## *Personal Income and Hierarchical Power*

*Blair Fix*

**Abstract**: This article examines the relation between personal income and hierarchical power. In the context of a firm hierarchy, I define hierarchical power as the number of subordinates under an individual's control. Using the available case-study evidence, I find that relative income within firms scales strongly with hierarchical power. I also find that hierarchical power affects income more strongly than any other factor for which data is available. I conclude that this is preliminary evidence for a hierarchical-power theory of personal income distribution.

**Keywords**: personal income, firm hierarchy, social power

**JEL Classification Codes:** D31, B5

What explains personal income? This article tests the hypothesis that income is most strongly explained by hierarchical power. My approach represents a twist on the longstanding institutionalist view that income stems from power. The primary theoretical contribution of this article is to restrict the study of power to that found in a hierarchy, and to offer a specific way of measuring this power. I define hierarchical power as the ability to influence subordinates within a hierarchical chain of command. I propose that this power can be measured in terms of the number of subordinates under an individual's control

Using this definition, I conduct the first investigation of how hierarchical power (within firms) affects individual income. To be clear, this type of investigation is in its infancy and relies on a relatively small sample of data. However, the evidence that does exist is unambiguous. I find that relative income within case-study firms scales strongly with hierarchical power. Furthermore, I find that grouping individuals by hierarchical rank (across society) affects income more strongly than any other factor tested here. I argue that this is preliminary evidence for a hierarchical power theory of personal income distribution.

The article is organized as follows. I first outline the motivations behind my proposed hierarchical power-income hypothesis. I then look for a correlation between hierarchical

power and relative income within case-study firms. Lastly, I investigate the strength of the hierarchical power-income effect (at the societal level) using a variation of the analysis of variance method. All methods and sources are documented in the Appendix.[1] I conclude with thoughts on the significance of the hierarchical power-income relation, and I discuss avenues for future research.

## Hierarchical Power and Income

I hypothesize that personal income can be explained most strongly by differentials in hierarchical power. Before diving into the specifics of this hypothesis, I want to provide a rationale based on the big picture of human history. I begin by asking a simple question: what aspects of human history suggest that hierarchical power might affect how humans distribute resources?

Let's begin with our deep history—the evolutionary backdrop of the human species. Humans are but one of a wide variety of social mammals, virtually all of which form dominance hierarchies, or "pecking orders" (Barroso, Alados, and Boza 2000; Guhl, Collias, and Allee 1945; Kondo and Hurnik 1990; Meese and Ewbank 1973; Sapolsky 2005; Uhrich 1938). A key characteristic of these dominance hierarchies is that high social rank is associated with preferential access to resources, particularly sexual mates (Bradley et al. 2005; Haley, Deutsch, and Le Boeuf 1994; Girman et al. 1997; Gerloff et al. 1999; Wroblewski et al. 2009).

Of course, human behavior is far more complex than even the most intelligent non-human primates. Just because we evolved from hierarchy-forming animals does not necessarily mean that hierarchical rank still plays a role in how we divide up the pie. However, there is good evidence that humans do have an instinctual behavior towards hierarchy formation. Several studies have shown that children and adolescents spontaneously form dominance hierarchies when placed into small groups (Frankel and Arbel 1980; Savin-Williams 1980; Strayer and Trudel 1984). Other studies have shown that, like other social mammals, human reproductive success increases with social status (Hopcroft 2006; Betzig 2012). There is even evidence that social status at birth is epigenetically imprinted on human DNA (Borghol et al. 2012)—something that also occurs in Rhesus monkeys (Massart et al. 2017). Given our evolutionary heritage, it seems plausible that hierarchy plays a role in the way humans distribute resources.

Another reason to suspect that resource distribution has to do with hierarchy and power is the ubiquity of inherited status in human history. It is hard to justify the wealth of a hereditary aristocracy as stemming from anything but power and privilege. Interestingly, inherited status has surprisingly deep historical roots. There is tentative archaeological evidence for inherited status beginning in the Neolithic era (Boric 1996; Halstead 1993; Van der Velde 1990), and widespread evidence beginning in the bronze age around 5000 years ago (Aranda and Molina 2006; Aranda-Jimenez, Monton-Subias and Jimenez-Brobeil 2009; Graziadio 1991; Kristiansen 2000; Harding 2000). It is around this time that the first Egyptian dynasty formed (Dee et al. 2013), followed later by dynasties in Mesopotamia (Reade 2001) and China (Guo et al. 2000).

---

[1]    All appendices mentioned throughout this article are available as supplemental data online as found on the title page of the article.

Since then, as Gaetano Mosca observes, the existence of a hereditary ruling class has been the norm:

> There is practically no country of longstanding civilization that has not had a hereditary aristocracy at one period or another in its history. We find hereditary nobilities during certain periods in China and ancient Egypt, in India, in Greece before the wars with the Medes, in ancient Rome, among the Slavs, among the Latins and Germans of the Middle Ages, in Mexico at the time of the Discovery and in Japan down to a few years ago. (Mosca 1939)

But while history may be sordid, there is always the possibility that modern societies have made a clean break with the past. Power may have played a central role in the distribution of resources in past societies, but in modern societies reciprocal exchange is what matters most. This is the story that emerged in the writings of Adam Smith (1776) and was codified into neoclassical theory by William Stanley Jevons (1879), Carl Menger (1871), and Leon Walras (1896). To paraphrase George Orwell (1972), this is now the prevailing orthodoxy that most right-thinking economists accept without question.

But what if there has not been a clean break with the past? What if power still plays an important role in shaping resource distribution? A wide variety of scholars have argued that this is the case. A non-exhaustive list would include Adolph Berle and Gardiner Means (1932), Clair Brown (1988), John Commons (1924), William Dugger (1989), John Galbraith (1985), Evelyne Huber, Jingjing Huo and John Stephens (2017), Gerhard Lenski (1966), C. Wright Mills (1956), John Munkirs (1985), Jonathan Nitzan and Shimshon Bichler (2009), James Peach (1987), Jim Sidanius and Felicia Pratto (2001), Marc Tool and Warren Samuels (1989), Marc Tool (2017), Thorstein Veblen (1904, 1923), Max Weber (1978), and Erik Wright (1979). These scholars argue that power plays a central role in shaping income distribution.

If there is to be a power-based theory of income distribution, what should it look like? According to Christopher Brown:

> [A] theory of distribution should be indistinguishable from a theory of power. A satisfactory theory of power would, beyond defining what power is, elucidate principles to explain how power is established, enlarged or diminished, protected and perpetuated, redistributed, exercised, and rendered legitimate or illegitimate. (Brown 2005)

A full-fledged theory of power is a tall order. In this article, I narrow the focus to look only at hierarchical power and its relation to personal income. My ideas stem from the work of Herbert Simon (1957) and Harold Lydall (1959), who independently proposed income distribution models based on the hierarchical structure of firms.

The focus of Simon and Lydall's work is the branching nature of firm hierarchies, in which each superior controls multiple subordinates. This structure is unique to humans. All other animals form linear hierarchies—an ordinal ranking from top to bottom. The most important feature of a branching hierarchy is that it concentrates power in the hands of the few. I propose that differentials in hierarchical power can be used to explain differentials in income. The main theoretical contribution of this article is to offer a quantifiable definition

of hierarchical power that allows power differentials to be directly compared to income differentials.

