Dynamic Comparative Advantage: Implications for China

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Over the last two decades the structure of the Chinese economy has transformed rapidly. The transformation has had a significant impact on other economies, particularly as Chinese exports maintain their global ascendance. The economic threats and opportunities posed by China will continue to change over time. Yet very little research has been conducted on the economic forces that spur the transformation of China's economic structure. We present a model of the forces underpinning China's evolving economy, investigating the determinants of China's progression through key economic stages, including the initial transition from agriculture to manufacturing. To highlight the speed of structural transformation we analyze data from 1985-2003. Our forecasts suggest that while China currently has a comparative advantage in labor-intensive manufacturing, comparative advantage is likely to shift to capital-intensive industry early in the next decade.

Key words: *Flying Geese model, comparative advantage, China*

JEL classification: *O41, O53, P27*

INTRODUCTION

Exporters from small, open economies increasingly realise that as global markets evolve, they must have the flexibility to respond quickly and decisively. Continually updating knowledge of overseas markets and anticipating change are pivotal elements of trade success. The more that exporters adopt a static view of comparative advantage, the greater the risk of losing trade share as global markets develop and evolve. This paper suggests a forward-looking framework for considering *dynamic* comparative advantage. If systematic mismatches of changing demand and supply can be predicted in an overseas market, then exporters can prepare themselves for future trade openings. We outline a simple and intuitive framework, known as the flying geese model, that summarises the supply side of a foreign market. The model explains how developing

economies tend to move through distinct economic stages or structures, from agriculture to labor-intensive manufacturing to capital-intensive manufacturing, and so on (Akamatsu 1962, Adams and Shachmurove 1997, Erturk 2002, Ray et al. 2004). The changing composition of output has implications for a country's exports and imports, giving rise to changing patterns of trade (eg, see Perkins 1994). The primary concern of this paper is to offer insights into the dynamics of a country's progression through the production stages. In so doing, we hope to offer new insights into evolving comparative advantage, using China as an illustration. China's astounding trade performance since the beginning of its reforms to the present day, the impact of its exports and imports on the major economies of the world, and the prospect of a transition from export growth based on labor-intensity to capital- and technology-intensity (Lai 2004) make China a timely and important illustration of dynamic comparative advantage.

On the surface, the flying geese pattern of structural change and trade is relatively straightforward to discern (Dowling and Cheang 2000). From the pattern certain stylized facts emerge for major developing countries such as China. Overall, labor-intensive activity has been growing strongly since the early to mid-1980s to now dominate China's production structure. Given its labor abundance, China has a comparative advantage in labor-intensive manufactures (Adams and Shachmurove 1997, Kwan 2002a). Using specialization indices as a proxy for comparative advantage, Kwan (2001) shows that China's early post-reform growth in labor-intensive manufacturing occurred during a period in which the sector had a negative specialization index. The rise in labor-intensive manufacturing was accompanied by a declining share of agriculture in GDP, even though agriculture had a much stronger revealed comparative advantage than manufacturing at the time. The stylized facts thus suggest a number of questions. Why might a sector grow, with the growth driven principally by market forces, when a country does not have an initial comparative advantage in the sector? Could the transition between economic stages in the flying geese model *cause* a change in comparative advantage? For example, could the economic forces that drove the growth of labor-intensive manufacturing, even when China did not have a comparative advantage in it, nevertheless have contributed to the eventual shift of comparative advantage to the sector? And if labor abundance currently drives China's comparative advantage, how can we explain the rapid ascendance of manufacturing over agriculture in both GDP and export share, when both are labor-intensive?

Our paper offers a theoretical and empirical link between observed patterns of economic development, particularly the transition between economic stages or structures, and revealed comparative advantage. We seek to demonstrate that the economic stages in the flying geese model are connected, at least for China's agriculture and labor-intensive manufacturing. For China the transition from agriculture to manufacturing eventually led to revealed comparative advantage shifting from agriculture to labor-intensive manufacturing. We suggest that the shift in comparative advantage resulted from predictable, underlying economic characteristics of the sectors in general.

