PRODUCT INNOVATION AND PERFORMANCE OF MANUFACTURING SMALL AND MEDIUM ENTERPRISES

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ABSTRACT

This paper evaluates technical efficiency performance and examines the relationship between product innovation and firm performance of Vietnamese manufacturing small and medium enterprises (SMEs). In particular, it evaluates the impact of two types of production innovation, namely major improvement in existing products and introduction of new products, on technical efficiency performance of Vietnamese manufacturing SMEs. The paper uses firm level data from three surveys in 2002, 2005 and 2007 with a total of 5,204 observations of Vietnamese domestic non-state manufacturing SMEs to find out about technical efficiency level of the SMEs and the impact of product innovation on technical inefficiency.

1. INTRODUCTION AND BACKGROUND

Most Vietnamese enterprises are small and medium enterprises (SMEs). They were first officially defined in 2001 as enterprises with fewer than 300 workers or a registered capital of less than 10 billion VND (about US$630,000 at the time). A more recent definition, which became effective from 20 August 2009, provides a definition for each economic sector. It changes the capital clause from registered capital in the earlier definition to total capital of up to 100 billion VND (about US$ 5.6 million at the time). While the upper limit for employees remains below 300 for Agriculture, Forestry and Fishery sector, and Industry and Construction sector and it reduces to less than 100 workers for Services sector. Of the 155,771 formally registered enterprises in operation in 2007, SMEs accounted for 97.4 percent of the total enterprises according to the employee criterion or 84.7 percent according to the registered capital criterion in the definition in 2001. In the same year SMEs accounted for 99.8 percent of the 3.93 million total business establishments that include informally registered enterprises in the country.

After the introduction of an economic reform program known as Doi Moi in 1986, the Company Law and Private Enterprise Law were passed in 1990 and 1991. With the implementation of these laws, registrations of domestic private enterprises increased steadily from 1992 (Figure 1). New business registrations were mostly in the private sector. Between 1992-1999 the private sector grew at 24 percent per annum (Steer, 2001:4). Although this growth rate was high, it started from a small base. By the end of 1999, a total of 45,000 enterprises had been established. This is a modest number given the size of the population. Despite the official recognition of the private sector under the laws, the newly emerged non-state SMEs faced several major obstacles in the 1990s including institutional weakness, capital shortage, limited access to markets, technical and management limitations, and unfavourable public attitudes (Le Cong Luyen Viet, 2001). Furthermore, during the 1990s, state-owned enterprises were politically favoured and development strategy was focussed on import substituting. Meanwhile, the private sector had weak management and capital generation ability in the early period after Doi Moi. All of these had their influence on the growth of the private sector in the 1990s (Webster, 1999; Webster & Taussig, 1999).
However, Figure 1 also shows that the growth in registration of new enterprises since 2000 has been strong. This comes as the result of the new Enterprise Law (EL) which became effective in 2000. This important law combined the earlier Company Law and Private Enterprise Law into one law. Thus, it provided the legal framework for all types of domestic private enterprises. The EL contains an important innovation with a principle often referred to as “to register first, then to check” by the business community (World Bank, 2005). This represents a fundamental shift in the approach and tools with which the government manages enterprises. The EL has also revitalized entrepreneurship and strengthened the trust of investors and entrepreneurs in the reforms and policies initiated by the Government (Vo Tri Thanh & Nguyen Tu Anh, 2006). According to statistics from the National Business Information Centre, more than 414,000 enterprises have been established from 2000 to 2009, which is more than nine times the number of registrations for the 1991 - 1999 period (National Business Information Centre, 2009). Thus, the cumulative number of business registrations during 1992 - 2009 reached almost 460,000 enterprises. At the current rate of growth, it is expected that total business registrations will reach about 540,000 in 2010 surpassing the target to have 500,000 business registrations by 2010, set under the SME Development Plan 2006-2006, by eight percent.

This paper evaluates the efficiency performance and examines the relationship between product innovation and firm performance for Vietnamese manufacturing SMEs. In particular, it evaluates the impact of two types of production innovation, namely major improvement in existing products and introduction of new products, on technical efficiency performance of manufacturing SMEs in aggregate and individually for its 9 sub-sectors. The paper is structured as follows. Section 2 below provides a brief discussion about the relationship between innovation and firm performance. Section 3 describes the data and explains the methodology, including two econometric models: stochastic frontier production function (SFPF) model and a technical inefficiency effects model. Section 4 presents and discusses the estimation results for manufacturing SMEs in aggregate and nine individual sub-sectors within the manufacturing sector. Section 5 concludes the paper and provides some policy recommendations.

2. INNOVATION AND SMALL FIRM PERFORMANCE

Small enterprises are widely recognised as playing a seedbed role in the economy (Grosh & Somolekeze, 1996; World Bank, 2004). They play this role by being the breeding ground for large enterprises, a source of entrepreneurship and innovation, and by nurturing entrepreneurial spirit. In addition, they have the potential to promote new products with flexibility and affordability. They could promote competition and shape the path of a sector.