## Measuring Hierarchical Power

What is hierarchical power? I define it as the ability to control subordinates within a hierarchical chain of command. This definition builds on the common Weberian definition of power, articulated by Reinhard Bendix (1998) as "the possibility of imposing one's will upon the behavior of other persons" (cited in Wallimann, Ch Tatsis, and Zito. 1977). Or put another way, Raymond Aron (1964) defines the Weberian concept of power as "the chance of obtaining the obedience of others to a particular command" (cited in Wallimann, Ch Tatsis and Zito 1977).

The link between hierarchy and power is implicit in the etymology of the word "hierarchy" itself, which derives from the Greek term hierarkhes, meaning "sacred ruler" (Verdier 2006). In essence, a hierarchy is a nested set of power relations between a superior (a ruler) and subordinates (the ruled). The hierarchical chain of command confers the right of each superior to direct the activity of all those in subordinate positions. I propose that one's power within a hierarchy is proportional to the number of subordinates under one's control. I put this in formula form as:
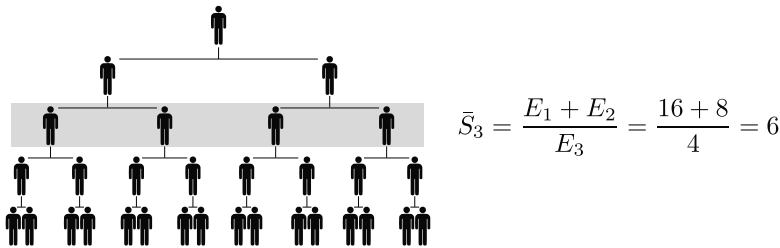
$$hierarchical\ power = number\ of\ subordinates + 1 \qquad (1)$$

The logic of this equation is that all individuals start at a baseline power of 1, indicating that they have control over themselves. Power then increases linearly with the number of subordinates.

If we had access to the exact chain of command structure of an institution, we could use this definition to measure the power of each individual within a hierarchy. Unfortunately, chain of command information is rarely available. Instead, existing case studies report *aggregate* hierarchical structure only–total employment by hierarchical level. While we cannot calculate the power of *specific* individuals, we can use this data to calculate the *average* power of all individuals in a specific hierarchical level:

$$\bar{P}_h = \bar{S}_h + 1 \qquad (2)$$

**Figure 1. Calculating the Average Number of Subordinates**



$$\bar{S}_3 = \frac{E_1 + E_2}{E_3} = \frac{16 + 8}{4} = 6$$

Here $\bar{P}_h$ is the average power of individuals in hierarchical level $h$, and $\bar{S}_h$ is the average number of subordinates below these individuals. The average number of subordinates $\bar{S}_h$ is equal to the sum of employment ($E$) in all subordinate levels, divided by employment in the level in question. Figure 1 shows a sample calculation of the average number of

subordinates below individuals in the third hierarchical level. Each shaded individual has 2 direct subordinates, and 4 indirect subordinates, for a total of 6 subordinates. The average hierarchical power of individuals in level 3 is therefore 7.

Using summation notation, we can write the following general equation for the average number of subordinates in hierarchical level $h$ (here $h = 1$ is the bottom hierarchical level):

$$\bar{S}_h = \sum_{i=1}^{h-1} \frac{E_i}{E_h} \tag{3}$$

Together, equations 2 and 3 allow us to define and measure the average power of individuals in a hierarchy.

*Two Hypotheses*

I propose that hierarchical power is a strong determinant of income. To refine this hypothesis, I break it down into two parts:

**Hypothesis A**: Relative income within a hierarchy is proportional to hierarchical power.

**Hypothesis B**: Hierarchical power affects income more strongly than any other factor for which data is available.

The reasoning behind this two-part hypothesis has mostly to do with the format of the available data. In principle, we could look at the proportionality between income and hierarchical power and test the strength of this effect all in one go. We would simply measure the correlation between individual income and hierarchical power and compare the strength of this correlation to the correlation between other income-affecting factors. Unfortunately, few studies of firm hierarchy report individual level data. Those that do report this data do not report a wide range of other income-affecting factors against which to test the strength of the power-income effect.

The two-part hypothesis offers a way to deal with these data constraints by separating the measure of correlation between income and hierarchical power, and the measure of the strength of this effect. In the proceeding section, I use the available firm case-study evidence to investigate the correlation between relative income and hierarchical power. I then use a variant of the analysis of variance method to estimate the strength of the relation between hierarchical power and income.

### Correlation Between Hierarchical Power and Relative Income Within Firms

Hypothesis A proposes that relative income within a hierarchy is proportional to hierarchical power. To test this hypothesis, I use the available firm case-study evidence to look for a correlation between hierarchical power and relative income within firms. I first look for a *static* correlation, followed by an analysis of the *dynamic* correlation between changes in income and changes in hierarchical power.
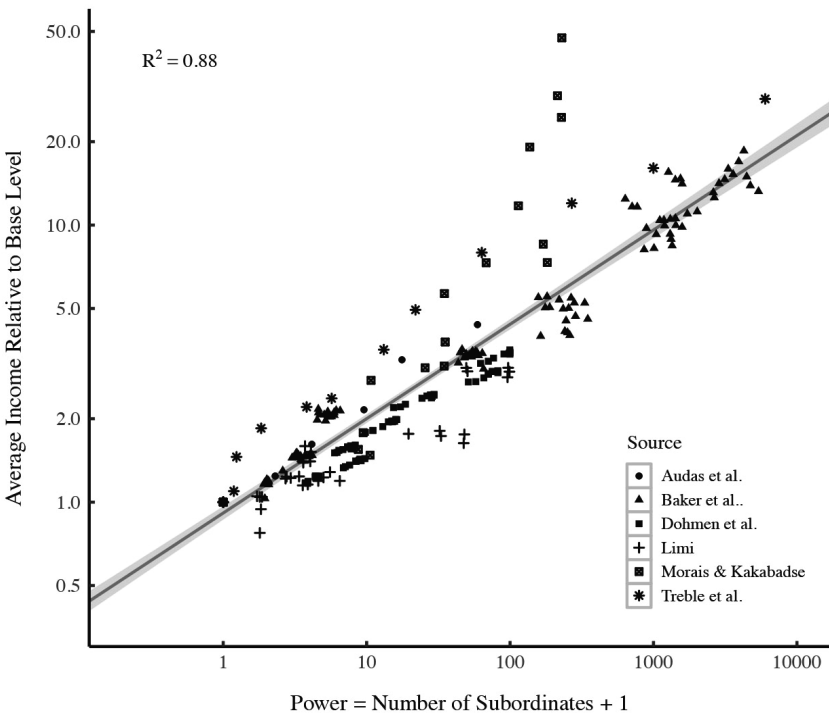
*Static Power-Income Correlation*

