Trade and Growth: Development paradigms after globalisation's second unbundling

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1. INTRODUCTION

Globalisation is typically viewed as driven by an inexorable, fairly monotonic decline in trade costs. Globalisation, however, has acquired fundamentally different aspects since the early 1990s due to the ICT revolution and the transformative changes in information management that it triggered. This "second unbundling" has important implications for all sorts of policies – ranging from social policies (Blinder 2009, Baldwin 2006a) to industrial policy to the interlinkages between regionalism and multilateralism. This paper turns the focus to the implications that the 'second unbundling' has for developing nations' trade and growth strategies. The basic premise of this paper is that the change in globalisation's nature needs to be reflected thinking about trade's role in developing nation's growth and industrialisation strategies.

In the area of trade and growth, the monotonic view of globalisation has led development experts to look to the development success stories from the pre 1990s period for guidance on which development paradigm late-industrialising nations should adopt. For example, some economists present the pre-1985 success of Korea and Taiwan as evidence that interventionist trade and industrial policies work, while others use the same examples to argue the opposite (Rodrik 2005 versus World Bank 1993). More recently, the Growth Commission (2009) bases much of its thinking on 13 success stories, many of which ended by the mid-1990s (Table 1).

Table 1: Growth Commission's success stories.

Economy	Period of 7%+ growth	GDP/pop at start of high growth	GDP/pop in 2005
Botswana	1960–2005	210	3,800
Brazil	1950–1980	960	4,000
China	1961–2005	105	1,400
Hong Kong, China*	1960–1997	3,100	29,900
Indonesia	1966–1997	200	900
Japan*	1950–1983	3,500	39,600
Korea, Rep. of*	1960–2001	1,100	13,200
Malaysia	1967–1997	790	4,400
Malta*	1963–1994	1,100	9,600
Oman	1960–1999	950	9,000
Singapore*	1967–2002	2,200	25,400
Taiwan, China*	1965–2002	1,500	16,400
Thailand	1960–1997	330	2,400

Source: Growth Commission (2009), Table 1.

1.1. Globalisation as the great unbundling(s)

The high cost of moving goods, people and ideas long forced the geographical bundling of economy activity. Before the days of easy shipping, communities were obliged to make almost everything they consumed. The gradual reduction of shipping costs, accelerated by the steam revolution from roughly 1850 onwards, meant that factories did not have to be near consumers. Once this 'transportation glue' melted, separating production and consumption became feasible, and once feasible, comparative advantage and scale economies made it inevitable. Production shifted towards the most cost-effective locations and international trade boomed. Here trade involved goods made in a factory in one nation and sold to customers in another. This was globalisation's "first unbundling".

The first unbundling, however, did not flatten the world – far from it. While the first unbundling spread production among nations, it concentrated it within nations. It resulted in: 1) the spatial clustering of production into large-scale factories with these gathering in industrial districts, and 2) the clustering of consumers in ever larger cities.

The first point is the key as concern development strategies. The most efficient producers shifted to massively complex production processes that were continually evolving to eke out a few percentage points of efficiency gains every year. The production of horse shoes and nails shifted from the village blacksmith to giant factories. As it turned out, the need for continuous, two-way flows of goods, people, information, training, investment and services among the various production stages made it easier, cheaper, faster and more reliable to coordinate such massively complex and constantly morphing processes when the various stages were tightly clustered spatially. Importantly, this sub-national clustering was driven by a very different type of 'glue' – not transportation costs, but rather coordination costs.

1.1.1. The first unbundling and development strategies

The first unbundling brought about many modern wonders – including the industrialisation of a handful of formerly agrarian societies such as the United States, France, Russia, Germany, Japan and more recently, Korea and Taiwan.

When it comes to development, the implications of the first unbundling – that is to say a world where transportation glue had been weakened but coordination glue had not – were clear. Successful development strategies in globalisation's first unbundling had no choice but to build an industrial base, or more specifically to build supply chains for the industries in which they wished to be competitive. The point is simple. The first unbundling operated at the level of industries because it was economical to keep all manufacturing stages in close proximity (say within the radius of a couple hours driving). Without the whole supply chain, or most of it, a nation's industrial could not be competitive with nations that did have deep and wide industrial bases. High coordination costs made it too dear to source most parts and components abroad.

This premise was accepted by all 'development paradigm' thinkers. The different first-unbundling development strategies arose over how best to build a supply chain from scratch. One school thought it best to build a supply chain by focusing on internal demand (imports substitution industrialisation). Another focused on both internal and external demand (outward oriented development strategies). India is a good example of the inward strategy; Korea is a good example of the outward strategy. In both cases, the basic strategy was to start with final-good production – importing the most difficult-to-make components – and then progressively developing the local industrial base to replace expensive imported components with cheaper locally produced ones. Or at least that was the concept behind import substitution industrialisation.

It should be noted that although import substitutions has been largely abandoned by policymakers and most economists, this is a relatively new. Before WWII, all successful industrialisations (except Britain's) took place behind high, man-made trade barriers (Balassa 1981 p.2). Moreover the early postwar import substation policies in light industry were broadly judged to be a success (Balassa 1982). Indeed, this received wisdom was so clear that a report by a blue-ribbon panel of economists appointed in 1957 by the GATT to study the role of trade and development took it as given that developing nations would need trade barriers to industrialise (the Haberler Report, written by Gottfried Haberler, Roberto de Oliveira Campos, James Meade and Jan Tinbergen). A contemporary review of the Haberler Report stated that: "Referring to the underdeveloped countries in a general way, the authors recognize that, in their case, special considerations justify a rather greater use of trade controls and of protection than in the highly industrialized countries. *Few economists will disagree with this view*." (Emphasis added, Richter, 1959 p.578). This is one of the reasons the GATT members thought it was a good idea to provide special and differential treatment for developing nations' trade policies.

If globalisation really were well captured by a progressive lowering of trade barriers, debates on inward and outward orientation would still be relevant. Developing nations might have need of "policy space" to strategically provide some infant industries. But things changed. The path of globalisation took a turn.

