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## **New ways to slice the pie: Span of control and wage and salary distribution within firms**

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### **Abstract**

In recent decades, firms have been seen to “delayer” and shrink middle management. We show in this paper that changes in management structure affect income distribution within the firm. The managerial wage bill follows from an accounting relationship that depends on the manager’s span of control and step increases in managerial pay. Holding those factors fixed, CEO pay is found to increase with the size of the firm, thereby reproducing one of the best-documented observations of firm compensation. Also, the contribution of within-firm wage inequality as measured by the Theil index is found to be of the same order of magnitude as between-sector inequality. When the span of control rises, as it has in recent decades, wage and salary inequality declines. We argue that the well-documented rise in income inequality is a result of rapidly expanding equity-based compensation. Following traditions in economics that propose a social basis for income distribution, the paper argues that changing the span of control and step changes in pay between levels in the managerial hierarchy, as well as the profit share, are factors through which upper management, middle management and production workers can negotiate their slice of the pie.

**Keywords:** delayering; downsizing; financialization; functional income distribution; span of control

**JEL:** D33, L22

## 1. Introduction

Norms of managerial structure change over time. Whereas until the mid-1980s firms often had several layers of middle management (at least in the UK, US and Australia), by the 1990s many firms began to shrink the number of layers and expand the duties of middle managers in a process called “delayering” (Littler and Innes 2004; McCann et al. 2008). Within the management literature, the supervisory burden of managers is reflected in their “span of control” (Urwick 1956), or the number of their direct reports (for other definitions, see Ouchi and Dowling 1974). It is generally understood, following Woodward (1965), that different technologies have different optimal spans of control, and developments in information technology partly explain the expansion in span of control. However, other factors, notably cost, also contributed.<sup>1</sup> As Davison (2003) argues, the need to manage costs has led firms in recent decades to shift from asking how wide the span of control *should* be to how wide it *can* be without diminishing performance. While middle managers who survive a delayering process are often happy in their positions (McCann et al. 2008; Dopson and Stewart 1990), they report higher stress, and the thinning of the managerial ranks reduces opportunities for advancement. Middle managers accept these conditions because they perceive them to be necessary.

Managerial structure influences income distribution within the firm, with the corollary that distributional conflicts within the firm are partly reflected in managerial structure. In this paper we propose a “middle-manager” model for wage and salary compensation, in which capital and associated labor requirements determine a “base” level of employment, while the span of control determines the size of the managerial super-structure. The institutional norm that supervisors get paid more than reports then yields an unequal distribution of wage and salary compensation (or salary and bonuses) within the firm, while equity-based compensation is additional to salary and bonuses.

The model developed in this paper can be seen as unpacking a parameter introduced by Palley (2005; 2012) and Lavoie (2009). Those authors split the wage bill into production workers’ wages and managerial pay, with an exogenously specified ratio between the two, while Palley (2015) endogenizes the ratio. These models assume different consumption and savings behavior for managers compared to production workers, so the ratio of their respective wage bills provides a meaningful macroeconomic distributional parameter in addition to the conventional split between profits and wages. As shown by both authors, the resulting models provide for diverse outcomes regarding distribution and growth. The

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<sup>1</sup> Dopson and Stewart (1990) found that “pressures for change included: intensified, often international, competition; deregulation of markets; developments in information and manufacturing technologies; government legislation and policies; changing attitudes to authority and demographic changes.”

main result from the model developed in this paper is that the ratio introduced by Palley and Lavoie can be represented in terms of more fundamental parameters: the span of control and the increase in pay between levels of the managerial hierarchy. Also, we distinguish managerial pay and bonuses from equity-based pay, and discuss the wage bill of non-managerial non-production staff.

One surprise from the model is that the increase in span of control in recent decades leads to a lower ratio of managerial to worker wage bills, even if the pay for individual managers is rising. This goes against the well-recognized phenomenon of rising inequality, which is associated, reasonably, with rapidly rising CEO income. The strong divergence in income was driven by increasing equity-based compensation, part of a broader process of financialization of the economy (Hein and van Treeck 2008). As noted by Galbraith and Hale (2006), high-value firms in the US tend to be concentrated in one area of the country or the other, and through the 1990s geographic inequality in the US tracked the NASDAQ.

## **2. The span of control, executive compensation and wage distribution**

A standard assumption in the management literature is that the span of control is constrained, but not uniquely determined, by cognitive and technological factors. That is, people can pay sufficient attention to a limited number of direct reports, while different technologies require different degrees of direct supervision. The original argument for using the span of control as a measure of managerial effectiveness referred to cognitive factors (Urwick 1956), while Woodward (1965) and Bell (1967) provided evidence that different technologies have different optimal spans of control. The concept of span of control does raise controversies, but they are over normative questions (e.g., whether a smaller span of control is necessarily better) (Simon 1946; Meier and Bohte 2003), as well as the determinants of span of control other than technology and cognitive factors (Udell 1967). We assume that span of control can vary within constraints, taking values that depend on negotiations within the firm. We further assume that managers nearly always earn more than their reports, as a social norm. This second assumption is uncontroversial, to the extent that it is tacitly assumed and seems not to be made explicit in the management literature. It is explicit in the economic literature, as in Rosen (1982), while Tilly (1998; 2000), a sociologist, addressed it in his relational theory of inequality.

