VERTICAL SPECIALIZATION WITH HETEROGENEOUS ENTREPRENEURS: CAN TRADE PROMOTE INDUSTRIALIZATION OF DEVELOPING COUNTRIES?

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Abstract

This paper explores the theoretical link between trade liberalization and industrial development in developing economies. A two-country, three-good, and three-factor computable general equilibrium model is developed, which features a capital-intensive intermediate good, and a special factor of production, the entrepreneurial skill. The numerical results suggest that with free trade, the developing economy can import the cheaper capital-intensive intermediate good and largely expand its manufacture sector. Moreover, the developing economy can export its manufactured product to the developed economy. Unlike the conventional static trade models that predict that developing economies will de-industrialize with free trade, this theory helps to understand the rapid industrial expansion in newly industrialized economies while liberalizing their international trade.

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1 Introduction

Trade liberalization versus trade protectionism has been one of the lasting debates among economists. In developing countries where the degree of protection is stronger, one prominent argument against trade is that trade would cause the undesirable effect of domestic de-industrialization for a developing country. However, development experiences from the past few decades suggest that this conventional belief based on static trade models of comparative advantages may not be true. Contrary to this argument, many emerging economies have experienced fast economic and industrial growth while relaxing controls over international trade. For example, South Korea, Taiwan and some ASEAN economies have experienced simultaneous surge of international trade and manufacturing production. This observation poses a serious theoretical question: Does trade promote industrial production in a developing economy or does it promote primary good production as predicted by conventional trade theories?

This paper explores the theoretical link between trade liberalization and industrial growth, based on an important observation that in these emerging economies, the surge of the manufactured good export was accompanied by the large increase of imported capital-intensive intermediate goods. A general equilibrium model is developed to incorporate vertical production and to study its role in the relationship between trade liberalization and industrial production. The intuition is simple. A developing economy can utilize the technology developed by industrialized economies to upgrade its manufacture sector. These technolo-

gies often are embedded in the capital-intensive intermediate goods. Purchasing these goods through international trade is likely to be faster and less expensive than developing their own technologies.

Existing studies that have focused on relationship between trade and industrialization are limited. A standard two-country, two-good and two-factor Heckscher-Ohlin model predicts that the developing economy (relatively capital scarce) will specialize more in the primary production, or in other words, cause de-industrialization. Clark (1997) established empirical link between trade liberalization and industrial development, showing a negative relationship between distortionary trade policy and industrial expansion. Although studies on relationship between industrialization and trade regime are few, there exists rich literature studying the relationship between economic growth and trade regime. Due to the high correlation between industrial expansion and economic growth, these studies on trade and economic growth can serve as indirect evidence for trade and industrial development. Many studies of this topic can be found in the survey by Balassa (1989). Puga and Venables (1999) have investigated theoretically the relationship between trade and industrialization, showing that the unilateral trade liberalization can benefit the industrial development in developing economies more than the protective regime. However, the assumption made in the paper that developing and developed economies have the same level of capital endowment limits the implication for developing economies with severe capital scarcity. Literature on intermediate good exists mainly in the area of multinational production in which intermediate goods are typically labor-intensive and

produced by a developing economy, as in Konan (2000). A study by Din (1994) shows that establishing export processing zone can be beneficial to the domestic economy with a non-tradable intermediate good. Some studies on intra-industry trade also incorporate the feature of intermediate good production. For example, Kei-Mu Yi (1999) demonstrated that with vertical integration, it can explain most of the increase in trade volume by trade liberalization, which can not be explained by conventional trade models.

This article differs from the existing studies in various aspects. First, the focus is on the surge of import of capital-intensive intermediate goods observed in many emerging economies, not developed economies as Kei-Mu Yi (1999). The intermediate good is the more capital-intensive and the market structure is competitive, which is different from the usual multinational production models. Second, unlike Puga and Venables (1999), the developing and developed economies differ not in technology but in factor endowment, in particular, the developing country is relatively capital-scarce. Moreover, an additional factor of production, the entrepreneuring skill is introduced. This is an important feature of this paper. This skill is not necessarily measured by education. Rather this skill is the intrinsic ability in capturing market opportunity and organizing a human network to deliver a product. This skill varies across the population but not necessarily rely on education, even though some literacy may be required. [1] In a sense, any economy with a reasonable history of commercial production

[1] An example can be the booming village-ship and township productions in China and numerous private small enterprises, and typically those entrepreneurs are with very limited education, not to mention MBA.

and commercial trade will be endowed with a large number of people with high measurement in this skill. [2] Therefore, even though a developing economy is poorly endowed with college graduates, it may still have a fair stock of people with entrepreneuring skills. With other necessary elements of production, this developing economy has the potential of industrial development.

