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Firm Characteristic Determinants of SME Participation in Production Networks

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Abstract: This paper provides an empirical analysis of small and medium enterprise (SME) participation in production networks. It gauges firm characteristic determinants of SME participation in production networks. The empirical investigation utilizes results obtained from an ERIA Survey on SME Participation in Production Networks, conducted over a three month period at the end 2009 in most ASEAN countries (i.e., Thailand, Indonesia, Malaysia, Philippines, Vietnam, Cambodia, and Laos PDR) and China.

The results suggest that productivity, foreign ownership, financial characteristics, innovation efforts, and managerial/entrepreneurial attitudes are the important firm characteristics that determine SME participation in production networks. The paper extends the analysis to identify the determinants that allow SMEs to move from low to high quality or value adding participation in production networks. The results suggest that size, productivity, foreign ownership, and, to some extent, innovation efforts and managerial attitudes, are the important firm characteristics needed by SMEs to upgrade their positions in production networks. The finding suggests that SMEs really exploit competitiveness from economies of scale only when they are able to engage in production networks.

***Keywords*:** Small and Medium Enterprises (SMEs), Production Networks, Firm characteristics, East Asia.

***JEL Classification*:** L20, L25

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1. Introduction

It is generally a well accepted argument among policy makers and scholars that small and medium enterprises (SMEs) play pivotal role in economic development of a country. Generating employment, alleviating poverty, and distributing wealth are, among others, the commonly cited benefits arising from the growth of the SME sector. Promoting a sustained and strong growth of SMEs, however, has always been, and continues to be, a challenging task. SMEs are inherently constrained by their capacity to grow and they usually face much stronger business challenges relative to their large counterparts.[1] More importantly, and this is particularly important in the globalisation era, is the challenge of an increase in the threat of survival that comes from much tougher competition among firms in a globalised business environment.

It is commonly argued that globalisation does not necessarily pose a threat for SMEs; in fact, it could present favourable business opportunities. An ideal way for this to occur is by increasing the extent of SME participation in regional production networks. As a number of scholars have put forward regional production networks have uniquely been developed in the past few decades, particularly in East Asia.[2] A better understanding of firm characteristics that likely determine greater SME participations in production networks is, therefore, needed. This paper aims to gauge

[1] Many, if not most, of these benefits are well covered by the literature. See, for example, Harvie (2002; 2008), Harvie and Lee (2002; 2005), and Asasen *et al*. (2003).

[2] See, for example, Ng and Yeats (2003), Kimura and Ando (2005a; 2005b), Ando (2006), and Athukorala and Yamashita (2006) for studies that document evidence on increased production networks between countries in East Asia.

some of these characteristics, utilizing the results of a firm-level survey conducted in some ASEAN member countries.[3]

The rest of this paper is organised as follows. Section 2 discusses pertinent literature to provide a framework for our analysis and to establish some testable hypotheses. Section 3 presents the methodology for the empirical exercise, including a brief description of the survey from which the data for this study was drawn. Section 4 and 5 presents the results of the empirical exercises and Section 6 summarises the key findings and presents the key conclusions from these findings.

2. Analytical Framework and Testable Hypotheses

The trade pattern in East Asia has changed from the traditional pattern where final products, such as consumer goods, intermediate goods, and capital goods, were predominant in trade, to one where predominance is now given to parts and components (Lim and Kimura, 2009; Athukorala and Kohpaiboon, 2009). Intermediate goods trade amongst Asian countries has expanded intra-industry and intra regional trade.

Trade patterns have now become quite different from the traditional pattern based on static comparative advantage. Production processes now involve sequential production blocks that locate across countries. Different stages of production are located in different countries and undertaken by different firms, consequently products traded between different firms in different countries are components instead of final

[3] The surveys were conducted as a part of ERIA research on SMEs in 2009.

products. While networks can be formed in various industries the most important ones in East Asia are those in the machinery industries, including general machinery, electric machinery, transport equipment and precision machinery (HS 84-92) (Kimura, 2009).

This phenomenon is known as cross border production sharing or fragmentation of production. The literature on fragmentation theory and its empirical verification expanded rapidly after the seminal contribution of Jones and Kierzkowski (1990)[4], proving its applicability in analysing cross border production sharing at the production process level (Kimura and Ando, 2005a). Looking from an East Asian perspective, however, production/ distribution networks have become quite distinctive and the most developed in the world (Kimura and Ando, 2005b) as measured by their significance for each economy in the region, their extensiveness in terms of country coverage, and their sophistication which can involve subtle combinations of intra-firm and arm's length (inter-firm) transactions. Consequently, these networks have developed beyond the original idea of fragmentation, requiring a re-appraisal and expansion of the original analytical framework in order to capture more subtle and sophisticated intra-firm and arm's length (inter-firm) transactions. In this context Kimura and Ando (2005a) propose the concept of two dimensional fragmentations to analyse the mechanics of production/ distribution networks in East Asia[5].

Fragmentation theory focuses on the location of production processes, where processes are fragmented or separated into multiple slices and located in different countries to lower total production costs of firms. The fragmentation occurs for the

[4] See also Arndt and Kierzkowski (2001), Deardorff (2001) and Cheng and Kierzkowski (2001) for further elaboration of the fragmentation theory.

[5] See Kimura and Ando (2005a), especially pages 7-13.

following reasons. First, there must be production cost saving in fragmented production blocks where firms can take advantage of differences in location advantages between the original position and a new position. Second, the service link costs involved in connecting remotely located production blocks must be low. Finally, the cost of setting up the network must be small**.** The feasibility of fragmented production/distribution (location and by firm) in an industry is heavily influenced by: the number of parts and components required in the production of the final product, the greater the variety of technologies utilized in the production of these parts and components, and the economic environment within individual countries and for the region as a whole.

Kimura and Ando (2005a) organise and categorise various type of fragmentation activities into two groups: fragmentation based on distance and fragmentation based on firm disintegration. There are advantages and disadvantages arising from both these forms of fragmentation. Table 1 shows that fragmentation by distance, involving intra and/or inter firm fragmentation (both domestic and cross border), is likely to increase service link costs (greater transportation, telecommunications, logistics, distribution, coordination and cross border) but have the potential to reduce production costs from location advantage (wages, access to resources, lower utility costs, access to technological capability). Fragmentation by firm disintegration, involving intra and/or inter firm fragmentation (both domestic and cross border), is likely to increase service link costs (related to loss of control and lack of trust) which include additional information costs in seeking a suitable partner, monitoring cost, contract costs, dispute settlement costs, legal costs, legal and institutional system deficiencies. However, this is potentially offset by reduced production costs due to the

increased availability of business partners, both domestic and foreign, the development of supportive industry, institutional capacity for various types of contracts and the degree of complete information. It is, therefore, apparent that reductions in service link and production costs can trigger a further rapid expansion in product fragmentation.

Table 1. Trade-offs in Two Dimensional Fragmentation

	Service link cost connecting production blocks	**Production cost in production blocks**
Fragmentation by distance (intra and inter firm, domestic and foreign)	Cost will increase with geographical distance: • Transportation, telecommunications, logistics and distribution (inefficiency) • Trade impediments • Coordination cost	Cost reduction from location advantage: • Wage costs • Access to resources • Infrastructure service inputs (utilities, industrial estates) • Technology capability
Fragmentation by firm disintegration	Increased transaction costs from loss of control/trust: • Information cost from seeking suitable business partner. • Monitoring cost • Contract costs • Dispute settlement cost • Legal system and institutional system deficiencies	Cost reductions from disintegration: • Availability of various types of potential business partners including foreign and indigenous firms • Development of supporting industry • Institutional capacity for various types of contracts • Degree of complete information

