R&D and Innovation in East Asia[1]

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Abstract

This paper uses a survey of 1,826 firms distributed over eleven East Asian economies - Indonesia, Korea, Malaysia, the Philippines, Singapore, Thailand, and five Chinese cities - to investigate a range of firm-level, market, and institutional conditions that influence both the effectiveness of the R&D process and overall firm performance. We are able to distinguish between two sets of factors. The first, which includes the composition of public and foreign ownership, R&D transactions and networks with external sources, and internet use and IT investments within firms, affect firm productivity and profitability through their interaction with the firm's R&D program. That is, they enhance the efficiency of R&D. A second set of factors, including the role of imports and market share, government assistance, and location in industrial parks, affect firm performance through channels other than R&D. We then group these attributes into four categories – openness and competition, human capital, R&D institutions and networks, and institutions and infrastructure – and measure the incidence of these attributes across the 11 economies included in the survey. We find a close association between the incidence of these attributes and the performance of the pooled samples for each of the economies. Building on firm-level data, our conclusions underscore the importance of R&D in driving the innovation, productivity, and profits of firms and whole economies. We further find that a range of factors associated with R&D transactions and networks affect the efficiency of R&D.

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1. Introduction

This paper analyzes the factors that shape innovative activity and its effects on firm performance across seven national economies: China, Indonesia, Korea, Malaysia, the Philippines, Singapore, and Thailand. Because the China sample includes five cities, the World Bank data set effectively spans 11 economies. Whether these economies are able to catch up with the world's most advanced economies will depend fundamentally on their ability to create and sustain technological progress. Technological progress, in turn, will depend on the innovative capabilities of the firms that produce the goods and services within these economies. It is these collections of firms that convert new knowledge - both that created at home and absorbed from abroad - into commercial uses that propel rising living standards.

This paper identifies firm, market, and institutional attributes that directly influence the ability of firms to utilize their R&D resources to enhance productivity and profitability. Among these factors are participation in R&D networks, the interaction of firm R&D with purchased technologies, and the role of human capital, including the use of the internet and other IT resources. Having identified factors that shape R&D performance at the firm level, we measure the distribution of these attributes across the country and city economies in the sample. We then examine whether aggregated at the economy-wide level, firm performance is consistent with the distribution of the driver variables across the 11 economies included in the survey.

2. Key research issues

The paper examines five questions. These five questions that we outline below also identify the broad outlines of our research strategy.

1. How does the intensity of innovation activity differ across the countries and cities included in the survey?

2. Do we find robust statistical relationships between R&D inputs and innovation activity? Can we associate R&D inputs with identifiable innovation outputs? Are these innovation outputs associated with productivity and profitability at the firm level? Do these relationships vary significantly across the eleven economies in our survey?

3. The World Bank survey includes an extraordinarily rich set of firm, market, and institutional variables. Can we distinguish which of these affect firm performance? Does the impact of these variables operate through an identifiable R&D process or do they operate independently of formal R&D channels?

4. Once we have identified a set of "driver variables" using the firm level data, can we distinguish the incidence of these attributes across the11 country/city economies covered in the survey? Specifically, when we group the driver variables by

openness/competition, human capital, R&D network, and institutional/infrastructure can we identify a ranking of the economies according to the relative concentrations of these attributes?

5. Once we have identified a comparative composite measure of country/city attributes, can we identify a systematic association between overall productivity and the composite measures of these economies? Can we identify an association between the measured returns to R&D activity and the composite measures?

Before examining each of these issues, we describe the data that are available in the World Bank firm survey.

3. The data set

The data are drawn from a survey that was administered in five cities in the People's Republic of China and six Asian economies other than China. Within each of these eleven economies, the sample is distributed over five manufacturing sectors and five service sectors. The distributions of firms across the countries and cities and by sector are shown in Tables 1a and 1b.

The data set spans a total of 1,826 firms of which 1,500 are located in China. The remaining 326 firms are distributed among Indonesia (76), Korea (85), Malaysia (56), Philippines (65), Singapore (18), and Thailand (26).

The data set includes a strikingly rich set of data that detail characteristics of the participating firms, the markets in which they operate, and their links with government, competitors, suppliers, clients, foreign firms, and research institutes. A central challenge of this research project is to identify which of the many variables and associations are important drivers that distinguish economic performance at both the level of the firm and across countries and cities. This process of statistical identification, however, also requires a conceptual framework within which we can hypothesize and test important economic and commercial relationships.

4. Distribution of innovation activity by country and city

Innovation is appropriately viewed as a deliberate activity (Usher 1954). Firms employ resources to produce new knowledge that is embodied in new products and processes, as well as quality improvements in products and processes. Before examining the link between innovation inputs and outputs at the firm level, we compare the intensity of innovation activity at the level of the country and city economies included in the Bank survey.

Innovation outputs. Table 2a shows the distribution and intensity of reported innovation outputs. Overall, the new product sales ratio (column 2) is higher in China than elsewhere. Within China, Shanghai exhibits the highest ratio of new product sales. Columns 3 through 7 show the incidence of five distinct forms of innovation. The first

two – introduced new product(s) in an existing business line and entered new business line(s) – measure the incidence of new product innovation. Compared with the new product-sales ratios shown in Column 2, these figures indicate only a small advantage for Chinese firms.

Table 3 formally tests the statistical significance of differences in each innovation type across the 11 countries and cities. Here and elsewhere, Beijing is used as the reference location in the regression analysis. One difference between Tables 2a and 3 is that the latter controls for differences in industrial composition. The results in Table 3 show that firms in the Shanghai sample stand out as high-incidence new product innovators; other than Shanghai, only Indonesia stands out as a high-incidence new product innovator. By comparison, the Tianjin sample exhibits the lowest rate of innovation, followed by Guangzhou, Malaysia, and the Philippines.

In Table 2a columns 4 through 6 represent three process-related areas of innovation: new production process improvement(s), new management technique(s), and new quality control(s). The incidence of production process innovation is comparable between Chinese and the other East Asian economies. For the two forms of process innovation – management techniques and quality controls – the Chinese sample exhibits approximately a two-to-one advantage. This difference may reflect the likelihood of a higher incidence of ownership and management restructuring in the Chinese sample during the latter half of the 1990s.

The last column of Table 2a shows the incidence of new patent application, both at home and in the U.S. The inventions may relate either to new products or to new processes. Our samples of Chinese firms and other Asian firms both show very low rates of patent applications pending in the U.S. – larger in the other six countries than in China, but still less than one percent. Among home patent applications, China enjoys a small advantage. Within China, the firms in Tianjin, once again exhibit the lowest rate of innovation.

Table 3, which focuses on differences in the likelihood of process innovation, confirms the results shown in Table 2a. Controlling for industry composition, Table 3 shows that in comparison with the six country economies, the Chinese cities, with the exception of Tianjin, exhibit somewhat higher rates of process innovation. Chengdu emerges as the high-incidence process innovator, followed by Guangzhou and Shanghai.

Innovation inputs. Table 4 shows the intensity of innovation effort. The first two columns report differences in R&D intensity measured as the R&D expenditure/sales ratio. The means, shown in the first column, show Chengdu, Guangzhou, the Philippines and Korea will similar expenditure intensities. Column 2 shows, however, that among the 11 economies, only Chengdu exhibits a statistically higher expenditure ratio.

Columns 3 and 4 report the intensity of innovation measure in terms of the share of R&D personnel in total employment. By this measure, Korea exhibits by far the highest ratio,

which is shown in Column 4 to be significant greater than any of the other country and cities. At the other end of the distribution, the Philippines, Tianjin, and Malaysia exhibit personnel ratios that are significantly less than the other included Asian economies.