The paper begins with a general overview of the flying geese model. This is followed by a model of transition from one economic stage to another. Using specialization indices, we show that China's revealed comparative advantage shifted away from agriculture in favor of labor-intensive manufacturing by the early 1990s and persists to the present. This claim is supported by an examination of China's current export successes, which are primarily grounded in labor-
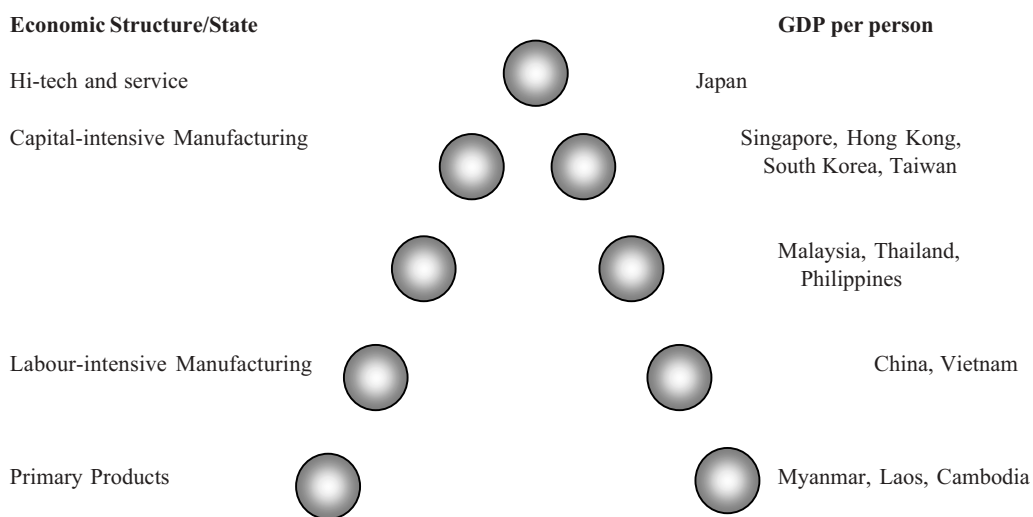
intensive industry (Rowen 2001, Kwan 2002b, Lai 2004). Finally, we undertake forecasts to estimate when China may move from its current comparative advantage in labor-intensive manufacturing to the next stage in the flying geese model, namely capital-intensive industry.

THE FLYING GEESE MODEL

Figure 1 depicts a schematic flying geese pattern, where the position of each country is based loosely on GDP per person and economic structure (or stages of development). Japan is Asia's lead goose; Singapore, Hong Kong, Taiwan and South Korea occupy the second tier; and so on, with China as a latecomer goose (Ozawa 2001). The left hand side of the figure reflects the changing composition of a country's economy as it moves sequentially to higher stages over time, and therefore represents the *supply* side of the economy. The right hand side ranks countries according to GDP per person. According to World Bank statistics for 2003, Japan had a per capita gross national income of US$34,180, ranking it first in Asia. South Korea had US$12,030; Malaysia, US$3,880; Thailand, US$2,190; and China, US$1,100 (World Bank 2005). Here, income elasticities of demand can be very useful in predicting changing *demand* patterns as countries move upwards and increase their per capita GDP. Gaps between the supply and demand sides create opportunities for trade cycles to emerge. By anticipating how the stages evolve within a country, exporters will be better placed to anticipate new markets and adjust their business strategies as new doors open and old ones close.

We explore the progression through the broad production stages of the flying geese model, that is, the left hand side of Figure 1, focusing on two competing explanations: intersectoral complementarities and changing comparative advantage. In its original conception, the model refers to a sequential development of sectors in developing economies. It relates the economic development of latecomer countries to more industrialized ones via domestic interindustry complementarities or linkages (Akamatsu 1962). In terms of a catch-up framework, imports of

Figure 1
An Asian Flying Geese Pattern

Economic Structure/State	GDP per person
Hi-tech and service	Japan
Capital-intensive Manufacturing	Singapore, Hong Kong, South Korea, Taiwan
	Malaysia, Thailand, Philippines
Labour-intensive Manufacturing	China, Vietnam
Primary Products	Myanmar, Laos, Cambodia

productivity-enhancing industrial inputs and technologies from advanced countries accelerate the growth of the late-comer's dominant sector, such as agriculture. Agricultural growth spurs demand for the imported products, in turn stimulating domestic production of the industrial products (eg, see Akamatsu 1961). Over time the structure of the domestic economy changes with the ascendance of an industrial sector. Importantly, the structural change results from *intersectoral complementarities*, not changing comparative advantage. International trade may have provided the impetus to agricultural growth, but the rise in incomes implied by the growth establishes resource and demand linkages with industry, which grows in turn.

More recent contributions to the flying geese model emphasize the role of comparative advantage. Kojima (2000 and 2003) discusses foreign direct investment flows from developed to developing countries based on changing comparative advantage (see also Blomqvist 1996). Wage rises in the developed, donor country lead to FDI flows to lower wage, developing economies. With the donor country's loss of international competitiveness in cheap labor, for example, production of labor-intensive products shifts to an economy on a lower tier in the flying geese pattern. The recipient country expands its labor-intensive industrialisation stage as labor and other resources shift out of its primary production (Lim 2002). Industrialization accelerates as capital, technology and managerial expertise flow from the donor country to the host country (Kojima 2000).

However, China's transition from agriculture to labor-intensive manufacturing was dominated not by FDI flows, but by the mobilization of domestic resources and the promotion of beneficial, self-reinforcing linkages between agriculture and industry (Islam 1991, Shi et al. 1993). China's movement between the two economic stages broadly followed Akamatsu's (1962) intersectoral complementarity conception of the flying geese model. Nevertheless the evolving nature of comparative advantage, based in part on labor abundance, must also be acknowledged in China's economic transition. It is the synthesis of the intersectoral complementarity and comparative advantage approaches that we now develop.

CHANGES ON THE SUPPLY SIDE:
AGRICULTURE AND MANUFACTURING LINKAGES

Given the spontaneous economic forces underpinning changing comparative advantage, we model structural changes by focusing on China's agricultural and labor-intensive (rural) industrial sectors. Agriculture was liberalized in 1979 and rural industry in 1985, allowing predominantly market forces to determine movement between the flying geese stages and subsequent changes in comparative advantage. (At that time, the capital-intensive industrial sector was still heavily controlled by the state plan.) As we show in the following section, China's comparative advantage, as measured by specialization indices, shifted from agriculture to labor-intensive manufacturing by the early 1990s and remains there to the present day.

