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Regional Comparative Advantage in Northeast Asia: Determinants of the Present Structure and Some Future Possibilities

Burnham O. Campbell

INTRODUCTION

During the past year interest in Northeast Asia as a region has greatly increased, both in the media concerned with Asian affairs and within the region's governments. Sometimes this increased attention has focused on the Tumen River project, but more often it has involved the region in general. Recognizing the opportunity presented by the quantum changes in world politics in the past two years, there has been much discussion of the possibilities for Northeast Asian economic development based on regional complementarities and on the scope for specialization along regional lines (Kim and Campbell, 1992). It is now time to take a more detailed look at the underpinnings of the Northeast Asian economy and make some substantive suggestions about the direction regional specialization and trade might take. We will look at what might be, not at what is.

Table 3.1 sets the stage by presenting several key economic indicators of the Northeast Asian region, defined here and subsequently, unless otherwise noted, to include Japan, Mongolia, Northeast China (Liaoning, Jilin and Heilongjiang Provinces), North Korea, South Korea, and the Russian Far East.[1] The very wide differences in per capita income and in per capita exports reflect three major and inter—related factors, differences in capital/labor ratios, differences in the efficiency of resource utilization, and differences in the degree of international specialization. Roughly, they imply that Japan has a current comparative advantage in capital—intensive production, including human capital—intensive production, that South Korea is moving toward this position, and that the remainder will have a comparative advantage either in labor—intensive production (NEC) or in resource—intensive production (RFE, Mongolia and possibly DPRK).

DETERMINANTS OF COMPARATIVE ADVANTAGE IN NORTHEAST ASIA

The basic sources of comparative advantage in any country or region are relative resource endowments, relative amounts of labor and of human and physical capital available, and the possibility of economies of scale. What present comparative advantage actually is will also be determined by various government interventions, the accumulated experience of economic operatives, and the success in establishing brand names (monopoly advantages), with the latter two positively correlated to the stage of development.

Table 3.2 reviews the basis for regional comparative advantage set out in my paper for the Changchun conference last year and expands this basis to include mineral resources and economies of scale. Essentially, developing Northeast Asia has a world comparative advantage in mineral resources, including oil, in forest products, and in maritime resources, but no comparative advantage in agriculture.

Except for Mongolia, which has an agricultural comparative advantage but no maritime resources at all, supplying food for the domestic population in every instance will be a real challenge for the other countries and sub—regions of developing Northeast Asia. However, given the large absolute amounts of arable land available, specialization in agricultural cash crops may yield export growth for Northeast China even if the developing region as a whole is a net importer in the agricultural sector. In fact, even Japan and South Korea might have specialty agricultural exports as well as providing some (though much less than they now produce!) import substitute agricultural products. Basically this is a result of the high population density everywhere in the region except the Russian Far East and Mongolia and the fact that climate, topography, and the amount of arable land available prevent the latter two from filling the regional agricultural deficit.

The story is different for forest products. Taken together the Russian Far East and Northeast China, and to some degree Mongolia, give Northeast Asia's developing countries a strong comparative advantage in forest products. With a ready market nearby in Japan and South Korea, and in the rest of China, the possibilities should be good for joint ventures bent on capturing more of the manufacturing value added as trees are transformed into furniture, construction materials, office supplies, etc. The entire region would also have a clear comparative advantage in maritime products, because of both the long coast lines involved and the lengthy experience of both Japan and South Korea in the fishing industry.

In terms of mineral resources, the picture is less clear. Certainly with Japan included, the Northeast Asian region would be a net importer of petroleum products and other energy sources (coal for example). However, there would likely be some minerals whose regional supply equals or exceeds regional demand, and so I would expect the Northeast Asian region to have a current comparative advantage in world markets in non—petro based minerals as a group. In fact, the USSR is the only country in the world included among the top producers of every one of the minerals or processed minerals monitored by the World Resources Institute (1988). Although comparable numbers cannot be presented for the Russian Far East, discussions of the former Soviet Union's natural resources suggest a substantial proportion of these

Table 3.1 Northeast Asia: General economic data

	Gross domestic product (bil) US$	Population (mil) 1991	GDP per capita 1991	Exports per capita 1985	Km^2 per 1000 population 1991	Km^2 total agricultural land per 1000 poulation (1981-83)
Northeast China [a]	38.2	99.9	382	53.0	9.6	—
North Korea	21.5	21.8	986	73.5	5.6	5.6
Soviet Far East [b]	19.4	8.0	2,411	278.4	773.6	—
Mongolia	1.9	2.2	780	116.9	711.4	750.0
South Korea	239.7	43.2	5549	736.8	2.3	2.2
Total NEA	318.8	175.1	1820	235.8	51.1	—
Japan	3,123.5	123.8	25,230	1,455.8	3.0	2.6
Total NEA + Japan	3,442.3	296.7	11,600	750.6	31.4	—
U.S. (1990)	5,392.0	250.0	21,568	890.7	37.5	30.3
Canada (1990)	570.0	26.5	21,509	3,445.0	376.5	165.4
Former USSR (c)	691.8	289.0	2,394	314.4	77.5	54.8
China	338.8	1,151.3	294	26.3	8.3	5.1
World	—	—	—	—	—	18.2
Liaoning	18.5	39.7	466	99.5	—	—
Jilin	7.5	24.8	304	21.4	—	—
Heilongjiang	12.2	35.4	343	23.1	—	—

Sources: World Bank (1987, 1992); Chinese State Statistical Bureau (1989, 1991).

(a) Based on 1991 data from the Chinese Statistical Yearbook except for exports/capita.

(b) GDP is 2.8 percent of the former USSR GDP estimated as discussed in note (c).

(c) GDP is estimated from 1985 base given in Kim and Campbell, 1992, using estimates of annual growth rates from World Bank and news sources; population data are from World Bank (1992).

minerals is found in the Russian Far East (Jensen, et al, 1983). China also has a relatively large mineral resource index, and other sources suggest that many of these resources are located in Northeast China. In fact, Northeast China produces over half of the national output of the main mineral resource not included in the World Resource Institute list, crude petroleum. Furthermore, a substantial part of Mongolia's exports to the Soviet Union involved raw or lightly processed minerals.

It is worth noting that the advantages in forest and mineral resources for the Russian Far East and in forest, mineral, and agricultural resources for Northeast China, and possibly Mongolia, are mixed blessings. Although forest products have shown growth, the prices of many mineral and agricultural commodities have been on a downward trend in real terms for some time, and there is no evidence that productivity improvement has kept pace. Thus, the real or factorial terms of trade have been adverse over much of the past twenty years for many of these products. Although these price trends mean exporters of these products basically have to work even harder just to keep the same real income, the mere existence of these resources tends to penalize all manufacturing except that based on the resources. The equilibrium exchange rate in South Korea must be at a level that stimulates sufficient manufacturing exports to buy the agricultural, forest, and mineral inputs required by a growing economy. Where resources are abundant, the equilibrium exchange rate must take account of this fact, and as a result a much smaller number of non—resource—based manufacturing will be profitable either as export or import substitutes. This does not rule out export—led growth in resource rich countries, but it is a slower process. It should be no surprise that all the initial Asian tigers were extremely resource—poor in per—capita terms.

What this means is that for some time, developing Northeast Asia won't be as industrial as the NICs. The equilibrium exchange rate will preclude many "footloose or higher stage" manufacturing goods unless heavily subsidized, and such subsidization will "crowd out" goods in which the region has a comparative advantage. The most appropriate route to success is to try to capture much more of the manufacturing value added on the region's mineral and forest resources.

Moving on to the Hechscher—Ohlin basis for trade, rough and ready recent (1980s) estimates of capital—labor ratios are given in Table 3.2 along with the skill composition of the labor force as measured in absolute and relative terms by educational enrollment ratios. Educational attainment data would have been preferred but are not available for most of the countries or areas covered.

The capital—labor data show Northeast China to be very labor—intensive, Japan very capital—intensive, and the rest along the spectrum with only South Korea near the Japanese end. Obviously developing Northeast Asia has an advantage in labor—intensive goods. In terms of education, given their population size and enrollment ratios in higher education, Japan and South Korea have the critical mass of college—educated workers needed for high tech research, modern management, and supportive services. China, including Northeast China, which has an above average share of more highly educated people (China Statistical Yearbook, 1991), will have the critical mass for some advanced activities, but the ratio of college—educated personnel to basic workers will either not be high enough anywhere for

Table 3.2 Determinants of comparative advantage in Northeast Asia

	Capital labor ratios 1983 (000s US$)	Percent of primary level 1985	Age group secondary level 1985 %	Enrolled at tertiary level 1981 %	Km² arable land + permanent cropland meadows and permanent pasture per 1000 population (1981-83)	Km² forests and woodland per 1000 population (1981-83)	Kms coast line per 1000 population 1983	Mineral resource index [d] Japan = 100 1987	Economies of scale index[e] Japan = 100 1985
Northeast China[a]	3.7	≥100	>39	>2	?	?	?	?	22
North Korea [b]	4.6	100	96	16	1.1	4.4	128.7	0	5
Soviet Far East [c]	8.6	106	99	21	?	>33.1	>168.0	4	2
Mongolia	3.4	105	88	26	666.7	83.3	0.0	na	1
South Korea	11.1	96	94	32	0.6	1.6	59.3	0	13
Japan	48.4	102	96	30	0.5	2.1	114.1	100	100
U.S.	64.0	101	99	57	18.5	11.8	83.8	1247	272
USSR (d)	8.6	106	99	21	21.8	33.1	168.0	3350	89
China	2.6	124	39	2	3.8	1.3	13.6	600	230
Liaoning	2.7	≥100	>39	>2	—	—	—	—	9
Jilin	4.6	≥100	>39	>2	—	—	—	—	5
Heilongjiang	4.1	≥100	>39	>2	—	—	—	—	8
World	—	—	—	—	9.7	8.6	—	12500	—

Sources: Capital stock estimates were derived by totaling real investment provided on World Bank data tapes; labor supply estimates are from the same source; fixed assets per household, etc. from Chinese Statistical Yearbook 1988; USSR, North Korea, and Mongolia were estimated as described in Kim and Campbell; agricultural data from World Bank and World Resources Institute.