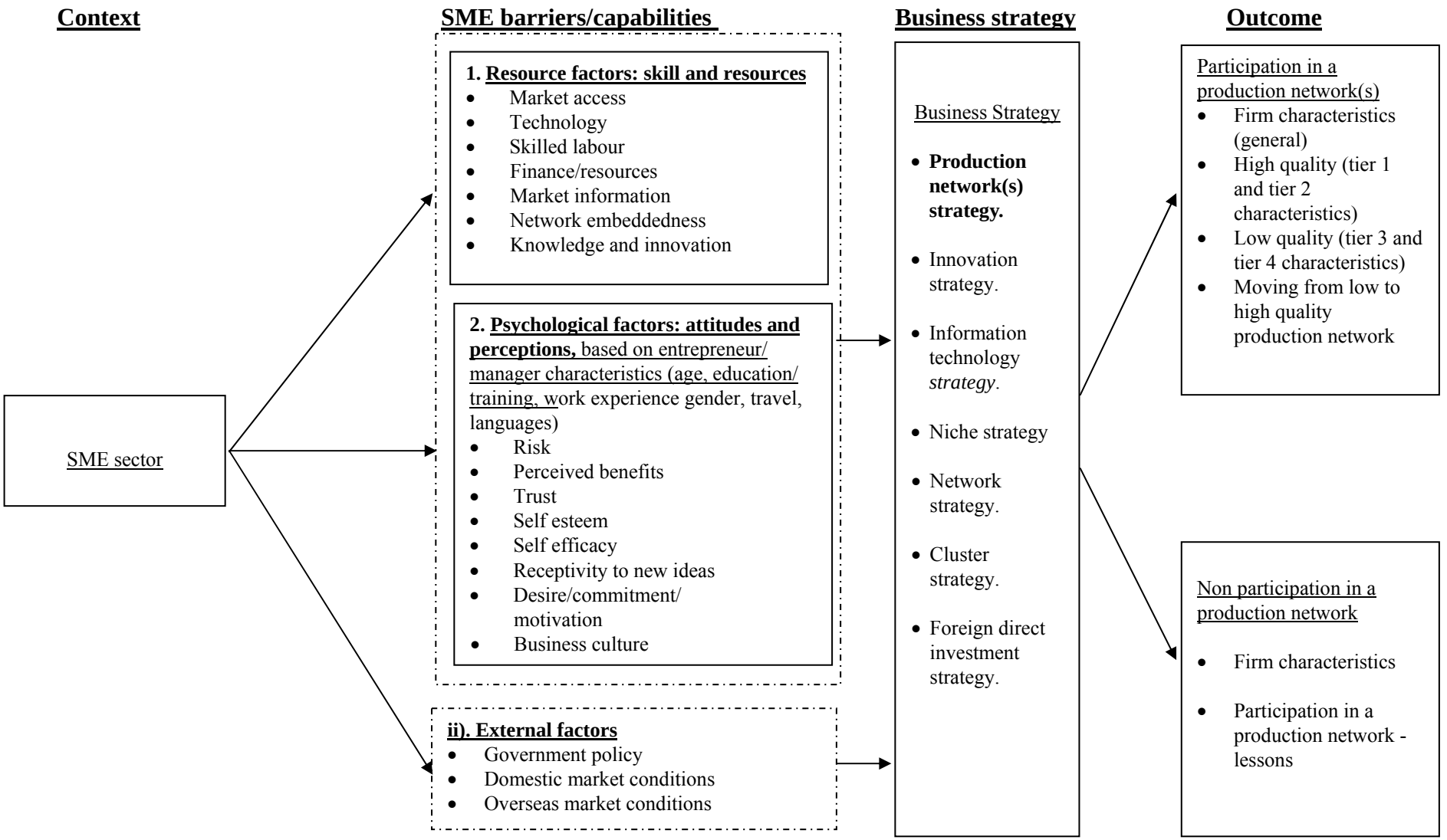
Source: Kimura and Ando (2005a).

As production/distribution networks and their sophistication expand, SMEs have the opportunity to play a crucial role both as indigenous and foreign based firms in the network on an arm's length basis in various forms, including subcontracting arrangements and OEM contracts. SMEs are also essential components of industrial

agglomeration. In this context, not only multi-national SMEs but also local SMEs can be important participants in a vertical arm's length division of labour.

SMEs need to overcome barriers related to their size and to develop capacities enabling them to become more intrinsically engaged and competitive in global markets, in order for them to fully participate in regional production networks. Their capacity constraints, or barriers, are multi-dimensional in nature and can be usefully highlighted and explored in the context of the integrative analytical framework summarized in Figure 1. We adapt this framework with application to the case of SME participation in production networks.

Figure 1. SMEs and Production Networks – Framework Outline



The framework emphasizes the importance of factors bearing upon the capability and capacity of an SME, and its ability to overcome barriers arising from its small size. These factors can be usefully classified into the two broad headings of internal and external factors. The internal factors can be further usefully broken down into two sub factors. The first is directly related to the small size and limited resources of SMEs. These resource factors relate to access to: markets, technology, skilled labour, finance, market information, network embeddedness and knowledge and innovation. The second internal factor relates to psychological factors, based on the characteristics of the entrepreneur, that determines the attitudes and perceptions of the SME towards risk, the benefits of participating in a production network, trust, self-esteem, self-efficacy, receptivity to new ideas, desire, commitment and motivation towards achieving outcomes from participation in a production networks etc. as well as the overall business culture of the SME. In addition to these internal factors, we must also consider external environment factors (government policy, domestic market conditions and overseas market conditions). These combine to determine the business strategy adopted by the SME, which include: a production network strategy, a niche strategy, an innovation strategy, an information technology strategy, a network strategy, a cluster strategy, and foreign investment strategy. It is the former which is of particular concern in the context of this study. However, these strategies are unlikely to be mutually exclusive. SMEs can adopt a niche strategy aimed at producing high quality products that could facilitate high value adding participation in a production network. Similarly, adoption of an innovation, network or cluster strategy could increase the competitiveness of an SME and facilitate its participation in a production network etc. The framework provides the basis for the empirical analysis, hypotheses testing and

profiling aimed at highlighting the key characteristics of SMEs that participate in production networks.

2.1. Hypotheses Relating to Firm Characteristics of SME Participation in Production Networks

a. Size[6]

Larger SMEs have a higher likelihood of participating and performing better in production networks. Traditionally, the importance of size is related to scale economies in production. If economies of scale in production exist, large firms may outperform small ones in a low demand situation by setting lower prices.[7] Access to resources is likely to be stronger for larger firms. In general, it is reasonable to argue that larger firms have greater access to resources, including those deemed important for SME growth. Consider, for example, access to finance. Larger firms tend to be better connected to banks or other formal sources of finance. Supporting this, Claessens *et al*. (2000) found that bank-dependent firms in Asian countries are mostly large firms.

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[6] This study addresses small and medium firms, and therefore it does not seem logical to consider size as a determinant of SME participation and performance in production networks. However, and as indicated in our sample and other studies, there is still large variation in size across even the very narrowly-defined small and medium firms. Hence, it turns out that size could still be an important determinant.

[7] While theoretically sound this argument sometimes is not fully backed up by evidence. The literature suggests mixed findings on a positive relationship between firm size and performance.

b. Age

It seems reasonable to hypothesize that a positive relationship exists between firm age and SME performance, as well as participation in production networks. First, older firms have accumulated more experience than younger firms. Theoretical explanations can be derived from Jovanovic (1982) who postulates that, over time, firms learn and improve their efficiency. Experience and knowledge essentially come from many sources, but, in the context of this study, the most likely source is from participation in a network of firms. These networks are particularly important because they facilitate peer-based learning and allow SMEs to reconfigure relations with suppliers. Firm age is also important because credit rationing can be expected to more adversely affect younger firms. Central to this proposition is the idea that the risk associated with any loan varies with the duration of the relationship between the firm and financial institutions (Diamond, 1991).

Having mentioned the arguments above, however, a negative relationship involving firm age might also be observed. This is because adjustment generally is more difficult to be achieved in older firms. Therefore, one could predict that it is much easier for younger SMEs to join a production network, compared to older ones.

c. Foreign Ownership

Foreign ownership is hypothesized to be positively related to an SME's performance and its participation in production networks. Forming a joint venture arrangement with foreign firms is clearly a favorable strategy for any SME wishing to engage and perform well in production networks. Doing so allows SMEs to exploit firm-specific assets owned by the foreign partners, and hence improve the

competitiveness of the SMEs in global markets. In practice, the advantage of this mechanism usually comes from technology transfers and sometimes from financial support.[8] The significance of foreign ownership, however, may depend on the share of the ownership. Foreign parent companies may restrict the transfer of the firm-specific assets if they do not hold a significant controlling interest over domestic firms.

d. Productivity

Firm-level productivity is hypothesized to improve both the chance of SME participation and performance in production networks. This draws from the findings of research on firm exporting that finds exporters are more productive than non-exporters.[9] This is often termed the 'selection hypothesis', which argues that only the most productive firms are able to survive in highly competitive export markets. This hypothesis is based on the presumption that there are additional costs involved in participating in export markets (Bernard and Jensen, 1999). Even when a firm has managed to grow from non-exporter to become an exporter, productivity still matters for the exporter's overall performance. This comes from a learning effect as a result of participating in export markets.[10]

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[8] In a more general firm performance context, Desai *et al*. (2004) and Blalock and Gertler (2005), for example, argue and show that domestic firms with some foreign ownership were able to better overcome financial difficulties during the 1997 Asian financial crisis.