As shown in later sections, distributional conflicts between production workers, middle management, the CEO and the board may be resolved in a number of ways that can be captured by a small set of distributional variables. First are the profit rate and production worker wage, which are the conventional distributional variables. To these we add the span of control and the step increase in managerial wages between levels in the hierarchy. Additional and important factors influencing

employment and compensation within firms include equity-based compensation and the size and cost of non-managerial, non-production staff, a category that overlaps substantially with what Galbraith (2007) called the “technostructure”. Equity-based compensation is introduced in this paper both as an incentive for managers to support a rise in the profit rate and as a component of compensation with distinct features from wages. Employment and wages of non-production, non-managerial workers – mostly clerical and professional staff – are discussed in the paper, but not included in the model.

Before introducing the model, it is helpful to first report stylized facts that have been established in this well-studied field, as well as recent trends.

### *Stylized facts*

The literature on managerial structure and compensation has produced a handful of stylized facts, of which we report four. The first of these is that, while span of control varies considerably, from one to over twenty, typical values fall within a relatively narrow range. A second is that the median value tends to increase with firm size. In both older (Udell 1967) and more recent (Davison 2003) literature, the median value for small and medium-sized firms was found to lie between 5 and 7, while for firms with more than 2,000 employees it was found to be 8 or 9. Woodward (1965, cited in Udell 1967) reported a median value of 6.

A third stylized fact is that CEO compensation increases with the size of firms in a relationship that has proven remarkably stable over time (Kostiuk 1990; Murphy 1999). In a neoclassical model this can only be true if CEOs in larger firms have a higher marginal productivity. Rosen (1982) provided such a model, including the span of control as a variable. In Rosen’s model, the CEO’s marginal productivity (and that of other managers) is enhanced because it multiplies the productivity of his or her direct and indirect reports down the hierarchy. The higher marginal productivity thereby leads to a higher wage. Without contradicting Rosen’s hypothesis that hierarchies can multiply the effectiveness of the upper layers, we show in this paper that if wages and salaries are determined largely by social factors rather than marginal productivity then this stylized fact follows immediately without invoking any neoclassical arguments. The neoclassical approach is closely tied to the “tournament” theory of executive compensation (Lazear and Rosen 1981). While there is some evidence in favor of tournament theory (e.g., Lee et al. 2007), the evidence is mixed, with some studies providing evidence that social and psychological factors are more important in explaining top executive salaries (O’Reilly et al. 1988; Main et al. 1993; Henderson and Fredrickson 2001), as we assume in this paper.

The fourth and final stylized fact is that production wages increase with firm size. This is very well documented (Mellow 1982; Gerlach and Schmidt 1990; Oi and Idson 1999) and is puzzling, because the effect persists after controlling for diverse explanatory variables. For example, using German data, Gerlach and Schmidt (1990) found a statistically significant effect of firm size after controlling for labor quality, working conditions, tenure, fringe benefits, heterogeneity of the workforce and monopoly power. Arai (2003), using data for Sweden, explains the effect as arising from rent sharing through local bargaining within the firm or establishment. The model in this paper does not attempt to explain this stylized fact, but we refer to it.

### *Trends*

In addition to the stylized facts, there are also trends. First, despite the relatively steady value for median span of control reported above, there is evidence that span of control has been growing in recent years. McCann et al. (2008), in a survey of middle managers in the UK, found that their responsibilities and spans of control were increasing “considerably”, while the firms they worked for reduced the number of layers in the hierarchy. Littler and Innes (2004), using data for Australia, found contradictory trends at the level of individual firms, but an overall trend towards managerial downsizing through delayering accompanied by increasing span of control. They also found that trends for organizational downsizing sometimes diverged from those for managerial downsizing, suggesting that the number of non-production, non-managerial staff is to some degree independent of the number of managers.

A second trend in the US is a general rise and then fall in the number of non-production staff, including managers. The rise lasted at least from the 1960s until to the 1980s, while the fall began in the 1980s (Caves et al. 1993; Berman et al. 1994). Goldstein (2012) identifies the period 1984-2001 as the “shareholder value era”, and points out that even as firms downsized, the proportion of managerial staff increased, again consistent with the argument that managerial and non-managerial non-production employment can follow divergent trends. These downsizings were often undertaken in an effort to boost stock values. However, contrary to popular reports, they rarely achieved that objective (Abraham 2004), although stock market reactions did become less negative over time (Farber and Hallock 2009). Also, downsizing did sometimes improve performance. Love and Nohria (2005) found that firms with slack (as proxied by sales, general and administrative expenses) who undertook broad restructuring when they were already performing well saw a subsequent increase in their performance as measured by end of year returns over either market or book value of their assets. For this paper the actual impact of downsizing is less relevant than the perception: upper-level managers given an incentive to boost shareholder value may pursue downsizing as a strategy.