5. A conceptual framework

The central purpose of this paper is to identify ways in which firm, market, and institutional attributes affect the innovative capabilities of firms and the comparative performance of whole city and country economies. To the extent that firm-level capabilities and performance are shaped by R&D networks and spillovers from other firms or by public goods that are created and sustained by government policy and resources, then we should expect to find a clustering of attributes and performance by geography. This study attempts to identify robust relationships between attributes and performance at the firm level and then test if country and city economies in which these attributes are concentrated also exhibit the performance outcomes of their constituent firms.

We catalog the long list of attributes that are measured in the World Bank survey into four broad categories. These are openness and competition, human capital, R&D networks, and institutions and infrastructure.

Openness and competition. The recent growth literature generally agrees that there is no systematic evidence to support the notion of a convergence of living standards among the world's rich and poor economies (e.g. DeLong, 1988). The growing acceptance of the stylized fact of non-convergence has motivated researchers to identify conditions that distinguish countries that exhibit convergence from those that do not. One such study of conditional convergence, demonstrates the tendency toward convergence among the world's most open developing economies. Creating an index of openness, Sachs and Warner (1995) demonstrate that the 30 countries among those most open to trade between 1965 and 1997 show convergence in income.

The World Bank survey does not formulate measures of openness and competition for each of the participating 11 economies. It does, however, collect data at the level of the firm that reveal the openness and competitiveness of the venue within which the participating firms operate. Among these data are the share of the domestic market supplied by imports, exports as a share of sales, the share of FDI in total equity, and the number of competitors identified by each firm. Our methodology is to use these measures individually to examine how they affect firm performance and also to aggregate the firm-level data that span ten key industries as approximations of the overall openness and competitiveness of each of the country and city economies.

Human capital. In their influential paper, Mankiw, Romer and Weil (1992) demonstrate that the "fit" of the Solow model could be improved by extending the model to include human capital. Within the context of this paper, human capital plays an important role, not only as a determinant of overall firm performance, but also as a factor that is likely to influence the effectiveness of the firm's R&D operation. Among the measures of human

capital included in the Bank survey are the foreign work experience of the workforce, the proportion of workers using the internet, and the educational level of management.

R&D networks. During the decades following the publication of Solow's neoclassical growth model, which underscored the reliance of long-run growth of living standards on technological progress, economists implicitly or explicitly assumed that technology was a public good. As a public good, technology could, at no or little cost, be shared or transferred among agents.

In recent years, researchers have become more interested in the barriers to technology transfer. These include formal, intentional barriers such as intellectual property rights law. At a less formal level, they also include the know-how networks examined by VonHippel and Carter.

Our measures of R&D networking include multiple measures. One group of such measures is commercial transactions, including the purchase of domestic and foreign licenses and other purchases of technology from outside the firm. A second broad category of networking measure is that relating to institutional linkages, such as contracts or long-standing relationships with R&D institutions, including universities and research institutes, and the receipt of external R&D from both private and public sources.

Institutions and infrastructure: The article based on the lecture R.H. Coase delivered when he received the Nobel price in economics – "The Institutional Structure of Production" (1992) – was both the culmination of and a significant contribution to the way in which economists view the role of institutions in shaping economic organization, behavior, and performance. During the past decade, numerous researchers and organizations have attempted to summarize and rank national economies by the attributes of the institutions that govern their economic activity.

Institutional and infrastructure measures potentially cover a wide area. Measures of institutional quality often cover issues of transparency and corruption. Our measures do not include these attributes; we focus on the share of public and foreign ownership within the firm and the country and city samples. We also include a measure of the extent to which governments extend services to local firms for the purpose of establishing relationships with foreign firms. Our measures of infrastructure include the role of industrial zones and the proportion of IT assets in total capital.

The list of candidate measures of firms, market, and institutional attributes that facilitate firm, city, and country economic performance is long. Our approach is to measure the economic and statistical significance of each of these as drivers of firm-level productivity and/or profitability. They may affect firm-level performance through one of two possible channels. They may directly affect the firm's performance; alternatively they may work to enhance the effectiveness of R&D input in which case they exhibit a positive interaction with the R&D variable.

6. A research strategy for identifying the channels through which attributes affect firm performance

Using firm-level data, we now formally test some of the associations that have emerged in the statistical analysis above. Our intention here is to examine the link between firm, market, and institutional attributes and the firm's innovation performance. In particular, two approaches present themselves. The first is to examine the link between firm-market-institutional attributes and the incidence of specific innovation outcomes, such as those reported in Table 3. We demonstrate this approach in Table 5. One clear inference that can be drawn from Table 5 – at least from the China side of the sample – is that for most innovation measures the incidence of innovation counts is substantially greater for R&D networked firms than it is for their non-networked counterparts.

This analysis, however, raises two issues. The first is whether this higher incidence operates through the formally specified R&D function. It may be, for example, that R&D linkages with universities, research institutes, and private companies result in the transfer of new products and processes independent of the firm's formally established R&D activity. That is, external R&D linkages and internal R&D operations may be substitutes. However, since studies seem to indicate that in order to absorb technology, firms require some independent R&D capability, it is more likely that the adoption of an innovation through an R&D network, such as documented in Table 5, requires some minimum level of R&D activity. The results shown in Table 6 confirm this intuition. Table 6 shows that for most of the five measures of innovation output, R&D is a highly associated with the incidence of innovation.

A second consideration is the link between R&D networks and firm performance. Innovations may be inconsequential or of high quality. Reported new product and process innovation may or may not systematically affect the key performance measures of productivity and profitability. Table 7 investigates this connection and finds evidence of such linkages. The introduction of new products, new management techniques, and quality controls all exhibit statistically significant relationships with productivity and profitability. That the introduction of new business lines does not exhibit such a connection may result from the contemporaneous disruption and subsequent break-in time required for radical product innovation.

Still, measured innovation outcomes may only weakly measure the impact of R&D on firm performance. A firm's R&D activity may affect firm performance through channels other than those formally measured. R&D personnel, for example, may expend effort on improvements in the quality of existing products, on the installation and efficient use of new machinery, or on other incremental tasks that substantially improve firm performance but are not captured in counts of innovation outputs.

In their study of R&D in Chinese industry, Jefferson, Bai, Guan, and Yu (2001) confirm the inability of measures of innovation to account for only a fraction of the measured returns to R&D. Using data on counts of patent applications and the share of sales accounted for by new products, Jefferson and his colleagues find that among China's

large and medium-size firms these measures account for only 18 percent of the returns to R&D personnel. The share of measured returns to R&D expenditure accounted for by patents and new products is substantially higher – 73 percent. The authors argue that the reason for this disparity is the tendency for R&D in large firms to be substantially more capital intensive than in smaller firms. Within the typical large firm, the model is one of an R&D lab in which R&D is focused on the production of patentable innovations and measurable new products. By comparison, the medium-size enterprise, which in China, accounts for approximately one-sixth of the sales of the typical enterprise classified as "large-size," maintains a far more labor-intensive R&D operation in which R&D teams appear to be focused on incremental innovation, such as product quality and small process improvements.

In principle, we can examine the impact of firm, market, and institutional attributes on the link between R&D and innovation outputs (i.e. those shown in Table 6); that is, we can incorporate interactive terms (with R&D and the respective attributes) into the regression analysis. Likewise, we could interact the same list of attributes with the innovation outputs shown in Table 7. These interactions could, for example, capture quality differences among innovations, such as differences in the productivity of innovation counts originating within an IT- intensive company as compared with a more traditionally-managed firm. The interactive term might also capture important complementarities that exist among new products and firm, market, and institutional attributes, such as imported equipment, the availability of external R&D assistance, and other attributes.

These exercises can be carried out in principle, but given the need to design a manageable research method, we choose here to examine the role of firm, market, and institutional attributes within the context of the reduced form. That is, we investigate how the interaction of firms, market, and institutional attributes with the formal R&D function influences the effectiveness of R&D measured in terms of productivity and profitability.

