NBER WORKING PAPER SERIES

# OCCUPATIONAL CHOICE AND DEVELOPMENT

Jan Eeckhout
Boyan Jovanovic

Working Paper 13686
http://www.nber.org/papers/w13686

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
December 2007

We thank Jonathan Eaton, Natalia Ramondo, Esteban Rossi-Hansberg, Ariell Resheff, Akiko Tamura, and Chad Syverson for comments and the NSF and the Kauffman Foundation for support. Eeckhout thanks the department of economics at NYU Stern for its hospitality. The views expressed herein are those of the author(s) and do not necessarily reflect the views of the National Bureau of Economic Research.

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December 2007
JEL No. L0,O1

## ABSTRACT

The rise in world trade since 1970 has raised international mobility of labor services. We study the effect of such a globalization of the world's labor markets. We find that when people can choose between wage work and managerial work, the output gains are U-shaped: A 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.

Jan Eeckhout
Department of Economics
University of Pennsylvania
Philadelphia, PA 19104
eeckhout@ssc.upenn.edu

Boyan Jovanovic
New York University
Department of Economics
19 W. 4th Street, 6th Floor
New York, NY 10012
and NBER
Boyan.Jovanovic@nyu.edu

# 1 Introduction

We study how the integration of the world's 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 consumed, as long as there is an adequate communication or transportation technology. In the light of this transformation of the labor market, we ask which local economies will record the biggest gains in output when the world labor market opens up. We show that the pattern of growth is U-shaped with major gains for economies with either high or low GDP. We also investigate how economic integration affects occupational choice and show 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. Identically skilled agents in the labor market make an occupational choice decision whether to become 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. We refer to this result as the middle-class theorem.

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.

In the general context of economic integration of any non-representative agent economy, we show that the equilibrium allocation of any subeconomy coincides with the planner's solution for the subeconomy. We also find that the economy that maximizes world output is the one that is fully integrated. Moving from any subeconomy to a fully integrated economy, however, may make some agents worse off. In general, full integration does not Pareto dominate partial integration. This is because the gains from integration are U-shaped, and the middle skill type who does not gain output relative to complete autarky under full integration is typically not the same type under partial integration.

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.

Finally our model is consistent with the finding by Gabaix and Landier (2006) 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 (2003), who argues that 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 (2003, 'KM') and Antràs, Garicano and Rossi-Hansberg (2006, 'AGR') who deal, as we do, with the globalization of labor markets.[1] To this work we add in two ways. First, we prove our middle-class result which neither KM nor AGR contains, and that for good reason: KM and AGR are both two-country models with heterogeneous populations, whereas 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. We do not know if such conditions have ever existed, but we do provide some evidence that the shift towards autarky early on in the 20th century and the shift towards globalization late in the century have both had effects that can be better understood with the help of the middle-class theorem. 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 (1978) 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 (2007) and Monge-Naranjo (2007). The former paper studies the flow of capital and management across countries and distinguishes country-specific and firm-specific effects on productivity.

## 2 The Model

We shall consider a world population consisting of agents endowed with a one-dimensional skill $x$.[2]

*Production.*—Firms produce output $q$ with the input of a manager and a set of workers. Denote the

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

[2] Two skills are considered in Section 7.1 and the results are similar.

production function by

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

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

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

which has the FOC

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

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

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

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

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

and market clearing.

# 3 The Middle-Class Result

In this section, we consider the transition from a collection of representative agent economies in autarky to a world economy with free trade.

**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 $\pi\left(x, w\right)$.

*Autarky Equilibrium* is a wage $w$ and a fraction $n$ of people that become workers, such that they solve the pair of equations (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 $xn/\left(1-n\right)$. 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, $\pi\left(x, w\right)$ 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**. Let $F(x)$ be the world distribution of $x \in \mathbb{R}_+$, assumed atomless. Now $w$ is a wage that 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).[3]

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,

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

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

$$\int_z^{\infty} g(x, w) dF(x) = \int_0^z x dF(x) \tag{10}$$

[3] 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 $\Sigma_i F_i$.

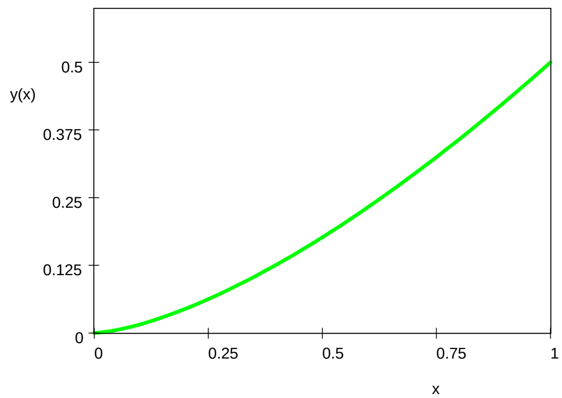



Figure 1: Income profile $y(x)$ under autarky

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

Now suppose that $\alpha = 1/2$ and that the skill distribution is uniform: $F(x) = x$. 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 is $z = 0.69$, $w^F = 0.42$, and incomes are max $\left(w^F x, \pi^F(x)\right) = \max\left(0.42x, 0.59x^2\right)$. Earnings under autarky in function of skills $x$ are plotted in Figure 1. In Figure panel 2, 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

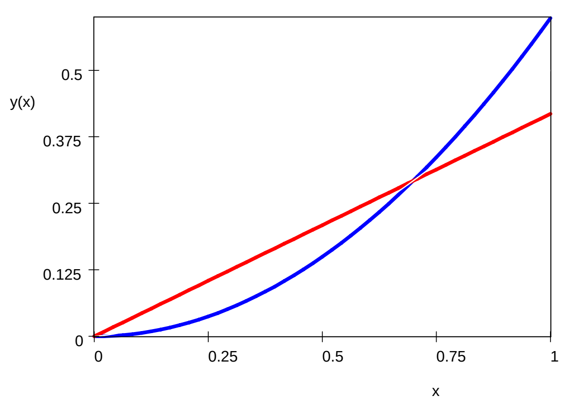



Figure 2: Income profile under factor mobility (wage earnings (red) - profits (blue))

full factor mobility, a 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.

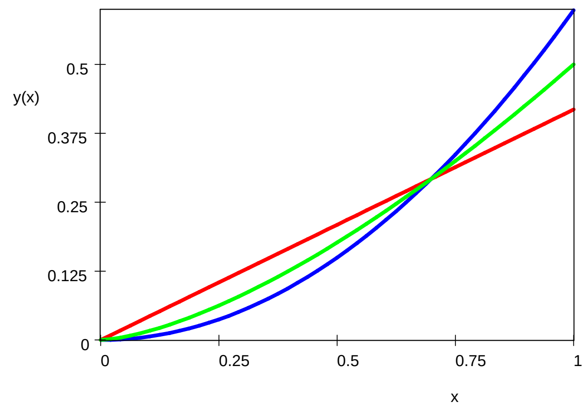



Figure 3: Income profiles $y(x)$ of all regimes

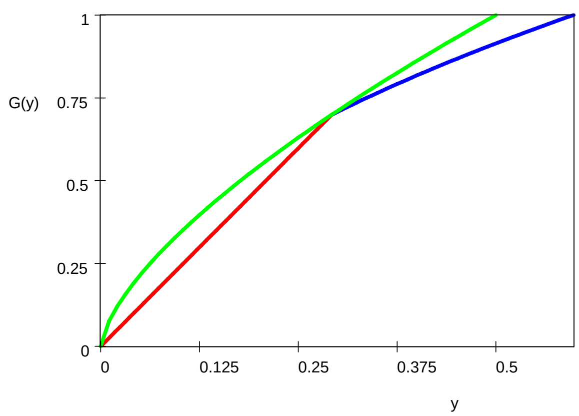



Figure 4: CDF and first-order stochastic dominance under factor mobility.

