College Education, Occupational Sorting, and International Trade

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We study how education system impacts endogenous formation of human capital, trade patterns and income inequality. We construct the model of education choice with modifying three-sector occupation choice model by Grossman and Maggi (2000). Over the countries, education systems are characterized by education cost and efficiency of education. We presume universal education system lowers unit education cost to make it evenly accessible to the public, while elite education system effectively reinforces human capital increase. Upon trade liberalization from autarky state, country with higher human capital has comparative advantage in the innovative sector while the other country specializes in the routine sector, with obtaining xed and lower returns. This specialization pattern promotes more education acquisition in the former country in expense of higher income inequality.

We also provide empirical evidence supporting our theory that countries with elite education system heavily specialize on high-tech industry while countries with universal education system specialize on non-high-tech industries such as agricultural & raw material production, food production, or manufactures. We construct education measures and industry specialization measures for 270 countries using publicly available university ranking data and World Development Indicators provided by World Bank. We conduct cross-country regression analysis to examine the theory, and the results confirm that elite education system and high-tech industries specialization are positively related and that higher returns to education, which is delivered by elite education system, leads to higher wage inequality controlling population, real GDP per capita, and trade openness. The empirical results are consistent and robust across specifications.

JEL Classification: F16; F66; I23; I24; I26; J31

1 Introduction

Education system reform has been a central issue that both economists and policy makers are facing. Since education is an important public-sector service that determines individual human capital accumulation, the debate over 'universal education' versus 'elite education' has become increasingly controversial and required extensive economic analysis. In this paper, focusing on tertiary education which directly affects individual occupation choice, we study how education system contribute endogenous formation of Ricardian comparative advantage, trade patterns and income inequality.

Particularly, two stylized facts motivate this paper looking at the underlying mechanism how education system endogenously interplays with trade liberalization. First, figure 1 (a) reveals that the high-tech portion of manufacturing exports in four major developed countries—U.S., U.K, Japan, and Canada– is negatively associated with their education attainment rate.[1] Second, on the other hand, figure 1 (b) presents that education quality, measured by the number of high quality college, increases in a same direction with high-tech portion of manufacturing exports and income inequality measures. These empirical facts trigger the interest on, among countries with similar development level, how education system drives distinct patterns of trade and consequence.

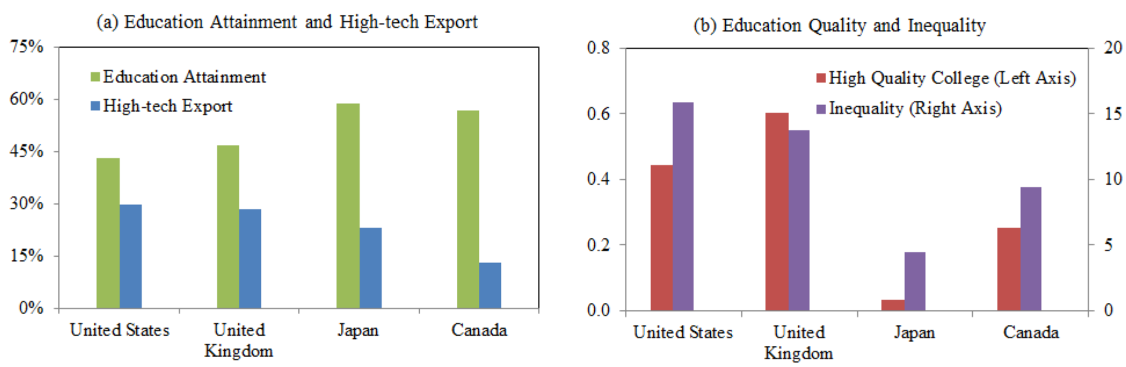


Figure 1: Education, trade and inequality

In order to address this question, we develop a three-sector trade model with endogenous education choice. We consider three sectors: a sector (routine sector) with a routine production process, a sector (manufacturing sector)with sequential tasks and teamwork, and a sector (innovative sector) with independent and innovative tasks.[2] This model setup follows the study by Grossman and Maggi (2000) where in some occupations, because of information asymmetry, performance of individual worker is

[1]High-tech industry, which produces aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery, has accounted for, on average, 27.6% of total manufactured exports in U.S. or $178 billion (in 2013 dollar) annually since 2000 to 2013.

[2]The routine sector requires only unskilled labor, and the manufacturing and software sectors require human capital inputs.

difficult to measure separately.[3] This imperfect contracting varies over industries, and thus, workers productivity is more measurable in some industries than others. This will induce more talented workers to choose a sector where they can be compensated more based on their own talent than average productivity of team.[4] The newly-born workers can enhance their human capital through college education before they enter the labor market based on their lifetime value change. One can think that enhancing the universal education system is associated with lowering unit education cost to make it evenly accessible to the public, while encouraging the elite education system is associated with reinforcing human capital increase from education. Then, we study which country specialize which sectors in response to the trade liberalization. (small open world and two country bilateral trade)

Under autarky, we demonstrate that both cheaper education cost and higher skill acquisition drive more workers to take education and raise product price in routine sector.[5] On the other hand, they induce more workers to choose the innovative sector where the workers can be compensated based on their human capital.[6] After trade liberalization, country with higher education has comparative advantage in the innovative sector while the counterpart country will specialize in the routine sector. This way of specialization promotes more education acquisition in the former country, and thereby reinforcing their comparative advantages.

We also show that country with higher education experiences higher income inequality in response to the trade liberalization due to higher dispersion of human capital distribution from education choice (and wage). Therefore, this result suggests that countries aiming to concentrate in high-tech industries or service industries needs to promote selective education for high quality in the expense of higher income inequality. It is unclear whether quality-focused education increases the total welfare. The higher education strengthens the comparative advantage of service- and high-tech industries over other countries, however, simultaneously increases the income inequality over time. In particular, this paper suggests that education system significantly determines the human capital distribution combining with the formation of comparative advantage in free trade.

This paper has to several important implications on growing literature. First, there are growing interests on the underlying link between the distribution of human capital and the pattern of international trade. However, previous literature assumes the exogenous distribution of human capital. Furthermore, in spite of the important role of high-tech industry separating from manufacturing sector, previous trade literature consider them as a same sector and overlooks the variation in trade patterns between manufacturing and high-tech sector. We endogenize the education choice into trade model and demonstrate the underlying channel. Since the education system is more persis-

[3] It is often hard to distinguish from other inputs, particularly, from their peers. Therefore, the contracts are likely to be tied to team performance and heterogeneous workers will receive similar compensation regardless of their skill/human capital.

[4] The workers with poor talent choose the routine sector and receive fixed wages. Since the workers having enough human capital prefer to do innovative tasks by herself, they choose the hi-tech industry. The workers in the middle choose the manufacturing sector.

[5] It increases total income but reduces the supply in the routine sector.

[6] It increases both supply and product price.

tent than other government policy (Glaeser, La Porta, Lopez-de Silanes, and Shleifer, 2004), the in-depth analysis on the link between education system and trade outcome may provide significant implications.

The rest of the paper proceeds as follows. Section 2 presents the environment and equilibrium configuration. Section 3 characterizes the steady state equilibrium of autarky and open economies. Section 4 provides numerical experiments to examine the effects of different education systems on the pattern of international trade and Section 5 concludes.

2 The Model

2.1 Environment

We consider a small open economy populated by a unit measure of workers, who are working in three different sectors, 'traditional', 'manufacturing', and 'high-tech' sectors denoted by $i = x$, y and z, respectively. Workers enter the labor market with different 'ability' $a \in [\underline{a}, \overline{a}]$, where ability a represents the units of human capital that she can utilize. We call the worker with a-units of human capital 'a-type worker'. All agents discount future at discount factor $\beta \in [0, 1]$. In what follows, we restrict our attention to the steady state equilibrium.

