Power, luck and ideology in a model of executive pay

By

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Abstract
The microprocessor and related technologies have transformed corporate and industry structure; applied in a neo-liberal environment, the technologies have had profound effects on the relative power of different groups. Skott and Guy (2007) and Guy and Skott (2008) formalized one aspect of this process of *power-biased technical change*: firms' increased ability to monitor low-paid employees and the resulting changes in inequality and employment at the low end of the income distribution. This paper addresses power biases and income inequality at the high end. Increasing firm-level financial volatility has intensified the agency problem and increased the power of corporate executives. These effects, which have been compounded by changes in ideology and pay norms, yielded an explosion in executive pay.

Keywords: Communications technology, power-biased technical change, inequality, executive pay, efficiency wage

JEL classification: J31, O33

1 Introduction

A large literature connects changes in technology with changes in the distribution of income. Most of this literature is based on the skill-biased technological change (SBTC) hypothesis, which assumes that technology affects distribution through the demand for skill.[4] In relation to executive pay, Gabaix and Landier (2008), for example, attribute the explosion to the demand for scarce talent associated with a parallel rise in the market value of corporations; the high pay is seen as market-based and efficient.[5] Changes in the demand for skill, however, may be less important than technology's contribution to changes in workplace power relationships – what we call power-biased technological change (PBTC).

Skott and Guy (2007) and Guy and Skott (2008, 2008a) formalized one aspect of this process of power-biased technical change: firms' increased ability to monitor low-paid employees and the resulting changes in inequality and employment at the low end of the income distribution.[6] This paper addresses power biases and income inequality at the high end, with PBTC now applied to executives: new technologies and shorter product life cycles have led to a rise in executive power and pay. We caution, however, that these effects of technology on market structure and top pay are institutionally contingent.

The importance of agency problems for the pay of top executives should not be controversial, given both the voluminous literature on the issue and the belief by compensation committees that the problems are critical. When the relationship between executive pay and technological change are discussed, however, agency problems tend to be ignored; implicitly the analysis excludes effects of technological change on the severity of the agency problems. This exclusion is unfounded.

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[4] See Card and DiNardo (2002), Autor et al. (2008) for an overview.

[5] One obvious problem with that analysis is that it ignores agency – a central question in the pay of CEOs since the work of Jensen and Meckling (1976), and Jensen and Murphy (1990). Another is that CEO pay has not always been so tied to market value. Before the explosion, pay at the top was a relatively steady function of pay on the bottom of the same companies (Simon 1957; Guy 2005); attributing the rise in pay to the rise in market valuation does not tell us why the two came to be tied together.

[6] Truck drivers, for instance, have seen their power reduced as new technologies enable their employers to monitor their behavior more closely. As it says on the website of the manufacturer of the 'Road Safety Fleet Black Box', "it is like being able to sit next to every one of your drivers every second they drive" (http://www.roadsafety.com/fleet.php). No longer can a delay be blamed on bad weather or heavy traffic. Similar changes have taken place in a range of occupations from retail clerks to call centers.

New technologies have aggravated the agency problem for top executives by changing the structure of markets. They have done this in two ways. First, ICTs have, accentuated markets' winner-take-all (WTA) characteristics; second, both WTA markets, and a reduction in product life cycle time (von Braun 1990; Kurzweil 1992), contribute to an increase in firm-level volatility (Comin and Mulani 2006; Chun et al. 2008). WTA means that greater consequences ride on the choices made by top executives; firm-specific volatility exacerbates the information asymmetry between executives and shareholders. Thus, both WTA and volatility change the parameters of the agency problem. The result -- using standard agency arguments -- is a rise in executive pay. [7]

Our focus on technology and the principal-agent problem should not be seen as a denial of the importance of the institutional framework. The changes in market structure, first, affect the normative framework within which executives work. The volatility of firm level outcomes and the greater mobility of executives reduce attachment to employees; paying executives as if they were capitalists helps increase social separation between them and their subordinates, and increases identification (as well as incentive alignment) with their principals. On balance, these changes, we argue, accentuate the agency problem and contribute to the rise in executive pay. Second, and more important, ICTs create WTA markets because the state allows them to. Formal institutions create the framework within which, for instance, network products or intellectual property produce a WTA outcome. Competition policy, intellectual property law, labor market institutions, corporate governance institutions, and the tax system all affect the distribution of gains within a given product market structure, and also affect the incentives to shape product markets in particular ways. Thus, rising executive pay -- and rising inequality, more generally -- should not be understood as one of technology rather than institutions. But the institutional problem needs to be understood as one of choosing how to regulate markets, given a particular technological endowment. The revolution in information and communication technologies has made new corporate structures and new market structures possible; post-1980 neo-liberal regimes represent a political choice to scrap mid-century regulation rather than adapting it to the new technologies.

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[7] Our approach helps explain not only the rise in executive pay, but of any agent responsible for strategic decisions affecting corporate ownership or investment; critically, it applies to people involved in those choices from outside the corporation, such as investment bankers: both CEOs and investment bankers are decision makers with important private information in uncertain markets. Note also that we are explaining increases in *earnings* (salaries and business income); as Piketty and Saez (2003) show, the increased income share of the top 0.1% has, in the US, been primarily from those sources – in marked contrast to the top echelon's previous dependence on property income.

This view of the linkages between technology and institutions stands in contrast to the SBTC literature which typically ignores any role of institutional change, except a mechanistic one from technology to institutions: it is suggested – sometimes implicitly – that the simultaneous increase in both relative employment and relative pay of particular groups of workers can be explained only by SBTC. We reject this claim; PBTC can produce the observed pattern (Skott and Guy 2007) as can changes in the minimum wage in economies with 'overeducation' (Slonimczyk and Skott 2012).

Our position is closer to the literature that attributes the rise in executive pay – and the rise in inequality generally - to institutional change; e.g. Atkinson (2000), DiNardo et al (1996), and Levy and Temin (2007). [8] It is somewhat unsatisfying, however, to treat a large *set* of institutional changes – what we can call neo-liberalism – as exogenous. We can, more reasonably although with necessary caveats, treat technological change as exogenous, and this literature typically ignores any possible interdependence between technological and institutional change.