1.1.2. The second unbundling

The ICT revolution was to the second unbundling what steam power was to the first. In a gradual shift that occurred between 1985 and 1995, falling communication and coordination costs fostered a second unbundling – this time of the factories themselves were unbundled. Cheaper, higher quality and more reliable communications reduced the need to perform most manufacturing stages near each other. As with the first unbundling, changing technology opened the door to spatial separation and competitive pressures pushed industry across the threshold. Even more recently, the second unbundling has spread from factories to offices with the result being the outsourcing and offshoring of service-sector jobs.

This revolution in computer and communication technologies – and the firestorm of innovation it sparked in information and workflow management – weakened the coordination glue. It became feasible to organize some types of complex manufacturing activity among spatially separated facilities. As the factor intensity of manufacturing stages can vary greatly within a single production process, and factor prices variable greatly across nations, the ability to spatially unbundling the process opened the door to a new type of "vertically specialised" trade also known as "fragmentation", "production sharing", "international supply chains", "global value chains", etc. (See Kimura et al 2007 and Campa and Goldberg 1997 for evidence.). Here we shall call it the second unbundling to distinguish it from the first unbundling driven by lower shipping costs.

In essence, the second unbundling meant that various 'production bays' in the old style factories were unbundled and relocated to nations with lower production costs. Trade in parts and components flourished as rich-country manufacturers offshored labour-intensive stages to emerging economies. For developing nations, trade and investment became almost synonymous.

The ICT revolution, however, did not result in the death of distance – far from it. Separating production stages internationally did not end the need for coordination. With the labour intensive stages located in labour-abundant nations, there was now a need for *international* two-way flows of goods, people, information, training, investment and services among the

production stages to minimise disruption and mistakes in the manufacturing stages. Shipping and communications costs were lower, but the total cost of moving technicians and managers did not fall substantially (air fares plus time opportunity costs). As a result, the second unbundling typically occurred regionally, not globally. Indeed it first occurred in the mid-1980s across the US-Mexico border (Hanson and Feenstra 1997) where the phenomenon is known as maquiladora trade, and, simultaneously, within East Asia where it is known as Factory Asia (Baldwin 2006b, Ando and Kimura 2005).

As far as this paper in concerned, the key point is that the second unbundling opened the door to a brand new development paradigm – a new pathway to industrialisation. Developing nations – especially those geographically close to industrial powerhouse nations like Japan, the US and Germany – now could choose between building their own supply chain and joining an existing one.

For many developing nations, the choice between 'build' or 'join' was simple. Building an entire industrial base and related service sector superstructure took decades in the US, German, Japanese, Korean, and Taiwanese cases. Joining a US, Japanese or German supply chain, by contrast, brought the developing nation sophisticated manufacturing facilities in a matter of months, or years, or at least it did in cases like Mexico, Thailand, the Philippines, Poland and Slovakia.

1.1.3. Questions that need theory to address

While this new industrialisation pathway is widely recognised in the policy world, there does not seem to be any systematic theory behind it. Without such logical underpinnings, it is difficult to evaluate various policy options and design empirical work. For example, should a nation first specialise in a particular industry – say autos as Thailand has – or should it strive to develop a very broad-based outward processing sector like the Philippines. Moreover, does country size matter? Can Vietnam follow the process that is occurring in China? The goal of my paper is to make a first stab at filling the gap.

The outline of this first draft is as follows. The next section (Section 2) introduces the workhorse model and the subsequent sectors studies industries under the first unbundling (Section 3) and under the second (Section 4). This draft concludes with a summary and a few remarks, but subsequent sections will marshal some facts from trade and growth patterns to shed empirical clarification on the model's key concepts and predictions.

2. THE BASIC MODEL

Before introducing the model, it is worth considering the main facets of reality that need to be capture. Here is the basic story the model tries to capture. Under colonialism, Home – the developing nation under study – is fully open to trade, fully specialised in the agriculture (Sector A) and imports all its manufactures. Upon independence, the nation strives to develop manufacturing.

Manufactured goods can be made with two distinct technologies. The traditional technology uses only labour and thus requires no specialised inputs, and no supply chain. The modern technology, however, requires labour, a continuum of intermediate goods (the supply chain) and local availability of specialised "competencies". We think of competencies as specialised training, producer services, etc. The flow of output of competencies is produced using only labour, however, creating a new competency requires a fixed investment of a_I units of labour. The asset thus created can be thought of as human capital since a one-time investment provides and infinite flow of productive services.

The supply chain is shown schematically in Figure 1.

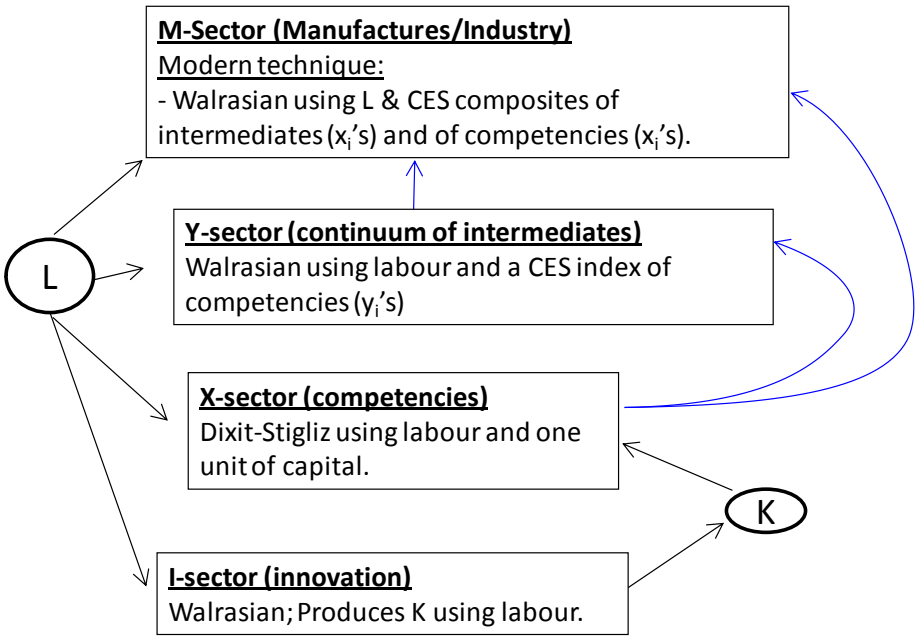

Figure 1: The supply chain.