The traditional sector is characterized by a routine production process as in agriculture and routine service, which does not require human capital inputs, *i.e.* knowledge or knowhow acquired through advanced education. The high-tech sector such as fashion design, finance, and computer software industries asks each individual worker to perform an independent and innovative task by fully utilizing their human capital. Bougheas and Riezman (2007) label the former as a primary commodity sector and the latter as a high-tech product sector. In addition to the two sectors, we introduce the manufacturing sector, which produces manufactured products such as 'automobiles' through a sequence of sophisticated tasks. The manufacturing sector requires cooperative human capital inputs by n number of workers as in Grossman and Maggi (2000), Grossman (2004), and Buera, Kaboski, and Shin (2011). The production technology of each sector is given by

$$y_i(h) = \begin{cases} \alpha_x & \text{if } \ i = x \\ \alpha_z h & \text{if } \ i = z \end{cases}, \quad \text{and} \quad y_y(h_1, h_2, \cdots, h_n) = \alpha_y (\sum_{k=1}^{n} h_k^{\mu})^{\frac{1}{\mu}}, \tag{1}$$

where $\mu < 0$. The final goods are sold in perfectly competitive markets. The production technologies reveal that the human capital inputs by individual workers are not required in the traditional sector, whereas they are cooperatively and independently utilized in the manufacturing and high-tech sectors, respectively.

An individual worker with income flow w consumes each products (q_x, q_y, q_z) to maximize her per period utility, $(q_x^{\sigma} + q_y^{\sigma} + q_z^{\sigma})^{1/\sigma}$, subject to the budget constraint $p_x q_x + p_y q_y + p_z q_z = w$, where (p_x, p_y, p_z) are the prices of each sectoral products in the world market. The individual demand for each sectoral products is given by

$$q_i = w p_i^{\frac{1}{\sigma-1}} P^{\frac{\sigma}{1-\sigma}}, \quad \text{where} \quad P = \left(p_x^{\frac{\sigma}{\sigma-1}} + p_y^{\frac{\sigma}{\sigma-1}} + p_z^{\frac{\sigma}{\sigma-1}} \right)^{\frac{\sigma-1}{\sigma}}. \tag{2}$$

The indirect utility flow from income flow w is obtained by wP^{-1}.

A worker in the traditional sector works by herself without human capital inputs. She obtains a fixed wage payment $w_x(a) = p_x\alpha_x$ and per period utility $u_x(a) = p_x\alpha_x P^{-1}$ regardless of her ability. An a-type worker in the high-tech sector can put at best a-units of human capital inputs in the production process. Since the worker in the high-tech sector works by herself, she maximizes her per period utility by adjusting her human capital inputs independently. She gets wage payment of $w_z(a) = p_z\alpha_z h$ and per period utility of

$$u_z(a) = \max_h \; p_z\alpha_z hP^{-1} - c(h;a), \quad \text{where} \;\; c_z(h;a) = \delta(a-h)^{-\xi}, \tag{3}$$

where $\xi > 0$ and $\delta > 0$. The cost function reveals that it is convexly increasing in human capital inputs h but strictly decreasing in ability a. The ability determines the upper limit of human capital inputs that each worker can make, and $c_z(h;a)$ goes to infinity as h approaches a. For the simplicity, we assume that the cost parameter δ is same across the countries.

The workers in the manufacturing sector, incurring a similar cost structure as the workers in the high-tech sector, $c_y(h;a) = \theta\delta(a-h)^{-\xi}$, work in teams and adjust their human capital inputs. Additionally, θ captures the effect of diversity on cost structure. To focus on the efficient outcome, we assume that both human capital inputs and wage payments are specified in the joint-surplus maximizing contracts among team members. The contracting solution dictates that

$$(h_1, h_2, \cdots, h_n) = \arg \max_{(h_1', h_2', \cdots, h_n')} p_y y_y(h_1', h_2', \cdots, h_n')P^{-1} - \sum_{j=1}^{n} c_y(h_j'; a_j). \tag{4}$$

In team production with strong complementarity, the human capital inputs by each member create positive externality, which makes it difficult for the worker to raise claims on her full contribution in a decentralized setting. In contrast, the collectively contracting solution in this paper achieves the efficient outcome by internalizing the positive externality of individual workers' human capital inputs. Denote by $\mathbf{h}_{-j} = (h_1, h_2, \cdots, h_{j-1}, h_{j+1}, \cdots, h_n)$ the vector of human capital inputs by all team members except the j-th worker. Let $h_y(a;\mathbf{h}_{-j})$ and $u_y(a;\mathbf{h}_{-j})$ be the efficient level of human capital inputs and the implied utility by the j-th worker when she has ability a and works with other members who jointly put $\mathbf{h}_{-j}$ units of human capital inputs. Then,

$$w_y(h_y(a;\mathbf{h}_{-j});\mathbf{h}_{-j}) = p_y\alpha_y(\sum_{k=1}^{n} h_y(a;\mathbf{h}_{-k})^{\mu})^{\frac{1}{\mu}-1} h_y(a;\mathbf{h}_{-j})^{\mu} \;\; \text{and} \tag{5}$$

$$u_y(a;\mathbf{h}_{-j}) = w_y(h_y(a;\mathbf{h}_{-j});\mathbf{h}_{-j})P^{-1} - c(h_y(a;\mathbf{h}_{-j});a). \tag{6}$$

Unlike our approach, Grossman (2004) examines the situation in which the individual workers' contributions are not verifiable by a court so that the labor contract cannot rely on it. In particular, Grossman (2004) assumes that the labor contract in team production could tie payments only to the performance of the team and each member is paid the average productivity of the team. We examine the case in Appendix B.

Taking the expected human capital inputs by all workers as given, workers choose in which sector they work. The Bellman equation for the worker having a is given by

$$E(a) = \max\{u_x, u_y(a; \mathbf{h}_{-j}), u_z(a)\} + \beta(1-\rho)E(a). \tag{7}$$

At each period, workers retire (or die) with probability ρ and all retirees are replaced by newly-born workers. The newly-born workers draw their innate ability a from the bounded Pareto distribution with shape parameter $\eta(>0)$ and support $[\underline{a}, \overline{a}]$. The cumulative distribution function is given by $F(a) = (1-(\underline{a}/a)^{\eta})/(1-(\underline{a}/\overline{a})^{\eta})$ for $a \in [\underline{a}, \overline{a}]$. The newly-born workers can acquire additional human capital through college education before they enter the labor market. They make their own decision such that

$$e(a) \in \arg\max \; E(a+e) - E(a) - c_e(e) \tag{8}$$

where $E(a)$ represents the lifetime value of the workers having a-units of human capital. and $c_e(e) = \kappa^{-1}e^{\kappa}$.

Let $G(a)$ be the proportion of workers who have human capital less than equal to a-unit in the labor market at each period. It evolves as follows on a steady state equilibrium.

$$G(a) = \int_{\underline{a}}^{a-e(a)} dF(a') \tag{9}$$

Definition *An* steady state equilibrium *consists of the distribution of human capital $G(\cdot)$, price vectors $\{p_i, w_i\}_{i\in\{x,y,z\}}$, allocation of workers $\phi_i(\cdot)$, consumption schedule $\{q_i\}_{i\in\{x,y,z\}}$, and value equations $E(a)$ at each period such that given expectation on $\{p_i, w_i\}_{i=\{x,y,z\}}$ and $G(\cdot)$,*

- (i) *forward-looking newly-born workers make their schooling decisions,*
- (ii) *each worker chooses her optimal consumption, human capital inputs (under the collective labor contract), and sector,*
- (iii) *the human capital distribution governed by (9) is consistent with $G(\cdot)$.*

3 Steady State Analysis

In this section, we characterize the steady state equilibrium. All proofs are postponed to Appendix.

