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Occupational choice and development ☆

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Abstract

The rise in world trade since 1970 has been accompanied by a rise in the geographic span of control of management and, hence, also a rise in the effective international mobility of labor services. We study the effect of such a globalization of the world's labor markets. The world's welfare gains depend positively on the skill-heterogeneity of the world's labor force. We find that when people can choose between wage work and managerial work, the worldwide labor market raises output by more in the rich and the poor countries, and by less in the middle-income countries. This is because the middle-income countries experience the smallest change in the factor-price ratio, and where the option to choose between wage work and managerial work has the least value in the integrated economy. Our theory also establishes that after economic integration, the high skill countries see a disproportionate increase in managerial occupations. Using aggregate data on GDP, openness and occupations from 115 countries, we find evidence for these patterns of occupational choice.

JEL classification: D21; D33; E23; E25; F40

Keywords: Occupational choice; Mobility; Matching; Openness

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1. Introduction

We study how the integration of the world's managerial and labor markets affects development. Increasingly in recent decades, economic agents who are very distant from each other can nonetheless potentially produce together. The labor inputs themselves do not necessarily need to move in order for the output to be produced, as long as there is an adequate communication or transportation technology.

The predicted gains to world welfare of such a transformation of the labor market depend directly on the extent of skill-heterogeneity of the world's labor force. That is, as in the standard model, the gains from trade depend on the heterogeneity of factor endowments which, in our model, consist of human capital per worker. These gains, however, are not equally distributed among local economies – not all of them will record the same increase in output when the world labor market opens up. We show that the gains from trade are larger in economies with either high or low GDP. We show furthermore that the increase in managerial occupations is disproportionately high in high skill economies, and provide evidence in support of this pattern of occupational shift.

The basic premise of our analysis is a span-of-control production technology where the exact allocation of skills between managers and workers determines the firm's productivity. Skilled agents in the labor market make an occupational choice decision whether to become a manager or a worker. Their choice is determined by equilibrium prices in the labor market. A manager's productivity is determined by her skill and limited by her span-of-control. High skill managers are more productive if they command a given set of workers than low skill managers. Because managers are not perfect substitutes in this span-of-control technology while workers are, the exact allocation matters both within the firm and economy-wide. The implication is that the compensation schedule for managers is non-linear in manager skill and linear in worker skill. This compensation structure leads to sorting of the higher skilled agents into managerial occupations.

Our model technology captures the production process of products like the Apple iPod or iPhone. Design and software development are executed by high skill managers in Cupertino, California, while most of the manufacturing happens in Taiwan and mainland China, and the final product is sold worldwide. The same is true for Italian designer clothing, the patterns of which are drawn and designed in Milan and the raw materials and couture are produced in China. The main characteristic of these production processes is the role of the managerial worker in affecting the final result. A small change in her skill will substantially affect the final output, given the mass production at low wages. The skill of the manager determines her span-of-control. Economic integration only exacerbates the impact of the manager's span-of-control because worker and manager need not be physically near to produce. In that sense, the production with "distant" labor inputs turns up in the statistics of intermediate goods being traded: Software and blueprints flow from California to Taiwan; hardware flows in the opposite direction.

As a first approximation we interpret autarky as a situation in which agents in each country have identical skills but in which they can trade freely with agents in the same country. A conversion from autarky to a world labor market leads to a U-shaped pattern with benefits being highest for the high GDP economies as well as for the low GDP economies. The high GDP countries now have access to a pool of cheap labor which gives their high skill managers a huge comparative advantage. This drives up the world wage for workers, increasing the gains for the low GDP countries. For the middle economies the gains are lowest, since there always exists a country, somewhere in the middle of the distribution, where the wage remains unchanged, and where the

residents are no better off than they were under autarky. The middle-income countries experience the smallest change in the factor-price ratio; for them the option to choose between wage work and managerial work has the least added value in the integrated economy.[1]

We account for how much of the gains in output are actually due to efficient occupational switching. Free trade raises output even in the absence of switching, simply because in a world market, workers face different prices for labor, and a manager in the US can now hire workers in, say, India at lower wages. Occupational switching allows for additional efficiency gains because it may benefit more US agents to choose a career in managerial occupations rather than as wage workers. To account for the additional occupational reallocation effect, we shall decompose the effect of openness into (i) the effect in which each agent's occupation is held constant, and (ii) the occupational switching effect, which our model has. Effect (i) raises the equilibrium span of control of high-ability managers and lowers it for the low-ability managers, and implies a reallocation of existing workers among existing managers. Effect (ii) allows low-ability managers to become workers and high-ability workers to become managers, and this leads to additional output gains. We show that the efficiency gains from occupational switching are large.

Because higher skilled managers generate higher output with the same set of workers, a high skill economy has a comparative advantage in managerial occupations. With increased openness and economic integration, this leads to a disproportionately high occupational choice of managerial jobs in high skilled economies. High skill managers can now access cheap labor world wide, which leads a large portion of the agents to switch from wage labor before to management after economic integration.

Our theory of occupational choice, and the prediction that high skill economies disproportionately switch into managerial occupations is borne out by occupational choice data. Using ILO standardized occupation categories for 115 countries between 1970 and 2004, we find that there is indeed a disproportionate increase in the fraction of managerial jobs added in the economy. While all economies on average have added managerial jobs since 1970, the high skill economies, those with a high GDP per capita, have added substantially more. This tilting of the relation between occupational choice and skills provides evidence of a pattern of occupational choice that is consistent with our theory. We confirm this hypothesis with an additional data set and measure the impact of an index of globalization on entrepreneurial activity. Of course, these facts merely confirm the consistency with our model and cannot rule out alternative explanations, which we further discuss at the end of the paper.

Finally our model is consistent with the finding by Gabaix and Landier [12] that the recent rise in the level and dispersion of managerial earnings is explained by a similar rise in the level and dispersion of the resources under their control. Such a rise occurs in our model as a result of globalization, but it does not take place in the standard model. Although it is formally about occupational choice, our model is in the same general spirit as that of Yi [27], who argues that

[1] A similar result sometimes obtains in a Heckscher–Ohlin framework: Deardorff [10] points out that if one were to order goods in terms of their factor intensities, then a country's exports must rank higher on this list than its imports. In particular, there exists a pair of goods in the chain such that if a country produces just these goods, it would gain least from openness. The inverted U-shaped gains to trade that the standard Heckscher–Ohlin model would predict refers to the middle of the distribution of factor endowments. If, in addition, factor ratios relate monotonically to incomes per head then the result would be the same as ours. In our setup, there is also a role for the allocation of managerial jobs. We separate a pure trade effect as in Heckscher–Ohlin from the sorting effect when we analyze globalization with no occupational switching (Section 3).

at some point the post-1960 tariff reductions suddenly led to a rise in the tendency for countries to specialize in the production of particular stages of a good's production sequence, and the consequent rise in the international trading of intermediate goods.

Work closest to ours is Kremer and Maskin ([15], 'KM'), Murphy, Shleifer and Vishny ([21], 'MSV'), and Antràs, Garicano and Rossi-Hansberg ([3], 'AGR') who deal, as we do, with the globalization of labor markets.[2] To this work we add in two ways. First, we prove our middle-class result which KM, MSV, and AGR do not contain, and that for good reason: MSV is not about trade and focuses on talent diversion into rent-seeking occupations, whereas KM and AGR are two-country models with heterogeneous populations. The middle-class result emerges only in a many-country world in which, prior to globalization, each country is sufficiently homogeneous when compared to the dispersion of skills in the world as a whole. Second, we show new evidence that the integration of labor markets has been accompanied by a rise in the fraction of agents choosing to be managers, more so in the rich than in the poor countries. This confirms our model's implication that with globalization the rich countries should have experienced the largest rise in managerial employment, but this is an implication that one finds also in AGR and, under some conditions, in KM and in several other span-of-control models, and so we offer this evidence as supporting span-of-control models generally.

Lucas [16] has a similar model, but in it workers all have the same wage, and so the distribution of earnings has a counterfactual spike at the lowest income that most of the economy's agents earn. Similar spikes also exist in the models of Burstein and Monge-Naranjo [7] who study the flow of capital and management across countries and distinguishes country-specific and firm-specific effects on productivity and of Monge-Naranjo [20] who studies the impact of foreign firms for the accumulation of domestic skills in a developing country. Our paper treats skills as given; they do not respond to globalization. By contrast, Easterly and Nyarko [11] study how skills respond to the possibility of a brain drain, a regime shift somewhat similar to the one implied by globalization.

McGrattan and Prescott [18] analyze the effect of openness in an economy with multinational production as opposed to trade, and Ramondo and Rodríguez-Clare [23] study this channel and intermediate-goods trade as well. Each channel represents a highly important way in which the labor market is being globalized although the rising importance of direct-employment relations between management and workers in distinct geographic locations is a third and direct mechanism of globalization. Our model interprets all these as mechanisms of technology transfer. What we add to this discussion is an analysis how gains to trade relate to the global dispersion in skills, and how the distribution of workers across occupations should respond.

Our model also relates to the recent work by Costinot and Vogel [9] and Acemoglu and Autor [1]. As in those models, ours aims to capture the change in the off-shoring opportunities that allow substitution of domestic by foreign labor, and it predicts non-monotone wage changes for different skills and job polarization. All these models have in common a task-based labor market where market wages are the result of the equilibrium assignment of skills to tasks.

We analyze only the static economy and so we do not add to an area in which David Cass (Cass [8], e.g.) provided fundamental insight. Since we assume that after globalization a manager can manage workers in a distant location as easily as he can manage workers in his own location, in our world it is not necessary that management skills be created locally in a devel-

[2] Gavilan (2006) adds physical capital to KM model and studies its impact on the equilibrium assignment of workers to managers.

oping economy. When this assumption fails, there will be transitional dynamics as the world economy moves towards the new steady state. Indeed, papers that study transition dynamics such as Kremer and Thomson [14] and Monge-Naranjo [20] assume that management must be supplied locally, although the costs of creating it may decline with foreign presence.

Geographical distance surely limits the reach of management, and yet there are several ways in which a manager can gain control of factors located in another country: FDI, M&As, and to a lesser extent contracting with firms (e.g., holding suppliers to tight but feasible specifications as Walmart does) in the country in question. Each mechanism is subject to frictions so that management services cannot instantaneously flow everywhere until their marginal product was equalized at all geographical locations. Impediments to these mechanisms are disappearing, but at rates that differ from country to country. For this reason we use a country-specific measure of openness to control the extent to which the forces that we highlight would affect individual countries.