[9] Bernard *et al.* (1995) and Bernard and Jensen (1999), for example, documented this for US manufacturing firms, while Aw and Hwang (1995) and Sjoholm and Takii (2003) document the same fact for Taiwanese and Indonesian manufacturing, respectively.

[10] One example is that exporters are often argued to be able to gain access to technical expertise, including product design and methods, from their foreign buyers (Aw *et al*., 2000, p.67).

The logic coming from the exporting literature can be applied in the context of SME participation in production networks, and hence it justifies our hypotheses. SMEs tend to suffer from many competitiveness issues, compared to larger firms, and the fact that most end products produced by networks of production are exported final goods, it is sensible to argue that SMEs wanting to participate in production networks need to mimic the characteristics of exporters in general. In the context of SMEs and production networks, this may be reflected in the ability of SMEs to meet the strict requirements of the higher – and larger – firms in networks of production. The reasoning above also justifies our hypothesis that productivity is not only expected to improve the likelihood that SMEs will participate in production networks, but also to improve the SMEs' performance once they are already in the networks, and/or exporting at the same time.

e. Financial Characteristics: Access to Finance and Financial Leverage

SMEs with better access to finance are hypothesized to have a higher probability of engaging and performing well in production networks. The potential for credit rationing – defined as the degree to which credit or loans are rationed, as a result of imperfections in the capital market (Stiglitz and Weiss, 1981) – is thought to be higher for smaller firms. Petersen and Rajan (1994) argue that the amount of information that banks can acquire is usually much less in the case of small firms, because banks have little information about these firms' managerial capabilities and investment opportunities. The extent of credit rationing to small firms may also occur simply because they are not usually well collateralized (Gertler and Gilchrist, 1994).

The ability of a firm to get a loan depends on how well the firm is able to service the debt. This, in turn, depends on the net worth of the firm, such as the value of cash inflow and the liquid assets that the firm is able to generate. Lower net worth implies lower ability to service debt and hence it reduces the chance of a firm getting a loan or a higher amount of credit. Banks, or any other lending institutions, are likely to attach a high-risk premium to a firm with a low net worth position.

SMEs that participate in production networks have the probability of better cash flows than those that do not. SMEs in production networks have more certainty in terms of their production, since most of the time they operate based on larger, stable, and more certain buying orders from other firms in the networks. More formal and modern managerial practice by firms operating in production networks, in addition to the likelihood of more interactions with banks, also helps SMEs that operate in production networks to gain more 'trust' from banks or other formal financial institutions. All these suggest that highly leveraged SMEs are expected to have lower probabilities of engaging and performing well in production networks.[11]

f. Innovation Efforts

SMEs that have made significant efforts to innovate are expected to have higher probabilities of engaging and performing well in production networks. Drawing from innovation literature, this study considers some innovation efforts falling under

[11] See Bernanke (1993) for a review of the literature and discussion about the 'balance-sheet channel' as well as other relevant topics.

process and product innovation.[12] Process-innovation efforts include those that improve the quality of output or reduce the costs of production and distribution. Emphasis is given to efforts that improve various aspects of the business strategies necessitated by firms who want to participate and grow in production networks. Meanwhile, Product-innovation efforts include those that improve a firm's production capability. The efforts should be able to significantly improve the products (goods or services) with respect to their characteristics or intended uses (e.g. technical specifications, components and materials, etc.). SMEs are usually located in the lower tiers of production networks; hence an improved or better production capability is critical, because the high-tiers firm demands set out strict requirements for the goods supplied by SMEs.

g. Location

As in the fragmentation model of Kimura and Ando (2005a), 'distance' creates service-link costs which arise because of the geographical distance between production blocks. In other words, some cost-saving can actually be generated from where firms are located. These advantages include not only the traditional economic factors, such as wage-level and resource availability, but also the existence and quality of infrastructure and infrastructure services, and the policies of the host-country's governments.[13] SMEs located near production blocks or ports are offered these cost

[12] The categorization of process and product innovation is commonly adopted in empirical studies on innovation, following the recommendation of Oslo Manual on the approach to measure the extent of innovation (see OECD and Eurostat (2005) for the latest edition of the Oslo Manual).

[13] These policies include a favourable investment climate, a liberal trade policy, a flexible labour policy, etc. (Kimura and Ando, 2005a).

savings. Some saving of service-link costs can be generated by geographical distance. This study, therefore, hypothesizes that SMEs located near industrial parks or export processing zones (EPZs), as well as located near ports, will have higher likelihoods of participating and performing well in production networks. Industrial parks or EPZs are frequently chosen for the establishment of production blocks.

h. Entrepreneurial and Managerial Attitudes

This study considers these attitudes as potential determinants of SME participation and performance in production networks. Specifically, it hypothesizes that willingness to take risks or to use new business ideas will improve the probability of an SME participating and performing well in production networks. A positive attitude towards risks and new business ideas is clearly necessary for SME managers, given the tight competition for operation in production networks. As explained, SMEs operating in production networks tend to face a constant and high survival threat, owing to the nature of their involvement in production networks that usually entails entering into contracts with larger firms in the networks.

3. Methodology

3.1. Questionnaire and Sample

Empirical work documented in this paper is based on the results of a questionnaire survey conducted during three months at the end of 2009. The questionnaire aimed at collecting information on SME characteristics, and the perceptions of their managers

of the factors that constrain SME growth. The questionnaire is divided into two parts, each of which addresses each of the survey's objectives. The first part tries to collect information on the characteristics of the SME, focusing on collecting information on the following characteristics: basic characteristics (i.e., size, age), ownership, cost and input structure, performance (i.e., sales, sales growth, profit rate, etc.), location in terms of distance to ports or industrial parks/economic processing zones (EPZs), sources of finance, and capability to innovate. The second part addresses the manager's perception of barriers to growth. The second part of the questionnaire follows OECD (2008). All SMEs in the sample were asked to assess the importance of 44 barriers using a five-point Likert scale ("(1) very significant" to "(5) not significant") and they were also asked to rank their constraints by 8 main categories, ranging from "very important" (1) to "less important" (8).

Firm size is defined in terms of employment and large firms are defined as those with employment of more than 200. In other words the sample contains observations of firms with a maximum employment of 200. There are 780 surveyed firms that fall into this definition. Table 2 summarizes the key characteristics of the surveyed SMEs. SMEs with persons employed between 6 to 49 accounted for 52% of the total, followed by 18.3%, 18%, and 11.3% for the employment groups of 100 to 199, 50 to 99, and 1 to 5, respectively. The average age of the SMEs was more than 10 years. More than 70% of the SMEs in the survey were domestically owned.

Table 2. Characteristics of the Surveyed SMEs

Characteristics	1 – 5 Persons			6 – 49 Persons			50 – 99 Persons			100 – 199 Persons		
	N	Mean	S.D	N	Mean	S.D	N	Mean	S.D	N	Mean	S.D
Age (year)	87	13.6	10.5	384	11.3	9.9	128	13.8	11.0	126	15.6	10.4
Ownership (%)												
Domestic	89	96.0	18.9	413	93.3	23.1	141	83.8	34.5	144	74.2	40.4
Foreign	89	4.0	18.9	413	6.2	22.6	141	14.5	33.5	144	22.4	39.6
Sale growth (%)												
2007	80	13.5	52.7	364	16.7	26.1	116	18.3	61.4	125	45.2	281.5
2008	81	6.4	23.4	365	32.5	206.6	117	28.6	100.9	127	16.1	29.2
Profit (%)												
2007	83	18.3	11.0	382	13.9	14.2	123	8.3	17.5	129	7.1	16.4
2008	84	18.5	15.2	398	11.7	27.3	135	6.2	27.2	141	8.8	17.9
Cost Structure 2008 (%)												
Labor	84	19.0	13.6	384	21.2	15.1	113	21.5	16.9	120	20.7	13.3
Raw Materials	84	48.0	17.6	392	53.2	19.8	129	58.4	21.7	137	57.7	20.6
Utilities	85	12.9	11.5	387	12.5	12.8	118	13.4	17.2	122	12.0	15.9
Interest	56	3.6	6.2	237	3.7	5.9	78	3.7	5.0	102	4.4	6.3
Other costs	76	9.4	8.7	348	10.8	10.8	99	12.0	15.8	106	12.0	15.4
Employees by Education (%)												
Tertiary	89	6.6	20.2	413	15.6	24.1	141	28.0	25.9	144	24.3	25.4
Vocational	89	14.5	30.5	413	23.8	29.5	141	18.9	18.6	144	21.3	21.7
High school or less	89	76.9	38.2	413	59.6	37.2	141	50.7	34.2	144	52.3	34.4
Source of Working Capital (%)												
Retained Earning	89	72.7	36.2	413	59.8	38.0	141	53.3	42.3	144	48.5	38.3
Bank	89	8.4	18.4	413	10.2	21.2	141	12.8	23.3	144	18.3	26.3
Other Financial Institutions	89	0.6	3.4	413	1.4	8.0	141	1.6	7.9	144	2.7	9.5
Others	89	18.4	33.2	413	25.6	34.0	141	24.4	36.5	144	27.1	37.9
Average Cost of Borrowing (%)	54	5.4	9.0	192	8.6	9.0	76	7.7	4.4	87	8.2	4.7
Sale Destination (%)												
Domestic	88	96.9	16.5	382	93.1	22.3	114	75.9	32.3	117	60.2	39.7
Export	2	90.0	14.1	49	56.2	36.2	55	54.3	29.7	82	60.5	34.9

Source: ERIA – SMEs Survey 2009.

