Centre on Regulation and Competition

WORKING PAPER SERIES

Paper No. 72

THE EFFECTS OF COMPETITION ON TECHNOLOGICAL AND TRADE COMPETITIVENESS: A PRELIMINARY EXAMINATION

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June 2004

ISBN: 1-904056-71-7

Further details: Centre Secretary
Published by: Centre on Regulation and Competition,
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INTRODUCTION[1]

There is considerable interest in the relationship between a country's export competitiveness and the part played by technological innovation in establishing and maintaining competitive advantage (Soete, 1987; Narula and Wakelin, 1995; Laursen, 2000). Most of the empirical work in this area has concentrated on the advanced OECD countries and relatively little research has been conducted on developing countries (Dalum, Laursen and Villumsen, 1996; Uchida and Cook, 2003). Both in relation to trade and technological change market competition is viewed as a pivotal element in inducing efficiency and innovation. Precisely how, however, is a matter of considerable theoretical debate (Krugman, 1989; Nickell, 1996).

The World Bank Report (1991) reiterates the consensus that has emerged in the last two decades that competitive markets are the most effective way for organising production and the distribution of goods and services. Indeed, as Singh (2003) observes the central tenet of the World Bank's analytical approach has been that domestic and international competition provide the incentives that unleash entrepreneurship and technological progress.

The purpose of this paper is to examine changes in technological and trade competitiveness and explore the relationship between them in a range of advanced industrialised countries and developing countries. Next to analyse the relationship between competition and changes in technological and trade competitiveness. The analysis is confined to three advanced industrialised countries, Germany, Japan and the United States and six developing countries, Hong Kong, South Korea, Singapore, Argentina, Brazil and Mexico.

In section two the theoretical and empirical literature on trade, technological innovation and competition are briefly examined. Section three discusses the methods and data used to derive indices of competitiveness and the approach adopted to examine the relationship between trade and technological competitiveness. Two indices are calculated, which measure technological and trade comparative advantage to be used as a proxy for competitiveness on a country and an industry basis. A measure of market competition is also derived based on market concentration. Section four analyses the patterns of trade and technological comparative advantage for each country and on an industry basis. Section five examines the relationship between changes in trade and technological competitiveness and the role played by domestic competition. Section six provides an analysis of the relationship between changes in the level of domestic competition and technological and trade competitiveness. The final section draws conclusions.

TRADE, TECHNOLOGY AND COMPETITION

It is now widely accepted that a contributory factor to success in trade relates to the inherent advantages of specialisation (Krugman, 1994). This can be rationalised from the perspective of neo-classical trade theory, emphasising factor endowments as an element in a country's comparative advantage and, as argued by new trade theorists, to the scope for specialisation that emerges from opportunities to exploit increasing returns to scale. In turn it is argued that a country's technological capability and specialisation reflect its trade specialisation, and influences the export competitiveness of enterprises within a country. The analysis of a country's trade pattern over time, therefore, reveals its technological specialisation and changes in its specialisation. This is a particularly neo-Schumpeterian explanation that links national systems of innovation to the sector structure of export performance (Narula and Wakelin, 1995). Indeed, the neo-Schumpeterian view indicates that international trade specialisation, as a measure of competitiveness, is the outcome of country and sector specific learning processes relating to technological capability. The mechanism linking the two leads to a stability of trade specialisation, in which trade patterns are likely to be stable and changes in the pattern of technological specialisation are cumulative or path dependent.

In the context of the East Asian economies competitive advantage has been viewed as the outcome of two opposing approaches, the market friendly versus the market stimulating policy approach (Amsden, 1994; Lall and Teubal, 1998). The former approach is reflected in the World Bank's analysis of the East Asian economies miracle performance (World Bank, 1993). The adoption of a market-friendly approach, with its focus on achieving policy neutrality in order to make markets work better, and implicit assumptions about the viability of the state to intervene effectively, has rested on rapid trade liberalisation to improve competitive incentives for technological acquisition and development. In contrast, the market stimulating policy approach has been more circumspect, on theoretical and empirical grounds, about the role the market mechanism alone has played in accounting for the economic success of the East Asian economies.

In the market stimulating approach the state exhibits dynamic complementarities with the market and the role of technology is more complex than in neo-classical market friendly model (Teubal, 1997). Technological upgrading is not simply related to acquisition and innovation but incorporates structuralist and evolutionary perspectives, in which 'technical choice, mastery of technologies, and more major technological innovations, are part of a continuum of technological effort, undertaken in a relatively risky and unpredictable world of imperfectly understood information and an even more imperfectly foreseen future' (Lall and Teubal, 1998: 1371). Competitive advantage in trade is related to technological deepening which arises through upgrading quality and technology within existing activities and moving from technologically simple to complex activities. In turn, enterprises using technologically intensive processes offer better prospects for growth since their products grow faster in trade and provide greater scope for learning possibilities. They also provide greater scope for spillovers in terms of creating new skills and generic knowledge that can be applied in other activities (Rodrik, 1996). In this approach, therefore, technological upgrading and deepening is the outcome of long and cumulative processes of learning, agglomeration, institution building and business culture and not sharp policy shocks (Lall, 2000).

As a consequence of the importance of learning, and specifically learning by doing, it has been argued by Lall (2000) that the best countries can retain their comparative positions even when they are losing their initial advantage. This occurs because the best countries have in place learning systems that allow them to absorb technologies efficiently and react competitively to changing technological conditions. By contrast, countries with weak learning systems find it difficult to establish competitive positions even in simple or resource-based activities.

The theoretical literature provides clear predictions concerning the longer term trend for patterns of specialisation. Stable patterns are predicted for advanced economies on the basis of scale economies (Krugman, 1987), and these patterns are likely to be manifested through the path dependency characteristics of the evolution of technological innovation (Metcalfe and Soete, 1984; Dosi, Pavitt and Soete, 1990). Cumulative experience or learning by doing maintains the impetus for productivity changes among leading economies (Laursen, 2000). Patterns of specialisation over shorter time horizons are more likely to be susceptible to market and policy-induced influences relating to changes in exchange rates, factor prices and promotional policies (Grupp and Münt, 1998). Less stable patterns, and correspondingly higher degrees of structural change in specialisation patterns, are denoted as features of catching-up economies (Beelen and Verspagen, 1994).

In terms of the relationship between trade and technological specialisation, Posner's (1961) technological gap theory suggested that transitory monopoly profits result from a technological lead which would improve prospects for trade in some sectors. In recent years there has been mounting support from empirical research, using both cross-country and panel data, to indicate that competitiveness in trade among OECD economies is indeed influenced strongly by a country's technological capability (Soete, 1981; Dosi, Pavitt and Soete, 1990; Amendola, Dosi and Papagni, 1993; Amable and Verspagen, 1995). In East Asia cumulative patterns of technological change were found to be important in Hong Kong, South Korea and Singapore, which in turn helped to maintain competitive advantage in trade for many industries (Uchida and Cook, 2003). The relationship between trade and technology is likely, however, to be more complex. As Lall (1992) indicates, export orientation has also generated competitive pressures and other incentives for technological accumulation, increasing the likelihood that some kind of two way or feedback relationship can be found to exist between trade and technology. The plant-level study by Clerides, Lach and Tybout (1998), also, concludes that exporting enterprises are more efficient than those that concentrate on the domestic market but finds that exporting experience or learning by exporting is not the cause of improvements in efficiency. Instead, they argue that it is more likely that low-cost producers choose to become exporters.

Both theoretical and empirical research in recent years has emphasised the productive and dynamic efficiency gains from competition (Baily and Gersbach 1995, Nickell, 1996). Productive or technical efficiency is linked to productivity-enhancing innovations which contribute to greater dynamic efficiency in the longer run. The role of competition in improving enterprise efficiency emanates through the incentives provided by the disciplining effect of market competition. This effect induces enterprises to introduce cost reducing improvements in production and speed-up innovation and technological progress. Competition also works through a process of selection, in which weaker enterprises give way or are replaced by more efficient ones. Although the strength of competition between enterprises is not just a function of the behaviour between enterprises but also of the external environment in which they compete, the state of infrastructure, legal framework and the effectiveness of the financial system (Carlin and Seabright, 2001).

In this dynamic setting, competition from new entrants in the market, that experiment with new technologies, become the driving force for innovation, and in turn market incumbents are forced to innovate for their survival (Dasgupta and Stiglitz, 1980). It is argued that in industries characterised by rapid technological change, as for example in the telecommunications sector, competition for the market through standard-setting innovations is likely to be more significant than cost-reducing static efficiency (Ahn, 2002). The examination of the empirical link between competition and dynamic efficiency has tended to concentrate on the relationship between market structure and technical change. Empirical studies have often focused on the relationship between the size of an enterprise or the market power of an enterprise and the propensity to innovate, based largely on economies of scale provided by size and the size of profit markups inducing research and development expenditure. This has translated into a spate of studies measuring the association between market structure and innovation, either as an input such as R and D expenditures or as an output to innovation activity through an assessment of the number of patents. Market power or the degree of domestic competition is usually measured by a statistical measure of concentration involving output or employment shares of the largest enterprises in a market, or price-cost margins of enterprises used as a gauge to the degree of monopolistic pricing. Import penetration, expressed as the ratio of imports to domestic production, is typically used to measure the extent of foreign competition.

Nevertheless, these are imperfect measures of the real extent and dynamic character of the competition process, and their use is primarily determined by the relative ease with which date can be obtained compared to other approaches that might more accurately capture the intensity of competition Carlin, Haskel and Seabright (2001), drawing on the World Bank/EBRD business environment survey, find that as measures of the short term, market structure, market power and behavioural measures of competition are broadly consistent with one another and provide useful information of the general state of competition. Difficulties also arise in the interpretation to be placed on high and low degrees of market concentration. Vigorous competition is likely to eliminate less efficient enterprises and contribute to increased market concentration, while at the same time signalling that competition is working well (Aghion and Schankerman, 2000 Metcalfe, 1993).