2. The model

We shall consider a world population consisting of agents endowed with a one-dimensional skill x.[3]

Production. Firms produce output q with the input of a manager and a set of workers. Denote the production function by

$$q = xQ(h) \tag{1}$$

where x is the manager's skill or efficiency and h is the total number of efficiency units of labor that the firm's workers possess. We assume $Q' > 0$, and $Q'' < 0$. The manager is the entrepreneur who owns the firm, and she hires workers at the price of w per their efficiency unit. The inputs into the production function (1) enter asymmetrically: Only one manager can perform the job, but there is substitution of quality and quantity of workers in h, and any number of workers can be hired.

The firm's decision problem. When facing an efficiency-units wage w, a manager of type x solves the problem

$$\pi(x, w) \equiv \max_h \{xQ(h) - wh\}, \tag{2}$$

which has the FOC

$$xQ'(h) = w. \tag{3}$$

Equilibrium. A market equilibrium for an economy satisfies the firm's decision problem

$$\pi(x, w) = \max_h \{xQ(h) - wh\},$$

occupational choice, i.e., the set of managers $E(w)$ satisfies

$$E(w) = \{x \in \mathbb{R}_+ \mid \pi(x, w) > wx\} \tag{4}$$

and market clearing (see Eq. (8) below).

[3] In Section 3.2 we consider the case of multi-dimensional skills.

3. Results

In this section, we consider the transition from a collection of economies in autarky to a world economy with free trade. This experiment yields the greatest gains to countries in the tails of the world income distribution. First we establish the result for the uni-dimensional skill type. The uni-dimensional model is of course highly stylized as a model of the world economy because all workers within a country are identical. In Section 3.2, we extend our analysis to the case of two-dimensional skills which generates within-country heterogeneity.

3.1. Uni-dimensional skill types

Autarky. Under autarky, each atomless agent belongs to a local economy or country. Within that country, agents are identical, each being of type, say, x, and each can become a worker or a manager. As a worker that person would earn wx and as a manager, he or she would earn $\pi(x, w)$.

Autarky equilibrium is a wage w and a fraction n of people that become workers, such that they solve the pair of Eqs. (5) and (6). In equilibrium the supply of h would be xn and per manager (the fraction of which is $1-n$) the supply of h would be $xn/(1-n)$. For managers to wish to employ this market-clearing quantity, it would have to satisfy (3), which then would read

$$xQ'\left(\frac{xn}{1-n}\right) = w. \tag{5}$$

For managers and workers to all be happy in the occupation they have chosen, $\pi(x, w)$ would have to equal wx. That is,

$$xQ\left(\frac{xn}{1-n}\right) - w\frac{xn}{1-n} = wx. \tag{6}$$

We denote the autarky equilibrium by $\{w(x), n(x)\}$. It is the pair of numbers (w, n) solving (5) and (6) for the type-x autarkic economy.

These equilibrium outcomes are driven by the feasible matches. In the case of autarky, only agents of the same type can work together, implying labor income $w(x)x$ and profits $\pi(x)$ are the same. The implication is of course that wages are different in each local economy indexed by x.

Example. Let $Q(h) = h^\alpha$. Then (5) reads $\alpha x h^{\alpha-1} = w$, and (6) reads $xh^\alpha - wh = wx$. Together, these two imply that $h = \frac{\alpha}{1-\alpha}x$. Since $h = xn/(1-n)$, this means that

$$n(x) = \alpha \quad \text{and} \quad w(x) = (1-\alpha)^{1-\alpha}\alpha^\alpha x^\alpha. \tag{7}$$

Worldwide labor market. We assume the managers can extend their span of control around the globe.[4] Let $F(x)$ be the world distribution of $x \in \mathbb{R}_+$, assumed atomless. Now w is a wage that

[4] The rise in intermediate goods and even in final goods imports may reflect a more worldwide labor market. Walmart, e.g., has considerable monopsony power in China and often dictates how the goods should be produced if it is to buy them. Effectively, Walmart's management partly designs the product that a Chinese worker will produce. Globalization of labor markets then implies that US imports from low-income countries should have risen more than US exports to them did. Bernard, Jensen and Schott [6, Table 16] show that this in fact happened. More generally, the share of US exports and imports accounted for by multinationals has risen – Bernard et al. [6, Table 13].

prevails world wide. A type-x manager in this economy still solves (2). Denote the manager's demand function $h = g(x, w)$; it solves (3) for h.

Then the set of managers is the set $E(w) = \{x \in \mathbb{R}_+ \mid \pi(x, w) > wx\}$. The market-clearing condition then reads

$$\int_{E(w)} g(x, w)\, dF(x) = \int_{\mathbb{R}_+ - E(w)} x\, dF(x). \tag{8}$$

Then a *world-market equilibrium* is a wage w that solves (8).[5]

Denote by z the skill type that is indifferent between becoming a manager and a worker:

$$\pi(z, w) = wz. \tag{9}$$

By the envelope theorem, $\pi_x = Q(g[x, w])$, and since $g_x > 0$, $\pi_{xx} > 0$. Since $\pi(0, w) = 0$, (9) has at most two intersections. Since F is atomless, it follows that $E(w) = [z, \infty)$, i.e., employers are drawn from the top of the distribution.

Under world-wide free mobility of labor, a high skilled agent can start a firm and hire workers on the world labor market at the world wage w (per efficiency unit). Because firms need both workers and managers, not all types can become managers. The managers are in the high skill economies and hire workers from low skill economies.

Example. Again, let $Q(h) = h^\alpha$. As under autarky, the FOC is $w = \alpha x h^{\alpha-1}$. Using this to substitute for w in (9), we get that for entrepreneur z, factor demand is $g(z, w) = \frac{\alpha}{1-\alpha} z$ and therefore,

$$w = (1-\alpha)^{1-\alpha} \alpha^\alpha z^\alpha, \tag{10}$$

which gives us w in terms of z. The second restriction on w and z is the market-clearing condition

$$\int_z^\infty g(x, w)\, dF(x) = \int_0^z x\, dF(x) \tag{11}$$

in which, for $x > z$, we have $g(x, w) = \frac{\alpha}{1-\alpha} z^{\frac{-\alpha}{1-\alpha}} x^{\frac{1}{1-\alpha}}$ after substituting w from (10).

Now suppose that $\alpha = 1/2$ and that the skill distribution is uniform on $[0, 1]$: $F(x) = x$. Then we have for the autarky solution that for all x, profits and wage earnings are $w(x)x = \frac{1}{2}x^{\frac{3}{2}}$. For the free-market solution, equilibrium satisfies $z = 0.69$, $w^F = 0.42$, and incomes are $\max\{w^F x, \pi^F(x)\} = \max\{0.42x, 0.59x^2\}$. Earnings under autarky in function of skills x are plotted in Fig. 1(a). In Fig. 1(b), the straight line (red) is the wage income, the constant wage times the efficiency units x. The convex function (blue) is the profit schedule. Low types are better off in the occupation of a worker, whereas high types earn profits that are over and above the wage income. The type z is the one who is indifferent.

In the case of full factor mobility, high skilled agents start firms and their demand for labor drives up world wages. Because the lower types have a competitive advantage as workers, they prefer to be hired rather than be a manager.

The main result below establishes that the marginal type does not gain from factor mobility relative to autarky. This is illustrated for the former example where we now plot the

[5] This analysis will later be applied to a closed economy in which F_i is the distribution of skill in country i and in which the world distribution of skills is $\Sigma_i F_i$.

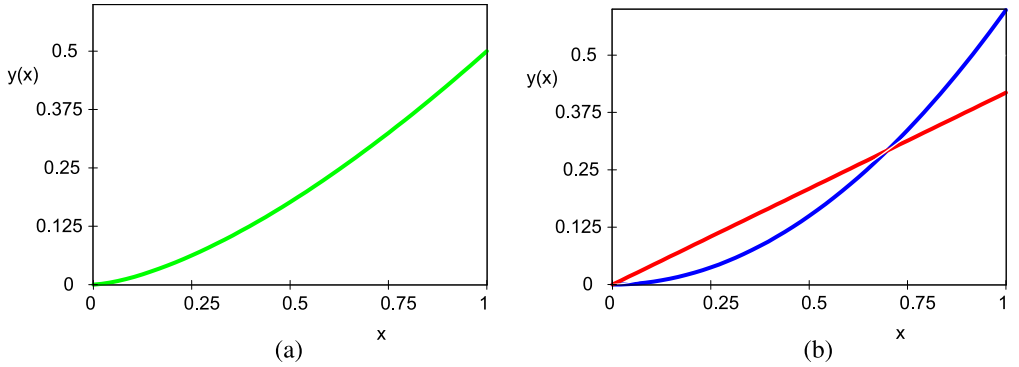

Fig. 1. Income profile $y(x)$ (a) under autarky and (b) under factor mobility (wage earnings (red) – profits (blue)). [Plots for $Q(h) = h^{0.5}$, $F(x) = x$.] (For interpretation of the references to color, the reader is referred to the web version of this article.)

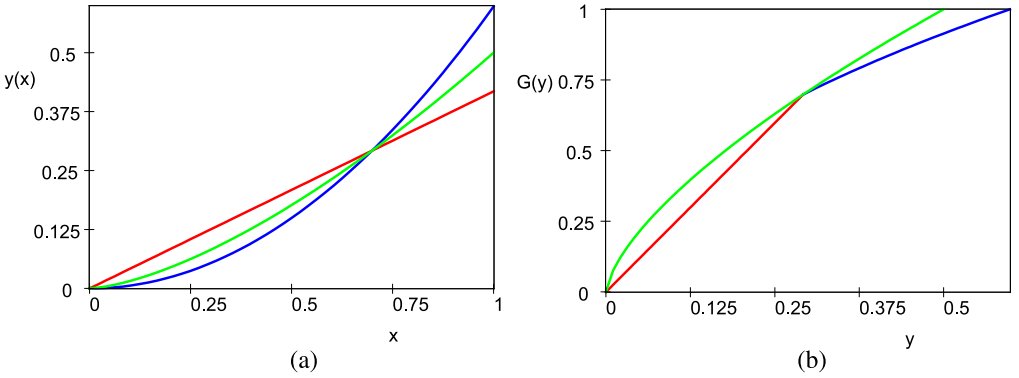

Fig. 2. (a) Income profiles $y(x)$ of all regimes; (b) CDF and first-order stochastic dominance of the distribution under autarky by that under factor mobility. [Plots for $Q(h) = h^{0.5}$, $F(x) = x$.] (For interpretation of the references to color, the reader is referred to the web version of this article.)

equilibrium wage and profit schedules on the same graph (Fig. 2(a)): autarky (in green) intersects exactly where wage earnings (red) and profits (blue) intersect. The graph plots income $y(x) = \pi(x) = wx$. That this dominance is *weak* follows because z is equally well off under autarky and factor mobility.[6] The plot for the CDF under both autarky (green) and factor mobility (red and blue) is in Fig. 2(b).