We begin by considering the early reform period, particularly the early 1980s. China had abundant labor, some land and other natural resources, but relatively less capital in agriculture. Agriculture was the first major sector to be liberalized under the reforms, with prices becoming increasingly freed and land leased to individual households. The labor-intensive rural industrial sector continued to be suppressed by the state planning mechanism that accorded priority to

food production. The fear was that growth in rural non-farm enterprises would draw labor away from farms, compromising the state's food self-sufficiency objective. But the strong impact of the agricultural reforms on food production (Lin 1992) offered greater leeway for the government to relax its controls over the non-farm rural sector. By 1985 the Chinese liberalized the rural industries, allowing labor to flow from agriculture to non-farm township and village enterprises (TVEs).

A mutualistic relationship emerged between agriculture and the newly-liberalized TVEs. The initial government decollectivization of agriculture facilitated the growth of a virtuous circle of higher farm incomes, more farm investment, higher incomes, and so on. The labor-saving farm investments released labor from agriculture, allowing their transfer to rural manufacturing enterprises. The surplus savings by farmers generated from their rising incomes could be channelled into manufacturing start-ups. Agriculture also provided demand linkages with rural enterprises, which supplied farmers with, among other things, farm implements, simple consumer goods, and construction and transport services. As manufacturing grew, it generated more employment, drawn from agriculture (Findlay, Watson and Wu 1994), and raised off-farm incomes. Part of the rising incomes were spent on or remitted to the agricultural sector. Farm incomes rose and farmers were able to increase their expenditures on inputs provided by manufacturing. A further virtuous circle emerged in which manufacturing and agriculture expanded in tandem (eg, see Byrd and Lin 1990; Findlay and Watson 1992; Sicular 1992; Ratha, Singh and Xiao 1994; Islam and Jin 1994; Lin 1995). Eventually a comparative advantage emerged in labor-intensive manufactures (Kwan 2001).

We formalize the above in the following model. Denote the number of farms in the agricultural sector by $A(t)$, where all farms in the sector are assumed to be identical and produce the same quantity of output. Associated with any given $A(t)$ there is thus a corresponding sectoral output or income. Let the sector grow based on an intrinsic, per unit rate of r_A, which reflects the rate at which the sector would grow in isolation (ie, without the inhibiting or beneficial impacts from other sectors). This rate may depend on factors such as the macro-or microeconomic environment, including the institutional setting governing production incentives.

As growth in economic activity consumes available resources, a physical limit to the number of farms that may exist in agriculture is approached. Refer to this physical limit as the carrying capacity or potential sectoral size, $\overline{A}$ (>0), defined as the maximum number of farms that resources in agriculture, in isolation, may support indefinitely. The logistic growth of the agricultural sector is given by:

$$\dot{A} = r_A(1 - \frac{A}{\overline{A}})A = (r_A - a_A A)A, \qquad \qquad ...(1)$$

where the dot represents the time derivative and $a_A = r_A / \overline{A}$. Note that the term $(1 - A/\overline{A})$ in equation (1) reflects *intrasectoral competition*, modifying the sector's growth rate. For example, as the number of agricultural firms, $A(t)$, approaches the potential, $\overline{A}$, the per unit growth rate, denoted now by $r_A(1 - A/\overline{A})$, tends to zero.

Now consider a mutually supportive or complementary articulation between agriculture and labor-intensive manufacturing (hereafter denoted simply as manufacturing). Let *M(t)* represent the number of manufacturing firms, such that:

$$\dot{A} = (r_A - a_A A + a_M M)A$$

$$\dot{M} = (r_M - m_M M + m_A A)M. \qquad \qquad ...(2)$$

The intrasectoral competition coefficient for manufacturing is denoted by $m_M = r_M / \overline{M}$, where r_M is the intrinsic growth rate of manufacturing and $\overline{M}$ (>0) is the potential sectoral size.

The terms a_M and m_A represent the respective intersectoral interaction coefficients, both of which are assumed to be strictly positive. The interactions are beneficial: m_A, for example, shows the positive effect of a production unit from agriculture on a unit in manufacturing, such as when agricultural growth releases surplus farm labor to factories. In the following, we assume that only surplus labor transfers from agriculture to industry, such that the labor redeployment implies no change in $\overline{A}$. This corresponds to China's case, where the urban household registration system placed restrictions on labor outflows from agriculture to urban areas in the transitional period of the 1980s.

The non-trivial equilibrium for the system (2), $E = (A^*, M^*)$, is given by:

$$A^* = \frac{\overline{A} + \alpha \overline{M}}{1 - \alpha\beta}$$

$$M^* = \frac{\overline{M} + \beta \overline{A}}{1 - \alpha\beta}, \qquad \qquad ...(3)$$

where $\alpha = a_M / a_A$ and $\beta = m_A / m_M$.

