# The Role of Technology, Investment and Ownership Structure in the Productivity Performance of the Manufacturing Sector in Vietnam

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**Abstract**

*This paper explores the productivity performance of the manufacturing sector in Vietnam between 2001 and 2007. Total Factor Productivity indices are computed using an index number approach and the productivity performance of manufacturing sub-sectors is analysed. We find that productivity increases in almost all sectors and that for many sectors the dispersion in productivity is declining over time. However, for the most productive sectors the gap is widening suggesting that productivity is being driven by the most productive enterprises getting better, leaving the least productive behind. The empirical analysis reveals investment and technology usage as important determinants of enterprise productivity levels. Specifically, higher levels of productivity are found in foreign- and state-owned enterprises, driven almost entirely by higher levels of investment and technology usage. Our results provide a strong quantitative basis in support of ongoing government initiatives aimed at encouraging investment in technology and innovation. They also point to the clear need for such initiatives to be complemented by measures to provide a more balanced distribution of investment, such that a level playing field is created for the different types of enterprises.*

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## 1. Introduction

A large part of the variation in income levels across countries can be explained by productivity differences. As such, understanding what drives productivity growth in the manufacturing sector in Vietnam is key in the design of effective policies to promote the sector. In this paper, four key determinants of productivity are in focus, namely technology, investment, ownership structure and trade.

We examine the productivity performance of the manufacturing sector and analyse the role that technology plays across enterprises and sectors. Firm level data from the Enterprise Survey collected by the General Statistics Office (GSO) are used, and an index number approach similar to Aw et al. (2001) is applied. Total Factor Productivity (TFP) measures are computed for each manufacturing firm for the period 2001 to 2007. TFP is measured as the change in output that cannot be attributed to corresponding changes in inputs (labour, capital and materials), and inputs are weighted by their proportional contribution to total costs. TFP is measured relative to a reference firm in each sector in each time period (taken to be average TFP) and is chain linked to the base year (2001) such that comparisons can be made across time.[1]

The second stage of the analysis uncovers determinants of productivity differences across firms. In particular, we explore the link between technology use and investment to understand the extent of technology deepening. Focus is on explaining differences in productivity across the various forms of legal ownership and how technology investment and usage helps to explain these differences. We consider the role of sector specific variables such as the extent of foreign or state ownership as well as the impact of competitive forces and trade intensity. The final element of the analysis is a sector specific examination of the relationship between technology usage and productivity.

The paper is structured as follows. Section 2 is an overview of current policy in Vietnam in relation to supporting technology and innovation. This section provides motivation and predictions for the empirical model. Section 3 reviews the literature examining the link between productivity, investment and growth. Section 4 presents our theoretical framework linking productivity to investment and outlines the approach to measuring productivity and the empirical model. Section 5 presents the data and Section 6 our results, while Section 7 concludes.

## 2. Policy Background

In recent years, policies aimed at promoting growth in manufacturing in Vietnam have focused on technology and innovation. In accordance with Decision 54/1998/QD-TTg (03/03/1998), government support for technological innovation has become an important component of government policy in relation to industrial development in Vietnam. Scientific and technological programmes are coordinated, regulated and implemented by various government line ministries, including the Ministry of Science and Technology and the Ministry of Planning and Investment, as well as local

[1] As a robustness check we also use the Olley and Pakes (1996) approach to measure productivity. A comparison of the results from each method is given in the Appendix.

government offices. In addition to the general incentives available to all enterprises, specific programmes target key technologically-intensive sectors that have been identified by government including information technology, biotechnology, technology of building materials and automation technology. Moreover, most Ministries at the central level and local governments of the larger cities (such as Hanoi and HCMC) devote part of their respective budgets to projects with an emphasis on technology and science. In 1999 policies aimed at promoting technology and innovation were taken a step further with Decree 119/1999/ND-CP (18/09/1999) which introduced financial policies and mechanisms for encouraging enterprises to invest in science and technology.

As a result, a range of measures are now in place or underway to encourage and support investment in technology and science related activities.

- Tax incentives exist for enterprises engaged in research and development (R&D) and for investment in technologically advanced machinery and equipment.[2]
- A state fund has been approved to allow firms investing in technology to have easy access to credit. This fund is, however, yet to be fully implemented.
- The state has invested in research infrastructure establishing large research laboratories within leading universities and research institutes. In addition, within specified industrial and export zones there has been significant investment in local infrastructure aimed at reducing costs and improving the competitiveness of firms located there.
- Since 1987 laws governing foreign direct investment (FDI) have been established and in particular, since 2000, FDI in the fields of education, medicine and science and technology have been prioritized.
- In 2005 the Law on Investment and the Law on Enterprise established a level playing field for all enterprises regardless of sector, form of legal ownership, size, *etc*.
- A National Fund for Technology Innovation (MST) has been passed by law, but is yet to be established and become operational. By law, this fund aims to support SMEs in technological innovation and improvement; accelerate technology transfer to mountainous and remote areas; support start-up of technological enterprises or incubators; and strengthen R&D for human resource build-up in technology transfer, innovation and improvement.

While a lot of recent literature has explored the mechanisms through which policy can further promote investment in technology and innovation among domestic and foreign enterprises a thorough evaluation of the impact that the current range of policies summarized here have had on all aspects of the manufacturing sector in Vietnam is timely.[3] Summary statistics recently produced by the GSO suggest that the proportion of enterprises using modern technology in the manufacturing sector remains small, despite an increasing number of firms investing in innovative machinery and equipment (from 6 per cent in 2001 to 18 per cent in 2004,GSO, 2001; 2004).

[2] For example, VAT exemptions on machinery that must be imported from abroad, tax deductions for expenditure on science and technology, business income tax exemptions for income from contracts related to science and technology and for share dividends from joint stock companies.
[3] See, for example, Nguyen Danh Son, (1999), and Nguyen Van Phuc (2002)

In contrast, the proportion of enterprises investing in research and development (R&D) has declined over the same period from 11 per cent in 2002 to 2 per cent in 2004 (GSO, 2002; 2004). There is also evidence to suggest that investment in training is low (CIEM/UNDP, 2003). The majority of investment in R&D and training takes place within large state-owned enterprises. This suggests that while in principle, government incentives to promote technology and innovation are aimed at all enterprises, in practice there are significant differences in the extent of accessibility of these schemes. According to GSO figures, 86 per cent of enterprises receiving public support for R&D are state owned, and there is also evidence to suggest that capital mobilization programmes do not always extend to small and medium sized enterprises.

Recent research by CIEM (2004a) reveals that over 90 per cent of enterprises believe that the main factor influencing their decision to invest in technology is competitive pressure in the market rather than government incentives.[4] Further research by CIEM (2004b) shows that many barriers to successful technological development continue to exist including a lack of information on appropriate technologies, low awareness of government technology initiatives, a lack of acknowledgement on the part of enterprises of a need for technology, and complicated procedures for availing of supports. Such constraints are particularly acute for non-state firms – in 2004, only 13 per cent of enterprises receiving incentives from the government were non-state private firms (Le Xuan Ba, 2008).

In sum, there is an evident acknowledgement on the part of the government of the potential benefits that investment in technology, innovation and R&D can bring to the development of the private sector. However, questions can be raised regarding the distribution of such schemes as well as the impact they are currently having on technological innovation and productivity improvements.

## 3. The Determinants of Productivity Growth

In this section, we provide an overview of the findings in the literature on the determinants of productivity growth which will be built into the empirical model outlined in Section 4. The factors that have been found to influence productivity growth can be divided into firm and sector specific factors.