To look for a static correlation between income and hierarchical power, I use six case studies that cover firms in the United Kingdom, the United States, the Netherlands,

and Portugal. (For a detailed discussion of these studies, see Appendix B). There are two important caveats to this analysis. First, the sample size is small. Having scoured the academic literature, these six studies are the only ones that I have found with the appropriate data. This paucity of data is partly due to the proprietary nature of firm payrolls. But more importantly, mainstream (neoclassical) economics has tended to ignore power, so there has been little academic incentive to study firm hierarchy. A second caveat to my analysis is that the case-study firms are all relatively large. This is not a methodological choice; instead, all of the available case studies have focused on large firms. The public sector is also excluded from analysis and left as a topic for future research.
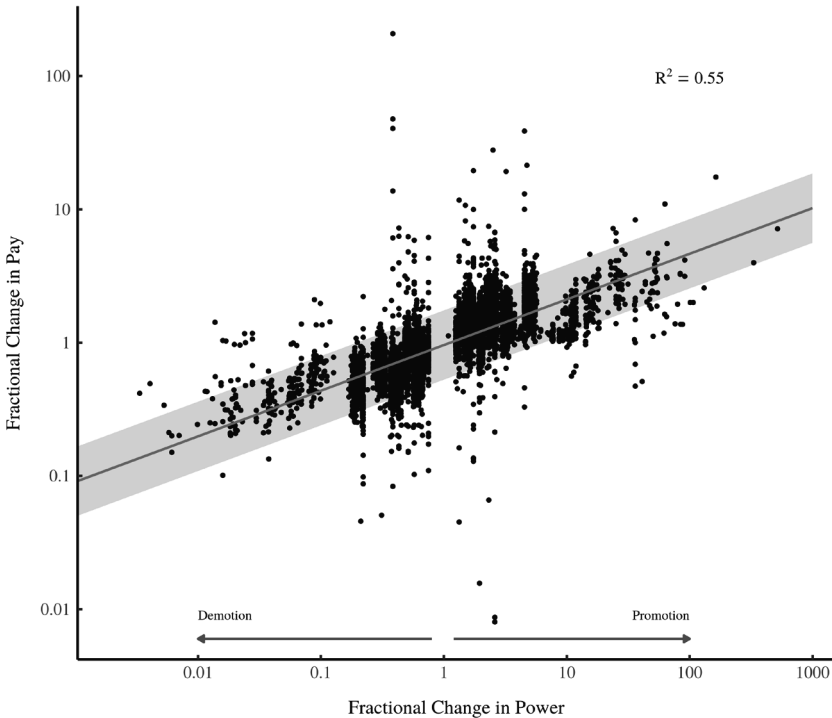
Figure 2 shows the correlation between relative income and hierarchical power within the six case-study firms. Each point represents a single firm-year observation, with the different case-study firms indicated by shape. Note that this figure plots *average* income (by hierarchical level) against *average* hierarchical power (by hierarchical level). In order to make comparisons across firms (and across time), I normalize incomes so that the mean income

**Figure 2. Average Income vs. Average Hierarchical Power in Case-Study Firms**



This figure plots average income against average hierarchical power for six case-study firms (Audas, Barmby, and Treble 2004; Baker, Gibbs, and Holmstrom 1993; Dohmen, Kriechel, and Pfann 2004; Lima 2000; Morais and Kakabadse 2014; Treble et al. 2001). Average income is normalized to equal one in the base hierarchical level. Average hierarchical power is calculated using Equations 2 and 3. Each point represents a single firm-year observation, and shape indicates the particular case study. The line indicates a log-log regression, while the grey region indicates the 95% confidence interval.

**Figure 3. Changes in Hierarchical Power and Pay During Intra-Firm Promotions**



This figure plots the fractional change in pay (Equation 5) versus the fractional change in hierarchical power (Equation 4) for individual promotions/demotions in the Baker, Gibbs, and Holmstrom (BGH) dataset (Baker, Gibbs, and Holmstrom 1993). Each point represents the resulting change in pay and power of a single individual. Over 16,000 promotion/demotion events are plotted here. The grey region indicates the 95% prediction interval of a log-log regression. The BGH data comes from an anonymous United States firm over the period 1969–1985. The dataset is available at http://faculty.chicagobooth.edu/michael.gibbs/research/index.html

in the bottom hierarchical level of each firm is equal to one. Although the firm sample is small, the evidence is unambiguous: there is a strong correlation between relative income and hierarchical power in these case-study firms.

*Dynamic Correlation*

I test for a dynamic correlation between changes in relative income and changes in hierarchical power using data published by George Baker, Michael Gibbs, and Bengt Holmstrom (1993)—the "BGH dataset." This dataset contains raw personnel data for a large U.S. firm over the years 1969–1985. Importantly, the BGH dataset tracks the income and hierarchical level of individuals over time. This allows the analysis of changes in income and hierarchical power when individuals are promoted or demoted. I define a promotion/demotion as a change in hierarchical level.

Since the chain of command is unknown, I begin by assigning all individuals the *average* hierarchical power ($\bar{P}$) of their respective hierarchical level. For each promotion/demotion

event, I then calculate the fractional change in an individual's hierarchical power ($\Delta \bar{P}$) as the following ratio:

$$\Delta \bar{P} = \frac{\bar{P}_{after}}{\bar{P}_{before}} \tag{4}$$

Here $\bar{P}_{after}$ is hierarchical power after the promotion and $\bar{P}_{before}$ is hierarchical power before the promotion. For each promotion/demotion event, I also calculate the fractional change in income ($\Delta I$):

$$\Delta I = \frac{I_{after} \Big/ \bar{I}_{after}}{I_{before} \Big/ \bar{I}_{before}} \tag{5}$$

Here $I_{after}$ is individual income after the promotion, and $I_{before}$ is individual income before the promotion. In order to isolate the effect of the promotion from the effects of inflation and/or general wage increases, I measure after-before incomes *relative* to the firm mean income in the appropriate year. Here $\bar{I}_{after}$ is firm mean income after the individual's promotion, while $\bar{I}_{before}$ is firm mean income before the individual's promotion.
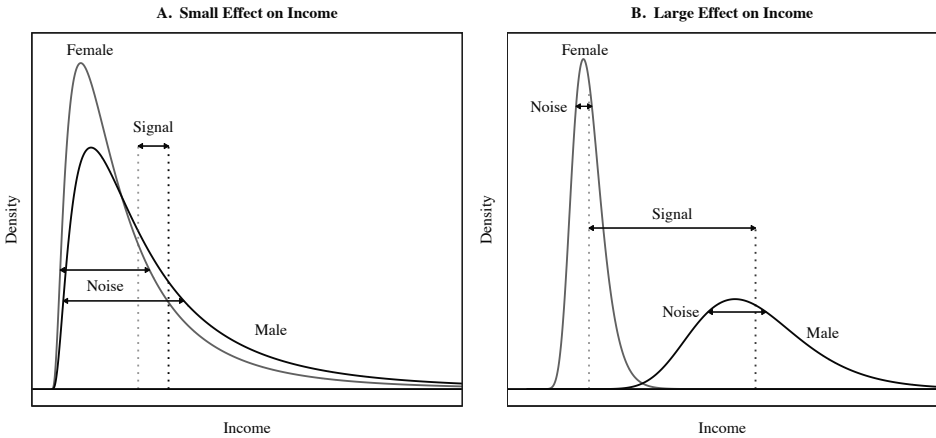
Figure 3 show the results of this dynamic analysis. Each point represents the fractional change in pay and hierarchical power for the promotion/demotion of a *single individual*. Over 16,000 promotions/demotion events are shown. Within the BGH data, a highly significant correlation exists between changes in hierarchical power and changes in individual income. Interestingly, the correlation holds both for promotions and for *demotions*, the latter occurring when an individual drops hierarchical levels. The relative pay reductions accompanying these demotions are difficult to understand from neoclassical marginal productivity perspective. Do these individuals suddenly experience a drastic reduction in ability/productivity? The evidence in Figure 3 suggests a better explanation: within the BGH firm, pay is largely a function of the power of a specific hierarchical *position*, irrespective of the person holding this position.