The model economy established in this paper has a stationary free trade equilibrium that produces a much higher amount of the manufactured goods than the equilibrium under autarky. The developing country can import the relatively cheap capital intensive intermediate good which results in more manufactured output in each enterprise. Moreover, increased profitability of industrial production will induce more entry. Altogether, the manufactured output can become much higher when trade is liberalized. The model also suggests that it is possible for a capital-scarce country to export the manufactured good if this country is reasonably well endowed with managerial skills.[3] Thus the pattern of trade between a developed country and a developing one is that the developing country exports manufactured goods and imports intermediate goods. This result matches well the observed trade pattern of the emerging economies with rapidly rising manufactured export to developed economies. The model does not incor-

[2]Thus economies that just emerged from barter trade or tribal communities, for example, Pacific Islands or some African economies, may not be richly endowed with this skill. This skill can be considered as a national market-organizational capital, which takes learning-by-doing to build. However, this model does not allow the accumulation of this skill. The reason is twofold: besides the technical complication, this types of skill takes at least decades or generations to build, to let people to learn the market culture. Therefore it is not essential to allow this accumulation when the intended time span of the model is only a few decades.

[3]Managerial skills and entrepreneuring skills are used interchangeablely throughout the paper.

porate capital accumulation for technical reasons. But the result should apply in a dynamic framework as well.

The rest of this paper is organized as follows. The next section presents the model. The third section defines the equilibrium of both open and closed economies. The fourth section computes the stationary equilibrium of a simple numerical example, and the final section concludes the chapter.

2 The Model Economy

The model has two economies and three factors of production. Each economy has three sectors: the agriculture sector that produces the primary product, the intermediate good sector that produces a capital-intensive intermediate good for use in the manufacture sector, and the manufacture sector that produces the final manufactured product. Goods produced by all three sectors are traded. Three factors of production are: capital, labor and entrepreneuring (or equivalently, managerial) skills. Factors of production are not traded.

The economy has a continuum of measure one of households, endowed with different managerial skills s. Households are also endowed with one unit of time each period, and $\bar{K}$ units of physical capital stock at date 0. Capital stock is assumed to be fixed, it does not depreciate and it cannot be accumulated. Households consume agricultural good a, and manufactured good m. They also decide whether to work as a worker or to become an entrepreneur and manage

their own enterprises.

The conventional agricultural sector takes labor inputs and produces an agricultural product a, which is consumed by households. The intermediate good sector takes labor and physical capital as inputs and creates a capital intensive intermediate good z.

The manufacture sector consists of a continuum of firms, each created by an entrepreneur with entrepreneuring skill s. To create a firm, it takes c units of intermediate goods. To exit, a firm disappears with no residue value. Re-entry requires the same costs as first-time entry. A manufacturer takes intermediate good z, and his or her own managerial skill as inputs, and produces a manufactured product which is consumed by households.

In the equilibrium of a closed economy, the country with the relative abundant physical capital endowment will have more industrial firms, and more manufactured goods produced.

2.1 Households

As mentioned, households are each endowed with a unit of labor, $\bar{K}$ units of capital stock, and managerial skills s. The distribution of managerial skills is $\Phi(s)$. Households are indexed by s in ascending order for convenience.

The households have homogenous convex and homothetic preferences. Households consume the farm good a and manufactured good m. The income of a

household consists of capital rental income and wage income if the occupation is worker, or rental income and profit if the household's occupation is entrepreneur.

A household makes decision every period on whether to become a worker or an entrepreneur. It requires entry cost c units of intermediate good for a worker to become an entrepreneur.

