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Skewness**

by

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Entry Costs, Task Variety, and Skill Flexibility: A Simple Theory of (Top) Income Skewness*

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Abstract

This paper develops a simple model that provides a unified explanation of the increased skewness of wage income distribution based on differences in flexibility of skills—modeled as differences in the setup costs required to combine/perform a given number of tasks. Our numerical experiments in a calibrated model show that, by increasing task variety, a decrease in the fixed costs of entry due to entry deregulation can be a quantitatively important source of both the increase in below-top skewness and the larger increase in within-top skewness. Moreover, the experiments imply that the observed differences in entry deregulation can cause significant differences in the top skewness across countries that have similar technological change. This can provide an answer to Piketty and Saez’s (2006) question.

Keywords: Entry costs, Task variety, Skill flexibility, Within-top skewness, Below-top skewness, Entry deregulation, Technological change

JEL Classifications: D31, D33, D63, J31, F12, L51

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1 Introduction

This paper attempts to provide a unified explanation of the increased skewness of wage income distribution. One of the most well-known facts relating to income skewness in the U.S. is the increase in below-top skewness¹: the upper-tail inequality in the bottom 90 percent of income distribution, such as the ratio of the 90th to the 50th percentile, has risen rapidly but the lower-tail inequality, such as the ratio of the 50th to the 10th percentile, has barely changed since the late 1960s. Based on Internal Revenue Service (IRS) micro data files, Dew-Becker and Gordon (2005)² reconfirm this fact for the U.S. over 1966-2001.³

Dew-Becker and Gordon (2005), however, go further and find a new fact that the skewness within the top 10 percent of the U.S. income distribution has increased substantially over the same period. They could do so because the IRS micro data files allow a microscopic view of incomes within the top 10 percent that the more frequently used Current Population Survey (CPS) data cannot.⁴

Dew-Becker and Gordon (2005) then do some simple calculations and show/argue that without this increased skewness within the top, the increased below-top skewness by itself cannot (1) cause 46 percent (almost half) of the real income gains to go to the top 10 percent^{5,6} or (2) cause the mean real income to increase more than the median to the extent implied by the U.S. data over the same period.⁷ Thus, to comprehensively explain the observed changes relating to U.S. income skewness, models should be able to explain not only below-top skewness but also within-top skewness.⁸ This is a challenge to theorists

¹Following Dew-Becker and Gordon (2005), we use the 90th percentile as borderline and call skewness below the top 10 percent of the income distribution as “below-top skewness” and skewness within the top 10 percent as “within-top skewness.”

²See also Dew-Becker and Gordon (2008), which is based on Dew-Becker and Gordon (2005), for a survey of several aspects of the rising inequality that are usually discussed separately.

³Dew-Becker and Gordon (2005) calculate real income using the Personal Consumption Expenditures (PCE) index. Data on median and mean income are also shown in Table 1 in Gordon (2009).

⁴A number of other studies corroborate the new findings by Dew-Becker and Gordon (2005) by analyzing income distribution (1) in a country other than the U.S., such as Germany or Sweden (e.g., Bach et al., 2007; Roine and Waldenström, 2008; Dustmann et al., 2009), (2) across countries (e.g., Piketty and Saez, 2006; Roine and Waldenström, 2009), or (3) during a different period (e.g., Kaplan and Rauh, 2007; Levy and Temin, 2007; Willis and Wroblewski, 2007; Thompson and Smeeding, 2010).

⁵Dew-Becker and Gordon (2005) make a calculation of the income level of the top 10 percent on the counterfactual assumption that the ratios of the 95th to the 90th percentile, the 99th to the 90th percentile, etc., were fixed at the 1966 ratio. Their calculation indicates that the top 10 percent would have captured only 36 percent of the real income gains over the period 1966-2001 instead of the actual 46 percent.

⁶For example, the bottom 20 percent also gained, but their share of the gains was only 1.7 percent (Dew-Becker and Gordon, 2005).

⁷Dew-Becker and Gordon (2005) explain that the labor’s share of total income has been stable, indicating that since a large gain in the part of that labor’s share is going to the top 10 percent, a decline in the part of that labor’s share is going to everyone else including the median earner.

⁸In this paper, “below-top skewness” and “within-top skewness” refer to inequality below and within the top 10 percent of income levels, respectively. However, it was brought to our attention that in the labor economics literature, authors often discuss between- and within-group inequality but groups are defined by characteristics other than income, such as education level or occupation. For example, in a recent work by Scotese (2012), “between-group inequality” and “within-group inequality” refer to inequality between and within occupations, respectively.

developing models.

The past studies have provided a separate explanation for each type of skewness. Dew-Becker and Gordon (2005), for example, argue that while skill-biased technological change (the benefits of which are widespread) plays some role in explaining the observed rise in below-top skewness⁹, it fails to explain the much larger rise in within-top skewness. They argue that the “economics of superstars” (Rosen, 1981) and escalating CEO pay premia are needed to explain the large increase in within-top skewness, particularly skewness within the top 1 percent.¹⁰

This paper, however, attempts to provide a unified, alternative explanation for both types of skewness.¹¹ To do so, we draw attention to the observation that the increase in the skewness of income distribution was accompanied by the decrease in entry costs in many developed countries. As shown in Figure 1, there is a positive relationship (solid line) between the entry cost reduction and income growth of the top 10 percent in 13 countries over the period 1978-1998.¹² The data for the entry cost reduction are from Nicoletti and Scarpetta (2003), and the data for the income growth of the top 10 percent are from Atkinson et al. (2011).¹³ Here, we want to emphasize that this positive relationship remains even if the entry cost reduction data are replaced with the 1978-1997 data from Ebell and Hafke (2009) as in Figure 2 (solid line). While this positive relationship is initially not statistically significant, removing Portugal (which is a distinct outlier in both cases) makes it both more positive (dashed lines) and statistically significant in both cases. Motivated by this observation, in this paper, we provide a mechanism that links the decrease in entry costs to an increase in the skewness of income distribution.

The structure of the model is as follows: There are a variety of goods that are differentiated by the firms that produce them. There are also many types of workers. The production of each variety requires combining all varieties of goods and a specific type of labor with a nested CES function. As handling each variety during the production process and combining it with all other varieties of goods constitutes a different task. As a result, we can interchangeably refer to varieties of goods and varieties of tasks.¹⁴ Types of labor

⁹Dew-Becker and Gordon (2005, 2008) also discuss unions, immigration, and trade as other factors affecting the below-top inequality. Dew-Becker and Gordon (2008) go beyond these three factors to also discuss the real minimum wage and the progressivity of taxation.

¹⁰Dew-Becker and Gordon (2008) broaden this distinction to a three-way distinction between superstars, highly-paid lawyers and investment bankers, and CEOs. Dew-Becker (2008) focuses on CEO pay in particular.

¹¹This paper focuses on the distribution of labor/wage income. Most of Dew-Becker and Gordon’s (2005) analysis focuses on labor income but they analyze non-labor income distribution as well. Their results show that the dominant share of real income gains at the top is as large for labor income as it is for total income, which contradicts economists who believe that the growing inequality is entirely a matter of the dominant share of non-labor income at the top.

¹²The 13 countries are Australia, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Portugal, Spain, Sweden, the U.K., and the U.S.

¹³Due to the data limitation, the top 5 percent income growth is used for Japan.