To summarize, the case-study evidence indicates that relative income within firms is both statically and dynamically correlated with hierarchical power. This evidence is consistent with the hypothesis that relative income within a hierarchy is proportional to hierarchical power.

### How Strongly Does Hierarchical Power Affect Income?

Having found a correlation between hierarchical power and income, the next step of the analysis is to measure the strength of this effect at the societal level. Hypothesis B proposes that hierarchical power affects income more strongly than any other factor for which data is available. To test Hypothesis B, we need to relate hierarchical power's effect on income to the effect-size of a variety of other factors. To do this, I use a signal-to-noise ratio similar to Cohen's $f^2$. As with the test of Hypothesis A, a caveat to this test of Hypothesis B is that the

**Figure 4. Visualizing Effect Size**



*This figure shows an example of how a two-group factor like a person's sex might affect income. Each panel shows a hypothetical income distribution of both males and females. We can judge the income effect size of being male vs. female by comparing the "signal" to the "noise." The signal is the income difference between group mean incomes (dotted lines), while the noise is the income dispersion within groups (visualized here as the standard deviation). The larger the signal is relative to the noise, the larger the effect on income. Individual's sex has a small effect on income in Panel A and a large effect in Panel B.*

available evidence on firm hierarchy is limited. Therefore, this analysis should be considered preliminary.

*Measuring Effect Size with A Signal-to-Noise Ratio*

I measure income effect size using a group-based signal-to-noise ratio. This method has two parts. First, we organize individuals into an income-affecting grouping (for instance, by individuals' sex). To measure the effect that this grouping has on income, we then calculate the signal-to-noise ratio by comparing dispersion in average income between groups to the average income dispersion within groups (Equation 6). The larger the signal-to-noise ratio, the larger the grouping's effect on income.

$$signal-to-noise\ ratio = \frac{between-group\ income\ dispersion}{average\ within-group\ income\ dispersion} \qquad (6)$$

Figure 4 shows an example of how a two-group factor like individuals' sex might affect income. Dispersion between groups is evident as the difference between mean incomes of each sex (dotted lines). Within-group dispersion is visible in terms of the average spread (width) of each sex's respective income distribution. Figure 4A shows a *small* effect on income—evident as a small difference between group means and large within-group dispersion. Conversely, Figure 4B shows a *large* effect on income—evident as a large difference between group means and small within-group dispersion. While the signal-to-noise ratio is most easily illustrated for a two-group factor, it can be generalized to an income-affecting factor with any number of groups.

Although there are many ways of measuring income effect size, an advantage of this group-based approach is that it is easily applicable to the qualitative variables that are well-known to effect income (such as "sex," "race," "occupation," "education," etc.). To compare

the income effect of two factors such as "sex" and "race," we compare the signal-to-noise ratio of grouping individuals by their sex to the signal-to-noise ratio of grouping individuals by their race. Another advantage of this group-based approach is that we do not need to have a single sample of individuals with an exhaustive list of their characteristics and income (like we would need for a multivariate regression analysis). Instead, we can use different datasets for each respective income-affecting factor, provided that each dataset is representative of the general population.[2]

In standard analysis of variance, the signal-to-noise ratio is called Cohen's $f^2$, and is calculated using variance as the measure of dispersion (Fleishman 1980; Steiger 2004). However, I do not use Cohen's $f^2$ to measure income effect size because variance is not commonly reported in income distribution statistics. Instead, statistical agencies typically report the Gini index of income dispersion within groups. Because of its ubiquity, I use the Gini index to calculate the signal-to-noise ratio:[3]

$$signal-to-noise\,ratio\,(Gini) = \frac{Gini\,index\,of\,group\,means}{average\,within-group\,Gini\,index} \qquad (7)$$

For a detailed discussion of this metric (and its relation to Cohen's $f^2$), see Appendix H.

*Grouping Individuals by Hierarchical Level*

In order to measure the income effect of hierarchical power using the signal-to-noise ratio, we must group individuals into different classes of hierarchical power. My method is to group individuals by *hierarchical level* across all firms, as illustrated in Figure 5. This method is theoretically attractive because hierarchical level is the principle determinant of hierarchical power. If a firm has a constant "span of control" (the number of subordinates controlled by each superior) then hierarchical power will increase *exponentially* with hierarchical level). This grouping method is also empirically convenient because the available data on firm hierarchies is limited, and the most commonly reported statistic is the distribution of income by hierarchical level.

---

[2] Readers trained in econometrics will observe that my method for measuring effect-size does not *isolate* the income-effects of a given factor. It does not show that, when *all* other factors are held constant, a change in factor A by amount *x* affects income by amount *y*. I make no attempt to do this because I think it is the wrong approach. As John Maynard Keynes (1939) long ago argued, the only conceivable way that an econometric model can *isolate* an effect is if the model includes a *complete* list of causal factors. But since we can never be sure that our causal list is complete, we can never know if our econometric model is wrong (Nitzan 1992). My thinking is more pragmatic. Given the complexities of human behavior, we can likely never isolate a factor to find its "true" effect on income. But we can *rank* effect-size with the full understanding that when we measure one factor's effect on income, enumerable other factors are included in this measurement. In the face of enumerable confounding variables, Occam's razor would suggest that we simply chose the factor with the largest effect on income and use it to build a theory of income distribution.

[3] A well-known shortcoming of the Gini index is that it has a downward bias for small sample sizes. If the sample size is n, the maximum possible Gini index is:
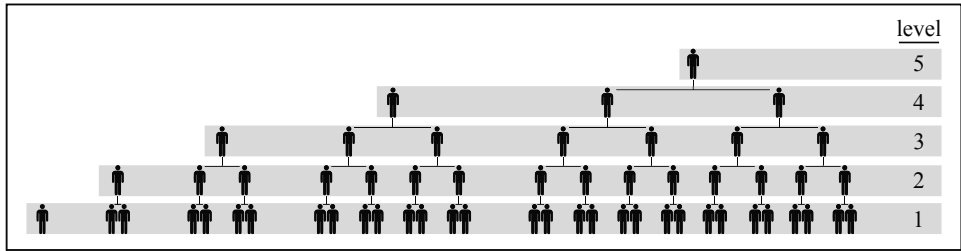
$$G_n^{\max} = \frac{n-1}{n} \qquad (8)$$

Thus, a sample size of n = 2 has a maximum Gini index of $G_2^{\max}$ = 0.5. To correct for this bias, I use the method proposed by George Deltas (2003). The bias-adjusted Gini index ($G^{adj}$) is defined by dividing the unadjusted Gini (G) by the maximum possible Gini ( $G_n^{\max}$ ):

$$G^{adj} = \frac{G}{G_n^{\max}} \qquad (9)$$

I use the adjusted Gini index for all between-group Gini calculations in this article.

**Figure 5. Grouping Individuals by Hierarchical Level**



*This figure shows how I group individuals by hierarchical power. My groups consist of all individuals (regardless of firm) that share the same hierarchical level. In this figure, each hierarchy represents a different firm. Groups are indicated by shaded regions.*

## Methods

Hypothesis B proposes that hierarchical power affects income more strongly than any other factor for which data is available. To test this hypothesis, I use the signal-to-noise ratio (Equation 7) to quantify the income effect of each factor shown in Table 1. All data (except those discussed below) come from the United States. If Hypothesis B is correct, grouping individuals by hierarchical level (across society) should produce the largest signal-to-noise ratio.