METHODOLOGY AND DATA

Two indices measuring technological and trade comparative advantage were calculated as a proxy for competitiveness with respect to technology and trade. These indices were calculated for four periods: 1978-82, 1983-87, 1988-92 and 1993-97 and analysed on a country and industry basis.

Data was obtained from the National Bureau of Economic Research (NBER) US Patent Citations (USPC) (Hall, Jaffe, and Tratjenberg, 2001) and the United Nations Commodity Trade Series (SITC, Revision 2, 3 digit level). A concordance table was developed since the data series for technology and trade have been compiled on the basis of different industrial categories. Using the concordance table, data has been rearranged into 29 manufacturing industries, based on the International Standard Industrial Category (ISIC). A full list of these industries is presented in Appendix 1.

The indices relating to revealed comparative advantage (RCA) for trade (Balassa, 1965) and technological comparative advantage (TCA) were calculated as follows:

$$RCA = (X_{ij} / \Sigma_i X_{ij}) / (\Sigma_j X_{ij} / \Sigma_i \Sigma_j X_{ij}), \quad (1)$$

where X_{ij} is the value of exports of sector *j* from country *i*.

$$TCA = (P_{ij} / \Sigma_i P_{ij}) / (\Sigma_j P_{ij} / \Sigma_i \Sigma_j P_{ij}), \quad (2)$$

where P_{ij} is the number of patents of country *i* in sector *j*.

The range of each index value lies between 0 and positive infinity. If the index equals unity, the share of the country *i*'s exports or patents in industry *j* is identical to its share of exports or patents in all industries. If the index value is greater than unity, it indicates that a country has a relative export or technological competitive advantage in industry *j*. If it is less than unity, the respective competitiveness with respect to trade and technology for each country in a given industry is weak.

Two cautionary notes are warranted regarding the derivation and use of the index for TCA. First, in the past many empirical studies collected patent counts based on the grant year, but as Hall, Jaffe, and Tratjenberg (2001) have pointed out, counts ought to be based on the year of application. The reasoning for this is that there is likely to be a time lag (possibly 1 to 3 years) between the granting of a patent and its application owing to bureaucratic delay. As a result, the use of patent counts based on the grant year introduces unnecessary measurement errors into the analysis. Second, Cantwell (1993) has argued that TCA indices are likely to suffer from so-called small number problems. It is reckoned that a minimum of a thousand patent counts distributed across 30 sectors or industries are necessary to generate statistically satisfactory normally distributed indices.

Seeking a solution to the normality problem associated with RCA and TCA indices has proved troublesome, in particular with the latter. The most commonly used method for RCA has been the logarithmic transformation of a RCA index (Soete and Verspagen, 1994). However, a TCA index has often resulted in values of 0 owing to zero patent counts, and in this case the log-transformation could not be applied. Fagerberg (1994) arbitrarily added a small integer, 0.1 to the logarithmic formula (ln(TCA + 0.1)) in order to resolve the zero value problem for TCA and also to improve the normality problem, although it had no statistical foundation. Laursen and Engedal (1995) have developed symmetric RCA and TCA indices (hereafter, SRCA and STCA, respectively) to deal with the zero count problem, as well as normality. These indices have an economic advantage in that they put the same weight to the changes below and above unity, and appear to be the best to improve the normality problem (Dalum, Laursen and Villumsen, 1996). Since most East Asian and Latin American developing countries fail to produce a sufficient number of patents, the possibility of adverse effects have been minimised by transforming the indices into SRCA and STCA indices by the following formula:

$$SRCA_t = (RCA_t - 1)/(RCA_t + 1), \quad (3)$$

$$STCA_t = (TCA_t - 1)/(TCA_t + 1). \quad (4)$$

Accordingly, each value for SRCA or STCA ranges from –1 to 1.

In order to measure the level of domestic competition, Herfindahl–Hirshman (HHI) indices were calculated using enterprise level sales data on a country and an industry basis from 1980 to 1997. Data was obtained from Thomson One Banker Analytics. The sales data available for enterprises varied according to country. In some cases data was not available for earlier periods. Specifically, data was available for 29 enterprises for Argentina (1993-1997), 106 for Brazil (1987-97), 490 for Germany (1980-97), 201 for Hong Kong (1990-97), 1591 for

Japan (1980-97), 227 for South Korea (1988-97), 56 for Mexico (1987-97), 138 for Singapore (1990-97), and 2413 for the United States (1980-97).

Herfindahl–Hirshman indices have been calculated as follows:

$$HHI = \sum^{n}_{i=1} (MS_i)^2 , \qquad (5)$$

where MS is the market share of the *i*th enterprise, $i = 1\ldots n$. Note that the above HHI formula is often multiplied by 10000. In this study, this multiplication was omitted for simplicity, and to enable a straightforward comparison the HHI was inverted and transformed into logarithm using the following formula: Ln(1/HHI).

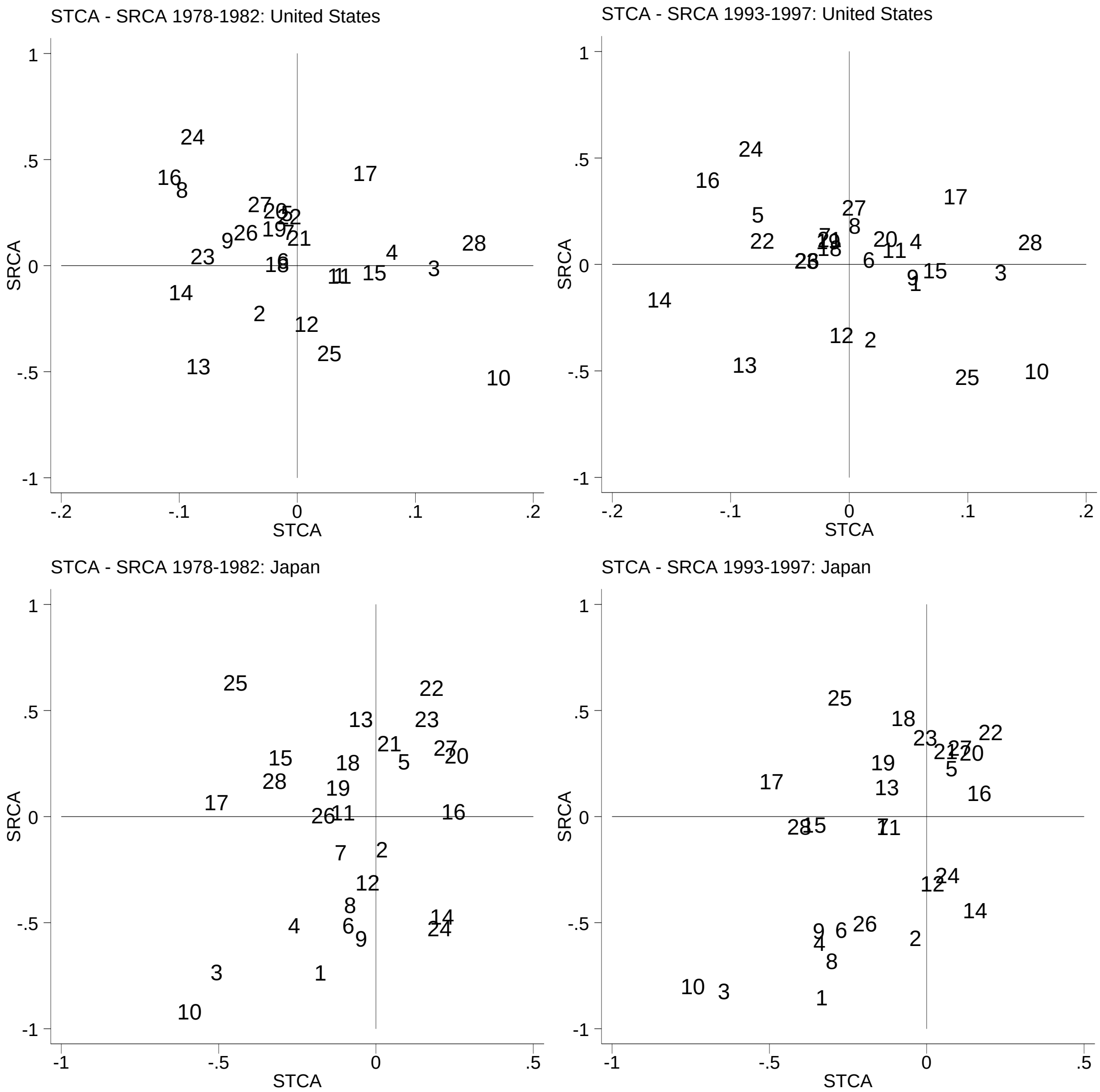
Thomson One Banker Analytics categorises enterprises based on the Standard Industrial Classification (SIC), and re-categorising these into more detailed categories is virtually impossible since a number of enterprises engage in various activities that spread across different industrial categories. As a result, the study developed a further concordance table, based on the SIC, to analyse the correlation between competition and the changes in technological and trade competitiveness. These industries have been rearranged into 20 industrial categories shown in Appendix 2.