*(*A non-trivial solution to $\dot{A} = 0$ implies that $r_A - a_A A + a_M M = 0$. A similar condition holds for $\dot{M} = 0$, yielding $M = (r_M + m_A A)/m_M$. Substituting this expression into the preceding expression yields the equilibrium value for *A*. Similarly for *M*.)

LEMMA Let the equilibrium, $E = (A^*, M^*)$, be stable. Then $0 < \dfrac{a_M m_A}{a_A m_M} < 1$.

Proof. To determine the stability of *E*, let $A = A^* + A_1$ and $M = M^* + M_1$, where A_1 and M_1 are small. Linearize the system (2) in the neighborhood of *E*, taking the first two terms of a Taylor series:

$$\dot{A}_1 = aA_1 + bM_1$$

$$\dot{M}_1 = cA_1 + dM_1.$$

The coefficients are the partial derivatives evaluated at *E*. For example, *a* is given by $\partial \dot{A}/\partial A = r_A - 2a_A A + a_M M$. When evaluated at the fixed point, and recalling that $r_A = a_A A - a_M M$ in equilibrium:

$$\left(\frac{\partial \dot{A}}{\partial A}\right)^* = -a_A A^*.$$

Thus we obtain:

$$\begin{pmatrix} \dot{A}_1 \\ \dot{M}_1 \end{pmatrix} = \begin{pmatrix} -a_A A^* & a_M A^* \\ m_A M^* & -m_M M^* \end{pmatrix} \begin{pmatrix} A_1 \\ M_1 \end{pmatrix}.$$

It is necessary to find eigenvalues, λ, satisfying:

$$\begin{vmatrix} -a_A A^* - \lambda & a_M A^* \\ m_A M^* & -m_M M^* - \lambda \end{vmatrix} = 0$$

$$\Rightarrow 2\lambda = -\left(a_A A^* + m_M M^*\right) \pm \sqrt{\left(-a_A A^* - m_M M^*\right)^2 + 4\left(a_M m_A A^* M^* - a_A m_M A^* M^*\right)}$$

Since the equilibrium is stable, it follows that $a_A m_M > a_M m_A$. Given that the constants are strictly positive, $0 < \dfrac{a_M m_A}{a_A m_M} < 1$.

Remark. The positive intersectoral interactions, a_M and m_A, are not stabilising. Stability derives from the self-regulatory effects, a_A and m_M.

PROPOSITION 1 (Complementary linkages) *Let each sector grow independently of the other sector. The maximum sizes of agriculture and manufacturing are $\overline{A}$ and $\overline{M}$, respectively. With mutually beneficial intersectoral articulation, $A^* > \overline{A}$ and $M^* > \overline{M}$.*

Proof. From (3), $A^* = \left(\overline{A} + \dfrac{a_M}{a_A}\overline{M}\right) \Big/ \left(1 - \dfrac{a_M m_A}{a_A m_M}\right)$. Since $0 < \dfrac{a_M m_A}{a_A m_M} < 1$ (Lemma),

$A^* > \overline{A}$. A similar result obtains for M^*.

Remark. Proposition 1 reinforces Akamatsu's (1962) view of intersectoral complementarities. The enhanced growth of manufacturing is the outcome of a positive stimulus from agriculture. In China's case, the agricultural reforms of the early 1980s led to strong output and productivity growth. Rising farm incomes allowed farmers to invest in labor-saving technologies, releasing labor to rural enterprises, and to channel greater savings to the emerging non-farm sector. This is summarized in the term m_A. The larger is m_A, the greater is the contribution of agriculture to manufacturing growth. The complementarities may lead to a structural transformation of the economy, ie, a shift from one stage to another in the flying geese model. Note, however, that the structural transformation in this framework is not due to changing comparative advantage *per se*. Indeed, as the following two propositions seek to show, it is the structural transformation that leads to changing comparative advantage. (An extension of this view relates to the actions of manufacturers based in China, who possibly respond to market liberalization and the eventual changes in comparative advantage by anticipating changes in world demand and supply patterns of manufactured goods. In effect, our approach of liberalization, structural change and evolution of comparative advantage sets the scene for a complementary, forward-looking, market-oriented approach on the part of domestic and foreign investors in taking advantage of the changes.)

DEFINITION Denote structural transformation, on the basis of an agricultural and industrial articulation, by an increase in X^*, the ratio of the equilibrium value of manufacturing, M^*, to agriculture, A^*.

PROPOSITION 2 (Structural transformation) *Let there be an increase in the positive feedback coefficient from agriculture to manufacturing (m_A), and a reduction in the positive impact of manufacturing on agriculture (a_M). Then the ratio of the equilibrium value of manufacturing to agriculture rises.*

Proof. From the Definition:

$$X^* = \frac{M^*}{A^*} = \frac{\overline{M} + \beta\overline{A}}{\overline{A} + \alpha\overline{M}} \qquad\qquad ...(4)$$

Recalling that the intrasectoral and intersectoral coefficients are strictly positive, as are the carrying capacities, it follows that $\partial X^*/\partial a_M < 0$ and $\partial X^*/\partial m_A > 0$.