My method is as follows. For each income-affecting factor, I divide a sample of the U.S. population into the appropriate groups. For example, the factor "sex" groups the U.S. population into males and females. Similarly, the factor "occupation" groups the U.S. population into fifty-five different occupations, the factor "education" groups the U.S. population into nine levels of education, and the factor "hierarchical level" groups the U.S. population into 12–14 hierarchical levels. (For more details about sources and methods, see Appendix A). Once we have the grouping for a specific factor, we calculate income dispersion between groups and compare it to average income dispersion within groups (using the Gini index). The ratio of these two quantities—the signal-to noise ratio—indicates the income effect size of the factor in question. We can then use these signal-to-noise ratios to rank the income effect sizes of the factors in Table 1.

The point of this analysis is to determine if grouping individuals by hierarchical level has the greatest effect on income. The problem, as I have stated previously, is that the data on firm hierarchy is quite limited. I am not aware of any dataset on hierarchical rank and income for a large sample of U.S. citizens. Because of this data shortage, I am forced to use model-dependent data. I build a model that extrapolates the available case-study data on firm hierarchy to estimate the hierarchical pay structure of 713 U.S. firms in the Compustat database (covering the years 1992–2015). This "Compustat Model" is discussed in detail in the Appendix. The model generates synthetic data from which we can estimate the signal-to-noise ratio of grouping individuals by hierarchical level. I also use the Compustat model to estimate the signal-to-noise ratio of grouping individuals by firm.

I supplement this model-dependent data with two non-U.S. studies that are purely empirical. The first source is a seminal study by Holger Mueller, Paige Ouimet, and Elena Simintzi (2016) that reports income distribution by hierarchical level for 880 United Kingdom firms over the period 2004–2013. The second source is a study by Fredrik Heyman (2005) that analyzes the pay distribution of the top four levels of management in 560 Swedish

firms in the year 1995. Heyman's data comes with the caveat that it does not represent all hierarchical levels—just the top four. (For this reason, I mark Heyman's results with an asterisk). I use this non-U.S. data as an empirical check on the Compustat model's results.

**Table 1. Income-Affecting Factors Used to Test Hypothesis B (cont.)**

| Geographic | Physical Attribute | Socioeconomic |
|---|---|---|
| Census Block Group | Age | Education |
| Census Tract | Cognitive Score* | Employee vs. Self-Employed |
| County | Race | Firm* |
| Urban vs. Rural | Sex | Full vs. Part Time |
| | | Hierarchical Level* |
| | | Home Owner vs. Renter |
| | | Occupation |
| | | Parents' Income Percentile |
| | | Public vs. Private Sector |
| | | Religion |
| | | Type of Income (Labor/ Property) |

*\* Indicates variables that use model-dependent data (at least in part). For sources and methods, see Appendix A*
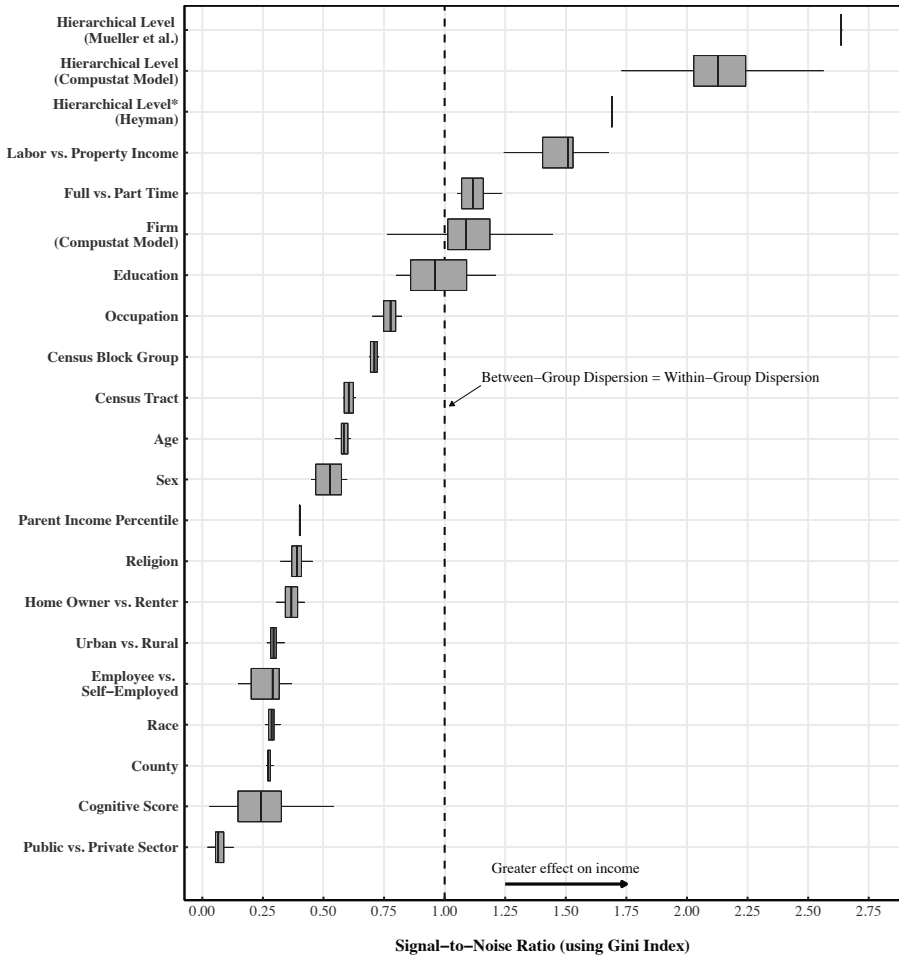
## Results

The results of my test of hypothesis B are shown in Figure 6, which plots signal-to-noise ratios for each of the nineteen different income-affecting factors. To reiterate, the signal-to-noise ratio is the ratio of between-group dispersion to average within-group dispersion. A larger signal-to-noise ratio indicates that grouping individuals by the factor in question has a larger effect on income. For all factors except religion and cognitive score, the boxplots indicate the variation of the signal-to-noise ratio over time (typically the last twenty years). For religion, the boxplot range indicates uncertainty in the signal-to-noise ratio. For cognitive scores, the boxplot range represents variation between different studies.

This test of hypothesis B yields unambiguous results. Of the nineteen different income-affecting factors tested; the evidence suggests that grouping individuals by hierarchical level has the strongest effect on income. Importantly, the Compustat model produces a signal-to-noise ratio that is consistent with the purely empirical (non-U.S.) studies of firm hierarchy. This supports the model's results.

In addition to the support for hypothesis B, Figure 6 reveals a few other notable findings. Firstly, physical attributes (age, cognitive score, race, and sex) have a relatively insignificant effect on income. Geographic effects are also quite small, although they become larger as the geographic area *decreases*. (Geographic factors ranked from largest to smallest area are: county, tract, block group).