A further trend is the substantial growth in equity-based compensation at the end of the 20<sup>th</sup> century, arguably inspired by a paper in the *Harvard Business Review* by Jensen and Murphy (1990). Those authors claimed that CEO compensation was too weakly tied to the market value of firms, so CEOs were not given the proper incentives to meet the presumed purpose of the firm, which is to maximize the value of shareholders' stock. Whether this is in fact the best goal for a modern mature firm is debatable (Galbraith 2007), but the idea that goals are made to align with incentives is not. As predicted by Jensen and Murphy, increased equity-based compensation did cause managers to "find creative ways to enhance corporate performance," but their victory was Pyrrhic, as it encouraged risk-taking, resulting in large losses as well as gains (Sanders and Hambrick 2007) and spectacular examples of illegal activity. Also, the practice was taken up in sectors, such as banking, in which risk aversion is a virtue (Chen et al. 2006). Mehran (1995) found a positive relationship between equity-based compensation and both Tobin's  $q$  and return on assets for US firms in the 1970s and 1980s, while Frye (2004) noted that equity-based compensation rose considerably in the US during the 1990s, and had a positive impact on stock value as measured by Tobin's  $q$ . However, the impact on accounting return on assets was ambiguous, with a positive relationship to equity-based compensation in the early 1990s and a negative relationship later in the decade. Frye hypothesized that by the late 1990s equity-based compensation had become so widespread that it was having a dilution effect on the stock, thereby lowering its value. This hypothesis is consistent with the observation of Ofek and Yermack (2000) that executives with high ownership tended to exercise their options in order to sell the stock, and thereby diversify their holdings.<sup>2</sup>

Behind these trends were broader changes in economic structure and productivity. Basu and Vasudevan (2013, p.76) summarize trends in profit rate and profit share in the US since the end of the Second World War. In the US in the mid-1960s, capital productivity began to fall after rising since the end of war. As profit shares were also declining, this meant a sharp fall in the profit rate. Beginning in the 1980s, capital productivity began to increase again, while the profit share began to rise, leading to a rise in the profit rate as well. Productivity began to fall again in the late 1990s, but the profit rate did not fall until close to the 2007 crisis due to further increases in profit share. The 1980s were also a period of declining union strength (Western and Rosenfeld 2011). Union membership had been declining since the mid-1950s, but the decline accelerated in the 1980s (Farber and Western 2001). The period of rising span of control therefore coincided with a trend toward rising profit share and declining labor bargaining power after a long period of declining profitability. Rising span of control can thus be seen as part of a

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<sup>2</sup> Executives' response to equity-based compensation is sensitive to tax law. The trend of falling accounting returns to assets may change in the future, because in 2006 the US required firms to expense stock options, leading them to diversify their equity compensation packages (Reda et al. 2014).

broader strategy to shift the distribution of income away from wages and toward profits to offset the effect of declining capital productivity.

### 3. A middle-manager model of firm compensation

In this section we present the model, which covers the distribution of wages and salaries. Other types of compensation, such as bonuses or equity-based compensation, are discussed when they are relevant.

The model applies at the level of a firm with accumulated capital  $K$ . The firm has a Leontief production function, and its value added,  $Y$ , is proportional to  $K$  with a coefficient  $\kappa$ ,

$$Y = \kappa K. \tag{1}$$

The number of production workers required to operate the capital,  $L_0$ , is given by a technical coefficient  $\lambda$ ,

$$L_0 = \lambda K. \tag{2}$$

We call this the “base” employment level. It is also a “normal” employment level in that actual employment of production workers fluctuates in a pro-cyclical fashion over the business cycle. It is reasonable to use normal employment as a base for determining the size of the management super-structure, because non-production employment is less cyclically sensitive than production employment (Berman et al. 1994, p.370). The size of the managerial super-structure can therefore be thought of as fixed, as in Lavoie (2009). In the model, production workers have managers, who then have their own managers and so on up to the CEO. Each level in the hierarchy is assumed to have the same average span of control,  $m$ , so there is one CEO, who has approximately  $m$  direct reports, who among them have  $m^2$  direct reports and so on down to the  $L_0$  production workers. For a firm with  $N$  layers of management,  $L_0$  equals  $m^N$ . For simplicity, we refer to all managers other than the CEO as “middle management”. In actual firms, below the CEO is a layer of upper management with responsibilities distinct from those of middle managers (Schlesinger and Oshry 1984).

We assume that firms are large enough that the difference between  $L_0$  and  $L_0 - 1$  can be neglected and the CEO’s salary is a negligible fraction of the total wage bill of the firm (a reasonable threshold might be  $L_0 \geq 50$ ). Even for a large firm, the number of layers is typically not large: with a base employment of 5,000 and a span of control of 9, the number of layers is  $N = 4$ . Because the number of layers is a relatively small integer, we cannot use a continuous approximation. We do, however, allow  $m$  to be a fractional value, because it is an average. We write



$$L_0 = m^N, \quad \text{so} \quad m = L_0^{1/N}. \quad (3)$$

*The labor force and the wage bill*

As can be seen by examining Figure 1, the total number of managers and production workers  $L$  can be calculated from the following sum, which includes the  $L_0$  production workers, their supervisors, the supervisors of those supervisors and so on, to the CEO:

$$L = L_0 + \frac{L_0}{m} + \frac{L_0}{m^2} + \cdots + \frac{L_0}{m^{N-1}} + 1. \quad (4)$$

The sum can be evaluated explicitly. Discarding a small term, the total number of workers and managers in the firm is given by

$$L = \frac{m}{m-1} L_0. \quad (5)$$

From this it is possible to show that the management-production worker employment ratio is equal to  $1/(m-1)$ . If  $m$  takes a median value of 6, then the management-production worker ratio is 0.20. This is close to the value of 0.17 for the ratio of managers to blue-collar workers in US manufacturing in 1987, estimated using figures from Berman et al. (1994, table I).