Section 2 describes important changes in technology and their effects on market structure and the agency problem. Section 3 discusses the institutional contingency of some of these effects. Section 4 considers interactions between technological and institutional factors. Section 5 presents a formal model of CEO pay. The analysis of a benchmark version based on Shapiro and Stiglitz (1984) is followed in Section 6 by extensions that incorporate social norms and ideology. Chapter 7 concludes.

2 New technology, winner-take-all, and volatility

Market structure is different today than it was in the mid-twentieth century. Then, stable oligopoly was the rule in sectors dominated by large corporations; today, many such markets have winner-take-all (WTA) characteristics. Then, aggregate volatility dominated; in recent decades, even when aggregate volatility has been low, the volatility of outcomes for the individual firm has been high (where is Blackberry? Where will Nokia be tomorrow?). WTA means that greater consequences ride on the choices made by CEOs; firm-specific volatility exacerbates the information asymmetry between executives and shareholders.[9] Thus, the application of new ICTs in a deregulated, neo-liberal

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[8] This literature is often coupled with critiques of the SBTC hypothesis (Card and DiNardo 2002; Howell 2002; Mishel et al. 2013).

[9] Winner-take-all markets are usually illustrated with examples from sports or the arts. Even if we accept the talent explanation in the case of those examples (we might not: Watts (2011) finds a large element of luck and path-dependence in the relative popularity of songs), there is little if any information asymmetry in our judgment of the value of the performance of a basketball player or singer: we like what we like, *de gustibus*. Many aspects of the work of executives, on the other hand, entail substantial information asymmetries.

environment changes the parameters of the agency problem. The result is a rise in the power and pay of top executives.

Codification

Use of ICTs involves codification, which can be understood as the process of turning knowledge into information or, in other terms, making tacit knowledge explicit: it puts some knowledge in a standard form (a code), which makes it easier to communicate, to re-use, or to share knowledge. Codification has long been important in the advance of the organization of production – consider the standardization of production methods and the creation of interchangeable parts (Hounshell 1984), the ability to incorporate such instructions in computer programs, or the ability to manipulate the genetic code.

Codification is often a source of increasing returns: codification is costly, and results in a set of instructions which reduce the marginal cost of production. For what we can call pure information products, the marginal cost of production at any scale is trivial in comparison to average cost: for example, digitized music, film, and games; general purpose software, such as Microsofts's Office and Windows; and genetically modified organisms. More generally, the costs of designing products and processes have risen while the marginal costs of production have fallen for many goods and services.

When the replicable code and/or the technical standard are proprietary, they create private increasing returns and winner-take-all markets. This tendency can be reinforced by network effects.

Modularity: outsourcing, offshoring, and corporate parts

ICTs (along with transport technologies, such as container freight and air travel) facilitate the geographical dispersal of production. The new technologies facilitate outsourcing on a modular basis, with technological and contractual details sufficiently well codified that business in a highly interdependent supply chain can be conducted on an arm's length (Sturgeon 2002).

Modularity makes it possible to isolate sources of rents -- in the language of business strategy, sources of "sustainable competitive advantage" or "core competencies" of the organization -- limiting the pool of people who are able to exercise some claim on a share. Earnings differentials within organizations are lower than what we would expect for the same individuals in the market (Frank 1985). Thus, modularity directly helps explain the particularly steep rise in between-firm wage inequality (Card et al. 2012; Juhn et al. 1993).

More importantly, from the perspective of executive pay, modularity fuels the market for corporate control, by creating smaller and more internally homogenous corporate elements for which there is a readier market -- a sort of market in company parts.

WTA, technological change and volatility

During the 'great moderation' of the late 1980s and 1990s, many aggregate measures saw reduced volatility while, at the firm-level, volatility of both financial and productivity measures grew. Growing firm-level volatility has been tied, empirically, to new technology, either through uneven experiences with the adoption of technology (Chun et al. 2010), or uncertainty in the firm's market for its own technology (Comin et al. 2009, Pastor and Veronesi 2009). The latter is consistent with WTA markets, and also with the common observation that product life cycles have become shorter (von Braun 1990, Kurzweil 1992).

For our purposes, the important point is that firm-specific volatility presents a problem of information asymmetry. Executives may have private information as to whether a bad performance by the firm was unavoidable, or the result of poor executive judgment or effort. But as volatility grows, owners face an increasing risk of dismissing executives for bad performance when the bad performance was outside their control or, conversely, retaining poor executives when good performance came as a result of pure luck.

3 Institutional contingency

Thus far, our story has been technological: new ICTs change market structure. Yet WTA markets and much of the associated firm-level volatility exist not only because of technology, but because institutional arrangements allow them to exist. Consider four examples: network effects, monopoly due to intellectual property rights, modularity, and the market for corporate control.

Network effects

Many markets created by new ICTs have WTA properties because of network effects, as seen in Facebook and Twitter's domination of their respective markets, or Microsoft's domination of personal computer operating systems and standard productivity applications. This has a technological face, but also a regulatory one: Microsoft's position has been hard fought with courts and regulators in many countries for many years, and rests not on the substance of its products, but on the slender reed of

being allowed to control certain application program interfaces (APIs), such as document formats. In an alternate regulatory regime where such interfaces are public property, software markets would have very low entry barriers, and could function largely as markets for customization and service (Stallman 1985; Raymond 1998).

The institutional contingency of technologically facilitated network monopolies is also apparent in one that has not happened: despite persistent lobbying by internet service providers (ISPs) for the right to prioritize content as they choose, in the case of the Internet (unlike, say, the case of cable TV, which often goes down the same wires) 'net neutrality' has been largely maintained in the US. This represents the continuation -- and adaptation to a new technology -- of the common carrier principle, a legacy of earlier generations of network regulation.