Remark. As the manufacturing sector changes the composition of its output to supply fewer inputs to agriculture, the positive feedback coefficient from manufacturing to agriculture, a_M, falls. A given agricultural expansion now requires more of other inputs such as labor. All other things being equal, since this labor is no longer released to manufacturing, the agricultural expansion involves a higher opportunity cost in terms of manufacturing output foregone. An increase in the positive impact of agriculture on manufacturing, m_A, arises from resource transfers from agriculture. In China's case the rising farm incomes associated with the agricultural reforms facilitated investment in labor-saving technologies. Underemployed farm labor was released to manufacturing (Shi et al. 1993) at a low opportunity cost in terms of farm output foregone.

PROPOSITION 3 (Changing comparative advantage) *Assume comparative advantage initially lies with agriculture. Structural transformation (Proposition 2) implies a relative shift in comparative advantage from agriculture to manufacturing.*

Proof. An increase in the positive feedback from agriculture to manufacturing expands manufacturing at a low opportunity cost in terms of agricultural output foregone (see the previous Remark). A fall in the positive feedback from manufacturing to agriculture forces agriculture to expand at a higher opportunity cost. As manufacturing expands at a lower opportunity cost relative to that of an agricultural expansion, comparative advantage shifts towards manufacturing.

EMPIRICAL ANALYSIS: THE PACE OF STRUCTURAL CHANGE

The model in the preceding section explored the connections between sectoral complementarity and comparative advantage to explain progression through the flying geese pattern. Yet it sheds little light on the speed at which the progression takes place. To highlight the pace at which the Chinese were able to shift their comparative advantage from agriculture to labor-intensive manufactures, we consider specialization indices. For a given industry, a specialization index is given by a country's trade balance divided by the volume of two-way trade; ie,

$$Specialization\ index = \frac{Exports - imports}{Exports + imports}.$$

The index offers a rough guide to changing comparative advantage, as suggested by a country's trade structure. Strong comparative advantage in a product would predict a high ratio of exports to imports. For example, if exports of a product were \$100m and imports were \$0, the index would equal 1, the upper limit. The lower the index, the lower the level of exports relative to imports, and therefore the weaker the comparative advantage in the product.

Following Kwan (2001), we construct specialization indices for China. Figure 2 considers three main sectors: primary commodities (comprising food and live animals, beverages and tobacco, crude materials, fuels, and animal and vegetable oils and fats), other manufactures (chemicals and manufactured goods) and machinery (machines and transport equipment). 'Other manufactures' are a proxy for labor-intensive manufactured products, while 'machinery' proxies capital- and knowledge-intensive products (Kwan 2001). The data are from the Asian Development Bank-Key Indicators 2004 (*www.adb.org/statistics*).

By 1990/91, the specialization index for 'other manufactures' overtook that of primary commodities, even though the expansion of labor-intensive manufacturing effectively only began in 1985. Until the beginning of the rural industrial reforms, the Chinese economy had suffered from major sectoral imbalances. In the countryside the focus was mainly on grain production; in the cities heavy industry was emphasized. Light industry was a low priority, particularly consumer goods. The biased production structure changed dramatically from the mid-1980s with the liberalization of rural manufacturing. Light industrial growth boomed as agricultural and other resources shifted to more profitable rural enterprises. This is reflected in the rapid increase in the 'other manufactures' index between 1985-90, as labor and other