(a) All China ratio times average Northeast China or provincial ratio of original cost fixed assets per household/all China original cost fixed assets per household.

(b) Derived from partial data in Eberstadt and Banister (1990) and World Bank (1987).

(c) Assumed same as the USSR where other information is not available.

(d) Based on number of times in World Ressource list of top 15 producers weighted by share in world output when listed.

(e) Equals 3 x's GDP index (Japan base) + Pop Index (Japan base) with sum + by 4.

modern production if spread evenly or will lead to large disparities in productivity and incomes. The Russian Far East may also have this capability, but the numbers would be small and perhaps reverse the Chinese ratio of college—educated personnel to basic workers. The situation in North Korea suggests that its advanced education is ahead of China and close to that of South Korea, but isolation may have reduced severely the quality of whatever higher or secondary education that takes place.

Looking at the next level, Japan, South Korea, and Northeast China all have a large group of workers with the skills provided by secondary education. This was an obvious prerequisite for what has happened in Japan and South Korea and means, other things being equal, that Northeast China will have a strong comparative advantage in labor—intensive production requiring semi—skilled or skilled workers. The region is ready for modern production although it is sobering to note that the fastest growing province in China, Guangdong, has one of the highest ratios of population with only primary education in all of China. The much more open and competitive environment in Guangdong more than compensates for this shortfall. Other things are clearly not equal here.

Whatever they are at present, relative physical and human capital/labor ratios can change with time, changing the factor proportion basis for comparative advantage. Thus South Korea's high savings rate moved its capital/labor ratio from below that of the Philippines in the 1950s to a level several times higher in the 1980s. Similarly the relatively high rate of investment inflows to Thailand pushed its capital/labor ratio ahead of most developing countries. Thailand's mostly resource—based manufacturing exports flourished. Far above average growth in per capita income and relative growth in more capital—intensive products followed in both countries, with South Korea a decade or so ahead of Thailand, as their comparative advantage changed.

Completing the quantitative story of comparative advantage, Table 3.2 also gives estimates of the potential economies of scale based on a weighted average of population and per capita income, with GDP given thrice the weight of population. On this basis, developing Northeast Asia, because of Northeast China, is a major market, over 30 percent of the Japanese market, making possible economies of scale for all but the highest priced goods. With South Korea included[2] even some of these could be produced for regional consumption close to the bottom of the long—run cost curve and, of course, if Japan is included the region can get economies of scale for any and all goods. In this respect, the Northeast Asian market is large enough, in total or only considering the developing portion, to support, with sufficient competition, a growing intra—industry trade, a major basis for continued growth in gains from specialization in the developed regions of the world. It is also large enough to be attractive to exporters and investors from all over the world, establishing, because of market size, the possibility of mutually beneficial specialization over a broad spectrum of commodities. Finally, the developing regional market is large enough, if open competition is allowed, to present an opportunity for efficient import substitution—that is for using reversible protection to change comparative advantage through intra—regional competition with time.

Beyond the not very satisfactory information provided by enrollment ratios, no data are available to measure the present stage of technological development or the

preparation for future technological development in the region. Some indication of the current status may be gained when we look at the regional structure of exports below. This will also give an indication of where "learning by doing" is going on. Established brand name advantages, except for some joint venture products being exported under widely known labels (Nike, Phillips, Mitsubishi) in Northeast China are mostly nonexistent in the developing part of the Northeast Asian region. This source of comparative advantage is still far off in the Russian Far East, Mongolia, North Korea, and most of Northeast China. It is in the process of being successfully established in South Korea and has given rise to some of the world's best known brand names in Japan.

Even more important is the absence of much more than anecdotal data on the factors determining economic efficiency. The very low rates of output per employee in the state—owned enterprises in Northeast China compared to the rates for cooperatives and village owned enterprise reported in the China Statistical Yearbook, 1991 suggest that inefficiency plays an important role in setting relative prices in China. As more and more emphasis is placed on the private sector in the Russian Far East, this phenomena will also appear there. The main effect of inefficiency in Mongolia will not be on relative prices, since inefficiency is widespread, but on the amount of output attained from the resources employed. Because planning distorts prices and production is generally inefficient—if the basically anecdotal information available is believed—both income loss and specialization that does not reflect opportunity costs are likely in North Korea.

Thus at present, relative prices may not represent relative opportunity costs in developing Northeast Asia. However, despite the many interventions, trade tends more often to follow roughly the path expected based on relative resource endowments and factor proportions rather than the other way around. What inefficiency and interventions do is limit the output attained from the resources used far below the possible level, which in turn limits the number of goods that will be internationally competitive at acceptable exchange rates (acceptable based on the political necessity of importing many goods and services). As a result, the above comparative advantage data may be misleading in placing emphasis on labor—intensive production in Northeast Asia because of the large and educated population. The iron rice bowl mentality may well work against this basic comparative advantage and make it impossible to produce labor—intensive goods for international markets.

These factors were discussed at some length in my Changchun paper (Kim and Campbell, Chap. 2), and so I will not treat them further here. However, the possible stimulus to increased efficiency provided is undoubtedly the key to any meaningful gains from increased regional cooperation, inside or outside a free trade zone. Again, the inefficient use of existing resources, land, labor, and capital may be the most important problem of all for developing Northeast Asia, but there has been progress which should continue.

COMPARATIVE ADVANTAGE BROADLY STATED

Table 3.3 presents a comparative advantage matrix for Northeast Asia. Across the top, goods are classified on the basis of the following six production function categories: (1) resources as the major input (arable land, forests, minerals, or maritime resources); (2) primarily labor—intensive, with unskilled or semi—skilled labor as the major input; (3) profitable production ranges from labor—intensive to basic physical capital—intensive, usually somewhat more skilled labor and considerable physical capital are both necessary; (4) primarily physical capital—intensive using widely available technology; (5) ranging from physical capital—intensive to high tech—intensive, involving proprietary knowledge or large amounts of research and development expenditures and large amounts of human capital; (6) high tech—intensive, involving proprietary knowledge or large amounts of research and development expenditures and frontier products; highly human capital—intensive. Both the last two categories depend on a wide range of services generally provided only by highly developed countries, so domestic development or openness to the international suppliers of such services will also determine who has a comparative advantage in these categories.

Down the side, commodities are divided between producer goods, capital goods, consumer goods, and goods broadly used both by households and businesses. These in turn are classified as resource—based, where having the resources gives an important cost advantage, and higher stage, where other non—resource inputs dominate the cost structure. The latter generally include products in which most of the variation in cost around the world comes from other than current material inputs. Since there is no detailed information on which to base such a classification, a pragmatic approach is used. If a commodity can be produced and exported in countries without the basic embodied resources, then they are higher stage. The resource—based commodities are further subdivided between those primarily using land or agricultural inputs (e.g., cotton yarn), those using primarily forest products (e.g., paperboard), those based on maritime (including fresh water) resources, and those based on mineral resources (e.g., steel).

The assignment of countries or the region to a particular cell is based on a number of considerations. Most important is the relation between the country or region's relative resource and factor endowments and the SITC 3 digit products assigned to each cell.[3] Also considered, especially in looking at the future, are the size of the local market for the output of a particular SITC classification (e.g., tractor production for Northeast China's large agricultural sector) and each country's stage of development and experience in the production of the product involved. Countries or regions are then listed in the cells where they appear to have a comparative advantage in one or more of the products included in the cells. Where I expect the Northeast Asian region has a comparative advantage, that also is shown. Finally, a stab at what might become a comparative advantage in the future is taken, based on the products that, given country resource endowments and factor proportions and growth rates, would seem to be most likely to respond to market forces in the next decade or so. The intent is to suggest the SITC categories containing products that might be "best" for joint ventures or even government support if that road is taken. In these "future" categories, Northeast Asia does not refer to the entire region as it does for present comparative

Table 3.3 Comparative advantage in Northeast Asia

	Resources mostly	Labor	Labor/Basic	Basic	Basic/high tech	High tech	?
Producer goods							
Resources-based	—	—	—	—	—	—	jpn
a. land	nec,mg	nec,mg NEA	nec,mg NEA	—	—	—	—
b. forest	rfe,nec NEA	nec,rfe NEA	rfe,nec NEA	—	—	—	—
c. maritime	dprk,rfe,rk,jpn NEA	—	—	—	—	—	—
d. mineral	—	nec,mg NEA	rfe,nec,mg,dprk NEA	nec,rfe,rk,jpn,dprk NEA	rk,jpn	—	—
future	—	—	—	—	*nec,rfe,NEA*	—	—
Higher stage	—	—	rk,nce	rk,jpn,nec	—	—	—
future	—	—	*nec,dprk*	*nec,rfe,dprk NEA*	*nec,rfe NEA*	—	—
Capital goods							
Higher stage	—	—	—	—	—	—	—
a. for resource based mfg.	—	—	—	nec,rk,jpn	—	—	—
future	—	—	*nec,rfe NEA*	—	—	—	—
b. general	—	—	nec,rk	rk,j	rk,jpn,nec,rfe NEA	rk,jpn NEA	—
future	—	—	*,dprk NEA*	*nec,dprk NEA*	*nec,dprk*	*nec,rfe*	—