According to the US Small Business Administration innovation is defined as “a process that begins with an invention, proceeds with the development of the invention, and results in introduction of a new product, process or service to the market place” (Acs & Audretsch, 1990). Small firms often serve as carriers of new ideas and they are particularly good at product innovation (Carlsson, 2001). New small firms provide an essential source of new ideas and experimentation that would otherwise remain untapped in the economy (Acs, 2003). This results in either the start-up of new firms or in new products and processes. Hence, they provide new gist for the economic mill (Carlsson, 2001).

According to Schumpeter (1934) the entrepreneur is an innovator. The entrepreneur brings about change through the introduction of new technological processes or products. Thus, the entrepreneur has a role in ‘creative destruction’ in the short run. Nevertheless, he predicted that large corporations would have the innovative advantage over small and new enterprises, and the economic role of small and new firms would diminish and perhaps disappear in the long run. He concluded “innovation itself is being reduced to routine. Technological progress is increasingly becoming the business of teams of trained specialists who turn out what is required and make it work in a predictable way” (Schumpeter, 1942:132).

Recent firm-level studies about innovation and productivity of SMEs in developed economies come to the conclusion that innovation, as represented by R&D expenditure, has a positive effect on productivity (Hall, Lotti, & Mairesse, 2009). However, the evidence from developing countries is mixed. For example, a study of Chilean SMEs in 1996 finds that technical efficiency is positively associated with innovation based on product differentiation (Alvarez & Crespi, 2003). Nevertheless, Benavente (2006) observe that Chilean firms’ productivity during the 1995-1998 period is not affected by innovation in the short-run. This finding is different from most studies in developed countries. Hall and Mairesse (2006) explained that it resulted from differing circumstances in a developing Latin
American economy. With regards to the types of innovation, in a study of firms with 10-200 employees in seven countries in the European Community (E.C.), Heunks (1998) found that only process innovation, but not product innovation, stimulates productivity. He also observes that innovation is not very important for the success of a medium sized firm (with 50–200 employees). He also found evidence that innovation is often associated with low profits either as a reason for innovation or as a price of innovative investments at least in the short term.

There have been limited studies about innovation of Vietnamese SMEs. In a study based on survey data in 2005, Nguyen et al., (2008) found that there is a positive relationship between three measures of innovation, namely product innovation, process innovation and modification of existing product, and exporting among Vietnamese SMEs. They concluded that there is a higher propensity of exporting for innovation-active firms. Another study based on case studies found evidence that innovation occurred in small producers’ clusters in Northern Vietnam (Voeten, Haan, & Groot, 2009). As such, no study has addressed the impact of innovation on efficiency performance of Vietnamese SMEs. This will be the first study to examine this relationship which is based on an analysis of a large dataset of Vietnamese SMEs in the period 2002 – 2007. The focus of the study will be on the impact of product innovation on technical efficiency. This is relevant because innovation in small firms emphasises new products and improved products, whereas innovation in larger firms emphasizes process innovation and these firms are able to carry out intensive R&D activities (Heunks, 1998).

3. DATA AND METHODOLOGY

Productivity and efficiency represents the economic aspects of firm performance. Growth in efficiency and productivity is the most important aspect of growth as it focuses on the quality of growth. For this reason theoretical and empirical works on firm performance focus on measuring enterprise productivity and efficiency (Storey, 1990).

Average labour productivity had been used as a measure of efficiency until Farrell (1957) introduced a method to measure efficiency in his seminal paper. Farrell’s efficiency measure contains an efficient production frontier which is the output that a perfectly efficient firm could obtain from any given combination of inputs. The performance of a productive unit will be measured against that efficient frontier (Farrell, 1957:254).

According to Kalirajan and Shand (1999:152) a measure of technical efficiency in the ith firm can be defined as:

\[
TE = \frac{Y_i}{Y^*i}
\]  
(1)

where:

- \(Y_i\): Actual output
- \(Y^*i\): Maximum possible output

The above equation is the basic model used for measuring technical efficiency. The actual output is observable in this equation. However, maximum possible output is not observable and must be estimated. A ratio of one in the above equation would mean that the firm is technically efficient and operates on the production frontier.

A number of techniques have been developed to estimate this frontier. Several authors broadly classified them into two main groups: parametric and non-parametric (Coelli, Rao, & Battese, 2005; Kalirajan & Shand, 1999; Kumbhakar & Lovell, 2003; Murillo-Zamorano, 2004). The parametric method uses an econometric technique by specifying a stochastic production function which assumes that the error term is composed of two elements. One is the typical statistical noise which represents randomness. The other represents technical efficiency which is commonly assumed in the literature to follow a one-sided distribution (Alvarez & Crespi, 2003; Murillo-Zamorano, 2004).

