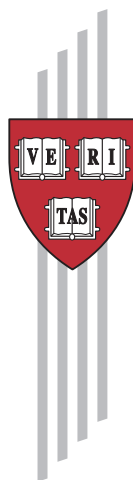


Gradual Spread of Market-Led Industrialization

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Abstract

The paper introduces asymmetric production conditions between firms and asymmetric transaction conditions between countries into the Murphy-Shleifer-Vishny model of industrialization. It explores a general equilibrium mechanism that generates circular causation loop that each firm's profitability and its decision of involvement in a network of industrial linkages and trade flows is determined by the size of the network, while the network size is in turn determined by all firms' decisions of participation. It shows that the very function of the market is networking relevant self-interested decision makers and utilize the network effects of industrialization, though this function is not perfect. Hence, market led industrialization will gradually spread until the whole world economy is integrated in a single network of trade and industrial linkages as transaction conditions are improved. Also, this general equilibrium mechanism predicts empirical observation that temperate zone is involved in this industrialization process more early than the tropic zone because of its better climate and public health conditions. This paper devises a new approach to specifying zero profit condition for a marginal modern firm, while keeping original feedback loop between positive profit and the extent of the market of the MSV model. Hence, this new method and the trade off between economies of scale and transaction costs can be used to endogenize the number of modern sectors and increases applicability of this type of models which is featured with compatibility between economies of scale and competitive market.

Keywords: globalization, industrialization, market-led development

JEL codes: F10, O40

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1. Introduction

The purpose of the paper is threefold. First, it formalizes one branch of high development economics which describes industrialization as a market led gradual spreading process. Second, it investigates effects of transaction conditions, which are affected by geography, institutions, and transportation and communication technology, on gradual spread of industrialization. Finally, this paper devises a new method to handle the Murphy-Shleifer-Vishny model (1989). This new method will extend applicability of this model to the analysis of many trade and development phenomena. Let us motivate the three tasks one by one.

Since the end of the 1980s, many general equilibrium models with increasing returns have been developed to formalize what is called by Krugman (1995) “high development economics.” There are two different views in high development economics. One is referred to as the theory of big push and balanced industrialization, represented by Rosenstein-Rodan (1943) and Nurkse (1952). The other is referred to as the theory of unbalanced industrialization, represented by Fleming (1954) and Hirschman (1958). When economists were not familiar with technical substance of general equilibrium models, they can only use vague words to address general equilibrium phenomena, such as circular causation, interdependent decisions in different industries, pecuniary externality of industrial linkages, and so on.

In essence, Rosenstein-Rodan’s idea (1943) about big push industrialization is to advocate for state led industrialization because of coordination failure in exploiting network effects of industrial linkages in a decentralized market. This idea is formalized by the MSV model with the

feedback loop between the extent of the market and economies of scale that can be exploited. Hirschman's idea (1958) about pecuniary externality of industrial linkages relates more or less to market led industrialization since the network effects of industrial linkages are pecuniary (which can be exploited by the price system). Term "balanced vs. unbalanced industrialization" may be misleading. Unbalanced industrialization strategy may be associated with specialization of a country in a particular sector and international division of labor between countries. Hence, from a view of the world market, such a strategy is a balanced industrialization strategy, although it is not balanced within a single country (Sheahan, 1958). We shall extend the MSV model to formalize Hirschman's idea on market led gradual spread of industrialization.

Casual observation indicates that industrialization was gradually spread from the UK to Netherlands and France, then to Germany and other central and north European countries, and finally reached south Europe and the rest of the world. In Asia, industrialization started in Japan in the end of 19th century, then gradually spread to Hong Kong, Singapore, Taiwan, South Korea, and other Asian countries.

The observed gradual spread of industrialization is affected by transaction conditions. There are three major determinants of transaction conditions: institutions, geography, and technology. Industrialization started in the island countries, then spread to coastal regions of the continent, then to hinterland countries. It was so in Europe in the 18th and 19th century (the UK is an island country, Netherlands and France are in coastal region, and Germany and other central European countries are hinterland countries) and in Asia in the 19th and 20th century (Japan and Taiwan are island countries, Singapore, Hong Kong, and South Korea are in coastal region, China and India are continental countries with vast hinterland areas).

Effects of institutions on transaction conditions and thereby on economic development have been investigated by North (1981), North and Weingast (1989), Mokyr (1990, 1993), and others. Gallup and Sachs (1998) provide empirical evidences for effects of geography on transportation conditions and thereby on economic development. They use cross country data to show that the population share of coast region and distance from the major international market have very significant impact on per capital income.

Institutions and geography are not independent of each other. Baechler (1976, pp. 78-80) notes that geographical conditions of Europe created a variety of polity and rivalry between hostile sovereigns within the same cultural whole in Europe, which encouraged many different institutional experiments. A particular geographical condition ensured that Britain could avoid war with other countries at low defense expenses and had transportation advantage for trade. Pursuit of riches was legitimated under the prevailing ideology, so that talents were diverted from military, religious, and bureaucratic careers to business activities prior to and during the Industrial Revolution.

Geography affects economic development also via its connection to climate and public health conditions. One of the most important patterns of international development is the large and secularly rising gap in incomes between temperate and tropical economies. This gap is largely unexplained in the literature, and thus constitutes one of the greatest intellectual puzzles in development economics. The general mode of explanation is that the tropics lags the temperate zone because of political reasons. In Marxist theory, the exploitation of the tropics by temperate zone economies during the colonial era, and the continuing exploitation through post-colonial dependency, lies at the heart of explanation. In much neoclassical speculation, the tropical zone economies are poorly governed, with a lack of property rights and with predation

by the state. Why "good" governments should be found in the temperate zone and "bad" governments in the tropics is left unexplained. Another way of thinking is that the political patterns (to the extent that they exist) are outcomes rather than fundamental causes of the income differences. In this view, the tropics were conquered by the temperate zones because of some more basic advantages in the temperate zone. The poor governments in the tropics are a result of poverty, rather than a cause.