¹⁴This is similar to the task-based-model literature in which a variety of goods used in production are construed as a variety of tasks. For examples of this interpretation, see Mitchell (2005), Grossman and

differ with respect to flexibility, i.e., their ability to handle the diversity of tasks. Flexibility is measured in terms of the setup costs incurred by a firm to enable workers to handle diversity of tasks, as described in Mitchell (2005). A worker with greater flexibility is able to handle a given number of varieties of tasks used in production at lower setup costs. A representative consumer with homothetic preferences consumes all varieties of goods.

We calibrate the key parameters of the model, the labor setup costs and the productivity parameter, to the wage data for 1979 provided by Dew-Becker and Gordon (2005) and the data on the cost share of intermediate goods in gross output provided by Jorgenson et al. (1987). The reason for calibrating the model to the 1979 data is that the data on entry costs that we use for our numerical experiments allow us to see the change in the fixed costs of entry from 1978 to 1998 and the closest year to 1978 with the wage data is 1979. We also choose the values of other parameters based on the evidence.

In our benchmark numerical experiment in the calibrated model, we change fixed costs of entry as in the data. In addition, we change productivity parameter, which measures technological change, to match the change in GDP in the data. We then examine the ability of the model to match the change in the skewness of the U.S. income distribution. This experiment allows us to assess the overall impact of two channels—entry deregulation that is our main interest and technological change that is the central hypothesis in the literature explaining the increase in U.S. income inequality—on the change in the U.S. income distribution. In particular, we show how our calibrated model is able to qualitatively and quantitatively capture the empirical facts regarding changes in both below- and within-top skewness and also reproduce the related facts on the changes in the mean versus the median and on the share of the top 10 percent in the income gains. Overall, the results of this benchmark numerical experiment show a good performance both qualitatively and quantitatively.

In order to separate the contributions of changes in entry costs and technological change to the overall quantitative performance of the model, we conduct two counterfactual experiments where we allow for: (1) only technological change and (2) only entry deregulation. The first counterfactual experiment indicates that technological change does not have quantitatively important impact on the skewness of wage distribution. The second counterfactual experiment, on the other hand, indicates that entry deregulation and the resulting change in fixed costs of entry can result in a quantitatively important increase in income skewness that is consistent with the empirical facts mentioned above.

It is worth emphasizing that our main mechanism is also consistent with available evidence. We link a decrease in entry costs to an increase in top skewness under the assumption that higher-skilled workers are more flexible to handle a variety of tasks. First, this link between entry costs and top skewness is compatible with the data shown in Figures 1 and 2. The countries with a greater reduction in entry costs have witnessed a larger growth in

Rossi-Hansberg (2008), and Blanchard and Willmann (2011).

the income share of the top 10 percent. Second, the assumption about flexibility is also compatible with Lazear's (2005) theory and evidence. He argues that entrepreneurs (who are in the top of the income distribution) need not excel in any one skill but are competent in many. His model of the choice to become an entrepreneur implies that individuals with balanced skills are more likely than others to become entrepreneurs. His theory is empirically confirmed using data on Stanford business school alumni. Lazear (2010) also proposes the theory that leaders (a subset of which are entrepreneurs) are generalists, and this theory is also empirically confirmed using data on Stanford business school alumni. Furthermore, Frederiksen and Kato (2011) use Denmark's registry data to empirically confirm that broadening the scope of human capital by becoming a generalist is advantageous for career success.

Of course, there are a number of recent studies that strive to explain the causes and understand the effects of the observed changes in the skewness of wage income distribution. For example, one set of studies attempts to provide job-polarization-based explanations for the increase in below-top skewness (upper-tail inequality in the bottom 90 percent of income distribution has risen rapidly but lower-tail inequality barely changed).¹⁵ Here, "job polarization" refers to employment shifts into high- and low-wage jobs at the expense of middle-wage jobs (Goos and Manning, 2003). For example, Autor et al. (2006) and Goldin and Katz (2007) both argue that computers strongly complement the non-routine tasks of high-wage jobs, directly substitute for the routine tasks found in many traditional middle-wage jobs, and may have little impact on the non-routine manual tasks of many low-wage jobs. Furthermore, they note that this pattern of demand shifts appears to be reinforced by international outsourcing and offshoring. In fact, Blanchard and Willmann (2011) build a model in which trade can cause job polarization, and they derive policy implications regarding the potential differential impacts of strengthening educational institutions versus trade protection. Furusawa and Konishi (2013) also link trade to wage polarization.

Another set of studies attempts to analyze the effects of increased income skewness on phenomena such as equity returns and financial crises. For example, Walentin (2010) develops a model to study the effects of increased labor income skewness on equity prices through an increase in stockholders' share of aggregate labor income. Fitoussi and Saraceno (2010) and Hein (2011) both argue that increased income skewness can contribute to financial crises.

Our paper makes the following contributions to this line of studies. First, previous studies have paid significant attention to below-top skewness but little attention to within-top skewness due to the limitations of data. Although Dew-Becker and Gordon (2005) look at both below- and within-top skewness, as mentioned above they suggest a separate explanation for each. They argue that while skill-biased technological change (the benefits of which are widespread) plays some role in explaining the observed rise in below-top skewness,

¹⁵By comparison, Palley (2007) argues that financialization is a factor of the increased income inequality.

the economics of superstars and escalating CEO pay premia are needed to explain the large increase in within-top skewness. However, our paper provides a unified explanation for both types of skewness. It demonstrates that through a change in task variety, entry deregulation can cause an increase in below-top skewness as well as a larger increase in within-top skewness. Thus, while Dew-Becker and Gordon (2005) view below- and within-top skewness arising for different reasons, these are just two variations of the same phenomenon in our model, that is, both below- and within-top skewness are results of the differences in flexibility among workers.

Second, our benchmark and counterfactual numerical experiments suggest that technological change is not that important a source of increased skewness of the wage income distribution. On the other hand, entry policy possibly is. This, in turn, implies that differences in entry deregulation can cause significant differences in the top skewness between countries that have similar technological change. Thus, our paper provides an answer to the question posed by Piketty and Saez (2006): Why have top wages surged in English speaking countries in recent decades but not in continental Europe or Japan, which have gone through similar technological change? This paper suggests differences in entry policy changes as one explanation for these differences. As Figures 1 and 2 indicate, entry deregulation has been more pronounced in English speaking countries.

The rest of this paper is organized as follows: We develop our simple model in Section 2. Section 3 explains our calibration. In Section 4, we conduct our numerical experiments and also derive an important implication on Piketty and Saez’s (2006) question. Section 5 concludes.

2 Model

Consider a country in which there are a variety of goods that are differentiated by the firms that produce them. There are also workers, and we assume that there are I types of workers $i = 1, 2, \dots, I$.¹⁶ The production of each variety requires the combination of all varieties of goods and a specific type of labor. Handling each variety of good during the production constitutes a different task. Types of labor differ in their flexibility to handle the diversity of tasks, which is measured by setup costs a_i , as it is in Mitchell (2005). Higher i reflects a greater flexibility/ability to handle task diversity, which translates into lower setup costs a_i so that $a_1 > a_2 > \dots > a_I$. The country has a given endowment of each type of labor equal to L_i .