We will now show that in general, all agent types but one are strictly better off in a free market than under autarky. The one type that remains no better off than before is type z – the type that under the free market is indifferent between management and wage work. To avoid confusion, we shall use the superscript "A" for the value that a variable assumes under autarky, and the superscript "F" for its free-market value.

[6] That country z is no better or worse off under free trade is a result that has a counterpart in the standard two-skill model with a continuum of countries but with no occupational choice. Let factor endowments differ. There always would be one country in which the skill premium under autarky is the same as the world skill premium under free trade. That country would then be no better off under free trade than under autarky.

Proposition 1. *If* (i) $F(\cdot)$ *is atomless and continuous, and if* (ii) $Q'(h)$ *decreases continuously from* $+\infty$ *when* $h = 0$ *to* 0 *when* $h = \infty$, *an equilibrium with factor mobility exists at* z, *satisfying*

$$x_{\min} < z < x_{\max}, \tag{12}$$

where $x_{\min}$, $x_{\max}$ *are the minimum and maximum on the support of* x, *and, moreover,*

$$\pi\big(z, w^A[z]\big) = w^A(z)z = w^F z = \pi^F(z). \tag{13}$$

The proof starts from the premise that at z, the equilibrium allocation must satisfy the equilibrium conditions for the equilibrium with factor mobility. The proof then shows that the exact same allocation also satisfies the equilibrium conditions for autarky. The proof consists of two lemmas:

Lemma 1. *If* (z^F, w^F) *is a free-market equilibrium, then* w^F *is the autarky wage in a country for which* $x = z^F$.

Proof. Since (z^F, w^F) is an equilibrium,

$$\pi\big(z^F, w^F\big) = w^F z^F.$$

Now in autarky in country $x = z^F$, the indifference condition is also met. I.e., (13) holds. This leaves the market-clearing condition and the FOC. This requires that there be a measure of workers n such that

$$z^F Q'\left(\frac{nz^F}{1-n}\right) = w^F \quad \Longleftrightarrow \quad Q'\left(\frac{nz^F}{1-n}\right) = \frac{w^F}{z^F},$$

where $\frac{nz^F}{1-n}$ is human capital per manager. But by (ii), as the number of workers, n, rises from zero to unity, Q' declines from $+\infty$ to zero, and so a unique $n \in (0, 1)$ exists for which this equation will hold, with $1 - n$ being the number of managers, so that the number of bodies adds up to unity. Finally, total human capital supplied, nz^F, equals the amount of it demanded,

$$nz^F = (1-n)\left(\frac{nz^F}{1-n}\right).$$

Thus all the conditions of an autarky equilibrium are met at (z^F, w^F). □

Lemma 2. z^F *satisfies* (12).

Proof. Suppose $z^F = x_{\max}$. Then by (i) since there is no mass point at $x_{\max}$, demand for h would be zero, and there would be an excess supply of workers. Conversely, if $z^F = x_{\min}$ there would be an excess supply of workers. □

Together, Lemmas 1 and 2 imply (13) and thus Proposition 1. Because under factor mobility, occupational choice effectively implies that the equilibrium allocation is the upper envelope of the wage and profit schedule, the next proposition immediately follows:

Proposition 2 *(First order stochastic dominance). The distribution of earnings under factor mobility* (*weakly*) *stochastically dominates the distribution under autarky.*

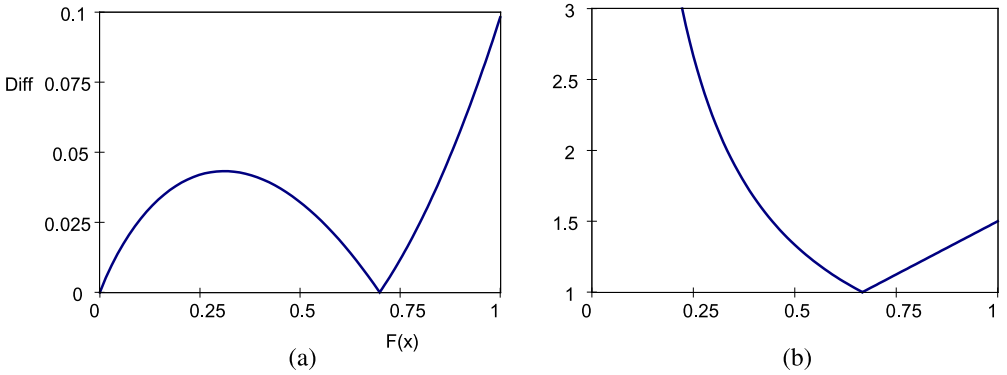

Fig. 3. Earnings from factor mobility: (a) differences; (b) ratio. [Plots for $Q(h) = h^{0.5}$, $F(x) = x$.]

We now investigate the implications for growth and occupational switching.

The implications for growth. By Proposition 1, there are gains from factor mobility. However, from Lemma 1 those gains are not distributed equally over all types. At least one type is no better off. In Fig. 3, we plot the gains from factor mobility by rank of the distribution. Fig. 3(a) has the absolute differences and Fig. 3(b) has the growth rates.

Fig. 3(a) shows that in absolute terms, the biggest winners are in the right tail: The high types who own the firms and become managers gain most from factor mobility, and so do the workers. The type who is indifferent does not gain. In our example with the uniform distribution, the lower type does not gain anything from factor mobility because output is zero before and after.

Fig. 3(b) shows that relative to their initial position, the biggest winners are in the *left* tail. Growth rates exhibit a U shape. The extremes of the distribution gain most from factor mobility. To see this, consider the lowest types, who under autarky work with low productivity managers and earn very low wages. After opening up to factor mobility, their labor is demanded from all over the world and their wage is determined in the world labor market. This results in a huge increase in earnings.

The high types do grow and the growth rate is increasing in type, i.e. the top of distribution gains proportionally more the higher up in the distribution. At the bottom of the distribution (below the no-gaining middle-income group) in growth rates now there is monotonicity. While worker salaries went up everywhere in the lower part, they went up proportionally more for the lower types. Their output therefore grows more the lower the type. That nonetheless does not translate into any income differences as the lowest types still produce zero output; hence the non-monotonicity in income differences.

Globalization with no occupational switching. The question remains how important the role is of occupational switching. Opening up trade in itself will generate welfare gains even without occupational switching. We therefore perform the experiment in which we allow for mobility of labor, but we do not allow agents to switch occupations.

If a single global labor market opens, there is a single wage $\tilde{w}$ that would clear the market. Because occupational switching is not allowed, $n(x)$ type-x agents are still workers and $1 - n(x)$ are still managers in the new regime. Manager x solves the decision problem in (2), and has a factor demand $g(x, w)$, just as before. The market clearing wage again satisfies a single condition but, instead of (11), that condition is

$$\int_0^\infty g(x,w)\big[1-n(x)\big]\,dF(x)=\int_0^\infty xn(x)\,dF(x), \tag{14}$$

where $n(x)$ is given by the equilibrium allocation under autarky. Notice that the RHS does not depend on the wage – workers have no choice but to remain workers no matter what they are paid. There is a gain in output over autarky, but it is limited by the inability of agents to switch occupations.

The intuition for the gain in output despite the absence of occupational switching stems from the change in factor prices. Now there is one world wage which changes the optimal allocation of workers to managers. In other words, wage equalization requires a reallocation of labor from low skill managers to high skill managers and this raises overall efficiency, even if there is no change in the number of managers and workers.

The Cobb–Douglas example again. From (7) we know that $n(x)=\alpha$, and from the FOC which reads $w=\alpha x h^{\alpha-1}$, that

$$g(x,w)=\left(\frac{\alpha x}{w}\right)^{\frac{1}{1-\alpha}}.$$

Therefore (14) reads

$$(1-\alpha)\left(\frac{\alpha}{w}\right)^{\frac{1}{1-\alpha}}\int_0^1 x^{\frac{1}{1-\alpha}}\,dx=\alpha\int_0^1 x\,dx,$$

from which we have

$$w=\alpha\left(\frac{2(1-\alpha)^2}{\alpha(2-\alpha)}\right)^{1-\alpha}.$$

Now aggregate output is

$$\int_0^\infty \big[g(x,w)\big]^\alpha\big[1-n(x)\big]\,dF(x)=(1-\alpha)^2\left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\alpha}}.$$

We plot the level of output (Fig. 4(a)) and the growth (Fig. 4(b)) that is due to openness while keeping the allocation constant. For the uniform distribution with $\alpha=\frac{1}{2}$, we have that $n(x)=\frac{1}{2}$ and we get $w=\frac{1}{\sqrt{6}}=0.40825$, and $\pi(x)=0.61237x^2$. When there we constrain agents not to switch occupations, identically skilled agents will have different earning depending on their occupation. We calculate the average per capita income in each country x, which is the weighted sum of wx and $\pi(x)$ or $y(x)=0.20413x+0.30619x^2$. Compare to autarky where $y^A(x)=\frac{1}{2}x^{\frac{3}{2}}$.