There are some deep reasons for higher food productivity in the temperate zones than in the tropics. In cases where food crops cross ecological lines (wheat in the temperate and sub-tropical zones; rice and maize in the temperate, sub-tropical, and tropical zones), intrinsic productivity is almost always higher in the temperate regions. This productivity advantage has been related to fundamental conditions of net photosynthetic potential, soils, and hydrology. With regard to public health, the main difference in regions lies in the prevalence of vector-borne diseases. Most disease agents (bacteria, viruses, other parasites) require living conditions in warm environments, specifically, at temperatures near that of the human body itself. Some disease agents can be transmitted directly between persons (e.g. tuberculosis, which is transmitted by aerosols in human breath), but many others are transmitted by an animal vector (i.e. intermediate animal host). Such vectors, in the case of flies (e.g. trypanosomiasis), or mosquitoes (e.g. malaria and yellow fever), or snails (e.g. schistosomiasis) are usually highly dependent on warm temperatures for survival and infectivity. Other parasites transmitted between persons partly through a phase outside of the body or another host (e.g. in the ground, in the case of helminths), and so too must be transmitted in a warm environment in order to survive.

Gallup and Sachs (1998) provide empirical evidences that the countries in the temperate regions outperform those in the tropic regions. In the current paper, we will identify a general

equilibrium mechanism that dictates the interplay between climate and other geographical conditions, transaction conditions, and economic development.

In the paper, we will introduce asymmetric production conditions between firms and asymmetric transaction conditions between countries into the Murphy-Shleifer-Vishny (MSV) model of industrialization (1989). In the MSV model competitive market is compatible with economies of scale (see also Rosen, 1983 and Yang and Ng, 1998 for a discussion on compatibility between increasing returns and competitive market) and its algebra is easy to manage. The feedback loops between the extent of the market, dividend earnings, economies of scale that can be exploited, and quantities demanded nicely formalize a general equilibrium mechanism that can talk to circular causation, network effects of industrial linkages, and interdependence between production and market conditions and decisions in different sectors, which concerned high development economists.

There is some technical difficulty of this kind of models that restricts its broad application. The price of the goods produced by the active modern sectors is a constant, determined by the zero profit condition of cottage firms with constant returns to scale technology. This paralyzes the functioning of the price system to transmit information of the production condition of the modern firms to consumers. Hence, the number of modern sectors cannot be endogenized by using the zero profit condition. Kelly (1997) introduces the trade off between economies of scale and transaction costs into the MSV model to endogenize the number of modern sectors. Because of zero profit condition, consumers' utility does not go up as the number of modern sectors increases in that model. If the assumption of positive profit is maintained to keep the flavor of feedback loop between the extent of the market and economies of scale, the model is short of one equation to endogenize the number of modern sectors.

In this paper, we develop an analytical approach to specifying a zero profit condition for a marginal modern firm, while keeping positive profit for other active modern firms. Following Kelly, we specify the trade off between economies of scale and transaction costs to endogenize the number of active modern versus traditional sectors. This approach keeps the original flavor of the MSV model: interdependence between the extent of the market and economies of scale, and compatibility between competitive market and global economies of scale. A key ingredient that makes this approach work is asymmetry of production conditions between different modern firms and asymmetry of transaction conditions between countries. This new approach to handle the MSV model will make this model more applicable to the analysis of many problems in economic development, trade, urbanization, and industrial organization.

The introduction of the trade off between economies of scale that can be exploited and transaction costs can accommodate empirical evidence that is at odds with the MSV model. The MSV model predicts that a large population size has a positive effect on industrialization. But the first country that was industrialized (UK) was not the most populous country (China). Empirical evidences provided in National Research Council (1986) and Dasgupta (1995) reject this type of scale effect. Murphy, Shleifer, and Vishny (1989) suggest to introduce transaction costs to counteract the scale effect. Our model will substantiate their idea and show that there exists substitution between population size and transaction conditions in promoting industrialization and economic development and that a large country can be locked in the development trap if its transaction conditions are very bad.

In section 2, equilibrium and comparative statics of the extended MSV model are solved. We then extend the model to the case with many countries to endogenize a dual structure

between integrated developed world and autarkic less developed world in section 3. In addition, a dynamic version of the model is considered. The final section concludes the paper.

2. An Extended Murphy-Shleifer-Vishny Model of Industrialization

Consumers' decisions.

Following MSV, we assume that the set of consumption goods produced by the industrial sector is a continuum with mass m . Each consumer-worker-owner has a Cobb-Douglas-CES utility function. Her decision problem is:

$$(1) \quad \text{Max: } U = [\int_0^m x(j)^\rho dj]^{\alpha/\rho} z^{1-\alpha}, \text{ s.t. } \int_0^m p(j)x(j)dj + p_z z = I = (\pi+w).$$

where $j \in [0, m]$ is an index of industrial goods, $x(j)$ is the quantity of good j consumed, $p(j)$ is the price of good j , z is the quantity of agricultural good consumed, p_z is the price of the agricultural good. Each consumer endowed with one unit of labor has income I which consists of dividend earning π and wage income w . Labor is assumed to be the numeraire, so that $w = 1$. Ownership of all firms is equally shared by all consumers. Later, we shall show that in equilibrium $p(j) = 1$ for all j . Hence, the optimum quantity demanded of good j is the same for all j . Using the symmetry, the solution to the problem (1) can be found as follows.

$$x = \alpha I/m, \quad z = (1-\alpha)I/p_z$$

The total market demand is:

$$(2) \quad X^d = \alpha I L/m = \alpha(\Pi+L)/m, \quad Z^d = (1-\alpha)(\Pi+L)/p_z, \quad \Pi = \pi L.$$

where Π is total dividend earning which is equal to total profit. We now consider the production of z . The production function of z is

$$(3) \quad Z = \theta L_z$$

where θ is an agricultural productivity parameter, L_z is the amount of labor allocated to the production of z . The equilibrium price of good z is thus $p_z = 1/\theta$ and the equilibrium quantity of good z consumed and produced is then $Z = (1-\alpha)\theta(\Pi+L)$.