7. The Relevance of Firm, Market, and Institutional Attributes for the Effectiveness of R&D

By substituting the estimation equations in Table 6, which identify the relationship between R&D and innovation, into those estimated in Table 7, which identify the relationship between innovation and firm performance, we can then estimate a set of reduced form equations, i.e. the relationships between R&D and firm performance. We then aggregate the five productivity equations into a single productivity equation; likewise, we aggregate the five profitability equations into a single profit equation. The estimates of these two equation are shown in Table 8.

Table 8 reports the elasticities of productivity and profitability with respect to R&D personnel. Both elasticities are statistically significant and in the range of 0.15. In the subsequent tables – Tables 9a through 9c and Tables 10a and 10b – we test the channels through which the firm, market, and institutional attributes affect productivity and profitability. As we test the link between the attributes and firm performance, we find

one of three links. The attributes may have no effect on firm performance; they may affect firm performance through the intercept, or they may robustly interact with the measure of R&D personnel. Tables 9a, 9b, and 9c identify the attributes that operate, in some significant measure, through the formal R&D function. The attributes in Tables 10a and 10b do not exhibit statistically significant interactive terms with R&D personnel. They do, however, exhibit significant direct impacts, which operate through intercept shifts, on productivity and profitability.

7. Conditions that shape firm-level innovation capabilities

Tables 9a, 9b identify a list of firm, market, and institutional attributes that complement the contribution of R&D personnel to firm-level productivity and profitability. With the exception of ownership structure and the number of competitors – a market factor that serves to limit profit, the factors.

The results in Table 9a indicate that a firm's ownership structure affects the productivity and profitability of R&D. While foreign ownership increases the effectiveness of R&D, public ownership appears to limit the returns to a firm's R&D operation.

With the exception of the number of competitors, the other factors embody qualities that relate to the R&D process. That firms in which a high proportion of firms are internet users also operate relatively successful R&D operations should not be a surprise. As a source of technical information and channel for the exchange of know-how, the internet provides an invaluable R&D network for R&D personnel. Firms that invest heavily in information technology (IT) assets are creating within the firm the physical infrastructure needed to participate effectively in the internet-based R&D network.

The finding that both of these characteristics – the proportion of workers using the internet and investment in IT assets – are important drivers of R&D efficiency should not be surprising. To a substantial degree these are complementary inputs to an internet-based R&D network. In principle, we should combine these, as well as other characteristics that we believe enhance the effectiveness of the R&D process, into a single regression equation. Otherwise, owing to the high correlation of these attributes, estimating the effect of each of these attributes alone is likely to create an upward bias in estimates of their contribution to the efficiency of R&D. On the other hand, multicollinearity may frustrate an attempt to distinguish between the separate contributions of highly complementary inputs. In future work, we intend to investigate the nature of the interactions among the attributes shown in Table 9 – and Table 10 – but in this paper, we examine the impact of each attribute without controlling for complementary factors, other than the usual controls for conventional capital and labor.

Before looking at explicit measure of external R&D linkages, we examine the negative impact of the number of competitors on the returns to R&D. The negative sign most likely reflects the tendency of competition to limit the markup on innovations. Lower markups – and prices – depress measures of both profit and productivity. This result seems to give support for Schumpeter's view ( ) of the advantages of market power in

innovation in comparison with those of Arrow ( ), who argued that by spreading an innovation over a larger number of sales in a competitive market, the innovation would net more than it would in a monopoly market.

Each of the four attributes shown in Table 9b relates to explicit external R&D- related transactions of the firm. The purchase of outside technology, including the purchase of foreign licenses, enhances the effectiveness of R&D. Likewise, the receipt of R&D assistance from an external source raises R&D efficiency. Finally, firms that provide design or R&D services to a foreign firm exhibit relatively efficient R&D operations. The results suggest a consistent pattern in which R&D networking – external commercial and exchange transactions and the establishment of resources within the firm, such as internet and IT capabilities – enhances the effectiveness of R&D.

Tables 10a and 10b identify a number of attributes that are associated with higher firm productivity and profitability, but their effect does not, at least in a statistically significant sense, operate through the firm's formal measure of R&D. The attributes each create positive intercept shifts in the measure of firm performance.

The one variable that we would expect to operate through the R&D variable, but seemingly does not, is the R&D network variable. For this variable, the firms is asked "Did you have a contractual or long-standing relationship with any of the following to perform R&D for your plant?" The possible sources of R&D services are a local university, government research institute, private research institute, or private company. That this attribute significantly affects the firm's performance without enhancing its R&D program indicates that contracting for services may represent a substitute for internal R&D capabilities. The services improve firm performance but, unlike other forms of R&D transactions and networking, the avenue of impact does not run though the firm's R&D operation.

The other factors – imported equipment, market share, the market share of imports, industrial park location, and government assistance in locating a foreign client, supplier, or investor relationships – all enhance firm performance. Like externally-performed R&D services, each of these attributes impacts firm performance through channels other than the firm's R&D operation.

8. The distribution of attributes by country and city

Having at the firm level identified attributes that enhance firm performance, both directly and through enhancement of the firm's R&D function, we now examine how these important attributes are distributed over the 11 economies covered in the World Bank project. We look at the four of the five categories used by Hal Hill (2001) uses in his analysis. These are openness, human capital, R&D institutions, and institutions and infrastructure.

Openness. "More than 90 percent of the world's R&D is undertaken in the OECD economies, and thus openness to the world is critical for borrowers and latecomers, such

as those in East Asia" (Hill, p. 5). Our measure of economy-wide openness incorporates five of the 15 measures include in Tables 9 and 10. These are shown in Table 11.

To identify the incidence of these attributes in each of the 11 economies, we regress the attribute on a set of country/city dummies as well as a set of industry dummies. When the survey data provide us with a continuous measure of the attribute, we use a log-linear estimation equation. When the attribute is on-off, such as imported equipment, we use a logit model.

As we see in Table 11, we have created two composite measures. The first is the number of statistically significant estimates ($t > 1.95$). The relative incidence of each attribute may be positive/or negative. The second composite measure is the sum of the t-statistics. For both composite measures, we reverse the sign on the number of competitors, since our interpretation is that the negative impact of this factor on measured productivity and profitability arises from a reduced markup. Where competition is relatively low, measured productivity and profitability should be relatively high.

Our results show similar levels of openness among Indonesia, Malaysia, and the Philippines, Korea, and Shanghai, and Guangzhou. The results show Singapore and Thailand lagging behind this upper tier, but it is also the case as shown in Table 1b that these countries have the least number of survey observations. The low t-statistics for these countries may simply reflect the paucity of observations. The fact that all of the Asean 4 economies have 76 or fewer observations may explain why the pooled estimates for this group are generally more efficient than for any of the individual countries. This is not a problem for Beijing, Tianjin, and Chengdu, which report the lowest degree of openness.

Human capital. Table 12 shows the distribution of human capital over the 11 economies. We include three measures of human capital, including the ratio of R&D personnel to the total workforce. Korea stands out as the economy with the highest measured intensity of human capital. None of the other economies is, as is Korea, positive and (nearly) statistically significant in all three measure of human capital.

R&D institutions/networks. In Table 13, we examine the distribution of five measure of R&D institutions and networks across the 11 economies. Among the 11 economies, Chengdu stands out as that with the highest intensity of R&D attributes. Closer examination of these results shows that this apparent advantage results from two measures -–the purchase of domestic licenses and the purchase of outside technology. Apart from the fact that the inclusion of both of these measures may imply double counting, it is interesting that for Chengdu over 70 percent of the composite t-statistic measure are derived from the purchase of outside, largely domestic, technologies. None of the other economies closely approximates the importance of either the estimates of these two attributes or their statistical significance. Within China, Shanghai and Tianjin appear to occupy opposite ends of the pole.