Keeping the occupational allocation fixed, opening up the world labor market implies that the initially identical people now face different opportunities depending on their occupation. For the high x countries, because now there is a world wage that is lower than the high x wage under autarky, the entrepreneurs now earn more than the workers, even though they have the same type. In the low x countries, the opposite is true: the workers do relatively better than the entrepreneurs. Next, we plot the ratio of the highest earner by country in the economy where the allocational choice is frozen. All countries now have some degree of inequality, and it is

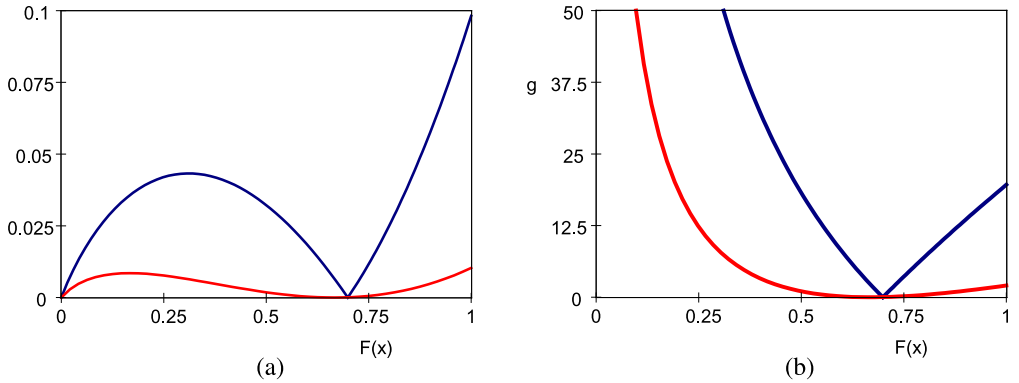

Fig. 4. Gains from trade with (blue)/without (red) sorting: (a) levels; (b) ratio. [Plots for $Q(h) = h^{0.5}$, $F(x) = x$.] (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

largest at the extremes. There is one country (typically different from z) without any inequality at all.

The implications for occupational switching. We can show that it is generally true that openness leads to disproportionate occupational switching into managerial jobs in high skill economies.

Proposition 3. *The fraction of managerial jobs increases in the high skill economy, and decreases in the low skill economy.*

Proof. Immediate from the fact that under autarky there is strictly no full specialization, whereas under free trade there is full specialization in managerial jobs ($x > z$) and in waged labor ($x < z$). □

3.2. Multi-dimensional skill types

Endow agents with a pair (x, y), where x represents the skill level as a manager and y is the skill level as a worker, distributed according to $F(x, y)$.[7] Firms still produce output q according to (1) and solve (2), except that h is the total amount of skill y that manager x employs.

Global market. Now w is the world-wide wage per unit of y and $h = g(x, w)$ is factor demand by manager x. Instead of (4), the set of managers is

$$E(w) = \left\{(x, y) \in \mathbb{R}^2_+ \;\middle|\; \pi(x, w) > wy\right\}.$$

Instead of (8), the market-clearing condition is

$$\int_{E(w)} g(x, w)\, dF(x, y) = \int_{\mathbb{R}^2_+ - E(w)} y\, dF(x, y). \tag{15}$$

[7] This section builds on Jovanovic [13], a two-skill span of control model.

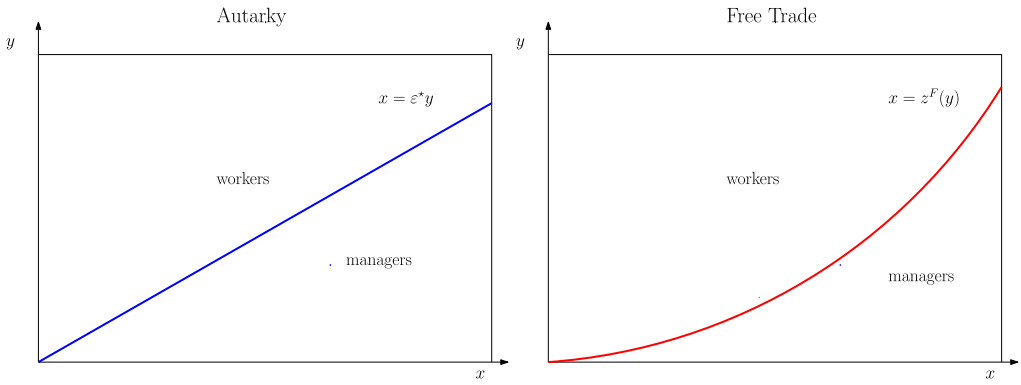

Fig. 5. Two-skill equilibrium.

Now the managerial-skill type $z^F(y)$ is indifferent between becoming a manager and a worker. That is, $z^F(y)$ solves for z the equation

$$\pi(z, w) = wy. \tag{16}$$

Denote the world-equilibrium wage by w^F.

Then (16) implies

$$z'(y) = \frac{w^F}{\frac{\partial \pi}{\partial x}} > 0.$$

From the envelope theorem, $\frac{\partial \pi}{\partial x} = Q(h)$ and therefore $z''(y) < 0$ because h is strictly increasing in x. Therefore its inverse is convex as shown in panel 2 of Fig. 5.

Autarky. We assume that while y differs over countries, each country is homogeneous with respect to y. That is, in country y agents are identical as workers, but different as managers, precisely as Lucas [16] assumed. Thus (1) in country y reads $q = xQ(yn)$ where n is the number of workers hired, and (2) becomes

$$\pi(x, w) \equiv \max_n \{xQ(yn) - w(y)ny\},$$

where $w^A(y)$ is the autarky wage per unit of y in country y. This problem gives rise to the demand $n = n^d(x, y, w)$. There is exactly one type $x = z^A(y)$ who is indifferent so that $z^A(y)$ solves for z

$$\pi\big(z, w^A(y)\big) = w^A(y)y.$$

Then country y's market-clearing condition which $w^A(y)$ must solve for w is

$$\int_{z^A(y)} n^d(x, y, w)\, dF(x \mid y) = F\big(z^A(y) \mid y\big), \tag{17}$$

the RHS being the fraction of country y's population that elects wage working as its occupation.

We now assume that x and y are sufficiently positively correlated that $w^A(y)$ will strictly increase in y, as occurs under assumption (A) in Proposition 5 that leads to the explicit form (19).

Lemma 3. *There exists a unique $y^\star$ in the interior of the support of H for which $w^A(y) = w^F$.*

Proof. Since $w^A(y)$ is strictly increasing there can be at most one such $y^\star$. Since w^A is also continuous, if such a $y^\star$ did not exist, the solution w^F to (15) would have to exceed $w^A(y_{\max})$ or be less than $w^A(y_{\min})$, the latter two solving (17). But in the free-trade economy, that would entail an excess supply of h or an excess demand for h. □

Proposition 4. *Each agent in country $y^\star$ is indifferent between autarky and free trade.*

Welfare effects of globalization. In contrast to the one-skill case, now there are agents that are made worse off from the globalization of labor markets. Broadly speaking, worse off are the workers in rich countries and entrepreneurs in the poor countries. In poor countries, those with $y < y^\star$, the remaining entrepreneurs are worse off because there $w^F > w^A(y)$: the entrepreneurs must pay higher wages to hire the same workers. And in rich countries, those with $y > y^\star$, the remaining workers are worse off because there $w^F < w^A(y)$. To better describe these outcomes we now assume:

(A) *The ratio x/y is identically distributed over countries so that*

$$x = y\varepsilon,$$

where $\varepsilon \sim G(\varepsilon)$, and G does not depend on y.

This leads to the following characterization of autarky equilibrium:

Proposition 5. *If* (A) *holds and if $Q(h) = h^\alpha$, then*

$$n^\star = \frac{\alpha}{1-\alpha}, \tag{18}$$

$$w^A(y) = \alpha\varepsilon^\star\left(\frac{1-\alpha}{\alpha}\right)^{1-\alpha} y^\alpha \tag{19}$$

and

$$z^A(y) = \varepsilon^\star y, \tag{20}$$

where $\varepsilon^\star$ uniquely solves

$$G\left(\varepsilon^\star\right) = \left(\frac{1}{\varepsilon^\star}\right)^{1/(1-\alpha)} \frac{\alpha}{1-\alpha} \int_{\varepsilon^\star}^{\infty} \varepsilon^{1/(1-\alpha)}\, dG(\varepsilon). \tag{21}$$

Proof. For manager $y\varepsilon$, the FOC w.r.t. n reads $y^2\varepsilon Q'(yn) = wy$, i.e.,

$$y\varepsilon Q'(yn) = w. \tag{22}$$

The marginal manager $y\varepsilon^\star$ satisfies $y\varepsilon^\star Q(yn^\star) - wyn^\star = wy$, i.e.,

$$\varepsilon^\star Q\left(yn^\star\right) = w\left(1+n^\star\right) \tag{23}$$

where $n^\star$ is $\varepsilon^\star$'s employment. Evaluate (22) at $\varepsilon^\star$ and combine it with (23) to get

$$Q\left(yn^\star\right) = yQ'\left(yn^\star\right)\left(1+n^\star\right). \tag{24}$$

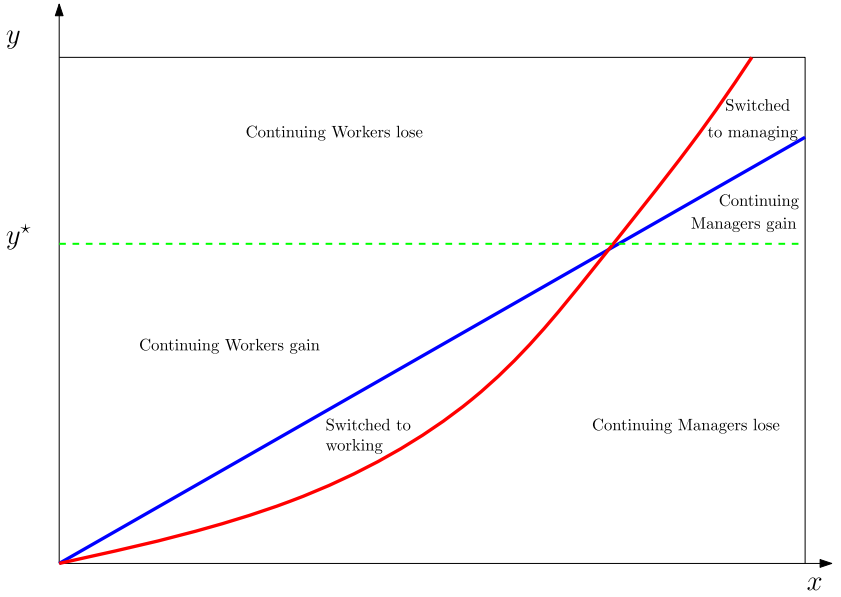

Fig. 6. Welfare effects of globalization. (For interpretation of the references to color, the reader is referred to the web version of this article.)