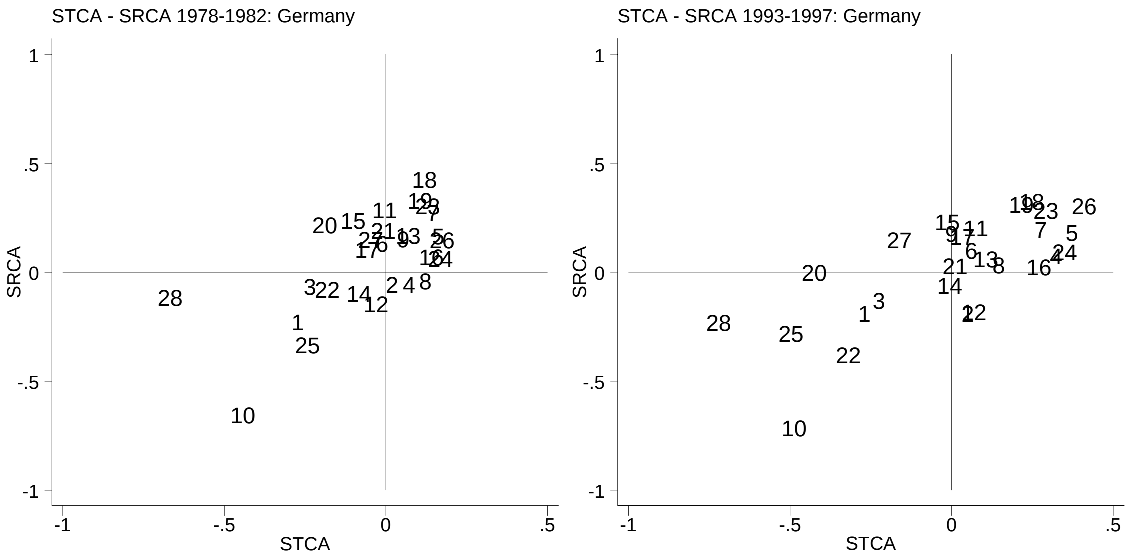
ANALYSIS OF TECHNOLOGICAL AND TRADE COMPETITIVENESS

This section analyzes the changes in technological and trade competitiveness in the nine countries between the initial five year period and the last five year period of the dataset, namely 1978-82 and 1993-97. The analysis compares the movement of industries each economy, shown in graphs 1-3, between the two periods. Each graph is divided into four quadrants at the point (0, 0), and STCA indices are plotted on the x-axis and corresponding SRCA indices on the y-axis. The industries in the upper right quadrant possess both technological and trade comparative advantage. Those in the lower right quadrant have technological comparative advantage without trade comparative advantage. The upper left quadrant shows the industries that do not have technological comparative advantage but possess trade comparative advantage. Finally, industries in the lower left quadrant hold no advantage with respect to trade or technology.

In the case of the advanced economies, as shown in graph 1, it is apparent that there is very little movement between quadrants. Some exceptions are observed for the United States. The agricultural chemical industry (8) moved from the upper left to the upper right quadrant, gaining both trade and technological advantage. There was also some movement in the case of toiletries (6), computers (20) and instruments (27). In general, the results confirm the findings of a number of earlier empirical studies that technological and trade competitiveness in the advanced countries exhibits a cumulative or path-dependent pattern.

Graph 1 Relationship between Technology and Trade: Advanced Countries



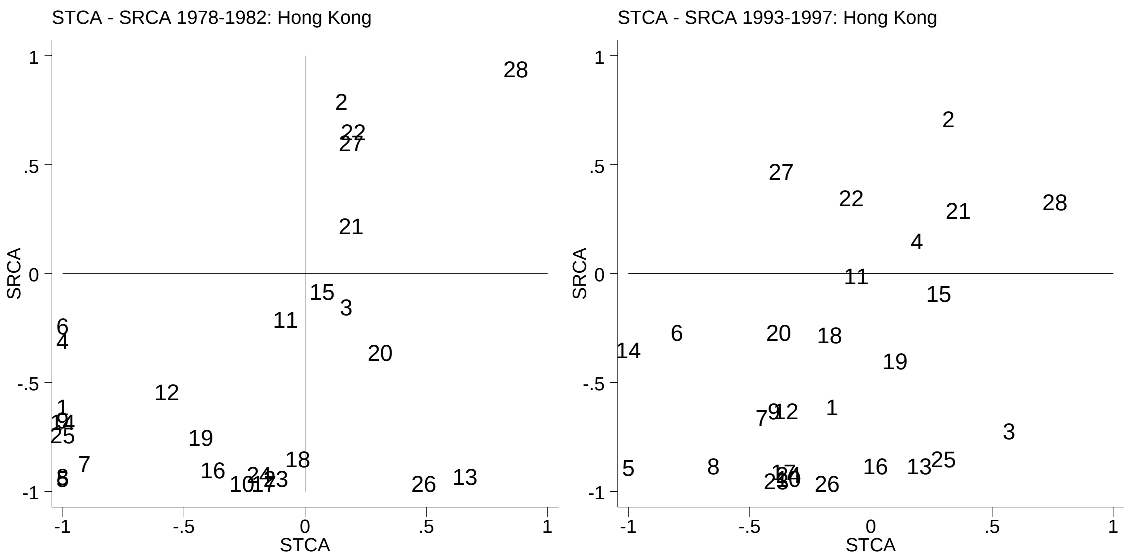


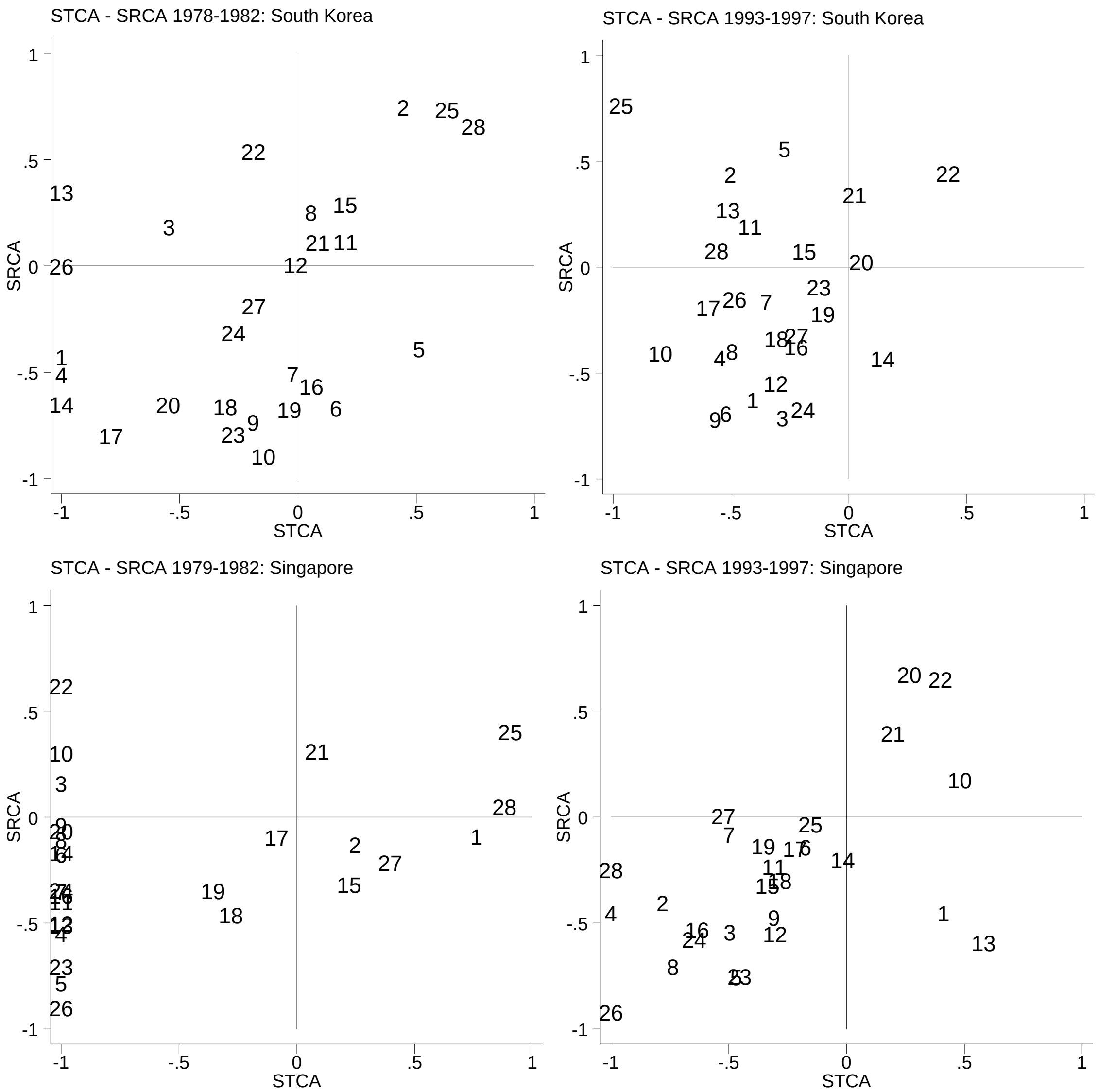
As for the East Asian developing economies the transformation of technological and trade competitiveness are far more evident. This is vividly revealed in graph 2. Although Hong Kong's transformation pattern more or less resembles those observed in the advanced economies, the noticeable difference is the movement from the right to the left quadrants. The electronics (22) and instruments (27) industries moved from the upper right to the upper left quadrant, losing their technological advantage while retaining trade advantage, and computers (20) moved from the lower right to the lower left, losing both trade and technological advantage. Thus, it may appear that Hong Kong has been losing its technological capabilities in the relatively high-tech industries. South Korea's transformation pattern is quite different. Here high-tech industries moved from the upper left (electronics (22)) and from the lower left (computers (20)) to the upper right quadrant, gaining both technological and trade competitiveness in the last period. In contrast, most of the traditionally well-established industries, such as textiles (2), shipbuilding (25) and toys (28), moved from the upper right to the upper left quadrant, losing their technological advantage but retaining their trade competitiveness. A similar but more rapid transformation can also be found in Singapore, where high-tech industries, computers (20) and electronics (22), appear in the upper right quadrant in the last period. The decline of traditionally established Singaporean industries, shipbuilding (25) and toys (28), has been more rapid than in South Korea, and these industries now possess no technological or trade advantages.

More moderate transformations are observed in Latin America, as shown in graph 3. In Argentina toiletries (6), agricultural chemicals (8), motor vehicles (23) and shipbuilding (25) gained both technological and trade advantage in the later period. Brazil maintained a relatively stable pattern of technological and trade advantage, although a few industries such as woods (3), stones (12) and non-ferrous products (14) gained trade and technological advantage. It is noticeable that in both Argentina and Brazil the relatively high-tech industries, such as computers (20) and electronics (22), failed to achieve both technological and trade advantage.