Institutions and infrastructure. Table 14 covers five measures of the institutional and infrastructure setting of the firms included in the Bank survey. On this measure the non-Chinese economies typically (with the exception of Korea) outperform the Chinese economies. These differences reflect the relative scarcity of public ownership in the Asean 4, Korean and Singapore. The principal reason for Shanghai's (marginal) advantage over Korea is the high incidence of foreign investment in the Shanghai sample. The relatively low incidence of FDI in Korea is consistent with characterizations of Koreas's industrial development strategy, which emphasize the role of human capital in reverse engineering imported goods and equipment rather than FDI. The Korean emphasis on human capital is confirmed by the results reported in Table 12. Overall, for the institution-infrastructure measure, the Asean 4 register the highest level, while Chengdu, Beijing, and Tianjin exhibit the lowest scores.

Summary of attributes. In Table 13, we attempt a composite measure of the five individual country-city attributes. While this index is necessarily arbitrary, it suggests a ranking has been aggregated from data and experience reported by individual firms. The index is therefore based on firm-level survey data. Since the Singapore and Thailand ranking that are based on only 18 and 26 firms respectively, these are probably the least reliable rankings. It should also be emphasized, that, for the most part, the ranking are based on measures that have been corrected for variations in industry composition.

The rankings in Table 13 suggest two basic finding. The first is that there appear to be three clusters of country-city economies. Malaysia and the Philippines stand at the high end of the distribution, while Beijing, Tianjin, and Chengdu stand apart at the low end of the distribution. The second notable result is the existence of considerable variation in the attributes of Chinese cities. Guangzhou and Shanghai rank relatively high in our attribute ranking, as within our eleven-economy comparison, Beijing, Tianjin, and Chengdu rank the lowest.

9. The association at the country-city level between attributes and performance

Based on their composite measures, Table 16 assigns each of the 11 economies to one of three tiers – low, medium, and high. Overall, we find a broad association between the overall economic performance of these 11 economies – their pooled productivity and profits – and the composite measures of openness, human capita, R&D networks, and institutions and infrastucture.

[Once, Tables 11-15 have be reconciled with Tables 9-10, Table 16 needs to be revised; also we can estimate the regressions using the data in Table 16. Using a similar method, we can estimate the marginal productivities and profitability of R&D and associate these with the human capital and R&D network attributes across the 11 economies].

10. **Conclusions**

11.

The principal, but tentative, conclusions that result from the above analysis are:

Table 1a
Distribution of Firms by Country and City

China/industry	Beijing	Tianjin	Shanghai	Guangzhou	Chengdu	total
apparel	49	42	40	46	45	222
elec. equipment	41	36	40	40	35	192
elec. components	43	41	40	39	40	203
consumer products	21	35	40	33	36	165
vehicles and parts	44	46	40	42	44	216
IT service	25	29	20	30	24	128
commications	11	11	20	12	17	71
accounting	23	23	20	18	20	104
advertising	20	19	20	11	19	89
logistic	23	18	20	29	20	110
total	300	300	300	300	300	1500

Table 1b
Distribution of Firms by Country and City con't

Other East Asia/industry	Indo-nesia	Korea	Malaysia	Philip-pines	Singa-pore	Thai-land	total
apparel	21	9	4	18	0	8	60
elec. Equip	0	15	7	9	1	1	33
elec. Comp	4	18	9	5	3	4	43
cons. Products	0	8	4	0	0	1	13
vehicles	5	5	4	5	2	2	23
IT service	11	8	7	7	2	2	37
communications	6	7	2	4	0	0	19
accounting	10	2	4	4	3	1	24
advertising	4	5	4	4	2	1	20
logistics	15	8	11	9	5	6	54
total	76	85	56	65	18	26	326

Manufacturing industries – code		**Service industries – code**	
Apparel	Apparel and leather goods	IT service	Information technology services
Elec.equip	Electronic equipment	Communications	Communications service
Elec.comp	Electronic components	Accounting	Accounting and related services
Cons. Prod	Consumer products	Advertising	Advertising and related services
Vehicles	Vehicles and vehicle parts	Logistics	Business logistics services

Table 2a
Distribution of Innovation Activity by Country and City

Location	New product/ sales (mean) in 2000 (%)	New products (1)[1]	New business lines (2)[1]	New processes (3)[1]	New mgt techniques (4)[1]	New quality controls (5)[1]	# of firms filing patent applications[2]
		1498	1498	1498	1499	1499	
China total	36.1 (498)[3]	35.5 (533)	20.5 (307)	29.5 (442)	47.5 (713)	45.2 (678)	198(13.2)/7
Beijing	35.8 (109)	35.0 (105)	21.3 (64)	28.0 (84)	46.0 (138)	44.3 (133)	48(16.0)/1
Chengdu	33.20 (117)	40.7 (122)	26.3 (79)	38.0 (114)	53.3 (160)	51.0 (153)	55(18.3)/3
Guangzhou	35.6 (79)	30.0 (90)	20.0 (60)	30.3 (91)	54.7 (164)	52.0 (156)	43(14.3)/1
Shanghai	39.8 (138)	51.0 (153)	23.2 (70)	34.3 (103)	49.3 (148)	47.3 (142)	34(11.3)/1
Tianjin	38.7 (55)	21.0 (63)	11.3 (34)	20.0 ((50)	34.3 (103)	31.3 (94)	18(6.0)/1
Other East Asia total	24.4 (81)	32.5 (106)	19.6 (64)	30.7 (100)	22.7 (74)	23.3 (76)	37(11.4)/10
Indonesia	30.7 (16)	39.5 (30)	19.7 (15)	21.8 (16)	27.6 (21)	26.3 (20)	11(14.5)/3
Malaysia	22.8 (9)	30.4 (17)	21.4 (12)	42.9 (24)	33.9 (19)	25.0 (14)	5(8.9)/2
Philippines	24.5 (13)	21.5 (14)	13.9 (9)	32.3 (21)	23.1 (15)	24.6 (16)	2(3.1)/0
Thailand	19.2 (8)	34.6 (9)	19.2 (5)	15.4 (4)	11.5 (3)	7.7 (2)	2(7.7)/0
Asean 4		31.3	18.4	29.2	26.0	23.3	20(9.0)/5
Korea	23.5 (28)	34.1 (29)	22.4 (19)	32.4 (28)	15.3 (13)	24.7 (21)	14(16.5)/5
Singapore	21.4 (7)	38.9 (7)	22.2 (4)	38.9 (7)	16.7 (3)	16.7 (3)	3(16.7)/0

[1]proportion of firms reporting innovation for the year 2000 in each of the following categories:

1 = introduced new products in an existing business line (B1.1); 2 = entered new business line (B1.2); 3 = new process improvements (B1.3); 4 = new management techniques (B1.4); 5 = new quality controls in production (B1.5)

[2]Number of firms filing patent applications filed at home (proportion shown in parentheses)/in the U.S. during 1998-2000.

[3]The total number of firms reporting the relevant observation (i.e. ≥ 0).

Table 2b
Distribution of Innovation Activity by Industry

Industry	New product/ sales (avg) in 2000	New products (1)	New business lines (2)	New processes (3)	New mgt techniques (4)	New quality control (5)	# of firms filing patent application[2]
Accounting (128)	14.643(14)	20	16	5	35	25	5/0
Advertising (109)	29.636(11)	16	12	13	27	24	3/0
Apparel (282)	35.216(51)	62	20	79	103	115	21/1
Logistic (164)	14.45(20)	29	22	18	60	40	3/1
Communic (90)	27.391(23)	22	22	13	40	26	4/3
Cons. prod. (178)	35.789(71)	72	38	55	75	83	51/4
Elec. comp (246)	28.827(110)	115	58	115	129	135	29/0
Elec. equip (225)	43.546(119)	126	79	103	117	117	51/4
IT service (165)	41.745(55)	63	56	37	78	55	29/2
Vehicles (239)	35.4(105)	114	48	104	123	134	39/2
Total (1826)	34.807(579)	639	371	542	787	754	235/17

[1]proportion of firms reporting innovation for the year 2000 in each of the following categories:

1 = introduced new products in an existing business line (B1.1); 2 = entered new business line (B1.2); 3 = new process improvements (B1.3); 4 = new management techniques (B1.4); 5 = new quality controls in production (B1.5)

[2]patent applications filed at home/in the U.S. during 1998-2000.