*Firm-specific factors:*
It is widely agreed in the literature that an important source of sector-level productivity growth is firm turnover. Tybout (2000) presents a literature review relevant to developing country contexts and highlights the fact that the focus of many productivity studies in the past has been on the relationship between firm turnover and productivity. Firm level data have been used extensively, with many studies suggesting that entry firms are more efficient than enterprises exiting a particular sector. Accordingly, it is widely agreed that firm turnover is an important source of sector-level productivity growth.[5] As such, we include two indicators of firm dynamics: *exit*, a variable capturing whether a firm exits during the sample period;

[4] This research relates to the textiles and chemicals sectors in Hanoi and Ho Chi Minh City.
[5] See, for example, Aw *et al*. (2001), Bartelsman and Doms (2000) and Tybout (2000).

and *entry*, a variable capturing whether the firm enters during the sample period. In the same context, the longer a firm survives in an industry the more productive it will be as it will have survived the purging of unproductive firms over the years (Hopenhayn, 1992) and so we also include a measure of firm age in the analysis.

Also highlighted by Tybout (2000) is the fact that the size distribution of firms is very different in developing countries. This is particularly the case in Vietnam where on the one hand a few large scale enterprises operate alongside a large number of micro-enterprises producing similar products. It is also the case that small producers frequently operate in the informal sector. We would expect therefore, the size of the firm to impact on its place in the productivity distribution. We measure *size* as the total numbers employed by the firm.

In Vietnam, firm size is inextricably linked with the ownership structure of firms. As an economy in transition, the long tradition of state-ownership and a stringent set of constraints governing private sector expansion have resulted in a dual structure within the manufacturing sector in Vietnam. For example, state-owned enterprises tend to be both older and larger than privately owned firms, both of which are associated with higher levels of productivity. As revealed by the discussion in Section 2 it appears that state-owned enterprises have also been favoured in terms of policies aimed at promoting technological investment and R&D. However, one of the key arguments for privatization of state-owned enterprises is that they are inefficiently operated. Regardless of the direction of the relationship we would expect productivity levels to be different in state versus private-owned enterprises. Similar arguments apply to foreign-owned enterprises. Despite Vietnam being a late comer in attracting foreign investment relative to other countries in the region, in recent years, foreign investment has contributed significantly to the growth in output and productivity of the sector. For example, foreign firms contributed 13.3 per cent to GDP and 35 per cent to industrial output in 2001. We would expect foreign-owned enterprises to be more productive than private-owned firms given that foreign-owned enterprises are usually subsidiaries of large multinational corporations, tend to be large and also can benefit from tax breaks to entice them to establish in Vietnam. Until 2006, foreign and domestic investors were governed by two separate laws in Vietnam: the Law of Foreign Investment and the Law of Domestic Investment.[6] Although the 1999 Enterprise Law aimed at levelling the playing field for domestic and multinational firms, foreign investment has generally been directed towards special sub-sectors selected by the Vietnamese authorities.[7] Capital shortage and technological spillover arguments motivated the introduction of preferential treatment of foreign-owned enterprises in the late 1990s, and following the Chinese model, special economic zones were created. We expect that these benefits have contributed to a productive foreign-owned sector in Vietnamese manufacturing. Form of ownership is included in

[6] A new Investment Law came into effect in July 2006 (CIEM, 2006). This law aims at equalizing opportunities for domestic and foreign investors. However, as outlined in Freshfields Bruchhaus Deringer (2006), a truly common framework has not yet been achieved in all areas.

[7] Thuyet (1995) documents the Vietnamese government's approach to foreign investment, which includes a list of five broad sub-sectors where foreign investors are encouraged to conduct business. The five broad sub-sectors are: (1) large scale industries (with a focus on export-oriented and import substitution industries), (2) high-technology industries, (3) labour intensive industries using raw materials and natural resources available in Vietnam, (4) construction of infrastructure, and (5) foreign-exchange-earning service industries.

the model through a series of dummy variables capturing whether the firm is *private*, *state-owned* or *foreign-owned*.

Of particular interest in this paper is the link between investment in technology and technology usage and productivity. Ericson and Pakes (1995) and Olley and Pakes (1996) highlight the link between productivity and investment decisions. In their model, plants chose investment levels based on current capital stock and beliefs about future productivity and profitability. Thus we would expect to observe a positive relationship between productivity and firm level investment. As such we include in the model a variable measuring the overall level of investment made by the firm in the previous year (*lag_inv*).

Technological advancement can lead to productivity improvements; however, since most inventions take place in a small number of the world's richest countries, technology diffusion is an important part of the growth process for most countries. In particular, if we believe that investment in technological advancements will improve productivity we expect that investment specifically targeted at technology improvements to have a stronger effect. Therefore we might expect the stock of technological investments already made to have an impact on productivity. We proxy this through the number of personal computers used by the firm in the previous year (*lag_tech_use*) thus capturing the extent of technology usage made possible by previous technological investments. Within the model we control for sector-specific factors that may mean a firm requires the use of more personal computers compared with other sectors. The use of this measure is further validated by the fact that the majority of technological investments made by enterprises in Vietnam are in innovative machinery and equipment rather than R&D or training.

*Sector-specific factors*
First, we expect the dominance of state enterprises (state owned enterprise share of total sector output) to impact on the relative performance of firms in a sector. If SOEs receive preferential treatment it may make it difficult for non-state enterprises to compete. This could have the effect of reducing the relative productivity performance of other firms in the sector. At the same time, during the ongoing transition from a planning to a market economy, new opportunities in highly SOE concentrated industries for smaller (private) enterprises make it likely that private firms experience relative productivity improvements over time. The net effect is consequently an interesting empirical issue.

Second, similar arguments apply when considering the dominance of foreign enterprises (foreign enterprise share of total sector output). Aitkin and Harrison (1999) emphasize that preferential treatment of foreign-owned enterprises may distort competition and force (equally efficient) domestically-owned counterparts out.[8] However, one reason why governments grant special treatment is to promote technology transfer, and new products and/or production processes introduced by foreign firms may indeed spill-over to domestic firms. In sum, whether the dominance

[8] Evidence for Venezuela suggests that once sector specific effects are controlled for, domestic firms perform worse as foreign dominance in a sector increases (Tybout, 2000).

of foreign enterprises has a positive or a negative effect on productivity will depend on which of these effects dominate (competition versus technology transfer).[9]

Third, the level of competition in a sector might also affect the relative productivity of a firm. In more competitive sectors firms must be efficient in order to survive. Therefore we would expect average productivity levels to be higher in more competitive sectors of manufacturing. A proxy for competition often used in the literature is the concentration ratio (*CR*). In this paper we measure this as the ratio of the accumulated revenue of the four largest firms to total revenue in the sector. The higher this ratio the less competitive the sector of the economy is.

Finally, the trade-intensity of the sector may also impact on the productivity performance of firms. Evidence from the literature suggests that exposure to trade induces only the more productive firms to export while the least efficient are forced to exit as they can no longer compete (Melitz, 2003). Similarly, in import competing sectors, firms have to remain efficient in order to survive (Pavcnik, 2002). The main impact of trade liberalization is thus to induce a reallocation of resources across firms forcing the least productive to exit and the most productive to expand. The relatively recent exposure of the Vietnamese manufacturing sector to trade makes it important to both understand and disentangle these mechanisms. We construct a measure of trade intensity (*TI*) as the total value of exports plus imports as a proportion of total output in a sector in a given year. These data are taken from the World Bank's World Integrated Trade Solution (WITS) database collected from the United Nations' COMTRADE database.

Market factors such as sudden shifts in consumer preferences affecting demand, supply shocks driven by changes in industry structure due to policy reform, new or refined production technologies and trade liberalization may all affect the productivity of firms. These unobservable factors are controlled for through the inclusion of sector specific and time effects.