Note: dprk = Democratic People's Republic of Korea
jpn = Japan
mg = Mongolia
NEA = Northeast Asia
nec = Northeast China
rfe = Russian Far East
rk = Republic of Korea

Table 3.3 (continued)

	Resources mostly	Labor	Labor/Basic	Basic	Basic/high tech	High tech	?
Consumer goods							
Resources	—	—	—	—	—	—	—
a. land	—	mg,nec	nec,mg	—	—	—	—
future	—	—	*dprk,nec NEA*	—	—	—	—
b. forest	—	rfe,nec	—	—	—	—	—
future	—	*NEA*	—	—	—	—	—
c. maritime	—	rfe,dprk,rk,jpn NEA	—	—	—	—	—
d. mineral	—	jpn,rfe	—	—	—	—	—
Higher stage	—	rk	jpn,rk,nec NEA	nec,jpn,rk	jpn,rk NEA	—	?
future	—	*nec,dprk NEA*	*rk,nec NEA*	*nec*	*nec*	—	—
Bus/household goods							
Resources	—	—	—	—	—	—	—
d. mineral	—	—	nec,rk	—	rfe?	—	—
future	—	—	*,dprk,rfe NEA*	—	—	—	—
Higher stage	—	—	jpn	nec,rk,jpn NEA	jpn,rk NEA	jpn,rk NEA	?
future	—	—	—	—	*nec NEA*	*nec*	—

Source: UNCTAD (1992).

advantage, but to the comparative advantage of the developing portion of the region.

Analyzed in this manner, of the cells in which there is both a current Northeast Asian regional comparative advantage and at least one developing country or sub—region, nine of thirteen are in the upper left—hand corner of the table. This means they are resource—based producer goods, produced under resource—intensive or labor—intensive to labor/basic production functions except for one basic/mineral cell. In total, ten of the thirteen cells meeting this criterion are resource—based. Looking at the structure of developing Northeast Asian country comparative advantages, independently of whether or not a Northeast Asian regional comparative advantage also exists, the story is similar. Eighteen of the 26 cells meeting this criterion are resource—based. Only Northeast China, eight times, and the Russian Far East, once, were classified as having a higher stage comparative advantage, and only Northeast China, twice, was classified as having a current comparative advantage in an SITC cell utilizing something more advanced than a basic production function—although my crystal ball sees that regional cooperation and development could in the future lead to a comparative advantage for the Russian Far East and North Korea in several higher stage activities and for the Russian Far East, North Korea, and Northeast China in several basic/high tech and high tech cells.

EXPORTS AND COMPARATIVE ADVANTAGE

We will later name and select among the SITC categories included in the cells in Table 3.3 those most likely to provide a basis for current development and cooperation, but first we look at what recent export experience tells us about the current comparative advantage of countries and sub—regions. We will also consider how closely this experience conforms to the basic determinants of comparative advantage just discussed.

A rigorous discussion of revealed comparative advantage on, say, a 3 digit SITC basis is ruled out by lack of data. However, we can give estimates of comparative advantage by broad categories of exports as Table 3.4. A country has a revealed comparative advantage in one of the very broad categories shown in this table if the share of the category in the country's exports is greater than the share of the category in world exports. Table 3.5, which shows some of the current key products in international trade and so begins the necessary disaggregation, is interpreted in the same manner. Both Table 3.4 and Table 3.5 provide data data on the import structure by the same categories, and this gives some feel for where import substitution may be possible and indicates the importance, at this level of aggregation, of intra—category trade.

Revealed comparative advantage shows the effect of actual relative commodity prices measured at the actual international price levels determined by exchange rates and domestic price. Of course, where barter is involved, important in the Northeast Asian region, this does not follow. Revealed comparative advantage also does not tell us whether the observed pattern of trade resulted from underlying real or opportunity costs or was distorted by various kinds of government interventions affecting relative prices (subsidies, tariffs, monopoly privileges, state political pricing, etc.) or affecting

Table 3.4 Commodity structure of world trade

	Total value	All food 0+1+22+4	Agriculture raw materials 2-(22,27,28)	Fuels 3	Ores and metals 27+28 68	Manufact. goods 5 to 8-68	Chemical products 5	Other manuf. 6+8-68	Mach. and equip. 7	Unallocated 9
World trade										
1970	311,905	15	5.8	9.2	7.3	60.9	—	—	—	—
1988	2,829,098	9.9	3.5	8.7	4.1	71.6	8.2	24.2	33.0	6.22
					Export structure					
China										
1975	6,328	32.8	7.9	12.5	3.8	41.8	4.6	35.7	1.5	1.3
1989	52,538	13.7	5.0	8.2	2.6	53.9	6.2	40.4	7.3	16.6
Hong Kong										
1970	2,037	2.0	0.6	0.0	1.5	95.7	0.9	83.0	11.8	0.2
1989	28,731	2.0	0.3	0.3	1.1	95.0	2.4	69.4	23.3	1.2
Japan										
1970	19,319	3.5	1.6	0.2	1.4	92.5	6.4	45.6	40.5	0.8
1989	275,040	0.6	0.6	0.4	0.9	96.1	5.3	25.5	65.3	1.4
South Korea										
1970	830	9.6	7.1	1.1	5.7	76.5	1.4	67.9	7.2	
1989	62,283	3.7	1.2	1.0	1.1	92.9	3.4	54.5	35.0	0.1
USSR										
1970	12,800	7.4	9.2	15.5	20.2	29.0	2.3	5.0	21.7	18.7
1989	110,559	1.7	4.8	42.2	2.8	27.8	3.2	8.1	16.5	20.7

Table 3.4 (continued)

	Total value	All food 0+1+22+4	Agriculture raw materials 2-(22,27,28)	Fuels 3	Ores and metals 27+28 68	Manufact. goods 5 to 8-68	Chemical products 5	Other manuf. 6+8-68	Mach. and equip. 7	unallocated 9
					Export structure					
China										
1975	—	—	—	—	—	—	—	—	—	—
1989	59,140	8.9	6.7	2.8	3.3	66.0	12.8	21.7	31.6	12.2
Hong Kong										
1970	2,905	19.9	6.7	2.9	2.1	68.2	8.2	43.5	16.5	0.2
1989	72,154	7.9	2.8	2.4	2.0	84.5	7.8	51.0	25.7	0.5
Japan										
1970	188,883	16.9	16.2	20.7	20.9	24.8	5.3	8.2	11.3	0.5
1989	207,356	16.1	8.2	20.8	10.2	43.6	7.6	22.4	13.6	1.1
South Korea										
1970	1,983	17.2	15.4	6.9	5.7	54.8	8.3	16.8	29.7	0.0
1989	61,348	6.2	8.9	12.4	7.8	64.5	11.6	18.7	34.2	0.2
USSR										
1970	11,732	16.2	5.8	1.8	8.1	67.2	6.7	23.4	37.2	0.8
1989	88,871	18.2	3.1	2.3	7.8	68.0	7.5	20.2	40.3	0.5

Source: UNCTAD (1992).

the relative international price levels (inflation policy, exchange rate policy). Thus, the revealed comparative advantage relations shown almost certainly do not reflect the long—run optimum trade pattern—if one can be defined—but instead current realities.

China had a revealed comparative advantage in foods, agricultural raw materials, and fuels in 1970 and in foods and agricultural raw materials in 1989. In 1989 China had a revealed comparative advantage in the other manufacturing category that includes resource—based and labor—intensive manufactures. China's comparative disadvantage in chemicals, machinery, and equipment and in ores and metals, even though China imported a lower share of both of the latter than the world as a whole, probably reflects the domestic absorption of domestic production in these two sectors. This export/import structure generally follows the expected pattern based on China's comparative advantage in resource—based and labor—intensive production. The exception is the continued revealed comparative advantage in food exports.[4] Furthermore, the changes going on reflect those expected with growth.

Hong Kong, which is now only a proxy for South China but will represent an important part of the "real thing" in 1997, had the expected revealed comparative disadvantage in food, agricultural raw materials, and fuels and a large comparative advantage in manufacturing in both 1970 and 1989. This relative advantage is entirely in "other" manufacturing, and, if a look behind the scenes is taken, mostly in the labor—intensive sub—categories of SITC 800. However, Hong Kong is overcoming its comparative disadvantage in machinery and equipment manufacture. Hong Kong's status as an entry port and its dependence on imported inputs are clearly shown by the relative size of manufacturing imports. Hong Kong, like all of the other countries included, also has a comparative disadvantage in chemicals.

For the first four headings, Japan's export structure is very similar to Hong Kong's. The difference is in the structure of manufacturing. In 1970 the "other" category, mostly the labor—intensive component, and machinery and equipment were about equal, but by 1989 machinery and equipment had become clearly dominant. This is a direct result of the application of a relatively high rate of savings to human and physical capital accumulation along with research and development under more efficient (i.e., competitive) conditions than found in most of the world. Having a large domestic market was also a boon. These outcomes are exactly what we would expect with development for a country beginning at Japan's development level in the 1960s and having Japan's minimal natural resource endowment. The only surprising outcome, especially given the breadth of the categories involved, is the relative low share, far less than the share of such exports in world trade, of manufactured imports of all kinds, but especially of the "other" category. Among other things, this suggests opportunities for close—by intra—category specialization with Northeast Asia being greatly increased if Northeast Asian cooperation is successful.