One the other hand, the non-parametric approach does not distinguish between technical efficiency and statistical noise. It is, therefore, considered as a non-statistical technique as the inefficiency scores and the envelopment surface are ‘calculated’ rather than estimated. The non-parametric approach is often associated with Data Envelopment Analysis (DEA) which is based on a mathematical programming model to estimate the optimal level of output conditional on the amount and mix of inputs (Murillo-Zamorano, 2004). Figure 2 compares the two stochastic frontier and data envelopment analysis.
Stochastic frontier production function is one of the most common techniques to estimate this frontier. The stochastic frontier production model was developed independently and simultaneously by Aigner, Lovell and Schmidt (ALS) (1977), Meeusen and Van den Broeck (MB) (1977), and Battese and Corra (1977) (Figure 2). In this model there is a composed error term which captures the effects of exogenous shocks beyond the control of the analysed units in addition to incorporating technical inefficiency. Errors in measurement of outputs and observations are also taken into consideration in this model (Kumbhakar & Lovell, 2003; Murillo-Zamorano, 2004). This approach is most relevant to this study because of two reasons. The first reason is the ability of the stochastic frontier approach to consider both factors beyond the control of the firm and firm-specific factors, and hence it is closer to reality. The second reason is the separation of the random variation of the frontier across firms, the effects of measurement error and other random shocks from the effect of inefficiency.

The generalised functional form in the Cobb-Douglas case of the stochastic production function can be specified as:

\[ Y_i = x_i \beta + (V_i + U_i), \quad i = 1, \ldots, N, \]  

where

- \( Y_i \) is the production (or the logarithm of production) of the \( i \)-th firm;
- \( x_i \) is a \( k \times 1 \) vector of (or transformation of) the input quantities of the \( i \)-th firm;
- \( \beta \) is a vector of unknown parameters;
- \( V_i \) are random variables which are assumed to be independently and identically distributed (\( iid \)) as \( N(0, \sigma_v^2) \),
- \( U_i \) which are non-negative random variables that are assumed to account for technical inefficiency in production and are often assumed to be \( iid \) \( \left| N(0, \sigma_u^2) \right| \). It is assumed to be half-normal, exponential and truncated from below at zero.

The maximum likelihood method can be used to estimate the coefficients of the above production function. The likelihood function is expressed in terms of the variance parameters of the frontier function:

\[ \sigma^2 = \sigma_v^2 + \sigma_u^2 \quad \text{and} \quad \gamma = \frac{\sigma_u^2}{\sigma^2} \]  

where

- \( \sigma_v^2 \) is variance of noise
- \( \sigma_u^2 \) is variance of inefficiency effects.

If the value of \( \sigma_u^2 \) is equal to zero, then \( u_i \) is also zero which means the firms are fully efficient. \( \gamma \) has a value between one to zero. If the value of \( \gamma \) is zero, the deviations from the frontier are attributed to random error. If it has the value of one, the deviations are due to technical inefficiency.

There are several choices of functional form for the production frontier. The most common functional forms for the stochastic frontier production function are the Cobb-Douglas production function and the Transcendental-logarithm (Translog) production function. Hypothesis test results reveal that the Translog specification is most appropriate for this study with the exception of the Wood and Furniture and the Non-metallic sub-sectors in 2002. The Translog stochastic production function can be expressed as follows:

\[
\begin{aligned}
\ln Y_i &= \beta_0 + \beta_1 \ln K_i + \beta_2 \ln L_i + \beta_3 \ln ME_i \\
&\quad + \beta_4 (\ln K_i)^2 + \beta_5 (\ln L_i)^2 + \beta_6 (\ln ME_i)^2 \\
&\quad + \beta_7 \ln K_i \ln L_i + \beta_8 \ln K_i \ln \ln ME_i + \beta_9 \ln L_i \ln ME_i + V_i + U_i
\end{aligned}
\]  

where:

- \( Y_i \) = Output of firm \( i \)
\( K_i = \text{Value of Capital of firm } i \)

\( L_i = \text{Labour input of firm } i \)

\( ME_i = \text{Value of Materials and Energy for firm } i \)

\( V_i = \text{Random error in which } V_i \sim N(0,\sigma^2_v) \)

\( U_i = \text{Technical Inefficiency in which } U_i \sim N(\mu,\sigma^2_u) \)

The second line of Equation (4) includes the squared terms of the input factors, while the third line expresses the interaction terms among the inputs. Output and input variables in Equation (4) are described in Table 1.


In this study we model the factors influencing technical inefficiency including the firm-specific and external environment variables as follows:

\[
\mu = \delta_0 + \delta_{age} \cdot age + \delta_{size} \cdot size + \delta_{comp} \cdot comp + \delta_{urban} \cdot urban + \delta_{hh} \cdot hh + \delta_{coop} \cdot coop \\
+ \delta_{ld} \cdot ltd + \delta_{direx} \cdot direx + \delta_{foreign} \cdot foreign + \delta_{sub} \cdot sub + \delta_{credit} \cdot credit + \delta_{land} \cdot land \\
+ \delta_{credit2} \cdot credit2 + \delta_{new} \cdot new + \delta_{improve} \cdot improve + \omega
\]

The variables in Equations (5) and their description are summarised in Table 1.