## 4. Productivity Measurement

In this paper we use an index number approach to estimate Total Factor Productivity for firms in each sub-sector of the manufacturing sector in Vietnam between 2001 and 2007.[10] This approach is similar to that of Aw *et al*. (2001) who estimated productivity differentials for Taiwanese manufacturing. Productivity is measured relative to reference point which we take as the mean level of productivity in a given sector and year. In order to analyse changes in productivity over time we chain link this productivity differential to changes in the reference level of productivity from year to year. The index is given in equation (1). The measure is sector specific which

[9] Foreign enterprises may also create a basis for domestically owned firms to produce intermediate inputs as in the case of SOEs. Therefore, inter-industry spillovers from FDI may occur. Javorcik (2004) finds evidence of backward linkages for Lithuania while Alfaro and Rodriguez-Clare (2004) find similar evidence for Venezuela, Brazil and Chile.

[10] A broad range of methodologies have been developed for the purpose of estimating productivity. See Van Biesebroeck (2003) for an overview of the various methodologies that have been proposed in the literature. As a robustness check we also follow Olley and Pakes' (1996) approach which controls for simultaneity in the econometric estimation of the production function and selection bias due to firm exit.

means that in any given time period the productivity of a firm is compared relative to the average productivity of the 2-digit sector.

$$\begin{aligned}\ln TFP_{imt} = &\left(\ln Y_{imt} - \overline{\ln Y_{mt}}\right) + \sum_{\tau=2}^{t}\left(\overline{\ln Y_{m\tau}} - \overline{\ln Y_{m\tau-1}}\right) \\ &- \sum_{m=1}^{k}\frac{1}{2}\left(s_{mijt} + \overline{s_{mjt}}\right)\left(\ln X_{mijt} - \overline{\ln X_{mjt}}\right) \\ &+ \sum_{\tau=2}^{t}\sum_{m=1}^{k}\frac{1}{2}\left(\overline{s_{mj\tau}} + \overline{s_{mj\tau-1}}\right)\left(\overline{\ln X_{mj\tau}} - \overline{\ln X_{mj\tau-1}}\right)\end{aligned} \quad (1)$$

$Y_{ijt}$ measures output of firm *i* in sector *j* year *t*

$X_{mjit}$ measures the amount of input *m* used by the firm

$s_{mjit}$ measures the expenditure of the firm on input *m* as a share of the total expenditure of the firm

Variables with a bar are arithmetic means over the relevant dimensions. This index assumes constant returns to scales.

The TFP index will capture any factors that lead to profit differences across firms including managerial efficiency, differences in technology or quality of capital, size differences or output quality (Aw *et al*., 2001). As outlined in Section 3, there are a number of factors that may result in TFP differences across firms. In an attempt to explore these factors using the firm specific TFP measures we estimate the following empirical model which incorporates both firm and sector specific factors:

$$\begin{aligned}\ln TFP_{ijt} = &\alpha_0 + \beta_1 \ln age_{ijt} + \beta_2 exit_{ijt} + \beta_3 entry_{ijt} + \beta_5 size_{ijt} \\ &+ \beta_6 ownership_{ijt} + \beta_7 lag\_inv_{ijt} + \beta_8 lag\_tech\_use \\ &+ \delta_1 SR_{jt} + \delta_2 FR_{jt} + \delta_3 CR_{jt} + \delta_4 TI_{jt} + \gamma_t + \theta_j + \lambda_i + e_{ijt}\end{aligned} \quad (2)$$

This model controls for unobserved sector-specific time-invariant factors (such as traditional versus modern sectors or regional location, for example) through the inclusion of sector fixed effects ($\theta_j$), any shocks that affect all firms in all sectors (such as market reform) through the inclusion of time dummy variables ($\gamma_t$) and regional specific factors (such as infrastructure quality) through the inclusion of province dummy variables ($\lambda_i$).[11]

## 5. Data

The data used come from the Vietnamese Enterprise Survey for 2001-2007 provided by the GSO. The dataset includes only enterprises that are formally registered with provincial authorities (under the Enterprise Law) and were operating at the end of

[11] The lack of variation over time in some of the important firm specific variables (such as ownership for example), prevent the use of fixed effects to control for unobserved time invariant firm specific characteristics.

each year. We consider 19 two-digit level sub-groups of the manufacturing sector. The total sample consists of 142,908 observations on 48,202 manufacturing firms. We exclude firms with missing or unviable data on the key variables of interest and outliers in the top and bottom percentile of the distribution for each variable. Our sample is therefore restricted to 97,841 observations on 29,435 manufacturing firms.

The output variable is defined as the gross value of production of the firm deflated by the industrial output price index relevant to the two-digit sub-sector. It is constructed by adding the total revenue sales to the stock of inventory produced during the year. Three inputs are considered, labour, capital and other costs. The labour input is measured as the total number of persons employed at the end of the year in question. The cost of labour is the wages and salaries paid to employees during the year deflated by a GDP deflator. Capital is measured as the total assets of the firm at the end of the year deflated by the capital price series.[12] The cost of capital, or capital service, includes depreciation of fixed assets during the year and the opportunity cost of capital. The former is assumed to be at a constant rate of 2 per cent per annum while the latter is measured as the return that could be received by putting the asset to some alternative use. We use the annual average annual commercial bank lending rate to business to proxy this return. Other costs are computed as the residual once wages, salaries and capital costs are taken from the firm's total costs of production. Descriptive statistics by sector over time are presented in Table 1.[13]

[INSERT TABLE 1 ABOUT HERE]

The last column of Table 1 illustrates the 2007 levels of each variable relative to their 2001 level thus summarizing how that variable has changed over the 7 years. The number of firms in all sectors increased between 2001 and 2007. The greatest growth in numbers occurred in Publishing and Printing and Basic and Fabricated Metal Products, where the number of firms increased more than four-fold for the former and more than three-fold for the latter two between 2001 and 2007. Growth in average output, however, is more moderate, declining in many sectors, suggesting that entering firms are smaller in size than incumbents. For most sectors, growth in inputs was at a slower pace than the growth in output with the level of inputs declining in many cases. This is suggestive of productivity improvements across almost all manufacturing sectors. The cost share of each of the inputs remained relatively stable over the 7 years in most sectors. Other Costs make up a substantial proportion of total costs in all sectors.

Table 2 presents summary statistics for each of the firm specific explanatory variables considered in the productivity analysis. We first present the industry dynamic measures: the proportion of firms that enter and exit over the course of the sample period. There is evidence of firm turnover in all sectors. As suggested by the summary statistics presented in Table 1, the proportion of firms entering is greater than the proportion of firms exiting. Second, we present the ownership structure of each of the sectors by considering the proportion of privately-owned firms, state-owned enterprises and foreign-owned enterprises. Most sectors are dominated by private-owned firms. High levels of state-ownership are evident in Publishing and Printing

[12] This measure includes liquid assets, long-term investments and fixed assets of the enterprise.
[13] Value figures are presented in 1994 prices.

and Repairing Other Transport Equipment.[14] High levels of foreign-ownership are evident in the production of Leather Products and in high value added activities like Electrical Machinery, Radio and Communication Equipment and Medical and Optical Instruments. Third, we present the average level of investment made by enterprises within each sector during the year in question. These figures are deflated and are presented in millions of Vietnamese Dong.[15] The highest levels of investment are experienced in sectors where there are high levels of state ownership (Repairing Other Transport Equipment).[16] High levels of investment are also evident in sectors with a high concentration of foreign-owned enterprises. We consider interaction terms to explore the potential effects on productivity in the econometric model. The final column of Table 2 gives the average number of Personal Computers (PCs) per employee for firms operating in each sector. Technology usage is greatest in Publishing and Printing and the manufacture of Radio and Communications equipment where on average there are 0.23 and 0.21 PCs per employee, respectively. The former is associated with high levels of state ownership while the latter with high levels of foreign ownership. The effects of the interaction between ownership and technology usage on productivity are also considered in the econometric model.

