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. It links a decrease in entry costs to an increase in top income skewness under the assumption that higher-skilled workers are more flexible to handle a variety of tasks. Differences in flexibility of skills are modeled as differences in the setup costs required to handle 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 observed in the U.S. 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: 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?

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. It links a decrease in entry costs to an increase in top income skewness under the assumption that higher-skilled workers are more flexible to handle a variety of tasks.

One of the most well-known facts relating to income skewness in the U.S. is the increase in below-top skewness[1]: the upper-tail inequality in the bottom 90 percent of income distribution, such as the ratio of the 90^{th} to the 50^{th} percentile, has risen rapidly but the lower-tail inequality, such as the ratio of the 50^{th} to the 10^{th} 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 and, in fact, it has increased more than the below-top skewness. 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 data cannot.[4]

Dew-Becker and Gordon (2005) then do some simple calculations and show 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 developing

[1] Following Dew-Becker and Gordon (2005), we use the 90^{th} percentile as borderline. We 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."

[2] See 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.

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

[4] A 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).

[5] Dew-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 95^{th} to the 90^{th} percentile, the 99^{th} to the 90^{th} 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.

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

[7] Dew-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.

[8] In 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

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 skewness, 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.[9]

This paper, however, attempts to provide a unified, alternative explanation for both types of skewness.[10] 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.[11] 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).[12] 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.[13] 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

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.

[9] Dew-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.

[10] This 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.

[11] The 13 countries are Australia, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Portugal, Spain, Sweden, the U.K., and the U.S. We concentrate on developed countries for two reasons. First, entry cost data are available only for these countries. Second, the mechanism underlying the rise in inequality may be different for developing economies with different structural characteristics.

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

[13] As mentioned in Carrington and de Lima (1996), a number of Portuguese colonies became independent in the early 1970s, which led to a large scale return of the *retornados* from former colonies. They also mention that Portugal did widespread nationalization as it started charting a more socialist path during the 1970s and 1980s. These might be possible factors making Portugal an outlier: the increase in top skewness was large despite low deregulation.

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 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.[15] 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), respectively. 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 quan-

[14] This 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 Rossi-Hansberg (2008), and Blanchard and Willmann (2011).

[15] While we consider worker flexilibity, Campbell and Fisher (2004), for example, consider producer flexibility. In their model, increasing idiosyncratic risk induces a producer to substitute workers away from structured jobs that are costly to create and destroy and towards unstructured jobs that are costless. This substitution leaves the producer's employment more responsive to both idiosyncratic and aggregate disturbances.

titatively 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 the income share of the top 10 percent. Second, the assumption about flexibility is also compatible with the data on Stanford business school alumni and Denmark's registry data. Using data on Stanford business school alumni, Lazear (2005, 2012) empirically confirmed that leaders (who would be high-skilled workers) are generalists who are competent in many skills. Using Denmark's registry data, Frederiksen and Kato (2011) extended Lazear's analysis to the population of Danish workers and empirically confirmed that 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 has barely changed).[16] 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

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

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, 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.[17]

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. Those goods produced are used both for consumption as final goods and for production as intermediate goods. There are also I types of workers $i = 1, 2, .., I$.[18] The production of each variety requires the combination of all varieties of goods and a

[17] Gabaix and Landier (2008) attribute the income difference within the top workers to firm size. We can provide a flexibility-based explanation for this relationship between firm size and the top workers' income. As will be shown later, our model shows that the top workers with more flexibility work at larger (GDP share) firms and have a larger increase in income than the top workers with less flexibility.

[18] 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 within the top, in a simple manner.

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 $a_1 > a_2 > ... > a_I$. The country has a given endowment of each type of labor equal to L_i.

A representative consumer solves the problem of maximizing

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

subject to[19]

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

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 $z \in D_i$, $i = 1, 2, .., I$, has the production function

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

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.[20] 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 a_i. For the results of this paper,

[19] As will be shown later, we allow free entry of firms, which makes the profit of each firm zero. Thus there is no profit in the consumer's budget.

[20] The 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.