If $Q(h) = h^{\alpha}$, (24) reads $(yn^{\star})^{\alpha} = y\alpha(yn^{\star})^{\alpha-1}(1+n^{\star})$, i.e., $n^{\star} = \alpha(1+n^{\star})$, i.e., (18). To evaluate, (17) we first calculate n^{d}; (22) reads $\alpha y^{\alpha}\varepsilon n^{\alpha-1} = w$ so that

$$n^{d}(\varepsilon, y, w) = \left(\frac{\alpha y^{\alpha}\varepsilon}{w}\right)^{1/(1-\alpha)}.$$

Substituting into (17) and noting that $F(x \mid y) = G(\frac{x}{y})$, we see that if (20) did hold, (17) would read

$$G(\varepsilon^{\star}) = \left(\frac{\alpha y^{\alpha}}{w}\right)^{1/(1-\alpha)} \int_{\varepsilon^{\star}}^{\infty} \varepsilon^{1/(1-\alpha)}\, dG(\varepsilon). \tag{25}$$

Then (21) follows because (22) evaluated at $\varepsilon^{\star}$ reads

$$\alpha y^{\alpha}\varepsilon^{\star}n^{\star\alpha-1} = w \quad \Longrightarrow \quad \frac{\alpha y^{\alpha}}{w} = \frac{n^{\star 1-\alpha}}{\varepsilon^{\star}} = \frac{1}{\varepsilon^{\star}}\left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha}. \qquad \square$$

These autarkic economies have the same distribution of employment, determined by the distribution of ε along with α. They have the same fractions of managers and workers, as illustrated in panel 2 of Fig. 5 where the contour of indifferent types is linear. In contrast, under free trade the contour of indifferent types is convex, indicating that in the high skill countries there has been a higher increase in the fraction of mangers. Therefore the test reported in Section 4 and illustrated in Fig. 10 is consistent with the two-skill model too: the fraction of managers should rise for $y > y^{\star}$, fall for $y < y^{\star}$, and remain unchanged for $y = y^{\star}$, as is evident from Fig. 6.

Incomes in autarky and free trade. Under free trade, income of agent $(y\varepsilon, y)$ in country y is

$$\max\bigl(w^F y, \pi\bigl(y\varepsilon, w^F\bigr)\bigr),$$

whereas under autarky that same agent would earn

$$\max\bigl(w^A(y)y, \pi\bigl(y\varepsilon, w^A(y)\bigr)\bigr).$$

In each autarkic economy y, then, the distribution of income will be exactly as in the right panel of Fig. 5, but scaled up by the country-specific constant $y^{1+\alpha}$. But both before and after globalization, the world's income distribution will look more like the distribution in the right panel. When ε is unbounded, the two regimes compare as illustrated in Fig. 6.[8]

The welfare effects in Fig. 6 follow from $w^A(y)$ being higher than w^F above $y^\star$ and lower than w^F below $y^\star$. A rise in the wage is good for continuing workers and bad for continuing managers, and a fall in the wage has the opposite effect. The shaded areas involve switchers, and cannot be signed *a priori*. Agents along the dashed green line are exactly as well off as they were before.

Example. Uniform $\varepsilon \in [0, 1]$, uniform $y \in [0, 1]$. Noting that $\frac{\alpha y^\alpha}{w} = \frac{1}{\varepsilon^\star}(\frac{\alpha}{1-\alpha})^{1-\alpha}$, (25) reads

$$1 = \left(\frac{\alpha y^\alpha}{w}\right)^{1/(1-\alpha)} \frac{1}{\varepsilon^\star} \int_{\varepsilon^\star}^{1} \varepsilon^{1/(1-\alpha)}\, d\varepsilon = \left(\frac{1}{\varepsilon^\star}\right)^{(2-\alpha)/(1-\alpha)} \frac{\alpha}{1-\alpha} \int_{\varepsilon^\star}^{1} \varepsilon^{1/(1-\alpha)}\, dG(\varepsilon)$$

$$= \left(\frac{1}{\varepsilon^\star}\right)^{(2-\alpha)/(1-\alpha)} \frac{\alpha}{1-\alpha} \int_{\varepsilon^\star}^{1} \varepsilon^{1/(1-\alpha)}\, dG(\varepsilon)$$

so that $\varepsilon^{\star\frac{2-\alpha}{1-\alpha}}(1 + \frac{\alpha}{2-\alpha}) = \frac{\alpha}{2-\alpha}$, i.e.,

$$\varepsilon^\star = \left(\frac{\alpha}{2}\right)^{\frac{1-\alpha}{2-\alpha}}. \tag{26}$$

Since y too is uniform (also on $[0, 1]$), then

$$F(x) = \int_0^1 \min\left(1, \frac{x}{y}\right) dy = \int_0^x dy + \int_x^1 \frac{x}{y}\, dy$$
$$= x(1 - \ln x).$$

For the free-trade equilibrium, (3) reads $x\alpha h^{\alpha-1} = w$ so that $g(x, w) = (\frac{\alpha x}{w})^{1/(1-\alpha)}$. Then profits are $\pi(w) = x(\frac{\alpha x}{w})^{\alpha/(1-\alpha)} - w(\frac{\alpha x}{w})^{1/(1-\alpha)} = [(\frac{\alpha}{w})^{\alpha/(1-\alpha)} - w(\frac{\alpha}{w})^{1/(1-\alpha)}]x^{1/(1-\alpha)}$. Simplifying, and noting that $1 - \frac{1}{1-\alpha} = -\frac{\alpha}{1-\alpha}$, we get the maximized profit:

$$\pi\bigl(x, w^F\bigr) = (1-\alpha)\left(\frac{\alpha}{w^F}\right)^{\alpha/(1-\alpha)} x^{1/(1-\alpha)}. \tag{27}$$

The set of entrepreneurs is (removing the 'F' superscript from w)

$$E(w) = \bigl\{(\varepsilon, y) \bigm| \pi(\varepsilon y, w) > wy\bigr\}.$$

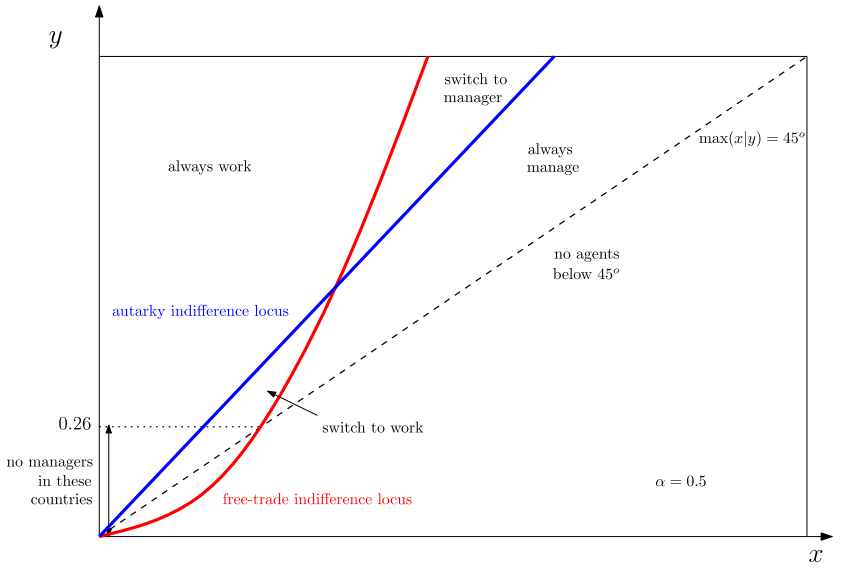

Fig. 7. The bivariate uniform example.

If it could hold at any y, indifference would imply

$$(1-\alpha)\left(\frac{\alpha}{w}\right)^{\alpha/(1-\alpha)}(y\varepsilon)^{1/(1-\alpha)} = wy, \quad \text{i.e.,}$$

$$(1-\alpha)^{1-\alpha}\left(\frac{\alpha}{w}\right)^{\alpha}\varepsilon = w^{1-\alpha}y^{-\alpha}, \quad \text{i.e.,}$$

$$\varepsilon^{\star}(y) = \frac{w}{(1-\alpha)^{(1-\alpha)}\alpha^{\alpha}}y^{-\alpha}.$$

Since $y^{-\alpha}$ goes to infinity as y goes to zero, $\varepsilon^{\star}(y)$ may exceed unity and the set of entrepreneurs may be empty at low values of y. The equation reads

$$\int_0^{\infty}\left(\int_0^{\min(1,\varepsilon^{\star}(y))} d\varepsilon\right) y\, d(y) = \int_0^{\infty}\int_{\varepsilon^{\star}(y)}^{\infty}\left(\frac{\alpha\varepsilon y}{w}\right)^{1/(1-\alpha)} d\varepsilon\, dH(y)$$

and w^F uniquely solves it. When $\alpha = 1/2$, Fig. 7 shows the situation under autarky and under free trade. Since $\varepsilon \leqslant 1$, we have $x \leqslant y$, so that all agents are above the 45° line. Note the following:

1. By (18), under autarky the smallest firm in a country has 1 worker. By (26) $\varepsilon^{\star} = (\frac{1}{4})^{(\frac{1}{2})(\frac{2}{3})} = 0.63$.
2. Economies with $y < 0.26$ have no managers under free trade, as was the case for the poor economies in the one-skill case. Under autarky, roughly one third of the population are managers, and so a large number of people switch from management to wage work.

[8] Let the support of G be unbounded and let ε be independent of y. Let $y \sim H(y)$ be the marginal distribution of y. Then the marginal on x is $F(x) = \int G(\frac{x}{y})\, dH(y)$.