[3]mean is for number of firms reporting new products > 0 (shown in parentheses).

Table 3
Likelihood of innovation by country/city*

	Indo	Malay	Phil	Thai	Asean 4	Korea	Sing	Tianj	Shang	Guang	Cheng	R^2/obs.
NPsales/ total sales (1)	-0.662 (-0.96)	-2.421 (-3.11)	-1.538 (-2.10)	-0.252 (-0.23)	1.321 (2.77)	-0.854 (-1.30)	1.009 (0.78)	-2.327 (-5.33)	1.163 (2.66)	-1.352 (-3.10)	-0.258 (0.59)	0.153 (1826)
NP in existing business line (2)	0.754 (2.67)	-0.157 (-0.47)	-0.529 (-1.54)	0.291 (0.64)	-0.116 (-0.57)	-0.143 (-0.52)	0.505 (0.93)	-0.809 (0.20)	0.724 (4.04)	-0.293 (-1.59)	0.258 (-1.59)	0.112 (1824)
Entered new business line (3)	0.187 (0.55)	-0.057 (-0.15)	-0.460 (-1.15)	0.156 (0.29)	0.060 (0.26)	-0.091 (-0.30)	0.138 (0.23)	-0.822 (-3.48)	0.091 (0.45)	-0.133 (-0.64)	0.280 (0.52)	0.071 (1824)
New product innov: (1) + (2) + (3)	**1/0**	**0/1**	**0/1**	**0/0**	**1/0**	**0/0**	**0/0**	**0/2**	**2/0**	**0/1**	**0/0**	
New process improvements (4)	0.166 (0.50)	0.964 (2.92)	0.430 (1.36)	-0.641 (-1.11)	-0.390 (-1.84)	0.120 (0.71)	1.123 (1.95)	-0.732 (-3.49)	0.337 (1.79)	0.114 (0.60)	0.515 (2.76)	0.119 (1824)
New management techniques (5)	-0.665 (-2.31)	-0.526 (-1.69)	-1.024 (-3.19)	-1.854 (-2.95)	0.836 (4.26)	-1.671 (-5.11)	-1.406 (-2.15)	-0.513 (-3.00)	0.135 (0.81)	0.327 (1.95)	0.301 (1.80)	0.069 (1825)
New quality controls (6)	-0.494 (-1.67)	-0.807 (-2.37)	-0.811 (-2.54)	-2.252 (-2.99)	0.822 (4.04)	-0.976 (-3.42)	-1.189 (-1.79)	-0.611 (-3.46)	0.124 (0.72)	0.308 (1.81)	0.278 (1.64)	0.087 (1825)
New process innov: (4) + (5) + (6)	**0/1**	**1/1**	**0/2**	**0/2**	**2/0**	**0/2**	**1/1**	**0/3**	**0/0**	**1/0**	**2/0**	

* The figures represent t-statistics; (-) represent regression results for which t-statistics < 1.

Table 4: Distribution of Innovation Inputs by Country and City

Location	% R&D expend/sales[1]	% R&D expend/sales[3]	R&D person/ total employ[1]	R&D person/ total employ[3]
Full six-country sample (326)	1.89 (242)[2]	-	3.90(276)	-
Indonesia (76)	1.77 (37)	-0.001 (0.01)	1.99(60)	-0.024 (1.62)
Malaysia (56)	0.04 (47)	-0.016 (1.47)	1.59(49)	-0.037 (2.25)
Philippines (65)	2.86 (55)	0.010 (0.94)	0.58(55)	-0.047 (3.05)
Thailand (26)	1.31 (19)	-0.001 (0.017)	1.12(20)	-0.022 (-0.92)
Asean 4	1.58(158)	-0.002 (0.27)	1.37(184)	-0.054 (0.34)
Korea (85)	2.82 (74)	0.008 (0.83)	10.37(79)	0.049 (3.57)
Singapore (18)	0 (10)	-0.020 (0.87)	0.37(13)	-0.052 (1.77)
Full China sample (1500)	2.40 (1217)	-	4.61(1254)	-
Beijing (300)	2.03 (262)	0.001 (0.021)	4.91(272)	0.010 (1.18)
Chengdu (300)	3.19 (268)	0.013 (2.17)	5.22(266)	0.007 (0.79)
Guangzhou (300)	2.91 (217)	0.009 (1.35)	5.91(236)	0.012 (1.25)
Shanghai (300)	1.98 (232)	0.000 (0.05)	4.73(237)	0.002 (0.18)
Tianjin (300)	1.84 (238)	-0.002 (0.32)	2.23(243)	-0.028 (3.01)
R /obs	-	0.075 (1459)		0.194 (1530)

[1]Three years' average and for rdsar00 < 1 or rdmr00 < 1.
[2]Numbers in brackets are the numbers of include observations
[3]Controls for differences across industry categories
[4]Here and elsewhere, when a single number is reported it is the t-test associated with the estimate of the relevant variable. In this case, the variables are country dummies.

Table 5: Impact of R&D Network on Innovation

	Type of innovation	Percent of R&D networked firms that report a given type of innovation				Percentage of non-R&D net-worked forms that report a given type of innovation
		Firms that have a relationship with a				
		Local university	Government research institute	Private research institute	Private company	
China	Introduce new product	70.47	73	68.75	52.44	16.67
	Enter new business line	49.74	48	56.25	35.37	25
	Intro process improvement	62.69	66	65.63	42.68	16.67
	Intro new mgt technique	74.61	77	84.38	67.07	58.33
	Intro new quality controls	74.09	76	78.125	58.54	66.67
Rest of East Asia	Introduce new product	64.17	66.67	54.55	52.27	(0/0)
	Enter new business line	33.33	38.89	54.55	34.09	(0/0)
	Intro process improvement	37.5	33.33	18.18	25	(0/0)
	Intro new mgt technique	20.83	38.89	9.09	25	(0/0)
	Intro new quality controls	25	33.33	9.09	22.73	(0/0)

Table 6
Knowledge Production
$LnX_i = \alpha_0 + \alpha_1 ln(R^* + 0.0001) + \alpha_2 lnSales + \Sigma\alpha_1 lnLOC + \Sigma\alpha_1 lnIND + \varepsilon$
$(i = 1,2,\ldots 5)$**