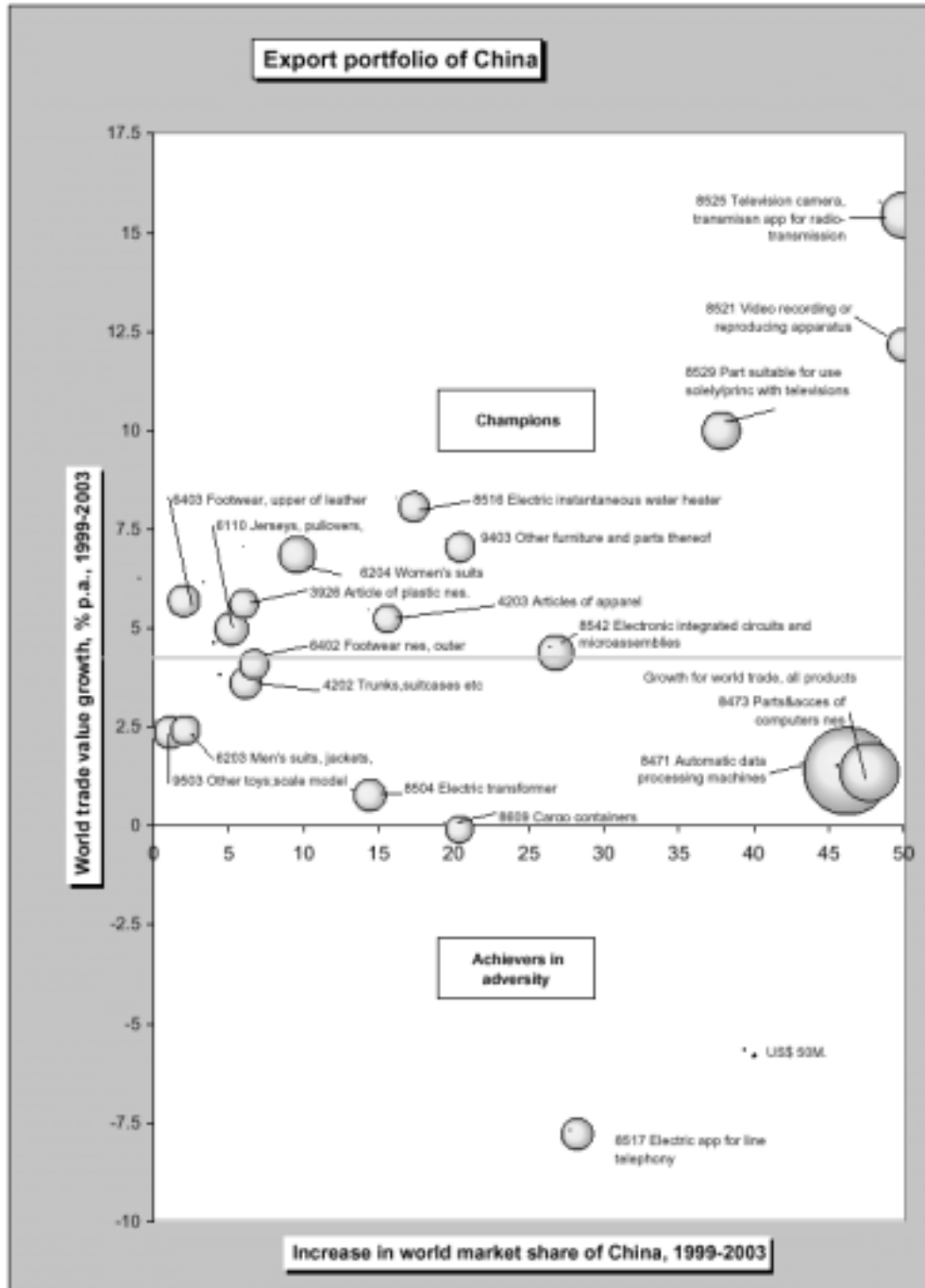**Figure 2**
Specialization Indices for China
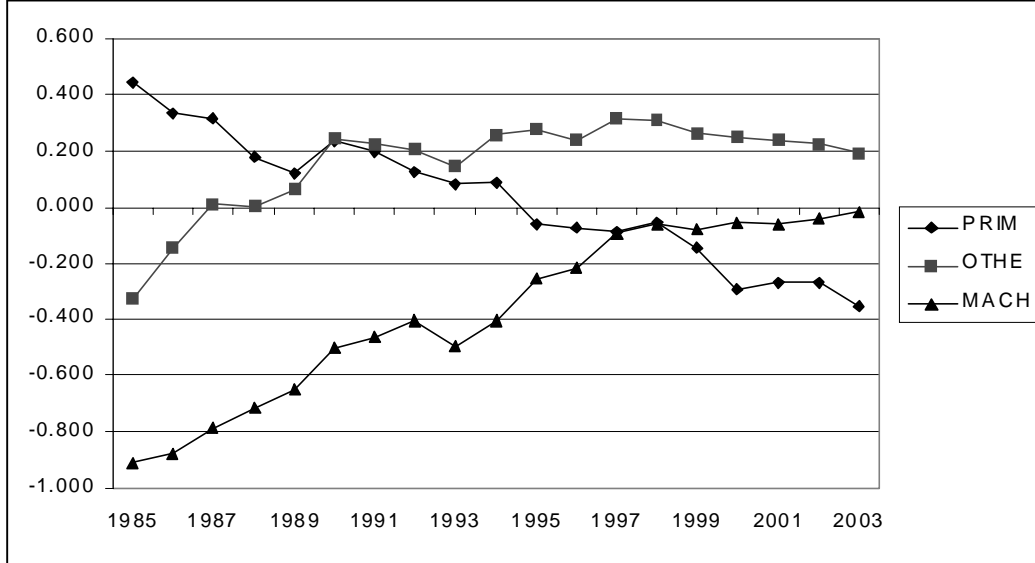
resources were drawn out of the 'primary' sectors following the liberalization of manufacturing. Perhaps even more remarkable is the rapid ascent of 'machinery' in the specialization stakes, hinting at possible future competition in heavy industry and technology with countries in higher tiers of the flying geese model.

ILLUSTRATIONS OF CHINA'S COMPARATIVE ADVANTAGE

We use China-Rest of World export data to disaggregate China's production structure predicted by the flying geese model and the specialization indices. The data and figures in this section are taken from the International Trade Center (ITC), an organization of UNCTAD/ WTO. Figure 3 below presents 'bubbles', whose size represents the value of important Chinese exports to the rest of the world. The industries selected for inclusion in the figure represent the 20 largest export industries for China at the 4-digit HS trade classification level.