Lemma 1 *Given $\mathbf{h}_{-j}$, both $h_y(\cdot; \mathbf{h}_{-j})$ and $u_y(\cdot; \mathbf{h}_{-j})$ are strictly increasing in a.*

The workers in the manufacturing sector form a team without friction. If an a-type worker applies to a particular team made up of $(a_1, a_2, \cdots, a_n)$ and $\min\{a_1, a_2, \cdots, a_n\} < a$, she will be welcomed by all members except the least able worker with $\min\{a_1, a_2, \cdots, a_n\}$. Lemma 1 says that the a-type worker will not put less inputs than the worker having $\min\{a_1, a_2, \cdots, a_n\}$ and also all other members put more human capitals in the new formation, which again accelerates the human capital inputs by the new member. Hence as long as $a > \min\{a_1, a_2, \cdots, a_n\}$, all members except the least able worker prefer substitution. The equilibrium formation requires that each worker has no profitable deviation from her status quo team in the manufacturing sector.

Definition *A team composed of* $(a_1, a_2, \cdots, a_n)$ *is* feasible to a-type workers *if* $a > \min\{a_1, a_2, \cdots, a_n\}$*. A team having a vector of* $\mathbf{h} = (h_1, h_2, \cdots, h_n)$ *is* stable *if no worker can get more than* $u_y(h(a; \mathbf{h}_{-j}); \mathbf{h}_{-j})$ *from any other feasible teams.*

The stable formation requires that each team should pay to its members their maximum wages from all feasible team formation and all workers of a same type should be paid the exactly same wages. It makes positive assortative matching occur.

Lemma 2 *Only homogenous teams composed of the same types survive on equilibrium.*

Lemma 2 says that on equilibrium all teams should be made up of n-number of homogenous workers. It is consistent with Kremer (1993) and Grossman and Maggi (2000) in the sense that complementarity and super-modularity drives positive assortative matching. In particular, Kremer (1993) argues that a small mistake or failure in a sequence of complementary tasks may destroy the entire value of the product in many production processes, which drives positive assortative matching. We reflect his insight by embodying complementarity among human capital inputs of individual team members. By invoking Lemma 2, we drop $\mathbf{h}_{-j}$ from $h_y(a; \mathbf{h}_{-j})$ and $u_y(a; \mathbf{h}_{-j})$ and use $h_y(a)$ and $u_y(a)$ respectively in what follows. The a-type workers in sector y and z will choose the level of their human capital inputs such that

$$h_y(a) = a - \Big(\frac{\theta\delta\xi P}{p_y\alpha_y n^{\frac{1-\mu}{\mu}}}\Big)^{\frac{1}{\xi+1}}, \text{ and} \tag{10}$$

$$h_z(a) = a - \Big(\frac{\theta\delta\xi P}{p_y\alpha_y}\Big)^{\frac{1}{\xi+1}}, \tag{11}$$

on equilibrium. In equation (10), as n increases, $h_y(a)$ declines. Plugging (10) and (11) into (3) and (6) yields that

$$u_y(a) = p_y\alpha_y n^{\frac{1-\mu}{\mu}}\Big\{a - \Big(\frac{\theta\delta\xi P}{p_y\alpha_y n^{\frac{1-\mu}{\mu}}}\Big)^{\frac{1}{\xi+1}}\Big\}P^{-1} - \theta\delta\Big(\frac{\theta\delta\xi P}{p_y\alpha_y n^{\frac{1-\mu}{\mu}}}\Big)^{\frac{1}{\xi+1}}, \text{ and} \tag{12}$$

$$u_z(a) = p_z\alpha_z\Big\{a - \Big(\frac{\delta\xi P}{p_z\alpha_z}\Big)^{\frac{1}{\xi+1}}\Big\}P^{-1} - \delta\Big(\frac{\delta\xi P}{p_z\alpha_z}\Big)^{\frac{1}{\xi+1}} \tag{13}$$

on equilibrium.

Lemma 3 *On any equilibrium, it should be the case that* $p_z/p_y > n^{-1}(\alpha_y/\alpha_z)$*.*

Lemma 3 implies that the most able worker always works in the high-tech sector. From equations (12) and (13), it is true that $(du_z(a)/da) > (du_y(a)/da) > 0$ and $u_z(0) < u_y(0)$. It implies that the per period utility of working in sector z should cross the utility of working in sector y from the below just once. In other words, for sufficiently large $\overline{a}$, there exists a unique $a_z \in (\underline{a}, \overline{a})$ such that $u_z(a_z) = \max\{u_x(a_z), u_y(a_z)\}$. Lemma 4 and 5 tell us that the threshold for each industry is well-defined.

Lemma 4 *Suppose that Equilibrium Restriction 1 holds.*

(*i*) *For any* $a > a_z$, $u_z(a) > \max\{u_x(a), u_y(a)\}$.

(*ii*) *For any* $a < a_z$, $u_z(a) < \max\{u_x(a), u_y(a)\}$.

Moreover, suppose to the contrary that $u_x(a_z) \geq u_y(a_z)$. Since $u_y(\cdot)$ is strictly increasing in a and u_x is constant, $u_y(a) < u_x$ for any $a < a_z$. Then, no worker works in sector y and p_y is not well defined. Thus, we obtain that $u_x < u_y(a_z)$ and there exists an $a_x \in [\underline{a}, a_z)$ such that $u_x(a_x) = u_y(a_x)$ on equilibrium. Putting these together yields that

$$a_x = \frac{p_x \alpha_x P^{-1} + p_y \alpha_y n^{\frac{1-\mu}{\mu}} \left(\frac{\theta\delta\xi P}{p_y \alpha_y n^{\frac{1-\mu}{\mu}}} \right)^{\frac{1}{\xi+1}} P^{-1} + \theta\delta \left(\frac{\theta\delta\xi P}{p_y \alpha_y n^{\frac{1-\mu}{\mu}}} \right)^{\frac{1}{\xi+1}}}{p_y \alpha_y n^{\frac{1-\mu}{\mu}} P^{-1}} \quad \text{and} \tag{14}$$

$$a_y = \frac{p_y \alpha_y n^{\frac{1-\mu}{\mu}} \left(\frac{\theta\delta\xi P}{p_y \alpha_y n^{\frac{1-\mu}{\mu}}} \right)^{\frac{1}{\xi+1}} P^{-1} - p_z \alpha_z \left(\frac{\delta\xi P}{p_z \alpha_z} \right)^{\frac{1}{\xi+1}} P^{-1} + \theta\delta \left(\frac{\theta\delta\xi P}{p_y \alpha_y n^{\frac{1-\mu}{\mu}}} \right)^{\frac{1}{\xi+1}} - \delta \left(\frac{\delta\xi P}{p_z \alpha_z} \right)^{\frac{1}{\xi+1}}}{p_y \alpha_y n^{\frac{1-\mu}{\mu}} P^{-1} - p_z \alpha_z P^{-1}} \tag{15}$$

Lemma 5 *Suppose that* a_x *satisfies* (14).

(*i*) *For any* $a < a_x$, $u_x(a) > u_y(a)$.

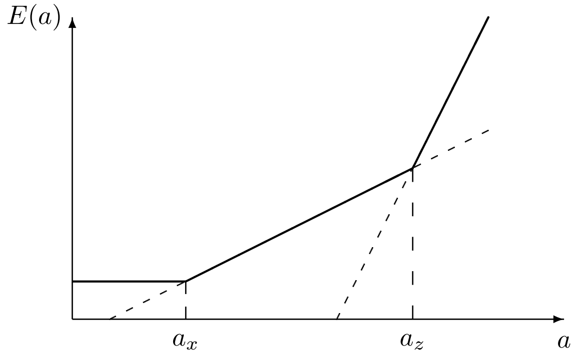
(*ii*) *For any* $a > a_x$, $u_x(a) < u_y(a)$.