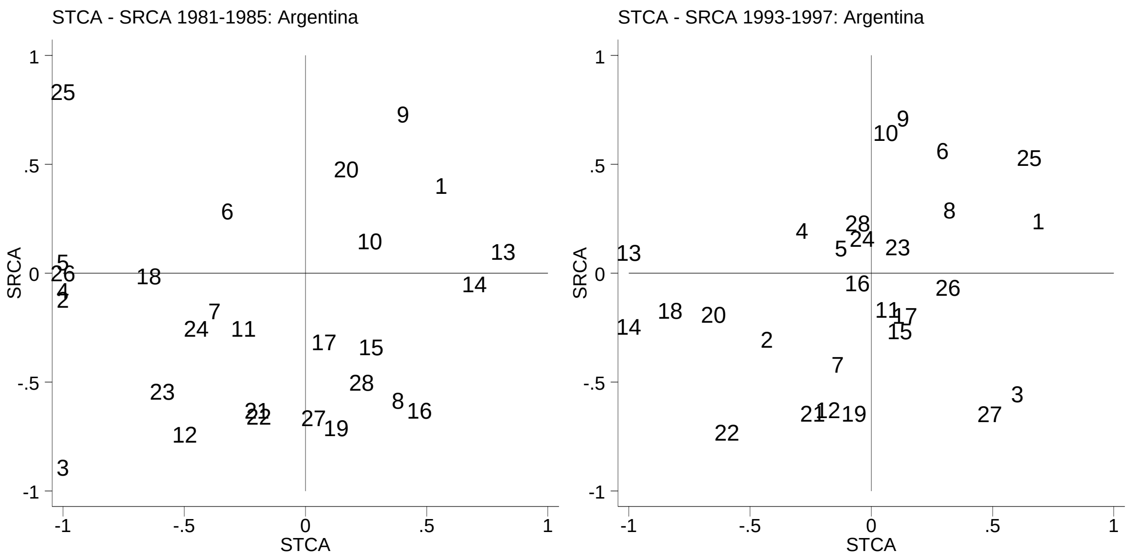
In contrast to Argentina and Brazil, Mexico’s transformation pattern is more unique. While only one industry, engines (16), appeared in the upper right quadrant, eight industries, including plastic materials (5), drugs (9), electricals (21), electronics (22), motor vehicles (23), aircraft parts (24) and railroads (26), moved from the lower left to the upper left quadrant, indicating the establishment of trade advantage without any corresponding technological advantage. This conspicuous transformation, is likely to have resulted from the effects of the North American Free Trade Agreement (NAFTA) or the relocation of assembly-type activities from the United States and other advanced countries to the northern part of Mexico.

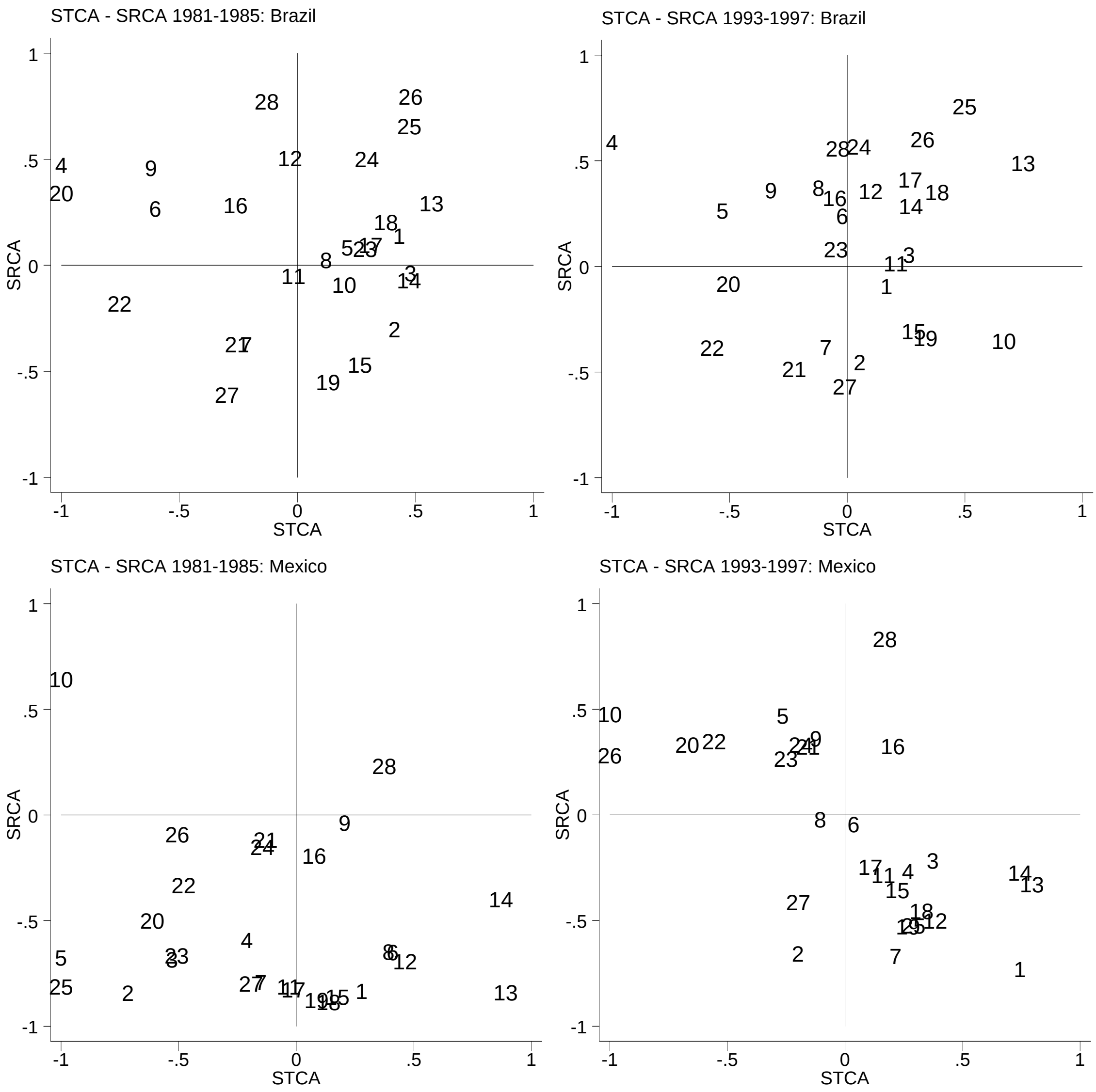
Graph 2 Relationship between Technology and Trade: East Asia





Graph 3 Relationship between Technology and Trade: Latin America





In summary, as all three graphs have shown, a total of nineteen industries moved to the upper right quadrant between the two periods. These included eleven industries moving from the upper left to the upper right quadrant. These were toiletries (6), agricultural chemicals (8), computers (20) and instruments (27) in the United States; toiletries (6) in Germany; electronics (22) in South Korea; petroleum products (10) and electronics (22) in Singapore; toiletries (6) and shipbuilding (25) in Argentina; and stones (12) in Brazil. As for other cases, five industries moved from the lower right to the upper right quadrant: plastic products (11) in the United States; agricultural chemicals (8) in Germany; agricultural chemicals (8) in Argentina; woods (3) and non-ferrous products (14) in Brazil. The remaining three industries moved directly from the lower left to the upper right. These were paper products (4) in Hong Kong; computers (20) in Singapore; and motor vehicles (23) in Argentina.

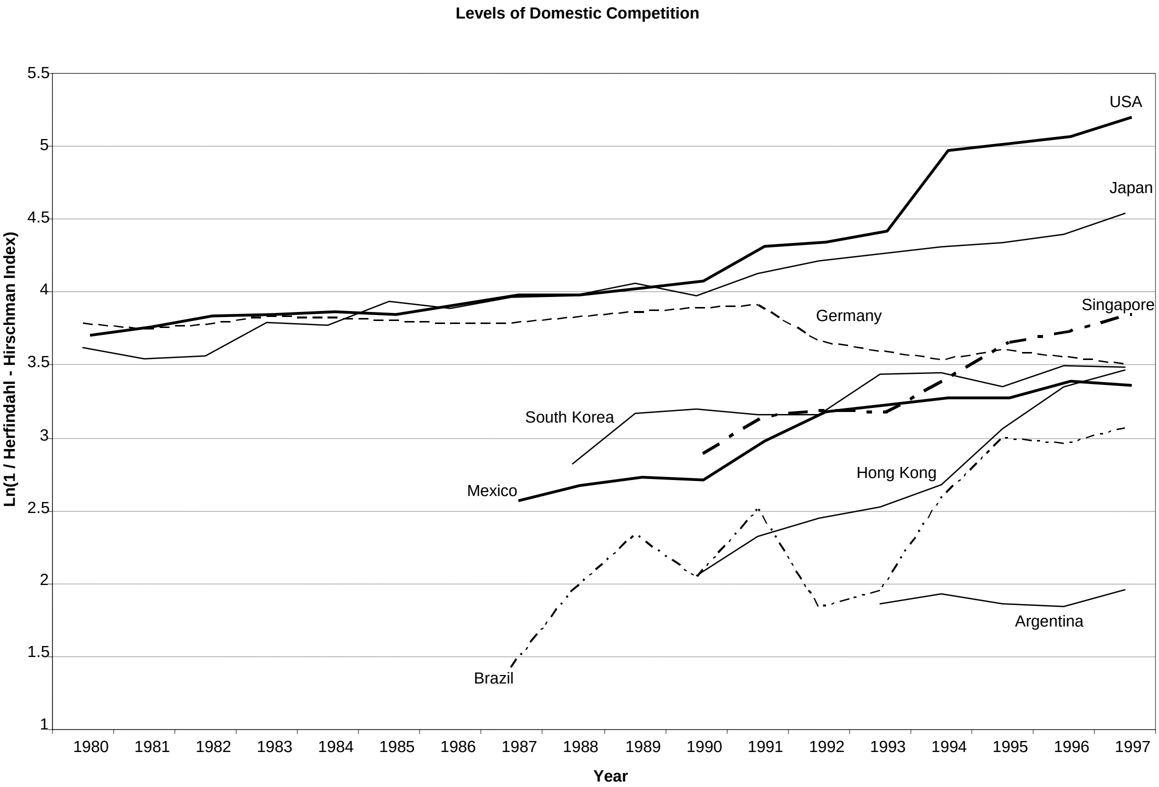
It can be observed that, as far as the advanced countries are concerned, the pattern of technological and trade competitiveness can be considered to be cumulative or path dependent. With respect to the East Asian economies, the transformation of competitiveness is more evident and rapid, particularly in the cases of South Korea and Singapore. In these latter two countries the transformation is characterised by changes in the industrial structure, from relatively low-tech and labour intensive industries to relatively high-tech industries. In Hong Kong, it appears that some of the high-tech industries are losing their technological capabilities. In the Latin American countries, a contrast between Mexico and the others is observed. While the transformation is moderate in Argentina and Brazil, in Mexico a number industries have gained trade competitiveness without a corresponding competitive advantage with respect to technology.