[INSERT TABLE 2 ABOUT HERE]

Table 3 presents summary statistics for each of the sector-specific explanatory variables included in the analysis. In this case the proportion of state ownership and foreign ownership refers to the proportion of total employment attributable to state and foreign owned enterprises, respectively. The fact that these proportions are higher than the number of firms within each ownership category presented in Table 2 indicates that within sectors state-owned enterprises and foreign-owned enterprises contribute a greater proportion to employment than their private sector counterparts. Also presented in Table 3 is the concentration ratio (CR) for each sector. This is measured as the ratio of the accumulated revenue of the four largest firms in the sector to the total revenue in the sector. The higher this ratio the more concentrated and less competitive a sector is. The trade intensity variable (TI) measures the proportion of exports plus imports in total output of the sector. This is particularly high for the manufacture of Machinery and Equipment and the Manufacture of Medical and Optical Instruments and can be attributed to a high level of imports associated with these sectors rather than exports from these sectors (the ratio of exports to output for the former is only 40 per cent and for the latter is 96 per cent). High levels are also found in Textiles, Wearing Apparel and Leather Products, as well as Chemical and Chemical Products, the manufacture of Basic Metal and Radio and Communication Equipment. A low level of trade intensity is found for Publishing and Printing and Non-metallic Mineral Products and with ratios of between 15 and 20 per cent.

[INSERT TABLE 3 ABOUT HERE]

[14] High levels of state ownership were also found in the manufacture of Tobacco and Tobacco Products and Office Machinery and Computers but this sector had to be excluded due to an insufficient number of observations.

[15] Value figures are presented in 1994 prices.

[16] This is also the case for the manufacture of Tobacco and Tobacco Products and the manufacture of Office Machinery and Computers.

## 6. Results

Section 4 outlines the procedure used to estimate TFP for each subsector of manufacturing in Vietnam. Productivity is a relative concept and so the productivity performance of each firm is measured relative to the average performance of the sector in each time period which is in turn chain linked to the average performance of firms in the sector in a base reference period which we take to be 2001. This allows us to compare the performance of firms within sectors and across years.

Table 4 presents an index of Total Factor Productivity change where each firm's contribution to the index is weighted by their contribution to total output of the relevant sector in each year. With the exception of Paper and Paper Products, all sectors experienced some growth in productivity between 2001 and 2007. Wood and Wood Products, Chemical and Chemical Products, Non-metallic Mineral Products, Machinery and Equipment, Electrical Machinery and Apparatus and Medical and Optical Instruments, all exhibited a particularly impressive performance with productivity between 20 and 30 per cent higher in 2007 compared with 2001.[17]

INSERT TABLE 4 ABOUT HERE

In Table 5, the dispersion of TFP across firms in each sector is presented along with how this dispersion changed between 2001 and 2007. The relative productivity level at the 25$^{th}$, 50$^{th}$ and 75$^{th}$ percentile of the distribution are given along with the Inter-Quartile Range (IQR - the difference between the 75$^{th}$ and 25$^{th}$ percentile levels). A decline in the IQR indicates a narrowing of the productivity distribution over time signifying that the difference between the best performing and worst performing firms is narrowing. For a sector that is experiencing productivity improvements, a narrowing of the distribution suggests that this is fuelled by productivity improvements by firms in the lower half of the distribution and vice versa.

INSERT TABLE 5 ABOUT HERE

A narrowing of the productivity distribution is experienced in most sectors. Amongst the sectors with the greatest productivity growth, Wood and Wood Products and Non-metallic Mineral Products experience a narrowing in the productivity distribution. This suggests that productivity growth is due to productivity improvements in the lower half of the productivity distribution. For Chemical and Chemical Products, Machinery and Equipment, Electrical Machinery and Apparatus and Medical and Optical Instruments, however, the distribution widened suggesting that the best performing firms are driving productivity growth leaving those in the lower half of the distribution behind. Other sectors experiencing a widening in the distribution include Radio and Communication Equipment, the Assembly and Repair of Motor Vehicles

[17] As a robustness check the trend in productivity growth estimated using the index number approach is compared to the trend estimated using Olley and Pakes' (1996) methodology. In all cases the trend moves in the same direction and in most cases the estimates correlate very well. There are some divergences in places which is most likely due to the fact that the Olley and Pakes' approach controls for selection bias in the productivity estimates and statistical noise. The drawback of using this approach is that it requires data on investment which are not available for all firms in every year and also excludes any firms that report zero investment. We therefore proceed with the index number approach for the remainder of the analysis.

and the Assembly and Repair of Other Transport Equipment. The widening of the distribution is coupled with virtually no growth in productivity in these sectors suggesting that those in the bottom of the distribution are performing very poorly.

INSERT TABLE 6 ABOUT HERE

In an attempt to better understand the differences in productivity across firms we estimate the model given in Equation 2. The results are presented in Table 6. Column (A) presents the results from the baseline model. As hypothesised in Section 3, we find that productivity is positively correlated with the age. Also in line with expectations, we find that entry firms are less productive than incumbents. The productivity of exit firms, however, is not found to be significantly different. As expected larger firms have a higher level of productivity. In Section 3 we hypothesised that state-owned enterprises tend to be both older and larger than private enterprises and so might be expected to have higher levels of productivity. However, we find here that, at least in the baseline model, productivity is not significantly different than private enterprises once age and size are controlled for. Foreign-owned enterprises, in contrast, are found to be more productive than private-owned firms as expected however the magnitude of this difference is small. An important aim of this paper is to analyse the link between investment and productivity. The results presented in Table 6 suggest that higher levels of investment are associated with higher productivity levels. The lag of investment is used to control for any potential endogeneity between current period investment and current period productivity. In addition, the extent of technology usage, our proxy for previous technological investments, also has a positive and significant effect of a very high magnitude. Combined these results provide strong evidence of the important role of investment, and in particular investment in technology, for productivity growth.

We further explore the role of ownership structure by considering its interaction with investment and technology usage. First, state-ownership is interacted with lagged investment in Column (B) given that state-owned enterprises are associated with higher levels of investment. We find that once we control for the fact that state-owned enterprises invest larger amounts than private firms, the effect of state-ownership on productivity is negative and significant. The independent effect of investment remains positive and statistically significant. A similar negative effect of state ownership on productivity is found in Column (C), when we control for the interaction between state ownership and technology usage. This suggests that once we control for the fact that state-owned enterprises have a greater stock of technology relative to private firms, they are less productive than their domestic counterparts. As for investment, the independent effect of lag technology on productivity remains positive and statistically significant. We also consider the interaction between age and state ownership under the hypothesis that state-owned enterprises tend to be older than private firms and may have built up a stock of knowledge allowing them to produce more efficiently. As revealed in Column (D) the interaction term is negative and statistically significant, contrary to expectations, suggesting that older state-owned enterprises are less productive. Once this interaction is controlled for the effect of state-ownership on productivity is positive. This suggests that older state-owned enterprises have not benefited in terms of higher productivity from surviving for longer in the industry.