By combining the market clearing conditions together and normalizing p_x to be one, we get

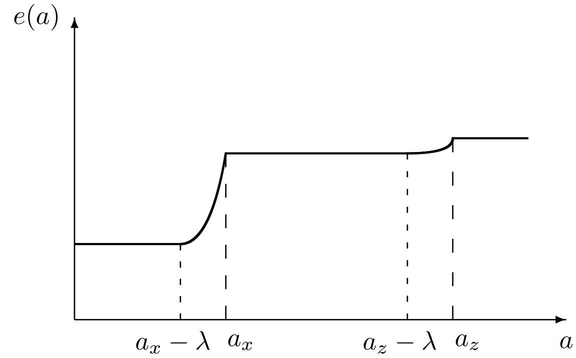
$$p_y^{\frac{1}{\sigma-1}} = \left[\frac{\alpha_y}{n} \int_{a_x}^{a_z} h_y(a) dG(a) \right] \left[\alpha_x G(a_x) - \underline{q} \right]^{-1}, \quad \text{and} \tag{16}$$

$$p_z^{\frac{1}{\sigma-1}} = \alpha_z \left[\int_{a_z}^{\overline{a}+\lambda} h_z(a) dG(a) \right] \left[\alpha_x G(a_x) - \underline{q} \right]^{-1}, \tag{17}$$

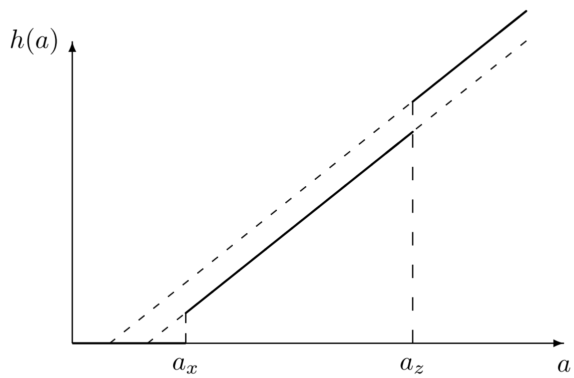
where $G(\cdot), \alpha_x$, and α_z are respectively given in (9), (14), and (15). Since the right hand side of (16) cannot be negative, $\alpha_x G(a_x) > \underline{q}$. Otherwise, there is no equilibrium. The condition says that the aggregate supply in sector x should be greater than the subsistence level of the sectoral products.



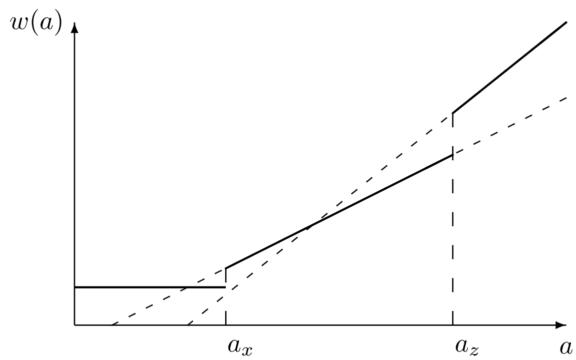
(a) Lifetime Values



(b) Education Choice



(c) Human Capital Inputs



(d) Wages

Figure 2: The dotted triangles represent the areas in which the equilibrium outcomes under the uniform pricing rule is better than those under the discriminatory pricing rule. As $(a - c)$ grows larger, the areas for Assumption 2B and 2C as well as the dotted triangles disappear.

Proposition 1 *There exists a unique steady state equilibrium if and only if (i) the non-linear system of equations summarized in* (16) *and* (17) *has a unique solution and (ii) the solution satisfies* $\alpha_x G(a_x) > \underline{q}$.

Since it's trivial, we skip the proof of Proposition 1. Instead, [Figure 2] presents some interesting properties of the equilibrium. Panel (a) in [Figure 2] shows that $E(a)$ is flat if $a \in [\underline{a}, a_x]$, convexly increasing otherwise. The workers with $a < a_x$ work in the traditional sector, the workers with $a \in [a_x, a_z)$ in the manufacturing sector, and the workers with $a > a_z$ in the high-tech sector. Panel (b) in [Figure 2] depicts the education choice by each type. The value differentials $E(a + \lambda) - E(a)$ is convexly increasing and the education choice function itself has a logit formula. As a result, the schooling decision is strictly increasing in a. It is flat for $a \in [\underline{a}, a_x - \lambda]$ because getting the advanced education does not affect their occupation choice. Panel (c) and (d) depict the loci of the human capital inputs by and wage payment for each type.

The fact that the wages convexly rise accounts for the emergence of 'superstars' as in Rosen (1981) in the high-tech sector.

Proposition 2 *$e(\cdot)$ is strictly increasing in a, as long as $a > a_x - \lambda$.*

Proposition 2 points out 'self-selection' in schooling decision as in Roy (1951) and Willis and Rosen (1979). It implies that the workers with higher innate abilities are more likely to get the advanced education. It is caused by the convexity of the lifetime value and human capital inputs. As a result, the income inequality worsen. In particular, the country with a well-developed elite education system characterized by a high λ may suffer from 'polarization'.

We consider a shock that alter the country-specific ethnical composition such as changes in immigration policy or trade policy. A positive shock on ethnical diversity may increase δ the coefficient for the cost function in the manufacturing sector. The diversity can reduce the team work due to barriers as such in language and culture.

4 Empirical Evidences

4.1 Data Sources

4.1.1 Education Measures

The Times Higher Education World University Ranking is founded in the United Kingdom in 2010 and widely regarded as one of the most influential and frequently observed university measures. We extract the list of top universities in 2011-2017 from the website and use it for constructing variables, *timesnum*, the number of universities in each country among the top 400, averaged in 2012 and 2013.[7]

The Center for World University Rankings (CWUR) is founded in Saudi Arabia in 2012 and publishes the global university ranking that measures the quality of education and training of students as well as the prestige of the faculty members and the quality of their research without relying on surveys and university data submissions. We extract the list of top universities in 2012-2016 and use it for constructing a variable, *cwurnum*, the number of universities in each country among the top 100, averaged in 2012 and 2013.[8]

We also construct dummy variables, *timesdum* and *cuwrdum*, which equal 1 if the country has any university listed among top 400 and top 100, respectively. Table 2 shows the list of countries with university rankings in the data.

[7] http://www.cwur.org/

[8] https://www.timeshighereducation.com/world-university-rankings/2017/world-ranking#!/page/0/length/25/sort_by/rank/sort_order/asc/cols/stats/

4.1.2 World Development Indicators

World Development Indicators (WDI) is the primary World Bank collection of development indicators, compiled from officially recognized international sources. It presents the most current and accurate global development data available, and includes national, regional and global estimates. We extract imports and exports data in various categories and use them as dependent variables. We take *agricultural & raw materials exports (Agri&Raw)*, *food exports (Food)*, *manufacture exports (Manu)*, and *high-technology exports (Hi-Tech)* from this dataset, all in current US$, and construct high-tech industry specialization measures, *Hi/Agri*, *Hi/Food*, and *Hi/Manu*, each defined as the ratio of *high-technology exports* to *agricultural & raw materials exports*, the ratio of *high-technology exports* to *food exports*, and the ratio of *high-technology exports* to *manufacture exports*, respectively. The size of the economy is controlled using goods and services exports for all export variables. Figure 3 shows the countries' high-tech exports, agricultural raw material exports, and food exports. We can see that there is a negative tendency between high-technology exports and non-high-tech exports, especially agricultural & raw materials exports and food exports. Figure 4 shows positive relationship between high-technology exports and high-tech industry specialization measures.

4.1.3 Penn World Table 9.0

Population, real GDP per capita, and trade openness are drawn from a single source, Penn World Table version 9.0, which is constructed by Robert Summers and Alan Heston of the University of Pennsylvania, together with Irving Kravis and currently maintaied by scholars at the University of California, Davis and the Groningen Growth Development Centre of the University of Groningen. In addition to this dataset, we added oecd dummy variable and regional dummy variables.

From the above data soures we construct a noble dataset, and its summary statistics are reported in Table 1, and the list of countries with university rankings in the data is reported in Table 2.