FIGURE 1 NEAR HERE

Next, we assume that at each step in the hierarchy, the manager's salary is equal to  $v$  times the wage or salary of his or her direct reports. All salaries are relative to the wage  $w_0$  paid to production workers, which we refer to as the "base" wage. Both  $w_0$  and  $v$  are subject to bargaining and norms, as well as market forces. The production workers' wage bill  $W_0$  is then the product of the base wage and the number of production workers. The total wage bill is given by

$$W = W_0 + W_0 \left(\frac{v}{m}\right) + W_0 \left(\frac{v}{m}\right)^2 + \cdots + W_0 \left(\frac{v}{m}\right)^{N-1} + W_0 v^N. \quad (6)$$

The first term is the wage bill for production workers  $W_0 = w_0 L_0$ , while the last term is equal to the CEO's salary  $W_{\text{CEO}}$  (excluding equity-based compensation). The other terms are the salaries of middle managers. Assuming that the CEO's salary is a negligible fraction of the total (although it is likely to be much higher than any individual production worker's wage), the total wage bill is given by

$$W = \frac{m}{m-v} W_0. \quad (7)$$

The ratio of the managers' wage bill,  $W - W_0$ , to the production workers' wage bill  $W_0$ , a parameter that appears in the models of Palley (2005; 2012) and Lavoie (2009), is given by

$$\gamma = \frac{W - W_0}{W_0} = \frac{v}{m-v}. \quad (8)$$

Note that with the approximations we have made, this ratio depends on management structure, but not on the size of the firm.

Step increases in pay,  $v$ , are not often cited outside of industry surveys. Newbould and Sparkes (1980) provide a rare example. In their Table 3, in the US in 1969 and 1975,  $v$  was about 1.3. Main et al. (1993, Table 2) report average increases in pay when a VP is promoted to CEO in the period 1980-1984 of between 11% and 37%, but they note that this is a raise from the top levels of the VP range, so it is an underestimate of the step increase of the average VP pay to that of CEO. Assuming  $v = 1.3$  and  $m = 6$ ,  $\gamma$  is equal to 0.28.

#### *CEO compensation and firm size*

We next find an expression for  $v$  that relates it to a statistic that has been the topic of some research, the elasticity of CEO pay with firm size. First, we write the CEO's salary explicitly, as

$$W_{\text{CEO}} = w_0 v^N. \quad (9)$$

From equation (3) it then possible to show that

$$W_{\text{CEO}} = w_0 L_0^\alpha, \quad \text{where } \alpha = \frac{\ln v}{\ln m}, v = m^\alpha. \quad (10)$$

The CEO's salary is thus positively related to the size of the firm, as measured by the number of production workers  $L_0$ . As noted earlier, this is a stylized fact about CEO pay, and it emerges naturally in this model. To compare with estimates in the literature, we note that workers' wages increase with firm and plant size (Oi and Idson 1999); Doms et al. (1997) find an elasticity of about 0.04 for production worker wage with respect to plant employment, after correcting for technology, while Oi and Idson (1999) report an overall value of 0.06. The value of  $\alpha$  can be estimated, from equation (10), to be 0.15 when  $m = 6$  and  $v = 1.3$ . As we do not separate the effects of technology, we add 0.06 to this figure to get an estimate of 0.21 for the elasticity of the CEO wage with respect to firm size. This is at the low end of

the range of empirical estimates, which rarely fall below 0.20 or rise above 0.40, with a typical value of around 0.25 (Kostiuk 1990; Murphy 1999 Table 1).

#### 4. Distributional conflicts within the firm

Total value added  $Y$  is the sum of profits, wages and salaries. In this paper we do not explicitly distinguish different profit flows, such as retained profits, dividends, debt payments and executive compensation, but do mention them where relevant. Also, we exclude wages and salaries paid to non-managerial non-production staff. As noted by Galbraith (2007), this category of employee plays a decisive role in the modern mature firm. Also, it is not a small fraction of the labor force: from Berman et al. (1994, table I), managers were only about 30% of white-collar staff in US manufacturing firms in 1987. However, as this component of the labor force changes independently of managerial staff, it would add complexity to the present discussion without adding clarity.

