left(\frac{2\sigma-1}{\sigma-1}\right)^{-1/\sigma},
\end{aligned}$$

which is increasing in σ. Put $s_c=\left(\frac{2\sigma-1}{\sigma-1}\right)^{-1/\sigma}$ into the term for X to obtain the term for the nominal GDP:

$$\begin{aligned}
X &= \frac{\sigma}{\sigma-1}\left(\frac{2\sigma-1}{\sigma-1}\right)^{-1/\sigma} \\
&= \left(\frac{2\sigma-1}{\sigma-1}\right)^{-(1-\sigma)/\sigma}-\left(\frac{2\sigma-1}{\sigma-1}\right)^{-1/\sigma}.
\end{aligned}$$

Since both curves intersect once, there exists a unique equilibrium solution for X and s_c

Note that since the production worker wage is the numéraire, the GDP X must exceed 1: $\left(\frac{\sigma}{\sigma-1}\right)^{1}\left(\frac{2\sigma-1}{\sigma-1}\right)^{-1/\sigma}>1$.

Next, the expected compensation for managers can be stated as follows:

$$
\begin{aligned}
r(s) &= \mu M\left(s^{\sigma-1}-s_c^{\sigma-1}\right)+1 \\
&= \mu\left(X\left(1-s_c^{\sigma}\right)^{-1}\right)\left(s^{\sigma-1}-s_c^{\sigma-1}\right)+1 \\
&= \mu\left(\left(s_c^{1-\sigma}-s_c\right)\left(1-s_c^{\sigma}\right)^{-1}\right)\left(s^{\sigma-1}-s_c^{\sigma-1}\right)+1 \\
&= \mu\left(\left(\frac{s_c^{1-\sigma}-s_c}{1-s_c^{\sigma}}\right)\right)\left(s^{\sigma-1}-s_c^{\sigma-1}\right)+1 \\
&= \mu\left(\frac{s_c\left(s_c^{-\sigma}-1\right)}{1-s_c^{\sigma}}\right)\left(s^{\sigma-1}-s_c^{\sigma-1}\right)+1 \\
&= \mu\left(s_c^{1-\sigma}\right)\left(s^{\sigma-1}-s_c^{\sigma-1}\right)+1 \\
&= \mu\left(\left(\frac{s}{s_c}\right)^{\sigma-1}-1\right)+1.
\end{aligned}
$$

Furthermore, the equity share v^* is equal to

$$
\begin{aligned}
v^* &= \frac{r(s)}{\pi(s,z)}\Lambda \\
&= \frac{\mu M\left(s^{\sigma-1}-s_c^{\sigma-1}\right)+1}{Ms^{\sigma-1}}\Lambda \\
&= \left(\mu+\frac{1-\mu}{Ms^{\sigma-1}}\right)\Lambda.
\end{aligned}
$$

Open Economy Equilibrium with Low-Skill Integration (Proposition 2)

The zero cutoff earnings curve remains unaffected: since the price index remains identical to the closed economy case for any value of s_c (there are still only Northern managers and technologies affecting the price index). However, there is a larger supply of production agents from the South that can be employed by Northern firms such that the labor market clears for

$$X = \frac{\sigma}{\sigma-1}\left(s_c+L\right).$$

The new marginal skill level s_c satisfies

$$
\begin{aligned}
s_c^{1-\sigma}-s_c &= \frac{\sigma}{\sigma-1}\left(s_c+L\right) \\
s_c^{1-\sigma}-\frac{2\sigma-1}{\sigma-1}s_c &= \frac{\sigma}{\sigma-1}L
\end{aligned}
$$

such that s_c falls with increasing L. Furthermore, the nominal GDP increases which can be directly concluded from $s_c\downarrow$ and the zero earnings cutoff condition (8). The expected compensation $r(s)$ is still determined by the assignment equation that equates the expected marginal cost of a manager with skill s with the expected marginal benefit of this manager and remains unaffected

$$r(s) = \mu M \left(s^{\sigma-1} - s_c^{\sigma-1}\right) + 1 = \mu \left(\left(\frac{s}{s_c}\right)^{\sigma-1} - 1\right) + 1.$$

Consequently, the lower marginal skill level s_c implies that there will be more Northern agents in management occupations and that the expected skill premium for management occupations increases for all Northern managers. Furthermore, the equity share v^* is falling due to a larger effective market size M ($s_c \downarrow \Rightarrow M \uparrow \Rightarrow v^* \downarrow$) and the value of equity is increasing for each manager in the North.