4.2 Empirical Results

4.2.1 Education System and High-Tech Specialization

Our theory suggests that elite education system and high-tech industries specialization are positively related. We conduct cross-country analysis using the noble dataset to see this relationship. We run regressions using *high-technology exports (Hi-Tech)* and high-tech industry specialization measures, *Hi/Agri*, *Hi/Food*, and *Hi/Manu*, as dependent variables, and the regression results are reported in Table 3. Each country's economy size is controlled using goods and services exports for all export variables. We take education measures, real GDP per capita, population, and trade openness as explanatory variables. OECD dummy is included in odd-number columns, and regional dummies are included in even-number columns. We consider two education measures:

Top100 Dummy and *Top400 Number*. We take *Top100 Dummy* as an indicator of elite education system. If a country has at least one university in the top 100 university list, then we assume that this country has an elite education system. On the contrary, if a country does not have any university in the top 100 university list, then we assume that this country does not have an elite education system. We take *Top400 Number* as a measure of universal education system. If a country has many universities in the top 400 university list, then we assume that this country's universal education is strong. Our measures allow a country to have both strong elite education (positive coefficients on *Top100 Dummy*) and strong universal education (positive coefficients on *Top400 Number*) or to have both weak elite education (negative coefficients on *Top100 Dummy*) and weak universal education (negative coefficients on *Top400 Number*). However, in our theory, countries specialize on either elite education or universal education, and we expect that countries would show either a combination of positive coefficients on *Top100 Dummy* and negative coefficients on *Top400 Number* or a combination of negative coefficients on *Top100 Dummy* and positive coefficients on *Top400 Number*. Especially, if a country specializes on high-technology industries, then this country is expected to have high high-technology exports, positive coefficients on *Top100 Dummy*, and negative coefficients on *Top400 Number*, and this is supported by our results in Table 3. All coefficients on *Top100 Dummy* are positive and very significant, and all coefficients on *Top400 Number* are negative. In addition, our results show that coefficients on *real GDP per capita* are all positive across specifications, that coefficients on *population* are all negative across specifications, and that coefficients on *trade openness* are all positive and significant across specifications. Note that coefficients on *Top400 Number* in colomn (3) and (4) are less significant than those in the other specifications. We explain that a country's climate environment and natural resources play a big role in explaining agriculture & raw material exports, along with its education system. In other words, even if a country specializes on high-technology industry, this country's agriculture & raw material exports would be high if this country has a good climate environment for farming and rich natural resources. Also, note that coefficients on *Top400 Number* in colomn (7) and (8) are less significant than those in the other specifications. This can be explained by the fact that high-tech industries tend to have connections with manufactural industries in most countries.

4.2.2 Returns to Education and Wage Inequality

Our theory suggests that, as a country adopts elite education system, returns to education increses, and it causes higher wage inequality. We study this relationship with cross-country panel regressions. Table 4 and Table 5 are drawn from Lee (2017), and they show strong and positive relationship between returns to education and wage inequality.[9] Also, note that coefficients on trade openness are positive and significant in both tables. The empirical results are robust across specifications, and they support our theoretical outcome that country with higher education experiences higher wage

[9] The Theil measure of wage inequality is used in the regressions, and it is given by the following formula: $T = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{Y_i}{\overline{Y}}\right)\ln\left(\frac{Y_i}{\overline{Y}}\right)$, where n is the number of all earners in the country, Y_i is the wage of individual i, is the mean wage of the population in the country.

inequality in response to the trade liberalization due to higher dispersion of human capital distribution from education choice and wage.

5 Conclusion

We study how education system impacts endogenous formation of human capital, trade patterns and income inequality. We construct the model of education choice with modifying three-sector occupation choice model by Grossman and Maggi (2000). Over the countries, education systems are characterized by education cost and eciency of education. We presume universal education system lowers unit education cost to make it evenly accessible to the public, while elite education system eectively reinforces human capital increase. Upon trade liberalization from autarky state, country with higher human capital has comparative advantage in the innovative sector while the other country specializes in the routine sector, with obtaining xed and lower returns. This specialization pattern promotes more education acquisition in the former country in expense of higher income inequality.

We also provide empirical evidence supporting our theory that countries with elite education system heavily specialize on high-tech industry while countries with universal education system specialize on non-high-tech industries such as agricultural & raw material production, food production, or manufactures. We construct education measures and industry specialization measures for 270 countries using publically available university ranking data and World Development Indicators provided by World Bank. We conduct cross-country regression analysis to examine the theory, and the results confirm that elite education system and high-tech industries specialization are positively related and that higher reterns to education, which is delivered by elite education system, leads to higher wage inequality controlling population, real GDP per capita, and trade openness. The empirical results are consistent and robust across specifications.

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Appendices

A Mathematical Appendix

Proof of Lemma 1 The first order condition of the contracting solution implies that

$$n^{-1}p_y\alpha_y(\sum_{k=1}^{n} n^{-1}h_k^{\mu})^{\frac{1}{\mu}-1}(h_y(a;\mathbf{h}_{-j}))^{\mu-1}P^{-1} = (h_y(a;\mathbf{h}_{-j}))^{\xi-1}a^{-\xi}$$

Suppose to the contrary that there exist a pair of (a, a') such that $a > a'$ but $h_y(a;\mathbf{h}_{-j}) \leq h_y(a';\mathbf{h}_{-j})$. Since $\mu < 0$ and

$$\begin{aligned} n^{-1}p_y\alpha_y\Big(\frac{(h_y(a;\mathbf{h}_{-j}))^{\mu}}{\sum_{k=1}^{n} n^{-1}h_k^{\mu}}\Big)^{1-\frac{1}{\mu}}P^{-1} &\geq n^{-1}p_y\alpha_y\Big(\frac{(h_y(a';\mathbf{h}_{-j}))^{\mu}}{\sum_{k=1}^{n} n^{-1}h_k^{\mu}}\Big)^{1-\frac{1}{\mu}}P^{-1} \\ &= (h_y(a';\mathbf{h}_{-j}))^{\xi-1}(a')^{-\xi} > (h_y(a;\mathbf{h}_{-j}))^{\xi-1}a^{-\xi}, \end{aligned}$$

$h_y(a;\mathbf{h}_{-j})$ cannot be the solution of the first order condition. Therefore, if $a > a'$ then $h_y(a;\mathbf{h}_{-j}) > h_y(a';\mathbf{h}_{-j})$. Again, let $a > a'$. Then,

$$\begin{aligned} u_y(a';\mathbf{h}_{-j}) &= w_y^j(h(a');\mathbf{h}_{-j}) - c(h(a');a') < w_y^j(h(a');\mathbf{h}_{-j}) - c(h(a');a) \\ &\leq w_y^j(h(a);\mathbf{h}_{-j}) - c(h(a);a) = u_y(a;\mathbf{h}_{-j}). \end{aligned}$$

The second strict inequality follows from the property of the cost function and the third inequality follows from the optimality. It completes the proof.

Proof of Lemma 2 Suppose to the contrary that there exists a team composed of $(a_1, a_2, \cdots, a_n)$ with $\max\{a_1, a_2, \cdots, a_n\} > \min\{a_1, a_2, \cdots, a_n\}$. Without loss of generality, let $a_1 = \max\{a_1, a_2, \cdots, a_n\}$ and $a_n = \min\{a_1, a_2, \cdots, a_n\}$. Also denote by $\mathbf{h}'_{-j}$ the vector of the human capital inputs by the members of the team except the j-the worker. The stability condition dictates that no a_1-type workers can receive strictly more than $u_y(h_y(a_1;\mathbf{h}'_{-1});\mathbf{h}'_{-1})$ on the equilibrium. Since it is feasible to a_1-type, another a_1-type worker from the outside can substitute the n-th worker. Then, given $\mathbf{h}'_{-n}$, $h_y(a_1;\mathbf{h}'_{-n}) > h_y(a_n;\mathbf{h}'_{-n})$ and also all other members put more human capital in the new formation, which increases further the human capital inputs by the new member. Denote by $\mathbf{h}''_{-j}$ the new input vector by all other members except the j-th worker in the new team. Apparently, $0 < w_y(h_y(a_1;\mathbf{h}'_{-1});\mathbf{h}'_{-1}) < w_y(h_y(a_1;\mathbf{h}''_{-n});\mathbf{h}''_{-n})$, which contradicts the stability of other teams with a_1-type workers. Therefore, on equilibrium, $\max\{a_1, a_2, \cdots, a_n\} = \min\{a_1, a_2, \cdots, a_n\}$ in any teams of the manufacturing industry.