A software package which is most commonly used in the estimation of stochastic production frontiers in the literature is FRONTIER 4.1 developed by Coelli (1996). The software program carries out three steps of estimation. The first step is Ordinary Least Squares (OLS) estimates of the production function. It provides unbiased estimators for all the \( \beta \) except the intercept. The OLS estimates are then used as starting values to estimate the final maximum likelihood model. The second step carries out a two-phase grid search of the value of the likelihood function which is estimated for different values of \( \gamma \) with the \( \beta \) parameters derived in the OLS. The third and final step calculates the final maximum likelihood estimates (MLE) with an iterative Davidon-Fletcher-Powell algorithm. This step uses the values of the \( \beta \)'s from the OLS and the value of \( \gamma \) from the intermediate step as starting values (Coelli, 1996). In addition, FRONTIER 4.1 also enables a single-stage estimation of the two econometric models which avoid the biases in the separate estimation of the two models in two stages.

This study uses recent firm-level data from three comprehensive and large-scale surveys of Vietnamese small and medium enterprises in 2002, 2005 and 2007. The surveys were carried out by the Vietnamese Institute for Labour Studies and Social Affairs (ILSSA) in Hanoi with the assistance of international counterparts who are Swedish International Development Authority (SIDA) and Danish International Development Agency (DANIDA). The surveys provide a valuable set of data about private sector SMEs in Vietnam. The surveys were implemented after the important Enterprise Law of 2000 was introduced. They contain the most comprehensive data about SMEs in Vietnam. Although other surveys have a larger coverage, they do not focus on SMEs. In addition, the focus on domestic non-state and manufacturing SMEs in the survey make it the only dataset available about this most important sector for SMEs in Vietnam. The surveys also had coverage in different regions of Vietnam, including urban and rural areas. The sample was stratified to ensure that different types of ownership were represented based on the overall distribution of ownership in the population of domestic non-state enterprises. In total, 6,619 enterprises from different sub-sectors in manufacturing industries were interviewed in the three survey rounds.
Information about two types of product innovation are available from the surveys, which asked whether firms introduced a new product or made major improvement to existing products in the previous two years. Table 2 shows the innovation rates of the surveyed manufacturing SMEs. Vietnamese SMEs tend to improve existing products more than introducing new products. This is understandable as it is less expensive to carry out improvements to existing products than introducing new products. Innovation rates increased rapidly in the 2002-2005 period. However, there was a sharp decline in innovation rates between 2005 and 2007. In 2005, 44.7 percent of the firms introduced new products but this was reduced to 5.7 percent in 2007. Similarly, the rate of product improvement among manufacturing SMEs also declined, albeit with a smaller rate, from 64.4 percent in 2005 to 50.9 percent in 2007. Rand et al. (2008) observe that the decline in the innovation rate during the 2005-2007 period is surprising, although the survey questionnaire design for this aspect has remained the same over time. However, it is possible that the business environment in 2007, when the economy started to show signs of weaker performance, was not conducive for the introduction of new products.

From the raw data obtained in the surveys described above, data for analysis is constructed for the domestic non-state manufacturing SMEs sector. Enterprises reporting in the survey that they were not in the manufacturing sector are removed from the dataset. Similarly, enterprises with missing values are also removed. After this process has been carried out, the eligible observations for analysis have been reduced to 5,204 with 926 firms in 2002, 2,228 firms in 2005 and 2,050 firms in 2007. The usable observations are classified into 9 sub-sectors according to the International Standard Industrial Classification (ISIC) codes for analysis. They are: (i) Food and Beverages (FB); (ii) Textiles, Garments and Footwear (TGF); (iii) Electrical and Electronic Equipment (EE) (iv) Wood and Furniture Products (WF); (v) Chemical, Rubber and Plastic Products (CRP); (vi) Paper, Printing and Publishing (PPP); (vii) Metal Products (MP); (viii) Non-metallic Products (NMP); and (ix) Machinery and Equipment (ME). Table 3 shows the distribution of observations for each of the nine sub-sectors.

4. EMPIRICAL RESULTS AND DISCUSSION

Estimation of the frontier production function is carried out for cross-sectional data from the three surveys in 2002, 2005 and 2007. The model for the stochastic frontier production function is based on production theory, with three inputs including labour, capital, and material and energy as described in Table 1. As shown in the summary Table 4, Vietnamese non-state manufacturing SMEs operated at a high level of technical efficiency. Aggregate manufacturing SMEs have mean technical efficiencies of 84.25 percent, 92.55 percent, and 92.34 percent in 2002, 2005 and 2007, respectively. The results indicate that these firms increased their current level of output by almost 15.7 percent in 2002, by about 7.5 percent in 2005 and by 7.7 percent in 2007 with the same level of inputs. Meanwhile, technical efficiency of manufacturing SMEs in different sub-sectors ranges from 70 percent to 100 percent, which means full technical efficiency, in the 2002 – 2007 period (Table 4). The high-tech Electronics and Electrical Equipment sub-sector has the lowest average technical efficiency level of around 80 percent for the three surveys. The low-tech Wood and Furniture sub-sector has full technical efficiency across all three surveys. Because Wood and Furniture enterprises tend to use simple technology in their production they could reach the best practice frontier more easily.