Intellectual property rights

Even absent network effects, WTA markets can be created by the structure of intellectual property rights (IPRs) (Guy 2007). In recent decades, IPRs have been extended through legislation, court decisions, and treaties (Sell and May 2001): new categories have become patentable (genetic code, software); broader patent claims are allowed, making it harder for competitors to 'invent around' a patent (Freeman 1995); pharmaceutical companies are permitted to leverage their patent rights with a variety of legal protections both from international trade and from sensible public procurement; the copyright doctrine of fair use is undermined by the rental model for digital media; internationally, the TRIPS treaty makes intellectual property protections more uniform and enforceable; IPR rights are commonly extended beyond the TRIPs provisions by bilateral agreements between the US or EU and their smaller trading partners. Thus, the private increasing returns of the "knowledge economy" are as much an institutional construct as a technological fact (Boldrin and Levine 2008).

Modularity

The ability to exploit modularity creates consequential choices for the executive, involving private information and uncertain outcomes. Yet, again, there are a number of ways in which a different institutional environment might constrain these choices: they are fueled by the trade policy (not only the reduction of trade barriers, but a range of tax subsidies to investment in new jurisdictions and locations), by a capital market highly tolerant of leverage, and in particular by weak protections for

employment, wage rates, pension rights, and union representation, all of which make it easier to exploit modularity for purposes of cost reduction.

Financialization

The fact that financial deregulation is associated with dramatically higher salaries in the financial sector is well documented (Philippon and Reshef 2008). The rise of pay on Wall Street is linked with the simultaneous rise pay of CEOs (Kaplan and Rauh 2010) by more than coincident instances of regulatory dereliction. Financial deregulation was part of what is often called the *financialization* of the economy, which has two salient characteristics. One is a high tolerance for risk, on the part both of regulators and investors, in a way consistent with the Minsky-Kindleberger model. The other is the elevation of shareholder value to its place as the overriding and central responsibility of corporate directors (Guy, 2009, pp. 146-151). The latter gained support from the movement of pension funds into securities markets (O'Sullivan 2001) – driven, in part, by growing firm-level volatility - which created a mass political constituency for the principle of maximizing shareholder value.[10] High leverage and the principle of shareholder value gave bankers and executives the means and the motive for creating an active market for corporate control – which includes, as noted in our discussion of modularity, a market for corporate parts. While this market has in the past been praised as offering a solution to the principal-agent problem (Jensen 1989), we want to emphasize something else: it offers, to both executives and their Wall Street counterparts, an unending stream of consequential decisions taken under conditions of asymmetric information and uncertainty.

4 Interactions

One can accept that the effect of technologies on agency problems is institutionally contingent, and still hold that technology (or what Marx called the forces of production) is crucial. To clarify this point it is useful to consider the role of earlier generations of technology in the period sometimes called the "great compression". Between 1942 and 1980, dispersion of wages and the income shares of the top 1 or 0.1% both were low compared with the periods before and since.

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[10] One factor encouraging this development was the growth of firm- and industry-level volatility, which made it less acceptable to keep pension obligations on a company's own books; countries where most pensions were delivered by publically managed pay-as-you go systems largely escaped both the move of pensions to the market,

Institutional change is the obvious proximate explanation of the compression. The list of institutions strengthened (or originated) at the dawn of the Great Compression is pretty much the same as those that neo-liberalism from ca. 1980 weakened (or abolished): protection of collective bargaining rights and, as a consequence, powerful unions; progressive taxation; regulation of banking and financial markets; price- or rate of return regulation of network industries; the common carrier principle in transport and communications; unemployment insurance; the minimum wage. Together with Keynesian fiscal and monetary policy, such measures constituted the regulatory framework of the Great Compression.

We can see the regulatory system of the Great Compression in the same way as the missing regulatory regime of our own time – a means of pulling in the tails of whatever income distribution would have been created by unregulated markets and unconstrained monopoly. In this case, the technologies are those associated with mass production; in recognition both of Ford's five dollar day and of the emblematic consumer good of the period, this is often known as Fordism (Piore and Sabel 1984; Marglin and Schor 1990; Kotz et al. 1994; Aglietta 2001), a deal sealed at the "treaty of Detroit" (Levy and Temin 2007).

In earlier work we have argued that the technologies of the Fordist era were essential to unionization and, in turn, that unionization was essential both to redistribution at the level of the firm or industry and to the political coalition that backed the larger institutional package of the Great Compression (Guy and Skott 2008). The technologies in question are, again, ICTs, in this case the likes of the telephone and the tabulating machine. That generation of technologies made it feasible to coordinate an elaborate, planned division of labor involving hundreds of thousands of employees in big corporations. The rigid bureaucratic structures for which the mid twentieth century was known were a reflection of both the capabilities and the limitations of the ICTs of the day. Economies of scale, scope, and speed offered substantial productivity benefits to large managerial firms; realization of these productivity gains was contingent on solving problems of coordination and control, and the limitations of the information systems necessitated a relatively rigid, single-path flow of materials and information. As result, in 1937 workers at General Motors were able to bring a large part of the operations of the company and many of its suppliers to a halt by sitting down in a few factories. Similarly, with telephone

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and the elevation of shareholder value maximization to the status of major public virtue (Gourevitch and Shinn 2005).

networks, the limited number of paths empowered operators -- who instead of sitting down went on strike by standing up, at the same time, across the country.

The same organizational rigidity that empowered groups of workers reduced executives' scope for action, and limited their agency rents. Moreover, by providing a setting for industrial conflict which sometimes threatened profitability, rigid organizations gave labor unions and government regulation a role in promoting orderly industrial relations. Thus, the limitations of ICT facilitated the institutional changes that contributed to the great compression.