Proof of Lemma 3 Suppose to the contrary that $p_z/p_y \leq n^{-1}(\alpha_y/\alpha_z)$. It implies that for any $a \in [\underline{a}, \overline{a}]$,

$$\begin{aligned} u_z(a) - u_y(a) &= (1-\xi^{-1})(a/P)^{\frac{\xi}{\xi-1}}\left[(p_z\alpha_z)^{\frac{\xi}{\xi-1}} - (n^{-1}p_y\alpha_y)^{\frac{\xi}{\xi-1}}\right] - p_z\alpha_z\underline{h}/P \\ &= (1-\xi^{-1})(p_y\alpha_z a/P)^{\frac{\xi}{\xi-1}}\left[(p_z/p_y)^{\frac{\xi}{\xi-1}} - (n^{-1}\alpha_y/\alpha_z)^{\frac{\xi}{\xi-1}}\right] - p_z\alpha_z\underline{h}/P \end{aligned}$$

$< \quad 0.$

The last strict inequality always holds as $\xi > 1$. Thus, no worker works in sector z, which is contradiction.

Proof of Lemma 4

(*i*) If $a > a_z$, $u_z(a) - \max\{u_x(a), u_y(a)\} > u_z(a_z) - \max\{u_x(a_z), u_y(a_z)\} = 0$.

(*ii*) First, suppose that $\max\{u_x(a_z), u_y(a_z)\} = u_x(a_z)$. When $a < a_z$, $u_x(a) = u_x(a_z) = \max\{u_x(a_z), u_y(a_z)\} = u_z(a_z) > u_z(a)$. Suppose that $\max\{u_x(a_z), u_y(a_z)\} = u_y(a_z)$. Then, $u_y(a) - u_z(a) > u_y(a_z) - u_z(a_z) = 0$. In any case, $u_z(a) < \max\{u_x(a), u_y(a)\}$.

Proof of Lemma 5

(*i*) Pick an arbitrary $a(< a_x)$. No matter which one is larger, $\max\{u_y(a), u_z(a)\}$ can be expressed as $A(a)a - B(a)$, where $A(a) > 0$ and $B(a) > 0$. Then, $a_x \leq A^{-1}(a)(p_x\alpha_x + B(a))$. $a < a_x \leq A^{-1}(a)(p_x\alpha_x + B(a))$, which implies that $u_x(a) = p_x\alpha_x > A(a)a - B(a) = \max\{u_y(a), u_z(a)\}$.

(*ii*) Pick an arbitrary $a(> a_x)$. Let $\max\{u_y(a_x), u_z(a_x)\} = A(a_x)a_x - B(a_x)$, where $A(a_x) > 0$ and $B(a_x) > 0$. Then, $a_x = A^{-1}(a_x)(p_x\alpha_x + B(a_x))$. Since $a > a_x$ and $u_x(a) = u_x(a_x) = p_x\alpha_x$, we get $u_x(a) = p_x\alpha_x = A(a_x)a_x - B(a_x) < A(a_x)a - B(a_x) \leq \max\{u_y(a), u_z(a)\}$.

Proof of Proposition 2

$$E(a+\lambda) - E(a) = (1-\beta(1-\rho))^{-1} \times$$
$$\begin{cases} 0 & \text{if } a \in [\underline{a}, a_x - \lambda) \\ (1-\xi^{-1})(p_y\alpha_y(a+\lambda)/(nP))^{\frac{\xi}{\xi-1}} - p_x\alpha_x/P & \text{if } a \in [a_x - \lambda, a_x) \\ (1-\xi^{-1})(p_y\alpha_y/(nP))^{\frac{\xi}{\xi-1}}\left[(a+\lambda)^{\frac{\xi}{\xi-1}} - a^{\frac{\xi}{\xi-1}}\right] & \text{if } a \in [a_x, a_z - \lambda) \\ (1-\xi^{-1})\left[(p_z\alpha_z(a+\lambda)/P)^{\frac{\xi}{\xi-1}} - (p_y\alpha_y a/(nP))^{\frac{\xi}{\xi-1}}\right] - p_z\alpha_z/P & \text{if } a \in [a_z - \lambda, a_z) \\ (1-\xi^{-1})(p_z\alpha_z/P)^{\frac{\xi}{\xi-1}}\left[(a+\lambda)^{\frac{\xi}{\xi-1}} - a^{\frac{\xi}{\xi-1}}\right] & \text{otherwise} \end{cases}$$

Together with the definition of (a_x, a_z), it implies that $E(a+\lambda) - E(a)$ is strictly increasing in a as long as $a > a_x - \lambda$. Therefore $e(\cdot)$ is also strictly increasing in a. *Q.E.D.*