Let $V_w(s)$ be the value function (life-time utility) of a household with worker occupation and with managerial skill s, and $V_e(s)$ be the value function of a household with entrepreneur occupation. Denote $V_{ew}(s)$ the value function of an entrepreneur who decides to become a worker in the next period. Denote $V_{we}(s)$ the value function of a worker who decides to become an entrepreneur the next period. Then:

$$V_w(s) = \max\{V_{ww}(s), V_{we}(s)\}, \tag{1}$$

and

$$V_e(s) = \max\{V_{ee}(s), V_{ew}(s)\} \tag{2}$$

Where

$$V_{ww}(s) = \max\{u(a,m) + \beta V'_w(s)\}$$

$$pa + m \leq w + rk$$

$$V_{we}(s) = \max\{u(a,m) + \beta V'_e(s)\}$$

$$pa + m + qc \leq w + rk$$

$$V_{ee}(s) = \max\{u(a,m) + \beta V'_e(s)\}$$

$$pa + m \leq \pi(s) + rk$$

$$V_{ew}(s) = \max\{u(a,m) + \beta V'_w(s)\}$$

$$pa + m \leq \pi(s) + rk$$

In the above expressions, $V'_w(s)$ and $V'_e(s)$ stand for value functions of a worker or an entrepreneur the next period, respectively.

In equilibrium, there exist two critical values of s. Because of the positive entry cost, the managerial skill level that a worker is indifferent in becoming an entrepreneur or remaining a worker is higher than the skill level that an entrepreneur is indifferent in becoming a worker or remaining an entrepreneur. It is because that the work has to pay an entry cost to become an entrepreneur, thus it takes higher skill to make more profit to compensate the entry cost. If the entry cost is zero, then this two cutoff skill levels will be equal. Define the cutoff skill level for an entrepreneur to be indifferent in becoming a worker or remaining an entrepreneur as s_1, and the cutoff skill for a worker to be indifferent in becoming an entrepreneur or remaining a worker as s_2. Within the same economy, $s_1 < S_2$, the gap is increasing in the entry cost c, keeping other parameters constant.

Mathematically, s_1 is such that:

$$V_{ee}(\hat{s}) = V_{ew}(\hat{s});$$

Because no entry cost is required, this also implies

$$V_w(\hat{s}) = V_e(\hat{s}). \tag{3}$$

And s_2 is such that:

$$V_{we}(\hat{s}) = V_{ww}(\hat{s}).$$

To simplify the analysis, without loss of generality,[4] I assume a single cutoff point of the skill level $\hat{s}$, $\hat{s} \in [s_1, s_2]$. Define $\hat{s}$ as the value of managerial skills such that all households with $s > \hat{s}$ are entrepreneurs, and that all households with $s < \hat{s}$.

Denote the career distribution at the beginning of a period as $X(s)$, which takes values of 0 or 1, where 0 means being a worker the last period, and 1 means being an entrepreneur the last period. Hence X(s) is an aggregate state variable. Denote the household's career decision by $x(s, X)$, where

[4]It is observed that the differentiation of s_1 and s_2 is relevant only during the dynamic transition. However, if the direction of transition is predictable, it is easy to see which value is the relevant one. This issue will be addressed again during the discussion of equilibrium with free trade.

$$x(s,X) = \begin{cases} 0 & \text{if the household with skill s decides to be a worker} \\ 1 & \text{if the household with skill s decides to be an entrepreneur} \end{cases}$$

Given the cut-off point *hats*, the career decision of a household can be rewritten as:

$$x(s) = \begin{cases} 0 & \text{if } s < \hat{s} \\ 1 & \text{if } s \geq \hat{s} \end{cases}$$

Then at the beginning of the next period, the career distribution $X'(s)$ satisfies:

$$X'(s) = x(s,X), \forall s. \tag{4}$$

Equation 4 is actually the law of motion for the career distribution.