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 equilibrium and profit schedules on the same graph (Figure 3: 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.[4] The plot for the C.D.F. under both Autarky (green) and Factor Mobility (red and blue) is in Figure 4. 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

[4]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.

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.

**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*

$$x_{\min} < z < x_{\max}, \tag{11}$$

*and, moreover,*

$$\pi\left(z, w^A[z]\right) = w^A(z)\, z = w^F z = \pi^F(z)\,. \tag{12}$$

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

**Proof.** Since $\left(z^F, w^F\right)$ is an equilibrium,

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

Now in autarky in country $x = z^F$, the indifference condition is also met. I.e., (12) holds. This leaves the market-clearing condition and the FOC. This requires that there be a measure of workers $n$ such that

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

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 $\left(z^F, w^F\right)$. ■

**Lemma 3** *$z^F$ satisfies (11).*

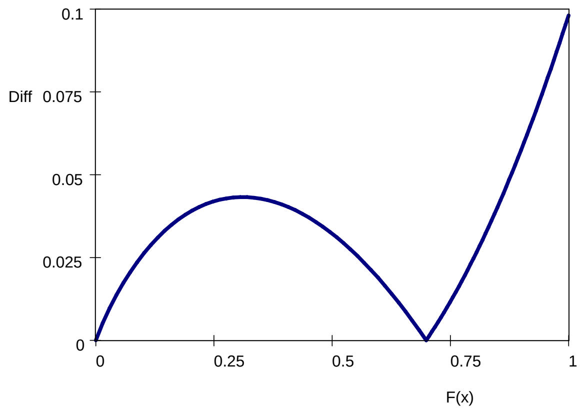



Figure 5: Earnings from factor mobility: differences

**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 (12) and the Proposition.

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 4** *(First order stochastic dominance) The distribution of earnings under Factor Mobility (weakly) stochastically dominates the distribution under Autarky.*

The question remains how important the role is of the occupational switching. Opening up trade in itself will generate welfare gains even without occupational switching. In the next section, we therefore perform the experiment in which we allow for mobility of labor, but we don't allow agents to switch occupations.

**The Implications for Growth**. By Proposition 2, there are gains from factor mobility. However, from Proposition 1 those gains are not distributed equally over all types. At least one type is no better off. In the next figure, we plot the gains from factor mobility by rank of the distribution[5]. Figure 5 has the absolute differences and Figure 6 has the growth rates.

[5] Because there is no rank-reversal in our model, we could as well use ability $x$ and in our uniform distribution example the scale does not even change, $x = F(x)$.

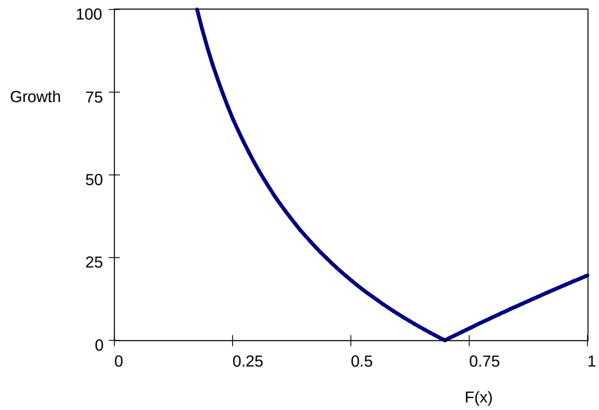



Figure 6: Earnings from factor mobility: ratio.

Figure 5 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. The type who is indifferent does not gain, and... workers gain throughout, except for the lowest type. This is because there is no lower bound on ability bounded away from zero. In our example with the uniform distribution, the lower type does not gain anything from factor mobility because output is zero before and after.

Figure 6 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**. 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 (10), that condition is

$$\int_0^\infty g(x,w)\,[1 - n(x)]\,dF(x) = \int_0^\infty xn(x)\,dF(x), \tag{13}$$

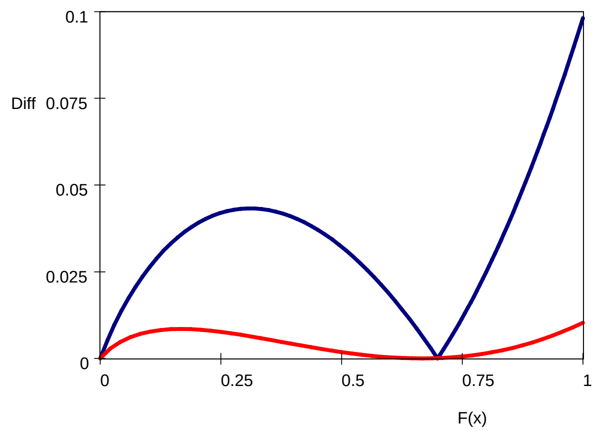



Figure 7: Gains from Trade with (blue)/without (red) sorting: levels

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 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 (13) 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

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

We plot the level of output (Figure 7) and the growth (Figure 8) 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 terms depending on their occupation. For the high $x$ countries,

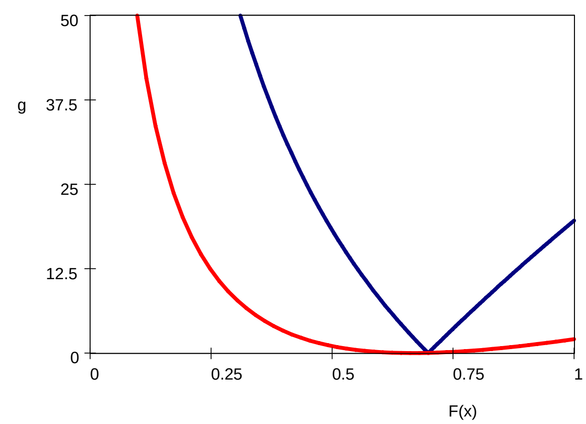



Figure 8: Gains from Trade with (blue)/without (red) sorting: levels

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 largest at the extremes. There is one country (typically different from $z$) without any inequality at all.[6]

# 4 Integrated Economies and Efficiency

Considering the case of representative agent economies under autarky is instructive for two reasons. First, it provides a transparent insight into the fact that in any economy, there is an agent type who is only as well off as under autarky of the representative agent economy. Second, the profile of earnings of the representative agent economies represents the lower bound on the world economy's earnings profile. To see this, consider a world economy that consists of a group of countries in the West and a group in the East. With full trade flows within the West, the earnings profile of the West economy will be U-shaped

[6] The occupation-switch effect that we have emphasized becomes sizeable only when the regime shift offers a non-negligible change in earnings opportunities, such as globailization probably affords. The analog in a single agent problem is the change in utility when prices change. For instance,

$$\frac{d}{d\theta}\left\{\max_x U(x,\theta)\right\} = \frac{\partial}{\partial\theta} U\left(x^*(\theta),\theta\right)$$

where $x^*(\theta)$ is the decision optimally taken when the environment is $\theta$. The equality holds only for infinitessimal changes in prices; this is the envelope theorem. But for large changes, say from $\theta$ to $\theta'$,

$$\max_x U(x,\theta) - \max_x U\left(x,\theta'\right) \geq U\left(x^*(\theta),\theta\right) - U\left(x^*(\theta),\theta'\right).$$

relative to the full autarky economy in the West, and likewise in East. This follows immediately from Proposition 1, as applied to the East and West subeconomy. As a consequence, there will be a skill type $z$ in each subeconomy that is indifferent between full autarky and free trade within the subeconomy. In this section, we analyze the properties of integrating those initially isolated free trade zones in West and East. First, we analyze the planner's problem, then the properties of an integrated economy and finally the Pareto ranking of integrated economies.