Open Economy Equilibrium with High-Skill Integration (Proposition 3)

The price index in the high-skill integration case can be stated as follows:

$$\begin{aligned}
P^{HI} &= \left[\int_{j \in J} p_j^{1-\sigma} dj\right]^{1/(1-\sigma)} \\
&= \left[\int_{s_c}^{\alpha} \left(\frac{\sigma}{\sigma-1} s^{-1}\right)^{1-\sigma} \frac{\alpha+L}{\alpha} ds + \int_{\alpha}^{1} \left(\frac{\sigma}{\sigma-1} s^{-1}\right)^{1-\sigma} ds\right]^{1/(1-\sigma)} . \\
&= \frac{\sigma}{\sigma-1} \left[\frac{\alpha+L}{\alpha} \left\| \frac{1}{\sigma} s^{\sigma} \right\|_{s_c}^{\alpha} + \left\| \frac{1}{\sigma} s^{\sigma} \right\|_{\alpha}^{1}\right]^{1/(1-\sigma)} \\
&= \frac{\sigma}{\sigma-1} \left(\frac{1}{\sigma}\right)^{1/(1-\sigma)} \left[\frac{\alpha+L}{\alpha} \left(\alpha^{\sigma} - s_c^{\sigma}\right) + \left(1 - \alpha^{\sigma}\right)\right]^{1/(1-\sigma)} \\
&= \frac{\sigma}{\sigma-1} \left(\frac{1}{\sigma}\right)^{1/(1-\sigma)} \left[1 - s_c^{\sigma} + \frac{L}{\alpha} \left(\alpha^{\sigma} - s_c^{\sigma}\right)\right]^{1/(1-\sigma)} .
\end{aligned}$$

Using P^{HI}, the zero earnings cutoff condition requires

$$\begin{aligned}
M s_c^{\sigma-1} &= 1 \\
\frac{1}{\sigma} \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} X \left(P^{HI}\right)^{\sigma-1} s_c^{\sigma-1} &= 1 \\
X &= \left[1 - s_c^{\sigma} + \frac{L}{\alpha} \left(\alpha^{\sigma} - s_c^{\sigma}\right)\right] s_c^{1-\sigma}
\end{aligned}$$

which can be stated as

$$X = \left(1 + L\alpha^{\sigma-1}\right) s_c^{1-\sigma} - \left(1 + L\alpha^{-1}\right) s_c.$$

Note that X could become negative for $s_c \to 1$ as $(1 + L\alpha^{\sigma-1}) < (1 + L\alpha^{-1})$. However these cases are irrelevant in the high-skilled integration case since $s_c < \alpha$. For $s_c = \alpha$ nominal GDP is

$$\left(1 + L\alpha^{\sigma-1}\right)\alpha^{1-\sigma} - \left(1 + L\alpha^{-1}\right)\alpha = \left(\alpha^{1-\sigma} + L\right) - (\alpha + L) = \alpha^{1-\sigma} - \alpha > 0$$

such that $X > 0$ for all $s_c < \alpha$.

There is also a larger supply of production agents from the South (since not all Southern agents become managers) that can be employed by Northern firms. Production labor supply equals $\frac{L+\alpha}{\alpha}s_c$ such that the labor market clears for

$$X = \frac{L+\alpha}{\alpha}\frac{\sigma}{\sigma-1}s_c.$$

Solving for the new marginal skill in equilibrium yields

$$\begin{aligned}
\left(1 + L\alpha^{\sigma-1}\right)s_c^{1-\sigma} - \left(1 + L\alpha^{-1}\right)s_c &= \frac{L+\alpha}{\alpha}\frac{\sigma}{\sigma-1}s_c \\
&\Leftrightarrow \\
s_c &= \left[\left(\frac{\alpha+L}{\alpha+L\alpha^{\sigma}}\right)\frac{2\sigma-1}{\sigma-1}\right]^{-1/\sigma}.
\end{aligned}$$

Since $\frac{\alpha+L}{\alpha+L\alpha^{\sigma}} > 1$, the marginal skill level is lower than in the closed economy. Furthermore, as $\partial\left(\frac{\alpha+L}{\alpha+L\alpha^{\sigma}}\right)/\partial L = \frac{\alpha(1-\alpha^{\sigma})}{(\alpha+L\alpha^{\sigma})^2} > 0$, the marginal skill level falls with more integration (larger L). As the zero earnings cutoff is satisfied in equilibrium, M must be larger. This increase in M implies that the GDP level is higher (because P is lower).

To determine equilibrium expected compensation $r(s)$ a case distinction is necessary. The marginal benefit of a manager is given by

$$\frac{\partial E\left[(1+\eta)(1+e)\pi(z,s)\right]}{\partial s} = \frac{\partial M\left(z^{1-\mu}s^{\mu}\right)^{\sigma-1}}{\partial s} = \mu(\sigma-1)M\left(s^{\sigma-2}\right).$$

Integrating the marginal benefit over the skill distribution from s_c to s and fixing $r(s_c) = 1$ gives

- for skills $s_c < s < \alpha$

$$\begin{aligned}
\int_{s_c}^{s}\mu(\sigma-1)Mt^{\sigma-2}\frac{\alpha+L}{\alpha}dt &= \mu(\sigma-1)\frac{\alpha+L}{\alpha}M\left\|\frac{1}{\sigma-1}t^{\sigma-1}\right\|_{s_c}^{s} + 1 \\
&= \mu M\left(1+\frac{L}{\alpha}\right)\left(s^{\sigma-1} - s_c^{\sigma-1}\right) + 1
\end{aligned}$$