We perform the same exercise for foreign-owned enterprises. We find that the interaction between foreign ownership and both investment and technology usage, illustrated in Columns (E) and (F), respectively, have a very strong positive effect on productivity. The inclusion of the interaction with investment renders the coefficient on the foreign-owned dummy negative and significant. The positive effect of foreign ownership on productivity remains once its interaction with technology is included, although it is of a much lower magnitude. This implies that the productivity differential between foreign and private domestic enterprises is driven by higher levels of investment and a superior stock of technology. Further insight into the driving force behind the relationship between productivity and ownership structure is revealed through the interaction between foreign ownership and age. We find that the interaction effect is positive and significant indicating that older foreign-owned enterprises are more productive than other firms. With the inclusion of this interaction term the level effect of foreign ownership becomes negative and significant. This suggests that along with investment and technology the length of time a firm is in business is also an important indicator of how much more productive foreign firms are compared with their domestic counterparts.[18]

As a robustness check we run the same set of models but include a dummy variable for private-owned firms rendering foreign and state-owned enterprises to the base category. The results are presented in Table 7. Column (A) reveals that, as expected, private owned firms are significantly less productive than foreign and state-owned enterprises. All other variables have the same effect. In columns (B) to (D) we control for the interaction between private ownership and investment, technology use and age, respectively. We find that in all cases the interaction term is negative and significant. However, once we control for the fact that private-owned firms have lower levels of investment (Column B) the productivity of private owned firms is greater than that of foreign or state-owned enterprises. This confirms our previous finding that investment and technology usage drive the productivity differential between state and foreign-owned enterprises as compared with private domestic firms.

INSERT TABLE 7 ABOUT HERE

The sector specific factors also lead to some interesting conclusions. Contrary to expectations the concentration of foreign-owned enterprises in a sector (FR) does not have a significant effect on productivity. The concentration of state ownership in a sector (SR), however, has a positive and significant effect on productivity. This result is robust to the inclusion of all interaction effects. As hypothesized in Section 3, this suggests that the ongoing process of transition in Vietnam may create opportunities for firms in previously SOE concentrated sectors. The overall level of concentration of a sector (CR) is not found to have a statistically significant effect. The level of trade intensity (TI) is found to be positive, highly significant and robust to the various model specifications considered. This effect is consistent with much of the literature on the link between trade and productivity: sectors which are more exposed to trade, and are therefore more open, are more productive. The direction of causality, however, is in question here given that there may be potential endogeneity issues to consider and so this result should be interpreted with some caution.

[18] All results are robust to the inclusion of interaction terms between sector dummies and year dummies.

Next, we explore the extent to which the factors determining productivity growth are different across 2-digit sectors of manufacturing. Table 8 presents the results of the baseline model for each sector and the interaction between form of ownership and technology usage.[19]

INSERT TABLE 8 ABOUT HERE

The only variables significant in the baseline model for the Food Products and Beverages sector are foreign ownership, lag investment and lag technology usage. We find that all three have a positive effect on productivity. Once the interaction between state ownership and technology usage is included we find that the effect of state ownership becomes negative while the interaction term is positive, significant and of a high magnitude. The interaction between foreign ownership and technology usage does not have a significant effect on productivity.

In the Textiles and Wearing Apparel sectors we find a positive and significant relationship between age and firm size and productivity. For Textiles we find that entrants are more productive than exits, which is more in line with the literature on industry dynamics than the findings of the general model. Both investment and technology usage have significant positive effects in both sectors. In Textiles, we find that, even in the baseline model, state-owned enterprises are less productive than private firms. This effect is of an even greater magnitude once the interaction between state-owned enterprises and technology usage is included in the model. In the case of foreign-owned enterprises the baseline model suggests that the productivity of foreign-owned enterprises is not statistically different to that of private firms. Combined these results suggest that a productive private sector may be emerging within the Textiles sector in Vietnam, in particular in the last two years of the sample where impressive productivity gains have been made. The interaction between foreign-owned enterprises and technology usage is positive and significant as in the general model but the level effect remains the same. In contrast, in the Wearing Apparel sector we find that both state-owned and foreign-owned enterprises are more productive then their private domestic counterparts, even when higher levels of technology use are controlled for, although, for foreign-owned enterprises, technology usage does not drive this differential. The solid productivity performance of the Wearing Apparel sector in recent years, however, coupled with a narrowing in the productivity distribution suggests that private domestic firms are managing to compete in these sectors and are catching up in terms of productivity over time.

The productivity experience of Wood and Wood Products and Paper and Paper Products is very similar. For both sectors we find in the baseline model that both state-owned and foreign-owned enterprises are more productive than private domestic firms. For Wood and Wood Products we find that both investment and technology usage have a positive and significant effect on productivity while for Paper and Paper Products only technology usage is significant and positive. For both sectors we find that once higher levels of technology usage by both state and foreign-owned

[19] Sector level regressions for Leather and Leather Products, Basic Metals, Machinery and Equipment, Electrical Machinery and Apparatus, Radio and Communication Equipment, Medical and Optical Instruments, Assembling and Repairing Motor Vehicles and Repairing of Other Transport Equipment are excluded due to a small number of observations in each of these sectors preventing accurate models from being estimated.

enterprises are controlled for through the inclusion of the interaction terms, private domestic firms are in fact more productive. In contrast, for Publishing and Printing, state-owned enterprises are more productive than private enterprises, even when technology usage is controlled for, while productivity levels of foreign-owned enterprises are not statistically different.

Technology is an important driver of productivity growth in the manufacture of Chemical and Chemical Products. This is driven by foreign-owned enterprises the more technology intensive of which are the most productive in the sector. State-owned enterprises do not perform well in this sector, with lower productivity levels than private domestic firms once higher levels of technology usage are controlled for. In contrast, state-owned enterprises are much more productive than private domestic firms in the manufacture of Rubber and Rubber Products. This is also due to the technological intensity of state-owned enterprises in this sector. While foreign-owned enterprises in this sector are more productive than domestic firms the magnitude of the differential is low and is not driven by technology usage.

Ownership and technology usage are also important to the productivity story of the Non-metallic Mineral Products sector. In the baseline model, state-owned and foreign-owned enterprises are more productive than their domestic counterparts and both investment and technology drive productivity growth. The large magnitude of the positive effect of the interaction between technology usage and state-ownership on productivity is of particular note with its inclusion rendering the coefficient on state-ownership negative. In contrast, technology intensive foreign-owned enterprises have lower productivity levels than all other firms suggesting an inefficient use of technology by foreign-owned enterprises in this sector. As revealed in Tables 2 and 3 this sector has a large presence of state-owned enterprises and only a small concentration of foreign-owned enterprises. Strong productivity growth in the sector over the last few years, coupled with a widening in the dispersion of the productivity distribution, may make it difficult for foreign-owned enterprises in this sector to compete with their technology intensive state-owned counterparts.

Within the Fabricated Metal Products sector age and size are both positively related with productivity. The baseline model also suggests that the productivity performance of state-owned enterprises is no different to that of private domestic enterprises while foreign-owned enterprises are more productive. Both investment and technology have a positive and significant effect on productivity. Inclusion of the interaction between ownership and technology usage renders the coefficient on state ownership negative and significant and the coefficient on foreign ownership insignificant suggesting that productivity differences across ownership structure are driven by technology intensity.

Finally, productivity in Furniture production is positively related to firm size. There is also some evidence to suggest that state-owned enterprises are more productive than private domestic firms in this sector, with technological intensity being an important source of this productivity differential. The productivity of foreign-owned enterprises is not found to be statistically different to private owned firms. The dynamics of this sector also provides an interesting story. We find that entry firms are more productive than incumbents suggesting that productivity enhancing reallocations are occurring in this sector.