Production of Industrial Goods

For each industrial good, there are two available technologies. The modern one exhibits economies of scale and the traditional one is $x_h = L_{hx}$, x_h is the output of a traditional (cottage or handcraft) sector and L_{hx} is the amount of labor allocated to this sector. Because of the existence of the traditional technology, the labor prices of all industrial goods are always 1, so that the quantity demanded is the same for all industrial goods. If we specify an iceberg transaction cost coefficient $1-t$ for each goods produced by the modern sectors and purchased by a consumer, and assume that this cost coefficient is 0 if all manufacturers in the modern sectors reside in the city and is positive if they have dispersed residences, then it can be shown that all manufacturers in the modern sectors always reside in the city in equilibrium. Hence, the population share of urban residents equals the employment share of modern sectors.

The production function of the modern sector producing good j is

$$(4) \quad x_j = (L_j - F_j)/b, \quad F_0 = \delta, \quad F_j = \gamma j > \delta \text{ for } j \in (0, m].$$

where x_j is the quantity supplied, L_j is the amount of labor allocated to the production of the industrial good, and F_j is the fixed production cost of good j . We assume that the fixed cost differs across modern sectors and that the industrial goods are indexed according to their fixed costs. Industrial good 0 has the smallest fixed cost δ , which is a very small positive number, industrial good m has the largest fixed cost γm , and for $j \in (0, m]$, $F_j = \gamma j \in (\delta, \gamma m]$. Here, γ can be considered as a general production condition parameter. As γ decreases, the fixed cost for any

modern sector j decreases. Also, F_j can be interpreted as the degree of capital intensity. A large value of F_j implies that the modern sector j needs a high investment in fixed cost before a positive output can be produced. Hence, index j can be considered as an index of capital intensity of the modern sectors.

We assume further that there is a variable transaction cost for each modern firm. The transaction condition differs across countries. The transaction cost incurred to a modern firm in country i is

$$(5) \quad C_i = c_i x_j, \quad c_0 = s, \quad c_i = \mu i > s \text{ for } i \in (0, M].$$

where $i \in [0, M]$ is an index of countries, s , a very small positive number, is the transaction cost coefficient for country 0, and x_j is the output level of modern sector j which is the same in any country and in any sector as we have shown. The set of countries can be either a continuum or a finite set $\{0, 1, \dots, M\}$. The specification implies that two factors determine the transaction cost coefficient: a general transaction condition μ and country specific transaction condition represented by index i . for a larger i , the transaction cost coefficient c_i is larger.¹ A country's geographical condition and institutional and cultural tradition determines its ranking index i . For any given i , the transaction cost coefficient c_i decreases as μ decreases. A decrease in μ can be caused by worldwide changes in transportation technology or institutions. We may consider country 0 as the most developed country and country M as the most underdeveloped country. The profit of firm j in country i is

$$(6) \quad \pi_{ij} = x_j - L_j - c_i x_j = (1 - \mu i - b) x_j - \gamma_j$$

¹ We take the transaction cost coefficient as a black box. The literature of endogenous transaction cost has opened the black box and shown that moral hazard, adverse selection, and other opportunism may generate endogenous transaction costs. See Milgrom and Roberts (1992), Hart (1995), and Holmstrom and Roberts (1998).

where $x_j = X^d$ is determined by the demand function given in (2). Total dividend earning is equal to total profit of n active modern firms.

$$(7) \quad \Pi = \int_0^n \pi_{ij} dj$$

where $n \in [0, m]$ is endogenously determined. Plugging this expression for total dividend earning into (2), total market demand for the good produced by firm j can be found as

$$(8) \quad x_j = \alpha(\Pi+L)/m$$

where the number of all industrial goods is m , the number of active traditional sectors is $m-n$.

(6)-(8) nicely captures the feedback loop between income, demand, and production conditions. It also captures the idea of big push industrialization. If the transaction cost is 0, as more modern firms operate (n increases), dividend earning and income increases, demand increases, which makes more modern firms profitable. Hence, as the population size reaches a threshold level, the equilibrium number of modern sectors, n , jumps from 0 to its upper bound m (see Murphy, Shleifer, and Vishny, 1989). But in our model, transaction costs counteract the positive feedback between the extent of the market and economies of scale that can be exploited, so that industrialization may occur gradually as the transaction conditions are improved.

Inserting (8) into (6), then inserting the resulting expression into (7), we can conduct integration and then express total income $\Pi+L$ as a function of n .

$$(9) \quad \Pi+L = (L-0.5\gamma n^2)m/[m-\alpha n(1-b-\mu i)]$$

where $L-0.5\gamma n^2 > 0$ and $m-\alpha n(1-b-\mu i) > 0$ are required by positive income. We now consider the zero profit condition for the most capital intensive active modern sector n . Letting j equal n in (6) and $\pi_n = 0$, we get the zero profit condition, $\pi_n = (1-b-\mu i)x_j - \gamma n = 0$. Inserting the demand function, given in (8), into the zero profit condition for the marginal active modern firm generates another expression of $\Pi+L$.

$$(10) \quad \Pi + L = \gamma mn / (1 - b - \mu i) \alpha.$$

where $1 - b - \mu i > 0$ is required by positive income. (9) and (10) together give the equilibrium number of active modern firms n as a function of parameters $\gamma, \mu, L, b, i, \alpha$.²

$$(11) \quad f(n, \gamma, \mu, L, b, i, \alpha) = \alpha(L + 0.5\gamma n^2)(1 - b - \mu i) - \gamma mn = 0$$