Of symbolic interest is the one-to-one value for the signal-to-noise ratio—the point where the signal is of equal size to the noise. Besides hierarchical level, only two other factors have an income effect size that is significantly larger than this one-to-one threshold: labor vs. property income and full vs. part time. The latter is easily understandable. Part-time individuals work significantly fewer hours than full-time individuals, so we would expect

**Figure 6. The Signal-to-Noise Ratio for Different Income-Affecting Factors**



* Includes only top 4 hierarchical levels.
*This figure shows signal-to-noise ratios for each of the 19 income-affecting factors used to test Hypothesis B (which proposes that hierarchical power affects income more strongly than any other factor for which data is available). The signal-to-noise ratio indicates the income effect of grouping individuals according to the factor in question. The boxplots indicate the total range (horizontal line), twenty-fifth to seventy-fifth percentile range (the box), and the median (vertical line) of the signal-to-noise ratio. With the exception of hierarchical level data from Mueller, Ouimet, and Simintzi (2016) and Heyman (2005), all data is from the United States. For sources and methods, see Appendix A.*

significant income differentials between the two groups. Added to this effect is the fact that part-time jobs are often in sectors (such as retail) that have lower wages than in sectors where full-time employment is the norm (like mining).

But what should we make of the significant effect of *functional* income type (property vs. labor)? At first glance, this may seem to support many political economists' deeply held convictions about functional income distribution: capitalists tend to be much wealthier than workers. While this may be true, the results shown here indicate something different. They indicate that property income is on average *much less* than labor income. This result is best thought of as an artifact of the U.S. Census accounting method. In the Census data,

"property income" includes *anyone* with some form of dividend, interest, or rental income. This means that average property income is trivially small—about 8% of the average income from wages/salaries. This is because many people earn small amounts of property income in the form of interest on savings or dividends from small investments. Since these people likely earn income from other sources, this comparison of Census data for labor and property income has little meaning. However, I include it here for the sake of completeness.[4]

To summarize, the available evidence (which is preliminary) suggests that grouping individuals by hierarchical level affects income more strongly than any of the other eighteen factors tested here.

## *Discussion*

The evidence presented here raises many questions for future research. For instance, how general is the correlation between hierarchical power and relative income within firms? Does this correlation generalize to the public sector? Does it vary between countries? And related to this—does the income-effect of grouping individuals by hierarchical level vary by country (or over time)? When better data on firm/government hierarchy becomes available, we can begin to answer these questions.

Another important question to ask is – what are the mechanisms that cause income to be correlated with hierarchical power? My hunch is that there are no simple answers to this question, because there are many "pathways to power" (Price and Feinman 2010). A hierarchical chain of command can be sustained in many different ways, ranging from the pure use of ideology to the pure use of force. In the purely ideological case, the hierarchy functions because subordinates simply agree that their superior has legitimate authority. In this case, subordinates likely believe that their superior deserves to earn more than them. On the other end of the spectrum, the history of slavery indicates that a hierarchy can also function through brutal repression. In this case, the income of superiors is an outcome of the judicious use of force. In both cases, the superior has power over subordinates, but the appearance (and justification) of this power is very different. An intriguing possibility is that greater inequality within a hierarchy might be associated with a greater use of intimidation and fear (rather than the use of a legitimizing ideology).

It is also plausible that belief in the legitimacy of a hierarchy increases with hierarchical rank (Schmidt 2001). If this is true, it should manifest in opinions about income. Interestingly, a recent survey reveals that a majority of Americans question the legitimacy of CEO income (Larcker et al. 2016). Only 16% of the general public agree that CEOs are "paid the correct amount relative to the average worker." Yet a majority of Fortune 500 CEOs (64%) thought that CEO pay was "correct." It would be fascinating to expand this type of survey to see if there is a gradient of opinion by hierarchical rank.

Another complexity is that firms are not islands unto themselves—there are power relations between institutions as well as within them (Bichler and Nitzan 2017). Government regulation, for instance, can have a significant impact on CEO pay. CEOs in the highly

---

[4] To compare the income-effect of functional income type, what we really need to do is group individuals by the proportion of income coming from property sources. Based on the work of Thomas Piketty (2014), it is reasonable to expect that this would strongly affect income. Piketty shows how the proportion of capitalist income increases with income fractile in the United States. But this grouping is the reverse of what would be required to apply my analysis of variance method. Piketty groups individuals by income size, while the method used here would require grouping individuals by the proportion of capitalist income. At present, I am not aware of the data sources that would allow such a grouping.

regulated U.S. utility sector have significantly lower pay than CEOs in other sectors (see Appendix F, as well as Joskow et al. (1993). There is also evidence that CEO pay has a class-like cohesiveness. The average compensation of top U.S. CEOs moves coherently with the capitalization of large firms (Mishel and Davis 2014). This raises interesting implications for integrating the concept of hierarchical power with Jonathan Nitzan and Shimshon Bichler's (2009) "capital as power" hypothesis, in which capital is conceived as a symbolic representation of power.

Lastly, the evidence presented here raises questions about recent increases in income inequality that have occurred in the United States and other countries (see Piketty and Saez 2001, 2006; Piketty 2014; Atkinson and Piketty 2010; Alvaredo et al. 2013). To what extent has this increase been due to an increase in hierarchical pay inequality? Because the empirical study of the relation between income and hierarchical power is in its infancy, the avenues for future research are expansive.

## Conclusions

The hypothesis that income is related to power has been proposed numerous times over the last century. However, in its general form a power-income hypothesis is difficult to test. Power is simply too broad a concept to pin down empirically. In this article, I have attempted to overcome this difficulty by narrowing the focus to hierarchical power only, which I define as the number of subordinates under an individual's control.

Although the data on firm hierarchy is limited (and thus results should be considered preliminary), the available evidence is clear. There is a strong correlation between relative income and hierarchical power within case-study firms. Moreover, the available U.S. evidence suggests that grouping individuals (across society) by hierarchical level affects income more strongly than any other factor tested. I suggest that this is preliminary evidence for a hierarchical power theory of personal income distribution.

I conclude by offering some thoughts on the ideological implications of such a theory. Regardless of their scientific merit, all theories of income distribution evoke some form of ethics that either justifies income *redistribution* or justifies the *status quo*. Conventional (neoclassical) theories of income distribution illicit an ethics of fairness—"*To each according to what he and the instruments he owns produces*," as Milton Friedman famously put it (Friedman 1962). The effect of this theory is to justify as fair any conceivable distribution of income. The result is an innate bias towards the status quo, whatever it may be.

A hierarchical power theory of income distribution is very different. If we parallel Friedman's language, we might state that a hierarchical power theory elicits the following ethos: "*To each according to his/her power to take*." Few would argue that this is fair—it is the basic recipe for *despotism*. But if individual income is most strongly determined by hierarchical power, then acts of income redistribution can be considered largely as *checks* on power—no different than the checks and balances that form the governmental basis of most liberal democracies.

# References

Alvaredo, Facundo, Anthony B. Atkinson, Thomas Piketty, and Emmanuel Saez. 2013. "The Top 1 Percent in International and Historical Perspective." *The Journal of Economic Perspectives* 27 (3): 3–20.

Aranda, Gonzalo and Fernando Molina. 2006. "Wealth and Power in the Bronze Age of the South-East of the Iberian Peninsula: The Funerary Record of Cerro De La Encina." *Oxford Journal of Archaeology* 25 (1): 47–59, doi:10.1111/j.1468-0092.2006.00248.x.

Aranda-Jimenez, Gonzalo, Sandra Monton-Subias, and Silvia Jimenez-Brobeil. 2009. "Conflicting Evidence? Weapons and Skeletons in the Bronze Age of South-East Iberia." *Antiquity* 83 (322): 1038–1051.