Initially, Home has zero competency in modern manufacturing. Industrialisation is defined as a switch from the traditional technique to the modern technique.

2.1. Import substitution industrialisation

We assume parameters such that the nation would have a comparative advantage in manufacturing if only it had an industrial base that was sufficient broad and deep. The width of the industrial base is measured by the range of specialised competences available locally; the depth is measured by the range on intermediate goods that are produced locally. The local availability of competencies matters since there are prohibitively high costs of using foreign competencies in Home industrial production. There are also high coordination costs involved in sourcing intermediates abroad. Here we are thinking of the costs of coordinating the specifications of foreign-made components with Home's manufacturing.

The goal of the trade and development policy is to foster the creation of a sufficiently wide and deep industrial base.

2.1.1. The industrialisation process: Building a supply chain

To spur development, Home imposes a prohibitive tariff on the final manufactured goods, but no tariffs on the imported components needed to produce it with modern techniques.

This immediately starts production of Z but only using traditional techniques that requires no local competencies. The local demand for Z spurs investment in the range of local competencies necessary to make the modern technique profitable. This involves a gestation phase. That is, the traditional technology is used until Home accumulates sufficient local competencies to make modern techniques more profitable. During the gestation phase, investment in competencies is ongoing, but no revenue is being generated as there is not yet demand for competencies. Our solution technique relies on perfect foresight, but we discuss the possibility for coordination failure (a la Rodrigues-Clares and Rodrik) during the

gestation phase (or other problems such as poor capital markets, unstable investment climates, unanticipated changes in trade policy, regulation or taxation, etc.). Once a sufficiently broad range of competencies exists locally, manufacturing switches to modern technique, owners of competencies begin to earn a reward for their investments, and Home begins to import intermediates (paying for them with exports of A).

Note that initially local production of intermediates cannot compete with imports despite the high coordination costs. The reason is that intermediates are more intensive in competencies than is manufacturing of the final good. We order intermediates according to their competency-intensity, so that intermediates further up the supply chain are more sophisticated in the sense of being more demanding of local competencies.

We assume parameters such that the switch to modern techniques happens before the steady-state range of competencies is attained. As a consequence, the switch to manufacturing starts a second stage of industrialisation – the import-substitution phase. As the range of competencies rises towards its steady state value, more of the continuum of intermediates can be produced locally more cheaply than they can be imported. (They are not exported, however, due to the high coordination costs they would face in foreign markets.)

As the range of competencies widens and the local supply chain deepens, Home's marginal costs of manufacturing the final good continues to fall. At some point, Home becomes competitive and Home becomes an exporter of manufactures. This leads to a jump in the local derived demand for both competencies and intermediates and so spurs further widening and deepening of Home's industrial base. Ultimately, the nation has switched from being fully specialised in agriculture to fully-specialised in manufactures.

It may be helpful to this of this as the Korean case. Of course, there are other constellations of parameters where all this happens yet the nation is not ultimately competitive in manufactures and requires high tariffs to maintain its industrial base. In this case, the nation makes both agriculture and manufactures, paying for its essential industrial imports with its agriculture production. It may be helpful to this of this as the Indian case, i.e. where the policy does create a deep and wide industrial base, but the resulting industry is not globally competitive, i.e. 'infant industry' never grows up.

2.2. Assumptions and initial conditions

We work with an atomistic Home nation (i.e. it takes world prices as parametric) that is endowed with a single primary factor of production. There are two final good sectors agriculture, A, and manufacturing Z. The agricultural sector is assumed to be as simple as possible, namely it is Walrasian with production function $A=L_A/a_A$; here a_A is the unit labour input coefficient.

The manufacturing sector is also Walrasian but it can be produced with two distinct technologies. The traditional technique uses only labour, so if Z is produced with the traditional technique, this is a classic 2 sector Ricardian model. However, Z can also be produced with a "modern" technique that uses labour, a range of specialised "competencies", X, and intermediate inputs, Y. The competencies are intended to reflect the complex combination of inputs needed by a modern manufacturing sector, such as specialised skills, communications infrastructure, financial, regulatory, legal and judicial infrastructure, producers services, specialised training, etc. (X, Y and Z are mnemonics for the most upstream input, competencies X, the intermediate goods Y, and the final good Z).

The traditional (first expression) and modern Z-sector production function (second expression) are, respectively:

$$Z = L_Z / a_T$$
$$Z = \frac{L_Z^{1-\alpha-\beta} X^{\alpha} Y^{\beta}}{\tilde{a}_Z}; \quad X \equiv \left(\int_{i \in G_X} x_i^{1-\frac{1}{\sigma}} di \right)^{\frac{1}{1-1/\sigma}}; \quad Y \equiv \prod_{j=0}^{1} y(j) \tag{1}$$

where $0 < \alpha, \beta < 1 < \sigma; \forall j$, L_Z and a_T are the unit labour input coefficient for the traditional technology and Z-sector labour employment, $\tilde{a}_Z$ parameterises Home's overall comparative advantage in modern Z production, α and β are the Cobb-Douglas cost shares for the continuum of competencies X and the continuum of intermediates Y, and σ is the usual CES elasticity. The composite input, Y, is a Cobb-Douglas aggregate over a continuum of intermediates normalised to range from j=0 to unity with equal weights on each intermediate, y(j). Here the set of locally available competencies is defined by the set G_X.

The corresponding cost functions are:

$$C_Z = a_T w Z$$
$$C_Z = a_Z w^{1-\alpha-\beta} P_X^{\alpha} P_Y^{\beta} Z \tag{2}$$

where

$$P_X \equiv \left(\int_{i \in G_X} p_x(i)^{1-\sigma} di \right)^{\frac{1}{1-\sigma}}; \qquad P_Y \equiv \left(\prod_{j=0}^{1} p_y(j)^{\psi(j)} \right)$$

and $p_x(i)$ and $p_y(j)$ are the prices of competency-i and intermediate-j respectively; a_Z is the $\tilde{a}_Z$ times the usual combination of Cobb-Douglas parameters.