Some adjustments have been made to prepare the data for this study. In most cases, this involved adjustments to make the data consistent and comparable across the surveyed countries. Adjustments were made for some obvious errors in the data entry process. This is typical for a firm-level survey, where there is always incomplete or

missing information. This study, however, did not attempt to replace the missing information with a predicted value. This approach is taken to minimize potential errors from the prediction values, given that sometimes there is no certainty of whether or not the existing information from the survey is sufficient to produce reliable predictions. The adjustments made, and the missing information, reduce quite significantly the number of observations for econometric analysis, from about 700 to 350 small and medium sized firms.

3.2. Statistical Method

The determinants of SME participation in production networks are examined by way of statistical regression. The statistical model in its general form is given as follows:

$$PN_i = \gamma_0 + \Gamma' X_i + \varepsilon_i \qquad (1)$$

where (1) is the equation for participation in production networks. i represent firm i and X_i is a set of explanatory variables that capture firm characteristic determinants. Industry and country-group dummy variables are included for differences across industries and countries. The industry dummy variables identify whether firms are in the following sectors: garments, auto parts and components, electronics –including electronics parts and components, or other sectors. Meanwhile, country-group dummy variables identify whether a firm operates in the group of developed ASEAN countries (i.e., Thailand, Malaysia, Indonesia, and Philippines) or the group of new ASEAN member countries (i.e., Cambodia, Lao PDR, and Vietnam).

The dependent variable, is a binary variable and identifies whether or not a firm participates in a production network. A participating firm is defined if it meets the following requirements: first, it supplies to any tier in a production network as defined by Abonyi (2005), and, second, it either imports intermediate inputs or exports some of its products.[14]

Equation (1) is estimated within the framework of binary choice models (i.e., probit or logit model), instead of a linear probability model (LPM). This is mainly because the predicted probability derived from an LPM may lie outside the 0-1 region, which is clearly not reasonable in practice. Despite this, a binary response model also has a number of shortcomings. One important shortcoming is that the potential for bias arising from neglected heterogeneity (i.e. omitted variables) is larger in a binary choice model than in a linear model. Nevertheless, Wooldridge (2002) points out that estimating a binary response model by a binary choice model still gives reliable estimates, particularly if the estimation purpose is to obtain the direction of the effect of the explanatory variables.

3.3. Measurement of Variables

The following variables are employed to account for the hypothesized firm characteristics. Firm size is proxied by the number of employees. The other common alternatives, such as output or profits, are not used as they tend to be more sensitive to changes in the business cycle or macroeconomic variables. The head-count measure is chosen because the number of hours worked, which is the ideal measure of

[14] See Figure 2 for a description of the tiers and the location of SMEs in a production network.

employment, is not available. Meanwhile, the age of the firm is proxied by the number of years the plant has been in commercial production.

Foreign ownership is proxied by the percentage share of foreign ownership. This study does not consider the discrete measure of foreign ownership (i.e., a dummy variable that identifies whether a firm has a foreign ownership share) because, as suggested by the literature, the behavior of foreign business partners in sharing their firm-specific assets depends on the extent of ownership of the foreign investors in a joint venture firm.

This study employs output per unit of labour as a proxy for labour productivity. Output is proxied by the sales revenue of firms. The more traditional approach of using value- added as the numerator is not adopted because value-added information is not available. However, the use of output is acceptable, and in fact more appropriate, because output is measured at the firm level.

The loan interest rate is measured by the interest rate on the loans that SMEs in the sample were able to obtain. This tends to be firm-specific since it reflects the risk premium value assessed by the banks or other lending institutions that advance loans to the SMEs.

This study employs the interest coverage ratio, or ICR, to measure a firm's financial leverage situation. It is defined as

$$(\text{Interest coverage ratio})_i = \frac{(\text{EBIT})_i}{(\text{interest payments})_i}$$

where EBIT is equal to sales (or earnings) before deduction of interest payments and income taxes.

ICR measures the number of times a firm's earnings exceeds its debt payments. In other words, it indicates how well a firm's earnings can cover interest payments. In general, a low ICR implies a firm is highly leveraged and has low capacity to take on additional debt (i.e. is more financially constrained).

It is worth mentioning that ICR is very approximate. This is because the ratio tends to understate the true extent of a firm's financial leverage. It focuses only on servicing the interest liability and does not take into account debt repayment. Usually, repayment of debt principal is higher than the interest payment, and therefore drains a larger amount of cash than the interest payment. In addition, the ratio does not take into account other mandatory and discretionary items, such as dividends and capital commitments, which are not included in the earnings figure.

Distance to industrial parks or EPZs and distance to ports are employed to measure the location characteristic. As the questionnaire asks, the distance variables are measured in terms of physical distance (i.e., kilometers) and time (i.e. hours). This study experiments with these two types of unit measurements in its empirical analysis.

As has been commonly applied in other empirical works, this study employs a skill intensity variable to proxy the human capital resources of firms. It is defined as the ratio of employees with tertiary or vocational education to the total number of employees,

$$(\text{Skill intensity})_i = \frac{(\text{total number of employees with tertiary or vocational education status})_i}{(\text{total number of employees})_i}$$

To measure the extent of a firm's process-innovation efforts, four dummy variables are created to identify whether a firm: (1) meets international quality standards, (2) has introduced ICT, (3) has established new divisions or plants, and (4) is involved in

business networking activities (e.g. business association membership, cooperation with other firms, R&D networks, etc.).

To measure the extent of a firm's product-innovation efforts, four dummy variables are created to identify whether a firm: (1) has bought new machines, (2) has improved its existing machinery, (3) has introduced new know-how or knowledge into its production, and (4) has introduced new products or services onto the market.

The value of each of these variables is equal to unity if a firm has conducted effort attached to each of these variables in the previous three months from the survey, or zero otherwise.

Two dummy variables are created to measure firm managerial and entrepreneurial attitudes. The first dummy variable is created to identify perceptions about taking business risks. It takes the value of unity if managers/owners have a positive attitude towards taking business risks or zero otherwise. The second dummy variable is created to identify willingness of the managers/owners to adopt a new business strategy. The variable takes the value of unity if there is a positive attitude towards adopting a new business strategy or zero otherwise.

4. Results and Analyses

It is useful to show some descriptive analysis before presenting and discussing the econometric results. To do so we compare the 'average' value of SME characteristics between SMEs that participate and do not participate in production networks. Table 3 shows the mean values of some characteristics for these two groups. The table also

compares the mean values and determines whether or not they are statistically different.

Table 3. Average Value of SME Characteristics, between SMEs Participating and Not-Participating in Production Networks

Characteristic	In Production Networks	Not in Production Networks	Statistically different
Size (employees)	66.2	52.1	Yes[+]
Age (years)	10.6	13.8	Yes[**]
Share of foreign ownership (%)	18.2	7.2	Yes[**]
Labor productivity (sales/employee, thousand USD)	26.8	23.0	No[2]
Loan interest rate (%)	6.1	8.9	Yes[**]
Interest Coverage Ratio, ICR[4]	250.0	77.5	Yes[*]
Credit interest rate (%)	6.2	8.9	Yes[**]
Distance to industrial parks or EPZs (hours)	1.0	0.9	No[3]
Distance to port (hours)	1.3	1.2	No[3]
Skill intensity[5]	0.4	0.3	Yes[**]

Notes:

1. + Significant at 10%; * significant at 5%; ** significant at 1%.
2. Significant at 65% confidence level.
3. Significant at 60% confidence level.
4. ICR is defined as the ration of sales to payment for interest.
5. Skill intensity is defined as the proportion of skilled labor (i.e., employees with tertiary and vocational education level) in a firm total employment.