Consider any economy with skill distribution $F(x)$, and with free trade within that economy (or subeconomy). Then the planner's problem is to choose an allocation to maximize output $Y$ subject to market market clearing. An allocation here is the allocational choice of all agents between worker and manager, and the efficiency units $h(x)$ employed in each firm. Because of the concavity of $Q(\cdot)$, the allocational choice consists of a cut-off type $z$ with all $x \geq z$ becoming managers, the remainder becomes workers. The planner's problem therefore is:

$$\max_{z,h} \int_z^\infty xQ(h(x))dF(x) + \lambda \left[ \int_\infty^z xdF(x) - \int_z^\infty h(x)dF(x) \right],$$

where $\lambda$ is the constant from the Lagrangian. The next result establishes the efficiency of the decentralized equilibrium. Denote the economy's per capita output by $Y(F)$.

**Proposition 5** *The decentralized equilibrium outcome implements the planner's solution.*

**Proof.** From the first order conditions on the planner's problem, we get:

$$h : xQ'(h) = \lambda$$
$$z : zQ(h) - \lambda h = \lambda z$$

and inspection reveals that for $\lambda = w$, this solution coincides with the decentralized equilibrium solution. ■

Now consider two economies $F_1(x), F_2(x)$ with world population shares $\alpha_1, \alpha_2$. Without loss of generality, let $F_1(x)$ be the low skill economy. The integrated economy has a skill distribution $F(x) = \alpha_1 F_1 + \alpha_2 F_2$. The next result establishes that output is larger in the integrated economy.

**Proposition 6** *Economies $F_1$ and $F_2$ induce different wages $w_1 \neq w_2$ if and only if the integrated economy generates higher per capita output: $Y(F) > \alpha_1 Y(F_1) + \alpha_2 Y(F_2)$*

**Proof.** The set of managers, $E(w)$, depends on $w$ alone. $(i)$ 'If': If $Y(F) > \alpha_1 Y(F_1) + \alpha_2 Y(F_2)$, either $E(w_1)$ or $E(w_2)$ must differ from $E(w)$. But then $E(w_1) \neq E(w_2)$, or there would be more than one

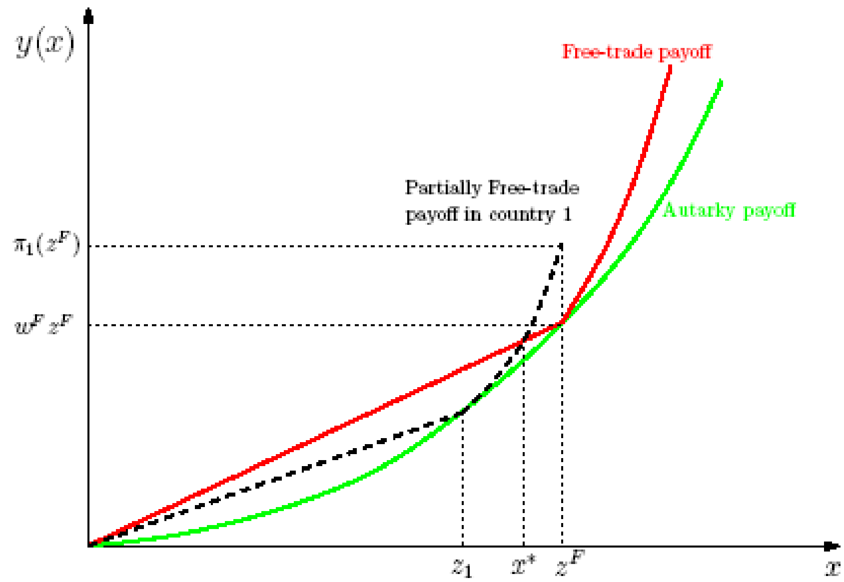



Figure 9: Illustration of Proposition 7.

market-clearing $w$ for economy $F$, which cannot be because $w$ is unique. $(ii)$ 'Only if': In light of the previous proposition, it is feasible for the planner to use $g(w_1, x)$ and $g(w_2, x)$ to allocate workers to managers in economy $F$. By concavity of $Q(\cdot)$, however, a convex combination of $g_1, g_2$ would world output $Y(F)$. ■

The proposition implies that if two economies $F_1, F_2$ induce identical wages $w_1 = w_2$, then they must generate the same aggregate output $Y(F) = \alpha_1 Y(F_1) + \alpha_2 Y(F_2)$ and vice versa.

Although aggregate output cannot be lower in the integrated economy, some agents may be worse off.

**Proposition 7** *Suppose the world income distribution $F(x)$ is atomless on the interval $[x_{\min}, x_{\max}]$. Then there is a partially-free trade allocation that is not weakly Pareto dominated by free trade.*

**Proof.** Since $z^F$ is on the interior of the support of $F$, consider two free-trade subeconomies, $\left[x_{\min}, z^F\right]$ and $(z^F, x_{\max}]$ with C.D.F.s $F_1(x) = \frac{F(x)}{F(z)}$ and $F_2(x) = \frac{F(x)-F(z)}{1-F(z)}$ respectively. Let us focus on the first free-trade zone, $\left[x_{\min}, z^F\right]$. Atomlessness of $F$ and market clearing imply that the indifferent agent in zone 1, call him $z_1$, satisfies $z_1 < z^F$. Now refer to income of agent $x$ in zone 1 by $y^1(x)$. But then the reasoning leading up to (12) implies that $y^1(z_1) = w^A(z_1) z_1$, and $y^1(x) = w^A(x) x$ for all $x \in (z_1, z^F]$. In particular, $y^1\left(z^F\right) > w^A\left(z^F\right) z^F = w^F z^F$, the second equality following from (12). This is illustrated in Figure 9. But then it follows that there is an entire interval $(x^*, z^F)$ in which agents in zone 1 are strictly better off than they would be under free trade. QED. ■

# 5 Occupational Choice and Openness

As a consequence of increased openness and trade of labor inputs, skilled agents switch occupations. More skilled economies see a disproportionately large switch into managerial jobs. In the case of extreme autarky, i.e. where each economy consists of identical agents, all economies initially have a fraction $1 - n(x)$ of managers. After the transition to free trade, the agents in those economies with skill level $x > z$ fully specialize in managerial jobs. As a result, there is an increase in the fraction of managers from $1 - n$ to 1. The opposite is true for those economies with skill levels $x < z$, where there is a decrease in the fraction of managers from $1 - n$ to 0. This logic hinges heavily on the setup of an extreme notion of autarky with representative agent economies.[7] In this section, we show that this pattern of occupational choice is general.

As before, consider two economies $F_1(x), F_2(x)$ with world population shares $\alpha_1, \alpha_2$, and with $F_1(x)$ the low skill economy, i.e. its distribution stochastically dominates country $2 : F_1(x) > F_2(x)$. We don't need to make any assumptions on the distributions directly, it is sufficient that each of the economies induce equilibrium wages such that $w_1 < w_2$. The integrated economy has a skill distribution $F(x)$ and wages $w$.

**Proposition 8** *The fraction of managerial jobs increases in the high skill economy, and decreases in the low skill economy.*

**Proof.** Suppose $w_1 < w_2$. Then we must have $w_1 < w < w_2$, otherwise $h$ would be in excess supply or excess demand. It follows that $z_1 < z < z_2$. ■

This is illustrated graphically in Figure 10, in which the fraction of managers is denoted by $p_i(F)$ so that, e.g., $p_1(F_1)$ denotes the fraction of managers in country 1 before integration and $p_1(F)$ is the fraction of managers after integration. A related result for their microfounded model of the knowledge economy is derived in Antràs, Garicano and Rossi (2006 Proposition 1(i)). What happens to the fraction of managers at the world level is indeterminate and depends on the characteristics of the initial distributions: the world wide fraction of managers after opening up can both increase or decrease. That is, either inequality $\alpha_1 F_1(z_1) + \alpha_2 F_2(z_2) \gtrless \alpha_1 F_1(z^W) + \alpha_2 F_2(z^W)$ could obtain.

The result that globalization leads to occupational switching hinges on the span-of-control technology drives occupational choice. In a standard model with one final good and two skills, globalization would not lead to any occupational switching. Remove the span of control and, instead, let managerial skill be perfectly substitutable in the production function which we may write as $q = G(X, H)$.