All intermediates can potentially be produced locally using labour and competencies according a the technology described by the cost function:

$$C_Y(j) = a_Y w^{1-\psi(j)} P_X^{\psi(j)}; \qquad 0 < \psi(j) < 1, \forall j, \quad \frac{d\psi(j)}{dj} > 0 \tag{3}$$

Where we have ordered the continuum of intermediates such that the most competency-intensive intermediates have the highest index (highest Cobb-Douglas cost share), so that $d\psi(i)/di > 0$. In this sense, Y goods with higher indices are more 'sophisticated'.

The X-sector (competencies) is marked by Dixit-Stiglitz monopolistic competition and increasing returns of the usual fixed-cost-and-constant marginal-cost type. All varieties of competencies are symmetric in terms of costs; each involves a one-time fixed cost and constant marginal costs, specifically the cost function is:

$$\pi + w a_X x \tag{4}$$

where π and w are the flow rewards to the variety's "capital" (i.e. the property associated with the one-time fixed cost) and labour, a_x is the unit labour input parameter and x is the output level; symmetry of varieties allows us to drop subscripts without loss of clarity.

Capital in this model is constructed from labour in the I-sector (a mnemonic for innovation/instruction/investment). The sector is Walrasian with the unit labour input requirement being a_I, so that the flow of new units of K – and thus new varieties of competencies – is:

$$\dot{n} = L_I / a_I \tag{5}$$

where L_I is the I-sector's employment, and $\dot{n} \equiv dn/dt$ is the flow of in units of capital. Since capital is used only by the X sector (one unit per variety), we can denote both the number of varieties and the number of units of knowledge capital with n. It may help to think of this as human capital and a_I as the time invested in training.

Preferences over final goods are Cobb-Douglas over the consumption of Z and A (D_Z and D_A with D as a mnemonic for demand). The expenditure share on manufactures is μ. The implied indirect utility function is:

$$V = \frac{E}{P}; \qquad P \equiv p_A^{1-\mu} p_Z{}^{\mu} \tag{6}$$

where E is consumer expenditure, P is 'perfect' price index, p_A is the price of A, p_Z is the consumer price of Z.

The exogenous border and world prices of Z and all intermediates y(j) are denoted as:

$$p_A = p_A^W, \quad p_Z = \tau T_Z p_Z^W, \quad p_Y(j) = \chi p_y^W(j) \tag{7}$$

where the W superscript is a mnemonics for world and unscripted prices are the prices inside the home nation. Note that A is traded costless.

Given the importance of shipping and coordination costs in our model, domestic prices are far above the 'world' price due to shipping costs (parameter τ which applies to the final good) and coordination costs of producing intermediates in a nation other than the nation where the final good is produced (parameter χ); T_Z is one plus the ad valorem tariff imposed on Z on top of the natural trade costs. Competencies are non-tradables and so have no international price. For simplicity, we normalise all $p_y^W(j)$ to be unity.

3. INDUSTRIALISATION UNDER THE FIRST UNBUNDLING

In this section, we assume a constellation of parameters such that the nation will – barring coordination problems – be able to build a globally competitive industrial sector.

3.1. Intermediate results

The A sector is intentionally simple. If there is positive production $p_A = wa_A$. The manufacturing sector is more complex due to the dual technologies.

If the modern production technique is in use, demand for a typical variety of x will come from locally produced intermediates, the y(j)'s, and locally produced final goods, Z. Demand arising directly from Z will be proportional to the Z-sector's total cost C_Z; demand arising indirectly from the Y-sector will be proportional to the Y-sector's total cost C_Y. Given (2), we know that $C_Y = \beta C_Z$, so using Shepard's Lemma, demand for a typical x-variety is:

$$x = p_x^{-\sigma} \left(\alpha + \Gamma \frac{C_Z}{P_x^{1-\sigma}} \right); \qquad \Gamma \equiv \int_{\in G_Y} \psi(i) di \tag{8}$$

where G_Y is the set of locally produced intermediates.

Given (8) and Dixit-Stiglitz monopolistic competition, x-firms find it optimal to change a constant mark-up, $1/(1-1/\sigma)$, over marginal costs. Choosing units such that $a_x = (1-1/\sigma)$, the price of a typical competency and its corresponding operating profit is:

$$p_x = w, \qquad \pi = \frac{(\alpha + \Gamma)C_Z}{n\sigma} \tag{9}$$

where n is the measure of G_X, i.e. the range of competencies. The second expression follows from mark-up pricing, symmetry of x-varieties, and (8).

With expression (9), we can write P_X and the marginal cost function for a typical Y variety in terms of w and n. Namely:

$$P_X = wn^{\frac{1}{1-\sigma}} \tag{10}$$

and

$$C_Y^{'}(j) = a_Y wn^{\frac{\psi(j)}{1-\sigma}} \tag{11}$$

With (11), we can calculate the range of intermediates that can be produced more cheaply at home for any given level of n. Local production of intermediates must compete with imports, so local substitution of imports occurs only for intermediates where local production is cheaper. Using (7), the condition is:

$$a_Y wn^{\frac{\psi(j)}{1-\sigma}} \leq \chi \tag{12}$$

Solving this for the threshold intermediate good $y(j^c)$, i.e. the good where the condition holds with equality, we get a threshold, or cut-off level of – denoted as j^c for any level of n (here the 'c' in j^c is a mnemonic for 'cut-off').[1] This "switching condition" yields a threshold, or critical value of n, for each j which is implicitly defined by:

$$\psi(j^c) = (1-\sigma)\ln(\frac{\chi}{a_Y w}) / \ln(n) \tag{13}$$

As $\psi(j)$ is increasing in j, j^c is increasing in n. This condition defines a 'supply chain locus' that links the range of the nation's competencies – as measured by n – to the depth of the local supply chain – as measured by the locally produced range, which is zero to j^c. Calling the range of competencies the 'width' of the industrial base, and j^c the depth of the industrial base, Figure 2, shows that as the width of the nation's industrial base rises, it depth also increases.