Source: ERIA Survey on SME Participation in Production Networks.

Results in Table 3 indicate that SMEs participating in production networks are significantly different from those that do not participate. As shown, participating SMEs in the sample are larger, younger, and have more foreign ownership than non-participating SMEs. All these characteristics are statistically different. In terms of foreign ownership the difference is quite substantial; that is, the share of foreign

ownership in SMEs in the participating group, on average, is about two times greater than that of SMEs in the non-participating group.

It is important to mention that although larger, the average foreign ownership share in the participating group is below 51%. This means that, on average, foreigners/parent companies or foreign partners are not likely be the dominant owner. The implication of this is that SMEs may not have a strong information spillover from their foreign partners. Nonetheless, the higher foreign ownership share in the participating group indicates that, somehow, SMEs still benefit from their foreign partners by their participation in production networks.

The descriptive results, surprisingly, do not show much difference in SME productivity levels between the two groups. This is rather puzzling given that one would expect that productivity should be one of the most important firm-characteristic determinants. The final inference on the importance of productivity, however, needs to be confirmed by the econometric analysis.

Results in Table 3 suggest that SMEs in production networks are less financially constrained. The ICR is significantly larger for these SMEs. The difference in the mean ICR for these two groups is also statistically significant. The larger ICR suggests that SMEs in production networks are more able to service their loans than SMEs that are not part of a production network. The results further suggest that SMEs in production networks are better connected to the financial sector. This is indicated by the realized interest rate on the loans, which, on average, is lower for SMEs in this group, compared to the average interest rate for SMEs not in production networks. The difference in the interest rate is statistically significant. Moreover, the difference is suggested to be quite large. Of the SMEs in the sample, on average, those in the

participating group managed to get three percentage point lower interest rates compared to those in the non-participating group.

Differences in average firm financial characteristics give some support to the argument that SMEs in production networks have better cash flows, due to large, stable and more certain purchase orders from other firms in the production network. Moreover, it also supports the idea that SMEs in production networks are able to convey more information to their banks, which reduces the extent of asymmetric information. This improves the trust of banks, or other financial institutions, in these SMEs, which then reduces the risk premiums assigned to the SMEs.

The results in Table 3 do not seem to support the importance of location in determining SME participation in production networks. There is not much difference in the distance to industrial parks or EPZs, and to ports when measured in terms of time (i.e., in terms of journey time). This study experimented with distance in terms of geographical distance (i.e., in terms of kilometers) but the same results were achieved.

Tables 4 and 5 present attempts to show the 'average' characteristics of process- and product-innovation efforts and managerial/entrepreneurial attitudes. These characteristics are represented by dummy variables, and therefore the tables present the frequencies for SMEs with a unity value for the dummy variables. The frequencies are produced for two groups, that is for SMEs that participate in production networks and for SMEs that do not participate in production networks.

Table 4. Innovation Effort Characteristics, Frequency (in %) of SMEs Participating and Not Participating in Production Networks

Characteristic	In Production Networks	Not in Production Networks	Statistically different
Met international standards (e.g. ISO, etc.)	44.4	36.5	Yes*
Introduced information and communication technology	35.5	36,0	No[2]
Established new divisions or plants	27.0	18.8	Yes*
Involved in business network activities	52.6	47.1	No[3]
Bought new machinery with new functionality	58.4	47.9	Yes**
Improving the existing machinery	72.5	59.1	Yes**
Introduced new know-how in production method	49.6	40.7	Yes*
Recently introduced new products	63.4	55.1	Yes*

Notes:

1. + significant at 10%; * significant at 5%; ** significant at 1%
2. Significant at 10% confidence level.
3. Significant at 84% confidence level.

Source: ERIA Survey on SME Participation in production networks.

Table 4 indicates that SMEs in production networks have superior characteristics in terms of their process innovation efforts. It shows that the number of SMEs carrying out a wide range of process innovation over the last three months is mostly larger for this group. The table suggests that SMEs in and not in production networks are not different in terms of introducing ICT nor being involved in business network activities, such as business associations, R&D networks, etc. However, SMEs in these two groups are quite different in terms of their efforts to meet international standards, or to establish new divisions/plants.

SMEs that operate in production networks seem to make stronger product-innovation efforts. Table 4 shows that SMEs in this group adopted new production methods, bought more new machinery, and upgraded their existing machinery over the

three months prior to the survey. Over this period these SMEs also introduced new production know-how and knowledge to a greater extent than those not participating in production networks.

Table 5 suggests that SMEs participating in production networks are different from those not in networks, in terms of managerial/entrepreneurial characteristics. There is a larger number of SMEs that acknowledge the risks of doing business in the participating group. In other words, more SMEs in the participating group have positive attitudes towards business risks, compared to those in the non-participating group. The table also shows that there is a larger number of SMEs willing to adopt a new business strategy in the production network participating group compared to those in the non-participating group.

Table 5. Managerial/Entrepreneurial Characteristics: Frequency (in %) of SMEs Participating and Not Participating in Production Networks

Characteristic	In Production Networks	Not in Production Networks	Statistically different
Considering risk in business operation	52.7	30.7	Yes**
Willingness to adopt new business strategy	42.3	26.6	Yes**

Notes: + significant at 10%; *significant at 5%; ** significant at 1%.

Source: ERIA Survey on SME Participation in Production Networks.

Table 6 reports the results of a maximum likelihood estimation of Equation (1) for the subset of the sample that consists of all firms/SMEs with a maximum size of 200 employees. The table reports the final specifications that give the best results, while the other specifications estimated during the experimental stage are not reported here. The Wald test of overall significance in all specifications passes at the 1 % level. The table reports robust standard errors for the reason of heteroscedastic variance.

Table 6. Firm Characteristic Determinants of SMEs in Production Networks

Independent variable	Dependent variable: (Participation in Production Network)$_i$												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(Size)$_i$	0.001	0.001	0.001	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	(1.60)	(1.56)	(1.45)	(0.40)	(0.33)	(0.33)	(0.63)	(0.65)	(0.77)	(0.88)	(0.49)	(1.31)	(1.19)
(Size^2)$_i$	-0.000	-0.000	-0.000	0.000	0.000	0.000	-0.000	-0.000	-0.000	-0.000	0.000	-0.000	-0.000
	(1.13)	(1.59)	(0.89)	(0.10)	(0.21)	(0.27)	(0.10)	(0.13)	(0.23)	(0.31)	(0.11)	(0.70)	(0.71)
ln(Age)$_i$	-0.075	-0.055	-0.038	-0.049	-0.049	0.005	-0.038	-0.048	-0.042	-0.029	-0.063	-0.044	-0.040
	(0.69)	(0.52)	(0.55)	(0.62)	(0.63)	(0.06)	(0.49)	(0.62)	(0.53)	(0.36)	(0.81)	(0.63)	(0.57)
(Labour productivity)$_i$	0.004	0.005	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
	(1.91)+	(1.88)+	(2.12)*	(2.01)*	(1.97)*	(2.29)*	(2.19)*	(2.04)*	(2.33)*	(2.30)*	(2.08)*	(2.44)*	(2.32)*
(Foreign ownership share)$_i$	0.588	0.533	0.415	0.330	0.402	0.433	0.425	0.381	0.430	0.439	0.403	0.378	0.403
	(1.97)*	(2.01)*	(2.18)*	(1.49)	(1.81)+	(1.97)*	(1.93)+	(1.74)+	(1.93)+	(1.98)*	(1.83)+	(1.93)+	(2.09)*
(Loan interest rate)$_i$	-0.035	-0.031	-0.033	-0.031	-0.030	-0.029	-0.031	-0.032	-0.031	-0.031	-0.031	-0.012	-0.013
	(2.71)**	(2.52)*	(2.72)**	(2.41)*	(2.33)*	(2.26)*	(2.43)*	(2.46)*	(2.35)*	(2.37)*	(2.41)*	(1.07)	(1.25)
(Interest Coverage Ratio)$_i$	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
	(1.74)+	(1.48)	(2.42)*	(2.69)**	(2.65)**	(2.47)*	(2.64)**	(3.00)**	(2.56)*	(2.40)*	(2.65)**	(2.41)*	(2.52)*
(Skill intensity)$_i$	-0.025	-0.022	-0.432	0.148	0.083	0.166	0.143	0.136	0.142	0.204	0.073	-0.468	-0.459
	(0.06)	(0.07)	(2.48)*	(0.64)	(0.34)	(0.71)	(0.60)	(0.59)	(0.61)	(0.86)	(0.30)	(2.61)**	(2.58)**
(Distance to industrial parks or EPZs)$_i$	0.096	0.161											
	(0.66)	(0.96)											
(Distance to port)$_i$	0.160		0.168	0.152	0.174	0.129	0.145	0.145	0.143	0.136	0.132	0.135	0.137
	(1.27)		(1.51)	(1.52)	(1.75)+	(1.32)	(1.49)	(1.49)	(1.47)	(1.37)	(1.34)	(1.35)	(1.42)