On the whole, the majority of industries, irrespective of the level of development of the countries of their origin, established both technological and trade competitiveness initially by maintaining trade advantage without a corresponding advantage in technology. This appears to have been achieved through a process of learning by doing linked to an exposure to international competition. Interestingly, even the high-tech industries in the US, such as the computer (20) and instrument industries (27) followed this pattern, moving from the upper left to the upper right quadrant. This sequence may cast some doubt on the notion that the evolution of these industries can be explained purely in terms of a technological push, which would see industries moving from the lower left or lower right quadrant to the upper right segment.

ANALYSIS OF DOMESTIC AND INTERNATIONAL COMPETITION

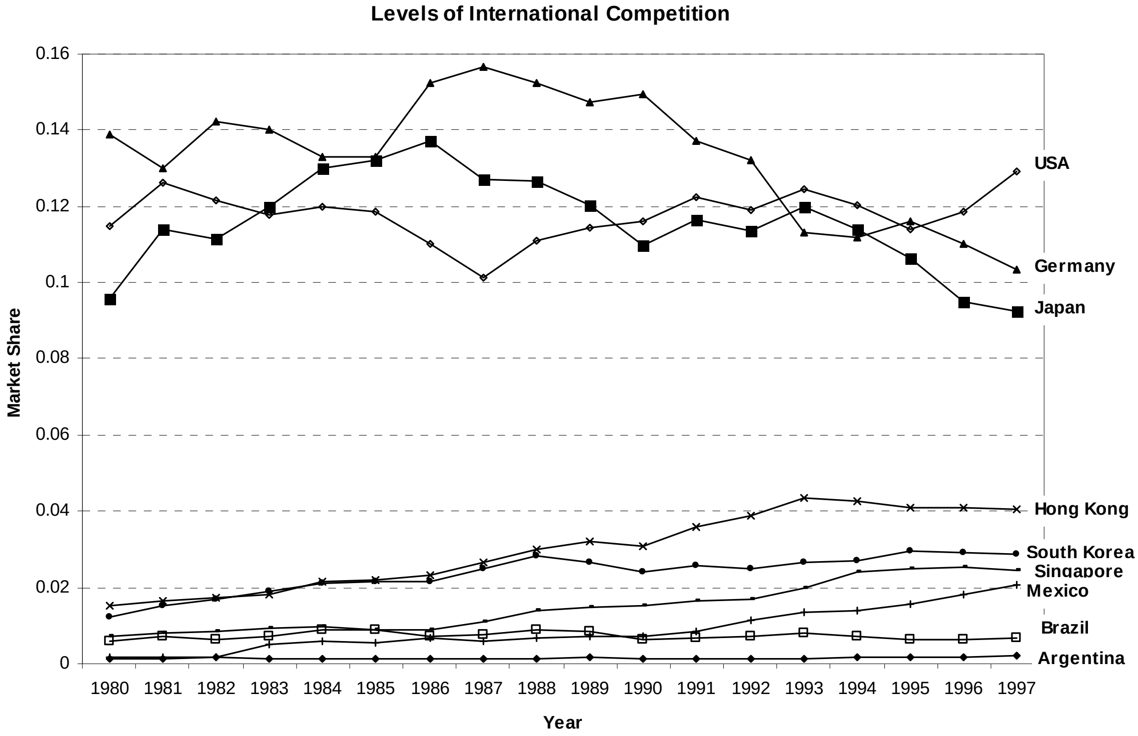
This section investigates the relationship between the changes in trade and technological comparative advantage and the role played by domestic competition. Graph 4 shows the level of domestic competition in the manufacturing sector on a country basis. The United States and Japan have the highest levels of domestic competition among the countries surveyed, and the former appears to have an increased level of competition since the early 1990s. In contrast, possibly owing to reunification, the level of domestic competition in Germany has been falling since the early 1990s. As a result, in 1997 Germany's competition level, measured in terms of industrial concentration, was lower than Singapore's and almost the same as Hong Kong's and South Korea's. South Korea gradually increased the level of domestic competition over time, while domestic competition in Singapore only began to accelerate in the early 1990s. A similar trend can be observed for the level of domestic competition in Mexico. The most substantial increase in the level of domestic competition is found in Hong Kong and to a lesser extent in Brazil. Argentina's level of domestic competition remains far lower than the other economies.

Graph 4 Levels of Domestic Competition in Manufacturing Sector



Graph 5 shows the changes in the share of manufacturing exports used as a proxy for international competitiveness in the manufacturing sector. Not surprisingly, the advanced economies have a higher share in manufacturing exports, suggesting that their international competitiveness is equally as high. Among these economies, the United States has been reinforcing its competitiveness since the early 1990s, while Germany and Japan have been losing their competitiveness. Hong Kong and South Korea followed a similar trend with one another up until the late 1980s, but since then, Hong Kong has increased its competitiveness. Singapore has lagged behind Hong Kong and South Korea in this respect until the late 1980s. Mexico started to catch up with East Asian economies in the early 1990s and its share was close to that of Singapore in 1997. In contrast, Argentina and Brazil have been maintaining stable and lower levels of international competitiveness throughout the period.

Graph 5 Levels of International Competitiveness



Similarly, RCA indices themselves convey information on international competitiveness. Accordingly, it can be inferred that higher values for RCA indices also point to higher levels of international competitiveness in those industries. While the earlier analysis emphasised the significance of learning by doing in relation to the movement of industries from the upper left to the upper right quadrant, this movement undoubtedly captures the crucial role played by the exposure to international markets and the resulting competitive pressures that are likely to have facilitated technological development.

In the analysis so far the role played by domestic competition in explaining changes in technological and trade competitive advantage has not been tackled. The remainder of this section, therefore, focuses on the relationship between domestic competition and trade and technology. The coefficients of variation for the HHI indices, measuring domestic competition on an industry basis for our sample countries, are shown in table 1.

Table 1. Domestic Competition: Coefficients of Variation (Standard Deviation/Mean)

Industry	Germany	Japan	USA	H.Kong	Korea	Singapore	Argentina	Brazil	Mexico
20. Food	0.56	0.30	0.11	0.48	0.91	0.22	0.20	0.61	0.56
21. Tobacco	na	na	0.04	na	na	0.01	na	na	na
22. Textile	0.11	0.21	0.34	0.45	0.95	na	na	0.45	0.05
23. Apparel	0.45	0.09	0.47	0.60	0.12	0.03	na	0.45	na
24. Wood	0.52	0.48	0.07	0.50	na	na	na	0.09	na
25. Furniture	0.34	0.50	0.16	0.25	na	na	na	na	na
26. Paper	0.38	0.15	0.11	0.59	0.24	0.27	na	0.26	0.18
27. Printing	0.10	0.34	0.24	0.48	0.24	0.26	na	na	0.02
28. Chemicals	0.14	0.19	0.24	0.34	0.76	0.36	0.22	0.56	0.17
29. Petro	0.03	0.30	0.06	0.29	0.25	0.00	0.23	0.05	na
30. Plastic	0.20	0.36	0.06	0.12	0.31	0.61	0.35	0.54	0.34
31. Leather	0.27	0.11	0.11	0.36	0.22	na	na	0.06	na
32. Stone	0.20	0.27	0.14	0.15	0.48	0.23	0.13	0.48	0.44
33. Pri.Metal	0.09	0.13	0.30	0.39	0.37	0.15	0.22	0.50	0.31
34. Fab.Metal	0.24	0.49	0.43	0.70	0.48	0.50	0.08	0.41	0.31
35. Machinery	na	0.21	0.24	0.56	0.77	0.48	na	0.32	0.23
36. Electronic	0.12	0.24	0.24	0.67	0.60	0.43	na	0.34	0.23
37. Transport	0.09	0.15	0.09	0.27	0.56	0.41	0.33	0.72	0.68
38. Instruments	0.07	0.17	0.11	0.59	0.33	0.40	0.05	na	na

Note: Industrial category is according to ISIC.

It is apparent that there are no obvious industry specific characteristics with respect to changes in domestic competition, except for the food industry. Here relatively high levels of changes in domestic competition are observed, possibly reflecting the relative ease of entry into this particular market. National or regional differences, however, are more prominent than industry specific ones. In the advanced economies, changes in the level of domestic competition are higher in the relatively low-tech industries, such as textiles, apparels, wood and furniture, than in the medium and high-tech industries. In contrast, changes in competition are higher in the latter categories of industries for East Asia, as for example in fabricated metals, machinery, electronics, and instrument industries. An interesting picture emerges in Latin America where the transport sector has higher levels of changes in domestic competition compared to other industries, in the country.