Given (13), we can express P_Y in terms of w and n[2]:

$$P_Y = a_Y w\left(\prod\nolimits_{j\in G_Y} n^{\frac{\psi(j)}{1-\sigma}}\right)P_Y^M \; ; \qquad G_Y = [0...j^c] \tag{14}$$

where P_Y^M is the Cobb-Douglas price index of imported intermediates, and G_Y is set of intermediates produced locally. Since local production only occurs when it is cheaper than imports, and the range of Y's for which this is true expands as n rises, we know that P_Y falls as n rises.

With this, the marginal cost function for the modern sector can be expressed in terms of w and n, namely:

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[1] By inspection of (12), and the stipulation that $d\psi(j)/dj>0$ from (3), the condition holds with inequality only for j's that are less than j^c, and it is false for $j>j^c$.

[2] Imported intermediates have a price of χ, so the exponent is the integral of the geometric weights for $j \notin G_Y$.

$$C_Z^{'} = a_Z a_Y^{\beta} w n^{\frac{\alpha}{1-\sigma}} \left(P_Y^M \prod_{j \in G_Y} n^{\frac{\psi(j)}{1-\sigma}} \right)^{\beta} \tag{15}$$

Note that the marginal cost of producing Z falls as the industrial base gets wider (n rises) and deeper (G_Y expands). This is essence of the mechanism by which an import substitution policy may work in the sense of improving the nation's competitiveness in the industrial good, Z.

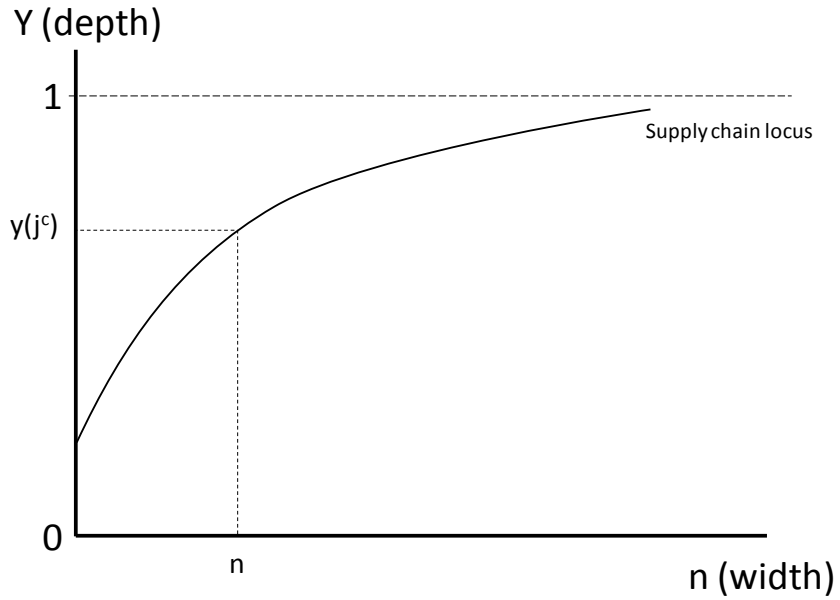

Figure 2: The supply chain locus.

3.1.1. Wages

As a small open economy, the nation's wages are pinned down by competition in the export sector. Given our initial conditions, specifically that the nation exports A at time zero, the nation's starting wage is be pinned by $p_A = wa_A$; this continues as long as it produces A. If at some point the nation starts exporting Z, it will cease exporting A (except in a knife-edge case) and its w will have to adjust to assure Z is competitive internationally. This means that w will have to be such that $p_Z^W = C_Z^{'}$ .Under such conditions, the nation's wage must exceed the initial wage p_A/a_A

In theory it is possible that the nation becomes an exporter of intermediates. To focus attention on early industrialisation efforts by developing nations, we impose regularity conditions on the efficiency of the nation's Y-sector and the size of the coordination costs so that this never happens. This condition is:

$$\frac{p_y^W(j)}{\chi} < a_Y w n^{\frac{\psi(j)}{1-\sigma}} \;\; ; \;\; \forall \; j \tag{16}$$

where w in the most competitive case is $w = p_A/a_A$.

Summarising this analysis:

$$w^A = \frac{p_A}{a_A} \text{ and } A > 0 \quad \text{or} \quad w^Z = \frac{p_Z^W}{a_Z a_Y^\beta \, n^{\frac{\alpha}{1-\sigma}} (P_Y^M \prod_{j \in G_Y} n^{\frac{\psi(j)}{1-\sigma}})^\beta} \text{ and } A = 0 \tag{17}$$

To identify the two cases, we use the superscript A and Z; where we wish to be general, we omit the superscript. Note that the "bang-bang" nature of the solution is a natural consequence of the underlying Ricardian nature of the model. In successful industrialisation effects, the wage will eventually switch from the first expression to the second but in both cases the wage is fixed for any given n.

Finally, we turn to characterising the level of n where Z-sector production switches from traditional to modern techniques. Comparing the expressions in (2), the modern technique is cheaper when:

$$a_T \geq a_Z a_Y^\beta \, n^{\frac{\alpha}{1-\sigma}} \left(P_Y^M \prod_{j \in G_Y} n^{\frac{\psi(j)}{1-\sigma}} \right)^\beta \tag{18}$$

Since G_Y expands as n rises, and P_Y falls as G_Y expands, it is clear that for a sufficiently high n, the modern technology is superior. This identifies a critical thresholds for n, which we label as n_Z^D, and define explicitly as the n for which (18) holds with equality.

As Z-sector competitiveness continues to improve as n rises, we can also find a threshold n beyond which the nation begins to export Z. Labelling this threshold, n_Z^E, it is defined by the n which satisfies:

$$\frac{p_Z^W}{\tau} = a_Z a_Y^\beta \, (n_Z^E)^{\frac{\alpha}{1-\sigma}} \left(P_Y^M \prod_{j \in G_Y} (n_Z^E)^{\frac{\psi(j)}{1-\sigma}} \right)^\beta \tag{19}$$

Here D and E are mnemonics for domestic and export sales.