Surprisingly enough, South Korea had a 1970 revealed comparative advantage in agricultural raw materials, probably, given the country's large import share in the same category, because the category includes "processed" raw materials. By 1989 the export structure represented by the first four columns is very much like Japan's and

very much what a forecast of the structure based on relative resource and factor endowments would conclude. Within manufacturing in 1970, the revealed comparative advantage was entirely in the "other" category—traditional labor—intensive or labor/basic goods. With development South Korea now has a small comparative advantage in machinery and equipment (although the share of imports in this category is almost the same). South Korea's *a priori* comparative advantage is solely in manufacturing (and services, where South Korea has a long way to go) and basically in "footloose" manufacturing where human and physical capital, technology, whether basic or new, and establishment of brand names and scale economies are the keys, not nearby resources. Generally, with development and ever—increasing openness, South Korea's export structure and revealed comparative advantage reflect this underlying comparative advantage. In this sense, South Korea is a good role model for the rest of mainland Northeast Asia.

In 1970 the former Soviet Union had a revealed comparative advantage in agricultural raw materials, fuels, ores, and metals. By 1989 this was reduced to agricultural raw materials and fuels, with almost all the export eggs in one basket, fuels. There is no advantage shown in any of the manufactured good categories, which seems unusual given the obvious technical knowledge available and the size of the domestic market. In comparative advantage terms, this is especially troubling for the resource—based component of the "other" manufacturing sector, as is the loss of comparative advantage in ores and metals. Unlike the other countries covered in the table, government interventions in the Soviet Union clearly distorted trade away from the structure suggested by the determinants of comparative advantage. Most likely, if data were available, they would show the same for Mongolia and North Korea.

Table 3.5 gives the breakdown by some key products and, along with the changes just described, indicates how dynamic comparative advantage is, at least the revealed proxy. China had an unexpected revealed comparative advantage in cereals (but is a large net importer) and an expected one in fibers, yarn, and clothing. In all other categories in this table, China has a relatively large export share only in crude petroleum. Hong Kong has a revealed comparative advantage in fibers, yarn, clothing, and electrical machinery, with the former falling and the latter growing with development. Japan had, but no longer has, a revealed comparative advantage in fibers, yarn, and clothing. Japan's revealed comparative advantage in metals, etc. (steel and steel products mostly) still exists but is much lower. Most outstanding is Japan's revealed comparative advantage and growing share of exports in all forms of machinery and transport equipment. Japan is following the development pattern established in the U.S. and going one better. This pattern follows the evolution of comparative advantage in textiles expected with economic growth. South Korea, as befits its transitional development stage, still has a revealed comparative advantage in textiles along with revealed comparative advantages in metals, etc. and in electrical machinery, both with growing export shares. And South Korea is almost there in non—electric machinery and transport equipment. Again this pattern follows that expected based on the determinants of comparative advantage. Perhaps most significant of all, however, is the reminder these data give us of how changeable or dynamic comparative advantage is.

Since no comparable data on any of the above categories are available for Mongolia, North Korea, and the Russian Far East, little can be said about the conformance of their export structure to the structure predicted by comparative advantage. The information that does exist, discussed briefly below, suggests that export structure in these Socialist countries roughly follows the *a priori* expected pattern, which differentiates the Russian Far East from the former Soviet Union as a whole. However, we will be able to take a fairly detailed look at the export pattern in Northeast China below.

Table 3.6 gives data on the 15 largest exports of Hong Kong, Japan, South Korea, China, and North Korea. These exports, which are initially by SITC 3 digit categories, are classified into the production types used in Table 3.3 to describe comparative advantage. Although they do not strictly show revealed comparative advantage, the results give the emphasis placed by each country on the different kinds of production, which are related to comparative advantage.

China and North Korea have by far the largest shares of resource—based exports in their top fifteen. They also, along with Hong Kong, have by far the largest share of labor—intensive exports among their top exports, although this kind of export remains high in South Korea. At the other extreme, Japan has almost twice the share of any other country in the technology—based goods categories, but South Korea is also a major exporter of such goods.

Except for Japan all countries have at least a fourth of their exports in relative factor—based categories. Again, in all instances, this distribution of the top fifteen exports follows the expected lines based on the determinants of comparative advantage, even in North Korea. While a more detailed analysis might uncover many exceptions, especially in the Socialist economies, this agreement in a broad sense suggests that if regional cooperation is to be successful, careful attention should be given to the region's current comparative advantage in making any decisions that will determine or guide the structure of production.

To save time I will not discuss the SITC product categories on which the data for Hong Kong, Japan, and South Korea in Table 3.6 were based. They are readily available in UNCTAD's Handbook and generally known. Instead, I will go over the product basis for the data on North Korea and China and discuss what we know about the export structure of the Russian Far East and Mongolia. Since there is much data available on China at the provincial level, I will also discuss the industrial base and export structure of Northeast China.

North Korea

Based on a "not for publication" source, in 1987 North Korea's major export, accounting for almost one—third of all exports, was clothing, sent to the USSR probably on a barter basis. It seems unlikely in world markets that North Korea would have a comparative advantage in such a labor—intensive category in the long—run. However, it could have one at present. North Korea's second, third, and fourth largest exports, accounting for 12.6 percent of total exports, were ores or minerals. In total, based only on the top exports as a share of total exports, mineral—based or metals

Table 3.5 Percent of total trade in selected products

	Cereals 4	Crude manuf. fertilizer 271+56	Crude petroleum 331	Petro products 332	Textile: Medical and pharma-ceutical products 54	Textile: Fibers, yarn, clothing 26+65+84	Metals and machinery: Metal manufact's 67+68+69	Metals and machinery: Non-electric 71	Machinery and transport equipment: Electrical 72	Machinery and transport equipment: Equipment 73
World trade										
1970	—	—	—	—	—	—	—	—	—	—
1988	1.2	0.5	5.6	2.6	1.1	6.6	6.7	9.7	11.5	11.7
					Exports					
China										
1970	—	—	—	—	—	—	—	—	—	—
1989	1.4	0.0	5.2	1.6	1.0	27.9	4.5	2.5	3.9	0.9
Hong Kong										
1970	0.2	0.0	?	0.0	0.3	44.3	3.4	0.8	10.5	0.6
1989	0.1	0.0	?	0.0	0.1	39.5	2.8	8.2	15.0	1.0
Japan										
1970	0.9	0.3	0.0	0.2	0.3	12.5	19.7	10.4	12.3	17.8
1989	0.1	0.0	0.0	0.3	0.3	2.5	7.8	22.2	18.9	24.2
South Korea										
1970	0.2	0.8	0.0	0.6	0.2	41.1	3.3	1.0	5.3	1.0
1989	0.2	0.3	0.0	1.0	0.2	23.9	9.6	7.5	18.6	8.8

Table 3.5 (continued)

	Cereals 4	Crude manuf. fertilizer 271+56	Crude petroleum 331	Petro products 332	Textile: Medical and pharma-ceutical products 54	Textile: Fibers, yarn, clothing 26+65+84	Metals and machinery: Metal manufact's 67+68+69	Metals and machinery: Non-electric 71	Machinery and transport equipment: Electrical 72	Machinery and transport equipment: Equipment 73
USSR										
1970	—	—	—	—	—	—	—	—	—	—
1989	—	—	—	—	—	—	—	—	—	—
					Imports					
China										
1970	—	—	—	—	—	—	—	—	—	—
1989	5.0	4.0	0.8	1.7	0.5	8.7	12.7	17.5	9.2	4.9
Hong Kong										
1970	3.3	0.0	?	2.8	1.6	23.2	5.3	5.5	8.6	2.4
1989	0.5	0.0	?	1.9	0.7	22.0	5.2	7.4	16.1	2.2
Japan										
1970	5.6	0.6	11.8	2.9	1.1	6.8	6.8	6.7	2.5	2.2
1989	2.3	0.3	10.2	4.2	1.3	8.1	7.9	5.5	4.7	3.3
South Korea										
1970	12.3	0.6	6.3	0.4	0.8	12.5	7.8	15.4	6.7	7.6
1989	2.3	0.3	8.0	1.3	0.4	5.7	9.4	17.3	13.0	3.9
USSR										
1970	—	—	—	—	—	—	—	—	—	—
1989	4.0	—	—	—	—	8.7	7.5	—	—	—

Note: Data in tialics were estimated from U.N. data following the latest classification scheme. They will differ somewhat from the country data.