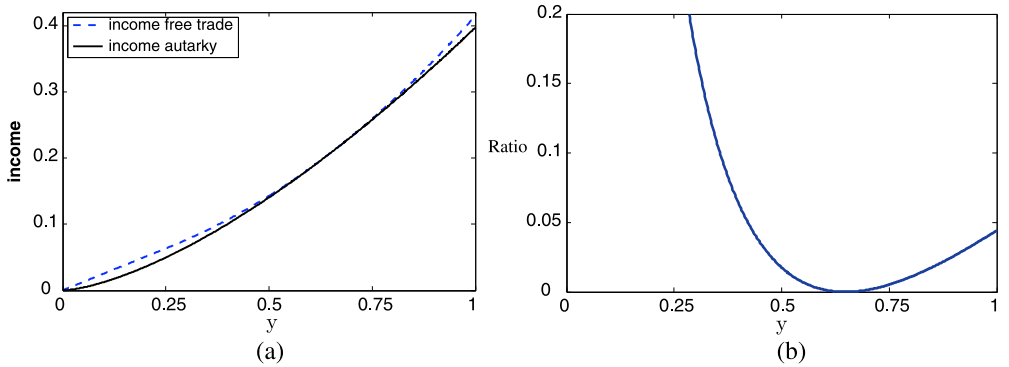

Fig. 8. Multi-dimensional skills: Earnings from factor mobility: (a) output levels under free trade (dashed) and autarky (solid); (b) ratio $(\text{GDP}^F - \text{GDP}^A)/\text{GDP}^A$. [Plots for $\alpha = 0.5$, $x = y\varepsilon$, $H(y) = y$, $G(\varepsilon) = \varepsilon$, $Q(h) = h^\alpha$.]

3. The "middle" country whose agents are all indifferent between autarky and free trade is $y^\star = 0.65$, which we can verify by comparing the wages in the two regimes. While $w^F = 0.25$, (19) gives $w^A(y) = 0.31\sqrt{y}$ so that $y^\star = 0.65$.

Finally, for this class of Cobb–Douglas technologies with multi-dimensional types, we illustrate that the gains from openness are largest for those countries that are in the extremes of the distribution of y. Fig. 8(a) reports the total income (GDP) generated in country y under autarky and openness. Fig. 8(b) plots the ratio of the increase in GDP from openness. The gains are clearly largest for those countries at the extremes of the distribution of y. This figure is remarkably similar to that in the case of the one-dimensional gains, reported in Fig. 3(b). There are some important differences though. Note that in Fig. 8 the intersection (without crossing) around the indifferent y is smooth, whereas it has a kink in Fig. 3. This is due to the fact that in the one-dimensional case, either all agents are workers or all are managers under free trade. As a result, the free trade output schedule is the upper envelope of two schedules with different slopes, thus generating the kink. This is not the case in the multi-dimensional case since countries are typically heterogeneous: in a given country y, low x types work and high x types are managers. This implies that the output schedule is smooth since the cutoff itself changes smoothly within each country. While the gains are larger in the extremes for this class of example, we have not been able to establish that this is true in general: we have not been able to rule out the existence of distributions and technologies for which the gains are lower in the tails.

4. Evidence

The rise in world trade since 1970. To find whether the predictions of the model are consistent with the facts, we need to document the increase in openness that in our theory is the causal factor of occupational choice. Fig. 9(a) shows US total trade as a percentage of GDP (from Mitchell [19]). The Penn World Tables (Summers–Heston) also include a measure of openness, again defined as exports plus imports (i.e., total trade) as a percentage of GDP, but reports data only starting in the 1950s. In Fig. 9(b) we plot the population-weighted average of openness of all 58 countries in the sample that have observations for all years between 1952 and 2003. Both sets of data confirm the rise in openness in the '70s, with the world opening up more gradually than the US. Of course, openness as measured by imports and exports does not nec-

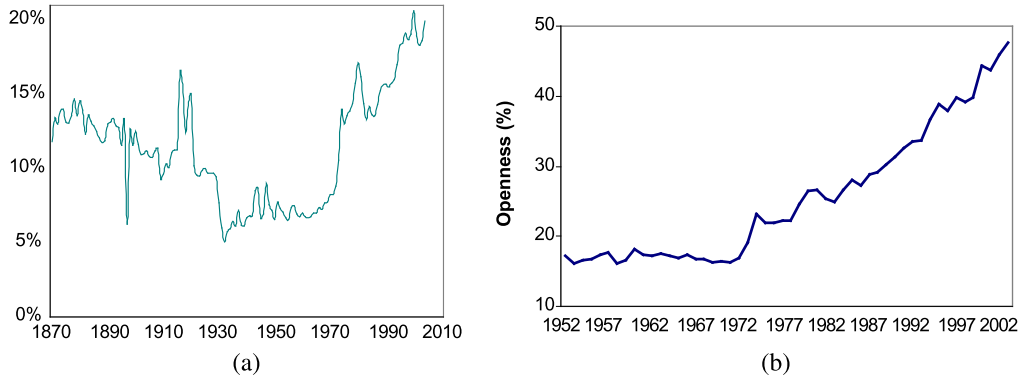

Fig. 9. Openness = (Imports + Exports)/GDP: (a) US; (b) World Average.

essarily measure the openness of labor markets. Yet, we believe it is a measure that is closely related when the globalization of the labor market is in terms of global access to labor inputs. Thus this measure of openness will capture labor market globalization better than, say, flows of migrants.

Evidence on occupational switching. The theory predicts that openness will lead higher skill economies to have a larger increase in the fraction of managerial jobs than the lower skill economies. We will verify whether that prediction is consistent with evidence from occupation data. We use data from the ILO,[9] reporting standardized occupation categories. We have annual data between 1970 and 2004 with observations for 115 countries, augmented with GDP/capita data from the Penn World Tables (Summers–Heston).[10] We construct a variable p with the proportion of managerial jobs. Managerial jobs include for example general and corporate managers, science and business professionals, but not office clerks and salespersons.

Let $p(y,t)$ be the fraction of managers in country y at date t, where y denotes GDP/capita measured in 2004 dollars. Theory predicts a dependence of $p(y,t)$ on income that increases with openness. Openness has increased substantially since the 1970s, and the effect of increased openness as predicted by the theory should be captured in the following regression:

$$p(y,t) = a_0 + a_1 \cdot \ln y_t + a_2 \cdot t \cdot \ln y_t + a_3 \cdot t.$$

We are looking for a significant positive estimate of the coefficient a_2 which indicates that over time, the dependence on income increases. We set $t_0 = 1950$ and $t = \{year\} - 1950$.

For the entire sample, we have $N = 1361$ observations, keeping in mind there are many missing observations, especially early on in the sample. The estimates for this specification are

$$\begin{aligned} p(y,t) &= a_0 + a_1 \cdot \ln y_t + a_2 \cdot t \cdot \ln y_t + a_3 \cdot t \\ &= \underset{(0.0865)}{0.1688} - \underset{(0.0102)}{0.0065} \cdot \ln y_t + \underset{(0.0002)}{0.0012} \cdot t \cdot \ln y_t - \underset{(0.0021)}{0.0078} \cdot t. \end{aligned}$$

The estimate $\widehat{a_2}$ is positive and highly significant, which confirms the more-than-proportional increase in the fraction of managerial jobs for high skill economies. From the outset, high income

[9] http://laborsta.ilo.org/.

[10] http://pwt.econ.upenn.edu/.

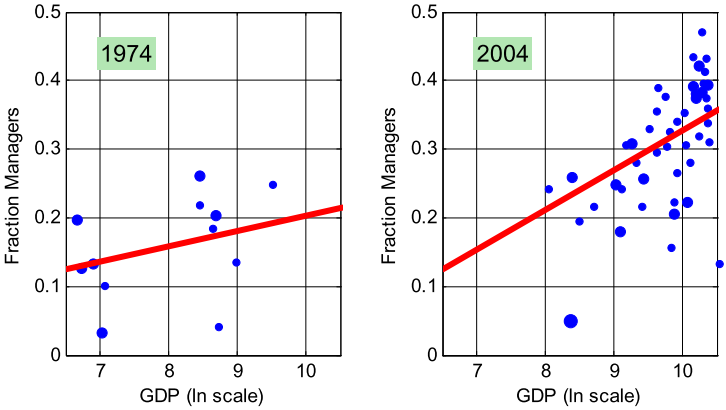

Fig. 10. Occupational choice by GDP.

countries have a higher fraction of managers ($\widehat{a}_1$ is positive). Due to increased openness, every year the high income countries increase the fraction proportionately more by 0.12 percentage points per $\ln y$. Over 35 years between 1970 and 2004, the cumulative effect is 4.2 percentage points.

This is also borne out in the data. Fig. 10 plots the regression line as predicted by the model for the years 1974 (left panel) and 2004 (right panel),[11] as well as the data. In Fig. 11 we also report these plots at five year intervals.

Table 1 translates the estimated proportion of managers for different levels of real income y in 2004 dollars between 1970 and 2004.[12]

On average, there has been a steady increase in managerial jobs between 1970 and 2004 for all countries in the sample. What Table 1 highlights is that the increase has been far bigger for high GDP countries: an increase in real GDP from 5,000 to 30,000 in 1970 implies an increase in the fraction managerial jobs of 3.1 percentage points (from 16.1% to 19.2%). In 2004, the same increase in real GDP from 5,000 to 30,000 induces an increase in managerial jobs of 10.4% (from 24.3% to 34.7%). In other words, the slope of the estimated relation between p and $\ln y$ has become 3.3 times steeper.

A concern is that our regression of the share of managerial jobs $p(y,t)$ on output is biased by the disproportionate availability of data towards later years. For most countries, there are few observations early one and many in later years (compare for example the panels in Fig. 10 or the panels in Fig. 11). This may lead to different types of selection. In order to circumvent this, ideally we would like to run the regression on a balanced panel. Unfortunately there are hardly any countries where there are sufficient observations for a reasonable subset of years in order to construct a balanced panel. Instead, and in spite of the sparse data availability, we therefore run the following tests for robustness.

First, we construct a subsample according to the following criterion: (1) only consider observations 1990–2004; (2) only include those countries that have at least 10 out of the 15 years of

[11] We use 1974 because it is the first year in the sample with sufficient observations.

[12] Observe that the regression coefficients are not driven by the mere size of China and India since they are not in the sample. For India we have no observations at all and for China we only have 2005. Since there are very few observations for 2005, we only included up to 2004.