This technological explanation for the onset of the great compression may help explain the fact that something similar seems to have occurred at about the same time in many different countries –within antagonists on both sides of World War II (the US, UK, France, Japan) and in neutral countries, both fascist and social democratic (Spain, Sweden) (Piketty and Saez 2007). Yet, these collapses in the income share of the top 1% are *so* close together in time that it is not really plausible to see them as independent national responses to technological changes: even if such responses were entirely mechanistic (which surely, they are not), the countries in question were at different levels of development. Whatever assistance there may have been from the technological quarter, we must also be looking at some sort of policy contagion. Today, the limits of technological determinism are illustrated by the diversity of international experience. Increases in inequality and executive pay are widespread, but vary considerably in magnitude. Looking ahead, it is hard to say whether a grand Polanyist social response like that which produced the Great Compression, is possible with today's technological endowment and existing American institutions; eighty years ago, at the start of 1933, it was not clear that the regulatory framework of the Great Compression was feasible, either.

5 A model of CEO pay

Some managerial activities target the efficient production of a chosen output; anything from organizing an efficient production line to payroll administration may fall into this operational category. But many of the activities of top management are what we may call portfolio activities: determining what should be produced, where it should be produced, and how and where it should be sold. Collecting and analyzing information to decide pricing strategies, the direction of new R&D, the location of new factories, possible mergers, outsourcing, or changes in financing -- none of this has anything to do with the technical transformation of inputs into output. Managerial time spent on decision making of this kind is neither a substitute for direct production inputs -- allocating more resources to making the right

pricing decisions does not reduce the input requirements per output unit -- nor a complement to production in any technical sense; the efficient production of a given amount of widgets does not require that prices be set at the profit maximizing level. These portfolio activities have no place in a standard production function. They are needed because making the right ('profit maximizing') decisions is no trivial matter in an uncertain environment and because of the important consequences for the firm -- for better or worse -- of the choices that are being made.

As outlined in sections 2-3, new ICT in combination with regulatory and institutional changes have increased the range of portfolio options; the portfolio aspect of managerial activity has become increasingly dominant.[11] These activities differ from the tasks of most production workers in at least two ways:

-- the indivisibility of the discrete managerial decision and the uncertainty surrounding the effects of the decision (and the counterfactual)

-- the skills required to perform the task.

A skill based approach highlights the second element, suggesting that new technology has raised the 'marginal product of the high-skill managerial input'. But as suggested by the first element, unpredictable elements play an important part in determining success. Moreover, the fact that skill is involved does not prove that executives are uniquely skillful or even that it is the skill that is being rewarded.[12] The agency problem suggests that high compensation may persist even if owners can choose from a pool of potential managers, all with exactly the same skills. In fact, as we shall argue, an increased sensitivity of profits to managerial input could lead to a reduction in pay.

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[11] This has been an ongoing process; Auerbach (1988) provides historical perspective on the changes in competition and managerial practice. The 'portfolio conception' of the firm has been emphasized by Crotty (2005, p. 88) who argues that there has been a shift

> "from an implicit acceptance of the Chandlerian view of the large NFC [non-financial corporation] as an integrated, coherent combination of relatively illiquid real assets assembled to pursue long-term growth and innovation, to a 'financial' conception in which the NFC is a 'portfolio' of liquid subunits that home-office management must continually restructure to maximize the stock price at every point in time."

[12] It is not clear that the existing managers are manifestly more skillful than other potential candidates. Commenting on the hearings of the Financial Crisis Inquiry Commission, Krugman (NYT 1/14/2010) observed:

> "Well, if you were hoping for a Perry Mason moment --- a scene in which the witness blurts out: Yes! I admit it! I did it! And I'm glad! --- the hearing was disappointing. What you got, instead, was witnesses blurting out: Yes! I admit it! I'm clueless! [it was] startling to hear Mr. Dimon admit that his bank never even considered the possibility of a large decline in home prices, despite widespread warnings that we were in the midst of a monstrous housing bubble."

If the function of top managers is intrinsically -- and increasingly -- linked with uncertainty about the properties of the world in which the firms are operating, the derivation of an 'optimal, profit maximizing managerial pay' becomes questionable (a well-defined optimal pay only exists if most of what a CEO does would not be needed in the first place). Still, it may be possible to outline how changes in the firm's environment can influence pay in a stylized model with stochastic elements as a proxy for uncertainty.

For simplicity disregard operational inputs (assume that these are chosen efficiently or alternatively, with a given level of competence) and focus on the portfolio activities -- pricing, investment, R&D, financing etc. -- that lie behind standard assumption of 'profit maximization'. The firm's profits before managerial pay depend on these decisions, and we write the profits as the sum of two terms,

$$\Pi = f(e; \mu, A) + \lambda \varepsilon \qquad (1)$$

We focus on CEO pay and assume a single manager. The first term in f relates profits to the CEO's 'effort' (e). As in efficiency wage models generally, effort should be seen as a shorthand for acting diligently and in the best interest of the principal. Thus, effort includes not just putting in the effort that allows sensible decisions to be made but also the making of the 'right' decisions, given the evidence, as opposed to skewing decisions in ways that favor managers at the expense of owners -- whether by wasteful expenditures on corporate jets or the manipulation of indicators that determine managerial remuneration. The parameters μ and A determine the shape and position of the f -function: an increase in μ raises the sensitivity of profits to managerial effort; an increase in A produces an upward shift in the profit function, raising profits uniformly for any level of effort. The second term is a random shock; ε is a stochastic variable with mean zero and variance σ^2; an increase in the parameter λ corresponds to a more risky environment.

New ICT and associated regulatory and institutional changes have affected the parameters A, μ, λ. Options to outsource, for instance, and the effects of this option on domestic wages have provided new sources of cheap labor and raised profits for any given managerial effort; the emergence of a range of new options have increased the sensitivity of the outcome to effort; a less stable and more uncertain business environment have increased both the sensitivity of profits to effort and the variance of the

firm-specific random component.