We therefore focus on the distribution of income to the firm between profits and wages of production workers and managers:

$$Y = \Pi + W = \Pi + \frac{m}{m-v} W_0. \quad (11)$$

Dividing through by  $Y$  gives a distributional constraint,

$$\omega_0 = \left(1 - \frac{v}{m}\right)(1 - \pi). \quad (12)$$

The conventional distributional conflict is between the share of income going to the workers producing goods and services,  $\omega_0$ , and profits  $\pi$  (properly, the profit rate  $r = \pi\kappa$ ). Equation (12) expands the set of options by including parameters that affect middle management. If the production workers' wage is resistant to change – for example, in the upswing of a business cycle or through effective collective bargaining – then pressures to raise profits shift the distributional struggle to one between the CEO and middle management. Because neither wants a reduction in the step increase in salary, the conflict is resolved through negotiation over the span of control.

##### *Conflicts over income*

The goals of different actors within the firm as reflected in model parameters are shown in Table 1. Every employee of the firm would like to maintain his or her relative income, or see it rise. For production workers, income is controlled by the nominal wage  $w_0$ , while for managers it is controlled by the base

wage  $w_0$ , the step increase in salary  $v$  and (if they receive equity-based compensation) the profit share  $\pi$ . We assume that managers make a relative comparison, so although the base wage  $w_0$  does affect their income, they focus their negotiations on  $v$ , and  $\pi$  if it is relevant. Workers compare their wage to those in similar occupations. This translates roughly into a comparison of their wage to their labor productivity, so they focus on  $\omega_0$ .

Board members wish to raise firm profits, both to meet their fiduciary duty and to convince investors and peers that they are effective. There is also a desire to maintain the autonomy of the firm, which unites the “technostructure” in seeking to maximize retained profits and therefore minimize dividends and wages (Galbraith 2007). However, in a fundamentally uncertain world, companies must pay dividends if they are to attract investors, whether because a “bird in the hand” is valuable (Findlay and Williams 2000, p.192; Baker and Weigand 2015, p.134) or because the past stream of dividends is the main source of information on future investment income (Gordon 1989, p.24). Whatever the reasons for paying them out a “stylized fact” of corporate dividend policy is that although dividends as a share of profits have fallen in recent decades they remain large in absolute terms and are important to investors, analysts and firms (Baker and Weigand 2015, p.138).

Absent equity-based compensation, there is direct competition between production workers and management, and between management and shareholders (as represented by the board). The balance can be shifted, and conflict managed, to some degree. Equity-based compensation, in sufficient quantities, aligns the interests of management with those of shareholders, as argued by Jensen and Murphy (1990), while class-based antagonism between production workers and middle management can be moderated by recruiting some production workers into the managerial hierarchy.

TABLE 1 NEAR HERE

#### *Conflicts over span of control*

Both production workers and middle management would prefer to have a smaller span of control, although not so small that they cannot perceive their role in the organization or they feel burdened by demands from different layers of management. For both, a smaller span of control (implying more layers in the hierarchy) offers better chances of advancement, while for those in management it reduces their stress. The CEO wants to increase visibility and efficiency of operations; as noted by Simon (1946), recommendations to CEOs to increase visibility are in conflict with equally well-meaning recommendations for a low span of control, so this brings the CEO into conflict with middle management

and production workers. Depending on its composition, the board may be more or less closely aligned with management. If it is primarily motivated both by its legal fiduciary duty and the perception of investors and peers about its performance, it may advocate a lean structure – and a high span of control – if its members perceive that to be a more effective and responsible way to organize the firm.

## 5. Organizational structure and distribution

The ratio of the managerial wage bill to that of production workers,  $\gamma$ , is a measure of income distribution within the firm that depends on the span of control  $m$  and step increase in salary  $v$ , as shown in equation (8). A measure of individual income inequality within the firm, as opposed to aggregate distribution between groups, is the Theil index (Theil 1972; Conceição and Galbraith 2000). Under the assumption that  $L_0 \geq 50$ , we can discard some small size-dependent terms to find that the Theil distribution for the firm is given by

$$T \cong \ln\left(\frac{m-v}{m-1}\right) + \frac{v}{m-v} \ln v. \quad (13)$$

Like  $\gamma$ , this expression depends only on the management structure, and not the size of the firm, for sufficiently large firms.

Both  $\gamma$  and the Theil index are shown in Figure 2. As seen in the figure, an increase in span of control  $m$ , as happened from the 1980s onward, leads to both a falling  $\gamma$  and a falling Theil index if  $v$  remains the same. As the  $\gamma$ -contours are relatively steep, the step increase in salary,  $v$ , would have to rise considerably if  $\gamma$  is to remain constant or increase, suggesting that a falling  $\gamma$  is the most likely outcome. Indeed, a rise in  $m$  has to lead to a falling  $\gamma$  if it is to contribute to redistribution away from wages and salaries toward profits. This can be seen by first expressing equation (12) in terms of  $\gamma$  and then solving for the profit share. This gives

$$\pi = 1 - (1 + \gamma)\omega_0. \quad (14)$$

For  $\pi$  to increase without unduly antagonizing either managers or production workers, both  $\omega_0$  and  $\gamma$  must decline. As discussed earlier, the apparent discrepancy between trends in wage and salary distribution and trends in the distribution of total income is explained because some of the expanded profits were diverted towards management; that is, equity-based compensation increased. Moreover, as the Theil-contours in Figure 2 are less steep than the  $\gamma$ -contours, wage inequality as measured by the Theil index can rise even if  $\gamma$  begins to fall.