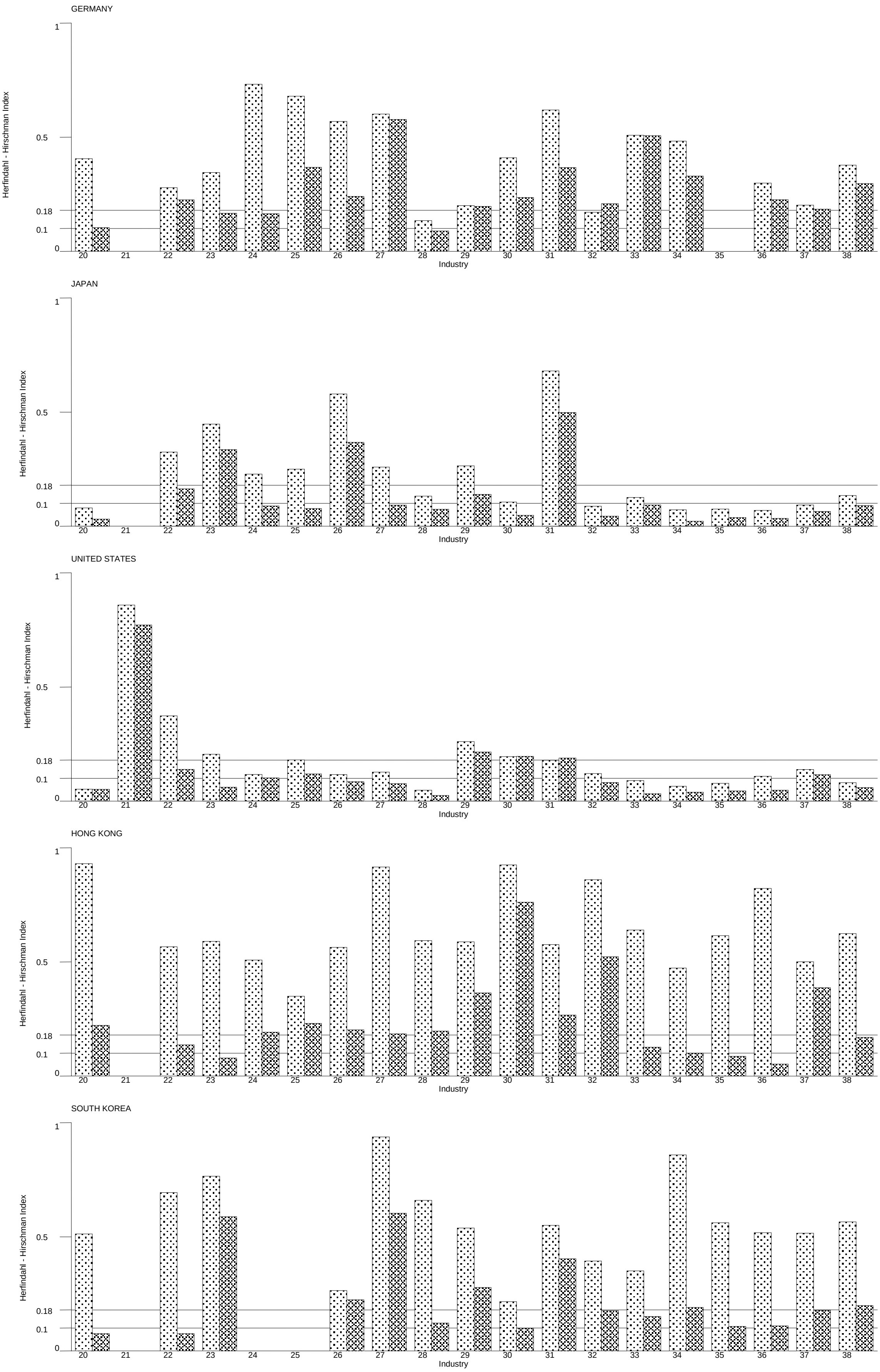
To examine these characteristics further, graph 6 shows the changes in the level of domestic competition between the first year when data are available (first bar for each industry) and 1997 (second bar) on an industry basis for each economy. The market concentration criteria used by the United States Department of Justice (1997), is applied to our analysis, where an Herfindahl–Hirschman indices (HHI) less than 0.1 indicates a low concentration of the market concerned, while values between 0.1 and 0.18 signify moderate concentration, and those greater than 0.18 indicate that the market is highly concentrated.

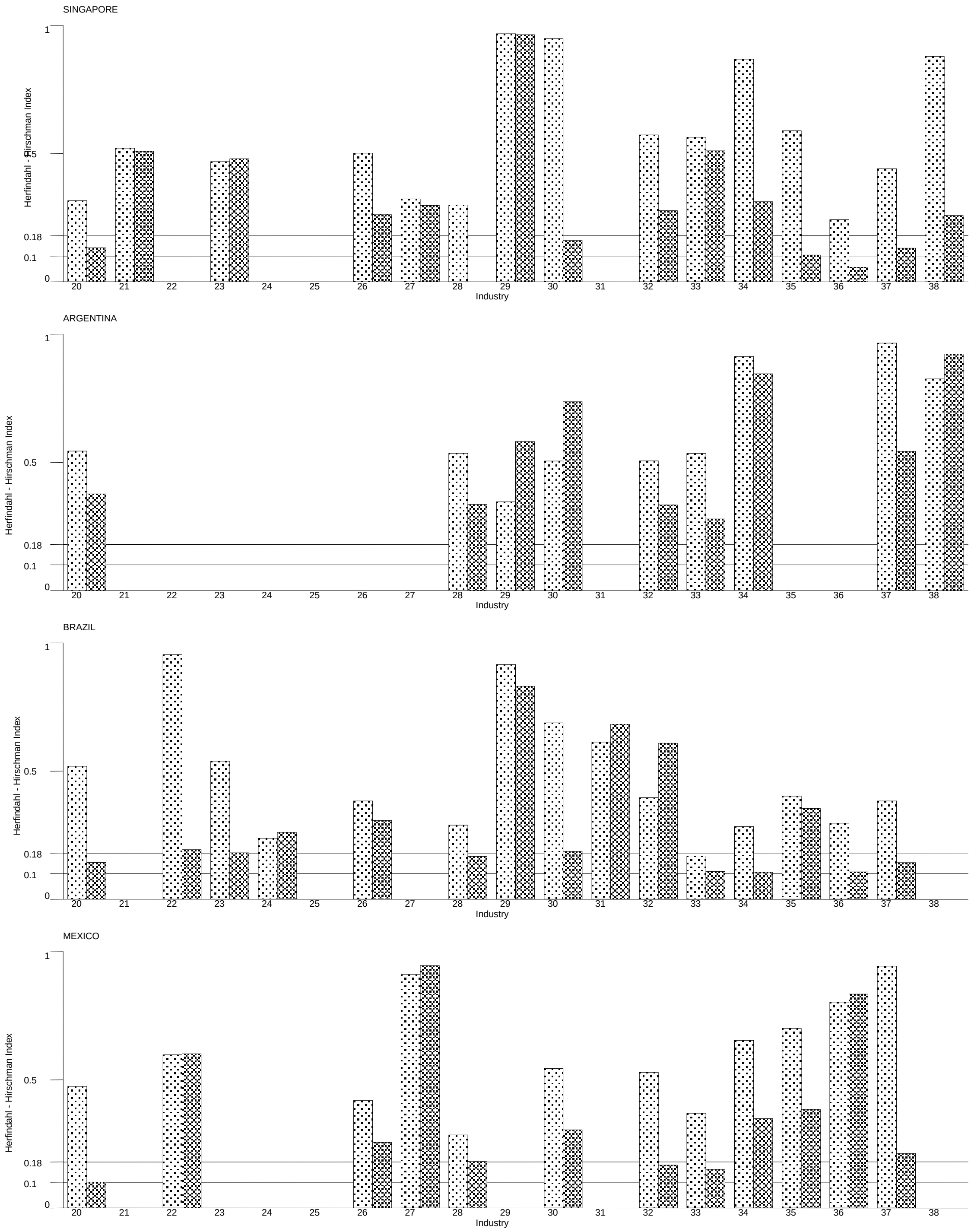
Among the advanced economies, it is apparent that domestic enterprises in almost all industries in the United States are operating in relatively competitive domestic markets. There are exceptions, for example, the tobacco (21) industry, followed by the petroleum product (29) industry. Similarly, Japanese enterprises operate in highly competitive domestic markets, except for apparels (23), papers (26) and leathers (31). In contrast, the levels of domestic competition for German industries are lower than those in the US and Japan. Only four industries, foods (20), apparels (23), woods (24) and chemicals (28), had either high or moderately competitive markets in 1997 according to the criteria specified above.

As for the East Asian economies, Hong Kong had low levels of competition in domestic markets for all industries in the late 1980s. In less than ten years, however, almost all industries had increased their level of competition, and several had highly or moderately competitive markets. In particular, electronics (36), apparels (23) and industrial machineries (33) have significantly increased the level of competition in their markets. Similarly, South Korea had relatively highly concentrated markets in the initial period. In less than ten years, however, almost all industries reduced their market concentration, particularly in textiles (22), foods (20) and chemicals (29). In Singapore, while several industries maintained relatively concentrated domestic markets, some industries, such as plastics (30), industrial machinery (35) and electronics (36), noticeably increased levels of competition in their markets over time.

All industries in Argentina continue to have highly concentrated markets. In two industries, petroleum products (29) and plastics (30), market concentration has increased over time. The patterns for competition exhibited in Brazil and in Mexico are, more or less, similar to each other. Several industries reduced their market concentration, while others maintained or increased it. In Brazil, foods (20), chemicals (28), primary metals (33), fabricated metals (34), electronics (36) and transport equipments (37) had either highly or moderately competitive markets in 1997. In Mexico, by 1997, industries such as foods (20), transport equipments (37) and stones (32) had reduced market concentration. Interestingly, the electronics (36) industry increased market concentration, despite the fact that the industry is one of the most dynamic industries in Mexico.