The average technical efficiency for non-state manufacturing SMEs in aggregate for the study period is 89.7 percent. This result indicates that manufacturing SMEs in Vietnam can reduce their current level of inputs by 10.3 percent to achieve the same level of output during the examined period. This result is higher than the technical efficiency level of 78.9 percent estimated for state-owned manufacturing enterprises in Vietnam in 1998 (Vu Quoc Ng, 2003), 50 percent for 1,492 manufacturing SMEs across all types of ownership in Vietnam in the 2000-2003 period (Nguyen Khac Minh, Giang Thanh Long, & Bach Ngoc Thang, 2007) or the 62 percent level for Vietnamese manufacturing enterprises of different ownership forms and sizes in 2003 (Pham, Dao, & Reilly, 2009). However, a direct comparison cannot be made because there are differences in the focus of the other studies in terms of firm size and ownership. Nevertheless, it is possible that the beneficial impacts of the policy measures take time to have an impact. Thus, technical efficiency is found to be higher in this study than previous studies as summarised in Table 3.

The estimated technical efficiency level found in this study is also higher than the mean technical efficiency of 62.33 percent obtained for Malaysian manufacturing SMEs during 1992-1999 by Oguchi et al. (2006), but is almost similar to the technical efficiency level of 87.7 percent for
Thailand’s industries in 1997 reported by Wiboonchutikula (2002). Compared to the mean technical efficiency at around 60 percent to 70 percent of the best practice frontier in developing countries, as reported by Tybout (2000), Vietnamese manufacturing SMEs are quite efficient. Nevertheless, as the technical efficiency of Vietnamese SMEs is estimated with regards to their best practice frontier, it is not possible to conclude that Vietnamese manufacturing SMEs are more efficient than their counterparts in developing countries.

The analytical results from the technical Inefficiency Effects model in this study indicate that there is no systematic pattern of the impact of product innovation on the technical efficiency for Vietnamese manufacturing firms in the non-state sector, in the 2002 – 2007 period. The results are different among sub-sectors, from one survey to the other and depend on the type of innovation. As shown in Table 5, the introduction of a new product has a positive relationship with the technical efficiency of the manufacturing sector and the CRP and ME sub-sectors in 2002. The NMP sub-sector is the only sub-sector where technical efficiency was negatively influenced by this type of innovation in 2002. The impact of the introduction of a new product on technical efficiency is not found for the four other sub-sectors in this survey. The results for 2005 are very different from the results in 2002. New product innovation is found to have a negative impact on the technical efficiency of the manufacturing industry, and the FB and PPP sub-sectors.

There are three possible explanations for the results above. First, there could be a lagged effect, as it may take time before the innovation results in gains in efficiency. The costs involved with the introduction of a new product could make firms become less efficient in the short-run. Second, introducing new products could be a sign that the firm is already experiencing difficulties, and has to make some changes to improve its situation. Of course, a new product can be introduced to capture new market opportunities but this should have a positive impact on technical efficiency. Third, not all new products are successful in the market and it also takes time to learn about this. Only in the CRP sub-sector does this type of innovation have a positive impact on technical efficiency, which is consistent with the results in 2002. Similar to 2002, introducing a new product is not significantly related to technical efficiency in the EE sub-sector and this is also the case in 2007. Meanwhile, the introduction of a new product does not have a significant effect upon the technical efficiency of SMEs in 2007. This is found for the manufacturing sector, and any other sub-sectors operating with technical inefficiency in 2007.

When relating the results in Table 5 with the new product innovation rates in Table 2, some interesting observations emerge. The negative impact of new product innovation on technical efficiency in 2005 coincides with a rise in innovation rates this year. An insignificant impact of this type of innovation is found for 2007, when the innovation rates dropped sharply. It suggests that the benefit of new production innovation in the early 2000s induced many SMEs to introduce new products in the mid-2000s, perhaps simply following other SMEs. However, by the late-2000s, many of them recognised that this was not a suitable strategy. These firms then had to change business strategy, which further explains the fall of new product innovation rates in 2007.

Table 6 summarises the impact of major product improvement on technical inefficiency. Again, this type of innovation has a mixed impact on the technical efficiency of different sub-sectors. However, it is positively correlated to the technical efficiency of the manufacturing sector in all three surveys. These aggregate results indicate that manufacturing SMEs, with major improvement to existing products, tend to have higher technical efficiency than those without this type of product improvement. Similar results are found for SMEs in the NMP sub-sector in 2002, FB sub-sector in 2005, and TGF sub-sector in 2007. However, this type of innovation negatively influenced the technical efficiency of firms in the ME and PPP sub-sectors in 2002, and PPP and MP sub-sectors in 2007. It does not have a significant impact on some other sub-sectors operating with technical inefficiency, as shown in Table 6. Thus product improvement does not always have a positive impact on technical efficiency of Vietnamese manufacturing SMEs.