A representative consumer solves the problem of maximizing

$$u = C, \tag{1}$$

¹⁶ As will be shown later, the assumption that there are I types of workers allows us to analyze changes in inequality, such as the top/bottom ratio, the medium/bottom ratio, and the increased skewness of the top, in a simple manner.

subject to

$$\begin{aligned} qC &\leq \sum_{i=1}^I w_i L_i, \\ C &\geq 0. \end{aligned} \tag{2}$$

Here, C is the CES consumption aggregator for the consumer and q is its price. w_i is the wage for labor i . The CES aggregator C of different varieties is given by

$$C = \left(\int_D (C_z)^\rho dz \right)^{\frac{1}{\rho}}, \tag{3}$$

where parameter ρ , $\rho < 1$, governs the elasticity of substitution, $1/(1 - \rho)$, between any two differentiated varieties in the interval $D = [0, n]$ of the varieties of goods.

The technology for producing goods exhibits increasing returns to scale because of the presence of fixed costs. Specifically, every firm $z \in D_i$, $i = 1, 2, \dots, I$, has the production function

$$y_{z,i} = \max \left\{ \frac{1}{A} \left(\left(\int_D x_{z',z}^\rho dz' \right)^{\varepsilon/\rho} + (l_{i,z} - a_i)^\varepsilon \right)^{1/\varepsilon} - F, 0 \right\}, \quad z \in D_i, \tag{4}$$

where $A > 0$ is a productivity parameter and $x_{z',z}$ and $l_{i,z}$ refer to variety z' and worker i , respectively, used in the production of variety z . Thus, production requires varieties and workers with a nested CES function.¹⁷ Here, firms face fixed costs of entry $F > 0$ in terms of output, which are common across all firms. As mentioned above, firms also face setup costs for labor a_i , which are different across types of firms but the same across firms using labor type i . One might think of a_i as training costs that depend on labor type i . We note that due to a_i this production function is non-homothetic. Thus, total fixed costs consist of fixed costs of entry F in terms of output and setup costs $w_i a_i$. For the results of this paper, the critical distinction between the two components of total fixed costs is that F does not depend on the type of labor employed whereas setup costs do. The manner in which these different components of fixed costs are modeled is not critical to the results.

It is important to note that although the same CES aggregator is used by all firms (and consumers) to convert varieties into a composite good, all firms create this composite good in-house. Therefore, the skill level of the labor employed, which is the same as flexibility in combining inputs in the model, is relevant to the production process because it determines the setup costs that differ between firms using different types of labor. We assume the same aggregation function for varieties for all firms (and consumers) only to simplify aggregate demand functions for the varieties.

¹⁷The firms in the model use one type of labor. This can be rationalized by interpreting them as real-world, within-firm units that employ workers with similar skills. In any case, in our numerical computations, firms in the model never find it optimal to combine labor of different types.

Let $\tilde{c}_z(q, w_i; y_{z,i} + F, a_i)$ be the solution to the cost minimization problem for firm $z \in D_i$. Given that each firm produces output using a nested CES function with workers and a composite input made from varieties as inputs, the cost function can be written in terms of the sub-cost functions as follows:

$$\tilde{c}_z(q, w_i; y_{z,i} + F, a_i) = w_i a_i + c_z(q, w_i)(y_{z,i} + F), \quad (5)$$

where

$$c_z(q, w_i) = A \left[q^{-\frac{\varepsilon}{1-\varepsilon}} + w_i^{-\frac{\varepsilon}{1-\varepsilon}} \right]^{-\frac{1-\varepsilon}{\varepsilon}}. \quad (6)$$

Thus, we can write $\tilde{c}_z(\cdot)$ as a linear function of $y_{z,i} + F$:

$$\tilde{c}_z(q, w_i; y_{z,i} + F, a_i) = G_{1,i} + G_{2,i}(y_{z,i} + F), \quad z \in D_i, \quad (7)$$

where $G_{1,i}$ and $G_{2,i}$ are independent of a firm's choices.

The firms are monopolistic competitors facing a downward sloping demand curve, and firm $z \in D_i$ sets its price $q_{z,i}$ to maximize profits:

$$\max \pi_{z,i} = q_{z,i} y_{z,i} - G_{1,i} - G_{2,i}(y_{z,i} + F), \quad (8)$$

taking all other prices as given.

Let us derive the demand for each variety z . The demand by the consumer for variety $z \in D_i$ is:

$$C_{z,i} = \left(\frac{q_{z,i}}{q} \right)^{-\frac{1}{1-\rho}} \frac{\sum_{i=1}^I w_i L_i}{q}, \quad (9)$$

where q can be written as an exact consumption-based price index of the prices of individual varieties as follows:

$$q = \left[\int_D (q_z)^{-\frac{\rho}{1-\rho}} dz \right]^{-\frac{1-\rho}{\rho}}, \quad (10)$$

where D is the set of all varieties, as defined earlier. Hence, we can write the consumption demand for variety $z \in D_i$ faced by the firm as

$$C_{z,i} = E q_{z,i}^{-\frac{1}{1-\rho}}, \quad (11)$$

where

$$E = \frac{\sum_{i=1}^I w_i L_i}{q^{-\frac{\rho}{1-\rho}}}. \quad (12)$$

Thus, the consumption demand varies with price $q_{z,i}$ with elasticity $-1/(1-\rho)$.

We can also write the input demand of each firm for variety $z \in D_i$ as

$$x_{z,z'} = T_i q_{z,i}^{-\frac{1}{1-\rho}}, \quad (13)$$

where

$$T_i = A \left(\frac{c_z(q, w_i)}{Aq} \right)^{\frac{1}{1-\varepsilon}} (y_{z,i} + F) \left(\frac{1}{q} \right)^{-\frac{1}{1-\rho}}. \quad (14)$$

Thus, the total consumption and input demand for variety z can be expressed as

$$y_{z,i} = T q_{z,i}^{-\frac{1}{1-\rho}}, \quad z \in D_i, \quad (15)$$

where

$$T = E + \sum_{i=1}^I n_i T_i, \quad (16)$$

which is again independent of a firm's choices.

Hence, given the number of varieties, the profit of firm $z \in D_i$ can be rewritten as

$$\pi_{z,i} = q_{z,i} T q_{z,i}^{-\frac{1}{1-\rho}} - G_{2,i} T q_{z,i}^{-\frac{1}{1-\rho}} - G_{1,i} - G_{2,i} F. \quad (17)$$

The first order condition for profit maximization with respect to $q_{z,i}$ then gives

$$q_{z,i} = \frac{G_{2,i}}{\rho}, \quad z \in D_i. \quad (18)$$

Further, by the zero profit condition for this $q_{z,i}$,

$$\pi_{z,i} = \frac{G_{2,i}}{\rho} y_{z,i} - G_{2,i} (y_{z,i} + F) - G_{1,i} = 0, \quad (19)$$

we obtain

$$y_{z,i} = \frac{\rho}{1-\rho} \left[F + \frac{G_{1,i}}{G_{2,i}} \right], \quad z \in D_i. \quad (20)$$

Definition 1 An *equilibrium* is a vector of prices $\{q_{z,i}, w_i\}_{i=1}^I$ and quantities $\{C_{z,i}, y_{z,i}, l_{i,z}\}_{i=1}^I$, $x_{z',z}$, $(z', z) \in D \times D$ and an interval $D = [0, n]$ such that:

1. Given the prices, the consumption plans $C_{z,i}$ solve the utility maximization problem of the consumer;
2. Given factor prices and demand, price $q_{z,i}$ and production plans (including the factor demands) of the firm z maximize profits and minimize costs;
3. Every firm $z \in D$ earns zero profits;

4. *The markets for goods clear*

$$\left[C_{z,i} + \int_D x_{z,z'} dz' \right] = y_{z,i}, \quad z \in D_i; \quad (21)$$

5. *The factor markets clear*

$$n_i l_{i,z} = L_i, \quad i = 1, 2, \dots, I, \quad (22)$$

where n_i is the measure of D_i ;

6. *The number of varieties available for consumption is the number of varieties produced,*

$$D = \cup_{i=1}^I D_i = [0, n].$$

3 Calibration

In this section, we describe the calibration of the model. Table 1 shows the values of the parameters calibrated or chosen based on empirical evidence.