3.2. Steady state analysis

The expressions above relate all the variables to the nation's range of competencies as measured by the state variable n. To reflect an initial situation of underdevelopment, we assume that n = 0 initially. As discussed, our analysis of import substitution industrialisation begins with the nation imposing a tariff on final goods just high enough to ensure some local Z production is viable. As n = 0, the marginal cost of the modern technique is infinite so local production begins with the traditional technology. To be concrete, we assume the initial tariff is set to make traditional production just worthwhile, i.e.

$$w a_T = \tau T_Z \, p_{|Z}^W \; ; \quad w = p_A / a_A \quad \Leftrightarrow \quad T_Z = \frac{a_T \, p_A}{a_A p_Z^W \tau}$$

3.2.1. Multiple steady states: Import substitutes works or not

This model has multiple steady states. In the first, the industrialisation strategy is successful only in the sense that Z production starts, but a failure in the sense that no modern industry appears.

With the tariff imposed, some of both goods will be produced, however since n = 0 the Z production is done with traditional technology (modern marginal costs are infinite). There is therefore zero contemporaneous demand for competencies and the nation neither imports nor

exports. National income equals wL. Importantly, there need not be any incentive to invest in Z in this situation, so the initial condition n = 0 is a steady state. In this case, the industrialisation strategy will be deemed a failure as no modern production is stimulated.

More precisely, consider a game among investors who choose their investment paths, taking as given those of all other investors. If each investor adopts a strategy such that she invests in the creation of new competencies only if n will rise above n_Z^D, there are two Nash equilibrium. One is where no investment occurs so n remains at zero and no atomistic investor has an incentive to deviate. The second is where n attains a steady-state value above n_Z^D and in anticipation of this, atomistic investors start creating new competencies and modern industry does appear. This is just the sort of coordination problem suggested in Rodrik (1997), and Rodriguez-Clares (1994).

To characterise the second steady state, we note that in steady state, capital formation (i.e. the production of new competencies) ceases and all income is spent on consumption. Denoting the expenditure on Z as E_Z a typical competency will earn $E_Z/\sigma n$ per period forever, so its present-value to investors with discount rates of ρ will be $E_Z/\sigma n\rho$. The replacement cost of a new competency is wa_I, so Tobin's q will be $E_Z/\sigma n\rho a_I$. Using (21), the steady-state condition, namely, q = 1 can be solved to find the steady-state n:

$$q \equiv \frac{E_X}{\bar{n}\sigma\rho a_I} = 1 \qquad \Leftrightarrow \qquad \bar{n} = \frac{E_X}{\sigma\rho a_I} \tag{20}$$

Where $\bar{n}$ is the steady-state value of n.

3.2.2. Three cases: LatAm, Indian and Korea

With (20), we can use the two thresholds for n – n_Z^D and n_Z^E – to define three cases – what we call the LatAm case, the Indian case and the Korean case.

When a country's internal market is too small (E_Z is small), its efficiency in training labour in have competencies relevant to industry is too low (a_I is high), or its Ricardian comparative advantage in Z is too low (a_Z is high), then $\bar{n} < n_Z^D$ and import substitution industrialisation fails to spark any modern industrial production – even if there are no coordination problems. This is the LatAm case.

By contrast, if the nation has a large internal market, is highly efficient at creating competencies and has a low native costs in producing Z, then $\bar{n} > n_Z^E$ and the nation becomes an exporter of Z. In this case E_X reflects world derived demand and since we are dealing with an atomistic nation, its production will be limited by its supply constraints that arises when all its labour has been shifted to its Z and Y sectors. (More on this below.)

Finally, the intermediate case – the Indian case – is where the policy is a success in the sense that the nation develops an industrial base using modern technology, but it is a failure in the sense that continued import protection is necessary to maintain this production. The infant industry grows up, so to speak, but even fully grown it is not competitive on world markets.

Importantly, coordination failures could prevent the Indian and Korean cases from producing modern industrial production even when the objective criteria are favourable. There is consequently a natural function for the state in preventing the coordination failure that would arise if all atomistic investors fail to invest in new competencies since they fear n will never rise above n_Z^D and their investment wa_I would be wasted. Obviously large conglomerates such as the Japanese Keiretsu and the Korean Chaebols could similarly serve to reduce the

chance getting stuck in the unfavourable steady state. Likewise, a steady macroeconomic environment that encouraged investment, or a governance system where property rights were sure could similarly make the unfavourable outcome less likely.

To close the model, we must express E_X in terms of fundamentals. To this end, we must derive national income and then consider the case where all Z demand (and thus all derived demand for X) comes from domestic sources and the case where some Z demand comes from foreign sources.

National income, denoted as E since there is no savings/investment in steady-state, equals factor earnings, namely wL plus nπ. We know that $\pi=E_X/\sigma n$, so $E = wL+E_X/\sigma$. In the LatAm case, $E_X = 0$ since there is no modern production, and w equals the first expression in (17), namely w^A. Thus $E=w^AL$. In the Indian case, there is modern production and so the income of competencies is not zero, but all demand for Z arises from domestic sources. Specifically, expenditure on Z is μE, and a fraction equal to $(\alpha+\Gamma)$ of this falls on the X sector, so we can write: $E = wL+\mu(\alpha+\Gamma)E/\sigma$. Gathering terms, we have that E equals $wL/(1-\mu(\alpha+\Gamma)/\sigma)$ when modern Z production occurs.

In the Korean case, i.e. when the nation's Z sector is competitive on world markets in steady-state, we must account for income earned in the X sector but demand for X is not pinned by domestic demand. Rather, demand comes from domestic and foreign sources, the latter being infinite at the world price since the home nation is assumed to be atomistic. In this case, the nation's entire resources are shifted to the Z sector and its allied upstream sectors, X and Y (as usual in a Ricardian model). Using the national income identity, the total cost of the Z sector C_Z must equal total national income, which is $wL+E_X/\sigma$, where $E_X = (\alpha+\Gamma)E$. Gathering terms E equals $E = wL/(1- (\alpha+\Gamma)/\sigma)$, where w is defined by the second expression in (17). To summarise:

$$E^{Afr} = w^A L, \quad E^{Ind} = \frac{w^Z L}{1-\mu(\alpha+\Gamma)/\sigma}, \quad E^{Kor} = \frac{w^Z L}{1-(\alpha+\Gamma)/\sigma} \tag{21}$$

Note that national income can be ranked. Recalling that $w^Z>w^A$, we have that national income is highest in the Korean case followed by the Indian case and the LatAm case.