(11) is a quadratic equation of n which can be rearranged as $f(n) = An^2 - Bn + D = 0$, where A, B, D are positive. The graph of this equation in the first and fourth quadrants of the n - f coordinates is a convex curve cutting the vertical axis above the horizontal axis since $f(0) = D > 0$, $f'(0) = -B < 0$, $f''(n) = 2A > 0$. The unique minimum point $n = B/2A > 0$ of this curve is given by $f'(n) = 0$. Hence, this curve may have two cutting points of the right half horizontal axis, which means two equilibria, given by $f(n^*) = 0$. Call the two solutions of $f(n) = 0$ n_1 and n_2 , respectively, and assume $n_2 > n_1$. Hence, we can see that

$f'(n_1) < 0$ and $f'(n_2) > 0$ for a convex curve with the unique minimum point that is below the horizontal axis. But we can show that for a positive income, $\partial f / \partial n = \alpha \gamma n(1 - b - \mu i) - \gamma m < 0$ must hold since positive income in (9) requires $m - \alpha n(1 - b - \mu i) > 0$. This implies that n_2 cannot be an equilibrium. We have then established the claim that there is only one equilibrium in this model.³

Differentiating (11) and using the implicit function theorem, we can identify the comparative statics of the equilibrium number of active modern firms.

$$(12) \quad \begin{aligned} dn/dL &= -(\partial f / \partial L) / (\partial f / \partial n) > 0, & dn/d\mu &= -(\partial f / \partial \mu) / (\partial f / \partial n) < 0, \\ dn/db &= -(\partial f / \partial b) / (\partial f / \partial n) < 0, & dn/di &= -(\partial f / \partial i) / (\partial f / \partial n) < 0. \end{aligned}$$

where $\partial f / \partial n = \alpha \gamma n(1 - b - \mu i) - \gamma m < 0$ and $\partial f / \partial \gamma = 0.5\alpha n^2(1 - b - \mu i) - mn < 0$ because the positive income in (9) requires $m - \alpha n(1 - b - \mu i) > 0$, $\partial f / \partial b, \partial f / \partial i, \partial f / \partial \mu < 0$, $\partial f / \partial L > 0$. (12) implies that there

² The market clearing condition for labor is not independent of (9) and (10) according to Walras' law. Hence, it can be used to check if the algebra is correct. Indeed, inserting the equilibrium values of the endogenous variables and transaction costs in terms of labor into this market clearing condition for labor confirms that it is the same as (9).

is substitution between transaction conditions and population size in promoting industrialization. For a given μ , a larger population size generates a higher degree of industrialization. For a given L , better general transaction conditions generate a higher degree of industrialization. $dn/di < 0$ implies that the degree of industrialization is lower for a country with the larger transaction cost coefficient which implies a larger i . This implies that a large country may have low degree of industrialization if its transaction conditions are very bad.

General equilibrium and comparative statics

The general equilibrium in country i is summarized as follows.

$$(13) \quad p_x = 1, \quad p_z = 1/\theta \quad L_z = (1-\alpha)(\Pi+L),$$

$$X = \alpha(\Pi+L)/m, \quad Z = (1-\alpha)\theta(\Pi+L)$$

$$L_x = \int_0^n \{ [b\alpha(\Pi+L)/m] + \gamma j \} dj = [b\alpha(\Pi+L)n/m] + 0.5\gamma n^2$$

$$R \equiv L_x/L, \quad U = m^{\alpha(1-\rho)/\rho} \alpha^\alpha [\theta(1-\alpha)]^{1-\alpha} [(\Pi/L)+1]$$

$$(\Pi/L)+1 = \gamma mn/\alpha(1-b-\mu i)L, \text{ and}$$

$$n \text{ is given by } f = \alpha(L+0.5\gamma n^2)(1-b-\mu i) - \gamma mn = 0$$

where U is per capita real income (equilibrium utility level), $(\Pi/L)+1$ is per capita income in terms of labor, L_x is the amount of labor allocated to all active modern firms, and $R \equiv L_x/L$ represents the degree of urbanization. Differentiating U in (13) and using (11) and (12), it can be shown that

$$(14) \quad dU/dL > 0, \text{ and } dU/d\mu < 0, \quad dR/dL > 0, \quad dR/d\mu < 0,$$

$$dn/dL > 0, \quad dn/d\mu < 0, \quad dn/db < 0,$$

$$d(m-n)/dL = -dn/dL < 0, \quad d(m-n)/d\mu = -dn/d\mu > 0.$$

³ Multiplicity of equilibria is discussed in Murphy, Shleifer, and Vishny (1989).

It is straightforward that the number of active traditional sectors $m-n$ decreases as the population size increases and/or as transaction conditions are improved. Hence, duality of economic structure is endogenized.

The comparative statics can be summarized in the following proposition.

Proposition 1: As population size increases and/or as general transaction conditions are improved, the equilibrium number of active modern sectors, degree of urbanization, degree of capital intensity of active modern firms, productivity, and per capita real income increase. For a given general transaction condition and population size, the country with more favorable geographical and institutional conditions for trade has higher degree of industrialization than in other countries.

Suppose general transaction conditions are very bad in the initial time. Then no modern firm operates in any country. As time goes by, general transaction conditions are improved, so that some modern firms operate in the country with the smallest transaction cost coefficient $c_0 = s$. But other countries are not industrialized. As general transaction conditions are further improved, those countries with slightly larger transaction cost coefficient start industrializing and the number of active modern firms in each of the industrializing countries increases. As general transaction conditions are further improved, those countries with the largest transaction cost coefficients are eventually industrialized. This process goes on until all countries and all sectors in each country are industrialized.