Figure 3: High-Tech Exports vs. Non-High-Tech Exports

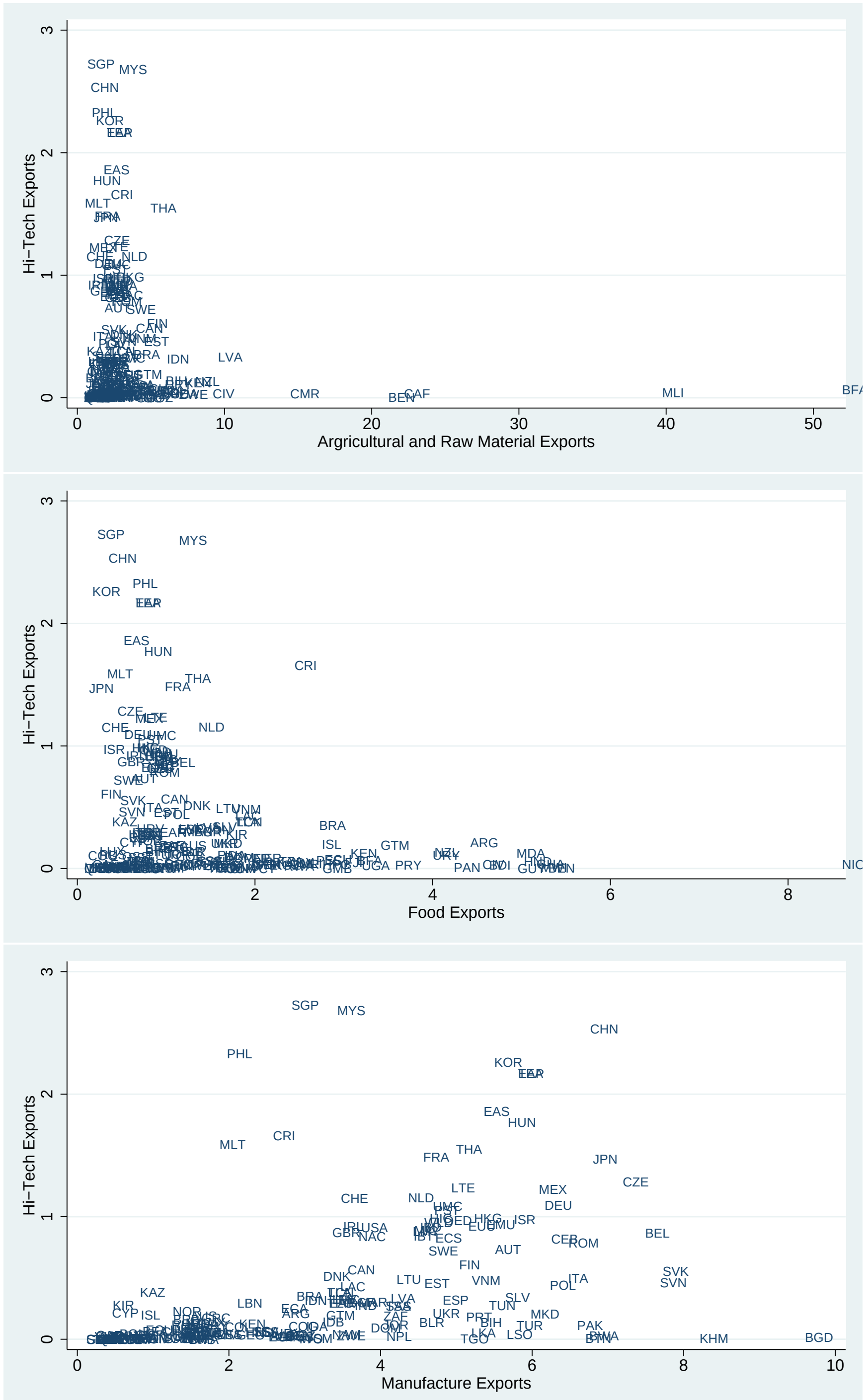

Figure 4: High-Tech Exports vs. Specification Measures

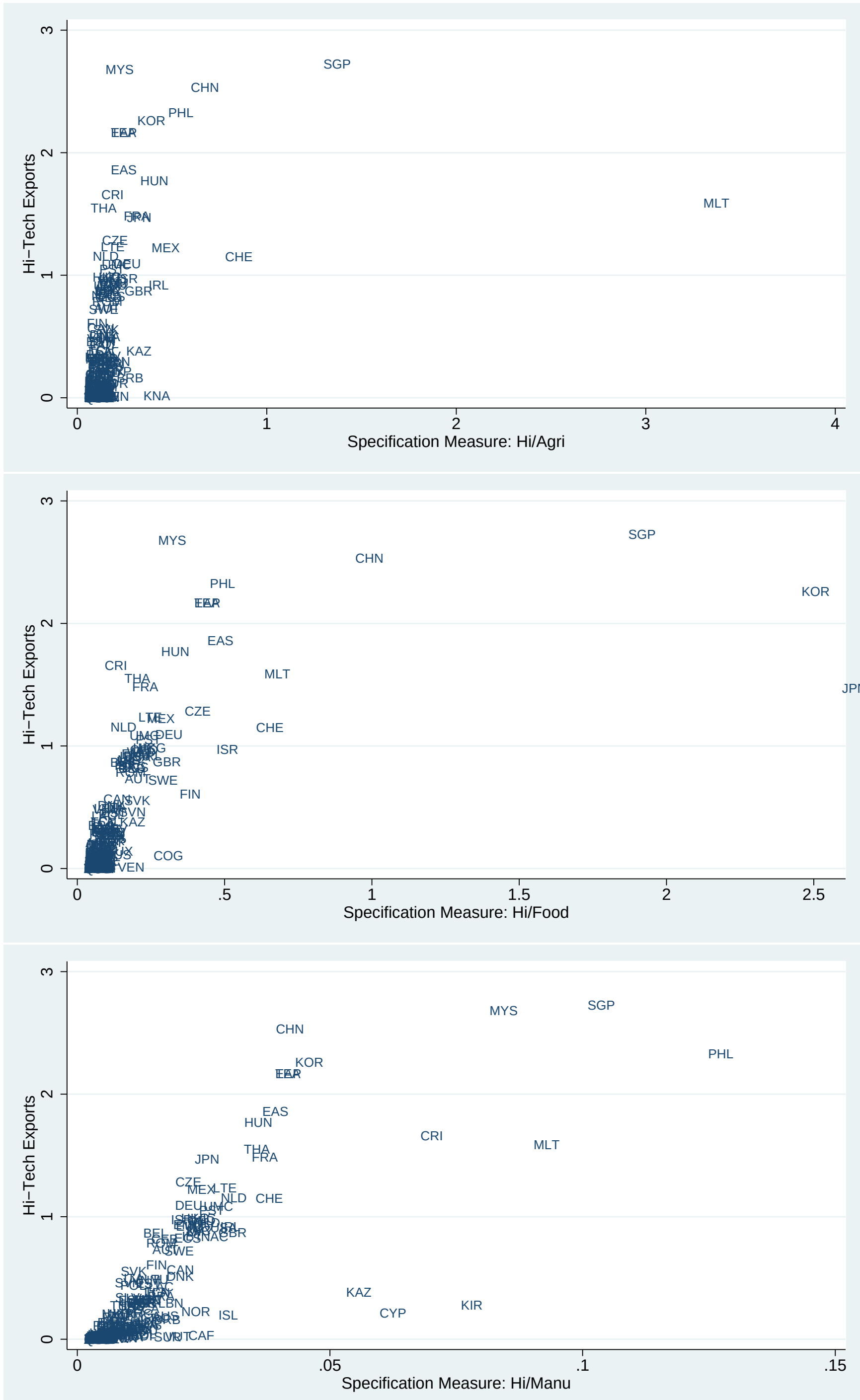

Table 1: Summary Statistics

	Obs	Mean	SD	Min	Max
Top400 Number	270	1.485	7.984	0.000	112.000
Top400 Dummy	270	0.159	0.367	0.000	1.000
Top100 Number	270	0.369	3.578	0.000	57.500
Top100 Dummy	270	0.063	0.243	0.000	1.000
Real GDP per Capita	182	0.048	0.161	0.000	1.525
Population	182	0.038	0.139	0.000	1.341
Openness	212	0.938	0.562	0.020	4.329
OECD Dummy	270	0.126	0.332	0.000	1.000
Agri&Raw	188	2.371	5.297	0.000	51.494
Food	193	1.295	1.313	0.000	8.532
Manu	183	2.987	2.098	0.027	9.510
Hi-Tech	183	0.408	0.584	0.000	2.726
Hi/Agri	175	0.073	0.284	0.000	3.377
Hi/Food	179	0.097	0.310	0.000	2.551
Hi/Manu	183	0.012	0.018	0.000	0.124

Rescaling: Agri&Raw*100, Food*10, Manu*10, Hi-Tech*10, (Hi/Agri)/100, (Hi/Food)/10, (Hi/Manu)/10, rGDP/10,000,000, Population/1,000.

Table 2: List of Countries with University Rankings

Countries with at least one university in top 100 (17):
Australia, Canada, Switzerland, Germany, Denmark, Finland, France, United Kingdom, Israel, Italy, Japan, South Korea, Netherlands, Norway, Singapore, Sweden, United States

Countries with at least one university in top 400 (26):
Austria, Belgium, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Spain, Estonia, Greece, Hong Kong, India, Ireland, Iran, Iceland, Mexico, New Zealand, Poland, Portugal, Russia, Saudi Arabia, Thailand, Turkey, Taiwan, South Africa