Table 6. Continued

Independent variable	Dependent variable: (Participation in Production Network)$_i$												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(Dummy variable for meeting international standard)$_i$				0.298									
				(2.14)*									
(Dummy variable for have introduced ICT)$_i$					0.352								
					(2.30)*								
(Dummy variable for have established new divisions)$_i$						0.603							
						(3.69)**							
(Dummy variable for involving in business networks)$_i$							0.151						
							(1.11)						
(Dummy variable for acquiring new machinery)$_i$								0.256					
								(2.05)*					
(Dummy variable for improving existing machinery)$_i$									0.414				
									(3.31)**				
(Dummy variable for acquiring production knowledge)$_i$										0.417			
										(3.18)**			
(Dummy variable for ability of introducing new products)$_i$											0.312		
											(2.36)*		
(Dummy variable for considering risk in business operation)$_i$												0.361	
												(3.25)**	
(Dummy variable for willingness to adopt new business strategy)$_i$													0.238
													(2.06)*

Table 6. Concluded

Independent variable	Dependent variable: (Participation in Production Network)$_i$												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(Dummy var. for garment sector)$_i$			-0.047	0.048	0.042	0.039	0.002	-0.014	-0.004	0.079	-0.015	-0.057	-0.052
			(0.33)	(0.30)	(0.25)	(0.24)	(0.01)	(0.08)	(0.02)	(0.47)	(0.09)	(0.40)	(0.37)
(Dummy var. for auto parts and components)$_i$			0.394	0.289	0.378	0.305	0.263	0.232	0.272	0.365	0.208	0.408	0.398
			(2.29)*	(1.41)	(1.81)+	(1.44)	(1.26)	(1.12)	(1.30)	(1.71)+	(0.98)	(2.35)*	(2.31)*
(Dummy var. for electronics, and electronics parts and component)$_i$			0.259	0.355	0.400	0.394	0.372	0.334	0.352	0.447	0.307	0.264	0.259
			(1.55)	(1.88)+	(2.12)*	(2.08)*	(1.98)*	(1.81)+	(1.88)+	(2.36)*	(1.64)	(1.56)	(1.54)
(Dummy var. for country group)$_i$			1.163	1.210	1.319	1.273	1.238	1.168	1.148	1.264	1.166	1.092	1.139
			(8.27)**	(7.77)**	(8.32)**	(8.02)**	(7.93)**	(7.47)**	(7.34)**	(8.01)**	(7.45)**	(7.65)**	(8.09)**
Constant			-1.259	-1.769	-1.862	-2.014	-1.803	-1.781	-2.030	-2.550	-1.689	-1.330	-1.303
			(5.21)**	(3.13)**	(3.29)**	(3.69)**	(3.10)**	(3.20)**	(3.45)**	(3.84)**	(2.98)**	(5.50)**	(5.42)**
Observations	543	543	713	543	543	542	541	543	543	539	540	713	713

Notes: 1. Robust z statistics in parentheses.

2. **significant at 1%; *significant at 5%; +significant at 10%.

Specifications (1) to (3) are the baseline. They consider all variables except the dummy variables for innovation efforts and managerial/entrepreneurial attitudes. These specifications are different in the way in which distance variables are included in the regression. Specification (1) includes both of the distance variables, i.e., the distance to industrial parks or EPZs, while specifications (2) and (3) enter each of these variables separately. Specifications (1) and (2) are motivated because of the potential collinearity of the two distance variables.

The key point coming from these specifications is the evidence that location is not an important determinant of SME participation in production networks. The estimated coefficients of the two distance variables are all statistically insignificant across the specifications. In addition, all of these coefficients are positive, which is not as hypothesized.

A possible explanation points to the role of infrastructure. If theory and other empirical studies underline that distance matters because it increases 'service-link costs', good transport infrastructure could reduce the disadvantage of being far from clusters of firms, such as in industrial parks or EPZs, which usually shelter firms involved in production networks. This proposition deserves some support. According to the 'flowchart approach' of cluster development (Kuchiki, 2005), good infrastructure facilities are necessary to attract both so-called 'anchor firms' as well as other firms that support these firms. Firms that support these anchor firms are, in many cases, SMEs.

Firm productivity determines the participation of SMEs in production networks. The estimated coefficients of labor productivity are positive and, more importantly, statistically significant at the 5 % level in most of the specifications. This is one of the

robust findings coming from the regressions. This finding supports our hypothesis of a positive relationship between productivity and SME participation in production networks. Moreover, it accords with our argument that SMEs who plan to participate in production networks need to prepare themselves by mimicking the characteristics of exporting firms in general, and one of the most important characteristics to mimic is superior productivity – compared to non-exporting firms. As an example, a superior productivity level for SMEs operating in production networks is clearly needed given the usually strict specifications for goods produced that are demanded by other firms in the higher tiers of production networks.

The results suggest that foreign ownership significantly determines the participation of SMEs in production networks. This accords with our hypothesis on this characteristic and is consistent with the key observation from the descriptive statistics presented earlier. Moreover, the magnitude of the foreign ownership effect in determining participation is large, as indicated by the larger value of the estimated coefficients across all specifications. Foreign ownership, however, is not as important as labour productivity in determining SME participation. The statistical significance of the estimated coefficient is only moderately high, switching either at the 5 or 10 % significance level across the specifications.

Nonetheless, this finding, together with that from the descriptive analysis, supports the argument that SMEs are able to exploit firm-specific assets owned by their foreign partners to improve their competitiveness – something that is really needed for the SMEs' successful performance in production networks. The high impact of the foreign ownership variable, meanwhile, indicates that SMEs are able to get high marginal benefit from having a greater involvement of foreign investment in

their firms. This clearly underlines a strong dependency of how much firm-specific assets or knowledge can be shared with SMEs based on foreign ownership shares.

SMEs that conduct process-innovation activities more actively are suggested to have a higher likelihood or opportunity of participating in production networks. The estimated coefficients of the three – out of four – dummy variables of process-innovation efforts is positive and statistically significant. These are shown in the results of specifications (4) to (7). The only process-innovation effort variable that is not significant is the dummy variable for participating in business networks (e.g. business associations). This confirms the earlier observation from the descriptive analysis, which indicates that SMEs participating in production networks are not much different from those not in the networks in terms of their process innovation activities.

Strong efforts in conducting product innovation significantly determine SME participation in production networks. The estimated coefficients of all dummy variables that represent these efforts are positive and statistically significant. These are shown in the results of specifications (8) to (11). The results suggest that the efforts of SMEs in more actively conducting product innovation significantly increase their probability of participation in production networks. Moreover, the impact of the innovation efforts is quite large, as indicated by the large value of the estimated coefficients.

The finding on the innovation efforts underlines the importance of having all the necessary technology and know-how for both getting invited to participate as well as surviving better in production networks. As previously noted production networks bring a hostile environment to SMEs, mostly stemming from strict product requirements that clearly call for the adoption of advanced technology.

The results suggest that the attitudes of firms toward risk or the adoption of new business ideas is an important determinant of SMEs' participation in production networks. The estimated coefficients of the two dummy variables that represent this, i.e., consideration of risk in business operations and a willingness to adopt a new business strategy are all positive and statistically significant. The magnitude of the coefficient further suggests the importance of this characteristic. This finding is consistent with the view that SMEs in production networks operate in a tough business environment and face a constant and continuous threat to their survival.

The result in relation to the skill intensity variable does not accord with our prediction. The estimated coefficient changes sign across the specifications. In most cases the coefficients are usually not statistically significant when they are positive (i.e., the predicted sign) but they are statistically significant when the sign is not as predicted. This is rather surprising given the results of the other variables. However, this may be caused by strong correlation of the skill intensity variable with the other variables, in particular the dummy variables for innovation efforts. It is natural to expect that firms with strong innovation efforts will tend to employ more skilled workers than those with weak technological capability.