[7] Below, in section 7.1, we introduce a more realistic environment with multi-dimensional skills. We show that the fraction of managers increases more in high skill economies, but the increases is gradually without the discrete change to 100% managers. After free trade, the fraction of managers is smoothly increasing in the economy's average skill.

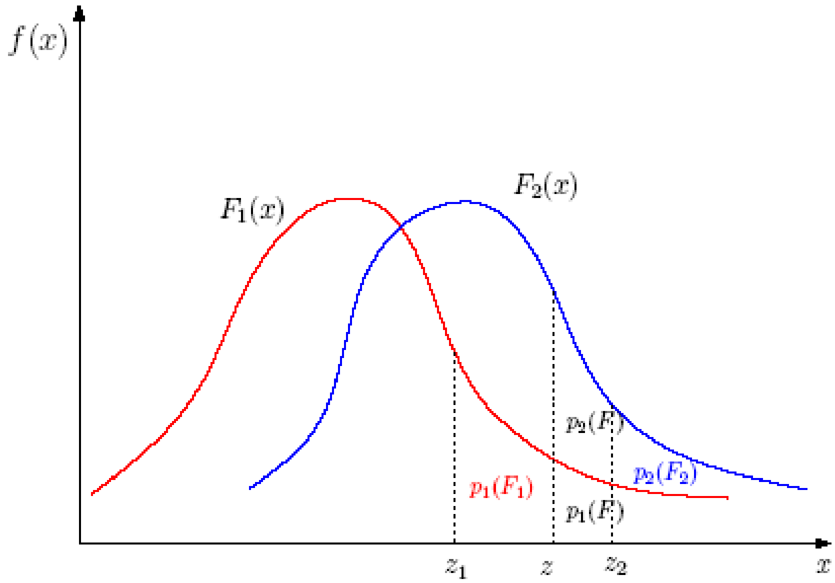



Figure 10: Occupational sorting after openness.

We now have $X = \int_E xdF(x)$ and, as before, the supply of worker skills is $H = \int_{\mathbb{R}_+ - E} xdF(x)$. If $G$ has constant returns and if there is perfect competition, the skill prices would be $w = \partial G/\partial H$, and $s \equiv \partial G/\partial X$. Occupational choice for a worker of type $x$ would now involve involves choosing a time allocation $n(x) \in \{0, 1\}$ to maximize $wnx + s(1-n)x$. In equilibrium therefore, if $w > s$, everyone would choose to be a worker, and if $w < s$ everyone would choose to be a manager. Therefore $w = s$. This would be true regardless of an economy's skill endowment. Therefore the fraction of managers would be the same in the two economies, and that fraction would remain the same if the two economies were to merge. This is completely in line with the Ricardian model of trade. Since both countries can access the same CRS production technology, no country has a comparative advantage in management and there are no gains from trade.

## 6 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. Figure 11 shows U.S. total trade as a percentage of GDP. 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 Figure 12 we plot the

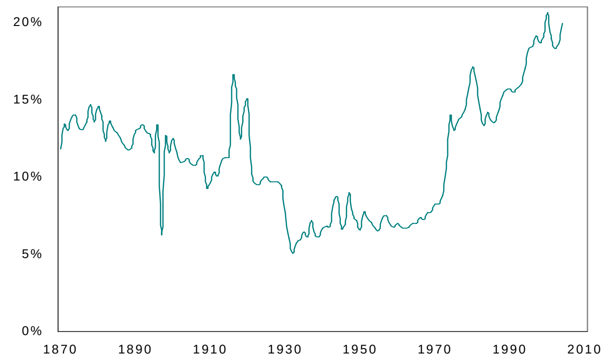



Figure 11: Openness US 1870-2004 (Imports + Exports/GDP).

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 U.S..

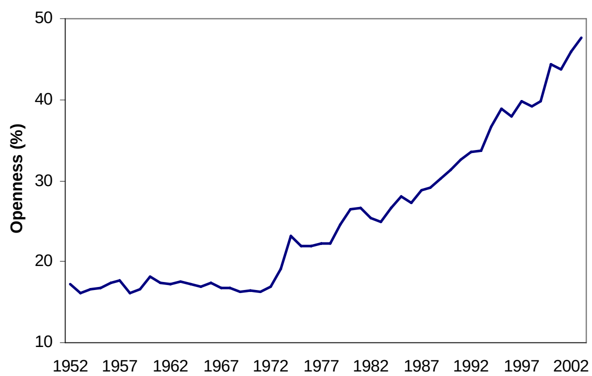



Figure 12: Openness World Average (Imports + Exports/GDP) – Penn World Tables

### 6.1 Evidence on Occupational Switching

Both in the one-dimensional and in the multi-dimensional version of the model (see Sec. 7.1), 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,[8] reporting standardized occupation categories. We have annual data between 1970 and 2004 with observations for 115 countries, augmented

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

with GDP/capita data from the Penn World Tables (Summers-Heston).[9] 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 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. The next table translates the estimated proportion of managers for different levels of real income $y$ in 2004 dollars between 1970 and 2004.

| $y$ | $p_{1970}$ | $p_{2004}$ | $\Delta p$ * |
|---|---|---|---|
| 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% |

* $\Delta p = p_{2004} - p_{1970}$

On average, there has been a steady increase in managerial jobs between 1970 and 2004 for all countries in the sample. What this table 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 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.

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

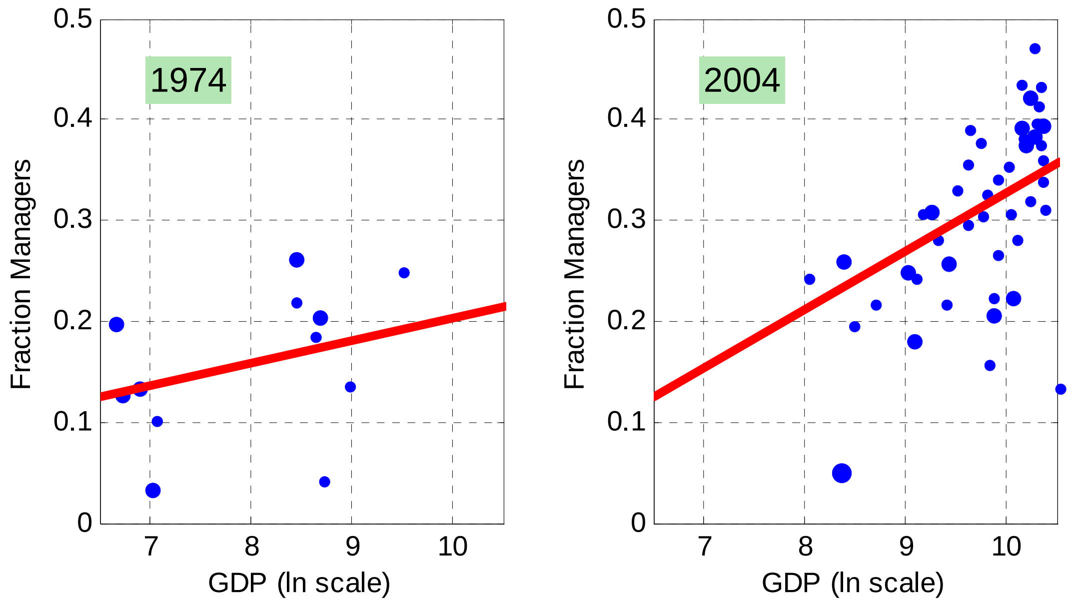



Figure 13: Occupational choice by GDP.

This is also borne out in the data. Figure 13 plots the regression line as predicted by the model for the years 1974 (left panel) and 2004 (right panel)[10], as well as the data. In the Appendix we also report these plots at five year intervals.