These changes and their effects can be formalized using a modified Shapiro-Stiglitz (1984) model. CEOs are hired from a pool of identical candidates; both the number of CEO positions and the size of the pool of potential CEO candidates are taken as constant. A CEO either provides low effort (shirks) or high effort. Assuming a simple linear version of (1), the corresponding profits in period t are

$$
\Pi_t = \begin{cases} A + \mu + \lambda \varepsilon_t & \text{with high effort} \\ \\ A - \mu + \lambda \varepsilon_t & \text{with low effort} \end{cases}
\tag{2}
$$

The CEO's performance is evaluated at the end of each period. Effort cannot be monitored directly; the evaluation is based entirely on the observable variable, Π_t. The CEO is fired if Π_t falls below a threshold M. The value of M determines the firing rates for both non-shirking and shirking CEOs.

A CEO maximizes

$$
E\{\sum_0^\infty (1-\rho)^t u_t\}
\tag{3}
$$

where

$$
u_t = \begin{cases} w - v & \text{if holding a CEO position and providing high effort} \\ w & \text{if holding a CEO position and providing low effort} \\ b & \text{if "unemployed"} \end{cases}
\tag{4}
$$

The utility b from being unemployed (having a non-CEO position) and the disutility v of supplying high effort are exogenously given in this version of the model; ρ is the discount rate.

Standard derivations (see Appendix A) give the following no-shirking condition:

$$
w^{no-shirk} = b + [1 + \frac{\rho + (1-\rho)(\delta + q)}{(1-\rho)p}]v
\tag{5}
$$

where δ is the separation rate for non-shirkers, p the firing rate associated with shirking, and q the hiring rate for currently unemployed managers. The hiring rate q is exogenous to a single firm. The values of δ and p, by contrast, are determined by the firm's firing threshold, M. The separation

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rate for non-shirkers has an autonomous rate δ_0 and a performance related component; depending on the threshold *M*, unlucky, non-shirking CEOs may be fired.

The values of M and w are set to maximize profits net of CEO compensation:

$$\max E\Pi - w$$

s.t.

(6)

$$E\Pi = \begin{cases} A + \mu & \text{if } w \ge b + [1 + \frac{\rho + (1-\rho)(\delta+q)}{(1-\rho)p}]v \\ A - \mu & \text{otherwise} \end{cases}$$

We assume that ε follows a uniform distribution on the interval [-1,1],

$$\varepsilon \sim R(-1,1) \tag{7}$$

Given this assumption and the firing condition, we have (see appendix B and Figure 1),

$$\delta = \begin{cases} 1 & \text{if } \frac{M-A-\mu}{\lambda} \ge 1 \\ \delta_0 + (1-\delta_0)(\frac{1}{2} + \frac{1}{2}\frac{M-A-\mu}{\lambda}) & \text{if } 1 > \frac{M-A-\mu}{\lambda} > -1 \\ \delta_0 & \text{if } -1 \ge \frac{M-A-\mu}{\lambda} \end{cases} \tag{8}$$

$$p + \delta = \begin{cases} 1 & \text{if } \frac{M-A+\mu}{\lambda} > 1 \\ \delta_0 + (1-\delta_0)(\frac{1}{2} + \frac{1}{2}\frac{M-A+\mu}{\lambda}) & \text{if } 1 > \frac{M-A+\mu}{\lambda} > -1 \\ \delta_0 & \text{if } -1 > \frac{M-A+\mu}{\lambda} \end{cases} \tag{9}$$

A profit maximizing firm will pay either the no-shirking wage given by (5) or the reservation wage *b*. Consider first the determination of *M* in the no-shirking case. The wage is a function of p and δ, and the values of p and δ are fully determined by M (cf. equations (8)-(9)). Tedious calculations show that in this no-shirking case the optimal value of *M* is given by

$$M^* = A + \mu - \lambda \tag{10}$$

The intuition behind equation (10) is straightforward. An increase in the firing rate for CEOs that do not shirk raises the effective discount rate and dilutes the incentive to provide effort. Thus, the increase could only be justified if it hurt shirkers more than non-shirkers; with a uniform distribution of the shock,

however, non-shirkers will be hurt at least as much as shirkers by an increase in M above the expression for M^* in (10)). It follows that M^* cannot be greater than the expression in equation (10). On the other hand, shirkers should be punished if it can be done without hurting the non-shirkers; M^* therefore cannot be less than the expression in (10)).

Combining equations (8)-(10), we get solutions for δ, p and q:

$$\delta = \delta_0 \tag{11}$$

$$p = (1 - \delta_0) \min\{1, \frac{\mu}{\lambda}\} \tag{12}$$

In a steady state the flows into and out of employment are equal,

$$q = \delta_0 \frac{n}{1-n} = \theta \delta_0 \tag{13}$$

where n is the employment rate for CEOs. By assumption the number of CEOs and the pool of potential candidates are constant; thus, the employment rate n and $\theta = n/(1-n)$ are constant too.

Plugging the solutions for p, δ and q into the expressions for w and $E\Pi - w$, we get

$$w^{no-shirk} = b + [1 + \frac{\rho + (1-\rho)\delta_0(1+\theta)}{(1-\rho)(1-\delta_0)\min\{1, \frac{\mu}{\lambda}\}}]v \tag{14}$$

$$
\begin{aligned}
E\Pi^{no-shirk} &- w^{no-shirk} \\
&= A + \mu - b - [1 + \frac{\rho+(1-\rho)\delta_0(1+\theta)}{(1-\rho)(1-\delta_0)\min\{1, \frac{\mu}{\lambda}\}}]v
\end{aligned} \tag{15}
$$

The expression in (15) has to be compared with the profits that are obtained when the no-shirking condition does not hold and the CEO is paid the reservation wage, b:

$$E\Pi^{shirk} - b = A - \mu - b \tag{16}$$

The firm will want to pay the high, no-shirking wage if

$$
\begin{aligned}
E\Pi^{no-shirk} &- w^{no-shirk} - (E\Pi^{shirk} - b) \\
&= 2\mu - [1 + \frac{\rho+(1-\rho)\delta_0(1+\theta)}{(1-\rho)(1-\delta_0)\min\{1, \frac{\mu}{\lambda}\}}]v \quad > 0
\end{aligned} \tag{17}
$$

This condition is satisfied if μ is sufficiently large, that is, if profits before CEO pay are sufficiently sensitive to CEO effort. We assume that the condition is met; without the condition, the agency problem

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becomes uninteresting.