Source: UNCTAD (1992)

Table 3.6 Structure of top fifteen exports of Northeast Asian countries

	Resource-based					Relative factor-based				Technology-based			Total					
	Resources mostly	Labor	Labor/ basic	Basic	Total	Labor	Labor/ basic	Basics	Total	Basic/ high tech	High tech	Total	Resources mostly	Labor	Labor/ basic	Basic	Tech based	Total top exports
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Hong Kong	<1.4	<1.4	<1.4	<1.4	3.7	36.9	9.7	2.7	49.3	9.6	1.4	10.9	<1.4	36.9	13.3	2.7	10.9	63.8
Japan	<1.5	<1.5	<1.5	2.8	2.8	<1.5	1.5	10.7	12.2	37.4	5.8	43.1	<1.5	<1.5	1.5	13.4	43.1	58.1
South Korea	<2.1	<2.1	<2.1	<2.1	0.0	17.7	2.7	6.1	26.5	21.8	2.8	14.6	<2.1	17.7	2.7	6.1	24.6	51.1
China	11.5	7.0	22.7	6.3	47.5	23.8	2.1	2.7	28.6	<1.7	<1.7	<1.7	11.5	30.8	24.8	9.0	<1.7	76.1
North Korea	11.2	4.8	7.9	3.1	27.0	30.7	na	2.2	34.4	na	na	na	11.2	35.5	56.9	6.8	na	59.4

Source: UNCTAD (1992), based on SITC classification.

exports, came to 20.6 percent of total exports. These exports relate closely to North Korea's comparative advantage (but in very small amounts). Heavy industry and equipment and machinery, including rolled steel, electric condensers, and lathes, came to 5.6 percent and would not be predicted on the basis of *a priori* comparative advantage. Because North Korea had a large trade deficit in 1987, the country's net imports were also large, especially of mineral fuels, machinery, and transport equipment.

Generally, the specifics of North Korea's comparative advantage will have to await more facts. However, it is clear that its trade has shrunk dramatically as hard currency payments are now required and barter trade is largely ruled out. Even in 1987, the net imports of mineral fuels alone were considerably larger than the combined net exports of all categories shown. The inability to barter for fuel has created a crisis situation, and the continuing decline in real mineral prices has not helped, since minerals or resource—based manufactures are a major part of the country's exports.

China/Northeast China

China's largest exports are derived from an almost complete list of exports by 3 digit SITC categories. (China Statistical Yearbook, 1991). They are dominated by labor—intensive goods, especially resource—based labor—intensive goods, including all forms of textile and clothing manufacture. Exports of crude petroleum and petroleum products are also important along with aquatic products, canned foods and cereals, higher stage labor—intensive goods, ranging from electronic components or parts to toys, are also high on the list. However, since we can look at the revealed industrial advantage of Northeast China as well as directly at its exports, and Northeast China is our primary concern, we will say no more about China's export composition.

Table 3.7 uses revealed domestic advantage to pinpoint the possible comparative advantage of the Northeast China provinces individually and collectively. Similar data for Inner Mongolia are given for comparative purposes. A revealed domestic industrial comparative advantage (RICA) exists when the share of a province or region in the national output of a particular product exceeds the province's or region's share in total industrial output. The RICA gives some idea of the product lines in which present specialization occurs and what might happen with greater openness.

In addition to raw materials, the most important of which are timber, crude petroleum, and natural gas, Northeast China's revealed industrial advantage is concentrated in a few resources and resource—based manufactures (e.g., plate glass, plastics, beer, and chemical fibers) and in heavy industries where factor proportions are extremely important (steel, motor vehicles, etc.). The former are not nearly as numerous as might be expected, and the latter do not seem likely to survive open competition, except at a very high cost to society. They reflect specialization dictated by central planning rather than comparative advantage, but they will also leave industrial skills and an experienced labor force that could be shifted to lighter manufactures.

The expected, labor—intensive production of goods does not now appear

important at the regional level. Generally, production in Northeast China does not, then, follow closely the *a priori* determinants of comparative advantage. If it did, there would be more emphasis on petroleum—based products, on wood—based products and on the mentioned labor intensive production. It is instructive that the most rapidly growing province, Guangdong, does have a comparative advantage in the production of all kinds of labor intensive and labor/basic consumer goods. Foreign funds go disproportionately to Guangdong, one of the most resource—poor regions with a relatively uneducated labor force. Light industry, unlike the rest of Northeast China, predominates, state enterprises face serious competition from numerous other enterprise types, and all are more efficient than in Northeast China (China Statistical Yearbook, 1991).

A list of major Northeast China export products organized by 1 digit SITC categories is given in Table 3.8. These tend to follow the region's comparative advantage much more than does industrial production. Food and agricultural products are most numerous, mainly in unprocessed form. Northeast China clearly has an agricultural comparative advantage if most of these goods were not marketed on a barter basis. That is not fully discernible, but a check of destinations of provincial exports suggests it is not the case. Labor—intensive manufactures, especially textiles and garments, are also important. Finally, crude oil and petroleum products were significant along with a few basic minerals. Missing are exports based on timber resources or the downstream petroleum—based products or the many heavy industrial products found in the revealed domestic industrial comparative advantage. The latter is expected as I argued. Anyway, what is missing suggests where the emphasis could well lie in projects promoted by regional cooperation, whether state—supported or, preferably, the result of market forces.[5]

Mongolia

Very little data is available on Mongolia's exports. Most have been based on barter deals with the former Soviet Union, with raw materials and agricultural products going into the USSR and consumer goods and some capital goods coming out. Thus exports followed Mongolia's comparative advantage but, as structured, left no room for growth. To get a larger share of the value—added from the products involved, more of the processing has to take place in Mongolia. Two major questions arise, where will hard currency markets come from to replace the former USSR barter demands and where will the capital come from to provide the manufacturing capability required? Growth in Northeast Asia would help to create a natural market for the mainly agricultural and energy products of this landlocked country, if the transportation infrastructure can be improved rapidly enough. Improved nearby port facilities and rail transport would help the country gain a wider market and cheapen its imports (China and the neighbors to the north willing).

Russian Far East

I have no trade details on a basis comparable to the other countries or the Northeast China provinces for the Russian Far East. Some partial data and much anecdotal material suggests that, of the small exports of the Russian Far East, the

Table 3.7 Industrial revealed comparative advantage in Northeast China and Guangdong

	Liaoning	Jilin	Heilongjiang	NEC	Inner Mongolia	Guangdong
Share nat'l ind'l	7.7	2.6	4.9	15.1	1.2	7
Chemical fibers T	9.4	—	5.8	17.1	—	—
Chemical fibers S	9.1	—	6.2	16.3	—	7.6
Chemical fiber cloth	—	—	—	—	1.8	—
Knit wool	—	—	—	—	1.7	—
Wool piece goods	—	—	—	—	3.5	—
Gunny bags	—	3.4	—	—	—	—
Paper/paper bds	—	4.2	—	—	—	—
Sewing machines	—	—	—	—	—	12.8
Bicycles	—	—	—	—	—	9.4
Watches	—	—	—	—	—	32.4
Alum prds daily use	—	—	—	—	—	11
Salt	—	—	—	—	4.6	—
Sugar	—	—	8.5	—	2.8	31.7
Edible veg oil	—	4	6.8	—	3.1	—
Total alch bev	—	3.9	6.2	15.7	1.9	—
Beer	7.9	5	7.8	20.7	2.2	—
Chinese medicine	—	7.8	—	—	—	18.7
Household refrigerator	—	—	—	—	—	22.8
Electric fans	—	—	—	—	—	56.3
Household washing mach	—	4.4	—	—	—	21.6
Radio sets	—	—	—	—	—	18.1
Recorders	—	—	—	—	—	53.8
TV total	—	—	—	—	1.4	12.2
TV color	—	—	—	—	1.5	25.4
Cameras	—	—	—	—	—	46.6
Coal	—	—	—	—	4.4	—
Crude oil	8.8	—	40.2	52.7	—	—
Natural gas	13.3	—	14.7	28.7	—	—
Elec total	—	2.8	—	—	2.7	—
Elec hydro	—	3.6	—	—	—	—
Pig iron	18.4	—	—	20.5	4.5	—
Steel	18.3	—	—	20.9	4.1	—
Rolled steel	18.2	—	—	21	3.4	—
Ferro alloy	—	11.2	—	18	1.5	—
Coke total	11	—	—	—	3.5	—
Coke mach md	15.6	—	—	20.8	3.6	—
Plate glass	12.3	—	5.3	19.7	3.1	—
Cement	—	—	—	—	—	9.9
Share nat'l ind'l	7.7	2.6	4.9	15.1	1.2	7

Table 3.7 (continued)

	Liaoning	Jilin	Heilongjiang	NEC	Inner Mongolia	Guangdong
Timber	—	10.7	26.9	39.2	9.4	—
Soda ash	20.1	—	—	20.7	1.3	—
Caustic acid	8.4	—	—	—	—	—
Calcium carbon	—	4.6	—	—	3.9	—
Plastics	—	—	10.5	18	—	—
Outer tires	—	2.8	—	—	—	—
Alternating mot	12.6	—	—	18.8	1.6	—
Metal cutting M	11.7	—	—	—	—	—
Motor veh total	—	14.3	—	20.1	—	—
Motor veh trucks	—	20.7	—	25.8	—	—
Tractors	—	7.4	—	—	—	—
Small tractors	—	3.7	—	—	—	—

Source: China Statistical Services (1991).

major items are basic mineral products, including some from the petroleum group, and maritime products (Ivanov, 1989). If so, these are all in line with existing comparative advantage. There is a huge undeveloped resource base and a potential for selected advanced engineering products and other high tech outputs based on existing military—driven activities. Whether these can be made economically efficient after operating in an environment where costs were of little or no concern is a moot point. There is very little labor, but what there is, probably relatively highly educated. With more labor—based and joint venture—based capital imports there could be much more capture of the value—added by manufacturing to the basic mineral and forest resources of the Russian Far East. At present this adds to income elsewhere in or out of Russia. Taking advantage of their comparative advantage in such production is a key to the expected gains from regional cooperation.