	New products (1)		New bus. line (2)		Process innov. (3)		New mgt tech. (4)		New quality controls (5)	
	All obs.	obs. > 0 only	All obs.	obs. > 0 only	All obs.	obs. > 0 only	All obs.	obs. > 0 only	All obs.	obs. > 0 only
constant	-1.527 (-3.54)	-0.230 (-0.33)	-2.177 (-4.30)	-1.217 (-1.58)	-.677 (-1.54)	-.631 (-0.91)	-.769 (-1.91)	-.645 (-0.90)	-.735 (-1.80)	-.336 (-0.47)
lnR*	0.159 (7.47)	0.299 (3.46)	0.136 (5.71)	0.359 (3.93)	0.183 (8.16)	0.161 (1.91)	0.113 (5.48)	0.184 (2.15)	0.123 (5.88)	0.189 (2.20)
lnSales	0.156 (4.90)	0.136 (2.60)	0.096 (2.72)	0.106 (0.055)	0.110 (3.38)	0.137 (2.64)	0.127 (4.31)	0.185 (3.45)	0.148 (4.90)	0.192 (3.55)
Indonesia	.378 (0.91)	0.704 (0.84)	.136 (0.28)	1.060 (1.26)	-.306 (-0.58)	-.319 (-0.35)	-1.141 (-2.51)	-1.457 (-1.65)	-.388 (-0.95)	-.708 (-0.86)
Korea	-1.573 (-4.36)	-1.499 (-3.17)	-1.065 (-2.73)	-1.446 (-2.84)	-.766 (-2.11)	-1.090 (-2.31)	-2.670 (-6.90)	-3.102 (-5.96)	-2.141 (-5.98)	-2.698 (-5.42)
Malaysia	-0.292 (-0.76)	-0.823 (2.58)	-0.134 (-0.33)	-1.679 (-1.55)	1.051 (2.77)	-0.023 (-0.03)	-0.608 (-1.73)	-1.851 (-2.44)	-1.083 (-2.76)	-2.671 (-3.01)
Philippines	-1.087 (-2.55)	-0.686 (-0.85)	-1.139 (-2.10)	-0.485 (-0.51)	-0.091 (-0.22)	-0.123 (-0.15)	-1.574 (-3.87)	-1.709 (-2.04)	-1.355 (-3.40)	-1.175 (-1.48)
Singapore	0.239 (0.30)	n.a.	0.936 (1.19)	n.a.	1.516 (1.96)	n.a.	-0.394 (-0.51)	n.a.	-0852 (-1.00)	n.a.
Thailand	0.221 (0.37)	-0.291 (-0.22)	0.478 (0.75)	n.a.	-0.551 (-0.70)	n.a.	-2.637 (-2.50)	n.a.	n.a.	n.a.
Tianjin	-0.324 (-1.45)	0.089 (0.24)	-0.395 (-1.53)	-0.132 (-0.34)	-0.302 (-1.27)	-0.102 (-0.28)	-0.215 (-1.09)	-0.161 (-0.44)	-0.278 (-1.37)	-0.460 (-1.25)
Shanghai	0564 (2.71)	0.817 (2.58)	-0.235 (-1.01)	-0.274 (-0.88)	0.199 (0.92)	0.030 (0.10)	-0.141 (-0.73)	-0.279 (-0.94)	-0.064 (-0.33)	-0.444 (-1.46)
Guangzhou	-0.352 (-1.67)	-0.066 (-0.22)	-0.284 (-1.21)	0.018 (0.06)	0.123 (0.58)	0.161 (0.53)	0.325 (1.71)	0.466 (1.48)	0.264 (1.37)	0.151 (0.48)
Chengdu	0.331 (1.65)	0.548 (1.91)	0.124 (0.57)	0.204 (0.71)	0.504 (2.44)	0.591 (2.06)	0.249 (1.35)	0.303 (1.05)	0.235 (1.25)	0.129 (0.44)
IND	Yes	yes	yes	yes	yes	Yes	yes	yes	yes	yes
Adj R^2/obs.	0.168 1458	0.108 (572)	0.102 1458	0.067 569	0.170 1458	0.089 569	0.105 1459	0.109 569	0.118 1442	0.101 569

*R = (R&D personnel)( )/total workforce (uc1a)
**Estimation equation with dummy for "0" observations; all dummy estimates were not statistically significant at the 5% level.

Table 7
Effect of Innovation on firm performance

	Productivity ln(VA)					Profitability lnProfit				
Constant	1.920 (7.19)	1.887 (6.99)	1.894 (7.02)	1.866 (6.94)	1.846 (6.86)	0.753 (2.14)	0.728 (2.05)	0.734 (2.08)	0.697 (1.98)	0.678 (1.92)
lnK	0.438 (13.66)	0.450 (13.90)	0.447 (13.80)	0.445 (13.76)	0.442 (13.66)	0.547 (13.20)	0.557 (13.40)	0.552 (13.27)	0.548 (13.23)	0.549 (13.20)
lnL	0.464 (9.05)	0.467 (8.98)	0.465 (8.93)	0.463 (8.94)	0.468 (9.06)	0.326 (4.95)	0.328 (4.94)	0.325 (4.90)	0.320 (4.84)	0.328 (4.96)
New product	0.434 (4.20)	-	-	-	-	0.404 (3.02)	-	-	-	-
New business line	-	0.116 (1.02)	-	-	-	-	0.152 (1.05)	-	-	-
New process innovation	-	-	0.157 (1.50)	-	-	-	-	0.291 (2.12)	-	-
New mgt technique	-	-	-	0.235 (2.40)	-	-	-	-	0.392 (3.11)	-
New quality controls	-	-	-	-	0.255 (2.61)	-	-	-	-	0.301 (2.40)
LOC	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IND	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AdjR (obs.)	0.68 (797)	0.67 (797)	0.67 (797)	0.67 (797)	0.67 (797)	0.60 (730)	0.60 (730)	0.60 (730)	0.60 (730)	0.60 (730)

Table 8
Effect of R&D on firm performance (reduced form)

	Productivity lnVA	Profit lnPROFIT
constant	2.350 (9.09)	1.271 (3.78)
lnK	0.429 (14.22)	0.522 (13.45)
lnL	0.419 (8.67)	0.287 (4.64)
lnR*	0.142 (4.58)	0.155 (3.93)
Indonesia	1.691 (1.29)	1.773 (1.10)
Korea	5.620 (10.41)	3.836 (5.03)
Malaysia	0.551 (1.20)	0.921 (1.23)
Philippines	2.685 (6.54)	2.234 (4.61)
Singapore	n.a.	n..a.
Thailand	2.707 (2.07)	-0.178 (-0.392)
Tianjin	-0.108 (-0.66)	-0.178 (-0.80)
Shanghai	0.761 (5.87)	0.731 (4.42)
Guangzhou	0.505 (3.85)	0.333 (1.93)
Chengdu	-0.061 (-0.44)	-0.019 (0.11)
Adj R^2/obs	0.671 (884)	0.588 (813)

R = average R&D personnel (1998-2000); “0” observations have been converted to “1”.

Table 9a
Effect of R&D interacted with firm-level factors
$\ln X = \alpha_0 + \alpha_1 \ln K + \alpha_2 \ln L + \alpha_3 \ln R + \alpha_4 (\ln R * \ln Z) + \Sigma \alpha_1 \ln LOC + \Sigma \alpha_1 \ln IND + \varepsilon$

Factor	variable	X_1 = Value Added	X_2 = Profit
Share of foreign ownership	ln R	0.189 (5.19)	0.221 (4.79)
	ln R* ln(foreignsh)[1]	0.009 (2.49)	0.013 (2.86)
	R^2 (obs)	0.662 (876)	0.591 (801)
Share of public ownership	ln R	0.073 (2.12)	0.085 (1.92)
	lnR* ln(publicsh)[1]	-0.014 (4.11)	-0.013 (2.97)
	R^2 (obs)	0.667 (875)	0.593 (800)
% workers using internet	lnR*	0.107 (3.44)	0.108 (2.66)
	lnR* ln(netsh)[1]	0.023 (4.63)	0.031 (4.77)
	R^2 (obs)	0.678 (866)	0.596 (798)
ITassets/total fixed assets	lnR	0.227 (4.69)	0.318 (4.38)
	lnR* ln(ITsh)[1]	0.047 (4.04)	0.055 (3.61)
	R^2 (obs)	0.718 (502)	0.636 (482)
Number of competitors	lnR	0.226 (4.58)	0.276 (4.58)
	lnR* ln(compete)	-0.032 (2.43)	-0.045 (2.70)
	R^2 (obs)	0.668	0.580 (723)
Industrial park/export processing zone	lnR	0.104 (3.01)	0.088 (2.02)
	lnR* zone	0.099 (2.33)	0.184 (3.39)
	R^2 (obs)	0.674 (881)	0.596 (808)
Manage-ment's level of education	lnR	0.496 (6.15)	0.474 (5.03)
	lnR* educ	0.391 (4.67)	0.360 (3.69)
	R^2 (obs)	0.678 (742)	0.607 (653)