We are left with two cases (see Figure 2). If $\lambda < \mu$, the range of possible profits under a shirking manager does not overlap with the range of profits under a non-shirking manager. Loosely speaking, the degree of uncertainty is small relative to the sensitivity of profits to managerial effort. As a result, realized profits fully reveal whether the manager has been shirking and marginal variations in A, μ and λ have no effect on managerial pay.

The more interesting case arises when uncertainty is high and $\lambda > \mu$ (Figure 2b). In this case, it follows from equation (14) that:

- an increase in A has no effect on CEO pay

- an increase in μ *reduces* CEO compensation and raises profits. The reason is simple. A higher sensitivity makes it easier to determine whether the CEO is shirking; the agency problem is alleviated.

- an increase in λ raises CEO compensation and reduces profits.

- a proportional increase in μ and λ leaves CEO compensation unchanged and enhances profits net of CEO compensation.

6 An extension: fairness and changes in reference groups

Efficiency-wage arguments can be cast in different ways. In section 4.1 we deliberately chose a version that is standard in the literature and that also seems to fit traditional Marxian notions of labor discipline. Formulations that emphasize fairness and reciprocity, however, may have more empirical support than the Shapiro-Stiglitz version; Akerlof and Yellen (1990) introduced fairness norms as a basis for efficiency wage models, and the survey evidence reported by Bewley (1999) strongly supports this approach.

A fairness element can be introduced into the Shapiro-Stiglitz framework by letting the disutility ν reflect the prevailing norms. The interpretation is straightforward. The disutility of providing effort that benefits someone else depends on one's feelings towards that someone; if the owners have been treating the CEO well, the disutility will be low.

Formally, let

$$v = \phi(\frac{w}{w_a}, \gamma); \quad \phi_w < 0, \phi_\gamma > 0 \tag{18}$$

where w_a is a reference wage and γ represents a shift variable. There is widespread evidence that the 'fair wage' is determined in relation to a reference wage. Thus, the first argument in (18) is the relative pay w/w_a, rather than the absolute wage w. Reciprocating an increase in the relative wage, the CEO is motivated to raise effort; that is, the disutility of effort is decreasing in the relative wage. The shift variable γ in equation (18) is a catch-all for other factors that influence pay norms, including the general ideological climate; the Reagan-Thatcher years, for instance, heralded a shift in attitudes on issues ranging from inequality to the limits on socially acceptable greed and self-promotion.

It seems reasonable to suppose that the reference wage w_a contains (at least) two elements: the average wage paid to other CEOs ($\bar{w}$) and the average wage paid to the firm's production workers (z). As a simple formalization, the reference wage can be written as a weighted average,

$$w_a = \alpha\bar{w} + (1-\alpha)z \tag{19}$$

The composition of the reference group may change, however; specifically, the value of α may have increased over the last 30 years. Evidence of this shift can be found in the increasing-- and increasingly formalized -- weight of CEOs of comparable companies in compensation committees' decisions (Elson and Ferrere (2012)).[13]

The implications of an increase in α follow directly from equations (14), (18)-(19). Substituting (18)-(19) into (14), using the equilibrium condition $w = \bar{w}$, and taking total derivatives, we get

$$\frac{dw}{d\alpha} = \frac{-B\phi' \frac{w(w-z)}{[\alpha w + (1-\alpha)z]^2}}{1 - B\phi' \frac{(1-\alpha)z}{[\alpha w + (1-\alpha)z]^2}} > 0 \tag{20}$$

where $B = 1 + \frac{\rho + (1-\rho)\delta_0(1+\theta)}{(1-\rho)(1-\delta_0)\min\{1, \frac{\mu}{\lambda}\}}$.[14] The net effect of the shift in the composition of the reference

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[13] The shifting weights are not surprising. The volatility of firm level outcomes raises the cost of attachment to employees; paying CEOs as if they were capitalists helps increase social separation between them and their subordinates, and increases identification (as well as incentive alignment) with their principals.

[14] Arguably, neither the steady-state assumption nor the full intertemporal optimization underlying the derivation of equation (14) in section 4.1 fit well with a norm-based approach. But fairness norms and reciprocity may

group is a rise in executive pay. This result is quite intuitive. The numerator in (20) is positive because the reference wage is increasing in α (equation 19), an increase in the reference wage raises the disutility of effort, for given w (equation 18), and an increase in the disutilty v raises the wage w; the denominator is greater than one, reflecting the dampening effects of a rise in w on the disutilty of effort. An analogous result can be derived for changes in the autonomous component γ; we have *dw/dγ>0*.

This extended Shapiro-Stiglitz model shows how shifts in pay norms – whatever the sources of the shift – can be a direct, non-market influence on the evolution of CEO pay. An increase in pay to the CEO is matched by a decline in net profits to owners without any necessary, derived effects on relative factor inputs. Thus, our analysis supports the emphasis on institutional and ideological factors (e.g. Atkinson 1998, Levy and Temin 2007, Piketty and Saez (2003) , Mishel et al. 2012, Elson and Ferrere 2012). Non-market forces are brought in to determine distribution.