It is clear from the results from the estimation of the technical inefficiency effects model that product innovation does not have an impact on technical efficiency of the high-tech Electrical and Electronics equipment sub-sector. This is also the sub-sector with lowest technical efficiency as reported and discussed earlier in this section. Product innovation either has no impact or a negative impact on the technical efficiency of the Paper, Printing and Publishing sub-sector. Chemical, Rubber and Plastic sub-sector is the only sector with a positive relationship between new product innovation and technical efficiency in more than one survey. All other sub-sectors tend to show a mixed result.
5. CONCLUSION AND POLICY RECOMMENDATIONS

This paper has evaluated technical efficiency performance and examined the impact of product innovation on technical efficiency performance of Vietnamese manufacturing SMEs. The results from this study indicate that Vietnamese non-state manufacturing SMEs operate at a high level of technical efficiency, both in the manufacturing sector in aggregate and by sub-sectors. While technical efficiency for manufacturing SMEs as a whole ranges from 84.25 percent to 92.55 percent, it is in the range from 70 percent to 100 percent (full technical efficiency) for the sub-sectors across the three surveys. These levels are higher than those found for Vietnamese manufacturing firms in previous studies (Nguyen Khac Minh, et al., 2007; Pham, et al., 2009; Tran Thi Bich, Grafton, & Kompas, 2008; Vu Quoc Ngu, 2003) and technical efficiency levels for manufacturing firms in other countries (Tybout, 2000). The sub-sector with the highest technical efficiency is the Wood and Furniture sub-sector, which consistently achieved full technical efficiency. The high-tech Electronics and Electrical Equipment sub-sector has the lowest mean technical efficiency. It is easier to reach the production frontier and achieve high technical efficiency in a sub-sector with simple production technology than in a sub-sector which uses high-tech equipment such as the Electrical and Electronics sub-sector.

Vietnamese non-state manufacturing SMEs have high rate of product innovation, especially in improving existing products. This indicates that Vietnamese SMEs are relatively flexible in adjusting to the rapidly changing market conditions in Vietnam. Nevertheless, the high rate of change in products could indicate that there may be an issue with the quality and price of products. The effectiveness of product innovation is the question that should be asked. The finding that new product innovation has a limited positive impact on technical efficiency suggests that SMEs should carefully research the market before introducing a new product. This product innovation should be done based on market demand and not because other firms introduced new products. In addition, empirical results from this study suggest that product improvement has a better capacity to enhance the technical efficiency of manufacturing SMEs in Vietnam. This is understandable given the high costs of introducing a new product and the time it takes to become accepted by customers as discussed above. Furthermore, product improvement innovation is based on existing products, so this type of innovation is better focussed in meeting market demand. Thus, there is evidence of value effect described by Barlet et al. (2000) when a novelty feature is a response to market demands and is valued by the market, then products new to the market are the most productive or profitable innovations (as cited by Lööf & Heshmati, 2006).

The results from this study suggest that Vietnamese manufacturing SMEs should upgrade their technology to move the production frontier upward as they have almost exhausted the current production frontier. Better technology and the resulting higher production frontier will enable Vietnamese manufacturing SMEs to move up the value chain and avoid the labour intensive, low skill, and low value-added trap. There is also a need for an effective targeting of government support to sub-sectors to encourage the appropriate types of product innovation. Focusing only on encouraging more SMEs to carry out product innovation does not always mean a better technical efficiency performance, and this is evidenced in this study. The government and its agencies could provide information, training and policies to facilitate beneficial product innovation for SMEs. In addition, SMEs should also be encouraged to carry out process innovation which has been found to have a better impact on SMEs’ efficiency and productivity (Hall, et al., 2009). Process innovation can upgrade technology, add value to SMEs’ activities and, therefore, can enhance the benefits from collaboration with foreign partners and subcontracting.

NOTES

1 This means that the errors are independently and identically distributed normal random variables with zero means and variances $\sigma^2$.

2 $U_i$ reflects one-sided deviations of actual output from the maximum level of production due to technical inefficiency. If a firm is fully technically efficient, $U_i=0$, otherwise it will be greater than zero. Thus, it is also called a one-sided error component.

3 For a description of the surveys, see Rand et al. (2004), Rand and Tarp (2007), and Rand et al. (2008)

4 They include the Industrial Censuses and Business Censuses carried out by the General Statistics Office and Business Environment and Enterprise Productivity Surveys conducted by the World Bank.
REFERENCES


FIRGURES AND TABLES

Figure 1: Enterprise Registration Increases Sharply from 2000

(*) Preliminary data.