- for skills $s_c < \alpha < s$

$$\begin{aligned}
\mu\left(\sigma-1\right)M\left(\int_{s_c}^{\alpha} t^{\sigma-2}\frac{\alpha+L}{\alpha}dt+\int_{\alpha}^{s} t^{\sigma-2}dt\right) &= \mu M\left[\frac{\alpha+L}{\alpha}\left(\alpha^{\sigma-1}-s_c^{\sigma-1}\right)+\left(s^{\sigma-1}-\alpha^{\sigma-1}\right)\right] \\
&\quad +1 \\
&= \mu M\left[s^{\sigma-1}-s_c^{\sigma-1}+\frac{L}{\alpha}\left(\alpha^{\sigma-1}-s_c^{\sigma-1}\right)\right]+1.
\end{aligned}$$

Since the market size M is equal to $s_c^{1-\sigma}$ in equilibrium, expected executive pay can be stated as

$$r\left(s\right)=\begin{cases}\mu\left(1+\frac{L}{\alpha}\right)\left(\left(\frac{s}{s_c}\right)^{\sigma-1}-1\right)+1 & if\ s_c < s < \alpha \\ \mu\left[\left(\left(\frac{s}{s_c}\right)^{\sigma-1}-1\right)+\frac{L}{\alpha}\left(\left(\frac{\alpha}{s_c}\right)^{\sigma-1}-1\right)\right]+1 & if\ s_c < \alpha < s.\end{cases}$$

Data Appendix

List of Covered Stock Market Indices

continental Europe: AEX, AEX MidCap, BCN GLOBAL 100, BEL 20, BEL 20 INSTITUTIONAL, CAC 40, DAX, EUROTOP 100, FTSE/MIB, IGBM, ISEQ OVERALL, LUXX, MDAX, MIBTEL, MIDEX, OBX, OMX, OMX 20, PSI 20, SBF 120, SMF, TecDAX, WIG 20

United Kingdom: FTSE 100, FTSE 250, FTSE AIM, FTSE FLEDGLING, FTSE SMALL CAP, FTSE TECHMARK ALL SHARE, JSE ALL SHARE

North America: DOW JONES INDUSTRIAL AVG, NASDAQ 100, S&P 500, S&P MidCap 400, S&P/TSX COMPOSITE, S&P/TSX 60

Variable Descriptions

ln Total pay: total annual compensation of an executive (in logs); comprises direct (cash) and indirect (equity) based compensation

ln Equity pay: total equity-based annual compensation of an executive (in logs); comprises all sorts of equity (option grants, stocks, LTIPS)

ln Wealth delta: change in the individual's wealth in the company for each 1% change in the stock price (in logs)

ln Wealth in shares: value of shares held by the individual (in logs); these are valued at the closing stock price of the annual report date

ln Pay gap: total annual compensation of an executive divided by `(ff_labor_exp` × `exch_rate_usd) / ff_emp_num` (in logs)

Within-firm pay inequality: total annual compensation of an executive (in logs) minus `(ff_labor_exp` × `exch_rate_usd) / ff_emp_num` (also in logs)

Ownership share: total executive wealth divided by total market capitalization; winsorized at 1%

CEO dummy: dummy=1 if manager is the CEO of the firm in the current year

Executive dummy: dummy=1 if manager is member of the executive board in the current year

Company value quartile dummies (Size Qx): dummies for each firm size quartile Q1 (largest) - Q4 (smallest); quartiles are based on average firm site during 2000 - 2014, where size is the mean of the total enterprise value, i.e. market capitalization plus value of debt (`ff_entrpr_val`)

ln Assets: total firm assets (in logs)

MNE: dummy=1 if firm reports any foreign assets (`ff_assets_intl`)

Leverage: value of debt (`ff_debt`) divided by the sum of debt and equity (`ff_debt + ff_eq_tot`); winsorized at 1%

ln Stock price: end-of-year stock price (`ff_price_secs`) (in logs)

ln Enterprise value: market capitalization plus value of debt (`ff_entrpr_val`) (in logs)

Offshoring: share of imported intermediates relative to the total intermediate consumption at the 2-digit ISIC Rev. 4 output industry level from WIOD Release 2016, matched to the main 4-digit SIC output industry of the firm

ln Industry output: gdp (in logs) at the 2-digit ISIC Rev. 4 output industry level from WIOD Release 2016, matched to the main 4-digit SIC output industry of the firm

ln Industry exports: exports (in logs) at the 2-digit ISIC Rev. 4 output industry level from WIOD Release 2016, matched to the main 4-digit SIC output industry of the firm

ln Industry imports: imports (in logs) at the 2-digit ISIC Rev. 4 output industry level from WIOD Release 2016, matched to the main 4-digit SIC output industry of the firm

World export supply: total sum of exported intermediates from and to third party countries (in million USD) weighted according to fixed country-level input coefficients from 2000, data are measured at the country-industry level for each year at the ISIC Rev. 4 output industry level from WIOD Release 2016

Figure 4: Aggregate Trends in the Sample