Finally, we also repeat the same exercise using openness instead of time. Openness can both increase or decrease the proportion of managers. Countries that become more open but are low skilled will see a lower impact relative to trend. The countries that are more open and highly skill will see a bigger increase in managerial occupations. To capture this, we construct a variable $\frac{T_t}{\bar{y}_t}$ that measures total trade per capita $T_t$ relative to the average income of all countries in the sample. This measure is equivalent to $\frac{T_t}{y_t}\frac{y_t}{\bar{y}_t}$ which measures trade as a percentage of GDP times GDP relative to average GDP. We estimate the following model:

$$\begin{aligned} p(y,t) &= a_0 + a_1 \cdot \frac{T_t}{\bar{y}_t} + a_2 \cdot t \\ &= \underset{(0.0134)}{0.0582} + \underset{(0.0000)}{0.0002} \cdot \frac{T_t}{\bar{y}_t} + \underset{(0.0003)}{0.0038} \cdot t. \end{aligned}$$

This model confirms the results from the theory. The coefficient on the openness variable is positive and significant indicating that the fraction managers has gone up more in those countries that are both more open and have a higher GDP relative to the country average. Again, there is also a trend and the proportion of managers increases across the board.

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

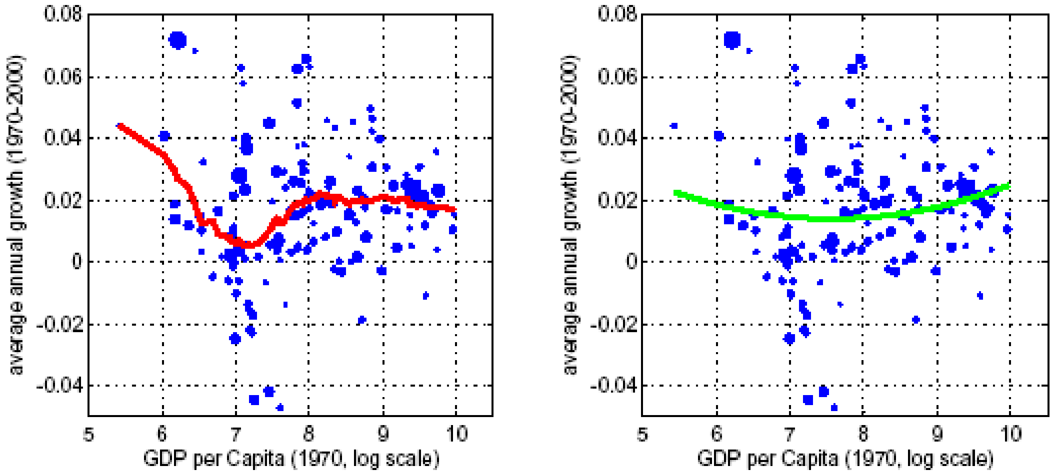



Figure 14: U-shaped Growth 1970-2000 – kernel regression (left) and polynomical fit (right).

## 6.2 Evidence on Growth

Our theory predicts a U-shaped pattern for growth in the presence of increased openness. Between 1970 and 2000, the middle countries did worse than countries in the tails of the distribution of GDP per capita. Summers and Heston provide data for 148 countries on GDP per capita (ppp-adjusted and at constant prices) and population. Figure 14 plots the scatter plot with the annualized growth rates. Each country is represented by a dot and the size of the dot is proportional to that country's population. Together with the data, in the left panel we plot the kernel regression which approximates the true relationship $g(y)$ between growth ($g$) and GDP ($y$). The estimate of $\widehat{g}(y)$ is a local average around the point $y$, which smooths the value of $g$ around $y$. We smooth using a Gaussian kernel, a continuous weight function symmetric around $y$, with bandwidth 0.5.

The Figure is consistent with the inverted U-shape of growth that the theory predicts. In addition to the kernel, in panel B we plot a second degree polynomial fitted to the data which further confirms the U-shaped pattern. Of course, growth is likely to have been affected by factors other than just the effect of increased openness on occupational choice. Nonetheless, even if other factors have affected growth, it is not immediate that those would lead to a U-shaped pattern.

*Robustness: Maddison Historical Data.* – Further evidence consistent with the theory is that the argument also works in reverse: As we move from free trade to autarky, growth rates will therefore exhibit an *inverted* U shape, being highest for the middle-income countries. The period following World War I arguably such a period. Figure 11 above suggests it, and so we shall assume that there also was a considerable drop in effective factor mobility between the pre-WWI era and the Great Depression. To cover this period, we use as a source the Maddison (1995) historical data. More specifically, we make use

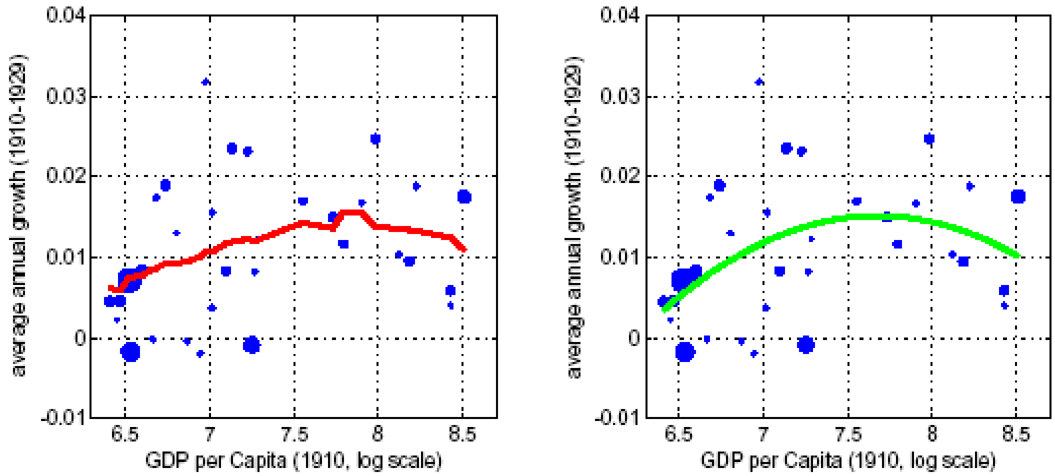



Figure 15: Inverted U-shaped Growth 1910-1929 – kernel regression (left) and polynomical fit (right).

of the series composed by Bourguignon and Morrisson (2002) based on Maddison (1995). To construct the entire world income distribution, this series bundles economies in 33 different groups of regions and comparable economies. It has observations for 1910 and 1929, so we calculate annual growth rates for this period.[11] As above for the period 1970-2000, the following Figure 15 has the annualized growth rates on the vertical and the log of GDP per capita on the horizontal, just like Figure 14. We have both the data points together with a graph of the kernel regression (left panel) to smooth out the relation (Gaussian kernel with bandwidth 0.5). The plot suggests that growth rates exhibit an inverted U shape in GDP/cap. The middle economies grow faster than the small and large economies. This is consistent with our theory since that period is an era of decreasing openness. This is further confirmed if when fitting the data to a second degree polynomial (right panel).

### 6.3 The Wage Distribution

The world's income distribution is bell-shaped and skewed to the right (Sala-i-Martin 2006), which favors our model in contrast to the Lucas (1978) type of model in which the distribution wages is degenerate because as workers, agents all have the same level of skill. As a result, all workers obtain the same wages, which leads to a mass point in the earnings distribution. In contrast, the input in production in our model is a worker's efficiency units and as a result, the equilibrium worker compensation depends on the worker's skill $x : y(x) = wx$. The underlying skill distribution will therefore determine the worker

[11] We exclude data for the 1930s as people argue that the Great Depression is caused by many other factors. The next observation in this data set is 1950, which according to the openness data is already too far after the decrease in openness we aim to capture.