## 7. Conclusions and Recommendations

This paper explored the productivity performance of the manufacturing sector in Vietnam from 2001 to 2007. Using an index number approach, TFP indices were calculated for each 2-digit sub-sector and productivity was compared within and across this time period. We conclude first of all that most sectors experienced productivity growth with Wood and Wood Products, Chemical and Chemical Products, Non-metallic Mineral Products, Machinery and Equipment, Electrical Machinery and Apparatus and Medical and Optical Instruments exhibiting particularly impressive performances. A narrowing of the productivity distribution is found in many sectors suggesting that the gap between the most and least productive enterprises is narrowing over time. However, for some sectors productivity is being driven by the best performing enterprises, that is those in the top percentiles of the productivity distribution (see, in particular, the results for Chemical and Chemical Products, Machinery and Equipment, Electrical Machinery and Apparatus and Medical and Optical Instruments).

A model of the determinants of productivity was then constructed. The particular focus of the analysis was to explore the impact of investment and technology on productivity and to link this to legal ownership structure. We find that higher levels of investment and technology usage are associated with higher levels of productivity. This conclusion provides direct support for government policy aimed at improving productivity through the provision of incentives for investment in technology and innovation. We also find that foreign-owned enterprises are more productive than both state-owned and domestic private enterprises; and that enterprises located in sectors with a high concentration of state-ownership have higher productivity levels.

Further investigation of the nature of the interaction between technology, investment and ownership structure reveals that once we control for higher levels of investment and technology usage, state-owned enterprises are found to be less productive than domestic private enterprises. This suggests that higher productivity levels of state-owned enterprises are attributable to higher levels of investment and technology usage. Given that previous research has shown that state-owned enterprises have greater opportunities to avail of government incentive schemes for both investment and technology development, this indicates that the productivity of these enterprises is highly reliant on government support.

A similar conclusion emerges for foreign-owned enterprises, with the interaction between foreign ownership and investment and technology usage having a very strongly positive and significant effect on productivity, dampening the magnitude of the level effect and in some cases making it negative. Again this suggests that higher productivity levels among foreign-owned enterprises is as a result of higher levels of investment and technology usage. In contrast to state-owned enterprises, however, there is no evidence to suggest that foreign-owned enterprises are given favourable investment and technology treatment in Vietnam. Rather, it is likely that the practice of having higher levels of investment and technology usage is imported from parent companies abroad. Combined, these results point to dynamism within the domestic private sector where enterprises are mainly disadvantaged by lower levels of investment and technology usage compared with their state-owned and foreign-owned counterparts.

These results provide support for the overall direction of government investment, technology and innovation policy. Given the narrowing of the productivity distribution in many sectors, we conclude that the support currently being provided is having some positive impact in improving the efficiency with which the economy is working. At the same time, there is strong evidence of an inequitable distribution of government support. Specifically, relative to its needs for efficient expansion, the domestic private sector appears to be receiving a disproportionately low share of assistance. Based on the finding of a strong and positive relationship between enterprise size and productivity, we conclude that small to medium sized enterprises are in need of specific targeted interventions to help mobilize capital for technological investments. Thus, current technology and innovation policies should be revised and reinforced such that a level playing field is created for the access to such services.

Further research should focus on understanding the *composition* of investment and its impact on productivity. The descriptive statistics presented in this paper indicates that government incentives have led to an increase in investment in technology equipment and machinery but not to an increase in the level of investment in R&D and training. We note that investment in technology equipment and machinery (measured by a technology use proxy) has a strong positive effect on productivity, but this is not so for private domestic enterprises. This finding should be complemented by an analysis of the efficacy of R&D investment and training.

In addition, given the higher productivity found for foreign-owned enterprises, further research should investigate and complement existing studies on the vertical integration of the supply chain in these sectors, and in particular, investigate the links between domestic enterprises and large multinational companies.

Finally, a large international literature exists linking higher levels of productivity with exporting enterprises. There is also evidence to suggest that imports can lead to technology transfers from abroad. We find a strong positive relationship between the trade intensity of a sector and productivity. Data limitations, however, prevent us from pinpointing the direction of causation. Gathering firm-level trade data to complement the sample used here would therefore represent an important next step in coming fully to grips with the performance of Vietnamese manufacturing enterprises.

**Table 1:** Summary Statistics

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2007/2001 |
|---|---|---|---|---|---|---|---|---|
| **15 Food Products and Beverages** | | | | | | | | |
| Number of Firms | 2,643 | 2,148 | 2,287 | 2,599 | 2,810 | 3,550 | 3,515 | 1.33 |
| Value of Production | 8,201 | 12,693 | 12,110 | 13,097 | 12,595 | 10,857 | 14,735 | 1.80 |
| Labour Units | 73 | 97 | 95 | 93 | 88 | 70 | 72 | 0.99 |
| Capital | 6,518 | 9,768 | 9,551 | 9,841 | 9,776 | 8,554 | 10,941 | 1.68 |
| Other Costs | 11,157 | 16,158 | 19,219 | 18,375 | 19,665 | 16,276 | 19,084 | 1.71 |
| Labour Cost Share | 11.8% | 11.8% | 11.9% | 11.8% | 12.3% | 10.9% | 11.5% | 0.97 |
| Capital Cost Share | 12.6% | 13.9% | 14.8% | 13.6% | 14.5% | 18.5% | 17.6% | 1.40 |
| Other Costs Share | 75.6% | 74.3% | 73.3% | 74.6% | 73.2% | 70.6% | 70.9% | 0.94 |
| **17 Textiles** | | | | | | | | |
| Number of Firms | 372 | 425 | 480 | 563 | 668 | 889 | 925 | 2.49 |
| Value of Production | 15,176 | 16,451 | 16,336 | 15,690 | 12,632 | 10,689 | 11,978 | 0.79 |
| Labour Units | 253 | 246 | 226 | 180 | 160 | 131 | 120 | 0.47 |
| Capital | 25,305 | 25,497 | 24,454 | 21,096 | 20,250 | 16,367 | 17,504 | 0.69 |
| Other Costs | 17,962 | 19,304 | 19,132 | 18,126 | 18,745 | 14,970 | 15,387 | 0.86 |
| Labour Cost Share | 17.4% | 16.1% | 15.6% | 15.0% | 16.3% | 16.2% | 15.8% | 0.91 |
| Capital Cost Share | 16.1% | 16.6% | 17.5% | 16.3% | 17.7% | 19.4% | 20.9% | 1.30 |
| Other Costs Share | 66.6% | 67.2% | 66.9% | 68.7% | 66.0% | 64.4% | 63.2% | 0.95 |
| **18 Wearing Apparel** | | | | | | | | |
| Number of Firms | 566 | 673 | 809 | 1,083 | 1,136 | 1,397 | 1,544 | 2.73 |
| Value of Production | 7,773 | 6,957 | 6,936 | 6,035 | 6,653 | 6,111 | 7,279 | 0.94 |
| Labour Units | 334 | 359 | 353 | 306 | 307 | 265 | 271 | 0.81 |
| Capital | 9,049 | 10,181 | 10,263 | 8,371 | 8,864 | 8,016 | 8,616 | 0.95 |
| Other Costs | 6,525 | 6,417 | 9,062 | 8,105 | 8,297 | 7,274 | 8,063 | 1.24 |
| Labour Cost Share | 35.7% | 34.5% | 34.8% | 33.5% | 33.6% | 30.3% | 29.9% | 0.84 |
| Capital Cost Share | 13.6% | 13.7% | 14.1% | 12.8% | 14.1% | 17.3% | 17.5% | 1.29 |
| Other Costs Share | 50.7% | 51.7% | 51.1% | 53.7% | 52.3% | 52.4% | 52.6% | 1.04 |
| **19 Leather Products** | | | | | | | | |
| Number of Firms | 260 | 265 | 281 | 361 | 406 | 396 | 431 | 1.66 |
| Value of Production | 25,373 | 26,963 | 29,868 | 24,983 | 24,891 | 26,991 | 29,797 | 1.17 |
| Labour Units | 962 | 965 | 1018 | 842 | 784 | 804 | 753 | 0.78 |
| Capital | 24,629 | 27,477 | 30,787 | 25,368 | 26,186 | 27,103 | 30,397 | 1.23 |
| Other Costs | 26,616 | 27,263 | 38,555 | 30,215 | 27,745 | 28,801 | 30,768 | 1.16 |
| Labour Cost Share | 33.6% | 32.6% | 32.8% | 31.7% | 32.0% | 28.8% | 29.8% | 0.89 |
| Capital Cost Share | 12.0% | 13.0% | 13.1% | 13.4% | 13.8% | 16.3% | 16.3% | 1.36 |
| Other Costs Share | 54.3% | 54.4% | 54.2% | 54.9% | 54.2% | 55.0% | 53.8% | 0.99 |
| **20 Wood and Wood Products** | | | | | | | | |
| Number of Firms | 689 | 680 | 771 | 928 | 1,069 | 1,350 | 1,476 | 2.14 |
| Value of Production | 2,489 | 3,146 | 2,905 | 3,009 | 2,914 | 2,617 | 3,086 | 1.24 |
| Labour Units | 68 | 80 | 75 | 70 | 63 | 45 | 46 | 0.68 |
| Capital | 2,816 | 3,518 | 3,225 | 3,210 | 3,454 | 2,722 | 3,015 | 1.07 |
| Other Costs | 2,554 | 3,494 | 2,843 | 3,281 | 3,540 | 2,974 | 2,949 | 1.15 |
| Labour Cost Share | 17.7% | 17.0% | 17.7% | 16.6% | 16.2% | 14.6% | 15.7% | 0.89 |
| Capital Cost Share | 14.2% | 13.1% | 12.7% | 12.2% | 13.2% | 15.3% | 17.0% | 1.20 |
| Other Costs Share | 68.0% | 69.8% | 69.6% | 71.2% | 70.6% | 70.0% | 67.3% | 0.99 |