The horizontal axis of Figure 3 represents the percentage change in China's world market share for a given product type. The vertical axis shows the percentage increase in world trade growth per annum (ie, growth in world demand), again for the product group under consideration. For both axes the per annum changes are averaged over the period 1999-2003. Note the horizontal reference line denoted 'Growth for world trade, all products'. This shows the average per annum growth in world trade for all product groups, which is slightly over 4% for the given period. This reference line, together with the vertical axis, defines four quadrants in the overall ITC framework (although only two are relevant for China in Figure 3). The quadrants are characterized by the ITC as Champions, Achievers in Adversity, Declining Sectors and Underachievers. For example, a Champion industry is one whose exports are winning an increasing

Figure 3
China's Labor-Intensive Champions

share of the world market for the product group, and where world trade in the product group is growing (eg, 9403 'other furniture and parts thereof').

Inspection of Figure 3 reveals that a large percentage of China's top 20 export industries fall within the Champions category. Of these the majority are produced by labor-intensive manufacturing processes (see Kwan 2002b). For example, about 60% of China's exports to Japan are labor-intensive and most of the rest are either low- or medium-technology (Economic Research Institute 2003). Japan is the leading market for three of China's top export product groups (6204 'women's suits,…', 6110 'jerseys,…', and 6203 'men's suits,…') (ITC 2005). Even when considering relatively hi-tech exports, such as 8525 'television camera,…' and 8529 'part suitable for use solely or principally with televisions,…', China's exports are largely re-exports of assembled products. For example, China's exports of 8529 'part suitable for use solely or principally with televisions,…' amounted to US$7,603.4b in 2003, yet in terms of the exports of this product group less imports of the product group, only a little over five percent of this is the net exported amount (ITC 2005). For China's IT exports as a group, including computers, office equipment, telecommunications equipment, semiconductors and video equipment, most of the recent increase in exports has focused on products with low value-added. Overall, it appears that labor-intensive manufacturing is where China has its strongest comparative advantage (Kwan 2002a).

FORECASTING RESULTS

The production structure illustrated in the preceding section offers only a snapshot of China's revealed comparative advantage and specialization. But the flying geese model implies a production structure, and therefore a comparative advantage, that are likely to change over time. Thus, we now return to the dynamics implied by the flying geese model, using a forecasting model to extend the specialization indices of Figure 2 (Lim 2004). A principal approach to the analysis of time-series data involves the identification of the component factors that influence each of the periodic values in the series - ie, the decomposition of the time series. In turn, these components are projected individually and combined to forecast the aggregate series. Three components are found in an annual time series, including the trend component, the cycle component and irregular fluctuations.

The forecasting approach employed here is as follows. The series are fitted as a smooth curve (such as linear, quadratic or linear-log) and residuals are obtained from 1985 to 1998. Observations from 1999 to 2003 are then used to undertake ex-post forecasts. The values of the residuals from trend fitting include cycle and irregular components that can be related to variables that might explain the fluctuations around the trend. From Figure 2, 'primary products' exhibit a steadily decreasing trend, while 'other manufactures' and 'machinery' exhibit a strong upward trend. However, it appears that the three series each have a different trend pattern. After some regression experiments, the series are fitted to three different trends, as shown in Table 1. The results from Table 1 suggest that the various time trends can explain more than 90 percent of the series' variation. The time series plot of the data and their fitted trends are shown in Figure 4.

Table 1
Regression Results from Trend Fitting

	Coefficients	Standard Error	t Stat	P-value
Intercept	0.427	0.026	16.638	0.000
T	-0.040	0.002	-17.796	0.000

The regression model is: $prim_t = a + bT + \varepsilon_t$ R-square = 0.949.

	Coefficients	Standard Error	t Stat	P-value
Intercept	-0.232	0.046	-5.033	0.000
Ln(T)	0.188	0.021	9.025	0.000

The regression model is: $Othe_t = a + b \ln(T) + \varepsilon_t$ R-square = 0.827

	Coefficients	Standard Error	t Stat	P-value
Intercept	-1.004	0.047	-21.200	0.000
Ln(T)	0.139	0.050	2.769	0.014
T	0.034	0.007	4.740	0.000

The regression model is: $Mach_t = a + b \ln(T) + cT + \varepsilon_t$ Adjusted-R-square = 0.959.

Figure 4
Time Series Data and their Fitted Trends
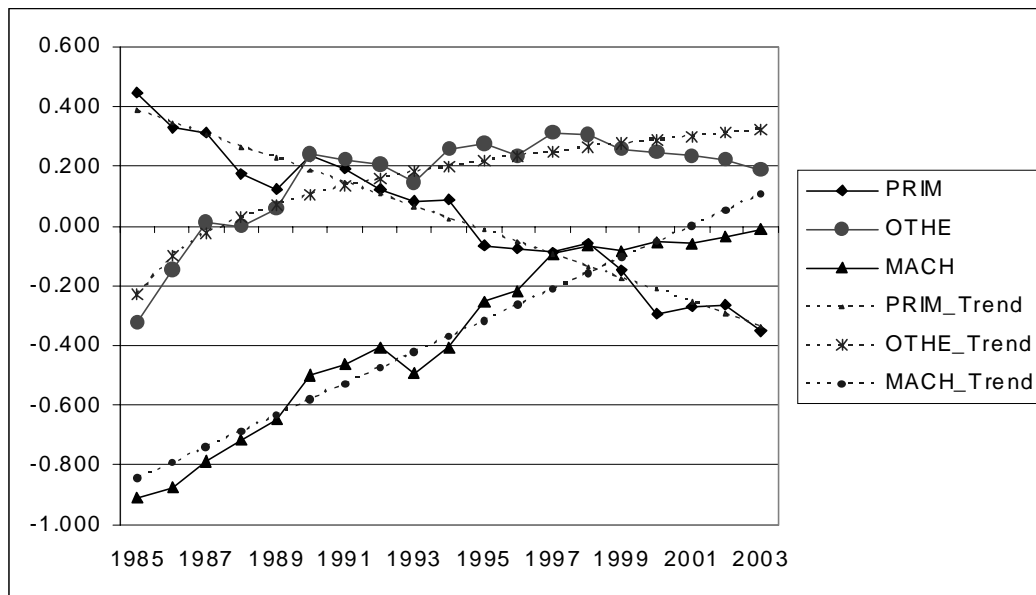
The residual analysis shows that they are white noise processes (identical and independently distributed). So it is not necessary to model the cycle. The future residuals can be simulated by random numbers from a normal distribution with zero mean. The future trend component can be easily computed from the regression models. The forecasting combines the trend and residual