MORE DETAILS ON COMPARATIVE ADVANTAGE

At some point it will be necessary to get much more specific about the product lines in which Northeast Asia or its component countries and sub—regions have a comparative advantage or, with attainable capital accumulation, are likely to have a comparative advantage. In this section we begin the process of disaggregation that is necessary for rational decisionmaking. The first step, and the only one taken here, is to identify the 3 digit SITC categories in which a country, regional, or sub—regional comparative advantage exists at present or is likely to exist in the near (decade or so) future. In other words, what might a Tumen FTZ or any other FTZ or free economic zone produce that is consistent with the comparative advantage of the region and its members? The simple answer might be, whatever foreign capitalists are willing to

Table 3.8 Trade structure in the Northeast Chinese provinces

	Liaoning	Jilin	Heilongjiang
Total exports	$3788 mil	$468 mil	$812.1 mil
Rank in China/share total	3/11.00%	18/1.35%	12/2.34%
Agriculture and sideline	12.5	63.2	56.5
Light industrial	16.2	22.7	24.5
Heavy industrial	71.3	14.1	19.0

	SITC 200/600	SITC 300	SITC 000	SITC 200	SITC 800	SITC 200/400	SITC 700
Liaoning over US $10 mil		*86%*	—	—	—	—	—
Steel	*magnesium*	crude oil	*frozen prawns*	cotton cloth	cot cloth dress	wax	—
Pig iron	arom hydro	light diesel	bean dregs	cotton yarn	cot poly dress	pulp, paper	—
—	—	naptha	soybeans	wool fabric	silk/satin dress	—	—
—	—	car gasoline	maize	—	wool fabric dress	—	—
—	—	combust oil	apples	—	carpet	—	—
—	—	—	bean cake	—	—	—	—
—	—	coal	peanut kernel	—	—	—	—
—	—	—	pickles	—	—	—	—
—	—	—	frozen chicks	—	—	—	—
—	—	—	pickles	—	—	—	—
—	—	—	rices	—	—	—	—
—	—	—	fresh shrimp	—	—	—	—
—	—	—	sesame	—	—	—	—

Table 3.8 (continued)

SITC 200/600	SITC 300	SITC 000	SITC 200	SITC 800	SITC 200/400	SITC 700
Jilin over US $10 mil	66%	maize	—	—	—	—
—	—	soybean	cotton yarn	—	—	—
—	—	frozen beef	—	—	—	—
—	—	ginseng	—	—	—	—
5-10 mil	6%	canned pork	—	garments	—	—
	—	—	—	gym shoes	logs	—

	SITC 200/600	SITC 300	SITC 000	SITC 200	SITC 800	SITC 200/400	SITC 700
Heilongjiang over US %10 mil		64%	—	—	—	—	—
—	—	coal	soybean	linen fine cloth	—	—	—
—	—	—	soybean cake	cot/poly yarn	—	—	—
—	—	—	soybean expell	etc.? (7/12)	—	—	—
US $5-10 mil		—	corn	linen yarn	—	—	—
graphite	—	—	—	—	—	paraffin	power
cement	—	—	frozen beef	vis fabric	—	—	gen equip
tires	—	—	ginseng	cot/lin fabric	—	—	color TV
—	—	—	—	linen	—	—	—

Source: China Statistical Services (1991)

finance as a joint venture or fund by lending.

However, it is important that the country or countries participating in regional cooperation or setting up individual free trade zones be careful about the sectors and products attracted or involved, if the goal is long—run sustainable growth. Even if it is decided to let risk—taking entrepreneurs determine what will be produced, they can do a better job for themselves and the society they operate in with a greater amount of relevant information—at least partially a government function. And if the government is going to intervene to select the industries "allowed" to operate or to receive subsidies, it is still more important that careful attention be paid to opportunity costs and underlying comparative advantage. Whatever the approach, governments are going to have to provide the infrastructure, which will not be the same for every kind of production, necessitating some attempt at forecasting what product categories are most likely to succeed in a particular time and place. In Tables 3.9, 3.10 and 3.11 the present and possible future comparative advantages by 3 digit SITC categories for the region are given. Time and space prevented my presenting similar data for the individual countries and sub—regions of Northeast Asia, although I will be happy to provide that information to anyone requesting it at a later date. All this is very subjective, but as noted, it is a necessary step. I have tried to provide sufficient information to make it possible for readers to edit my lists according to their own understanding and information sources.

Table 3.9 is derived as follows. First the cells in which Northeast Asia is asserted to have a regional comparative advantage in Table 3.4 were selected. For example, in the labor/basic and land resource—based cell, the Northeast Asian region, Northeast China, and Mongolia are shown as having a comparative advantage. Next the entire set of 3 digit SITC categories belonging to the cells with a regional comparative advantage (cf. Table 3.10) were reviewed, and all categories that involved little or no processing or manufacturing (e.g., unmilled cereals) were thrown out. Also discarded were resource—based products not climatically suited to Northeast Asia (e.g., natural rubber), products in which only the more developed Northeast Asian countries, Japan and/or South Korea, had a comparative advantage (e.g., motor vehicles) and consumer goods that emphasize brand names (except where it was guessed such goods could be produced for the owners of established brand labels more economically in developing Northeast Asia).[6]

From the list surviving the first filter described, all 3 digit categories with a world trade share of less than 0.1 percent (about $2.8 billion)[7] were removed since, the smaller the market, the less room there is for newcomers and the smaller the growth opportunities, including incentives for new producers. Finally, as a third filter, all SITC categories with lower than average growth, that is less than 4.1 percent per annum in the 80s, were removed. The basic argument, similar to that for the second filter, is that slow—growing markets will be more difficult for new producers to penetrate and that new producers have a better chance to survive learning mistakes in rapidly growing markets. Both the smaller and the slow—growing or declining markets meeting the first filter are shown in each table.

The categories remaining after these three filters are my "guesstimate" of what would be the best bets now. The market, if prices reflect comparative advantage (or

are being moved in that direction) will select similar types of production. Thus, these are areas into which joint ventures might be attracted or possibly guided—especially if they can underpin future development in other sectors of the country or regionally.[8]

Twenty—two 3 digit categories met all the criteria employed in Table 3.9. Twelve of these or over half were in the manufactured goods classified by materials or resource based 1 digit SITC heading. Four came under food and agriculture, and three under the machinery and transport equipment heading. To me, the most significant possibilities isolated in Table 3.9 with the countries primarily involved are:

1. Wood and paper products (SITC 634, 635, 641, 642) (RFE; NEC).
2. Engines and motors, non—electric (714) (NEC, DPRK).
3. Glass, glassware (664, 665) (NEC).
4. Electrical apparatus, etc. (772) (NEC, DPRK).
5. Alcoholic beverages (112) (especially beer—all can contribute).
6. Plastic goods (893) (NEC).
7. Industrial combustion engines and parts (713) (NEC).
8. Leather and leather goods (611, 612) (MG, Northeast China).

It is important to note, especially for the discussion of future prospects below, that the above list ignores any marketing constraints now in place (voluntary restrictions, direct quotas, marketing agreements, tied distribution networks, etc.). Also the role of transportation costs is not considered, which can be important for some bulky goods or goods which require timely delivery, either producer goods or goods with short seasonal markets. Finally, while weeded out for now, the slow growth categories may turn around, and they include some products that have a very clear regional comparative advantage in Northeast Asia. Where that is so, someone should be watching and monitoring the products involved.

Table 3.10 presents the SITC categories that have a comparative advantage for one or more developing countries at present but not a regional comparative advantage and that survived the same three filters discussed above. Most of these might be expected to evolve a regional comparative advantage in the next decade with capital accumulation and experience. Where that appears likely, that fact is indicated by an "N" in the left—hand column. The structure of this group is somewhat different than for those in Table 3.9. Of the eighteen 3 digit categories in the table, the largest single group, 6 in number, is in SITC 700, machinery and transportation equipment, followed by the food and live animal group with 5 members.

The general category of simple non—electric machinery (742-749) is an important inclusion in Table 3.10 along with small metal objects (694-699: tools, nails, screws, nuts, bolts). The first now has a comparative advantage in Northeast China and the second in Northeast China and North Korea. Both promise a regional comparative advantage with growth, have relatively low technology requirements, are basically labor—intensive, and are among the sectors that provide an input basis for the next stage of development. The markets for these products are also quite large. Civil engineering (723) may be of special importance to the transition from military to civilian activities in the Russian Far East. The agricultural—based products included here (014, 054-57, 081 and 098) are the basis for many brand name shelf

Table 3.9 NEA selected comparative advantage (3 digit SITC basis)

SITC #	Share in total w. exp's	Export growth class	Description of the SITC number
034	0.41	VF	Fish, fresh, chilled or frozen
036	0.36	VF	Crustaceans and mollusks-all forms
612	0.08	VF	Manufactures of leather or of composition leather, nes
714	0.57	VF	Engines and motors, non-electric
037	0.18	F	Fish, crust"s and mollusks, prepared or preserved, nes
048	0.22	F	Cereal preparations and preparations of flour or starch of fruits and veg's
112	0.53	F	Alcoholic beverages (especially beer)
251	0.51	F	Pulp and waste paper
431	0.13	F	Animal and vegetable oils and fats, processed and waxes
611	0.26	F	Leather
634	0.29	F	Veneers, plywood, improved or reconstituted wood
635	0.20	F	Wood manufactures, nes
641	1.43	F	Paper and paperboard
642	0.36	F	Paper and paperboard, cut to size or shape
663	0.25	F	Mineral manufactures, nes
664	0.26	F	Glass
665	0.19	F	Glassware
666	0.13	F	Pottery
684	0.86	F	Aluminum
686	0.09	F	Zinc
713	1.07	F	Internal combustion piston engines
772	0.94	F	Electrical apparatus such as switches, relays, fuses and plugs
893	0.72	F	Articles of material described in division 58 (plastics)