Figure 2: Stochastic Frontier and DEA Frontier

Source: Adapted from Smith and Street (2005).
Table 1: Descriptions of Variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Y$ ($\ln Y$)</td>
<td>The output of the firm, proxied by the sales revenue of the firm (the log form of the output)</td>
</tr>
<tr>
<td>$K$ ($\ln K$)</td>
<td>The capital input of the firm, proxied by productive capital (the log form of the capital)</td>
</tr>
<tr>
<td>$L$ ($\ln L$)</td>
<td>The labour input of the firm, proxied by the number wage bill of the firm (the log form of the labour input.)</td>
</tr>
<tr>
<td>$ME$ ($\ln ME$)</td>
<td>The materials and energy input of the firm, proxied by the costs of materials and energy (the log form of the material and energy input)</td>
</tr>
<tr>
<td>age</td>
<td>Number of years since establishment up to the survey year</td>
</tr>
<tr>
<td>size</td>
<td>Number of wage worker</td>
</tr>
<tr>
<td>comp</td>
<td>Dummy variable indicating if the firm faces competition when</td>
</tr>
<tr>
<td>urban</td>
<td>Dummy variable indicating if the firm is in urban centre when</td>
</tr>
<tr>
<td>hh</td>
<td>Dummy variable indicating if the firm is a household enterprises</td>
</tr>
<tr>
<td>coop</td>
<td>Dummy variable indicating if the firm is a cooperative, collective, or partnership</td>
</tr>
<tr>
<td>ltd</td>
<td>Dummy variable indicating if the firm is a limited liability company, sole proprietorship or joint-stock company</td>
</tr>
<tr>
<td>direx</td>
<td>Dummy variable indicating if the firm is a direct exporter</td>
</tr>
<tr>
<td>foreign</td>
<td>Dummy variable indicating if the firm has long term cooperation with foreign partner</td>
</tr>
<tr>
<td>sub</td>
<td>Dummy variable indicating if the firm is in subcontracting arrangement</td>
</tr>
<tr>
<td>credit1</td>
<td>Dummy variable indicating if the firm has received government assistance in the form of credit at start up</td>
</tr>
<tr>
<td>land</td>
<td>Dummy variable indicating if the firm has received government assistance in the form of land and premise at start-up</td>
</tr>
<tr>
<td>credit2</td>
<td>Dummy variable indicating if the firm has received government assistance in the form of credit during operation</td>
</tr>
<tr>
<td>new</td>
<td>Dummy variable indicating if the firm introduced a new product in the previous two years</td>
</tr>
<tr>
<td>improve</td>
<td>Dummy variable indicating if the firm introduced a major improvement to existing products in the previous two years</td>
</tr>
</tbody>
</table>

Table 2: Innovation Rates in Manufacturing SMEs

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2005</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduced New Product</td>
<td>32.7</td>
<td>44.7</td>
<td>5.7</td>
</tr>
<tr>
<td>Improved Existing Product</td>
<td>47.3</td>
<td>64.4</td>
<td>50.9</td>
</tr>
</tbody>
</table>

Source: Author’s calculation from survey data.
Table 3: Observations by Sub-sectors

<table>
<thead>
<tr>
<th>Sub-Sectors</th>
<th>2002</th>
<th>2005</th>
<th>2007</th>
<th>Sector Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Food and Beverages</td>
<td>114</td>
<td>603</td>
<td>434</td>
<td>1,151</td>
</tr>
<tr>
<td>2. Textile, Garment and Footwear</td>
<td>79</td>
<td>196</td>
<td>242</td>
<td>517</td>
</tr>
<tr>
<td>3. Electrical and Electronics Equipment</td>
<td>65</td>
<td>50</td>
<td>79</td>
<td>194</td>
</tr>
<tr>
<td>4. Wood and Furniture</td>
<td>199</td>
<td>463</td>
<td>378</td>
<td>1,040</td>
</tr>
<tr>
<td>5. Chemical, Rubber and Plastic</td>
<td>97</td>
<td>162</td>
<td>175</td>
<td>434</td>
</tr>
<tr>
<td>6. Paper, Printing and Publishing</td>
<td>61</td>
<td>120</td>
<td>124</td>
<td>305</td>
</tr>
<tr>
<td>7. Metal Products</td>
<td>141</td>
<td>398</td>
<td>408</td>
<td>947</td>
</tr>
<tr>
<td>8. Non-Metallic Products</td>
<td>84</td>
<td>158</td>
<td>139</td>
<td>381</td>
</tr>
<tr>
<td>9. Machinery and Equipment</td>
<td>86</td>
<td>78</td>
<td>71</td>
<td>235</td>
</tr>
<tr>
<td><strong>Manufacturing Total</strong></td>
<td>943(*)</td>
<td>2,228</td>
<td>2,050</td>
<td>5,204</td>
</tr>
</tbody>
</table>

Source: Author’s calculation from survey data.

Note: (*) Observations from separate sub-sectors do not add up to total manufacturing observations as industries for 17 sampled firms could not be determined.