The Theil index is decomposable, in that an aggregate index can be expressed as a sum of the weighted average of the index for subgroups (the “within” component) and the index computed using group average incomes (the “between” component). At national level, the Theil index for the manufacturing sector could be expressed as

$$T_{\text{manuf}} = \underbrace{T_{\text{sector}}}_{\text{between-sector}} + \underbrace{T_{\text{size}}}_{\text{between-size class}} + \underbrace{T_{\text{firm}}}_{\text{within-firm}} . \quad (15)$$

The expression given in equation (13) is the within-firm contribution. We now discuss the other components.

For the between-size class index, recall that the base wage increases with the size of the firm with an elasticity of about 0.06. Because the distribution can be taken to be independent of the size of the firm when  $L_0$  is greater than around 50, the average income also grows with this elasticity. Under the assumption that firm growth is independent of size, Simon and Bonini (1958) showed that the rank-size distribution should, in the tail, follow a Pareto distribution, and successfully tested the model against the data available to them. More recent empirical tests support the theory for firms in Europe (Fujiwara et al. 2004) and the US (Axtell 2001), with a Pareto exponent very close one (that is, the distribution follows Zipf’s law). Combining the size distribution with the wage dependence on size, it is possible to show that

$$T_{\text{size}} = \ln(1 - \beta) + \frac{\beta}{1 - \beta} \approx \frac{1}{2} \beta^2 . \quad (16)$$

The approximation holds if  $\beta$  is much less than one. For  $\beta = 0.06$ ,  $T_{\text{size}} = 0.002$ . Comparing to the values in Figure 2, this is smaller by an order of magnitude than the within-firm Theil index. For example, at  $m = 6$ ,  $v = 1.3$ ,  $T_{\text{firm}} = 0.011$ .

FIGURE 2 NEAR HERE

Between-sector Theil indices for manufacturing at the 3-digit ISIC level are collected in the UTIP-UNIDO database (Galbraith and Kum 2003). Figure 3 shows that manufacturing pay inequality has risen very little, and even fallen in the US, UK and Australia since the waves of downsizing commenced in those countries. As seen in the figure, the magnitude of the between-sector component of the Theil index is larger than, but of the same order of magnitude as, that for the within-firm component.

FIGURE 3 NEAR HERE

From the model developed in this paper, between-sector inequality can be due either to differences in the base wage or differences in firm structure. To better understand the potential size of the two contributions, we calculate the mean wage in each sector by dividing the total wage bill from equation (7) by total labor from equation (5),

$$\bar{w} = \frac{W}{L} = w_0 \frac{m-1}{m-\nu}. \quad (17)$$

This shows that the mean wage is given by the product of the base wage and a structural factor. Using data for the US from the US National Bureau of Economic Research (Becker et al. 2013), the base wage (production wage divided by production employment) across 4-digit ISIC categories in 2000 had a coefficient of variation (unweighted) of 0.27, whereas the coefficient of variation of the ratio of the average wage to the base wage, a proxy for the structural factor in equation (17), was 0.09. In 1970, the corresponding values were 0.21 and 0.06. This suggests that the variation of the base wage is more important than structural factors in explaining wage inequality between sectors.

In summary, these results suggest that wage inequality in the manufacturing sector is dominated by between-sector differences in the base wage and within-firm inequality as determined by structural factors.

## 6. Discussion

The model introduced in this paper expresses the ratio of managerial to production worker staffing and wage bill in terms of more fundamental parameters. The key parameter, which is widely discussed in the management literature, is the span of control. This parameter determines the staffing ratio, while a further variable, the step increase in pay between levels, determines the wage distribution. Both parameters also determine the value of the within-firm Theil index for the wage distribution in the model. As the Theil index is decomposable, this can be combined with data on between-sector wage inequality in the UTIP-UNIDO data set (Galbraith and Kum 2005) to estimate overall wage inequality. When the span of control rises, unless the step increase of pay rises quite sharply, the managerial wage bill is expected to fall relative to that of production workers. This decline then allows for an increasing profit share, some of which can be diverted toward managers in the form of equity-based compensation.

Determining distribution from organizational structure allows for a more cogent discussion of possible future trends. Business style can change, and there could in future be a return to less flat organizations. Managers are under stress, and while they are willing to work under these conditions, if

capital productivity were to rise for a sufficiently long time, firms might experiment with reducing the span of control. Also, outrage over extremely high CEO salaries and the mixed performance of equity-based incentives might lead to a shift away from equity-based pay. This combination of factors could lead to falling inequality in total incomes, but increasing wage inequality within firms. More broadly, sociological theories, such as that of Tilly (Tilly 1998; 2000; Voss 2010) could be used to explain longer-term changes in inequality within organizations (e.g., see Tomaskovic-Devey et al. 2009).