We begin by choosing the values of some of the parameters based on the evidence. We choose $\rho = 5/6$, which implies a 20 percent markup for the monopolistically competitive firms. This 20 percent markup is in accordance with the evidence relating to manufacturing industries in OECD countries presented by Martins et al. (1996). We also choose $\varepsilon = 1/6$ so that the elasticity of substitution between inputs and labor $1/(1 - \varepsilon)$, is 1.2. This is compatible with Rotemberg and Woodford's (1992) estimate. Basu (1995) notes that this elasticity (1.2) looks relatively large but is not surprising if service inputs are included. In fact, in our model, there is no distinction between varieties of manufactured or service inputs.

We next normalize the values of the fixed cost of entry, F , and the price index, q , to 1. We also set $I = 20$, so that there are 20 types of workers. All types have the same measure with $L_i = 5$ for $i = 1, 2, \dots, 20$. Twenty is the minimum number of types needed to calibrate and analyze skewness within the top 10 percent. Types 19 and 20 constitute the top 10 percent, and thus type 19 versus type 20 is skewness within the top 10 percent. The average of workers of types 10 and 11 is the median.

We now calibrate the key parameters: the setup costs, a_i , $i = 1, 2, \dots, 20$, and the productivity parameter, A . We calibrate the setup costs, a_i , so that the wage distribution generated by the model reproduces some of the major characteristics of the wage data for 1979 provided by Dew-Becker and Gordon (2005).¹⁸ The decision to use 1979 data is guided

¹⁸For the 1979 wage data, see the top panel "Real and Adjusted Wage and Salary Percentiles in Year 2000 Dollars, Selected Years, 1966-2001" in Table 8 in Dew-Becker and Gordon (2005).

by the fact that we have data on the change in fixed costs of entry from 1978 to 1998 which we use in our numerical experiments in the next section and 1979 is the closest year to 1978 for which wage data is available. With the normalization of the setup costs for the most flexible worker $a_{20} = 0$, we calibrate values of $a_1 - a_{19}$. Then, as shown in Figure 3, the wage distribution generated by the model exactly captures the wages for the 20th, 50th, 80th, 90th, 95th, and 99th percentiles in the data. As also evident from Figure 3, the wage distribution curve has been generated through a smooth inter/extrapolation of the wages of 20 different types of workers that are generated by the model.

Lastly, we calibrate the productivity parameter, A . This parameter affects the cost share of labor in gross output. We, therefore, calibrate the value of A so that the cost share of labor in gross output is 0.5 and so is the cost share of intermediate goods. This is compatible with the evidence provided by Jorgenson et al. (1987) that the share of intermediate inputs in total manufacturing output is 50 percent or more over the period 1947-1979.

4 Numerical Experiments

In this section, we assess the ability of the model to reproduce the changes in the U.S. wage income distribution over 1979-1999. In our benchmark experiment, we do so by accounting for both entry deregulation that is our main interest and technological change that is the central hypothesis in the literature explaining the increase in U.S. income inequality. Next, we also conduct two counterfactual experiments allowing for: (1) only technological change and (2) only entry deregulation. In each experiment, we see how our calibrated model can qualitatively and quantitatively capture the facts on both below- and within-top skewness and also reproduce the related facts on the mean versus median and on the share of the top in the gains.

4.1 Entry Deregulation, Technological Change, and Skewness of Income Distribution

We begin with the benchmark experiment. To capture entry deregulation, we decrease the fixed costs of entry, F , by 65 percent. This is in accordance with the evidence for the U.S. over 1978-1998 provided by Nicoletti and Scarpetta (2003), which has been shown in Figure 1. Technological change is not directly observable. We account for it indirectly by changing (inverse) productivity parameter, A , to allow for gross output to increase by 41.2 percent over 1979-1999. This is in accordance with the evidence for the U.S. productivity growth presented by Dew-Becker and Gordon (2005). According to them, the average productivity of the nonfarm private business (NFPB) sector in the U.S. grew at the rate of 1.74 percent

over 35 years (1966-2001) implying a productivity growth of 41.2 percent over 20 years.^{19,20}

We, then, examine the ability of the model to match the change in the skewness of the U.S. income distribution. This experiment allows us to assess the overall impact of two channels—entry deregulation and technological change—on the change in the U.S. income distribution.

The resulting change in wage distribution is shown in Figure 4, which shows that the model is able to generate a substantial increase in skewness, especially within the top. Ironically, it generates too much within-top skewness relative to the data. More detailed quantitative performance based on measures used in the literature is as follows:

1. *Change in below-top skewness:* In the data, from 1979 to 1999 the ratio of the 50th to the 20th percentile decreased by 0.52 percent, and the ratio of the 90th to the 50th percentile increased by 19.23 percent with a difference between the two of 19.75 percentage points.²¹ In this experiment, these ratios respectively decrease by 1.62 percent and increase by 7.93 percent, which implies a difference of 9.55 percentage points.
2. *Change in within-top skewness:* In the data, from 1979 to 1999 the ratio of the 99th to the 90th percentile increased by 32.74 percent. In this experiment, it increases by 79.85 percent.²²
3. *Share of the top 10 percent in total real wage gains:* In the data, 54.61 percent of total real wage gains over 1979-1999 went to the top 10 percent.²³ In this experiment, it was 57.75 percent.
4. *Change in mean versus median:* In the data, from 1979 to 1999 the mean increased by 45.71 percent while the median increased by 3.43 percent with the difference being 42.28 percentage points.²⁴ In this experiment, the mean rises by 37.41 percent while the median rises by 19.12 percent, which implies a difference of 18.29 percentage points.

It is worth mentioning that, in this experiment, the top 6.7 percent of workers experience above-average wage growth. In the data, this number is 10 percent.

Overall, the results of this experiment show a good performance both qualitatively and quantitatively. The performance of the model vis-a-vis facts 1 and 4 above is a bit inferior.

¹⁹According to Dew-Becker and Gordon (2005), the average productivity growth over the same 1966-2001 period for the entire economy is 1.57 percent.

²⁰In our model, productivity growth and output growth are equivalent.

²¹See Dew-Becker and Gordon's (2005) Table 8. For the data for 1999, we take a geometric average of the data for 1997 and 2001.

²²See footnote 21.

²³See Dew-Becker and Gordon's (2005) Table 7. For calculating the real wage of the top 10 percent for 1999, we take an arithmetic average of that for 1997 and 2001.