components, with the results shown in Figure 5. 'Machinery' is projected in our model to match the 'other manufactures' series in 2010 and finally cross it in 2012. If correct, these changes in China's economy suggest that China will move relatively quickly to the next higher stage in the flying geese model.

Figure 5
Forecasting Results
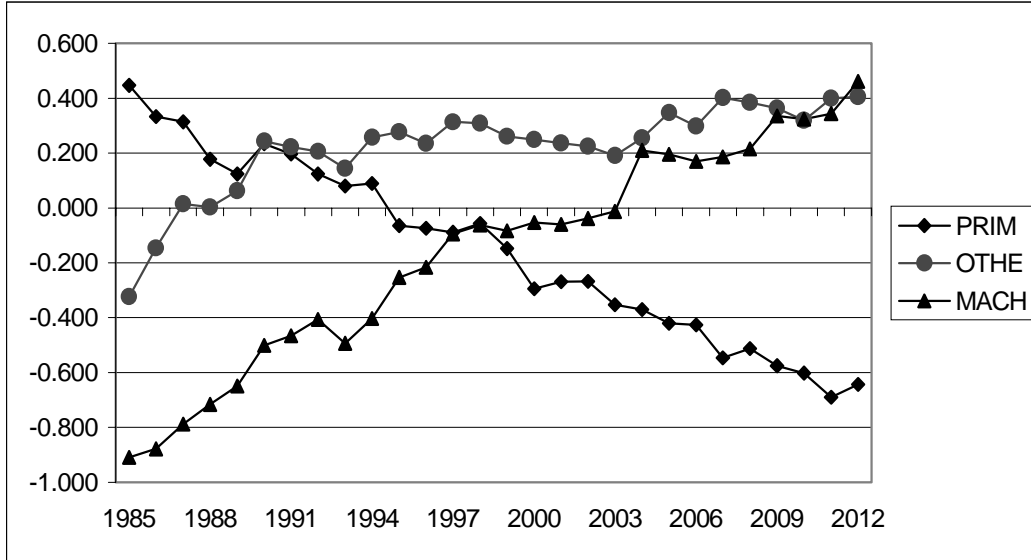
CONCLUSION

Standard textbook treatments of comparative advantage and international trade are sometimes of limited use for practitioners. Most economists would agree that the Chinese import dairy products from New Zealand, for example, because of New Zealand's comparative advantage in the goods, exploiting its land, climate and technology, while New Zealand imports garments from China because of China's labor-abundant, low wage economy. But this view is static, representing a fixed snapshot of comparative advantage. It reveals little about dynamics, and even less about how Chinese or New Zealand producers might anticipate changing market opportunities.

In Asia, comparative advantage can alter quickly (Rana 1990). The flying geese model suggests that exporters should treat target markets as continually changing, and changing in fairly logical and predictable ways. Over time markets may become increasingly sophisticated and diverse, and exporters will need to factor this into their analysis. As the production structure changes in a country, exporters may need to search for new opportunities that fit well with the changing requirements of the importing country. A complementary step in evaluating trade opportunities involves forecasting income changes in trading countries. As the composition of a country's output changes (the left hand side of Figure 1), there will be associated changes in incomes per head (the right hand side of the figure) as workers and the economy overall shift

into higher value-added activities. Multiplying the percentage change in income by the estimated income elasticity of demand for the relevant product helps to predict changing demand in the target country. Thus, as a country moves up the flying geese pattern, the primary question is whether changing product demand associated with income effects matches or drifts away from the changing output or supply side. Gaps between the supply and demand sides create opportunities for trade cycles to emerge. Such analysis of the income distributional impacts associated with dynamic comparative advantage is left to further research.

It is important to recognise that the deterministic view of the flying geese model as presented is subject to some uncertainties. In many cases, such as China's, the stages overlap. Changes in comparative advantage are not always smooth, and the social and economic adjustment costs could be high. Trade agreements, together with domestic policies and institutions (both of which are influenced by domestic interest groups), can affect the speed of change and therefore the response to export initiatives.

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