The model presented in this paper focused only on the link between structure and distribution, with no dynamics. It would be interesting to link it to a dynamic model. For example, an insight provided by the model is that changes in the span of control affect both employment and wage structure. This suggests a possible reformulation of the model developed by Palley (2015), who introduces an exogenous and fixed middle manager-to-worker employment ratio and an endogenous split between middle manager and worker wages. In the present model these dynamics can be represented by an exogenous span of control  $m$  and an endogenous change in step increase in pay  $v$ . Because it is difficult to renegotiate salaries, while responsibilities are more fluid, an alternative construction would be an endogenous  $m$  and an exogenous  $v$ , leading to fluctuations in both the size and compensation of management. A short-term dynamic model could use the model of Galbraith (1998) and Galbraith and Berner (2001) of the counter-cyclical movement of pay inequality over the business cycle.

As a final comment, we reiterate a point made in the body of the text, that nonsupervisory nonproduction staff are an important group. It constitutes a large proportion of manufacturing employment, and its size can change in a different direction to that of managers or production workers. According to Galbraith (2007), the goals of this group are, essentially, the goals of modern industry and, on a larger stage, the “planning system” composed of industry and the state. The degree of influence may have changed in recent years with the rise of equity-based compensation, but it remains significant. Further work on income distribution within firms should include a discussion of this important group of workers.

## **7. Conclusion**

The distribution of wages and salaries within firms depends on organizational structure, while structure depends only partly on technology. A key variable is the manager’s “span of control”, or number of direct reports. The ratio of the managerial wage bill to that of production workers is determined, for large enough companies, by the span of control and the step increase in pay between levels in the managerial hierarchy, and the same two variables also determine the Theil index of wage inequality within the firm.



It is found that the contribution of within-firm inequality to the Theil index is of the same order of magnitude as the between-sector component.

The model in this paper provides a way to interpret major changes in firm structure from the mid-1980s as resolutions to distributional conflict stimulated by a fall in capital productivity that began in the late 1960s. It also explains one of the best-established stylized facts of executive compensation, the positive relationship between firm size and CEO pay, without resorting to marginalist arguments.

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Table 1: Goals of different actors for distributional parameters within the firm

Actor	Income			Structure		
	Motivation	$\omega_0$	$v$	$\pi$	Motivation	$m$
Prod. workers	Income	high			Advancement	low
Middle mgmt	Income		high	(high) <sup>a</sup>	Manageable stress Advancement	low
Upper mgmt/ CEO	Income Performance		high	(high) <sup>a</sup>	Visibility Efficiency	high
Board	Fiduciary duty Performance			high	Fiduciary duty Performance	(high) <sup>b</sup>

<sup>a</sup>If middle management receives some equity-based compensation

<sup>b</sup>If the board believes lean operations are more effective and responsible

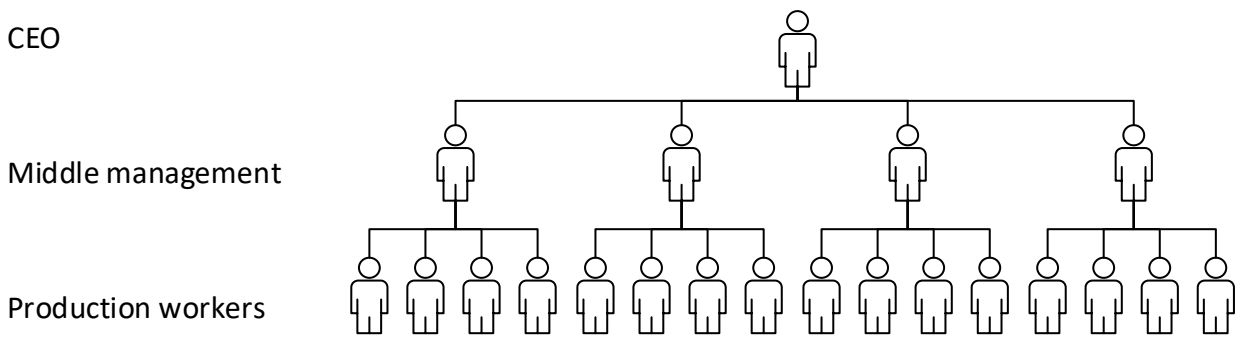


Figure 1: Management hierarchy in the model for  $N = 2$ ,  $m = 4$ , and  $L_0 = 16$ .