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 all firms create this composite good in-house, we assume that the same CES aggregator is used by all firms (and consumers) to convert varieties into a composite good. We assume it only to simplify aggregate demand functions for the varieties.

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:

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

where

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

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

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

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:

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

taking all other prices as given.

Let us derive the demand for each variety $z \in D_i,\ y_{z,i}$. The demand by the consumer for variety $z \in D_i$ is:

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

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

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

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

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

where

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

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

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

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

where

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

Thus, the total consumption and input demand for variety $z \in D_i$, $y_{z,i}$, can be expressed as

$$y_{z,i} = T q_{z,i}^{-\frac{1}{1-\rho}}, \qquad z \in D_i, \tag{15}$$

where

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

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

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

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

$$q_{z,i} = \frac{G_{2,i}}{\rho}, \qquad z \in D_i. \tag{18}$$

Further, we allow free entry. Then, by the zero profit condition for this $q_{z,i}$,

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

we obtain

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

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, 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*

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

5. *The factor markets clear*

$$n_i l_{i,z} = L_i, \qquad i = 1, 2, .., I, \tag{22}$$

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 available 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 $i = 1, 2, ..., 20$. 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, $i = 1, 2, .., 20$, 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).[21] The decision to use 1979 data is guided 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 20^{th}, 50^{th}, 80^{th}, 90^{th}, 95^{th}, and 99^{th} 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 bechmark 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 decreasing (inverse) productivity parameter, A, by 4.92 percent 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,

[21] For 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).

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.[22,23]

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 (see Table 2) can be summarized as follows:

1. *Change in below-top skewness*: In the data, from 1979 to 1999 the ratio of the 50^{th} to the 20^{th} percentile decreased by 0.52 percent, and the ratio of the 90^{th} to the 50^{th} percentile increased by 19.23 percent with a difference between the two of 19.75 percentage points.[24] 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 99^{th} to the 90^{th} percentile increased by 32.74 percent. In this experiment, it increases by 79.85 percent.[25]

3. *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.[26] 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.

4. *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.[27] In this experiment, it was 57.75 percent.

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

[23] In our model, productivity growth and output growth are equivalent.

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

[25] See footnote 24.

[26] The 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.

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

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. 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 (see Table 2) can be summarized as follows:

1. *Change in below-top skewness*: In the data, from 1979 to 1999 the ratio of the 50^{th} to the 20^{th} percentile decreased by 0.52 percent, and the ratio of the 90^{th} to the 50^{th} 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 99^{th} to the 90^{th} percentile increased by 32.74 percent. In this experiment, it increases by 5.96 percent.

3. *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.

4. *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.

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 (see Table 2) can be summarized as follows:

1. *Change in below-top skewness*: In the data, from 1979 to 1999 the ratio of the 50^{th} to the 20^{th} percentile decreased by 0.52 percent, and the ratio of the 90^{th} to the 50^{th} 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 99^{th} to the 90^{th} percentile increased by 32.74 percent. In this experiment, it increases by 66.37 percent.

3. *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.

4. *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.

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 $(= n_1 + ... + n_{20})$ 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 because a given decrease in F corresponds to a larger decrease in total fixed costs (entry costs plus labor setup costs) for firms employing more-flexible workers. For example, the ratio of the total fixed costs of firms employing the most flexible workers to those employing the least flexible workers falls by about 59 percent. As a result, the relative demand and 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 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 an increase in 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. Then the employment size of firms using the more-flexible workers shows a larger decrease. This is because while L_i is fixed, n_i shows a larger increase for firms using the more-flexible labor as has shown in Figure 7. The average size of firms, measured by output, also decreases from 22.12 to 8.65.[28] 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.

[28] The average size of firms, measured by the *value* of output, also decreases from 27.10 to 11.84.

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.

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 shown in Figures 1 and 2, the increase in top incomes in the U.S. since the late 1970s was much greater than in continental Europe and Japan (see also Dew-Becker and Gordon, 2008).