Countries with no university in top 400 (227):
ABW, ADO, AFG, AGO, AIA, ALB, AND, ANT, ARB, ARE, ARG, ARM, ASM, ATG, AZE, BDI, BEN, BFA, BGD, BGR, BHR, BHS, BIH, BLR, BLZ, BMU, BOL, BRB, BRN, BTN, BWA, CAF, CEB, CH2, CIV, CMR, COD, COG, COK, COM, CPV, CRI, CSS, CUB, CUW, CYM, CYP, DJI, DMA, DOM, DZA, EAP, EAR, EAS, ECA, ECS, ECU, EMU, ERI, ETH, EUU, FCS, FJI, FRO, FSM, GAB, GEO, GHA, GIB, GIN, GMB, GNB, GNQ, GRD, GRL, GTM, GUM, GUY, HIC, HND, HPC, HRV, HTI, HUN, IBD, IBT, IDA, IDB, IDN, IDX, IRQ, JAM, JOR, KAZ, KEN, KGZ, KHM, KIR, KNA, KSV, KWT, LAC, LAO, LBN, LBR, LBY, LCA, LCN, LDC, LIC, LIE, LKA, LMC, LMY, LSO, LTE, LTU, LUX, LVA, MAC, MAR, MCO, MDA, MDG, MDV, MEA, MHL, MIC, MKD, MLI, MLT, MMR, MNA, MNE, MNG, MNP, MOZ, MRT, MSR, MUS, MWI, MYS, NAC, NAM, NCL, NER, NGA, NIC, NPL, NRU, OED, OMN, OSS, PAK, PAN, PER, PHL, PLW, PNG, PRE, PRI, PRK, PRY, PSE, PSS, PST, PYF, QAT, ROM, ROU, RWA, SAS, SDN, SEN, SLB, SLE, SLV, SMR, SOM, SRB, SSA, SSD, SSF, SST, STP, SUR, SVK, SVN, SWZ, SXM, SYC, SYR, TCA, TCD, TEA, TEC, TGO, TJK, TKM, TLA, TLS, TMN, TMP, TON, TSA, TSS, TTO, TUN, TUV, TZA, UGA, UKR, UMC, URY, UZB, VCT, VEN, VGB, VNM, VUT, WBG, WLD, WSM, YEM, ZAR, ZMB, ZWE

Table 3: Education Quality and High-Tech Exports

	(1) Hi-Tech	(2) Hi-Tech	(3) Hi/Agri	(4) Hi/Agri	(5) Hi/Food	(6) Hi/Food	(7) Hi/Manu	(8) Hi/Manu
Top100 Dummy	0.689***	0.818***	0.224**	0.222**	0.681***	0.761***	0.019***	0.019***
	(0.153)	(0.159)	(0.100)	(0.104)	(0.095)	(0.098)	(0.006)	(0.006)
Top400 Number	-0.029***	-0.027***	-0.007	-0.006	-0.029***	-0.028***	-0.000	-0.000
	(0.008)	(0.008)	(0.005)	(0.005)	(0.005)	(0.005)	(0.000)	(0.000)
Real GDP per Capita	2.469***	2.465***	0.557	0.445	2.131***	2.147***	0.036	0.034
	(0.617)	(0.630)	(0.402)	(0.410)	(0.381)	(0.387)	(0.025)	(0.024)
Population	-0.418	-0.816	-0.081	0.072	-0.926***	-1.098***	-0.006	-0.014
	(0.485)	(0.511)	(0.317)	(0.333)	(0.300)	(0.314)	(0.019)	(0.020)
Openness	0.412***	0.344***	0.253***	0.266***	0.157***	0.137***	0.013***	0.011***
	(0.064)	(0.069)	(0.042)	(0.045)	(0.039)	(0.042)	(0.003)	(0.003)
Constant	-0.204***	-0.188	-0.166***	-0.005	-0.120***	-0.144*	-0.002	-0.002
	(0.073)	(0.140)	(0.048)	(0.091)	(0.045)	(0.086)	(0.003)	(0.005)
OCDE Dummy	Y	N	Y	N	Y	N	Y	N
Regional Dummy	N	Y	N	Y	N	Y	N	Y
R-squared	0.492	0.520	0.257	0.305	0.471	0.508	0.243	0.300
Observations	137	133	134	130	137	133	137	133

Standard errors in parentheses

Rescaling: Agri&Raw*100, Food*10, Manu*10, Hi-Tech*10, (Hi/Agri)/100, (Hi/Food)/10, (Hi/Manu)/10, rGDP/10,000,000, Population/1,000.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Returns to Education and Wage Inequality (1)

Dependent Variable: Theil Wage Inequality					
	(1)	(2)	(3)	(4)	(5)
Population	1.601***	-	-	-	-
	(0.339)	-	-	-	-
Real GDP per Capita	-0.194***	-0.143***	-0.143***	-	-
	(0.022)	(0.021)	(0.020)	-	-
Annual Growth of Real GDP per Capita	-0.007	-0.009	-	-0.056	-
	(0.049)	(0.053)	-	(0.060)	-
Openness	0.243***	0.109**	0.106**	0.019	-
	(0.052)	(0.046)	(0.044)	(0.051)	-
Returns to Education	0.164	1.196***	1.187***	1.720***	1.671***
	(0.474)	(0.450)	(0.446)	(0.508)	(0.501)
Constant	0.358***	0.339***	0.340***	0.144**	0.149***
	(0.058)	(0.062)	(0.061)	(0.063)	(0.051)
Adjusted R^2	0.370	0.281	0.285	0.055	0.062

Standard errors in parentheses

Note: 40 countries and 155 observations are included in the data.

List of countries includes: Australia, Austria, Belgium, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Denmark, Spain, Finland, France, United Kingdom, Germany, Greece, Guatemala, Honduras, Hungary, Ireland, Israel, Italy, Japan, South Korea, Luxembourg, Mexico, Nicaragua, Netherlands, Norway, Panama, Peru, Philippines, Poland, Puerto Rico, Russia, El Salvador, Sweden, Thailand, United States and Venezuela.

Rescaling: Theil Wage Inequality is multiplied by 10; Population is divided by 1,000,000; Real GDP per Capita is divided by 10,000; Growth of Real GDP per Capita is divided by 10; Openness is divided by 100; Micerian Returns to Education is divided by 100.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Returns to Education and Wage Inequality (2)

	Dependent Variable: Theil Wage Inequality							
	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Real GDP per Capita	-0.143***	-0.164***	-0.148***	-0.097***	-0.104***	-0.056**	-0.118***	-0.058*
	(0.020)	(0.026)	(0.020)	(0.027)	(0.029)	(0.025)	(0.032)	(0.031)
Openness	0.106**	0.123***	0.106**	0.094**	0.095**	0.082**	0.116**	0.103**
	(0.044)	(0.047)	(0.044)	(0.044)	(0.044)	(0.041)	(0.046)	(0.043)
Returns to Education	1.187***	1.357***	1.217***	0.695	0.766	1.111***	0.853*	1.217***
	(0.446)	(0.468)	(0.443)	(0.477)	(0.488)	(0.411)	(0.508)	(0.426)
Democracy Index	-	-0.016	-	-	-	-	-0.014	-0.003
	-	(0.016)	-	-	-	-	(0.017)	(0.015)
East Asia Dummy	-	-	-0.129*	-	-0.059	-	-0.043	-
	-	-	(0.078)	-	(0.084)	-	(0.090)	-
Latin America Dummy	-	-	-	0.136***	0.120**	-	0.139**	-
	-	-	-	(0.053)	(0.057)	-	(0.062)	-
OECD Dummy	-	-	-	-	-	-0.243***	-	-0.270***
	-	-	-	-	-	(0.046)	-	(0.049)
Constant	0.340***	0.380***	0.351***	0.288***	0.299***	0.413***	0.325***	0.426***
	(0.061)	(0.074)	(0.061)	(0.063)	(0.065)	(0.058)	(0.076)	(0.068)
Adjusted R^2	0.285	0.300	0.293	0.311	0.309	0.393	0.327	0.420

Standard errors in parentheses

Note: 40 countries and 155 observations are included in the data.

List of countries includes: Australia, Austria, Belgium, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Denmark, Spain, Finland, France, United Kingdom, Germany, Greece, Guatemala, Honduras, Hungary, Ireland, Israel, Italy, Japan, South Korea, Luxembourg, Mexico, Nicaragua, Netherlands, Norway, Panama, Peru, Philippines, Poland, Puerto Rico, Russia, El Salvador, Sweden, Thailand, United States and Venezuela.

Note: Partially linear regression model (PLR) is also tested. Real RDP per Capita and Mincerian Returns to Education are taken as non-linear components, and smoothing parameters are 0.8 for both PLR specifications. The results are highly robust across various values of smoothing parameter.

Rescaling: Theil Wage Inequality is multiplied by 10; Population is divided by 1,000,000; Real GDP per Capita is divided by 10,000; Openness is divided by 100; Micerian Returns to Education is divided by 100.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$