²⁴The mean is calculated from the data in Dew-Becker and Gordon's (2005) Table 2. The median for 1999 is a geometric average of that for 1997 and 2001 in Dew-Becker and Gordon's (2005) Table 8.

It may be pointed out that this is mainly driven by a much larger increase in the median in the model. In the next subsections, we separate the contributions of entry deregulation and technological change to the overall quantitative performance of the model.

4.2 Counterfactual Experiment 1: Only Technological Change

In order to assess the role of technological change in the above change in wage income distribution, we now only change the productivity parameter, A . Specifically, keeping the fixed costs of entry, F , unchanged at the initial value 1, we decrease the (inverse) productivity parameter, A , by 4.92 percent as in the benchmark experiment. The resulting change in wage distribution shown in Figure 5 seems to suggest that technological change does a reasonable job of capturing changes in the below-top part of the wage income distribution, while it clearly fails to generate enough within-top skewness. More detailed quantitative performance based on measures used in the literature is as follows:

1. *Change in below-top skewness:* In the data, from 1979 to 1999 the ratio of the 50th to the 20th percentile decreased by 0.52 percent, and the ratio of the 90th to the 50th percentile increased by 19.23 percent with a difference between the two of 19.75 percentage points. In this experiment, these ratios respectively decrease by 0.86 percent and increase by 1.86 percent, which implies a difference of 2.72 percentage points.
2. *Change in within-top skewness:* In the data, from 1979 to 1999 the ratio of the 99th to the 90th percentile increased by 32.74 percent. In this experiment, it increases by 5.96 percent.
3. *Share of the top 10 percent in total real wage gains:* In the data, 54.61 percent of total real wage gains over 1979-1999 went to the top 10 percent. In this experiment, it was 34.91 percent.
4. *Change in mean versus median:* In the data, from 1979 to 1999 the mean increased by 45.71 percent while the median increased by 3.43 percent with the difference being 42.28 percentage points. In this experiment, the mean rises by 13.92 percent while the median rises by 11.95 percent, which implies a difference of 1.97 percentage points.

In this experiment, the percent of workers with the above-average wage growth is the top 10.77 percent, while it is the top 10 percent in the data.

As can be seen, this technological change is skill biased since this productivity growth increases the relative demand for more-flexible labor. Because higher skill corresponds to greater flexibility in our model, this technological change shows a positive skill bias. However, comparing the results of this counterfactual experiment with those of the benchmark experiment indicates that the skill bias of technological change does not have quantitatively important impact on the skewness of wage distribution. While visually its performance in

explaining changes in below-top part of income distribution seems reasonable, quantitative assessment vis-a-vis facts 1 and 4 suggests otherwise.

4.3 Counterfactual Experiment 2: Only Entry Deregulation

In this counterfactual experiment, we assess the role of entry deregulation in generating the increase in skewness of wage income distribution in the benchmark experiment. We do so by only changing the fixed costs of entry, F . Specifically, we keep the productivity parameter, A , unchanged at the initial level and decrease the fixed costs of entry, F , by 65 percent as in the benchmark experiment. The resulting change in wage distribution is shown in Figure 6, which clearly shows the ability of entry deregulation to explain changes in within-top skewness. More detailed quantitative performance based on measures used in the literature is as follows:

1. *Change in below-top skewness:* In the data, from 1979 to 1999 the ratio of the 50th to the 20th percentile decreased by 0.52 percent, and the ratio of the 90th to the 50th percentile increased by 19.23 percent with a difference between the two of 19.75 percentage points. In this experiment, these ratios respectively decrease by 0.76 percent and increase by 6.64 percent, which implies a difference of 7.4 percentage points.
2. *Change in within-top skewness:* In the data, from 1979 to 1999 the ratio of the 99th to the 90th percentile increased by 32.74 percent. In this experiment, it increases by 66.37 percent.
3. *Share of the top 10 percent in total real wage gains:* In the data, 54.61 percent of total real wage gains over 1979-1999 went to the top 10 percent. In this experiment, it was 70.15 percent.
4. *Change in mean versus median:* In the data, from 1979 to 1999 the mean increased by 45.71 percent while the median increased by 3.43 percent with the difference being 42.28 percentage points. In this experiment, the mean rises by 19.46 percent while the median rises by 6.01 percent, which implies a difference of 13.45 percentage points.

In this experiment, the percent of workers with the above-average wage growth is the top 6.77 percent, while it is the top 10 percent in the data.

The primary implication of this counterfactual experiment is that entry deregulation can result in a quantitatively important increase in the skewness of wage distribution that is consistent with the empirical facts outlined above. Comparing the results of this counterfactual experiment 2 with those of counterfactual experiment 1 reveals that the impact of entry deregulation is quantitatively much more important than that of the technological change.

The key mechanism driving the results of this experiment is actually very simple. The reduction in entry costs, F , results in a significant proliferation of the number of varieties

produced. The number of varieties that are produced using type i labor, n_i , increases for all i . The overall number of varieties n ($= n_1 + \dots + n_{20}$) increases by about 180 percent (177.21 percent). This rise in n directly increases the marginal products of labor of all types but the increase in the marginal products of the more-flexible labor with lower setup costs, a_i , is disproportionately large. This is driven by a greater fall in total fixed costs (entry costs plus labor setup costs) that translates into an increase in their relative demand, as explained below. As a result, the relative wages of the more-flexible labor rise, which causes the wage distribution to become more unequal, as shown in Figure 6. Note that as the more-flexible sectors (like every sector) use the composite intermediate input produced using all intermediate varieties, there is an indirect increase in the demand for the less-flexible labor as well. Overall, therefore, wages rise for all types of labor, but wages of the more-flexible labor increase more. For example, in this experiment, w_1 rises by 5.07 percent whereas w_{20} rises by 63.40 percent.

To understand the mechanism in more detail, note that because consumers love variety, the reduction in F increases the number of varieties produced by all labor types. However, the proportionally large decrease in F results in a disproportionately larger increase in the number of varieties produced by the more-flexible labor. This can be seen from looking at the distribution of varieties for the case of only entry deregulation in Figure 7 (left panel). Specifically, n_1 rises by only 0.32 percent while n_{20} rises by 301.81 percent! This relative increase in the number of varieties produced by more-flexible labor translates into increases in both the relative demand for more-flexible labor and these varieties' share in GDP, as shown in Figure 7 (right panel). In contrast, these two effects are very weak for the case of only technological change as a look at the distribution of varieties and GDP share for that case reveals.

As the amount of each type of labor, L_i , is fixed, an increase in n_i implies that the size of each type of firm i , measured by the size of employment, decreases. The average size of firms, measured by output, also decreases from 22.12 to 8.65.²⁵ This implication of the model is consistent with the evidence documented by, e.g., Davis and Haltiwanger (1991) and Mitchell (2005). Both of these studies show that the size of U.S. manufacturing plants declined during the second half of the 20th century.

Though we do not report the results here, as an alternative experiment we also decrease the fixed costs of entry, F , by 88.45 percent. This is in accordance with the evidence for the U.S. over 1978-1997 provided by Ebell and Haefke (2009), which has been shown in Figure 2. As expected, this can result in a more quantitatively important increase in the skewness of wage distribution.

²⁵The average size of firms, measured by the value of output, also decreases from 27.10 to 11.84.