Table 4: Average Technical Efficiency

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Food and Beverages</td>
<td>80.43%</td>
<td>90.87%</td>
<td>100.00%</td>
<td>90.43%</td>
</tr>
<tr>
<td>Textile, Garment and Footwear</td>
<td>81.31%</td>
<td>100.00%</td>
<td>89.17%</td>
<td>90.16%</td>
</tr>
<tr>
<td>Electrical and Electronics Equipment</td>
<td>82.74%</td>
<td>69.97%</td>
<td>87.13%</td>
<td>79.95%</td>
</tr>
<tr>
<td>Wood and Furniture</td>
<td>100.00%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>Chemical, Rubber and Plastic</td>
<td>91.07%</td>
<td>94.01%</td>
<td>100.00%</td>
<td>95.03%</td>
</tr>
<tr>
<td>Paper, Printing and Publishing</td>
<td>89.44%</td>
<td>92.38%</td>
<td>88.74%</td>
<td>90.19%</td>
</tr>
<tr>
<td>Metal Products</td>
<td>100.00%</td>
<td>100.00%</td>
<td>90.26%</td>
<td>96.75%</td>
</tr>
<tr>
<td>Non-Metallic Products</td>
<td>81.57%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>93.86%</td>
</tr>
<tr>
<td>Machinery and Equipment</td>
<td>79.71%</td>
<td>100.00%</td>
<td>88.97%</td>
<td>89.56%</td>
</tr>
<tr>
<td>All Manufacturing</td>
<td>84.25%</td>
<td>92.55%</td>
<td>92.34%</td>
<td>89.71%</td>
</tr>
</tbody>
</table>

Note: Technical efficiency of 100% shown in the table indicates the absence of technical inefficiency.

Source: Authors’ calculation
### Table 5: New Product Innovation and Technical Inefficiency

<table>
<thead>
<tr>
<th>Industry</th>
<th>2002</th>
<th>2005</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Manufacturing</td>
<td>–</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Food and Beverages (FB)</td>
<td>0</td>
<td>+</td>
<td>n.a</td>
</tr>
<tr>
<td>Textiles, Garments and Footwear (TGF)</td>
<td>0</td>
<td>n.a</td>
<td>0</td>
</tr>
<tr>
<td>Electrical and Electronics Equipment (EE)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wood and Furniture (WF)</td>
<td>n.a</td>
<td>n.a</td>
<td>n.a</td>
</tr>
<tr>
<td>Chemical, Rubber and Plastic (CRP)</td>
<td>–</td>
<td>–</td>
<td>n.a</td>
</tr>
<tr>
<td>Paper, Printing and Publishing (PPP)</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Metal Products (MP)</td>
<td>n.a</td>
<td>n.a</td>
<td>0</td>
</tr>
<tr>
<td>Non-Metallic Products (NMP)</td>
<td>+</td>
<td>n.a</td>
<td>n.a</td>
</tr>
<tr>
<td>Machinery and Equipment (ME)</td>
<td>–</td>
<td>n.a</td>
<td>0</td>
</tr>
</tbody>
</table>

**Source:** Author’s calculation.

**Note:**
- +: Statistically significant with a positive correlation with technical inefficiency;
- -: Statistically significant with a negative correlation with technical inefficiency;
- 0: No correlation (statistically insignificant) with technical inefficiency;
- n.a: Not applicable due to the absence of technical inefficiency.

### Table 6: Major Product Improvement Innovation and Technical Inefficiency

<table>
<thead>
<tr>
<th>Industry</th>
<th>2002</th>
<th>2005</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Manufacturing</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Food and Beverages (FB)</td>
<td>0</td>
<td>–</td>
<td>n.a</td>
</tr>
<tr>
<td>Textiles, Garments and Footwear (TGF)</td>
<td>0</td>
<td>n.a</td>
<td>–</td>
</tr>
<tr>
<td>Electrical and Electronics Equipment (EE)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wood and Furniture (WF)</td>
<td>n.a</td>
<td>n.a</td>
<td>n.a</td>
</tr>
<tr>
<td>Chemical, Rubber and Plastic (CRP)</td>
<td>0</td>
<td>0</td>
<td>n.a</td>
</tr>
<tr>
<td>Paper, Printing and Publishing (PPP)</td>
<td>+</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>Metal Products (MP)</td>
<td>n.a</td>
<td>n.a</td>
<td>+</td>
</tr>
<tr>
<td>Non-Metallic Products (NMP)</td>
<td>–</td>
<td>n.a</td>
<td>n.a</td>
</tr>
<tr>
<td>Machinery and Equipment (ME)</td>
<td>+</td>
<td>n.a</td>
<td>0</td>
</tr>
</tbody>
</table>

**Source:** Author’s calculation.

**Note:**
- +: Statistically significant with a positive correlation with technical inefficiency;
- -: Statistically significant with a negative correlation with technical inefficiency;
- 0: No correlation (statistically insignificant) with technical inefficiency;
- n.a: Not applicable due to the absence of technical inefficiency.