3. Extension and Applications

In the industrialization process described in the preceding section, each less developed country gradually duplicates the industrialization in the relatively more developed country in the absence of international trade. This looks like that each less developed country carries out import substitution strategy and relies on domestic market for industrialization. Because of positive effect of population size on industrialization, as shown in (14), we can extend our model to the analysis of international trade and export oriented industrialization. The opening up of international trade will increase the population size in the integrated world market, thereby promoting industrialization and economic development. But in our model transaction costs counteract unlimited expansion of international trade. Hence, the degree of market integration can be endogenized using the trade off between economies of scale and transaction costs. Suppose M countries are divided between the developed world consisting of N countries and the underdeveloped world with $M-N$ countries. We now interpret L in (13) and (14) as the total population size in the N developed countries. In each of the N countries, some modern sectors operate and sell their produce to domestic as well as the world market. Each of the $M-N$ less developed countries does not trade with other countries and self-provides industrial goods by local cottage firms.⁴ The dividing line between the developed countries and the underdeveloped countries is given by the zero profit condition for the active modern sector with the smallest fixed cost in the marginal N th country. This implies that profit in all other modern sectors with larger fixed cost in this country are negative. Also profit in all modern sectors in $M-N$ less developed countries which have larger transaction cost coefficients than the marginal country are negative. This zero profit condition is

⁴ We need the assumption that migration from the less developed countries to the developed ones is prohibitively expensive. Otherwise, all individuals in the less developed countries will migrate to the developed countries which

$$(15) \quad \pi_{N0} = (1-\mu N-b)x_j - \delta = 0$$

where δ is the smallest fixed cost in the modern sector producing good 0 and x_j is the total market demand for this good in the integrated world market consisting of N developed countries.

Now, the zero profit condition for the marginal firm in the integrated market can be obtained by assuming the profit in modern sector n in country 0 which has the smallest transaction cost coefficient $c_0 = s$ to be zero. If this firm cannot break even in the marginal sector which has the largest fixed cost among all active modern sectors, the other countries with larger transaction cost coefficients than country 0 cannot possibly break even in this sector. This zero profit condition is

$$(16) \quad \pi_{0n} = (1-s-b)x_j - \gamma n = 0.$$

Using (15) and (16) to eliminate the total market demand x_j , which must be the same for all industrial goods, we can identify the connection between the network size of international trade N and the number of active modern sectors in the integrated world market, n .

$$(17) \quad N = [(1-b)/\mu] - [\delta(1-b-s)/\mu\gamma n],$$

$$dN/d\mu = (\partial N/\partial\mu) + (\partial N/\partial n)(dn/d\mu) < 0$$

where $\partial N/\partial\mu < 0$, $\partial N/\partial n > 0$, and $dn/d\mu < 0$ due to (12).

Interpreting L in (9) as the population size in the integrated market with N developed countries, (9), (15), and (16) determine the equilibrium n in the developed world in the extended model. Beside (17), the rest of comparative statics is the same as in (14). In each of the $M-N$ less developed countries which are not involved in international trade because of a large transaction cost coefficient c_i ($i \in (N, M]$) all industrial goods are supplied by traditional (or cottage,

have better transaction condition. Also, we need the assumption that all individuals in the developed countries can freely migrate between countries and they equally share ownership of all active modern firms. The two assumptions are quite ad hoc. But they are essential for keeping the extended model tractable.

handcraft) sectors. Per capita income is the same in all less developed countries, lower than in the developed countries. The autarky equilibrium for each of those countries is

$$p_z = 1/\theta, \quad p_x = 1, \quad X = \alpha L_i/m, \quad Z = (1-\alpha)\theta L_i$$

$$U = m^{\alpha(1-\rho)/\rho} \alpha^\alpha [\theta(1-\alpha)]^{1-\alpha}$$

where L_i is the population size of country $i \in (N, M]$. We now assume that in the initial period μ is so large that c_i is too large for any modern firm to break even in all countries $i > 0$. Hence, only country 0 (the UK) has modern sectors. As time goes by, μ decreases, the scope for trading off economies of scale against transaction costs is enlarged, so that the modern sectors with low fixed cost become profitable, this increases income and thereby demand, which makes more modern firms become profitable. This higher degree of industrialization in the developed world makes more less countries be willing to use international trade to exploit more economies of scale, which extends overseas market for domestic produce in the developed countries, which in turns attracts more participants of the network of trade. But increased transaction costs counteract the positive feedback between the extent of the market and economies of scale that can be exploited and between the number of countries involved in international trade and gains from trade. A new equilibrium is established that balances the trade off between economies of scale and transaction costs. Those countries with larger transaction cost coefficients and those modern sectors that are more capital intensive are not involved in international trade in the early stage of world development.

As general transaction conditions are further improved, the equilibrium number (measure) of modern sectors n and the number of countries involved in industrialization and international trade, N , increase. The newly industrializing countries produce and export goods of low capital intensity and those old industrialized countries produce and export capital intensive

goods. This process continues until the most capital intensive sectors are produced by the modern sector and all countries are involved in the integrated world market. This is what happened in the West Europe in the 18th and 19th century. Fig. 1 gives an intuitive illustration of this spread of market led industrialization.