4.4 An Answer to Piketty and Saez’s (2006) Question

Our numerical experiments suggest an answer to the following question posed by Piketty and Saez (2006): Why have top wages surged in English speaking countries in recent decades but not in continental Europe or Japan, which have gone through similar technological changes? In fact, as documented by Dew-Becker and Gordon (2008), the relative rise of top incomes in the U.S. post-1970 is much greater than in Europe or Japan, with the U.K. and Canada ranking somewhere in the middle.

A comparison of our benchmark and counterfactual numerical experiments readily shows that technological change is not that important a source of increased skewness of the wage income distribution. On the other hand, entry policy possibly is. This, in turn, implies that differences in entry deregulation can cause significant differences in the top skewness between countries that have similar technological change. Thus, our paper suggests differences in entry policy changes as one explanation for these differences in the experience of English speaking countries versus continental Europe or Japan.

To be more explicit, consider our benchmark experiment and counterfactual experiment 1. In both experiments, technological change is the same, but the former also has entry deregulation. Their results together show that entry deregulation is a very powerful driver to (top) income skewness. Thus, countries with similar technological change but with different experiences vis-a-vis entry deregulation can have significant differences in the evolution of (top) income skewness, which can provide an answer to Piketty and Saez’s (2006) question.

Consider, for example, the U.S. and Japan. According to Nicoletti and Scarpetta (2003) (see Figure 1), over 1978-1998 the entry costs in Japan decreased by 44 percent, which is less than a 65 percent decrease in the U.S. This might be a factor responsible for a lesser increase in top income skewness in Japan compared to the U.S. It is worth mentioning other factors that might also be weakening the top skewness in Japan. As Ito (1992), for example, documents, one characteristic of the Japanese labor market is rotation, pursuant to which workers rotate through different tasks requiring various skills early in their careers. “It is sometimes said that in Japan a generalist is valued more than a specialist” (Ito, 1992, p. 214). It is thus possible that, due to rotation, the share of flexible workers is larger in Japan and the top skewness is therefore smaller in Japan than in the U.S.

5 Conclusion

The main purpose of this paper was to develop a simple model with differences in the flexibility of skills that provides a unified explanation of the facts on both below- and within-top skewness. Using a calibrated model, our numerical experiments showed that by increasing task variety, a decrease in the fixed costs of entry due to entry deregulation can be a quantitatively important source of such wage income changes. Moreover, the numerical experiments implied that differences in entry deregulation significantly cause differences

in the top skewness between countries that have similar technological changes, which can provide an answer to Piketty and Saez's (2006) question.

This paper focused on entry deregulation and technological change as factors affecting wage income skewness. As Dew-Becker and Gordon (2005, 2008) argue, however, unions, immigration, and trade could be also possible factors. We leave the assessment of contributions of these factors to income skewness to future research.

References

- Autor, David H., Lawrence F. Katz, and Melissa S. Kearney.** 2006. "The Polarization of the U.S. Labor Market." *American Economic Review*, 96(2): 189-94.
- Bach, Stefan, Giacomo Corneo, and Viktor Steiner.** 2007. "From Bottom to Top: The Entire Distribution of Market Income in Germany, 1992-2001." IZA Discussion Papers 2723, Institute for the Study of Labor (IZA).
- Basu, Susanto.** 1995. "Intermediate Goods and Business Cycles: Implications for Productivity and Welfare." *American Economic Review*, 85(3): 512-31.
- Blanchard, Emily and Gerald Willmann.** 2011. "Trade, Education, and the Shrinking Middle Class." Working Paper, University of Virginia and Catholic University of Leuven.
- Davis, Steve J. and John Haltiwanger.** 1991. "Wage Dispersion between and within U.S. Manufacturing Plants, 1963-86." *Brookings Papers on Economic Activity: Microeconomics*, 1991: 115-200.
- Dew-Becker, Ian.** 2008. "How Much Sunlight Does it Take to Disinfect a Boardroom? A Short History of Executive Compensation Regulation." CESifo Working Paper Series 2379, CESifo Group Munich.
- Dew-Becker, Ian and Robert J. Gordon.** 2005. "Where Did Productivity Growth Go? Inflation Dynamics and the Distribution of Income." *Brookings Papers on Economic Activity*, 36(2): 67-150; also NBER Working Papers 11842, National Bureau of Economic Research, Inc.
- Dew-Becker, Ian and Robert J. Gordon.** 2008. "Controversies about the Rise in American Inequality: A Survey." NBER Working Papers 13982, National Bureau of Economic Research, Inc.
- Dustmann, Christian, Johannes Ludsteck, and Uta Schönberg.** 2009. "Revisiting the German Wage Structure." *Quarterly Journal of Economics*, 124(2): 843-81.
- Ebell, Monique and Christian Haefke.** 2009. "Product Market Deregulation and the US Employment Miracle." *Review of Economic Dynamics*, 12(3): 479-504.
- Fitoussi, Jean-Paul and Francesco Saraceno.** 2010. "Inequality and Macroeconomic Performance." Documents de Travail de l'OFCE 2010-13, Observatoire Francais des Conjonctures Economiques (OFCE).
- Frederiksen, Anders and Takao Kato.** 2011. "Human Capital and Career Success: Evidence from Linked Employer-Employee Data." IZA Discussion Papers 5764, Institute for the Study of Labor (IZA).

- Furusawa, Taiji and Hideo Konishi.** 2013. "International Trade and Income Inequality." Working Paper, Hitotsubashi University and Boston College.
- Goldin, Claudia and Lawrence F. Katz.** 2007. "Long-Run Changes in the U.S. Wage Structure: Narrowing, Widening, Polarizing." NBER Working Papers 13568, National Bureau of Economic Research, Inc.
- Goos, Maarten and Alan Manning.** 2007. "Lousy and Lovely Jobs: The Rising Polarization of Work in Britain." *Review of Economics and Statistics*, 89(1): 118-33.
- Gordon, Robert J.** 2009. "Misperceptions About the Magnitude and Timing of Changes in American Income Inequality." NBER Working Papers 15351, National Bureau of Economic Research, Inc.
- Grossman, Gene M. and Esteban Rossi-Hansberg.** 2008. "Trading Tasks: A Simple Theory of Offshoring." *American Economic Review*, 98(5): 1978-97.
- Hein, Eckhard.** 2011. "Distribution, 'Financialisation' and the Financial and Economic Crisis: Implications for Post-crisis Economic Policies." IPE Working Papers 09/2011, Berlin School of Economics and Law, Institute for International Political Economy (IPE).
- Ito, Takatoshi.** 1992. *The Japanese Economy*. Cambridge, MA: MIT Press.
- Jorgenson, Dale W., Frank M. Gollop, and Barbara M. Fraumeni.** 1987. *Productivity and U.S. Economic Growth*. Cambridge, MA: Harvard University Press.
- Kaplan, Steven N. and Joshua Rauh.** 2007. "Wall Street and Main Street: What Contributes to the Rise in the Highest Incomes?" NBER Working Papers 13270, National Bureau of Economic Research, Inc.
- Kurokawa, Yoshinori.** 2010. "Fixed Cost, Number of Firms, and Skill Premium: An Alternative Source for Rising Wage Inequality." *Economics Letters*, 108(2): 141-44.
- Lazear, Edward P.** 2005. "Entrepreneurship." *Journal of Labor Economics*, 23(4): 649-80.
- Lazear, Edward P.** 2010. "Leadership: A Personnel Economics Approach." NBER Working Papers 15918, National Bureau of Economic Research, Inc.
- Levy, Frank and Peter Temin.** 2007. "Inequality and Institutions in 20th Century America." NBER Working Papers 13106, National Bureau of Economic Research, Inc.
- Martins, Joaquim O., Stefano Scarpetta, and Dirk Pilat.** 1996. "Mark-Up Ratios in Manufacturing Industries: Estimates for 14 OECD Countries." OECD Economics Department Working Paper No. 162.