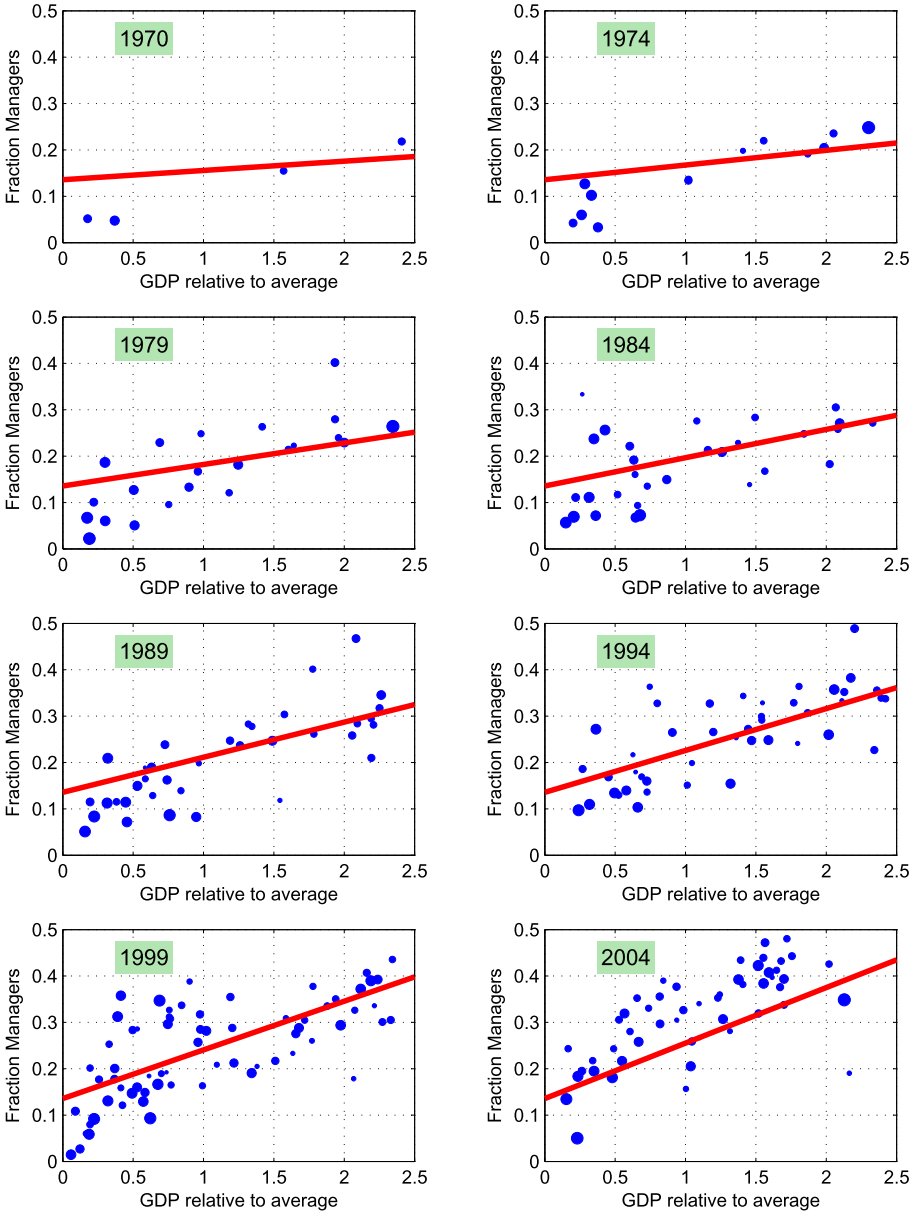

Fig. 11. Occupational choice by GDP.

data for p. Though this leaves us with a sharply reduced number of data points, the observations by country are more balanced. Despite the scarce data, the coefficient on the interaction between time and $\ln y$ continues to be positive, though it is no longer significant:

$$\begin{aligned} p(y,t) &= a_0 + a_1 \cdot \ln y_t + a_2 \cdot t \cdot \ln y_t + a_3 \cdot t \\ &= \underset{(0.46)}{-0.045} + \underset{(0.0497)}{0.012} \cdot \ln y_t + \underset{(0.0011)}{0.0006} \cdot t \cdot \ln y_t - \underset{(0.0099)}{0.0014} \cdot t. \end{aligned}$$

Table 1
Estimated percentages for representative incomes.

y	p_{1970}	p_{2004}	Δp[a]
5,000	16.1%	24.3%	8.2%
10,000	17.3%	28.3%	11.1%
20,000	18.5%	32.4%	13.9%
30,000	19.2%	34.7%	15.5%

[a] $\Delta p = p_{2004} - p_{1970}$.

Second, we construct a time-averaged change in our measure $p(y,t)$ by taking the difference between the last and the first observation, divided by the number of years. For example, if a country has a first observation in 1978 and a last one in 2003, then we calculate it as $(p(2003) - p(1978))/(2003 - 1978)$. Then we regress this measure for all countries for which we have at least two observations for p on GDP for the year 2003, $\ln y$:

$$\frac{p(\bar{t}) - p(\underline{t})}{\bar{t} - \underline{t}} = a_0 + a_1 \cdot \ln y_t$$
$$= \underset{(0.0082)}{-0.0040} + \underset{(0.0009)}{0.0008} \cdot \ln y_t.$$

Again, the coefficient on GDP is positive, indicating higher average increase in the proportion managerial positions p for higher GDP, though the coefficient is barely significant. The positive coefficient is robust even if we choose different measures of time-averaged change in p, including compounded growth, relative increase in p or the time-adjusted log of the ratio of p's.

As well as the sample selection issue addressed above, the regression analysis is subject to potential endogeneity problems. For example, more developed economies that have larger firms (and therefore more managers per worker) may in turn be more open according to this measure of openness. We therefore explore alternative measures of openness since our measure is limited by the fact that it is capturing a very broad measure of openness, i.e., aggregate trade flows. While tariffs would be more specific, they tend to reflect openness in goods trade. Moreover, because of differences between countries in the samples of firm level data we cannot consistently merge the occupational data with tariff data. Instead of openness, we therefore use an index of globalization (see below).

In addition to the occupations data, we use a different data set in order to test the same hypothesis of occupational sorting. The objective is to conduct a robustness check of our findings. Rather than using data on occupational choice directly, we use data on entrepreneurial activity. Entrepreneurs are likely to be involved in managerial tasks within the firm, and as a result, a measure of entrepreneurial activity will reflect the extent of local managerial activity.

Inspired by recent work by Vinig and de Kluijver [25], we use their country level data on total entrepreneurial activity (TEA) and their index of globalization (Index).[13] We have observations on 30 countries for the year 2003. Rather than analyzing the impact of time to measure the degree of openness, we use the index of globalization directly for the sample in the given year. The

[13] Van Stel, Carree and Thurik [24, p. 6] define the TEA data as follows: "The total entrepreneurial activity rate (TEA) is defined as that percent of adult population (18–64 years old) that is either actively involved in starting a new venture or the owner/manager of a business that is less than 42 months old." The original source of the TEA data is http://www.gemconsortium.org.

Table 2
Summary statistics.

	TEA	Index	Open
Mean	7.70	3.79	90.36
Standard Dev	5.68	1.12	82.37
Min	1.60	1.79	22.07
Max	29.30	6.86	392.64
# Observations	30	30	30

summary statistics of TEA and Index together with those for Openness (see below) are outlined in Table 2.

The hypothesis of our theory is that countries that are more globalized but are low skilled (i.e., they have a lower GDP) will see a relatively lower impact on entrepreneurship. Those that are more globalized and have highly skill will see a bigger increase in TEA. To capture this, we estimate the following model:

$$\begin{aligned}\text{TEA} &= a_0 + a_1 \cdot \ln y + a_2 \cdot \mathit{Index} \cdot \ln y + a_3 \cdot \mathit{Index} \\ &= \underset{(45.01)}{162.28} - \underset{(4.16)}{15.49} \cdot \ln y + \underset{(2.32)}{4.56} \cdot \mathit{Index} \cdot \ln y - \underset{(24.61)}{46.13} \cdot \mathit{Index}.\end{aligned}$$

While the direct impact of globalization (Index) is negative, the interaction between GDP and the Index is indeed positive and significant. High GDP countries have a relatively higher impact on entrepreneurial activity from openness than low GDP countries.

We repeat the same exercise, now measuring the impact on TEA of Openness instead of the Index of Globalization. The data on Openness are obtained from the Penn World Data and are calculated as the sum of exports and imports as a percentage of GDP. In principle, the measure for Openness should be similar to that of globalization. The following regression confirms this and the hypothesis from the theory.

$$\begin{aligned}\text{TEA} &= a_0 + a_1 \cdot \ln y + a_2 \cdot \mathit{Open} \cdot \ln y + a_3 \cdot \mathit{Open} \\ &= \underset{(25.03)}{117.54} - \underset{(2.46)}{10.75} \cdot \ln y + \underset{(0.05)}{0.13} \cdot \mathit{Open} \cdot \ln y - \underset{(0.47)}{1.29} \cdot \mathit{Open}.\end{aligned}$$

The positive and significant coefficient 0.13(0.05) on the interaction of openness and GDP establishes that high GDP countries tend to experience a larger impact from openness than low GDP countries.

Finally, when we include Open or Index as a covariate in the regression of our measure p on GDP and time, the coefficient on Open and Index and time is positive but insignificant.

5. Relation to prior work

We shall divide the discussion into two segments.[14] The first explains how the effects of a globalization of labor markets that we have modeled relates to the results of others on the effects of a globalization of goods markets, and capital markets. The second discusses some prior work on the effects of trade liberalization in the short run and in the long run.

[14] For an exhaustive overview of the most recent literature on organizations and trade, see Antràs and Rossi-Hansberg [5].

5.1. Factor-price equalization

Our results state that globalization of labor markets equalizes the prices of all different types of labor. This relates to other work showing that if countries have the same production functions but different factor intensities, then frictionless trade in goods will equalize factor prices. Wong [26] shows that identical production functions are necessary for this result, and Antràs and Caballero [2] show that the result fails if there are financial frictions impeding the flow of capital to some countries and sectors.

Our model has identical production functions and no capital, and we may expect the classical results to obtain. We now show that this result also obtains in our model if, instead of globalizing the labor market, we hold labor and management immobile and if, in contrast, we add just one freely-traded intermediate good that is produced with labor services alone, and that then combines with management skills to produce final output. The factor prices that are equalized are the price of labor services per efficiency unit, and the equilibrium rewards of each type of managerial skill. These prices can be equalized by globalizing the labor market, the management market, or the intermediate-goods market.