Table 3.9 (continued)

SITC #	Share in total w. exp's	Export growth class	Description of the SITC number
			Categories filtered out
035	<0.07	?	Fish, dried, salted or in brine; smoked fish
046	<0.07	?	Meat and flour of wheat and flour of meslin
047	<0.07	?	Other cereal meals and flours
271	<0.07	?	Fertilizers, crude
245	<0.07	?	Fuel, wood and wood charcoal
246	<0.07	?	Pilpwood (including chips and wood waste)
286	<0.07	?	Ores and concentrates of uranium and thorium
613	<0.07	?	Fur skins, taned or dressed, pieces or cuttings
685	<0.07	?	Lead
687	<0.07	?	Tin
688	<0.07	?	Uranium depleted in u235, thorium and alloys
689	<0.07	?	Misc. non-ferrous base meals used in metallurgy
711	<0.07	?	Steam and other vapor generating boilers, and parts
712	<0.07	?	Steam and other vapors power units, steam engines
248	0.58	S	Wood, simply worked, and realway sleepers of wood
661	0.19	S	Lime, cement, and fabricated construction materials
662	0.21	S	Clay construction materials and refactory constr. mats.
682	0.55	S	Copper
785	0.25	S	Motorcycles, motor scooters and invalid carriages
247	0.22	N	Other wood in the rough or roughly squared
281	0.26	N	Iron ore and concentrates
287	0.42	N	Ores and concentrates of base metals, nes
334	2.55	N	Petroleum products, refined
683	0.07	N	Nickel
681	0.22	VN	Silver, platinum, and other merals of the platinum group
333	5.58	VVN	Petroleum oil, curde, and crude oils obtained from bituminous minerals

Source: UNCTAD (1992)

VVVF≥20%; VVF = 15 to 19.9%; VF = 10 to 14.9%; F = 4.2 to 9.9%; S = 0.0 to 4.1%; N = 0.0 to 4.9%; VN = 5.0 to 9.9%; VVN ≤ -10%.

Table 3.10 Regions in NEA selected comparative advantage (3 digit SITC basis)

N=future cmp adv NEA	SITC #	Share in total w. trade	Export growth class	Description of the SITC number
N	014	0.12	F	Meat and edible meat offals, prepared or preserved, nes; fish extracts
N	054	0.45	F	Vegetables, fresh, chilled, frozen or simply preserved, roots, tubers
—	0.57	0.58	F	Fruit and nuts (excluding oil nuts), fresh or dried
N	081	0.51	F	Feeding stuff for animals (excluding unmilled cereals)
?	098	0.21	F	Edible products and preparations, nes.
N	511	0.54	F	Hydrocarbons, nes, and their halogenated or derivatives
?	551	0.10	F	Essential oils, perfume and flavor materials
N	592	0.12	F	Starches, inulin and wheat gluten, albuminoidal substances
N	694	0.18	F	Nails, screws, nuts and bolts or iron, steel or copper
N	695	0.36	F	Tools for use in hand or in machines
N	699	0.65	F	Manufactures of base metals, nes
?	723	0.56	F	Civil engineering and contractors plant and parts
N	742	0.30	F	Pumps for liquids, liquid elevators, and parts
N	743	0.52	F	Pumps, compressors, fans, and blowers
N	744	0.57	F	Mechanical handling equipment, and parts
N	745	0.51	F	Other non-electical machinery, tools, apparatus, and parts
N	749	0.96	F	Non-electric accessories of machinery
—	812	0.24	F	Sanitary, plumbing, heating and light fixtures
—	0.12	<0.07	?	Meat and edible meat offals, fresh, chilled or frozen
N	091	<0.07	?	Margarine and shortening

Table 3.10 (continued)

N=future cmp adv NEA	SITC #	Share in total w. trade	Export growth class	Description of the SITC number
—	223	<0.07	?	Oil seeds and oleaginous fruit whole or broken
N	267	<0.07	?	Other man-made fibers suitable for spinning; waste
—	411	<0.07	?	Animal oils and fats
N	424	<0.07	?	Other fixed vegetables oils, fluid or solid, crude, refined or purified
N	532	<0.07	?	Dyeing and tanning extracts, synthetic tanning materials
—	572	<0.07	?	Explosives and pyrotechnic products
?	688	<0.07	?	Uranium depleted in u235, thorium and alloys
Fu	056	0.16	S	Vegetables, roots and tubers, prepared or preserved, nes
—	222	0.38	S	Oil seeds and oleaginous fruit (excluding flours and meals)
N	562	0.42	S	Fertilizers, manufactures
N	721	0.25	S	Agricultural machinery and parts
N	951	0.22	S	Armored fighting vehicles, arms of war and ammunition
N	722	0.21	N	Tractors fitted or not with power take-offs

Source: UNCTAD (1992).

VVVF ≥ 20%; VVF = 15 to 19.9%; VF = 10 to 14.9%; F = 4.2 to 9.9%; S = 0.0 to 4.1%; N = 0.0 to -4.9%; VN = -5.0 to -9.9%; VVN ≤-10%.

Table 3.11 Selected comparative advantage in future (3 digit SITC basis)

N=future cmp adv NEA	SITC #	Share in total w. trade	Export growth class	Description of the SITC number
—	759	0.19	VVVF	Parts of and accessories suitable for date processing mach. and office mach.
N	775	1.60	VVF	Household type electrical and non-electrical equipment
N	583	1.31	VF	Polymerization and copolymerization products (plastic base)
—	726	0.29	VF	Printing and bookbinding machinery, and parts
—	763	0.54	VF	Gramphones, dictating and sound recorders
N	821	0.81	VF	Furniture and parts thereof
N	895	0.12	VF	Office and stationary supplies, nes
—	058	0.26	F	Fruit, preserved, and fruit preparations
N	022	0.29	F	Milk and cream
N	024	0.24	F	Cheese and curd
N	233	0.16	F	Synthetic rubber latex; syn. rubber and reclaimed rubbr; waste and scrap
N	531	0.22	F	Synthetic organic dyestuffs, etc., natural indigo and color lakes
N	533	0.32	F	Pigments, paints, varnishes and related materials
—	541	1.05	F	Medicinal and pharmaceutical products
—	554	0.18	F	Soap, cleansing and polishing preparations
N	591	0.22	F	Disinfectants, insecticides, fungicides, weed killers
N	598	0.61	F	Miscellaneous chemical products, nes
—	653	0.59	F	Fabrics, woven, of man-made fibers
N	724	0.66	F	Textile and leather machinery and parts

Table 3.11 (continued)

N=future cmp adv NEA	SITC #	Share in total w. trade	Export growth class	Description of the SITC number
N	725	0.17	F	Paper and pulp mill machinery, machinery for manufactures of paper
—	736	0.67	F	Machine tools for working metal or metal carbides, and parts
—	737	0.19	F	Metalworking machinery and parts
N	741	0.60	F	Heating and cooling equipment, and parts
—	751	0.35	F	Office machines
—	761	0.37	F	Television receivers
—	762	0.36	F	Radio broadcast receivers
—	773	0.33	F	Equipment for distributing electricity
—	851	0.83	F	Footwear
—	874	1.08	F	Measuring, checkiing, analyzing instruments
				Questioned Possibilities (see text)
N	512	0.24	F	Alcohols, phenols, phenol-alcohols, and their derivatives
N	513	0.31	F	Carboxylic acids, and their anhydrides, halides and derivatives
N	514	0.45	VF	Nitrogen-function compounds
N	515	0.36	F	Organo-inorganic and herocyclic compounds
N	516	0.21	F	Other organic chemicals
N	522	0.36	F	Inorganic chemical elements, oxides, and halogen salts
N	523	0.25	F	Other inorganic chemicals
N	524	0.21	S	Radioactive and associated materials

Table 3.11 (continued)

N=future cmp adv NEA	SITC #	Share in total w. trade	Export growth class	Description of the SITC number
N	842	0.49	F	Outer garments, men's, of textile fabrics
N	843	0.71	F	Outer garments, women's, of textile fabrics
N	844	0.19	VF	Undergarments of textile fabrics
N	845	0.74	VF	Outer garments and other articles, knitted
N	846	0.31	VF	Undergarments, knitted or crocheted
N	847	0.13	VF	Clothing accessories of textile fabrics
N	848	0.3	VF	Articles of apparel and clothing accessories, non textile
				Categories Filtered Out
N	584	≤0.07	?	Regenerated cellulose; cellulose nitrate and other cellulose esters
N	585	≤0.07	?	Other artificial resins and plastic materials
N	696	≤0.07	?	Cutlery
—	873	≤0.07	?	Meters and counters, nes
N	023	0.12	S	*Butter*
N	266	0.15	S	Synthetic fibers suitable for spinning
—	423	0.17	S	Fixed vegetable oils, soft, crude, refined or purified
N	693	0.10	S	Wine products and fencing grills
N	697	0.19	S	Household equipment of base metal, nes
N	335	0.15	N	Residual petroleum products, nes, and related materials

Note: Growth definitions same as in tables 3.9 and 3.10

Source: UNCTAD (1992)

products, and it is possible that Mongolia and/or Northeast China could become producers on contract for these brand name suppliers, for sales both inside and outside the region. Again, this list and my comments are meant to be suggestive. I may have overlooked some important possibilities or ignored some important problems, but my main concern is to provide some raw materials to stimulate a needed discussion.