4. IMPORT SUBSTITUTION INDUSTRIALISATION

Having studied the various steady-state outcomes and their dependence on the critical fundamentals – nation size, efficiency in training and natural comparative advantage in industry, we turn to the transitional dynamics, i.e. the industrialisation process.

4.1. Transitional dynamics: The industrialisation process

Note that in this draft, we take β=0 to simplify the presentation; subsequent drafts will remedy this.

Many critical interlinkages among trade, industrialization and the development process concern factors that change over time, so we must characterise the transitional dynamics. This requires a specification of investors' intertemporal behaviour.

The assumed intertemporal utility is:

$$U = \int_{t=0}^{\infty} e^{-\rho t} \ln \frac{E}{P} dt; \qquad P = p_A^{1-\mu} p_Z^{\mu} \tag{22}$$

where ρ is the rate of time preference. The only form of investment in the economy is the creation of capital for the y-sector, so an individual's asset accumulation equation is:

$$\dot{K}_i = (L_i + \pi K_i - E_i)/a_I \tag{23}$$

where L_i and K_i are her labour and capital (here we use K instead of n to stress the stock nature of n and to avoid confusion between the objective of an atomistic investor – who believes she has no influence on n – and a social planner that takes account of the spillovers generated by n).

The current valued Hamiltonian for this problem is: $H = \ln(E_i/P) + \lambda(L_i + \pi K_i - E_i)/a_I$, where π is the flow reward to owning capital. Here E_i is the control variable. K_i is the state variable, and λ is the co-state variable. The atomistic investor takes the time path of prices as exogenous to her decisions, so the necessary conditions are:

$$\frac{1}{E_i} = \frac{\lambda}{a_I}, \quad \dot{\lambda} = \frac{-\lambda\pi}{a_I} + \rho\lambda, \quad \dot{K}_i = \frac{L_i + \pi K_i - E_i}{a_I}$$

These and the standard transversality condition characterize the system.

Using the first expression to eliminate λ from the second and third expressions, the system is characterised by two autonomous, differential equations in E_i and K_i:[3]

$$\frac{\dot{E}_i}{E_i} = \frac{\pi}{a_I} - \rho, \quad \dot{K}_i = \frac{L_i + \pi K_i - E_i}{a_I}$$

where (9) gives π in terms of E and n.

Of course, capital and expenditure choices of individual investors sum to the aggregates, so the individual behaviour equations govern the evolution of the aggregate capital stock, n. Aggregating, and using (9), the system equations are:

$$\frac{\dot{E}}{E} = \frac{\pi}{a_I \sigma} - \rho, \qquad \dot{n} = \frac{L - E(1-1/\sigma)}{a_I} \tag{24}$$

As these are non-linear, first-order differential equations, we study the system with a phase diagram.

[3] Specifically, $v = a_I/E$; differentiating this with respect to time given dv/dt in terms of dE/dt. Using the level and rate of change expressions for v permits us to eliminate v and dv/dt from the system equations.

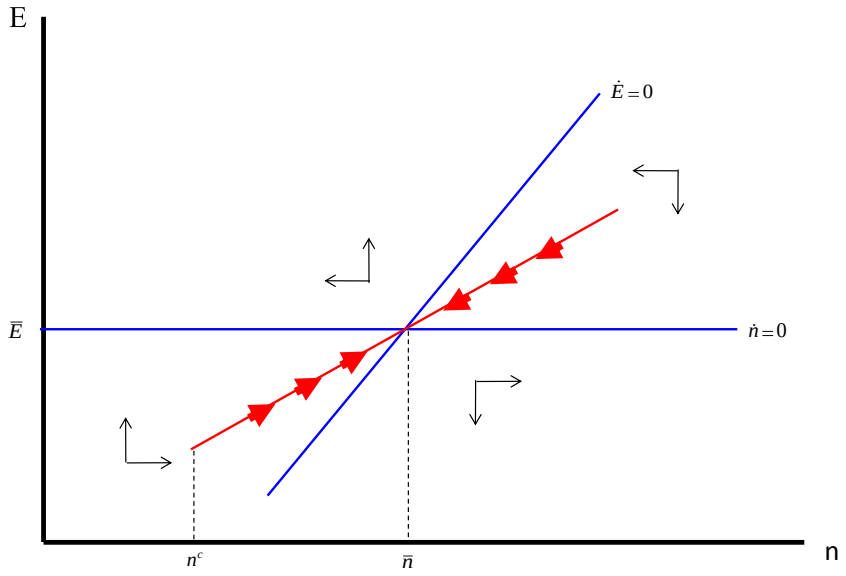

Figure 3: Phase diagram for autarky case with viable modern technology

Plotting the isokines and arrows that are indicative of the vector field, we see that the saddle path is rising (drawn linearly for convenience). Starting from an initial condition of $n = n^c$, investors find it optimal to adjust E to put the system on the saddle path since otherwise, one of the necessary conditions for optimisation (the transversality condition) would be violated. The movement during the take-off phase is shown in Figure 3.

We can think of this phase of development as "self-sustained industrialisation"; that is, modern production occurs and this creates demand for development of a wider range of competencies and a deeper supply chain which in turn make the modern industrial sector more productive. During this phase, i.e. while n is between n^c and $\bar{n}$, the investment rate is high, but falling; labour productivity is rising, and industrial output measured in constant prices is rising.