- Milberg, William.** 2007. "Shifting Sources and Uses of Profits: Sustaining U.S. Financialization with Global Value Chains." SCEPA Working Papers 2007-9, Schwartz Center for Economic Policy Analysis (SCEPA), The New School.
- Milberg, William and Deborah Winkler.** 2009. "Financialization and the Dynamics of Offshoring in the U.S." SCEPA Working Papers 2009-5, Schwartz Center for Economic Policy Analysis (SCEPA), The New School.
- Mitchell, Matthew F.** 2005. "Specialization and the Skill Premium in the 20th Century." *International Economic Review*, 46(3): 935-55.
- Nicoletti, Giuseppe and Stefano Scarpetta.** 2003. "Regulation, Productivity and Growth: OECD Evidence." *Economic Policy*, 18(36): 9-72.
- Palley, Thomas I.** 2007. "Financialization: What It Is and Why It Matters." Working Papers wp153, Political Economy Research Institute, University of Massachusetts at Amherst.
- Piketty, Thomas and Emmanuel Saez.** 2006. "The Evolution of Top Incomes: A Historical and International Perspective." *American Economic Review*, 96(2): 200-05.
- Roine, Jesper and Daniel Waldenström.** 2008. "The Evolution of Top Incomes in an Egalitarian Society: Sweden, 1903-2004." *Journal of Public Economics*, 92(1-2): 366-87.
- Roine, Jesper and Daniel Waldenström.** 2009. "Common Trends and Shocks to Top Incomes - A Structural Breaks Approach." Working Paper Series 801, Research Institute of Industrial Economics.
- Rosen, Sherwin.** 1981. "The Economics of Superstars." *American Economic Review*, 71(5): 845-58.
- Rotemberg, Julio J. and Michael Woodford.** 1992. "The Effects of Energy Price Increases on Economic Activity." Working Paper, Massachusetts Institute of Technology.
- Scotese, Carol A.** 2012. "Wage Inequality, Tasks and Occupations." Working Paper, Virginia Commonwealth University.
- Thompson, Jeff and Timothy M. Smeeding.** 2010. "Recent Trends in the Distribution of Income: Labor, Wealth and More Complete Measures of Well Being." Working Papers wp225, Political Economy Research Institute, University of Massachusetts at Amherst.
- Walentin, Karl.** 2010. "Earnings Inequality and the Equity Premium." *The B.E. Journal of Macroeconomics*, 10(1): 36 pp.

Willis, Jonathan L. and Julie Wroblewski. 2007. "What Happened to the Gains from Strong Productivity Growth?" *Economic Review*, Federal Reserve Bank of Kansas City, issue Q I: 5-23.

<i>Parameter values</i>	<i>Targets</i>	<i>Based on</i>
$\rho = 5/6$	20 percent markup	Martins et al. (1996)
$\varepsilon = 1/6$	Elasticity of substitution of 1.2 between intermediate inputs and labor	Rotemberg and Woodford (1992)
a_i	U.S. real wage data for 1979	Dew-Becker and Gordon (2005)
$A = 26.92$	50 percent share of intermediate goods in output	Jorgenson et al. (1987)
<i>Normalizations: $F = q = 1; I = 20; L_i = 5.$</i>		