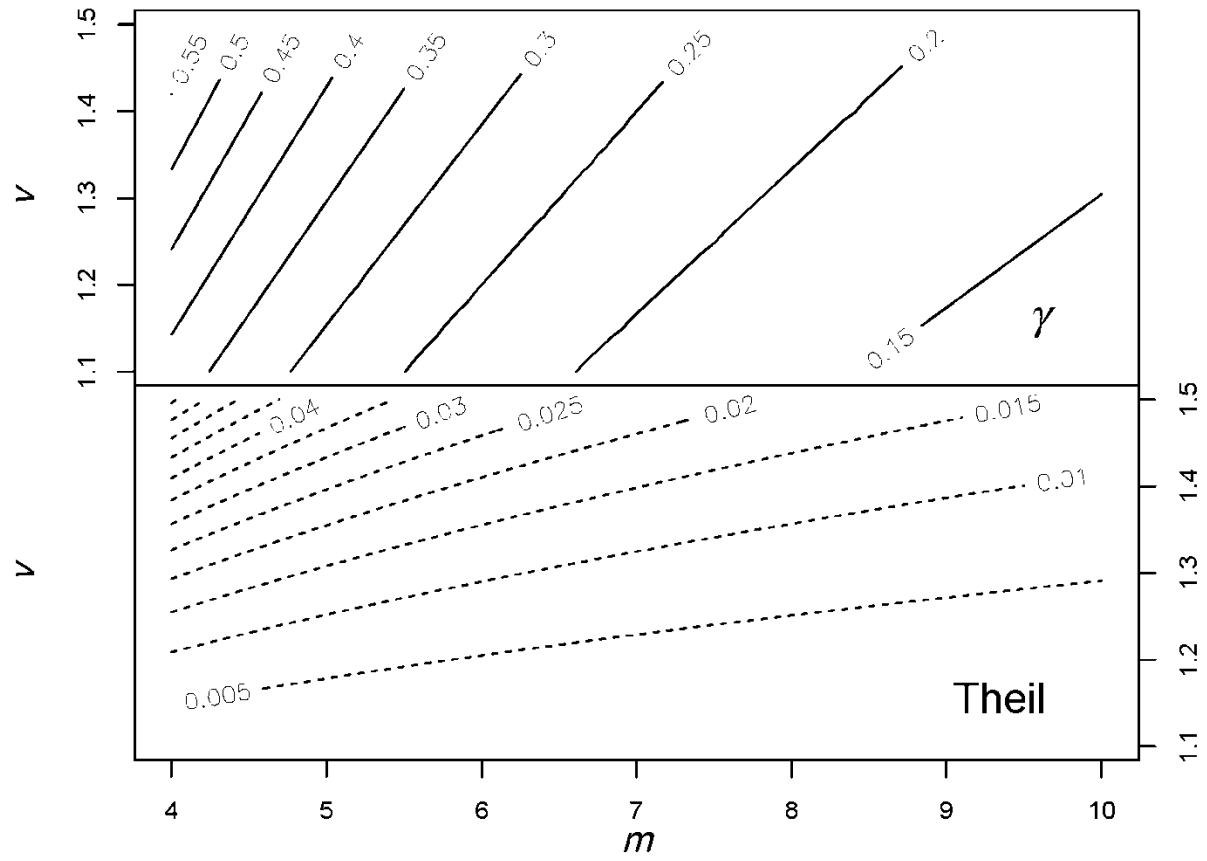


Figure 2: Within-firm wage bill ratio  $\gamma$  and the Theil index as functions of span of control  $m$  and step increase in income  $v$

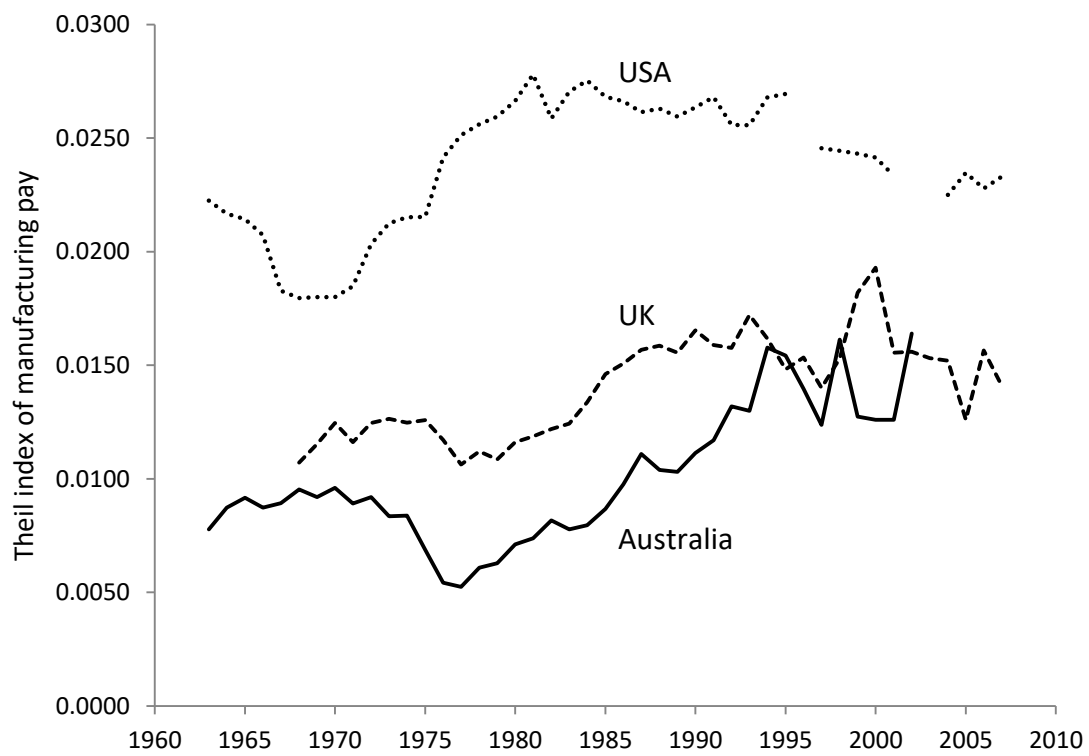


Figure 3: Inequality in manufacturing pay