Aron, Raymond. 1964. *German Sociology.* New York: Free Press.

Atkinson, Anthony Barnes and Thomas Piketty. 2010. *Top Incomes: A Global Perspective.* New York: Oxford University Press.

Audas, Rick, Tim Barmby, and John Treble. 2004. "Luck, Effort, and Reward in an Organizational Hierarchy." *Journal of Labor Economics* 22 (2): 379–395.

Baker, George, Michael Gibbs, and Bengt Holmstrom. 1993. "Hierarchies and Compensation: A Case Study." *European Economic Review* 37 (2-3): 366–378.

Barroso, F. G., Concepción L. Alados, and J. Boza. 2000. "Social Hierarchy in the Domestic Goat: Effect on Food Habits and Production." *Applied Animal Behaviour Science* 69 (1): 35–53.

Bendix, Reinhard. 1998. *Max Weber: An Intellectual Portrait*, vol. 2. London: Psychology Press.

Berle, Adolph Augustus and Gardiner Coit Means. 1932. *The Modern Corporation and Private Property*. London: Transaction Books.

Betzig, Laura. 2012. "Means, Variances, and Ranges in Reproductive Success: Comparative Evidence." *Evolution and Human Behavior* 33 (4): 309–317.

Bichler, Shimshon and Jonathan Nitzan. 2017. "Growing Through Sabotage: Energizing Hierarchical Power." *Capital as Power Working Papers* 2017 (02): 1-59.

Borghol, Nada, Matthew Suderman, Wendy McArdle, Ariane Racine, Michael Hallett, Marcus Pembrey, Clyde Hertzman, Chris Power, and Moshe Szyf. 2012. "Associations with Early-Life Socio-Economic Position in Adult DNA Methylation." *International Journal of Epidemiology* 41 (1): 62–74.

Boric, Dusan. 1996. "Social Dimensions of Mortuary Practices in the Neolithic: A Case Study." *Starinar* (47): 67–83.

Bradley, Brenda J., Martha M. Robbins, Elizabeth A. Williamson, H. Dieter Steklis, Netzin Gerald Steklis, Nadin Eckhardt, Christophe Boesch, and Linda Vigilant. 2005. "Mountain Gorilla Tug-Of-War: Silverbacks Have Limited Control over Reproduction in Multimale Groups." *Proceedings of the National Academy of Sciences of the United States of America* 102 (26): 9418–9423.

Brown, Christopher. 2005. "Is There an Institutional Theory of Distribution?" *Journal of Economic Issues* 39 (4): 915–931.

Brown, Clair. 1988. "Income Distribution in an Institutional World." In *Three Worlds of Labor Economics*, edited by Garth Mangum and Peter Philips, 51: 515–530. Armonk, NY: M.E. Sharp.

Commons, John Rogers. 1924. *Legal Foundations of Capitalism.* London: Transaction Publishers.

Dee, Michael, David Wengrow, Andrew Shortland, Alice Stevenson, Fiona Brock, Linus Girdland Flink, and Christopher Bronk Ramsey. 2013. "An Absolute Chronology for Early Egypt Using Radiocarbon Dating and Bayesian Statistical Modelling." *Proceedings of the Royal Society A.* http://dx.doi.org/10.1098/rspa.2013.0395

Deltas, George. 2003. "The Small-Sample Bias of the Gini Coefficient: Results and Implications for Empirical Research." *Review of Economics and Statistics* 85 (1): 226–234.

Dohmen, Thomas J., Ben Kriechel, and Gerard A. Pfann. 2004. "Monkey Bars and Ladders: The Importance of Lateral and Vertical Job Mobility in Internal Labor Market Careers." *Journal of Population Economics* 17 (2): 193–228.

Dugger, William M. 1989. *Corporate Hegemony*, vol. 97. Westport, CT: Greenwood Press.

Fleishman, Allen I. 1980. "Confidence Intervals for Correlation Ratios." *Educational and Psychological Measurement* 40 (3): 659–670.

Frankel, Daniel G. and Tali Arbel. 1980. "Group Formation by Two-Year Olds." *International Journal of Behavioral Development* 3 (3): 287–298.

Friedman, Milton. 1962. *Capitalism and Freedom.* Chicago: University of Chicago Press.

Galbraith, John Kenneth. 1985. *The Anatomy of Power.* Boston, MA: Houghton Mifflin Co.

Gerloff, Ulrike, Bianka Hartung, Barbara Fruth, Gottfried Hohmann, and Diethard Tautz. 1999. "Intracommunity Relationships, Dispersal Pattern and Paternity Success in a Wild Living Community of Bonobos (Pan Paniscus) Determined from DNA Analysis of Faecal Samples." *Proceedings of the Royal Society of London B: Biological Sciences* 266 (1424): 1189–1195.

Girman, Derek J., M. G. L. Mills, Eli Geffen, and Robert K. Wayne. 1997. "A Molecular Genetic Analysis of Social Structure, Dispersal, and Interpack Relationships of the African Wild Dog (Lycaon Pictus)." *Behavioral Ecology and Sociobiology* 40 (3): 187–198.

Graziadio, Giampaolo. 1991. "The Process of Social Stratification at Mycenae in the Shaft Grave Period: A Comparative Examination of the Evidence." *American Journal of Archaeology* 95 (3): 403–440.

Guhl, A. M., N. E. Collias, and W. C. Allee. 1945. "Mating Behavior and the Social Hierarchy in Small Flocks of White Leghorns." *Physiological Zoology* 18 (4): 365–390.

Guo, Zhiyu, Kexin Liu, Xiangyang Lu, Hongji Ma, Kun Li, Sixun Yuan, and Xiaohong Wu. 2000. "The Use of AMS Radiocarbon Dating for Xia–Shang–Zhou Chronology." *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms* 172 (1): 724–731.

Haley, Michael P., Charles J. Deutsch, and Burney J. Le Boeuf. 1994. "Size, Dominance and Copulatory Success in Male Northern Elephant Seals, Mirounga Angustirostris." *Animal Behaviour* 48 (6): 1249–1260.

Halstead, Paul. 1993. "Spondylus Shell Ornaments from Late Neolithic Dimini, Greece: Specialized Manufacture or Unequal Accumulation?" *Antiquity* 67 (256): 603–609.

Harding, Anthony Filmer. 2000. *European Societies in the Bronze Age*. Cambridge: Cambridge University Press.

Heyman, Fredrik. 2005. "Pay Inequality and Firm Performance: Evidence from Matched Employer–Employee Data." *Applied Economics* 37 (11): 1313–1327.

Hopcroft, Rosemary L. 2006. "Sex, Status, and Reproductive Success in the Contemporary United States." *Evolution and Human Behavior* 27 (2): 104–120.

Huber, Evelyne, Jingjing Huo, and John D. Stephens. 2017. "Power, Policy, and Top Income Shares." *Socio-Economic Review*:1–23. https://doi.org/10.1093/ser/mwx027.

Jevons, William Stanley. 1879. *The Theory of Political Economy*. London: Macmillan and Company.

Joskow, Paul, Nancy Rose, Andrea Shepard, John R. Meyer, and Sam Peltzman. 1993. "Regulatory Constraints on CEO Compensation." *Brookings Papers on Economic Activity. Microeconomics* 1993 (1): 1–72.

Keynes, John Maynard. 1939. "Professor Tinbergen's Method." *The Economic Journal* 49 (195): 558–577.