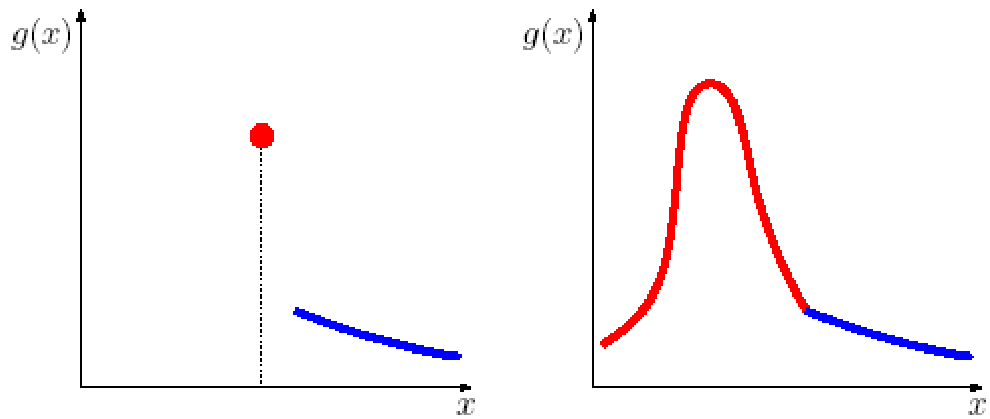



Figure 16: Predicted income distribution: Lucas (1978) (left) and our model (right).

earnings distribution. For example, if $\sigma^2$ is the variance of the skill distribution, then the variance of the worker income distribution is $w^2\sigma^2(x \mid x < z)$. In Lucas, the variance of the worker earnings distribution is zero, irrespective of the underlying skill distribution. This is illustrated in Figure 16. Because in 2004 on average 75% of employment is non-managerial, our model better captures the bulk of the earnings distribution.

# 7 Robustness

In this section we study the robustness of our setup. First, we introduce multi-dimensional skills and derive occupational choice in equilibrium. Second, we make explicit the intermediate-goods interpretation that we want to give and that is behind the mobility in this labor market. Third, we assume that zero-profit firms compete to hire both workers and managers. In each of these variations, our results are essentially unaltered.

## 7.1 Two skills

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 $F(x, y)$.[12] 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

[12]This section builds on Jovanovic (1994), a two-skill span of control model.

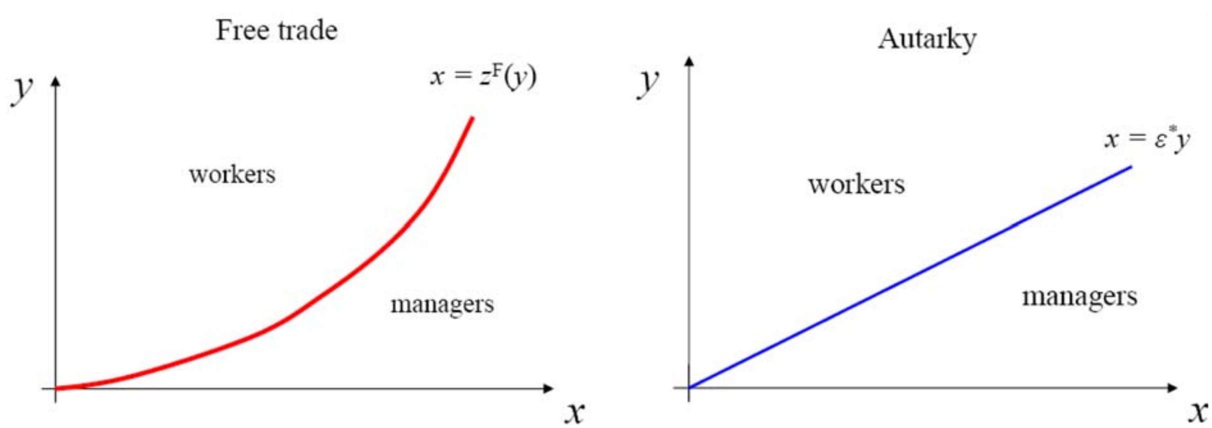



Figure 17: Two-skill equilibrium

manager $x$. Instead of (4), the set of managers is

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

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

$$\int_{E(w)} g(x, w)\, dF(x, y) = \int_{\mathbb{R}_+^2 - E(w)} y dF(x, y). \tag{14}$$

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

$$\pi(z, w) = wy. \tag{15}$$

Denote the world-equilibrium wage by $w^F$.

Then (15) 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 1 of Figure 17.

*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 (1978) 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 $z$

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

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

$$\int_{z^A(y)} n^d(x, y, w)\, dF(x \mid y) = F\left(z^A(y) \mid y\right), \tag{16}$$

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

**Lemma 9** *There exists a unique $y^*$ 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 $y^*$. Since $w^A$ is also continuous, if such a $y^*$ did not exist, the solution $w^F$ to (14) would have to exceed $w^A(y_{\max})$ or be less than $w^A(y_{\min})$, the latter two solving (16). But in the free-trade economy that would entail an excess supply of $h$ or an excess demand for $h$, respectively. ■

**Proposition 10 (Middle Class)** *Each agent in country $y^*$ 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 $y < y^*$, 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 $y > y^*$, 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 11** *If **(A)** holds and if $Q(h) = h^\alpha$, then*

$$n^* = \frac{\alpha}{1-\alpha}, \tag{17}$$

$$w^A(y) = \alpha\varepsilon^* \left(\frac{1-\alpha}{\alpha}\right)^{1-\alpha} y^\alpha \tag{18}$$

*and*

$$z^A(y) = \varepsilon^* y, \tag{19}$$

*where $\varepsilon^*$ uniquely solves*

$$G(\varepsilon^*) = \left(\frac{1}{\varepsilon^*}\right)^{1/(1-\alpha)} \frac{\alpha}{1-\alpha} \int_{\varepsilon^*}^{\infty} \varepsilon^{1/(1-\alpha)} dG(\varepsilon). \tag{20}$$

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

$$y\varepsilon Q'(yn) = w, \tag{21}$$

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

$$\varepsilon^* Q(yn^*) = w(1 + n^*) \tag{22}$$

where $n^*$ is $\varepsilon^*$'s employment. Evaluate (21) at $\varepsilon^*$ and combine it with (22) to get

$$Q(yn^*) = yQ'(yn^*)(1 + n^*). \tag{23}$$

If $Q(h) = h^\alpha$, (23) reads $(yn^*)^\alpha = y\alpha (yn^*)^{\alpha-1}(1 + n^*)$, i.e., $n^* = \alpha(1 + n^*)$,i.e., (17). To evaluate, (16) we first calculate $n^d$; (21) 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 (16) and noting that $F(x \mid y) = G\left(\frac{x}{y}\right)$, we see that if (19) did hold, (16) would read

$$G(\varepsilon^*) = \left(\frac{\alpha y^\alpha}{w}\right)^{1/(1-\alpha)} \int_{\varepsilon^*}^{\infty} \varepsilon^{1/(1-\alpha)} dG(\varepsilon). \tag{24}$$

Then (20) follows because (21) evaluated at $\varepsilon^*$ reads

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

■

These autarkic economies have the same distribution of employment, determined by the distribution of $\varepsilon$ along with $\alpha$. They have the same fractions of managers and workers, as illustrated in Panel 2 of Figure 17 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 6.1 and illustrated Figure 13 is consistent with the two-skill model too: the fraction of managers should rise for $y > y^*$, fall for $y < y^*$, and remain unchanged for $y = y^*$, as is evident from Figure 18.