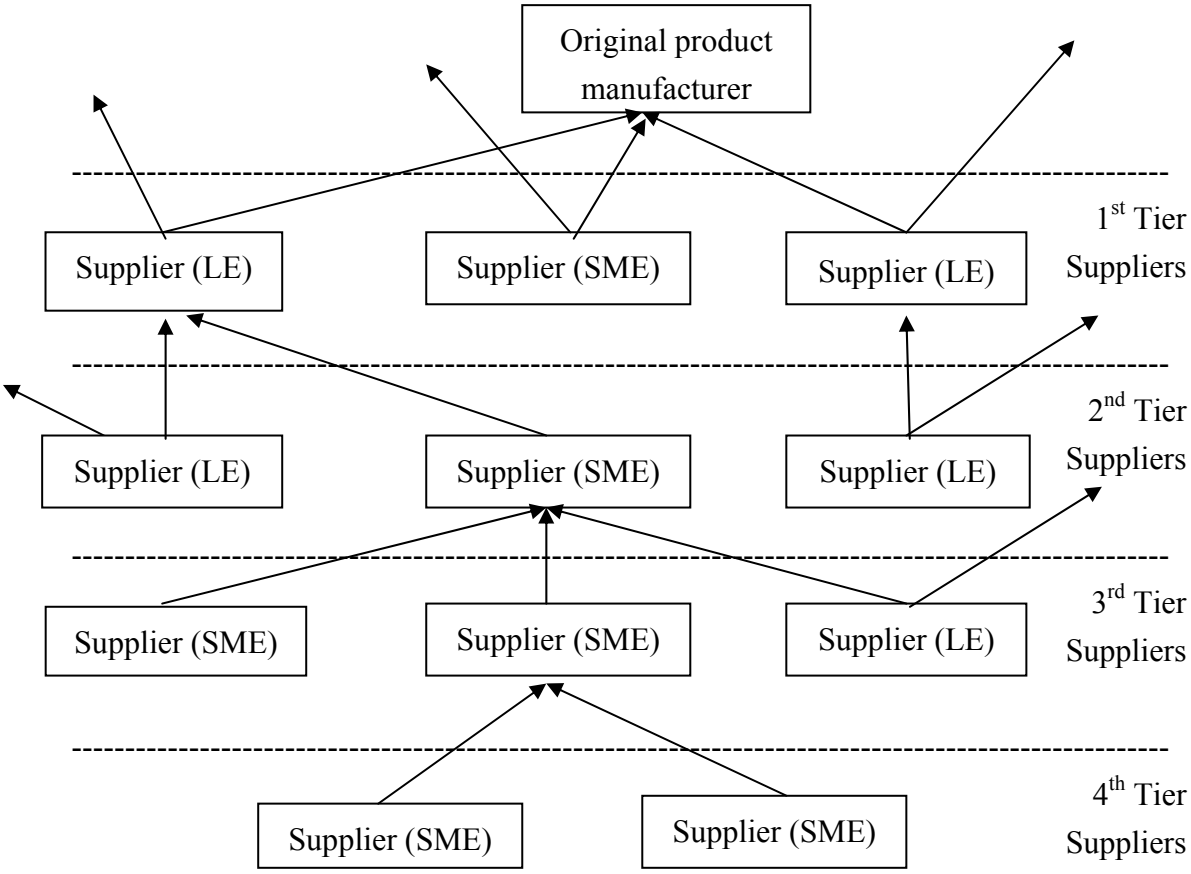
The econometric results confirm our earlier observation on the relationship between, on the one hand, access to finance or financial leverage and, on the other, SME participation in production networks. We can now more convincingly conclude that both of these characteristics determine the probability of SME participation in production networks. In particular, better access to financial institutions increase the probability of SMEs participating in production networks. As previously noted, the results indicate that SMEs participating in production networks suffer from the credit-

rationing problem, which arises from incomplete information, to a lesser extent than those operating outside these networks. This is another important characteristic to bear in mind. Meanwhile, a higher likelihood of participation in a production network is attached to SMEs that are able to service their debts. This is apparent from the results for the ICR variable. However, the impact of the financial leverage characteristic is small, as is indicated by the very small estimated coefficient of this variable.

5. The Determinants of Higher-quality SME Participation in Production Networks

An important issue given further emphasis in this study, beyond entry to a production network, is the quality upgrading of production network participation. SME participation can be at a variety of levels or tiers in the production process (see Figure 2). Higher level tiers, defined in this study to be tier 1 and tier 2, are likely to involve greater skill, technology, knowledge, innovative and value adding and creation activity, as well as pricing power and brand presence (Abonyi, 2005). Production network participation at lower tiers, defined to be tier 3 and tier 4, can be reasonably anticipated to involve lower skill, technology, knowledge, innovative and value adding activity, and the need to compete on cost. In the case of the latter this could involve simple assembly activity requiring unskilled labour and standardised low level technology. Consequently, it is an important issue to consider.

Figure 2. Global and Regional Production Networks and SMEs



LE – Large Enterprise
SME – Small or Medium Sized Enterprise

Source: Abonyi, (2005).

This section extends the previous analysis by gauging firm characteristics that allow SMEs to move from low to high quality participation in production networks, or from tier 3 or 4 to tier 1 or 2. This is done by utilizing the ordered logit model estimation which allows an identification of a firm/SME according to the different quality of its participation in production networks. Thus, the following general form of a statistical model is estimated:

$$QPN_i = \gamma_0 + \Gamma' X_i + \varepsilon_i \quad (2)$$

where QPN_i is a discrete choice variable and $QPN_i = 1$ if an SME operates in Tier 3 or 4 as a low-quality SME and $QPN_i = 2$ if an SME operates in Tier 1 or 2 as a high-quality SME. i represents firm i as in the previous section and X_i is a set of explanatory variables that captures firm characteristic determinants. Estimations also include dummy variables for industries and country groups. Estimations are conducted only on the sample of SMEs that participate in production networks, which give observations of about 190 firms/SMEs.

The results of the estimation are presented in Table 7. Larger participating SMEs have a chance to improve their position in production networks, or to move to higher tiers. The estimated coefficient for size is positive and very statistically significant at the 1% level. This finding is in contrast with the role of size in determining SME participation in production networks (i.e., the econometric analysis in the previous section). This suggests that SMEs only exploit competitiveness arising from economies of scale when they have successfully established their operations in production networks; they do not really exploit economies of scale at the stage when they are about to join a production network. This is consistent with the view that the competitive struggle among firms is more intensive or severe inside production networks, compared to that outside production networks.

Table 7. Firm Characteristic Determinants of Better-quality SMEs Participating in Production Networks

	Dependent variable: (Dummy variable for the quality of participation in production networks)$_i$									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(Size)$_i$	0.010	0.009	0.011	0.010	0.011	0.011	0.013	0.011	0.011	0.010
	(2.60)**	(2.23)*	(2.93)**	(2.67)**	(2.86)**	(2.87)**	(3.32)**	(2.89)**	(2.85)**	(2.70)**
(Size^2)$_i$	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.68)	(0.55)	(0.80)	(0.67)	(0.85)	(0.76)	(0.77)	(0.76)	(0.73)	(0.63)
ln(Age)$_i$	0.102	0.090	0.089	0.138	0.138	0.112	0.073	0.086	0.078	0.096
	(0.47)	(0.41)	(0.41)	(0.63)	(0.63)	(0.52)	(0.33)	(0.40)	(0.36)	(0.44)
(Labour productivity)$_i$	0.010	0.010	0.009	0.009	0.010	0.010	0.009	0.009	0.010	0.009
	(1.96)*	(2.00)*	(1.91)+	(1.97)*	(2.07)*	(2.06)*	(1.97)*	(1.92)+	(2.06)*	(1.97)*
(Foreign ownership share)$_i$	1.276	1.438	1.329	1.336	1.278	1.320	1.226	1.279	1.294	1.401
	(2.66)**	(2.96)**	(2.78)**	(2.80)**	(2.67)**	(2.75)**	(2.56)*	(2.67)**	(2.72)**	(2.90)**
(Loan interest rate)$_i$	-0.067	-0.070	-0.073	-0.076	-0.074	-0.070	-0.077	-0.063	-0.063	-0.066
	(1.66)+	(1.71)+	(1.79)+	(1.84)+	(1.82)+	(1.70)+	(1.81)+	(1.58)	(1.60)	(1.59)
(Interest Coverage Ratio)$_i$	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
	(0.32)	(0.39)	(0.16)	(0.35)	(0.30)	(0.27)	(0.58)	(0.33)	(0.31)	(0.12)
(Skill intensity)$_i$	-0.018	-0.420	0.051	0.107	0.132	0.041	0.210	0.104	0.058	0.167
	(0.03)	(0.66)	(0.09)	(0.18)	(0.22)	(0.07)	(0.35)	(0.18)	(0.10)	(0.28)
(Distance to port)$_i$	-0.144	-0.095	-0.132	-0.201	-0.189	-0.153	-0.062	-0.157	-0.185	-0.228
	(0.78)	(0.51)	(0.72)	(1.08)	(1.02)	(0.84)	(0.33)	(0.83)	(1.04)	(1.24)