**Table 1 (continued):** Summary Statistics

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2007/2001 |
|---|---|---|---|---|---|---|---|---|
| **21 Paper and Paper Products** | | | | | | | | |
| Number of Firms | 420 | 457 | 559 | 634 | 775 | 898 | 955 | 2.27 |
| Value of Production | 6,884 | 7,192 | 6,203 | 6,899 | 6,066 | 6,161 | 7,853 | 1.14 |
| Labour Units | 75 | 77 | 68 | 63 | 61 | 55 | 59 | 0.79 |
| Capital | 8,649 | 8,664 | 7,479 | 7,855 | 7,849 | 7,422 | 9,120 | 1.05 |
| Other Costs | 7,455 | 7,596 | 6,706 | 7,720 | 8,197 | 7,939 | 8,139 | 1.09 |
| Labour Cost Share | 10.6% | 10.1% | 10.1% | 10.1% | 10.2% | 9.1% | 9.7% | 0.92 |
| Capital Cost Share | 11.2% | 12.1% | 12.5% | 12.1% | 13.2% | 14.8% | 14.8% | 1.32 |
| Other Costs Share | 78.2% | 77.8% | 77.4% | 77.9% | 76.6% | 76.1% | 75.4% | 0.96 |
| **22 Publishing and Printing** | | | | | | | | |
| Number of Firms | 330 | 391 | 539 | 759 | 904 | 1,477 | 1,325 | 4.02 |
| Value of Production | 5,148 | 4,927 | 3,396 | 2,348 | 1,996 | 1,412 | 1,899 | 0.37 |
| Labour Units | 62 | 56 | 46 | 36 | 33 | 21 | 25 | 0.40 |
| Capital | 6,191 | 5,945 | 4,837 | 3,352 | 3,297 | 1,940 | 2,673 | 0.43 |
| Other Costs | 6,657 | 6,608 | 5,247 | 3,981 | 4,082 | 2,363 | 2,722 | 0.41 |
| Labour Cost Share | 16.9% | 16.9% | 16.9% | 16.6% | 17.3% | 14.1% | 15.5% | 0.92 |
| Capital Cost Share | 12.0% | 12.3% | 12.1% | 12.4% | 12.3% | 12.5% | 14.0% | 1.17 |
| Other Costs Share | 71.1% | 70.8% | 71.0% | 71.0% | 70.4% | 73.4% | 70.4% | 0.99 |
| **24 Chemical and Chemical Products** | | | | | | | | |
| Number of Firms | 420 | 471 | 558 | 645 | 768 | 965 | 1,032 | 2.46 |
| Value of Production | 23,843 | 20,902 | 20,566 | 18,271 | 16,273 | 16,578 | 17,447 | 0.73 |
| Labour Units | 108 | 100 | 91.7 | 83 | 76 | 68 | 66 | 0.61 |
| Capital | 21,272 | 19,761 | 19,346 | 19,193 | 18,791 | 18,267 | 19,507 | 0.92 |
| Other Costs | 26,204 | 24,851 | 24,683 | 24,807 | 24,416 | 24,302 | 21,487 | 0.82 |
| Labour Cost Share | 11.9% | 11.5% | 12.1% | 12.7% | 13.0% | 11.9% | 11.9% | 1.00 |
| Capital Cost Share | 12.4% | 13.7% | 13.7% | 13.2% | 14.3% | 16.8% | 19.2% | 1.55 |
| Other Costs Share | 75.6% | 74.8% | 74.1% | 74.1% | 72.7% | 71.3% | 68.8% | 0.91 |
| **25 Rubber and Plastic Products** | | | | | | | | |
| Number of Firms | 524 | 639 | 723 | 917 | 1,119 | 1,338 | 1,517 | 2.90 |
| Value of Production | 9,329 | 9,807 | 9,901 | 10,481 | 9,317 | 8,914 | 10,862 | 1.16 |
| Labour Units | 85 | 82 | 88 | 78 | 71 | 65 | 64 | 0.75 |
| Capital | 12,308 | 11,825 | 12,718 | 11,964 | 11,034 | 10,604 | 12,039 | 0.98 |
| Other Costs | 12,094 | 13,182 | 13,641 | 14,526 | 11,079 | 8,405 | 9,961 | 0.82 |
| Labour Cost Share | 12.7% | 11.6% | 10.8% | 10.6% | 10.1% | 9.8% | 9.5% | 0.75 |
| Capital Cost Share | 13.3% | 14.3% | 13.5% | 13.0% | 13.3% | 16.6% | 15.6% | 1.17 |
| Other Costs Share | 73.9% | 74.1% | 75.7% | 76.4% | 76.5% | 73.5% | 74.9% | 1.01 |
| **26 Non-metallic Mineral Products** | | | | | | | | |
| Number of Firms | 1,001 | 939 | 1,020 | 1,181 | 1,255 | 1,344 | 1,395 | 1.39 |
| Value of Production | 10,388 | 13,638 | 14,534 | 14,421 | 12,180 | 13,046 | 14,972 | 1.44 |
| Labour Units | 113 | 130 | 139 | 129 | 121 | 116 | 114 | 1.01 |
| Capital | 11,647 | 14,240 | 14,706 | 13,515 | 12,932 | 13,061 | 13,968 | 1.20 |
| Other Costs | 8,698 | 11,379 | 13,439 | 11,219 | 10,208 | 9,461 | 9,578 | 1.10 |
| Labour Cost Share | 23.1% | 23.6% | 22.6% | 21.8% | 20.9% | 19.7% | 21.9% | 0.95 |
| Capital Cost Share | 17.1% | 16.9% | 16.3% | 15.6% | 16.6% | 20.0% | 20.2% | 1.18 |
| Other Costs Share | 59.8% | 59.6% | 61.1% | 62.7% | 62.5% | 60.3% | 57.9% | 0.97 |