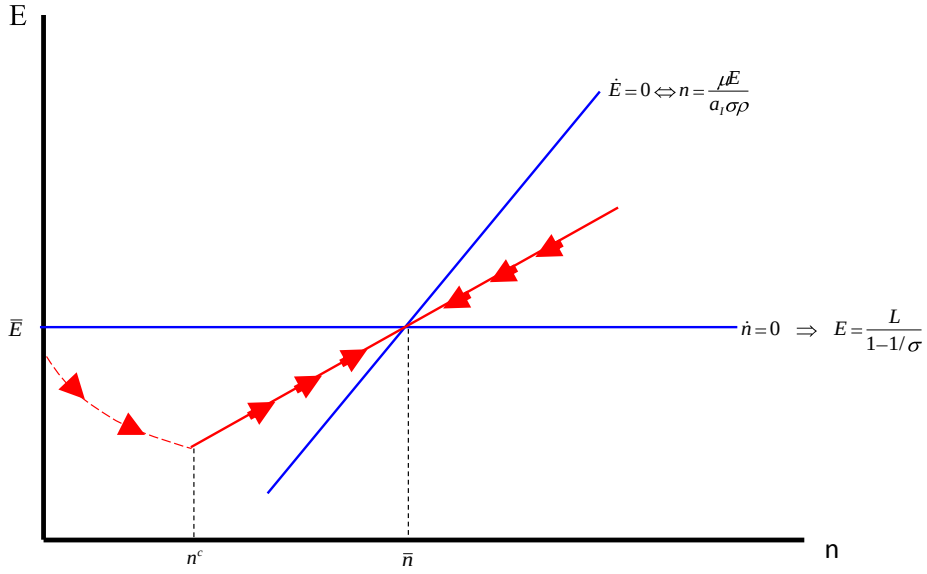

Figure 4: Transitional dynamics in gestation and take-off phases.

This analysis begs the question of how n gets from the initial condition n = 0 to the take-off value of n^c. During this phase – i.e. when n is between 0 and n^c – the range of competencies is not yet broad enough to make modern technology superior to traditional technology. This phase – what we call the gestation phase – sees investors in new x-varieties earning zero flow reward as there is not yet a demand from the nascent modern sector. In other words, the industry is still an "infant" even with respect to the traditional technology.

Given the lack of capital income, the investment problem is somewhat different. The Hamiltonian is $H = \ln(E_i / P) + \lambda(L_i - E_i)/a_I$, but now there is an endpoint condition that $n=n^c$ at time T^c, where T^c is endogenously determined. Endpoint conditions only affects the transversality condition, so the necessary conditions for intertemporal optimisation are:

$$\frac{1}{E} = \frac{\lambda}{a_I}, \quad \dot{\lambda} = \lambda\rho, \quad \dot{n} = \frac{L - E_i}{a_I} \tag{25}$$

The second expression says that the shadow value of a unit of capital must rise at the rate ρ, so the first expression implies E must fall at that same rate.

When n reaches the take-off level n^c, modern production occurs, so demand for x starts and capital owners start to earn π. As a consequence, the system equations switch to (24). As there can be no anticipated jump in the value of a unit of capital (by a standard arbitrage argument), there can be no jump in E as the system approaches the take-off point, n^c. Putting these facts together, we see that the transitional dynamics are characterised by the time path show in Figure 4.

4.1. Discussion

Figure 4 could be viewed as a stylized version of a successful import substitution industrialisation. The savings rate is high and rising in the first stage, but gradual declines as the modern sector matures. By definition of our steady state, savings falls to zero in the long run. During the take-off phase, output is growing rapidly along with labour productivity because the 'industrial base' is widening and deepening.

This simple model helps structure thinking about the received-wisdom determinants of

successful industrialisation. The first set concern factors that influence the initial investors' confidence that the take-off will actually occur. During the gestation phase, investors are investing in firms that do not yet have any customers. In our simple model, property rights are absolutely assured, but stepping slightly outside the model, it is clear that threats to the initial investors – be it an unstable macroeconomic environment or an loss of value (due to, for example, changes in regulation, taxation, or expropriation) could well prevent them from investing in the first place.

The role of large conglomerates, government industrial policy and capital market issues are also easy to think about in this model (although we have not introduced them explicitly). The gestation phase requires a degree of implicit or explicit coordination among investors as the value of all their investments depends upon that undertakings of all. In such a setting, a Chaebol-like conglomerate that integrates bank financing and eventually the purchases of inputs by Z producers could reduce the likelihood of a breakdown in cooperation or the fear of such. In this sense, conglomerates could make the take-off more likely. A similar role could be played by government allocation of credits and a sector-oriented industrial policy that focused investment effects in the development of the necessary competencies to launch a particular sector. In our model, there is only one Z sector, but one with more sectors could find that industrialisation happened faster and more surely when the development of intermediates was focused on one sector at a time, guided perhaps by a government plan.

5. INDUSTRIALISATION UNDER THE SECOND UNBUNDLING

This section needs more work, but the sketch of what it should do is provided in this first draft.

Interpreting the second unbundling in this model is simple. To reflect the fact that the world does not become flat, competencies continue to be non-tradable. To reflect the ICT revolution, the coordination costs of using foreign components falls to zero, namely χ from (7) drops to unity. The second unbundling has two first-order effects on the equilibrium. The first is that Home gains no particular advantage from sourcing parts locally. The second is that Home can focus its entire production on a single component that it sells on the global market. In other words, by eliminating what economic geographers call supply or forward linkages, the second unbundling restores the fundamentally Ricardian nature of the model.

The result is that Home will shift all of its labour into the good where its comparative advantage is highest. If Home comparative advantage turns out to be in Z, then the nation becomes an assembly platform, importing all the parts and exporting almost all the final good. If Home highest comparative advantage lies in an intermediate good, say y(j'), then the nations' entire labour force shifts to making y(j'). In both cases, but especially in the second, we can think of the nations as industrialising by joining a supply chain. Of course the model is too simple to have endogenous multinational corporations, but a reasonable conjecture would be that if it did, Home's y(j') production would be organised by the firms buying the output.

So far the critical role of foreign investment has not entered the picture. To do this, the model will allow foreign firms to set up production facilities in Home that use the foreign technology as in Baldwin and Robert-Nicoud (2010). In this case, the choice of which part to specialise in turns on the offshoring firm's decision. As usual, this will depend upon the offshoring costs and relative factor prices

6. CONCLUDING REMARKS

To be completed.

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