With cutoff point at $\hat{s}$, the total demand for good a is:

$$A^D = a_w \hat{s} + \int_{\hat{s}}^{\bar{s}} a_e(s) d\Phi(s) \tag{5}$$

where $a_e(s)$ is the demand of good a of household with skill s and with the entrepreneur occupation, a_w is the demand of the households with worker occupation, and $\bar{s}$ is the upper bound of managerial skills. Similarly, the aggregate demand for manufactured good is:

$$M^D = m_w \hat{s} + \int_{\hat{s}}^{\bar{s}} m_e(s) d\Phi(s) \tag{6}$$

where $m_e(s)$ is the demand of good a of household with skill s and with the entrepreneur occupation, and m_w is the demand of the households with worker occupation.

2.2 Agriculture Sector

The agriculture sector is labor intensive. It produces good a for consumption. The production technology is concave, constant return to scale.

For simplicity, assume labor is the only input. Then the production can be written as:

$$A^S \leq \gamma n, \tag{7}$$

where A^S is output supplied, n is labor input. Thus γ represents the agricultural productivity.

Let p be the price of the agricultural good in terms of manufactured good which is the numeraire. Let w be the real wage rate. The agricultural sector's cost minimizing problem implies:

$$\gamma p = w \tag{8}$$

2.3 Intermediate good sector

The production of intermediate good z is capital intensive. For simplicity, assume it takes only capital stock k as input. Thus the production technology can be expressed as:

$$Z^S \leq \alpha K^D \tag{9}$$

Let q be the price of good z in terms of the manufactured good. Let r be the real rental rate of capital. In equilibrium, the minimizing cost problem of the firm implies:

$$\alpha q = r \tag{10}$$

2.4 Manufacture Sector

The manufacture sector consists of continuum of enterprises, each managed by an entrepreneur with managerial skill s. A manufacturing enterprise takes intermediate good z as input and produces manufactured good m. The productivity of the enterprise is positively related to the entrepreneur's managerial skill. The production technology for manufactured good m is concave and decreasing return to scale:

$$m \leq sz^{\theta}, \tag{11}$$

where $0 < \theta < 1$.

Each enterprise maximizes profit. The enterprise's problem is:

$$\max_{m,z} sz^{\theta} - qz.$$

The enterprise's maximizing problem implies:

$$q = \theta s z^{\theta-1} \tag{12}$$

The total output of the manufacture sector is:

$$M^S = \int_{\hat{s}}^{\bar{s}} m(s) d\Phi(s) \tag{13}$$

where $\hat{s}$ represents the cutoff point for occupation.

The total demand of intermediate good is:

$$Z^D = \int_{\hat{s}}^{\bar{s}} z(s) d\Phi(s) \tag{14}$$

where $z(s)$ represents the optimal input decision of intermediate good by an entrepreneur with skill s.

3 Competitive Equilibrium for Autarky Economy and Open Economies

3.1 The Autarky Economy

A competitive equilibrium in an autarky economy is a list of policy functions for households: $\{a(w,s), a(e,s), m(w,s), m(e,s), x(s)\}$, a list of value functions: $\{V_w(s), V_e(s)\}$, policy functions for agricultural sector: $\{a^s(p,w), n^d(p,w)\}$, policy functions for intermediate good sector: $\{z^s(q,r), q^d(q,r)\}$, policy functions for the manufacture sector $\{m^s(s,q), q^d(s,q)\}$, the distribution of occupation $X(s)$, and prices $\{p(K,X), q(K,X), r(K,X), w(K,X)\}$, such that:

1. The household policy functions and value functions solve the households' problems.

2. The agricultural sector policy functions solve that sector's cost minimizing problem.

3. The intermediate sector policy functions solve that sector's cost minimizing problem.

4. The manufacture sector policy functions solve the enterprises' profit maximizing problems.

5. The market clearing conditions for two final goods, one intermediate good, and two factors of production are satisfied.

$$A^S = A^D \tag{15}$$

$$M^S = M^D \tag{16}$$

$$Z^S = Z^D \tag{17}$$

$$\hat{s} = N^D \tag{18}$$

$$\bar{K} = K^D \tag{19}$$

6. The law of motion for the distribution of occupations obeys Equation 4.

As suggested by numerical exercise in the next section, high capital endowment will result in lower price of intermediate good, and lower cut-off point for skill. Lower price for intermediate good and lower cut-off point for skill together lead to higher production of the manufactured good. In a developing economy, the opposite is observed, the price of capital- intensive intermediate good is high, the cut-off point of skill is high, implying smaller number of enterprises in the manufacture sector, and the total manufactured output is low. Therefore, when trade occurs between two economies with different capital endowment,the relatively capital-scarce economy will import the intermediate good from the relatively capital-abundant economy.