Table 9b
Effect of R&D interacted with firm-level factors
$\ln X = \alpha_0 + \alpha_1 \ln K + \alpha_2 \ln L + \alpha_3 \ln R + \alpha_4 (\ln R * \ln Z) + \Sigma \alpha_1 \ln LOC + \Sigma \alpha_1 \ln IND + \varepsilon$

Factor	variable	X_1 = Value Added	X_2 = Profit
Purchased a foreign license	LnR	0.131 (4.05)	0.147 (3.54)
	LnR* ln(forlicence)	0.179 (2.88)	0.174 (2.19)
	R^2 (obs)	0.672 (857)	0.583 (790)
Purchase outside technology	LnR	0.092 (2.60)	0.113 (2.52)
	LnR* ln(purch_tech)	0.135 (3.17)	0.111 (2.05)
	R^2 (obs)	0.673 (862)	0.593 (793)
Provide design or R&D services	LnR	0.131 (3.66)	0.123 (2.81)
	LnR*D(pro-vide_RD)	0.016 (1.38)	0.032 (2.27)
	R^2 (obs)	0.659 (642)	0.588 (540)
Received external R&D assistance	lnR	0.095 (2.45)	0.076 (1.54)
	LnR*D(extRD asst)	0.114 (2.70)	0.177 (3.31)
	R^2 (obs)	0.660 (779)	0.581 (705)
% of work-force with foreign experience	lnR	0.420 (2.42)	0.647 (2.93)
	LnR*(%for_ exper)	0.057 (1.92)	0.111 (2.95)
	R^2 (obs)	0.889 (65)	0.811 (57)

Table 10a
Direct impact of factors on value added and profit
(i.e. impacts intercept, not slope)
$\ln X = \alpha_0 + \alpha_1 \ln K + \alpha_2 \ln L + \alpha_3 \ln R + \alpha_4 \ln Z + \Sigma\alpha_1 \ln LOC + \Sigma\alpha_1 \ln IND + \varepsilon$

Factor	variable	X_1 = Value Added	X_2 = Profit
Imported equipment	constant	2.448 (9.32)	1.388 (4.07)
	LnR	0.142 (4.60)	0.155 (3.93)
	D(imp_ equip)[1]	0.217 (2.01)	0.269 (1.89)
	R^2 (obs)	0.672 (884)	0.590 (813)
Firm's share of market	constant	2.193 (6.88)	1.392 (3.52)
	LnR	0.123 (3.48)	0.136 (3.12)
	D(firm_ mktsh)	0.156 (4.01)	0.120 (2.45)
	R^2 (obs)	0.678 (631)	0.602 (570)
Purchased externally-performed R&D services	constant	2.330 (8.94)	1.270 (3.77)
	lnR	0.128 (3.93)	0.110 (2.65)
	D(RDnet)	0.163 (1.34)	0.483 (3.13)
	R^2 (obs)	0.061 (877)	0.604 (806)
Import market share	constant	2.559 (8.89)	1.358 (3.63)
	lnR	0.135 (4.11)	0.150 (3.49)
	ln(import_ mktshare)	0.026 (2.92)	0.134 (1.21)
	R^2 (obs)	0.675 (738)	0.582 (692)
Gov't assistance in identifying a foreign relationship	constant	2.183 (7.81)	1.132 (3.06)
	lnR	0.127 (3.86)	0.137 (3.21)
	D(gov't_ assistance)	0.263 (2.11)	0.367 (2.21)
	R^2 (obs)	0.676 (726)	0.580 (662)

Table 11
Openness/competition

	Indo	Malay	Phil	Thai	Asean 4[1]	Korea	Sing	Tianjin	Shang	Guang	Cheng	R^2/obs.[2]
% of domestic mkt. supplied by imports	1.112 (1.29)	2.888 (3.14)	0.260 (0.32)	0.508 (0.38)	1.224 (2.18)	2.822 (3.75)	1.344 (0.68)	0.320 (0.61)	1.192 (2.22)	1.099 (2.06)	-1.038 (2.08)	0.122/ 1316
% FDI/total capital	0.979 (0.76)	1.804 (1.57)	5.382 (5.19)	2.398 (1.33)	2.991 (4.32)	-2.356 (2.76)	5.467 (1.94)	-0.061 (0.12)	2.656 (5.34)	0.578 (1.16)	-2.001 (4.15)	0.131/ 1399
Imported equipment	0.985 (2.81)	1.201 (3.28)	1.724 (4.73)	0.411 (0.75)	1.204 (5.20)	0.562 (1.94)	0.033 (0.04)	-0.316 (1.49)	0.632 (3.09)	0.703 (3.49)	-0.445 (2.14)	0.179/ 1530
Number of competitors[2]	-0.876 (3.11)	-0.632 (2.14)	-0.803 (2.78)	-0.570 (1.20)	-0.755 (4.07)	-0.827 (3.52)	-0.142 (0.28)	0.187 (1.13)	-0.184 (1.10)	-0.116 (0.67)	0.096 (0.60)	0.114/ 1345
Firm's market share	2.038 (9.31)	0.697 (3.08)	1.198 (4.50)	1.430 (3.97)		0.764 (4.20)	1.706 (4.47)	-0.362 (2.81)	0.323 (2.48)	-0.260 (1.83)	-0.097 (-0.71)	0.161 1269
# for which t > 2/ t < -2 (sum of t-stats)	**3/0 11.34**	**4/0 16.19**	**4/0 20.17**	**0/0 5.15**	**5/0 23.91**	**4/1 15.59**	**1/0 4.16**	**0/0 -0.54**	**4/0 17.77**	**3/0 16.35**	**0/3 -8.58**	

[1]Estimates are obtained from a regression in which the observations for Indonesia, Malaysia, Philippines, and Thailand are pooled into a single ASEAN 4 category.
[2]Because a large number of competitors are found to depress measure productivity and profitability (probably through reduced markups), in creating the composite measures in the last row we reverse the sign of the reported t-statistics.

Table 12
Human capital

	Indo	Malay	Phil	Thai	Asean 4	Korea	Sing	Tianj	Shang	Guang	Cheng	R^2/obs.
R&D personnel/ total workers	-0.203 (0.51)	-1.141 (2.67)	-1.623 (3.99)	-0.510 (0.80)	-0.920 (3.47)	1.897 (5.38)	-1.913 (2.45)	-1.220 (5.02)	0.095 (0.39)	0.046 (0.19)	0.605 (2.55)	0.258/ 1530
% workers using the internet	2.111 (3.04)	3.142 (4.20)	1.485 (2.09)	3.395 (3.04)	2.336 (5.04)	4.422 (7.18)	4.248 (3.11)	-0.995 (2.31)	.464 (1.06)	0.673 (1.56)	-1.165 (2.79)	0.185/ 1492
Foreign work experience/total	0.148 (0.47)	0.227 (0.73)	0.862 (2.67)	0.842 (1.75)	0.441 (1.92)	0.495 (1.83)	1.622 (3.25)	0.842 (2.39)	0.005 (0.02)	-0.254 (0.94)	-0.139 (0.52)	0.245/ 369
Management's educ. Level	-0.073 (1.78)	-0.243 (6.91)	-0.307 (6.00)	-0.294 (3.37)	-0.201 (6.94)	-0.243 (6.91)	-0.079 (0.84)	0.034 (1.36)	0.002 (0.09)	0.018 (0.75)	-0.028 (1.20)	0.259 (1155)
# for which t > 2/ t < -2 (sum of t-stats)	**1/0 1.22**	**1/2 -4.65**	**2/2 -5.23**	**1/1 0.62**	**2/2 -3.45**	**2/1 5.07**	**2/1 3.07**	**1/2 -3.58**	**0/0 1.56**	**0/0 3.44**	**1/1 -1.96**	