Graph 6 Changes in Domestic Competition in Manufacturing Sector





THE RELATIONSHIP BETWEEN DOMESTIC COMPETITION AND COMPETITIVE ADVANTAGE IN TECHNOLOGY AND TRADE

We now turn to an examination of the relationship between changes in the level of domestic competition and technological and trade competitiveness. In terms of competition the patterns of concentration discussed above indicated that changes in the level of competition were more likely to be influenced by country specific factors or characteristics than industry specific ones. Of course, there were exceptions. In contrast, changes in technological and trade comparative advantage, as indicated earlier exhibited a mixture of both country and industry specific characteristics, particularly in respect to the high-tech industries.

Table 2 shows the Pearson correlation coefficients for each industry by country. Although the use of this method is somewhat simplistic, dictated largely by data constraints, it is nevertheless highly indicative of the relationship between the variables concerned. Since these results do not point to the direction of causality, however, their interpretation requires a fair degree of caution. With the exception of industries shown with double lines in table 2, most industries experienced an increased in the level of domestic competition.

The results reveal that there are a number of statistically significant correlations between a change in domestic competition and technological and trade competitiveness. Over fifty per cent of the results were statistically significant, except for those between domestic competition and technological competitiveness in the cases of Hong Kong (33%) and Argentina (33%), Brazil (7%) and Mexico (36%), and between domestic competition and trade competitiveness in the US (47%). In general, there are more statistically significant results in relation to trade than technology, suggesting that the level of competition has a more significant impact on trade competitiveness (or trade on competition), than on technological competitiveness. The US and South Korea are the significant exceptions. It seems that there are no apparent industry-specific characteristics that are evident across the sample economies.

Among the advanced countries, higher levels of competition are associated more with positive changes in technological competitiveness than with those in trade. Those statistics shown in the third from last column in table 2 are for Germany (57% and 17% respectively) and the United States (75% and 14%). In these countries, however, higher domestic competition is correlated more with the negative changes in trade competitiveness than with positive changes. In Japan interestingly, a higher level of domestic competition is correlated more with negative changes in both technological and trade competitiveness than with positive changes. While these characteristics are spread fairly evenly across all industries in these countries, two industries do have a positive correlation between higher levels of domestic competition and positive changes in both technological and trade competitiveness (i.e. papers (26) in Germany and apparels (23) in the US).

In contrast to the positive correlation, ten industries have a correlation between higher levels of domestic competition and negative changes in both technological and trade competitiveness in the advanced countries. These include electronics (36) and instruments (38) in Germany, textiles (22), apparels (23), woods (24), primary metals (33), fabricated metals (34), transport equipments (37) and instruments (38) in Japan, and electronics (36) in the US. Interestingly, the negative changes in technological and trade competitiveness in relatively high-tech industries in these countries (electronics in Germany and the US, and instruments (38) in Germany and Japan) are associated with higher levels of domestic competition. Exceptions in this regard are the correlation between higher levels of competition and the positive changes in technological competitiveness in electronics in Japan and instruments in the US.

In Hong Kong and Singapore, a higher level of domestic competition is correlated with changes in trade competitiveness (53% and 69%, respectively) rather than with technological competitiveness (33% and 55%). In contrast, in South Korea higher competition is more associated with technological competitiveness than with trade competitiveness (71% and 64%, respectively). Hong Kong, shows a more positive correlation between increased competition and changes in technological and/or trade competitiveness than a negative one. However, only the food industry has a positive correlation between competition and both technological and trade competitiveness. With respect to the other industries, an increased in competition in the chemicals (28), primary metals (33) and instruments (38) is positively correlated with trade competitiveness. While in apparels (23) and industrial machinery (35) the stronger correlation is with technological competitiveness.

With respect to South Korea, the correlation between an increased level of competition and changes in technological competitiveness is characterised by a negative relationship (70%), whereas the correlation between competition and trade competitiveness is positive. There are some industries where the relationship for technology is positive, and these are the medium to high-tech sectors, namely petroleum products (29), electronics (36) and instruments (38). It is also in the medium to high-tech range that competition and trade competitiveness are positively correlated (i.e. chemicals (28), plastics (30) and industrial machinery (35)). Interestingly, in the two cases of petroleum products and electronics, the positive correlation is extended to both technological and trade competitiveness.

In Singapore generally more industries are associated with a negative correlation between higher levels of competition and technological and trade competitiveness (60% and 57% respectively). An exception is the electronics (36) industry where competition is positively associated with technology and trade, and the primary metals (33), industrial machinery (35) and the instruments (38) industries where there is a positive relation with trade only. Positive associations with technology alone are found in foods (20) and transportation equipment (37) for Singapore.

Table 2 Correlation between Domestic Competition and Technological and Trade Competitiveness

		20	22	23	24	26	28	29	30	32	33	34	35	36	37	38	+ %	- %	Total
Germany 1980-1997*1	SRCA	0.21	-0.44**	-0.72***	-0.82***	0.72***	-0.80***	0.48**	-0.80***	-0.40**	-0.45**	-0.54**	na	-0.86***	0.09	-0.59***	16.7	83.3	78.6
	SRTA	0.10	0.86***	0.13	0.37	0.57***	0.85***	-0.40**	0.84***	0.12	0.10	0.31	na	-0.71***	0.05	-0.68***	57.1	42.9	50.0
Japan 1980-1997	SRCA	-0.70***	-0.71***	-0.93***	-0.81***	-0.88**	0.52**	0.81***	-0.78***	-0.46**	-0.88***	-0.93***	0.70***	-0.90***	-0.93***	-0.52**	20.0	80.0	100.0
	SRTA	-0.18	-0.52**	-0.61***	-0.46**	0.14	-0.80***	-0.72***	-0.14	0.72***	-0.38*	-0.66***	-0.27	0.69***	-0.77***	-0.88***	18.2	81.8	80.0
USA 1980-1997	SRCA	0.20	-0.58***	0.37*	-0.49**	-0.19	-0.94***	-0.10	0.20	-0.66***	0.16	0.11	-0.39**	-0.68***	-0.12	-0.23	14.3	85.7	46.7
	SRTA	-0.17	0.64***	0.65***	-0.23	-0.05	0.40**	-0.06	-0.32	-0.22	-0.35*	0.34*	0.96***	-0.77***	0.20	0.65***	75.0	25.0	53.3
Hong Kong 1983-1997*2	SRCA	0.92***	-0.31	-0.86***	-0.91**	0.30	0.87***	0.54	-0.83	-0.41*	0.76***	-0.32	0.17	-0.82***	-0.10	0.70*	62.5	37.5	53.3
	SRTA	0.51**	-0.23	0.56**	-0.76	0.01	0.20	0.54	-0.95*	0.16	0.32	0.14	0.41*	0.18	-0.09	-0.68*	60.0	40.0	33.3
S. Korea 1983-1997*3	SRCA	-0.59**	0.57	-0.54*	na	0.07	0.77***	0.70***	0.89***	-0.72***	-0.03	-0.68**	0.89***	0.60**	-0.35	0.36	55.6	44.4	64.3
	SRTA	-0.23	-0.37*	-0.50*	na	0.04	-0.47**	0.51**	-0.62**	0.20	0.00	-0.65**	-0.46*	0.80***	-0.75***	0.77***	30.0	70.0	71.4
Singapore 1983-1997*4	SRCA	-0.67***	na	0.28	na	-0.84***	-0.75***	-0.76*	-0.69**	0.22	0.62***	-0.15	0.75***	0.42*	-0.75***	0.95***	40.0	60.0	69.2
	SRTA	0.36*	na	na	na	na	0.26	0.21	-0.56*	-0.11	-0.50**	-0.68**	-0.59**	0.72***	0.58**	0.04	42.9	57.1	54.5
Argentina 1987-1997*5	SRCA	-0.44	na	na	na	na	-0.87**	-0.73***	-0.16	-0.40	-0.83***	-0.65*	na	na	0.70*	0.45	20.0	80.0	55.6
	SRTA	0.74**	na	na	na	na	-0.38	-0.27	-0.31	-0.79**	-0.64**	-0.31	na	na	-0.22	-0.75	33.3	66.7	33.3
Brazil 1989-1997*6	SRCA	0.34	-0.86***	-0.65*	-0.31	0.77***	0.29	-0.62**	0.63**	0.39	-0.76***	0.87***	-0.50*	-0.95***	0.08	na	33.3	66.7	64.3
	SRTA	-0.21	0.53	-0.17	0.22	-0.28	0.28	0.02	0.54*	-0.30	0.40	0.33	0.23	-0.31	0.32	na	100.0	0.0	7.1
Mexico 1983-1997*7	SRCA	-0.23	0.46**	na	na	0.19	0.57**	na	0.83***	0.45**	-0.09	0.71**	0.77**	0.35	0.91***	na	100.0	0.0	63.6
	SRTA	0.65***	-0.23	na	na	0.01	0.03	na	0.43*	0.38*	-0.30	0.79***	-0.21	0.55	0.08	na	100.0	0.0	36.4

Note: ***, **, and * are statistically significant at the 0.01, 0.05 and 0.10 levels, respectively.
20 = foods; **22** = textiles; **23** = apparels; **24** = woods; **26** = papers; **28** = chemicals; **29** = petro-products; **30** = plastics; **32** = stones; **33** = primary metals; **34** = fabricated metals; **35** = industrial machineries; **36** = electronics; **37** = transportation equipments; and **38** = scientific instruments.
+ % = the percentage of statistically significant positive results in relation to all statistically significant results.
- % = the percentage of statistically significant negative results in relation to all statistically significant results.
Total = the percentage of all statistically significant results in relation to all results, excluding na.
The columns with double lines are those industries that experienced a decrease in the level of domestic competition (see Graph 6).
*1: 23=1985-97; 24=1987-97; *2: 24,26=1994-97; 28=1986-97; 29,30=1995-97; 34=1991-97; 37=1985-97; 38=1992-97; *3: 23,30,33,34=1988-97; 26=1993-97; 35=1986-97; 36=1984-97; 38=1989-97; *4: 23=1992-97; 26,30,38=1991-97; 28=1984-93; 29=1993-97; 34=1987-97; *5: 20,37=1992-97; 28=1993-97; 32,34=1991-97; 38=1994-97; *6: 22,23=1991-97; *7: 30=1984-97; 34=1988-97; 35=1992-97; 36=1989-97.