A similar indeterminacy in the division of gross profits arises in matching models with match-specific rents. The indeterminacy in this alternative setting can be resolved by using a Nash bargaining model and assigning 'bargaining power' to the two parties. As in the efficiency wage setting, the outcome depends on power, and in many respects the conclusions from the two models may be similar. The advantage of the efficiency wage version, in our view, is that it highlights the agency problem and directs attention to factors that determine relative power; increasing uncertainty (volatility), for instance. Even when it comes to norm-based effects, the agency setting provides a clearer and in our view more convincing story: CEOs gain power from their ability and willingness to hurt the interests of the owners. Thus, a change in pay norms has a direct effect on pay because it influences the willingness of the CEOs to hurt owners by providing less effort.[15] If CEOs feel badly treated at pay rates below $10

produce a reduced-form equation of the same form as (14); that is,

$$w = b + Bv$$

with $B = B(\frac{\lambda}{\mu})$, $B' > 0.$

[15] In economics, the strategic role of emotions has been stressed by Frank (1988).

million, firms may have to pay $10 million to avoid shirking.[16] This fairness perspective is implicit in Elson and Ferrere's (2012) account of boards and compensation committees' choice of median (or above median) pay as the target:

> "If a board were to award lower than expected pay by compensating below median (market), it is understandable that there may be psychological consequences as a result of perceived inequitable treatment … Theories of pay equity suggest that when paid less than one's peers, a person may seek redress through the withdrawal of effort." (pp. 38-39)

7 Conclusions

Skill-biased shifts are commonly used to explain the trends in inequality and sky-rocketing CEO pay, in particular (e.g. Murphy and Zábojník 2004; Garicano and Rossi-Hansberg 2006; Gabaix and Landier 2008). The details differ but the essential element is that pay has increased because changes associated with new ICT have made profits increasingly sensitive to variations in the quality of the managerial input and/or have raised the reservation wage of high-skill managers. We find these skill-based explanations incomplete, at best. In corporate governance contexts the use of agency models is a standard way of modeling CEO pay, for good reason; the impact of new technologies is best approached by understanding how these technologies, and the consequent changes in market structure, affect the agency problems.

The new technologies have accentuated the information asymmetry between managers and shareholders. But there is an institutional context: WTA markets, which led to greater sensitivity of profit to managerial effort; the uncertainty in the mapping of observed profit outcomes onto managerial effort; the norms and social comparisons which mediate the manager's response to different pay outcomes – are all institutionally constrained. The international diversity in levels and changes in inequality testifies to the importance of this institutional contingency.

The formal models in Sections 5-6, finally, have obvious limitations. Uncertainty was replaced with a simple stochastic element; the dichotomy between low and high effort is attractive mainly because of its analytical tractability; the Shapiro-Stiglitz version of the model focused on steady-states with constant

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[16] The correlation between firm size and CEO pay, according to this perspective, may owe as much to the widespread view that pay ought to be related to size and CEO responsibility as it does to more objective differences in the severity of the agency problem.

values; it was assumed that firms have full knowledge of the various parameters underlying the choice of effort.[17] These simplifications make the analysis tractable and do not, we believe, distort the basic argument: increasing uncertainty and changing social norms have exacerbated the agency problem and contributed strongly to the explosion in executive pay.

A more serious objection may focus on the absence of performance related pay in the model. We took managerial pay to be a simple wage. Stock options and other performance related remuneration packages clearly play a role in executive pay. We have ignored this element for several reasons. The incentive effects of these packages, first, will be partly offset by golden handshakes. Performance pay, second, may be less important than often believed; according to Tosi et al. (2000), performance explains less than five percent of executive pay. The incentives, third, bring their own distortions as managers strive to augment the particular performance indicators that determine their pay; the distortions may include a focus on short-term profits (or immediate stock market gains) at the expense of long-term investment.[18]

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[17] We also disregarded the endogenous element in the formation of norms: fairness norms adjust over time in response to actual achievements. According to Kahneman et al. (1986, p. 730-1)

> "any stable state of affairs tends to become accepted eventually, at least in the sense that alternatives to it no longer readily come to mind. Terms of exchange that are initially seen as unfair may in time acquire the status of reference transaction. Thus, the gap between the behaviour that people consider fair and the behavior that they expect in the market-place tends to be rather small."

Skott (2005) includes endogenously changing pay norms in a model with two types of workers. Atkinson (1998, p. 19) also notes the endogeneity, arguing that

> "As more people are remunerated outside the conventional norms, so adherence to these norms becomes weaker, and the socially acceptable range of remuneration becomes wider."

[18] Crotty (2009) analyzes the distortions in financial firms.

Appendix A: Derivation of the no-shirking wage and expected profits

The CEO maximizes

$$E\{\sum_0^\infty (1-\rho)^t u_t\}$$

where (A1)

$$u_t = \begin{array}{ll} w-v & \text{if holding a CEO position and providing high effort} \\ w & \text{if holding a CEO position and providing low effort} \\ b & \text{if "unemployed"} \end{array}$$

The utility b from being unemployed (having a non-CEO position) and the disutility v of supplying high effort are exogenously given; ρ is the discount rate.

The value functions for employed CEOs satisfy

$$V_E = w - v + (1-\rho)[(1-\delta)V_E + \delta U]$$
$$V_S = w + (1-\rho)[(1-\delta)V_S + \delta U]$$
(A2)

where V_E and V_S are the value functions for managers with high and low effort, and U the value function for an unemployed manager. The no-shirking condition requires that $V_E = V_S = V$, and U is given by

$$U = b + (1-\rho)[qV - (1-q)U]$$
(A3)

Using (A2)-(A3) we get

$$\rho V = w - v + (1-\rho)\delta[U - V]$$
(A4)

$$\rho V = w + (1-\rho)(\delta + p)[U - V]$$
(A5)

$$\rho U = b + (1-\rho)q[V - U]$$
(A6)

Subtracting (A5) from (A4),

$$V - U = \frac{v}{(1-\rho)p}$$
(A7)

and, using (A4) and (A6),

$$\rho(V - U) = w - v - b - (1 - \rho)(\delta + q)[V - U] \qquad \text{(A8)}$$

Hence,

$$w = v + b + \frac{\rho + (1 - \rho)(\delta + q)}{(1 - \rho)p} v = b + [1 + \frac{\rho + (1 - \rho)(\delta + q)}{(1 - \rho)p}]v \qquad \text{(A9)}$$

The flows into and out of employment are equal in a steady state. Wages are set to satisfy the no-shirking condition, the outflow is given by δ, and it follows that

$$q(1 - n) = \delta n \qquad \text{(A10)}$$

where n is the employment rate. By assumption both the number of CEOs and the size of the pool of potential managers are constant; n therefore is also constant. Letting

$$\theta = \frac{n}{1 - n} \qquad \text{(A11)}$$

the wage equation can be written

$$w = b + [1 + \frac{\rho + (1 - \rho)\delta(1 + \theta)}{(1 - \rho)p}]v \qquad \text{(A12)}$$