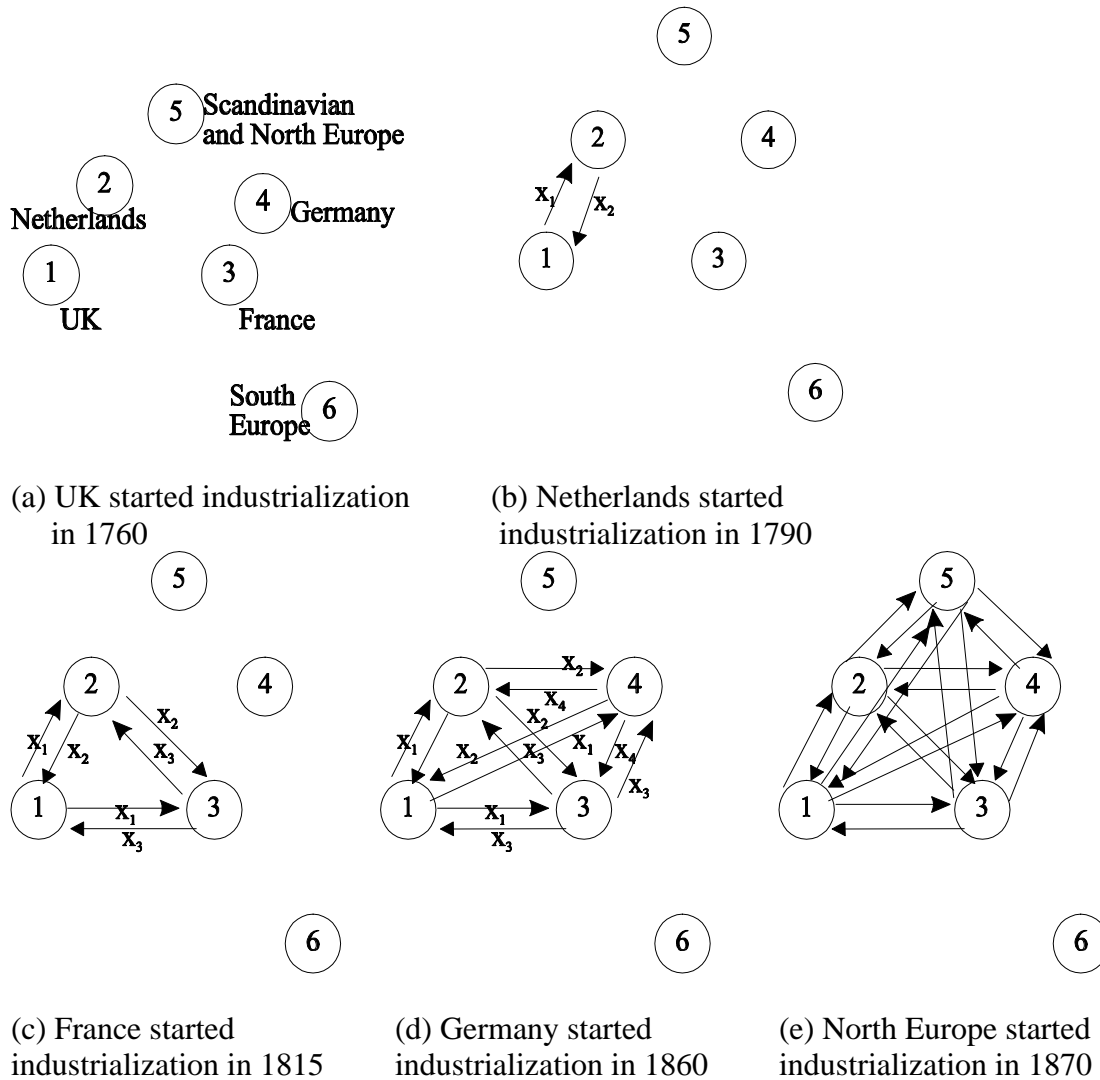


Figure 1: Map of Industrialization in Europe in 18th and 19th Centuries

Two types of dual structure

Our model endogenizes not only duality between modern and traditional sectors, but also duality between the developed and underdeveloped worlds. As worldwide transaction conditions are improved (μ decreases) or population size increases, the comparative statics indicate that per capita income increases for the developed countries involved in international trade, but per capita income in the less developed countries which are still left out of the world market does not change. Hence, inequality of per capita income between the developed and less developed countries increases. This inequality decreases as the last less developed country jumps into the world market.

If we assume that θ differs between countries, then it is easy to show the existence of Ricardian exogenous comparative advantages between countries. Hence, trade of agricultural and industrial goods between the countries with different values of θ can increase per capita real income too. Then we can add trade flow of agricultural goods to Fig. 1, which then looks more realistic.

Fig. 1, together with (13) and (17), captures a general equilibrium mechanism that entails circular causation: each modern firm's profit and thereby its decision of being active is determined by the network size of industrial linkages and trade flows (or the thickness of the market), while the network size is determined by all firms' decisions on whether they participate in this industrialization process. Each country's decision of being involved in the world market is dependent not only on the size of the world market, N , but also on the degree of industrialization, n , in the developed world, while the degree of industrialization and the network size of international trade is determined by all countries' decisions on whether they participate in this networking process. Our model shows that the notion of general equilibrium (fixed point) is a

powerful vehicle for figuring out the networking mechanism in a decentralized market. This is the essence of the idea of market led and "unbalanced" industrialization: the market plays a sophisticated function in networking self-interested participants of the network of industrial linkages and trade flows when all participants may not understand this function.

Import substitution versus export oriented industrialization

The import substitution strategy that was advocated by some development economists after the WWII is like the industrialization process in the absence of international trade, described in (13) and (14).⁵ The networking process of international trade and industrialization described in the extended model with M countries is consistent with export oriented industrialization. Suppose a developed country (UK) has a small transaction cost coefficient, so that it runs many modern sectors profitably. A less developed country has very large transaction cost coefficient, so that its modern sectors are not profitable. Suppose that θ is slightly smaller in the UK than in the less developed country due to limited arable land. Then, the UK can receive marginal gains from trade by exporting goods produced by the modern sectors. As general transaction conditions are improved in all countries (due to commercialized production of steam engines or automobiles), some modern sectors become marginally profitable in the less developed country. Hence, it can start import substitution industrialization. The import substitution strategy works to the degree that as μ decreases, less developed countries will start industrializing one by one in the absence of international trade. But the import substitution strategy artificially increases transaction cost coefficient c_i by imposing high tariffs, thereby missing faster industrialization that can be generated by expansion of the network size of the world market. Hence, it is inferior to export

⁵ See, for instance, Balassa (1980), Chenery, Robinson, and Syrquin (1986), Meier (1989, pp.297-306), and Bruton (1998) for discussion of development strategies.

oriented industrialization, which uses tariff reduction and free trade zone to reduce transaction cost coefficient c .