In Latin American countries, higher competition is correlated mainly with trade competitiveness, particularly in Brazil. The association tends to be more negative in relation to both technological and trade competitiveness. Only the transportation equipment (37) industry has a positive correlation between higher levels of competition, and trade competitiveness. In Brazil, higher competition is correlated more with negative changes in trade competitiveness, and only the plastics (30) industry has a statistically significant result with respect to technological competitiveness. Mexico displays a peculiar pattern, in which all statistically significant results between higher levels of competition and technology and trade are positive, except for textiles (22). Where the correlation is positive for both trade and technology, the industry range is mixed and includes plastics (30), stones (32) and fabricated metals (34).

Following the analysis in the previous section, those industries that moved to the upper right quadrant between the two periods, possessing both technological and trade competitiveness in the last period, are identified in order to examine the relationship between domestic competition and the movements of the industries. The industries that moved from the upper left to the upper right quadrant are: plastics (30) in Germany; petroleum products (28), industrial machinery (35), and instruments (38) in the US; apparels (23) in Hong Kong; petroleum products (29) and electronics (36) in Singapore; foods (20) in Argentina; and stones (32) and primary metals (33) in Brazil. Table 2 indicates that all these industries appear to have a statistically significant positive correlations between higher levels of competition and the changes in technological competitiveness, except for stones and primary metals in the case of Brazil. While Singapore's electronics (36) industry has a statistically significant positive correlation between competition and technological and trade competitiveness, all other industries have statistically significant negative correlations between competition and changes in trade competitiveness, except for instruments in the US, foods in Argentina and stones in Brazil, where no statistically significant relationships were found. It can be deduced that the movement of industries between the upper left and upper right quadrants has been influenced by increased levels of domestic competition.

The industries that remained in the upper right quadrant between the two periods, maintaining both technological and trade competitiveness are also identified as chemicals (28), industrial machinery (35), transport equipment (37) in Germany; electronics (36) and instruments (38) in Japan; papers (26) in the US; electronics (36) in Hong Kong; and electronics (36) in South

Korea. In these cases, there is no clear pattern in relation to the correlation between higher levels of competition and changes in technological and trade competitiveness. Only South Korea's electronics industry has a statistically significant positive correlation between competition and changes in technological and trade competitiveness. Chemicals in Germany and electronics in Japan have statistically significant positive correlations between competition and technology but statistically significant negative correlations between competition and changes in trade competitiveness. Transport equipment in Germany and the paper industry in the US show no statistically significant relationships, although the former increased its technological competitiveness, and the latter maintained almost the same level of technological and trade competitiveness between the two periods. Japan's instrument industry has a statistically significant negative correlation between higher levels of competition and changes in technological and trade competitiveness, while Hong Kong's electronics industry only has a statistically significant negative correlation between competition and trade competitiveness.

In addition to these, two industries, papers (26) in Germany and plastics (30) in the US, moved from the lower right (possessing technological competitiveness without trade competitiveness) to the upper right quadrant. A higher level of competition in Germany's paper industry is correlated with changes in technological and trade competitiveness, whereas the plastics industry in the US shows no statistically significant result. Thus, the role of domestic competition in relation to what may be described as a pure technological push involving industries moving up the right side of the quadrant, is unclear and anyway involved few industries.

It is also interesting to examine the relationship between domestic competition and the changes in technological and trade competitiveness in the industries that moved away from the upper right quadrant. The industries that moved from the upper right to the upper left quadrant, losing technological competitiveness while retaining trade competitiveness, are transport equipments (37) in Japan, textiles (22) and instruments (38) in Hong Kong, and apparels (23), plastics (30) and fabricated metals (34) in South Korea. In addition, textiles (22) and primary metals (33) in Japan moved from the upper right to the lower right quadrant, losing trade competitiveness but maintaining technological competitiveness, and textiles (22) in Brazil moved from the upper right to the lower left quadrant, losing competitiveness in both spheres.

CONCLUSIONS

The analysis has revealed, not surprisingly, that the United States, Japan, and to a lesser extent Germany have relatively highly competitive domestic markets. Further, that increases in recent years in the level of domestic competition has occurred mainly in the low-tech industries in these countries. In contrast, increases in the domestic level of competition in East Asia appears to have occurred in relation to the medium and high-tech industries within the last ten years. In Latin America reduced levels of concentration have been observed in a range of industries in Brazil and Mexico, and far less so for Argentina, where markets for most industries remain fairly concentrated. The transport equipment industry has witnessed the most significant reduction in market concentration among the Latin American economies reviewed. Explanations for the changes in competition in all countries appear to be country or regionally specific, rather than industry specific, possibly indicating that domestic or international policy changes have had some influencing effect.

In summary, the analysis of the correlation between domestic competition and changes in technological and trade competitiveness has revealed that on a country basis, the majority of the countries examined have more statistically significant correlations between higher levels of competition and changes in trade competitiveness rather than in technological competitiveness. Only the United States and South Korea have more correlations between higher levels of competition and changes in technological competitiveness. In Germany and the US, increases in competition are associated more extensively with positive changes in technological competitiveness and negative changes in trade competitiveness. In Argentina, Japan and Singapore, higher levels of competition are associated with negative changes in both technological and trade competitiveness. In Hong Kong and Mexico, higher competition is correlated more with the changes in both technological and trade competitiveness, although more significantly with a positive relation in the case of trade competitiveness. In South Korea, competition increases are correlated more with a negative change in technological competitiveness and a positive change in trade competitiveness. Finally in Brazil, higher competition is associated more with a negative change in trade competitiveness. There is only one correlation with a change in technological competitiveness which is statistically significant and, therefore, it is difficult to draw a firm conclusion, on this case.

On an industry basis, the analysis has also indicated that there is no industry-specific trend or characteristic as to the relationship between higher domestic competition and the movements of the industries in relation to their technological and trade competitiveness. Irrespective of industry and country, higher levels of competition appear to have a crucial role in the movement towards the upper right quadrant, particularly through the positive association with technological competitiveness. In East Asia, however, higher levels of competition have also been associated with negative correlations with the industries that moved away from the upper quadrant.

On a country basis, interesting characteristics have been observed among the relatively high-tech electronics industry. Among the advanced countries of Germany and the US, higher levels of competition have been negatively correlated with changes in technological and trade competitiveness in this industry, while Japan, has been associated with a positive change in technological competitiveness. In South Korea and Singapore, higher levels of competition have been correlated with changes in both technological and trade competitiveness in the electronics sector. In Latin America, Argentina and Mexico there has been no statistically significant results, and in the latter, the level of competition has actually decreased for electronics. Finally, in Brazil a higher level of competition has been associated with a negative change in trade competitiveness with respect to the electronics sector.

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Appendix 1: Industrial Classification

We have established a concordance table based on information that has been publicly available. These include Johnson (1992), Verspagen, van Moergastel and Slabbers (1994), Amendola, Guerrieri and Padoan (1998), Jon Haveman's Industrial Concordances (www.macalester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/TradeConcordances.html), and IFI CLAIMS Patent Services, Patent Intelligence and Technology Report (www.ificlaims.com/ ifipitx/pitindx.htm).

Our industrial categories are, in large part, in accordance with those of the International Standard Industrial Category (ISIC). In the context of the East Asian developing countries, we have added a new category, amusement devices, which consists of toys and games. For those industries that belong to more than one industrial category, we have divided the number of patents and the export values by the number of industrial categories that the industries belong to.

The Study's Classification based on ISIC
(SITC 3 digit level data and USP count data were rearranged accordingly)

1	Food and Kindred Products
2	Textiles, Apparel and Leather
3	Furniture, Wood Products and Home Fixtures
4	Paper, Paper Products and Printing
5	Plastic Materials and Synthetic Resins
6	Soaps, Detergents, Cleaners, Perfumes, Cosmetics and Toiletries
7	Chemistry and Chemical Products
8	Agricultural Chemical
9	Pharmaceuticals
10	Petroleum Refineries and Natural Gas Extractions
11	Rubber and Plastic Products
12	Stone, Clay, Glass, and Concrete Products
13	Primary Ferrous Products
14	Primary and Secondary Non-Ferrous Products
15	Fabricated Metal Products
16	Engines, Turbines, Motors and Parts
17	Farm, Construction, Mining and Material Handling Machinery and Equipment
18	Metal Working Machinery and Equipment
19	Industrial Machinery and Equipment
20	Computing and Office Machines (and Computing Software)
21	Electrical Apparatus, Equipment and Machinery
22	Electronics
23	Motor Vehicles and Parts
24	Aircraft and Parts
25	Ship and Boat Building and Repairing
26	Railroad Equipment
27	Professional and Scientific Instruments
28	Amusement Devices
29	Miscellaneous Manufacturing

United States Standard Industrial Classification (SIC) Codes
(SITC 3 digit level data and USP count data were rearranged accordingly)

20	Food and Kindred Products
21	Tobacco Products
22	Textile Mill Products
23	Apparel and Other Textile Products
24	Lumber and Wood Products
25	Furniture and Fixtures
26	Paper and Allied Products
27	Printing and Publishing
28	Chemical and Allied Products
29	Petroleum and Coal Products
30	Rubber and Miscellaneous Plastics Products
31	Leather and Leather Products
32	Stone, Clay, and Glass Products
33	Primary Metal Industries
34	Fabricated Metal Products
35	Industrial Machinery and Equipment
36	Electronic and Other Electric Equipment
37	Transportation Equipment
38	Instruments and Related Products
39	Miscellaneous Manufacturing Industries

[1] Paper prepared for the Joint Conference of the University of Illinois and the Centre on Regulation and Competition of the University of Manchester on The Regulation of Development and The Development of Regulation, held at the University of Illinois at Urbana – Champaign. 23-24 April 2004.