Appendix B: Choice of firing threshold

From (A12) it follows that M should be chosen to minimize the ratio

$$\frac{\rho + (1 - \rho)q + (1 - \rho)\delta}{(1 - \rho)p} \qquad \text{(B1)}$$

The values of ρ and q are exogenous to the firm; the separation rates δ and ($\delta + p$) for high and low effort managers are determined by M. Using (8)-(9) -- see also figure 1 -- we get

$$\frac{\partial(\delta + p)}{\partial M} = \frac{\partial \delta}{\partial M} > 0, \frac{\partial p}{\partial M} = 0 \text{ if } A + \mu + \lambda > M > A + \mu - \lambda \qquad \text{(B2)}$$

$$\frac{\partial(\delta + p)}{\partial M} > 0, \frac{\partial \delta}{\partial M} = 0, \frac{\partial p}{\partial M} > 0 \text{ if } A + \mu - \lambda > M > A - \mu - \lambda \tag{B3}$$

From (B2) it follows that the optimal M cannot exceed $A + \mu - \lambda$; from (B3) it follows that the

optimal M cannot be less than $A + \mu - \lambda$.

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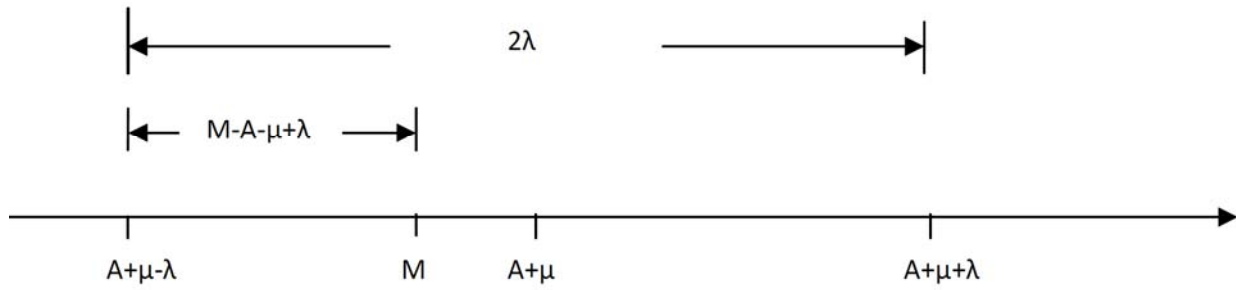
Figure 1

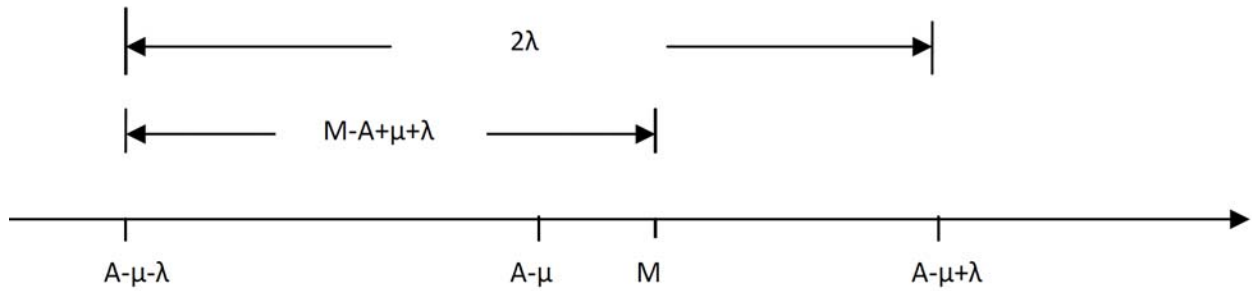Figure 1a: $\delta = \delta_0 + (1-\delta_0) [M-A-\mu+\lambda]/(2\lambda)$

Figure 1b: $p+\delta = \delta_0 + (1-\delta_0) [M-A+\mu+\lambda]/(2\lambda)$
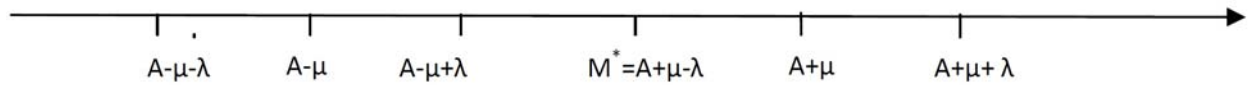
Figure 2

A-μ-λ   A-μ   A-μ+λ   M*=A+μ-λ   A+μ   A+μ+ λ

Figure 2a: $\mu > \lambda$, $\delta = \delta_0$, $p = (1-\delta_0)$

2λ

2μ

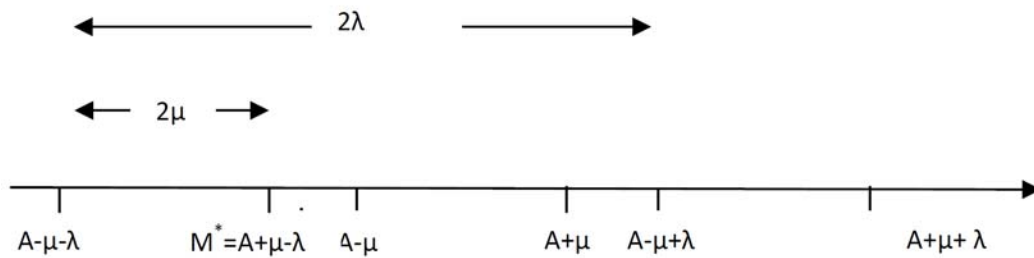A-μ-λ   M*=A+μ-λ   A-μ   A+μ   A-μ+λ   A+μ+ λ

Figure 2b: $\mu < \lambda$, $\delta = \delta_0$, $p = (1-\delta_0)\mu/\lambda$