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

$$\max\left(w^F y, \pi\left(y\varepsilon, w^F\right)\right),$$

whereas under autarky that same agent would earn

$$\max\left(w^A(y)\, y, \pi\left(y\varepsilon, w^A(y)\right)\right)$$

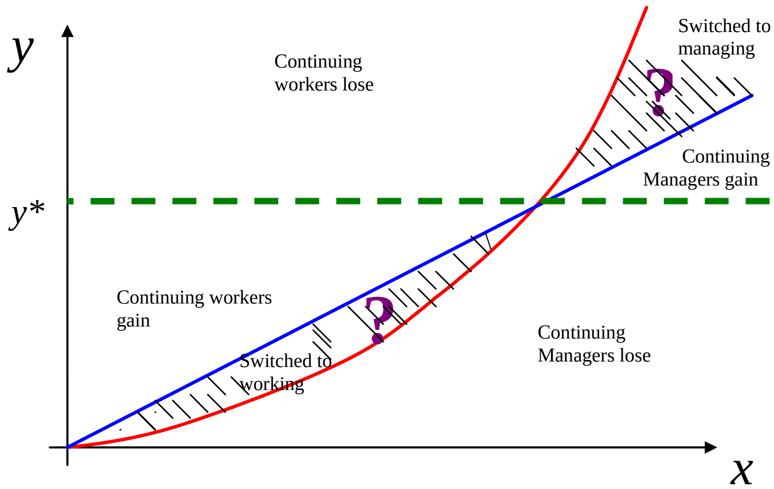



Figure 18: Welfare effects of globalization

In each autarkic economy $y$, then, the distribution of income will be exactly as in the left panel of Figure 16, 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 $\varepsilon$ is unbounded, the two regimes compare as illustrated in Figure 18.[13]

The welfare effects in Figure 18 follow from $w^A(y)$ being higher than $w^F$ above $y^*$ and lower than $w^F$ below $y^*$. 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 $\frac{\alpha y^\alpha}{w} = \frac{1}{\varepsilon^*}\left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha}$, (24) reads

$$\begin{aligned} 1 &= \left(\frac{\alpha y^\alpha}{w}\right)^{1/(1-\alpha)} \frac{1}{\varepsilon^*}\int_{\varepsilon^*}^1 \varepsilon^{1/(1-\alpha)} d\varepsilon = \left(\frac{1}{\varepsilon^*}\right)^{(2-\alpha)/(1-\alpha)} \frac{\alpha}{1-\alpha}\int_{\varepsilon^*}^1 \varepsilon^{1/(1-\alpha)} dG(\varepsilon) \\ &= \left(\frac{1}{\varepsilon^*}\right)^{(2-\alpha)/(1-\alpha)} \frac{\alpha}{1-\alpha}\int_{\varepsilon^*}^1 \varepsilon^{1/(1-\alpha)} dG(\varepsilon) = \end{aligned}$$

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

$$\varepsilon^* = \left(\frac{\alpha}{2}\right)^{\frac{1-\alpha}{2-\alpha}} \tag{25}$$

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

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

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

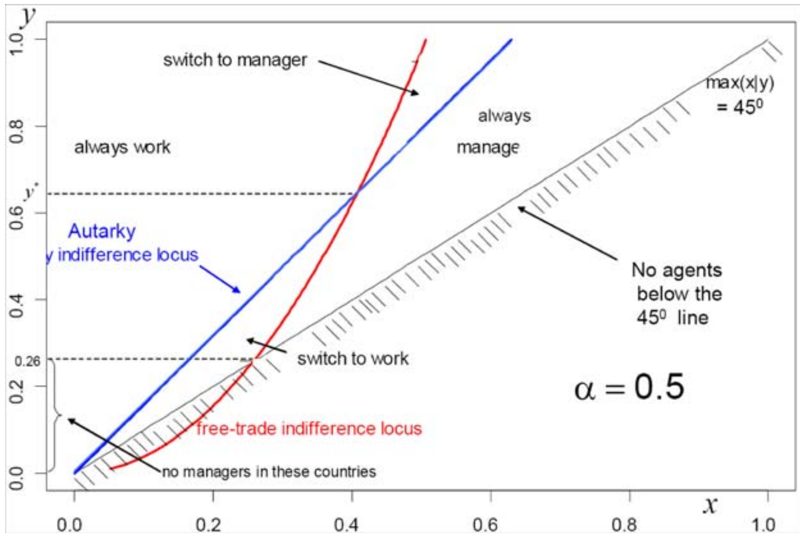



Figure 19: The bivariate uniform example

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

$$\pi\left(x, w^F\right) = (1-\alpha)\left(\frac{\alpha}{w^F}\right)^{\alpha/(1-\alpha)} x^{1/(1-\alpha)}. \tag{26}$$

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

$$E(w) = \{(\varepsilon, y) \mid \pi(\varepsilon y, w) > wy\}$$

If it could hold at any $y$, indifference would imply

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

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

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

and $w^F$ uniquely solves it. When $\alpha = 1/2$, Figure 19 shows the situation under autarky and under free trade. Since $\varepsilon \le 1$, we have $x \le y$, so that all agents are above the $45^0$ line. Note the following:

1. By (17), under autarky the smallest firm in each country has one worker. By (25) $\varepsilon^* = \left(\frac{1}{4}\right)^{\left(\frac{1}{2}\right)\left(\frac{2}{3}\right)} = 0.63$

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 switch from management to wage work.

3. The "middle" country whose agents are all indifferent between autarky and free trade is $y^* = 0.65$, which we can verify by comparing the wages in the two regimes. While $w^F = 0.25$, (18) gives $w^A(y) = 0.31\sqrt{y}$ so that $y^* = 0.65$.

## 7.2 An intermediate-goods interpretation

We interpret our model as one of trade in intermediate inputs, that allow managers and workers who are distant to collaborate in the same production process. Because our model remains agnostic about the exact specification of these intermediate inputs, we show how the intermediate-goods interpretation can be made explicit in our model.

By a change units, then, the model becomes one in which we can talk about the globalization of intermediate-goods markets, in the spirit of Yi (2006). Let us call $I$ an intermediate good and $c$ the only final good and that the production function for $c$ uses managerial skill $x$ and the intermediate good 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 $\tilde{Q}(I) \equiv Q\left(\frac{I}{A}\right)$.

*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

$$\pi(x, p_I) = \max_I \left\{ x\tilde{Q}(I) - p_I I \right\}. \tag{27}$$

*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

$$x\tilde{Q}'\left(\frac{Axn_I}{1-n}\right) = p_I \quad \text{and} \quad \pi(x, p_I) = xAp_I. \tag{28}$$

Since $\tilde{Q}'(I) = \frac{1}{A}Q'\left(\frac{I}{A}\right)$, we see that (5) and (6) imply that (28) 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

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

(the counterpart of (8)) where $g_I$ is the demand function for $I$ that solves the problem (27). Then arguing just as for the case of autarky, we find that if we set

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

then equilibrium in the market for services as defined after eq. (8) implies equilibrium in the market for intermediate goods and vice versa.

### 7.3 A market for management

Even though returns are not constant, we can decentralize the equilibrium using markets for both labor and management. We start with autarky which is much simpler.

*Autarky.*—Under autarky, it follows immediately that zero-profit firms would replicate the free-market equilibrium. A firm would hire $N$ workers, and assign a fraction $n$ of them to be managers, and a fraction $1-n$ to be workers. Let $p$ be the wage per worker. The firm would solve the problem

$$\max_{n,N}\left\{\left[(1-n)\,xQ\left(\frac{nx}{1-n}\right) - p\right]N\right\}$$

**Proposition 12** *Under autarky, the introduction of a managerial market and zero-profit firms leaves the equilibrium unchanged, and*

$$p = w(x)\,x.$$

**Proof.** The firm must make zero profits, i.e., $Q = \frac{p}{(1-n)x}$, or

$$Q = \frac{w}{1-n}, \tag{29}$$

so $N$ drops out of the problem. Moreover, since (6) can be written as $Q - w\frac{n}{1-n} = w$, it is equivalent to (29). It remains to show that (6) holds too. Upon dividing by $x$, the firm solves

$$\max_n \left\{ \left[ (1-n) Q \left( \frac{nx}{1-n} \right) - w \right] \right\}.$$

The FOC is

$$\begin{aligned} 0 &= -Q + \left( 1 - \frac{n}{1-n} \right) xQ' \\ &= Q - \frac{x}{1-n} Q' \left( \frac{1-n}{n} x \right) \end{aligned}$$