Development trap

Suppose that m is a variable, its upper bound is $m' \gg 1$ and its lower bound is 1. Assume further that per capita minimum consumption of the agricultural good is 1. We can show that in a country if θ is small enough to be close to 1 and the transaction cost coefficient c is very large, then only one industrial good is produced in this country and it is not involved in international trade. Hence, productivity and per capita real income in this country is very low. If agricultural productivity parameter θ is large in the temperate zone and is very small in the tropic zone because of the difference in climate conditions documented in Gallup and Sachs (1998), then our model predicts that tropic economies are more likely to be locked in the development trap. If c is small in this country, then this country can be pulled out of the development trap by international trade and specialization in producing industrial goods. Hence, a bad climate condition alone is not enough to lock a country in the development trap. Bad climate as well as bad transaction conditions can lock a country in the development trap. The effects of transaction and geographical conditions on development and trade performance are supported by historical evidences documented in North (1958) and by empirical evidences provided in Barro (1997), Easton and Walker (1997), Frye and Shleifer (1997), Gallup and Sachs (1998), Sachs and Warner (1995, 1997).

If the agricultural productivity parameter θ is interpreted as dependent on public health condition in different regions, the above analysis, together with the differences in public health conditions between the temperate and tropic zones documented in Gallup and Sachs (1998),

implies also that the tropic zone is more likely to be locked in the development trap. If we interpret marginal labor productivity of a modern firm, $1/b$, as dependent on health condition in different regions, then the comparative statics in (14) indicate that since the public health condition in the temperate zone is better than in the tropic zone, the equilibrium degree of industrialization, n , is higher in the former than in the latter.

In our story of development and trade, difference in transaction conditions explains difference in trade dependence and in gains that different countries receive from trade. Explaining economic development and trade by transaction efficiency may be considered as tautology by some economists. But from (11) we can see that complicated substitution between population size, L , transaction conditions μ , marginal productivity parameter of good x , b , fixed production cost, F , and taste parameter for final manufactured goods (income share of the final manufactured goods), α , in raising the equilibrium degree of industrialization, n , can be rigorously investigated using our model. Also, as transaction conditions are improved, total transaction cost $\alpha(\Pi+L)\int_0^n \mu_j dj/m = n^2\alpha(\Pi+L)/2m$ increases as trade connections and trade volume increase. Here, the number of active modern sectors (and the number of goods produced by the modern sectors) n and total income $\Pi+L$ are decreasing functions of the transaction cost parameter μ . This negative correlation between the transaction cost coefficient and total transaction cost is far beyond tautology. North (1958) provides empirical evidence for positive correlation between economic development and transaction conditions and North (1986) provides empirical evidence for the positive correlation between economic development and income share of the transacting costs.

The results of the extended model are summarized in the following proposition.

Proposition 2:

As transaction conditions are improved, and/or as the population size increases, the following development phenomena concur. The equilibrium dividing line between the developed world and less developed world moves in the direction that more less-developed and self-sufficient countries are involved in the integrated developed world. In the developed world, the number of operating modern firms increases, and per capita income, trade dependence, and degree of urbanization increase. In this process inequality of income distribution increases as dual structure emerges from the transitional stage and then declines as the dual structure disappears. The countries with better transaction conditions are involved in international trade before other countries are.

If we use the zero profit conditions in all active modern sectors to determine the prices of their produce, then we can express the representative consumer's utility as a function of the degree of industrialization, n . Maximizing the utility with respect to n yields the Pareto optimum degree of industrialization which is higher than the equilibrium one. This is because the price mechanism fails to transmit information of the production and transaction conditions of the modern firms to consumers. In other words, consumers receive benefit of industrialization via dividend earnings, but they allocate the same share of dividend earnings to buy a good produced by a modern or a cottage firm because of the misinformation of price signals. In the Pareto optimum, each consumer consumes more of produce of each modern sector than that of each cottage sector. Slight differentiation between a good produced by the cottage firm and that by the modern firm

will eliminate the distortions. But we will go to the regime of monopolistic competition which causes another type of distortion.

A dynamic version of the model

Assume that the transaction condition parameter μ in period t is determined by transaction volume in period $t-1$. Hence,

$$(18) \quad \mu_t = g(mX_{t-1}), \quad g'(\cdot) < 0, \quad mX_{t-1} = k(n_{t-1}), \quad k'(\cdot) > 0$$

where trade volume in the economy $mX_{t-1} = \alpha(\Pi + n_{t-1}L)$ is an increasing function of n_{t-1} , due to (13), and $k(\cdot)$ is given in (13). This relationship between transaction condition and trade volume implies that there are either learning by doing effects or increasing returns in trading activities. But because of the complexity of the interplay between the extent of the market and economies of scale that can be exploited, and interdependencies of many endogenous variables, in period $t-1$ a decision maker cannot make reasonably accurate forecast of trade volume in period t . Hence, each decision maker's horizon is only one period and she follows an adaptive decision rule. She makes her decision in period t according to the value of transaction cost coefficient c that she observes in this period.

Hence, the relationship between μ_t and the equilibrium n_t is given by (5) and (13) as

$$(19) \quad n_t = h(\mu_t), \quad h'(\cdot) < 0.$$

(18) and (19) together generate a difference equation that characterizes dynamics of μ_t , n_t , and other endogenous variables.

$$(20) \quad n_t = F(n_{t-1}), \quad F'(\cdot) > 0.$$

Since the equilibrium value of n cannot be analytically solved, we need to simulate it on the computer to see if this difference equation is stable or divergent. The gradual spread of

industrialization process in this dynamic version of our model has formalized the essence of the ideas on unbalanced industrialization, though this phrase does not accurately capture the essence of gradual spread of market led industrialization. Certainly, the gradual spread of industrialization is not Pareto optimal, because of myopic decisions. But it prevents mistakes and distortions caused by incorrect forecasts and long horizon planning, in particular by central planning which might infringe upon private property rights and destroy related incentives for industrialization. Also, the gradual spread of market led industrialization may move to be closer to the Pareto optimum industrialization pattern as time goes by, provided the difference equation in (20) converges to the more efficient pattern of industrialization.