Table 7. Continued

	Dependent variable: (Dummy variable for the quality of participation in production networks)$_i$									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(Dummy variable for meeting international standard)$_i$	0.210									
	(0.56)									
(Dummy variable for have introduced ICT)$_i$		0.976								
		(2.41)*								
(Dummy variable for have established new divisions)$_i$			-0.168							
			(0.44)							
(Dummy variable for involving in business networks)$_i$				0.457						
				(1.36)						
(Dummy variable for acquiring new machinery)$_i$					0.197					
					(0.58)					
(Dummy variable for improving existing machinery)$_i$						0.036				
						(0.10)				
(Dummy variable for acquiring production knowledge)$_i$							0.908			
							(2.51)*			
(Dummy variable for ability of introducing new products)$_i$								-0.106		
								(0.30)		
(Dummy variable for considering risk in business operation)$_i$									0.078	
									(0.24)	
(Dummy variable for willingness to adopt new business strategy)$_i$										0.646
										(1.94)+

Table 7. Concluded

	Dependent variable: (Dummy variable for the quality of participation in production networks)$_i$									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(Dummy var. for garment sector)$_i$	0.564	0.651	0.505	0.513	0.611	0.563	0.755	0.573	0.581	0.579
	(1.27)	(1.45)	(1.15)	(1.16)	(1.38)	(1.29)	(1.65)+	(1.31)	(1.34)	(1.33)
(Dummy var. for auto parts and components)$_i$	-0.392	-0.302	-0.412	-0.388	-0.273	-0.311	-0.451	-0.355	-0.308	-0.318
	(0.72)	(0.55)	(0.75)	(0.70)	(0.50)	(0.57)	(0.80)	(0.64)	(0.57)	(0.59)
(Dummy var. for electronics, and electronics parts and c	-0.202	-0.157	-0.184	-0.256	-0.177	-0.148	-0.275	-0.198	-0.150	-0.175
	(0.41)	(0.31)	(0.37)	(0.51)	(0.36)	(0.30)	(0.55)	(0.39)	(0.30)	(0.35)
(Dummy var. for country group)$_i$	-0.373	-0.067	-0.318	-0.401	-0.324	-0.281	-0.437	-0.471	-0.353	-0.333
	(0.78)	(0.13)	(0.67)	(0.83)	(0.69)	(0.60)	(0.88)	(1.00)	(0.78)	(0.72)
Observations	195	195	194	193	195	196	193	193	198	198

Notes:

1. Robust z statistics in parentheses
2. ** significant at 1%;
   * significant at 5%;
   + significant at 10%,

Foreign ownership seems to be really important for upgrading the level of tier involvement by SMEs in a production network. The estimated coefficient of foreign ownership is very large and statistically significant across the specifications. Moreover, the value of the estimated coefficients suggests that the effect of foreign ownership is significant. The estimated coefficients across the specifications suggest that a 10 percentage point increase in foreign ownership share, *ceteris paribus,* increases the possibility of an SME moving to higher tiers in a production network by about 12 times. This is a sensible finding given the more intensive firm competition inside the networks, which makes the marginal value of every unit of shared foreign-specific competitiveness much larger than that outside production networks. However, as the previous analysis shows, foreign ownership still plays a crucial role in increasing the probability of SME participation in production networks.

Productivity still matters even where SMEs have successfully established their operations in a production network. The estimated coefficients of labour productivity across the specifications are positive and statistically significant, mostly at the 5 % level. Higher productivity facilitates SMEs moving to higher tiers, and becoming higher value adding contributors in the production network. The finding on productivity is consistent with the finding on foreign ownership. Analytically, this suggests that SMEs tend to mimic the characteristics of strong exporting firms. The fact that foreign ownership and labour productivity still play an important role indicates a continuously learning process even after firms/SMEs have already established their position in production networks.

There is rather weak evidence on the impact of innovation efforts, at least when one compares it with the finding on innovation and its role as a determinant of SME

entry into production networks. This is because, unlike the earlier finding, only two out of the eight innovation-effort variables are positive and statistically important, and these are the dummy variables for "introduced ICT" and "acquiring production knowledge". Nevertheless, these positive and statistically significant dummy variables suggest that efforts to innovate by SMEs that have already participated in production networks to some extent still matter in upgrading SMEs to higher tiers in the network.

The characteristic of firm attitude towards risk does not seem to exert a strong influence on SMEs upgrading into a higher tier. While the estimated coefficient of the two variables that represent this characteristic are positive there is only one estimated coefficient that is statistically significant, and this is the estimated coefficient of the dummy variable for "willingness to adopt a new business strategy".

Besides revealing key characteristic determinants for higher quality SME participation in production networks, the results presented in Table 7 also imply that there is indeed room for improvement for SME to achieve higher quality participation. This is important from the perspective of policy makers, because there could be many problems for developing economies whose SMEs are involved in low value adding activities. Activities in tier 3 and 4 parts of production networks may be easier to enter but they may lock the country into low technology, basic assembly, low skill and value adding activities, and involve intensive competition from other low cost labour intensive developing economies. Placement at such a point in the production process makes them easier to replace, due to relatively easy switching by customers to other sources of supply. It is likely to involve intense competition on the basis of price and labour cost and constrain overall economic development. Having put forward this

argument, it is important to note that promoting SME participation even at the lower quality level is still worth pursuing. Participation at lower tiers does represent a starting point and it can be viewed as an opportunity to move up the production network value chain, by increasing the value content of activities and strengthening pricing power (Abonyi, 2005).

6. Summary and Conclusion

This paper has provided an empirical investigation on the participation of SMEs in production networks. It has attempted to reveal key firm characteristic determinants of SME participation in production networks. It builds on the analytical framework that considers the mechanics of production networks as well as the capability and capacity of SMEs in overcoming the barriers from their size disadvantages. The empirical investigation utilized results from an ERIA Survey on SME Participation in Production Networks, which was conducted over a period of two to three month period at the end 2009, in most of the ASEAN countries (i.e., Thailand, Indonesia, Malaysia, Philippines, Vietnam, Cambodia, and Laos PDR) and China. The approach has been to examine the difference in the firm characteristics of different groups of SMEs defined by participation status in production networks and to estimate the firm characteristic determinants of SME participation in these networks.

The descriptive and econometric analyses suggested that productivity, foreign ownership, financial characteristics, innovation efforts, and managerial/entrepreneurial attitude are the important firm characteristics that determine SME participation in

production networks. The descriptive analysis particularly finds that SMEs participating in production networks are larger, younger, and involve more foreign ownership than non-participating SMEs.

The econometric analysis strengthens the descriptive results. The robust findings from the estimations suggest the significance of firm-level productivity. It suggests that SMEs who plan to participate in production networks need to prepare themselves by mimicking the characteristics of exporting firms, one of which is a high level of productivity. Superiority in productivity is needed given the strict requirements of on goods produced by and used by other firms in participating in production networks. SMEs that actively conduct innovation activities seem to have a higher probability of participating in production networks. The characteristic of firm attitude toward risk, or the adoption of a new business idea, is another important determinant. This finding is consistent with the view that SMEs in production networks operate in a tough business environment and face a constant survival threat, because SMEs will not have a favourable survival chance if they are reluctant to accept new ideas and are not willing to face the business risks from participating in a production network.

The results meanwhile show that SMEs in production networks are less financially constrained and have better access to the financial sector. The latter is indicated in the descriptive analysis by the lower loan interest rate reported by these SMEs, compared to those not participating in such a network. These findings, particularly the former, suggest that SMEs in production networks have better cash-flow, which is most likely due to their large, stable, and more certain purchase orders from other firms in the network.

The empirical analysis was extended to gauge firm characteristics that allow SMEs to move from low to high quality participation in a production network, or from tier 3 or 4 to tier 1 or 2. The estimations reveal that size, productivity, foreign ownership, and, to some extent, innovation efforts and managerial attitudes, are the important firm characteristics needed by SMEs to upgrade their positions in production networks. The findings suggest that SMEs really exploit competitiveness from economies of scale only when they are able to engage in production networks. This behavior is also implied by foreign ownership and productivity.

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