Substituting from (29) and multiplying by $n$, we get $xQ'(h) = w$, i.e., (5). ■

*Free trade.*—In this decentralization, each person has a price, $p(x)$ that depends on his or her skill. Taking the prices as given, firms hire people and assign them to be either managers or workers. Markets are complete in the sense that for each $x$ there is a price. For each $x$, a representative firm hires $n(x) = f(x)$ people of type $x$ and uses $n_m(x)$ of them as managers, and the rest as workers.[14] It allocates $h(x)$ efficiency units to managers of type $x$. It chooses these things to solve the following problem

$$V = \max_{n(.), n_m(.), h(.)} \left\{ \int xQ(h[x]) n_m(x) dx - \int p(x) n(x) dx \right\}$$

subject to the (single) constraint that the number of efficiency units employed in wage work not exceed the number available among the non-managerial workers of the firm:

$$\int h(x) n_m(x) dx \leq \int x [n(x) - n_m(x)] dx.$$

and to the constraint (one for each $x$) that each type is divided between management and

$$0 \leq n_m(x) \leq n(x).$$

Finally, free entry of firms requires that profits be zero

$$V = 0.$$

The Lagrangean (we ignore the constraint $n(x) \geq 0$) is

$$\int xQ(h_x) n_{m,x} dx - \int p_x n_x dx - \lambda \left( \int h_x n_{m,x} dx - \int x (n_x - n_{m,x}) dx \right) + \theta(x)(n_x - n_{m,x}) + \mu(x) n_{m,x}.$$

[14] We use the more intuitive $n(x)$

The FOCs are

$$\begin{aligned} h: \quad & xQ'(h_x) - \lambda = 0 \\ n_{m,x}: \quad & xQ(h_x) - \lambda h_x + \lambda x - \theta(x) + \mu(x) = 0 \\ n_x: \quad & -p_x + \lambda x + \theta(x) = 0 \end{aligned}$$

**Proposition 13** *Let*

$$p(x) = \begin{cases} w^F x & \textit{for} \quad x < z^F \\ \pi\left(x, w^F\right) & \textit{for} \quad x \geq z^F \end{cases} \tag{30}$$

**Proof.** The proof will show that when (30) holds, occupational selection is the same, and allocation of efficiency units to managers is the same. Substitute from (30) into the FOCs along with $\lambda = w^F$ and show that they hold. Doing this the FOCs read

$$\begin{aligned} h: \quad & xQ'(h_x) - w^F = 0 \\ n_{m,x}: \quad & xQ(h_x) - w^F h_x + w^F x - \theta(x) + \mu(x) = 0 \\ n_x: \quad & w^F x + \theta(x) - \begin{cases} w^F x & \text{for} \quad x < z^F \\ \pi\left(x, w^F\right) & \text{for} \quad x \geq z^F \end{cases} = 0. \end{aligned}$$

Using the third to solve for

$$\theta(x) = \begin{cases} 0 & \text{for} \quad x < z^F \\ \pi\left(x, w^F\right) - w^F x & \text{for} \quad x \geq z^F \end{cases}.$$

Thus, the constraint $n_m(x) \leq n(x)$ is slack exactly for the same set of workers that choose the wage-work option in equilibrium. Now substitute for $\theta(x)$ into the second FOC to get:

$$xQ(h[x]) - w^F h(x) + \begin{cases} w^F x & \text{for} \quad x < z^F \\ \pi\left(x, w^F\right) & \text{for} \quad x \geq z^F \end{cases} + \mu(x) = 0.$$

Now from the definition of $\pi\left(x, w^F\right)$ we have the following solution for $\mu(x)$:

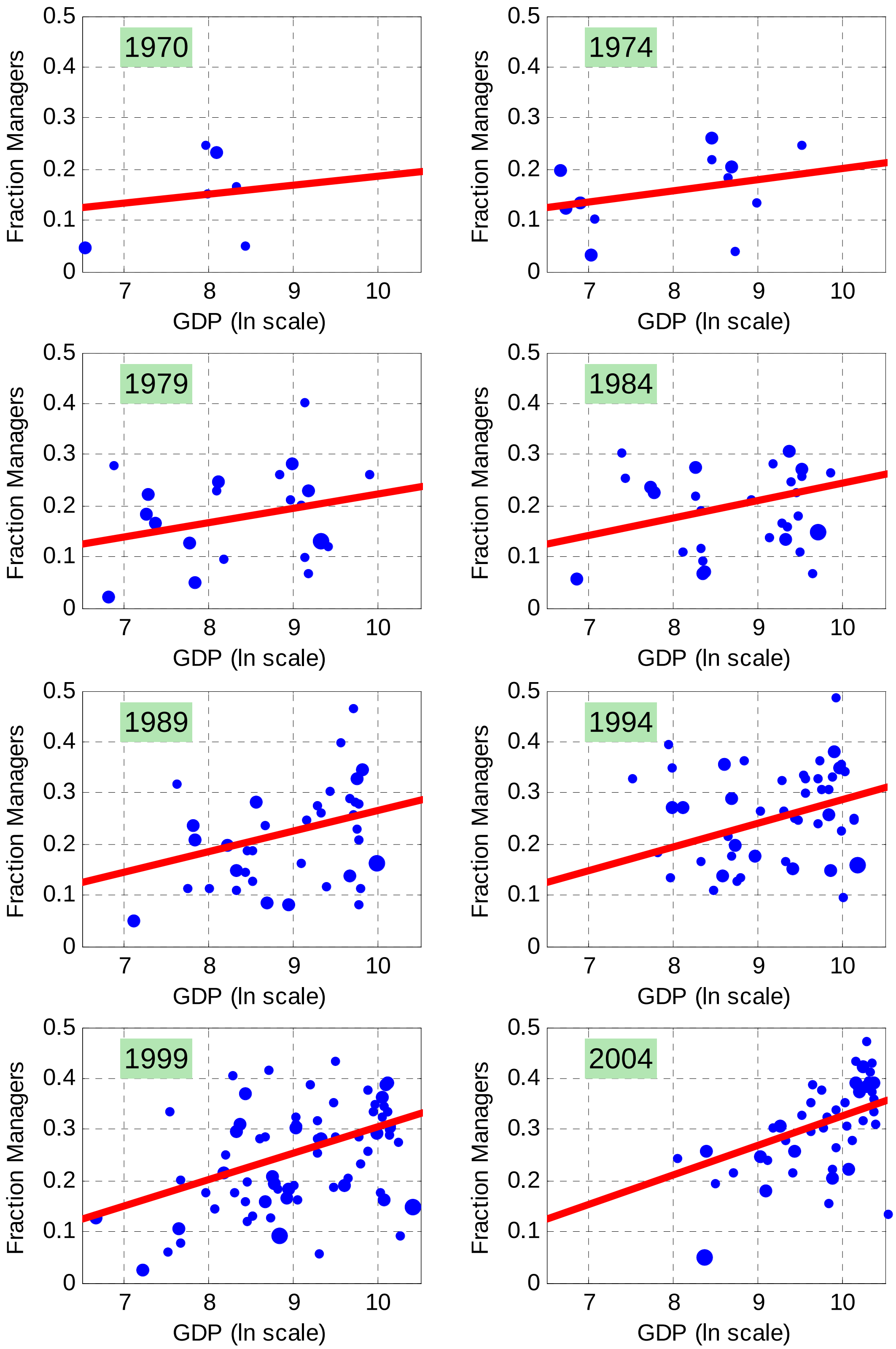
$$\mu(x) = \begin{cases} w^F(h(x) - x) - xQ(h[x]) & \text{for} \quad x < z^F \\ 0 \quad \text{for} \quad x \geq z^F \end{cases}.$$

Thus, the constraint $n_m(x) \geq 0$ is slack exactly for the same set of workers that choose the self-employment option in equilibrium. ■

# 8 Conclusion

We have argued that the integration of labor markets reallocates existing workers among existing managers, and that it prompts people to switch occupations so that the set of managers and workers changes. As in the standard model, 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 occupational choice adds substantially to the output and welfare gains to free trade in labor services. 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.

# 9 Appendix




Occupational Choice by GDP.

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