Let us call I an intermediate good and c the only final good and let the production function for c use managerial skill x and the intermediate good I as follows:

$$c = x\tilde{Q}(I).$$

The intermediate good is produced with labor services, h, alone:

$$I = Ah.$$

If these production possibilities are to be the same as under the previous interpretation, we must have $\tilde{Q}(I) \equiv Q(\frac{I}{A})$.

Wages, prices, and profits. Let p_I be the price of the intermediate good in terms of the numeraire consumption good. Competitive producers of I bid up the wage per unit of x to $w = Ap_I$, so that the income of a type-x worker in the intermediate-goods industry is xAp_I. As a final-good producer, that individual would earn a profit of

$$\pi(x, p_I) = \max_I \{x\tilde{Q}(I) - p_I I\}. \tag{28}$$

Autarky equilibrium. In homogeneous society x, let n_I be employment in the intermediate-goods industry. Then total production of I is Axn_I. Equilibrium is a price $p_I(x)$ and employment $n_I(x)$ solving for (p_I, n_I) the equations

$$x\tilde{Q}'\left(\frac{Axn_I}{1-n}\right) = p_I \quad \text{and} \quad \pi(x, p_I) = xAp_I. \tag{29}$$

Since $\tilde{Q}'(I) = \frac{1}{A}Q'(\frac{I}{A})$, we see that (5) and (6) imply that (29) holds if and only if

$$n_I(x) = n(x) \quad \text{and} \quad p_I(x) = \frac{1}{A}w(x).$$

Free-trade equilibrium. Now we look for the world price of I, p_I^F, and the set of final-goods producers E_I the set of producers of wine, i.e., the set of managers as before that prefer to manage than to be workers in the cloth industry:

$$E_I = \{x \mid \pi(x, p_I) > xAp_I\}$$

(the counterpart of Eq. (4)) with supply = demand of intermediate goods given by

$$\int_{\sim E} Ax\,dF(x) = \int_{E} g_I(x, p_I)\,dF(x)$$

(the counterpart of (8)) where g_I is the demand function for I that solves the problem (28). Then arguing just as for the case of autarky, we find that if we set

$$E_I = E, \qquad g_I(x, p_I) = Ag\big(x, w^F\big), \quad \text{and} \quad p_I^F = \frac{1}{A}w^F,$$

then equilibrium in the market for services as defined after Eq. (8) implies equilibrium in the market for intermediate goods and vice versa. The earnings of each type of agent and the sectoral choice of that agent (in this case interpreted as working in the final goods sector or in the intermediate-goods production) are identical to the equilibrium earnings in our original model.

Stated in this way, the equivalence is not surprising. It raises one's confidence in the robustness of the model's results regarding factor prices – including the rewards to different types of management – responds to each type of liberalization. The rise in the importance of intermediate-goods markets, documented recently by Yi [27] and analyzed in greater detail by Ramondo and Rodríguez-Clare [23], can therefore be interpreted as evidence supporting the type of globalization that we have modeled in this paper.

5.2. *Gains from trade*

Our paper divides the gains from labor-market openness into a short-run and a long-run effect. By short-run is meant where labor does not change occupations but when, after openness, labor can be managed by managers in other countries. The short-run gains arise because the same world labor pool can now be better allocated to the same world pool of managers. The long-run gain allows for the additional effects stemming from some people also switching occupation. In the short run workers are stuck, so the economy is like an endowment economy but there are gains from pure exchange, although the workers in the import competing sector in each country will be worse off. In the long run it is a Ricardian economy with gains from trade and everyone is better off. The gains with production reallocation (at least for the world as a whole) are greater.

When countries open up to trade in goods, similar long-run and short-run gains arise. In the short run the set of goods can be reallocated among the world's consumers and this leads to a short-run gain. Then in the long run each country can produce a different bundle of goods and this leads to a further gain. Classic papers on this topic are Mayer [17] and Mussa [22]; they treat workers as immediately mobile but capital as mobile only over time, but the idea is the same.

Burstein and Monge-Naranjo [7] also show that the gains from trade are larger if one allows for occupational mobility. They show that occupational choice magnifies the gains from firm international mobility. Indeed, the mechanism by which they obtain this is similar to ours – agents in developing countries switch to being workers, and agents in rich countries switch to being managers, and these responses are good for increasing world output. Therefore our evidence supports their model as well as ours. They too have only one good and, although they do not develop the point, the U-shaped gains to trade would arise in the many-country version of their model as well.[15] Antràs, Garicano, and Rossi-Hansberg [4] point to a friction of globalization

[15] With a continuum of countries, there would be an endowment level where the share of labor controlled by foreign firms after trade liberalization would be exactly zero (see their equation (25)).

that our model does not have, namely, that an effective cross-border transfer of top management requires also a need for locally provided middle management in the host country. This factor would reduce the gains of labor-market liberalization below those implied by our model.

5.3. Alternative explanations

Another explanation for why rich countries have experienced a greater occupational shift to management is the following: In a rich country firms may be more efficient for reasons *other* than management skill – a better financial and legal system, for example. In such a country firms will be larger and, under some additional assumptions, large firms have more managers per worker. In that case, a global shift to openness of trade in goods will raise firm size and the share of managers in that country relative to poor countries. It is hard to tell how much the observed occupational shift this alternative argument explains, partly because we do not know how well cross-country productivity differentials are explained by cross-country skill differences.

6. Conclusion

We have argued that globalization has accompanied a rise in the geographical span of managerial control. We have shown that the resulting integration of labor markets has reallocated existing workers among existing managers and that, in addition, it has prompted people to switch occupations so that the set of managers and workers has changed.

As in the standard model, the gains to trade depend on the heterogeneity of factor endowments, and a worldwide labor market raises output by more in the rich and the poor countries than in the middle-income countries. But we have also found that the option to switch occupations adds substantially to the output and welfare gains that would arise if people could not change occupations in response to the freeing up of labor markets. We also found, as the model predicts, that the rich countries have experienced a much larger increase in the fraction of people in management positions.

References

[1] Daron Acemoglu, David Autor, Skills, tasks and technologies: Implications for employment and earnings, in: Handbook of Labor Economics, 2011, forthcoming.
[2] Pol Antràs, Ricardo Caballero, Trade and capital flows: A financial frictions perspective, J. Polit. Economy 117 (4) (August 2009) 701–744.
[3] Pol Antràs, Luis Garicano, Esteban Rossi-Hansberg, Offshoring in a knowledge economy, Quart. J. Econ. 121 (1) (2006) 31–77.
[4] Pol Antràs, Luis Garicano, Esteban Rossi-Hansberg, Organizations and trade, Annual Review of Economics 1 (2009) 43–64.
[5] Pol Antràs, Esteban Rossi-Hansberg, Organizations and trade, Annual Review of Economics 1 (2009) 43–46.
[6] Andrew B. Bernard, J. Bradford Jensen, Peter K. Schott, Importers, Exporters, and Multinationals: A Portrait of Firms in the US that Trade Goods, Institute for International Economics, Washington, D.C., September 2005.
[7] Ariel Burstein, Alexander Monge-Naranjo, Foreign know-how, firm control and the income of developing countries, Northwestern University, mimeo, 2007.
[8] David Cass, Optimum growth in an aggregative model of capital accumulation, Rev. Econ. Stud. 32 (3) (July 1965) 233–240.
[9] Arnaud Costinot, Jonathan Vogel, Matching and inequality in the world economy, J. Polit. Economy 118 (4) (2010) 747–786.
[10] Alan Deardorff, Weak links in the chain of comparative advantage, J. Int. Econ. 9 (May 1979) 197–209.
[11] William Easterly, Yaw Nyarko, Is the brain drain good for Africa?, Brookings Global Economy and Development WP #19, March 2008.

[12] Xavier Gabaix, Augustin Landier, Why has CEO pay increased so much?, Quart. J. Econ. 123 (1) (2008) 49–100.
[13] Boyan Jovanovic, Firm formation with heterogeneous management and labor skills, Small Bus. Econ. 6 (3) (1994) 185–191.
[14] Michael Kremer, James Thomson, Why isn't convergence instantaneous? Young workers, old workers, and gradual adjustment, J. Econ. Growth 3 (March 1998) 5–28.
[15] Michael Kremer, Eric Maskin, Globalization and inequality, Harvard, mimeo, 2006.
[16] Robert Lucas, On the size distribution of business firms, Bell J. 9 (Autumn 1978) 508–523.
[17] Wolfgang Mayer, Short-run and long-run equilibrium for a small open economy, J. Polit. Economy 82 (5) (Sep.–Oct. 1974) 955–967.
[18] Ellen McGrattan, Ed Prescott, Openness, technology capital, and development, J. Econ. Theory 144 (2009) 2454–2476.
[19] B. Mitchell, International Historical Statistics, sixth ed., Palgrave Macmillan, 2007.
[20] Alexander Monge-Naranjo, Foreign firms, domestic entrepreneurial skills and development, February 2007.
[21] Kevin M. Murphy, Andrei Shleifer, Robert W. Vishny, The allocation of talent: Implications for growth, Quart. J. Econ. 106 (2) (1991) 503–530.
[22] Michael Mussa, Tariffs and the distribution of income: The importance of factor specificity, substitutability, and intensity in the short and long run, J. Polit. Economy 82 (6) (Nov.–Dec. 1974) 1191–1203.
[23] Natalia Ramondo, Andrés Rodríguez-Clare, Trade, multinational production, and the gains from openness, Penn State, mimeo, 2009.
[24] André van Stel, Martin Carree, Roy Thurik, The effect of entrepreneurship on national economic growth: An analysis using the GEM database, SCALES paper N200320, February 2004.
[25] G.T. Vinig, J. de Kluijver, Does globalization impact entrepreneurship? Comparative study of country level indicators, University of Amsterdam, mimeo, 2007.
[26] Kar-yiu Wong, Are international trade and factor mobility substitutes?, J. Int. Econ. 21 (1986) 25–43.
[27] Kei-Mu Yi, Can vertical specialization explain the growth of world trade?, J. Polit. Economy 111 (1) (February 2003) 52–102.