3.2 Competitive Equilibrium for Two Open Economies

The main difference between an equilibrium with trade and without is that the market clearing conditions for individual countries must be replaced by global market clearing conditions. Moreover, conditions for trade balance must be satisfied. Denote the foreign country variables by adding $*$ to domestic variables. The global market clearing conditions are:

$$A^S + A^{S*} = A^D + A^{D*} \tag{20}$$

$$M^S + M^{S*} = M^D + M^{D*} \tag{21}$$

$$Z^S + Z^{S*} = Z^D + Z^{D*} \tag{22}$$

$$\hat{s} = N^D \tag{23}$$

$$\hat{s*} = N^{D*} \tag{24}$$

$$\bar{K} = K^D \tag{25}$$

$$\bar{K}^* = K^{D*} \tag{26}$$

The trade balance condition is:

$$p(A^S - A^D) + (M^S - M^D) + q(Z^S - Z^D) = 0 \tag{27}$$

In computing the equilibrium, I assume that the developing countries has the cutoff point of managerial skills $\hat{s} = s_2$, and the developed country has the cutoff point $\hat{s*} = s_1^*$. The reason is that a developing country is more likely to start with a smaller manufacture sector. If trade allows rapid expansion of the manufacture sector, there will be more workers becoming entrepreneurs. Since s_2 represents the skill level at which a worker is indifferent as to become an entrepreneur or not, it is an appropriate cutoff point. On the other hand, since it is likely for some entrepreneurs in the developed country to become a worker after opening to trade, and since s_1 represents the cutoff point for an entrepreneur to become a worker, it would be a proper cutoff point for the developed country.

4 Numerical Analysis

This section solves numerically the equilibrium of autarky economy and the open economies. The purpose is to find out quantitative impact of trade on industrialization of developing countries.

Assume the Cobb-Douglas preference:

$$u(a, m) = \rho \log a + (1 - \rho) \log m$$

And assume uniform distribution of skills across households. Moreover, assume that both countries have a measure one of households, and that the two countries differ only in capital endowments. Table 1 gives the other parameter values.

4.1 Trade and Industrialization

When a developing country opens to trade with a developed country, with the access to cheap capital goods (intermediate good z), the developing country's industrial output (total manufactured output) M^S can increase substantially. If the developing country is closed to trade, since it has small endowment of capital stock, the cost of producing manufactured good will be very high, hence the industrial output will be much smaller compared with the case of opening to trade.

From Table 2, one can see that with ten times of difference in capital stock, if open to trade, the total manufactured outputs of the developed country and the developing country can be very close.[5] If the developing country decides to close the economy to trade, the manufactured output will be merely 2.91, which

[5]Positive entry cost causes the cutoff point of the developing economy to be slightly higher than that in the developed economy. With zero entry cost, this cutoff point will be the same for both economies, and the same with the total manufactured output.

The share of expenditure on good a: ρ	.29
Time discount parameter: β	.75
Technology parameter of agriculture: α	1.31
Technology parameter of intermediate good: γ	.60
Technology parameter of manufactured good: θ	.80
Entry cost: c	2.00

Table 1: Parameter Values

Variables	Open Economies		Autarky
	Developed	Developing	Developing
Capital Endowment	50.00	5.00	5.00
Cutoff Point of Skill	.796	.801	.824
Manufactured Output	11.63	11.48	2.91
Intermediate Price	.26	.26	.36

Table 2: Comparison of Trade and Autarky

is only about 25% of the level with free trade. That is, the manufactured output level with trade is nearly four times of the autarky level.