Table 1: The parameterization of the model

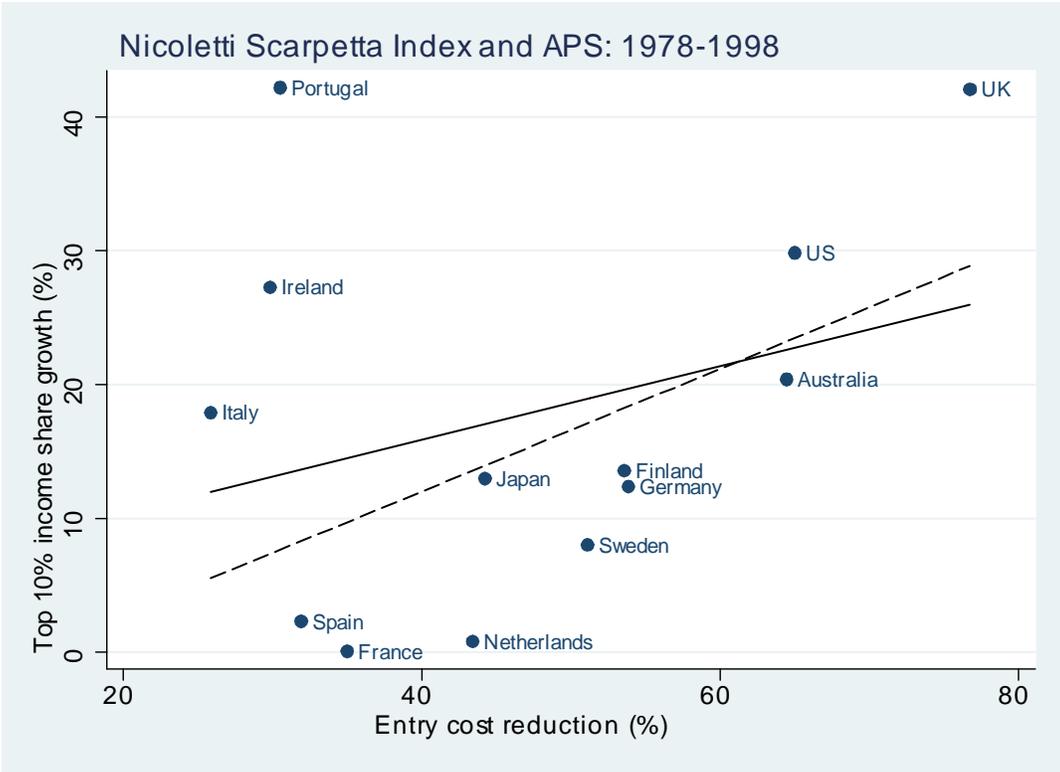


Figure 1

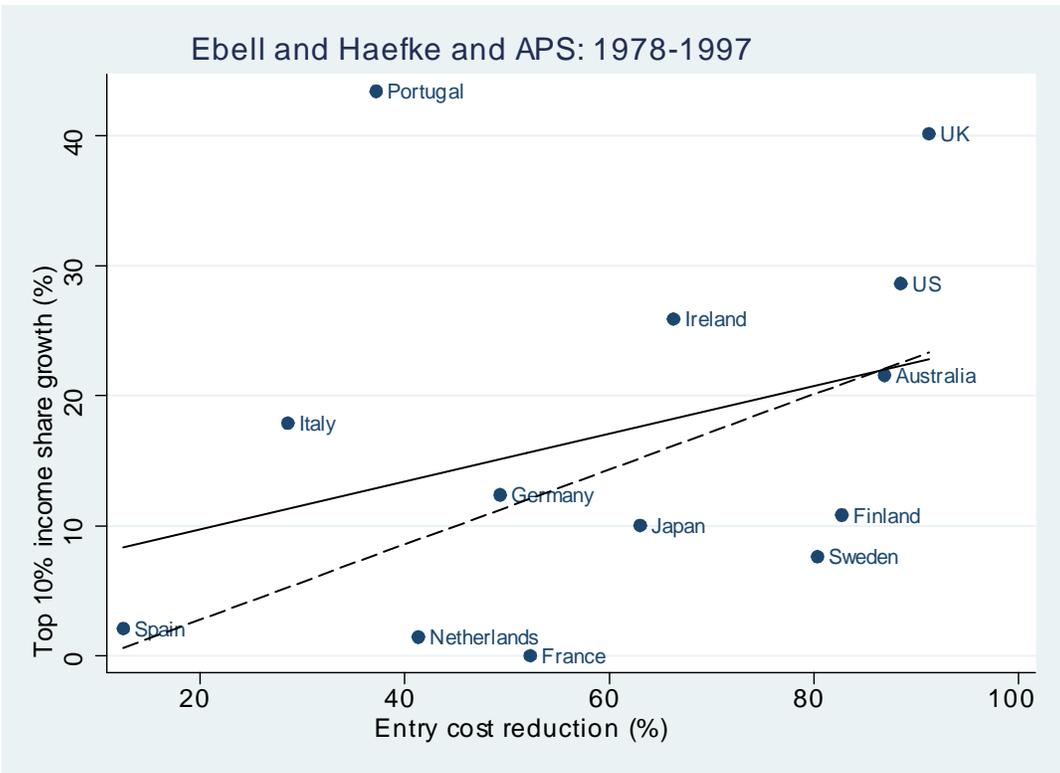


Figure 2

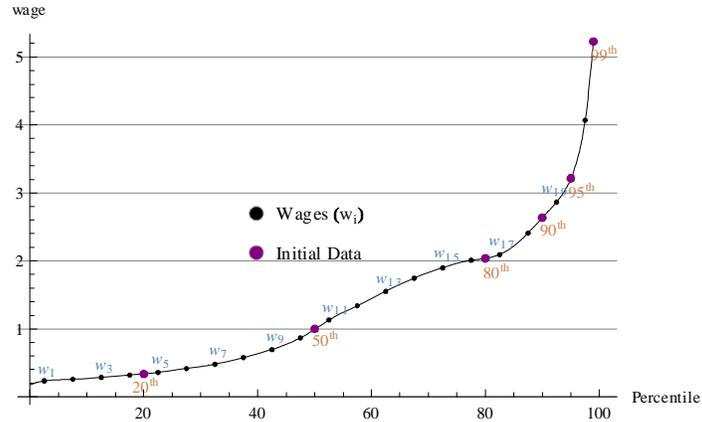


Figure 3: Calibrated wage distribution

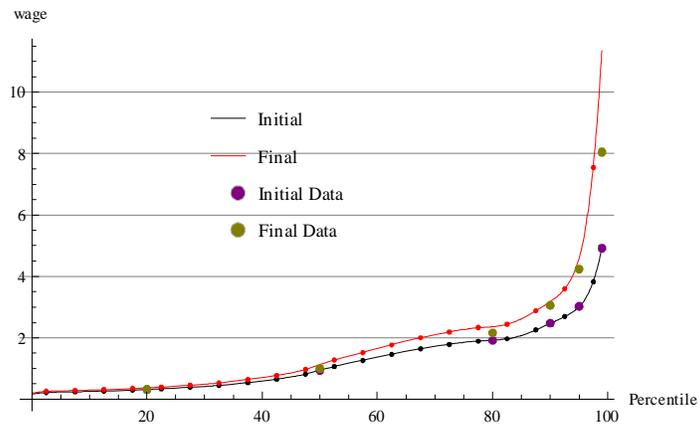


Figure 4: Benchmark experiment

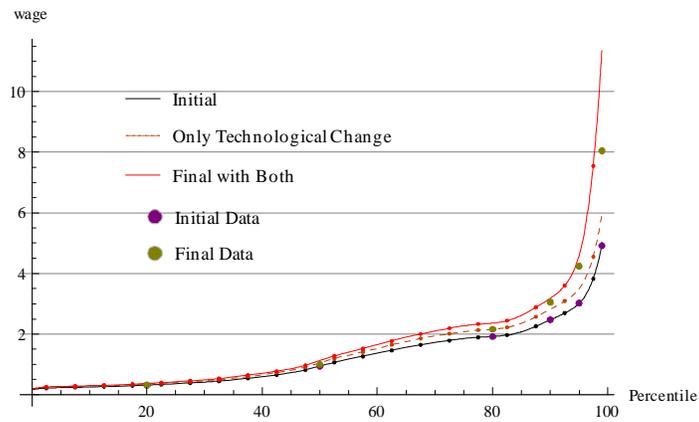


Figure 5: Counterfactual experiment 1 with only technological change

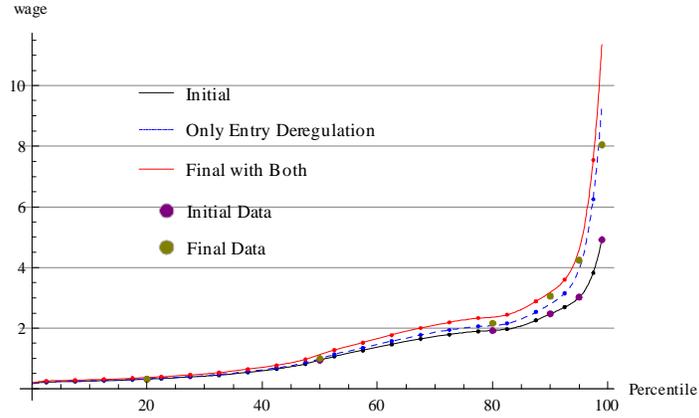


Figure 6: Counterfactual experiment 2 with only entry deregulation

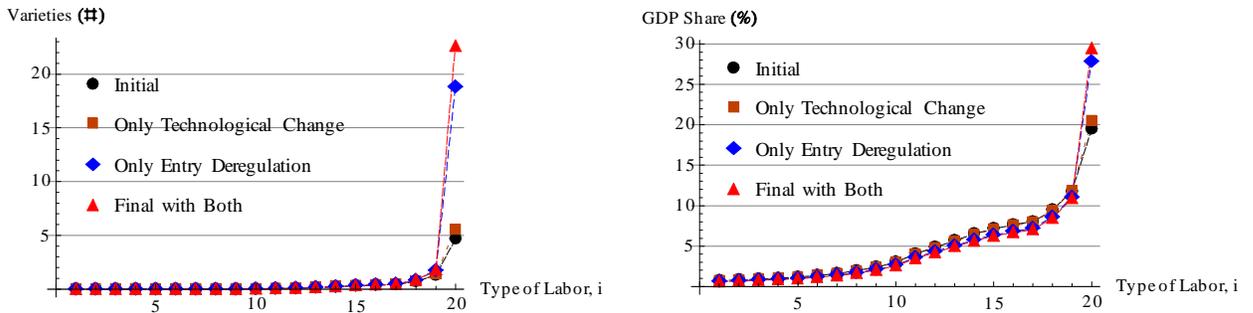


Figure 7: Distributions of varieties and GDP share