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, technlogical 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 decreased by 44 percent in Japan and by 65 percent in the U.S. Thus Japan showed a lesser decrease in entry costs than 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 that provides a unified explanation of the facts on both below- and within-top skewness. It linked a decrease in entry costs to an increase in top income skewness under the assumption that higher-skilled workers are more flexible to handle a variety of tasks. 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 the observed 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.[29] We leave the assessment of contributions of these factors to income skewness to future research.

[29] Dew-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.

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Parameter values	*Targets*	*Based on*
$\rho = 5/6$	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)
Normalizations: $F = q = 1$; $I = 20$; $L_i = 5$.		

Table 1: The parameterization of the model

	Data (1979-1999)	*Both*	*Only technological change*	*Only entry deregulation*
P50/P20	–0.52%	–1.62%	–0.86%	–0.76%
P90/P50	+19.23%	+7.93%	+1.86%	+6.64%
P99/P90	+32.74%	+79.85%	+5.96%	+66.37%
Mean	+45.71%	+37.41%	+13.92%	+19.46%
Median	+3.43%	+19.12%	+11.95%	+6.01%
Top 10%'s share in gains	54.61%	57.75%	34.91%	70.15%

Table 2: The data and the results for numerical experiments

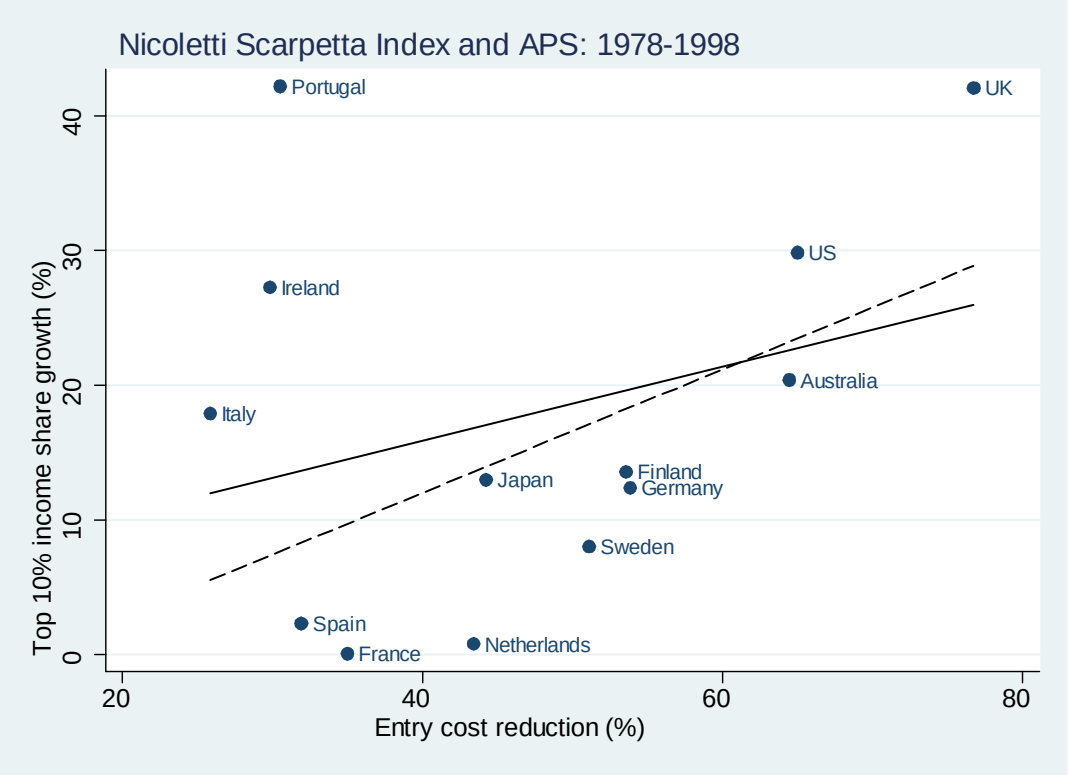

Figure 1

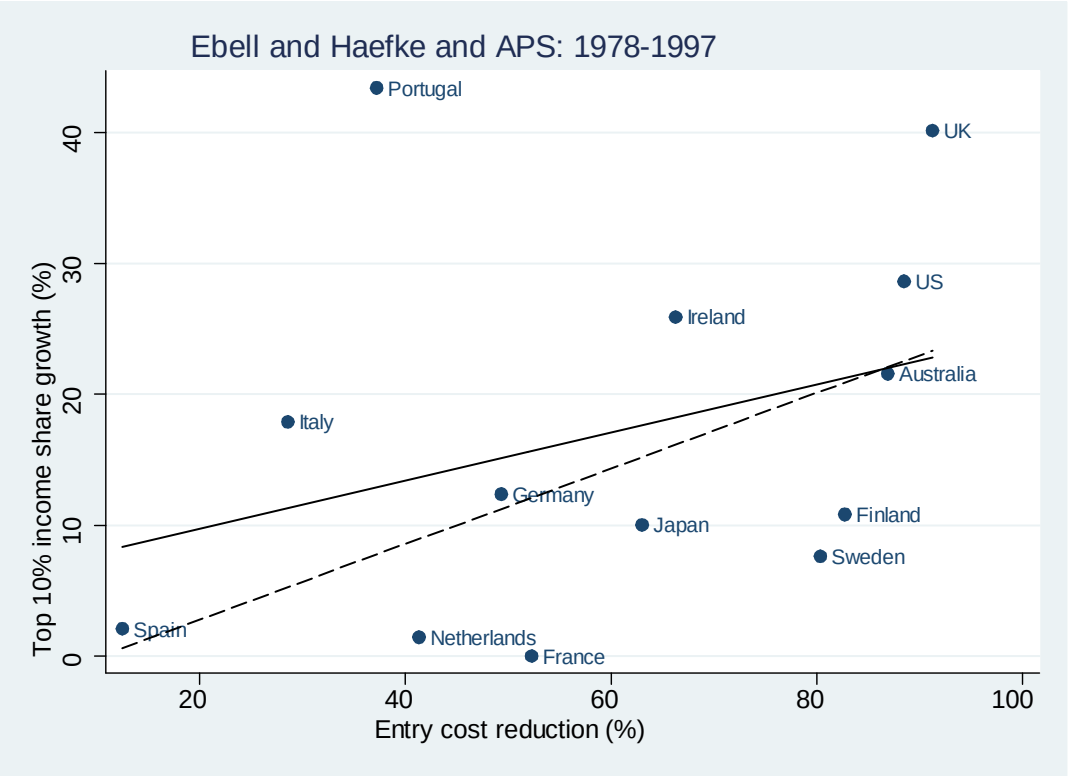

Figure 2

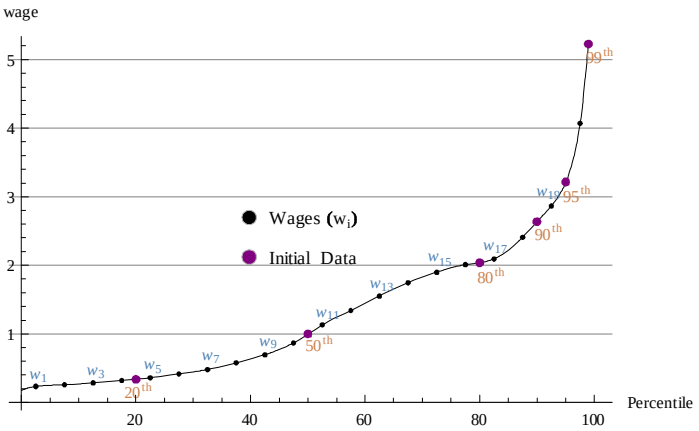

Figure 3: Calibrated wage distribution

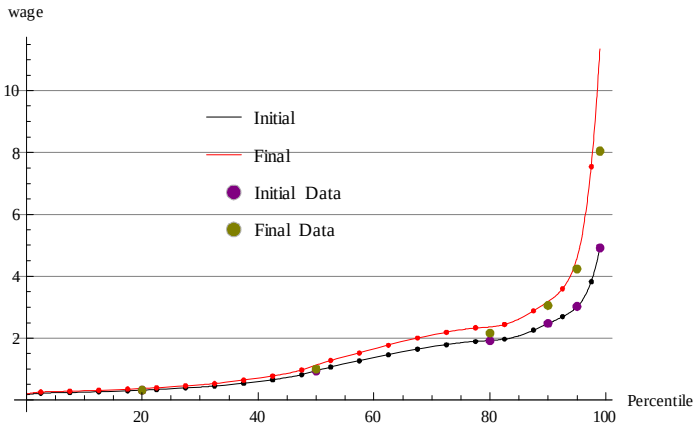

Figure 4: Benchmark experiment

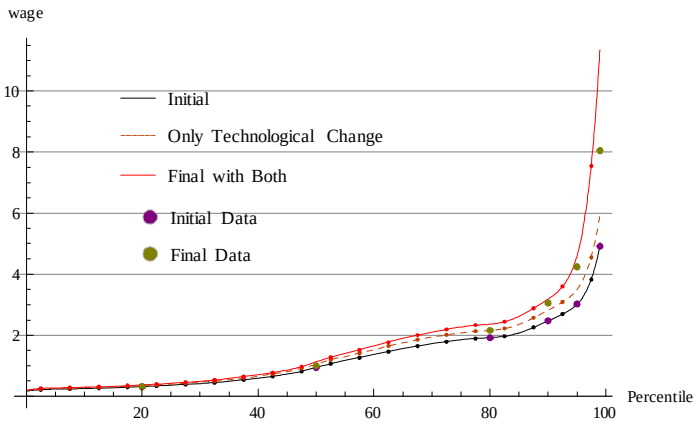

Figure 5: Counterfactual experiment 1 with only technological change

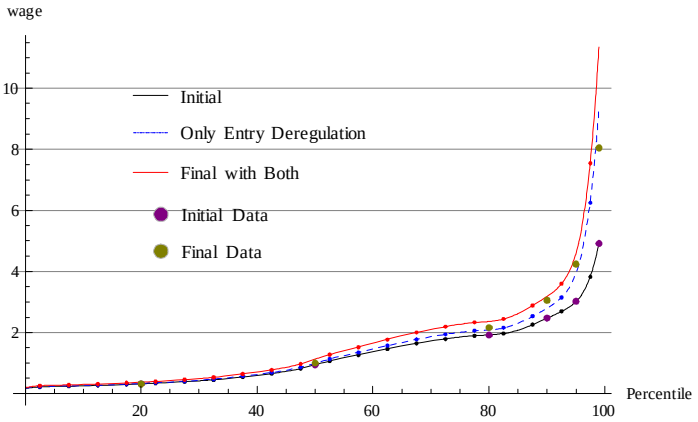

Figure 6: Counterfactual experiment 2 with only entry deregulation

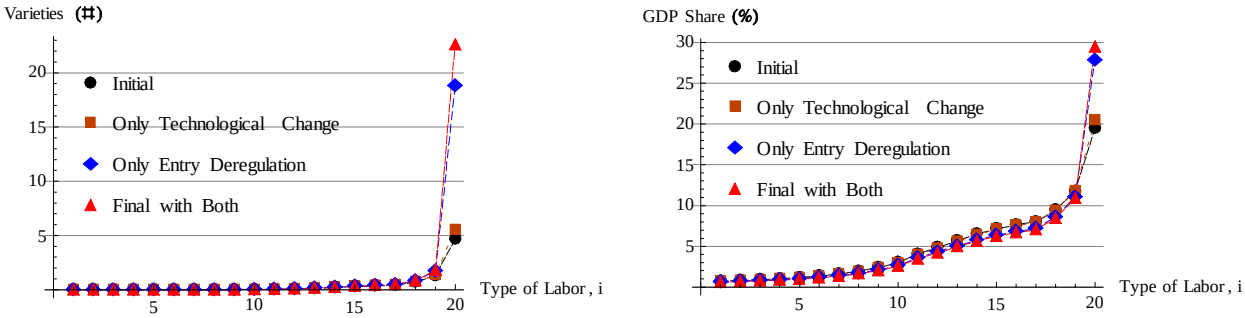

Figure 7: Distributions of varieties and GDP share