Two factors contribute to this huge difference of manufactured output level. One is that with trade, it is profitable for more households to switch from worker occupation to entrepreneur occupation. Thus the number of the manufacturing enterprises increases when the country opens to trade. The other factor is that with trade, the price of intermediate input decreases, thus the output of the manufacturing enterprises increases. Together, these two factors create a very

Variables	Open Economies		Autarky
	Developed	Developing	Developing
Capital Endowment	250.00	5.00	5.00
Cutoff Point of Skill	.797	.798	.824
Manufactured Output	39.49	39.39	2.91
Intermediate Price	.19	.19	.36

Table 3: Comparison with Larger Difference in Capital Endowment

large increase in manufactured output of the developing country when it opens to trade.

The larger the difference in capital endowment between the developing country and the developed country, the more the manufactured output of the developing country will grow when it opens to trade. Table 3 presents the result when the capital endowment in the developed country is fifty times as big as in the developing country. It shows that the manufactured output in the developing country increases more than twelve times when it opens to trade.

In comparison with Table 2, the number of the enterprises further increases than the case with smaller difference in capital endowments across countries, although this factor contributes to the increase of the manufactured output only to a small extent. It is the large reduction of price of intermediate input that contributes largely to the increase of the manufactured output in this case.

Variables	Equilibrium Allocation		Trade Pattern
	Developed	Developing	Developing Export
K	50.00	5.00	$---$
$\hat{s}$	.796	.801	$---$
M^S	11.63	11.48	5.3
M^D	16.9	6.2	$---$
qZ^S	16.8	1.7	-7.5
qZ^D	9.3	9.2	$---$
pA^S	4.8	4.8	2.2
pA^D	7.0	2.6	$---$

Table 4: The Trade Pattern Between the Developed and the Developing Country

4.2 The Pattern of Trade

Can a developing country specialize in producing the manufactured output or not? Will a developing country be capable of exporting its manufactured output to developed countries? Table 4 shows that a developing country certainly can export manufactured products as well.

It is clear form Table 4 that the developing country will export both the manufactured product and agricultural product but import the intermediate capital good. Table 5 gives similar results for the case that the difference in capital endowments across countries is larger. Note that in tables 4 and 5, values of allocations are presented. However, due to rounding errors, trade balance may not be exactly zero.

Variables	Equilibrium Allocation		Trade Pattern
	Developed	Developing	Developing Export
$\bar{K}$	250.00	5.00	− − −
$\hat{s}$	.797	.798	− − −
M^S	39.49	39.39	21.4
M^D	60.89	17.99	− − −
qZ^S	61.7	1.2	−30.2
qZ^D	31.5	31.4	− − −
pA^S	16.4	16.4	8.9
pA^D	25.2	7.5	− − −

Table 5: The Trade Pattern with Larger Difference in Capital Endowments

It is very possible that if the developing country is endowed with more households with relatively high skill level, the developing country may import the agricultural product as well. It could also happen that a country with smaller capital endowment imports the manufactured goods, but this will happen only if the difference in capital endowment across the countries is small and that the endowment of relatively high skill households is scarce in the developing country. However, If the difference of capital endowment is small, it will be considered the trade between developed countries (or developing countries), which is not the object of this study. In conclusion, the trade pattern between a developed country and a developing one is that the developing country exports the manufactured output and imports the intermediate capital goods.

5 Conclusion

Unlike what usual North-South trade models predict (that a developing country will mainly export primary agricultural goods and import the manufactured goods), the model described above demonstrates that with free trade, a developing country can become the exporter of the manufactured products. Moreover, the manufacture sector output can increase tremendously from the autarky level. This result has important implication on the development strategy for developing countries. If industrialization is one of major goals of a developing country, free trade is the right strategy to be adopted since it can substantially speed up the process of industrialization.

One important application of this theory is the study of the performance of import substitution and export promotion. Many empirical studies suggest that export promotion countries in general outperform import-substituting countries in growth of industrial output and export. Could it be the reason that export promotion countries are relatively more liberalized in international trade compared with import substituting countries? This model gives a positive answer, if a developing economy is endowed with reasonable number of people with entrepreneuring skills, opening up trade can lead to large increase of industrial production. Moreover, considering the difference of performance among export promotion countries themselves, the conjecture would be that, the economies with relatively more liberalized trade policy may perform better in industrialization than those with more restrictions on imports of capital-intensive intermediate

goods, conditional on other policy differences.

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