DYNAMIC COMPARATIVE ADVANTAGE—SOME CONJECTURES AND EXAMPLES

Using the same filters as before, Table 3.11 presents the 3 digit SITC categories where I deem there is no present comparative advantage, but in which one could develop with growth and economic reform. These are areas where government support (especially information) may be highly useful and in which foreign capital and technology may be a necessary partner. Although in some instances the basis is already there, and only more experience (and more competition) is needed to bring out the latent comparative advantage. Again, those I expect to achieve a regional comparative advantage are indicated by an "N" in the left—hand column.

The list of such products is lengthy; with 28 in total plus fifteen more I am less certain about. Of the twenty—eight, thirteen are in the machinery and transport equipment group, which traditionally improves with development, especially at the middle—level technology the group selected here mostly represents (736, 737, 741, 751, 773). Also likely to be important in the future is the production of machinery for categories in which Northeast Asia or some part of Northeast China already has a comparative advantage (724, 725, 726) or that responds at a manageable technological level to the data processing revolution (759). Finally this group of potential future success stories includes some simple consumer goods in worldwide demand and where production for owners of brand names is possible or the market has been deserted by advanced countries (775, 761, 762—TV sets, radios, and sound recorders). Northeast China could develop a comparative advantage in any of the products discussed and North Korea could do so in many. The Russian Far East could also find niches in this category at several possible entry points.

The second most important group in this future listing is the Chemicals group, where several petro—chemical derivatives appear based on those found in Northeast China and therefore the region's basic fossil fuel comparative advantage (233, 583, 531, 531, 591). It may seem surprising that more products from the labor—intensive SITC 800 category were not selected, but the comparative advantage in the most labor—intensive of these products will probably bypass Northeast Asia, skipping to parts of Southeast and South Asia. The labor—intensive products that did survive seem particularly well—suited to the region. For example, furniture (821) and stationery supplies (895) are both natural extensions for the Russian Far East based on its forest resources of both hard and soft woods. Also, they are among the fastest growing sectors in world trade. Also footwear (851), which could develop competitively in any or all of Mongolia, Northeast China, or North Korea presents a very large and fast—growing market, although one that would presently be quite competitive with South Korea. That is a good sign in terms of future relocation, since this industry

is not likely to retain a comparative advantage in South Korea with continued growth in real wages. Also fast—growing and large are the markets represented by the many components of the technical instrument industry (874), which could fit present factor endowments in the Russian Far East quite well.

A second group of products, which I label the Question group, is also presented in Table 3.11. The first part covers several chemical products whose basic inputs are frankly somewhat of a mystery to me. I think several may find a home in Northeast Asia, but I cannot be certain. They are all products with large world markets and, except for radioactive materials, with fast growth. Perhaps the participants at this conference can fill my information gap. The other category of products I included in the Question group covers all the SITC garment sectors, obviously—see Table 3.11—one of the fastest—growing components of trade. It is perhaps true that South China and Southeast and South Asia have the undergarment and cotton—based outer garments markets, short of high fashion, very well tied up, as they should on comparative advantage grounds. However, South Korea retains a large share of exports in these categories which must at some point leave or adapt to high fashion production. As with footwear, there is no reason why some of South Korea's relatively labor—intensive garment production could not relocate to North Korea or Northeast China.

More directly, Northeast Asia should have a comparative advantage in the production of woolen and knit garments for outerwear as well as silks and satins for the same purpose. Brand names would be difficult to establish, but there is a possibility for contract work and for distinctive Northeast Asian styling. Clothing accessories may also offer opportunities. This gives a rationale for exploring a finer breakdown of these 3 digit categories. In fact, taking a look at the sub—categories of every one of the 3 digit product classifications is a necessary next step. Considerations of comparative advantage help in selecting where to look, but that only begins the task for either private business or government.

MARKETING ISSUES

This section is somewhat of an aside, but it introduces a major issue that has yet to be discussed in consideration of the proposed regional free trade or, more correctly, export promotion zones. Building a better mousetrap is not enough to guarantee sales, especially for consumer goods. Bulk products, whether basic raw materials or semi—fabricated (e.g., textiles) primarily require that potential buyers know of their availability and specifications. Such products must meet certain widely set product standards. So, in marketing, attention to quality control and the dissemination of information are the key factors. Provision must be made for both. Goods, produced to order, whether producer or consumer goods, also must generally meet a set of specifications and minimum quality standards. Here again initial marketing involves primarily the provision of information, for the rest of the marketing process will be carried out by the ordering firm. The main problem here is in closing the initial information gap. One way to do so is through the act of setting up and publicizing free trade zones and attracting self—selected joint ventures producing brand name

products (e.g., Phillips TV sets in North China) or to specification industrial inputs (as the Japanese/Chinese factory I recently visited in Tianjin was doing for Chrysler).

As soon as production for sale firms are considered, there is a major marketing problem. This will be least where the products are producer goods that sell to a technically knowledgeable market, but it is still a formidable task to get the information needed to the purchasing agents that make the buying decisions. Product fairs, brochures, and selling agents can be used, but considerable capital may be needed to cover the time lags involved in getting established. These considerations are strong arguments for allowing international trading companies and financial intermediaries into any free trade zone established in the region. Production intended to attract orders for consumer goods produced for established labels is similar in the initial marketing and would also benefit from the aid of international trading companies and financial institutions.

Most difficult is trying to establish a shelf—recognizable brand for sale in retail or wholesale outlets. Not only must the name be established, but also the difficult problem in many countries of breaking into established distribution networks must be faced. In effect, these considerations have ruled out the selection of such products in my comparative advantage list for Northeast Asia and would similarly limit what can be expected from production in or as spin—offs from any free trade zone, including the Tumen River project. Only where a brand has been established in a large domestic market, as Northeast China in developing Northeast Asia, and with the close cooperation of international trading companies and financial services can new entrants from developing countries achieve this source of comparative advantage and then only with relatively high start up costs.

A BRIEF ACTION—ORIENTED RESEARCH AGENDA

Obviously there is much to be done. In closing, I would like to suggest that a program of business or product research be established to guide in more detail the private and public decisionmakers now or in the future likely to be involved in establishing regional cooperation and joint ventures in developing Northeast Asia. It is important to break down the categories I have discussed into their component parts, searching for the kinds of products that best fit the region's present and potential comparative advantage. Information about labor requirements including skill and educational levels, machinery requirements and working capital needs, and distribution networks and marketing approaches has to be developed for a broad range of products selected in the foregoing manner and then related to local conditions. Similar investigation into the supporting services needed, from infrastructure to financial and legal, needs to be done as does the determination of unwanted environmental effects or necessary ancillary inputs (e.g., water of a certain purity and importance of uninterrupted electrical supplies). Transportation costs need to be ascertained and related to the delivery cost structure and times for any products selected. Finally, a rough calculation of the expected rate of return for different time horizons and based on the above considerations needs to be calculated for all products selected, at both existing and shadow prices.

Once the above information is complete, the region can hunt for firms producing the products that appear profitable, socially desirable (e.g., meet shadow price profitability tests), and environmentally sound. Ideally the market should do all this for you, but it probably won't. The information gap is too large, and the main companies with a strong incentive to close it are firms that are having difficulty making it in developed country markets or underdeveloped country environmental constraints and are looking for a subsidy of some sort. Northeast Asian governments will have to take the responsibility of providing the information base required and making certain it gets the attention of desirable producers.

NOTES

1. For some purposes we will consider only the mainland portion of the region, excluding Japan. For other purposes we will consider only the developing portion of the region, excluding both South Korea and Japan.
2. Since the evaluation is in current US$ terms, if any year later than 1985 were used, the index numbers for Japan and South Korea would be greatly increased, and the number for the U.S. would be greatly reduced as a result of the depreciation of the dollar. China's index would also be reduced, but not very much since its value depends primarily on China's large population.
3. All the 3 digit SITC product classifications were assigned to various matrix cells. This was based on whatever information was readily available about production requirements and in many cases was outright guesswork. Readers should check my classification against their own knowledge. This is a major area for substantive and useful research if regional cooperation is to be given more than lip service.
4. China would be expected to have long—run exports in this sector, but not a share greater than the sector's share in world trade. This may reflect the effects of liberalization in the agricultural sector. If so, liberalization elsewhere is likely to reduce the share of agricultural exports below the world level.
5. In overall exports structure Liaoning has 71 percent of its exports in heavy industry while Jilin has a much larger share (63 percent) in agriculture and agricultural by—products with only 14 percent in heavy industry. Heilongjiang also emphasizes agricultural exports (56 percent) with soybean and coal topping the list. As in Jilin light industry accounts for 23 percent, including color T.V. Inner Mongolia, not shown in the table, has a greater emphasis on light industry in its exports along with meat products and a relatively large amount of border trade with the USSR. Except for Liaoning which accounts for an impressive 11 percent of China's current exports (42 percent goes to Japan) the others have less than average (3.3 percent) provincial shares in China's exports.
6. In making the final selection, the labor skills learned from the current structure of production and of exports, even if both were not along the lines of expected comparative advantage, were also given consideration. All SITC categories from the cells in which Northeast Asia or a Northeast Asian country or sub—region have a comparative advantage and that have been deleted for the foregoing reasons are given in Appendix Table 3.3.
7. The smallest market share for which growth data were available was 0.08. So we have no way of classifying by growth experience for the SITC categories involved.
8. This introduces an input—output dimension to possible markets for the goods in each SITC class that could be explored. Unfortunately, lack of data preclude this approach at present.

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