Kondo, Seiji and J. Frank Hurnik. 1990. "Stabilization of Social Hierarchy in Dairy Cows." *Applied Animal Behaviour Science* 27 (4): 287–297.

Kristiansen, Kristian. 2000. *Europe Before History*. New York: Cambridge University Press.

Larcker, David, John T. Thompson, Nicholas Donatiello, and Brian Tayan. 2016. "CEOs and Directors on Pay: 2016 Survey on CEO Compensation." Technical report, Rock Center for Corporate Governance, Stanford University.

Lenski, Gerhard E. 1966. *Power and Privilege: A Theory of Social Stratification*. Chapel Hill: UNC Press Books.

Lima, Francisco. 2000. "Internal Labor Markets: A Case Study." FEUNL Working Paper 378.

Lydall, Harold F. 1959. "The Distribution of Employment Incomes." *Econometrica: Journal of the Econometric Society* 27 (1): 110–115.

Massart, Renaud, Matthew J. Suderman, Zsofia Nemoda, Sheila Sutti, Angela M. Ruggiero, Amanda M. Dettmer, Stephen J. Suomi, and Moshe Szyf. 2017. "The Signature of Maternal Social Rank in Placenta Deoxyribonucleic Acid Methylation Profiles in Rhesus Monkeys." *Child Development* 88 (3)): 900–918.

Meese, G. B. and Roger Ewbank. 1973. "The Establishment and Nature of the Dominance Hierarchy in the Domesticated Pig." *Animal Behaviour* 21 (2): 326–334.

Menger, Carl. 1871. *Principles of Economics*. New York: University Press.

Mills, C. Wright. 1956. *The Power Elite*. Oxford: Oxford University Press.

Mishel, Lawrence and Alyssa Davis. 2014. "CEO Pay Continues to Rise as Typical Workers Are Paid Less." Economics Policy Institute, Issue Brief 380.

Morais, Filipe and Nada K. Kakabadse. 2014. "The Corporate Gini Index (CGI) Determinants and Advantages: Lessons from a Multinational Retail Company Case Study." *International Journal of Disclosure and Governance* 11 (4): 380–397.

Mosca, Gaetano. 1939. *On the Ruling Class*. New York: McGraw Hill.

Mueller, Holger M., Paige Parker Ouimet, and Elena Simintzi. 2016. "Within-Firm Pay Inequality." https://dx.doi.org/10.2139/ssrn.2716315

Munkirs, John R. 1985. *The Transformation of American Capitalism: From Competitive Market Structures to Centralized Private Sector Planning*. Armonk, NY: ME Sharpe Inc.

Nitzan, Jonathan. 1992. "Inflation as Restructuring. A Theoretical and Empirical Account of the US Experience." Ph.D. thesis, McGill University.

Nitzan, Jonathan and Shimshon Bichler. 2009. *Capital as Power: A Study of Order and Creorder*. New York: Routledge.

Orwell, George. 1972. "The Freedom of the Press." *New York Times Magazine*. October 8, 1972.

Peach, James T. 1987. "Distribution and Economic Progress." *Journal of Economic Issues* 21 (4): 1495–1529.

Piketty, Thomas. 2014. *Capital in the Twenty-First Century*. Cambridge: Harvard University Press.

Piketty, Thomas and Emmanuel Saez. 2001. "Income Inequality in the United States, 1913-1998 (series Updated to 2000 Available)." Technical report, National Bureau of Economic Research.

Piketty, Thomas and Emmanuel Saez. 2006. "The Evolution of Top Incomes: A Historical and International Perspective." Technical report, National Bureau of Economic Research.

Price, T. Douglas and Gary M. Feinman (Eds.). 2010. *Pathways to Power: New Perspectives on the Emergence of Social Inequality.* New York: Springer.

Reade, Julian. 2001. "Assyrian King-Lists, the Royal Tombs of Ur, and Indus Origins." *Journal of Near Eastern Studies* 60 (1): 1–29.

Sapolsky, Robert M. 2005. "The Influence of Social Hierarchy on Primate Health." Science 308 (5722): 648–652.

Savin-Williams, Ritch C. 1980. "Dominance Hierarchies in Groups of Middle to Late Adolescent Males." *Journal of Youth and Adolescence* 9 (1): 75–85.

Schmidt, Jeff. 2001. *Disciplined Minds: A Critical Look at Salaried Professionals and the Soul-Battering System That Shapes Their Lives.* New York: Rowman & Littlefield.

Sidanius, Jim and Felicia Pratto. 2001. *Social Dominance: An Intergroup Theory of Social Hierarchy and Oppression.* Cambridge: Cambridge University Press.

Simon, Herbert A. 1957. "The Compensation of Executives." *Sociometry* 20 (1): 32–35.

Smith, Adam. 1776. An *Inquiry into the Nature and Causes of the Wealth of Nations.* Edinburgh: A. & C. Black.

Steiger, James H. 2004. "Beyond the F Test: Effect Size Confidence Intervals and Tests of Close Fit in the Analysis of Variance and Contrast Analysis." *Psychological Methods* 9 (2): 164–182.

Strayer, Floyd F. and M. Trudel. 1984. "Developmental Changes in the Nature and Function of Social Dominance Among Young Children." *Ethology and Sociobiology* 5 (4): 279–295.

Tool, Marc. 2017. *The Discretionary Economy: A Normative Theory of Political Economy.* New York: Routledge.

Tool, Marc R. and Warren J. Samuels. 1989. T*he Economy As a System of Power.* New Brunswick, NJ: Transaction Books.

Treble, John, Edwin Van Gameren, Sarah Bridges, and Tim Barmby. 2001. "The Internal Economics of the Firm: Further Evidence from Personnel Data." *Labour Economics* 8 (5): 531–552.

Uhrich, Jacob. 1938. "The Social Hierarchy in Albino Mice." *Journal of Comparative Psychology* 25 (2): 373.

Van der Velde, P. 1990. "Banderamik Social Inequality—a Case Study." *Germania* 68 (1): 19–38.

Veblen, Thorstein. 1904. *The Theory of Business Enterprise.* New York: Martino Fine Books.

Veblen, Thorstein. 1923. *Absentee Ownership: Business Enterprise in Recent Times: The Case of America.* London: Transaction Pub.

Verdier, Nicolas. 2006. "Hierarchy: A Short History of a Word in Western Thought." In *Hierarchy in Natural and Social Sciences.* Methodos Series, 3: 13-17. Edited by Denise Pumain. Dordrecht: Springer.

Wallimann, Isidor, Nicholas Ch Tatsis, and George V. Zito. 1977. "On Max Weber's Definition of Power." *The Australian and New Zealand Journal of Sociology* 13 (3): 231–235.

Walras, Leon. 1896. *Elements D'economie Politique Pure, Ou, Theorie De La Richesse Sociale.* Paris: F. Rouge.

Weber, Max. 1978. *Economy and Society: An Outline of Interpretive Sociology.* Berkeley, CA: University of California Press.

Wright, Erik Olin. 1979. *Class Structure and Income Determination,* volume 2. New York: Academic Press.

Wroblewski, Emily E., Carson M. Murray, Brandon F. Keele, Joann C. Schumacher-Stankey, Beatrice H. Hahn, and Anne E. Pusey. 2009. "Male Dominance Rank and Reproductive Success in Chimpanzees, Pan Troglodytes Schweinfurthii." *Animal Behaviour* 77 (4): 873–885.