Suppose the gradual industrialization represented by (28) has already reached a relatively efficient pattern of industrialization in a developed country (UK) or in a developed region (West Europe). A less developed country may get free information about the efficient pattern of industrialization. A mimicking process may generate big push industrialization by jumping over the gradual evolutionary process. But there are two ways to carry out such big push industrialization strategy.

If private entrepreneurs can take into account the feedback between μ , n , profit, and market demand, they can invest in fixed cost more than the optimum level suggested by the current transaction and market conditions, a big push industrialization may occur (n discontinuously jumps from 0 to a very large value) as the transaction condition parameter reaches a threshold value. Also, the government may carry out a big push industrialization program.

Taiwan's experience of industrialization after 1960 was more like the first market led big push industrialization. Taiwan government mimics all successful institutional infrastructures from

developed capitalist economies (she copied continental law from Japan and Germany, corporation law from Britain, and other institutions from capitalist economies). But the government has carried out a liberalization and internalization policy in order to give private sector freedom to copy successful industrialization process.⁶

The experience of the Soviet Union in the 1930s and that of China in the 1950s is a special pattern of state led big push industrialization. The major features of this pattern are as follows.⁷

Mimicking all successful patterns of industrialization in developed capitalist economies, such as high saving rate, increasing income share of heavy industry, the Taylor scientific management approach, mass production, standardization, comprehensive investment programs, and internal organizational patterns of large corporations. However, the imitation was not through the market and private property rights as happened in Taiwan in the 1960s and 1970s. Instead, the imitation was conducted by the central planning system through infringements upon private property rights. The precondition for its success is to mimic whatever succeed in a capitalist economy. Many economists predicted that such a system could not succeed (see, for instance, Mises, 1922). But they were surprised by the relatively successful industrialization in the Soviet Union in the 1930s.

Despite of short-run success of the Soviet style big push industrialization, the fall of the Soviet Union pronounced the long-run failure of this big push industrialization strategy, compared to Taiwan's pattern of big push industrialization. As Sachs (1994) suggests, the fatal long-run negative effects of the Soviet style state led big push industrialization via mimicking the successful industrial pattern of the developed country and infringing upon private property rights will outweigh

⁶ A comparison between mainland China and Taiwan's economic development can be found from Rabushka (1987). China's experience of big push industrialization can be found from Riskin (1987).

its short-run positive effect on economic development once the potential for mimicking has been exhausted.

4. Concluding Remarks

This paper introduces the trade off between economies of scale and transaction costs into the MSV model to endogenize the number of modern sectors. We have developed an approach to analyzing the MSV model by specifying the zero profit condition for a marginal modern firm and keeping the original flavor of the MSV model which is featured with the feedback loop between positive dividend earning, the extent of the market, and economies of scale that can be exploited. However, as transaction costs are introduced, big push industrialization will not occur unless transaction conditions have a sudden big improvement. Our model predicts a gradual spread of industrialization from the countries with better transaction conditions to other less developed countries, as general transaction conditions are improved, or as a dynamic mechanism gradually gets more and more countries involved in the increasingly more integrated world market. In this process inequality of income between the developed and less developed countries increases as a dual structure emerges and finally decreases as the dual structure disappears eventually. Also, the number of modern sectors increases, the degree of trade dependence and urbanization increases, productivity of the industrial sector increases, per capita income increases, the degree of market integration increases, and the number of traditional sectors decreases.

This model formalizes the idea of unbalanced and market led industrialization. It also predicts possible big push industrialization for late comers who may mimic the relatively efficient industrial pattern that has been realized in the developed economy. But our model suggests that the

⁷ Zaleski (1980) have documented the role of mimicry by Soviet planners of Western production patterns. Lenin's works, for instance (1939), indicate that he was very familiar with the features of industrialization in a developed capitalist

feedback loop between dividend earning (based on private property rights to residual returns of firms), the extent of the market, and economies of scale that can be exploited is essential for successful industrialization though the networking function of the market is not perfect. If big push industrialization is realized by destroying this wonderful market mechanism, the positive effects of mimicking will be outweighed by the negative effects of absence of right incentives on economic development in the long-run.

A shortcoming of our model is that it predicts a scale effect that productivity of an active modern firm increases if and only if the average size of active modern firms increases. This prediction is rejected by empirical evidences provided in Liu and Yang (forthcoming). As shown in Shi and Yang (1995, 1998), Liu and Yang (forthcoming), and Sun and Lio (1997), a possible way to avoid this scale effect is to specify local increasing returns instead of global economies of scale. Their models of endogenous specialization and industrialization have formalized the argument of irrelevance of the size of the firm, proposed by Coase (1937), Cheung (1983), Stigler (1953), and Young (1928). According to this argument, if division of labor develops between firms, productivity increases while average size of firms declines (outsourcing, contracting out, disintegration, focusing on core competence). If division of labor develops within each firm, then the average size of firms and productivity increase simultaneously. However, these models are completely symmetric and cannot explore the implications of asymmetric production and transaction conditions for industrialization. Hence, a combination of approach developed in this paper and the model formalizing the argument of irrelevance of the size of the firm may be an interesting research agenda in the future.

It needs more research on the question: can further modification of model specification avoid the distortion of relative prices of modern and cottage sectors in equilibrium? Casual

economy.

observation indicates that many companies understand the negative network effect of greedy profit maximization pricing. They practice "generous pricing" rule which may pay internet traffickers for their clicking an internet message or give free email services or free computers for networking clients. It seems that self-interested decisions in decentralized market are much smarter than the simple profit maximization pricing in our model that generates Pareto inefficient degree of industrialization and multiple equilibria in the MSV model.

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