Table 13
R&D institutions/network

	Indo	Malay	Phil	Thai	Asean 4	Korea	Sing	Tianj	Shang	Guang	Cheng	R^2 (obs.)
Rec'd ext. perform R&D services	1.070 (3.07)	0.026 (0.06)	-0.446 (0.94)	n.a.	0.188 (0.71)	0.423 (1.32)	0.982 (1.51)	-0.788 (2.71)	0.019 (0.08)	-0.124 (0.49)	0.657 (2.96)	0.070 (1502)
External R&D assistance	-0.245 (0.55)	0.670 (1.75)	0.656 (1.46)	0.850 (1.43)	0.419 (1.63)	0.630 (1.97)	-0.743 (0.66)	-0.380 (1.60)	0.625 (2.88)	0.206 (0.90)	0.327 (1.54)	0.092 (1314)
Purchase domestic license	-0.566 (0.89)	-0.482 (0.76)	-1.756 (1.70)	-0.434 (0.41)	-.782 (1.86)	-.604 (1.19)	.667 (0.82)	0.373 (1.33)	-.013 (0.04)	0.225 (0.76)	1.325 (5.32)	0.096 (1473)
Purchase foreign license	1.204 (2.22)	1.308 (2.70)	0.940 (1.80)	n.a.	1.031 (2.81)	-0.869 (1.13)	0.359 (0.32)	-1.366 (2.39)	0.558 (1.59)	-0.032 (0.08)	-0.152 (0.40)	0.109 (1462)
Purchase of outside technology	0.242 (0.42)	0.095 (0.18)	0.189 (0.33)	1.010 (1.45)	0.162 (0.47)	0.207 (0.51)	-0.135 (0.13)	-0.811 (2.16)	0.680 (2.45)	0.287 (0.97)	1.189 (4.64)	0.096 (1473)
Provided R&D for a foreign firm	1.008 (1.44)	2.058 (3.97)	1.430 (2.68)	0.345 (0.32))		0.647 (1.20)	2.161 (2.31)	-0.469 (0.94)	0.580 (1.46)	0.756 (1.95)	-0.321 (0.67)	0.080 (1170)
# for which t > 2/ t < -2 (sum of t-stats)												

Table 14
Institutional and infrastructure setting

	Indo	Malay	Phil	Thai	Asean 4	Korea	Sing	Tianj	Shang	Guang	Cheng	R^2/obs
Share public ownership[1]	-4.483 (3.51)	-3.916 (3.35)	-4.179 (3.91)	-4.431 (2.30)	-4.198 (5.96)	-3.930 (4.53)	-4.019 (1.41)	-0.598 (1.19)	-0.465 (-0.92)	-1.336 (2.64)	1.472 (3.00)	0.085/ 1397
Share foreign ownership	0.979 (0.76)	1.804 (1.57)	5.382 (5.19)	2.398 (1.33)	2.991 (4.32)	-2.356 (-2.76)	5.467 (1.94)	-0.061 (0.12)	2.656 (5.34)	0.578 (1.16)	-2.001 (4.15)	0.131/ 1399
Industrial zone	0.759 (2.02)	2.170 (5.84)	1.339 (3.89)	-0.457 (0.58)	1.260 (5.26)	1.509 (4.98)	1.300 (2.00)	0.219 (0.95)	0.702 (3.11)	0.141 (0.61)	0.196 (0.86)	0.135/ 1456
Gov't assistance	0.245 (0.59)	0.721 (1.80)	0.589 (1.38)	2.476 (4.11)	0.741 (2.80)	-.910 (-1.65)	1.786 (2.70)	-0.384 (1.29)	0.101 (0.37)	-0.062 (-0.22)	0.686 (2.93)	0.065/ 1253
IT assets/total fixed capital	3.711 (2.32)	-0.047 (-0.08)	-0.117 (-0.27)	0.810 (1.01)	0.166 (0.50)	0.300 (0.52)	n.a.	0.536 (1.86)	-0.088 (-0.42)	0.073 (0.33)	0.118 (0.57)	0.430/ 523
# for which t > 2/ t < -2 (sum of t-stats)	**3/0 9.20**	**2/0 12.48**	**3/0 14.10**	**2/0 11.37**	**4/0 18.84**	**2/1 5.62**	**3/0 8.05**	**0/0 2.59**	**2/0 7.48**	**1/0 4.52**	**1/2 -2.79**	

[1]The sign of public ownership share is reversed in the tallies shown in the last row.

Table 15
Composite measure of country and city attributes

	Openness/ competition	Human capital	R&D network	Infrastructure/ institutions	**Composite measure**
Indonesia	3.83 (2/1)	3.00 (1/0)	4.27 (2/0)	9.20 (3/0)	**20.30 (8/1)**
Malaysia	11.91 (3/1)	2.26 (1/1)	3.93 (1/0)	12.48 (2/0)	**30.58 (7/2)**
Philippines	14.61 (3/1)	0.77 (2/1)	0.95 (0/0)	14.10 (3/0)	**30.43 (8/1)**
Thailand	3.09 (0/0)	3.99 (1/0)	2.47 (0/0)	11.37 (2/0)	**20.92 (3/0)**
Asean 4	15.67 (4/1)	3.49 (2/1)	3.76 (1/0)	18.84 (4/0)	**41.76 (11/2)**
Korea	15.59 (2/2)	14.34 (2/0)	1.48 (1/0)	5.62 (2/1)	**37.03 (7/3)**
Singapore	3.60 (0/0)	3.91 (2/1)	1.86 (0/0)	8.05 (3/0)	**17.42 (5/1)**
China					
Beijing	0.00	0.00	0.00	0.00	**0.00 (0/0)**
Tianjin	1.70 (0/0)	-2.49 (1/2)	-7.53 (0/3)	2.59 (0/0)	**-5.73 (1/5)**
Shanghai	15.57 (4/0)	1.45 (0/0)	6.96 (2/0)	7.48 (2/0)	**31.46 (8/0)**
Guangzhou	15.01 (3/0)	0.81 (0/0)	2.06 (0/0)	4.52 (1/0)	**22.40 (4/0)**
Chengdu	-9.46 (0/3)	-0.76 (1/1)	14.06 (3/0)	-2.79 (1/2)	**1.05 (4/5)**

Table 16
Impact of Country/City Characteristics on VA/Profit

City/country	Composite measure		Performance measure[1]	
	# of t's	Sum of t's	VA	profit
High				
Asean 4	11/2	41.76	-	-
Korea	7/3	37.03	5.620 (10.41)	3.836 (5.03)
Shanghai	8/0	31.46	0.761 (5.87)	0.731 (4.42)
Malaysia	7/2	30.58	0.55 (1.20)	0.921 (1.23)
Philippines	8/1	30.43	2.685 (6.54)	2.234 (4.61)
Medium				
Guangzhou	4/0	22.40	0.505 (3.85)	0.333 (1.93)
Thailand	3/0	20.92	2,707 (2.07)	-0.178 (0.392)
Indonesia	8/1	20.30	1.691 (1.29)	1.773 (1.10)
Singapore	5/1	17.42	n.a.	n.a.
Low				
Beijing	0/0	0.00	0.00	0.0
Chengdu	4/5	1.05	-0.061 (0.44)	-0.019 (0.11)
Tianjin	1/5	-5.73	-0.108 (0.66)	-0.178 (0.80)

[1]The estimates are from Table 8.

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