**Table 1 (continued):** Summary Statistics

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2007/2001 |
|---|---|---|---|---|---|---|---|---|
| **27 Basic Metal** | | | | | | | | |
| Number of Firms | 137 | 167 | 199 | 238 | 301 | 364 | 462 | 3.37 |
| Value of Production | 33,138 | 40,881 | 37,886 | 33,254 | 24,329 | 19,180 | 30,137 | 0.91 |
| Labour Units | 115 | 109 | 110 | 86 | 71 | 65 | 63.8 | 0.55 |
| Capital | 28,779 | 36,549 | 35,970 | 34,213 | 26,810 | 20,202 | 24,703 | 0.86 |
| Other Costs | 39,276 | 43,898 | 53,503 | 47,407 | 37,336 | 29,060 | 35,083 | 0.89 |
| Labour Cost Share | 9.3% | 8.9% | 8.1% | 7.3% | 6.6% | 7.3% | 7.5% | 0.81 |
| Capital Cost Share | 11.3% | 12.0% | 10.7% | 9.5% | 11.1% | 12.8% | 13.1% | 1.16 |
| Other Costs Share | 79.4% | 79.0% | 81.3% | 83.2% | 82.3% | 79.8% | 79.4% | 1.00 |
| **28 Fabricated Metal Products** | | | | | | | | |
| Number of Firms | 694 | 815 | 1,100 | 1,438 | 1,760 | 2,320 | 2,674 | 3.85 |
| Value of Production | 4,772 | 4,484 | 4,142 | 4,222 | 4,435 | 4,347 | 5,039 | 1.06 |
| Labour Units | 57 | 55 | 49 | 47 | 44 | 38 | 38 | 0.67 |
| Capital | 6,587 | 6,836 | 5,675 | 5,863 | 5,909 | 5,817 | 6,739 | 1.02 |
| Other Costs | 6,310 | 6,932 | 7,506 | 7,847 | 7,789 | 7,365 | 7,253 | 1.15 |
| Labour Cost Share | 15.2% | 14.2% | 13.8% | 13.9% | 13.9% | 13.3% | 13.3% | 0.88 |
| Capital Cost Share | 12.3% | 12.8% | 12.9% | 12.4% | 13.5% | 15.8% | 17.9% | 1.46 |
| Other Costs Share | 72.4% | 72.9% | 73.4% | 73.7% | 72.5% | 70.9% | 68.8% | 0.95 |
| **29 Machinery and Equipment** | | | | | | | | |
| Number of Firms | 265 | 306 | 359 | 433 | 498 | 592 | 679 | 2.56 |
| Value of Production | 9,153 | 9,280 | 8,836 | 7,075 | 4,829 | 4,960 | 7,123 | 0.78 |
| Labour Units | 117 | 97 | 94 | 78 | 66 | 57 | 59 | 0.50 |
| Capital | 11,248 | 11,488 | 11,525 | 10,302 | 9,968 | 8,854 | 10,791 | 0.96 |
| Other Costs | 10,604 | 11,842 | 12,607 | 9,822 | 8,731 | 7,421 | 9,795 | 0.92 |
| Labour Cost Share | 16.0% | 14.7% | 13.9% | 13.5% | 13.5% | 15.4% | 13.9% | 0.87 |
| Capital Cost Share | 14.6% | 15.0% | 14.7% | 13.6% | 14.6% | 17.6% | 17.9% | 1.23 |
| Other Costs Share | 69.4% | 70.3% | 71.4% | 72.9% | 72.0% | 67.0% | 68.2% | 0.98 |
| **31 Electrical Machinery and App.** | | | | | | | | |
| Number of Firms | 169 | 186 | 223 | 298 | 340 | 376 | 352 | 2.08 |
| Value of Production | 23,200 | 26,143 | 27,646 | 22,850 | 25,778 | 27,852 | 37,644 | 1.62 |
| Labour Units | 186 | 179 | 185 | 137 | 144 | 166 | 198 | 1.06 |
| Capital | 35,464 | 35,711 | 36,207 | 29,058 | 30,361 | 32,745 | 43,228 | 1.22 |
| Other Costs | 30,782 | 35,425 | 40,971 | 33,062 | 36,639 | 41,921 | 51,859 | 1.68 |
| Labour Cost Share | 11.1% | 11.0% | 10.7% | 11.1% | 12.0% | 11.4% | 10.6% | 0.95 |
| Capital Cost Share | 12.4% | 14.0% | 14.0% | 14.3% | 14.9% | 16.1% | 17.3% | 1.40 |
| Other Costs Share | 76.4% | 75.0% | 75.3% | 74.6% | 73.1% | 72.5% | 72.1% | 0.94 |
| **32 Radio and Communication Equipment** | | | | | | | | |
| Number of Firms | 83 | 89 | 110 | 144 | 153 | 176 | 207 | 2.49 |
| Value of Production | 53,583 | 59,464 | 49,076 | 41,638 | 27,762 | 40,599 | 37,807 | 0.71 |
| Labour Units | 158 | 160 | 157 | 160 | 146 | 158 | 172 | 1.09 |
| Capital | 53,451 | 56,157 | 47,119 | 40,495 | 36,613 | 40,791 | 41,697 | 0.78 |
| Other Costs | 62,787 | 75,568 | 69,071 | 61,308 | 56,894 | 72,272 | 66,484 | 1.06 |
| Labour Cost Share | 15.4% | 14.2% | 17.6% | 16.2% | 17.0% | 14.4% | 16.4% | 1.06 |
| Capital Cost Share | 14.3% | 15.1% | 15.3% | 14.4% | 15.5% | 16.7% | 19.6% | 1.37 |
| Other Costs Share | 70.3% | 70.6% | 67.1% | 69.4% | 67.5% | 68.9% | 64.0% | 0.91 |

**Table 1 (continued):** Summary Statistics

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2007/2001 |
|---|---|---|---|---|---|---|---|---|
| **33 Medical and Optical Instruments** | | | | | | | | |
| Number of Firms | 38 | 45 | 50 | 59 | 78 | 94 | 91 | 2.39 |
| Value of Production | 8,469 | 11,730 | 11,595 | 11,835 | 5,507 | 4,880 | 4,980 | 0.59 |
| Labour Units | 160 | 183 | 198 | 189 | 138 | 96 | 109 | 0.68 |
| Capital | 31,138 | 35,620 | 34,278 | 29,994 | 21,644 | 13,191 | 14,917 | 0.48 |
| Other Costs | 12,755 | 20,739 | 24,653 | 25,148 | 18,330 | 10,953 | 11,952 | 0.94 |
| Labour Cost Share | 14.4% | 15.7% | 14.4% | 15.5% | 18.0% | 18.9% | 19.6% | 1.36 |
| Capital Cost Share | 18.3% | 20.0% | 14.4% | 16.1% | 17.9% | 20.0% | 21.6% | 1.18 |
| Other Costs Share | 67.3% | 64.3% | 71.2% | 68.4% | 64.1% | 61.0% | 58.9% | 0.88 |
| **34 Assembling/Repairing Motor Vehicles** | | | | | | | | |
| Number of Firms | 170 | 181 | 177 | 220 | 253 | 211 | 236 | 1.39 |
| Value of Production | 13,888 | 22,153 | 26,350 | 24,160 | 20,128 | 22,766 | 25,851 | 1.86 |
| Labour Units | 79 | 107 | 108 | 111 | 101 | 148 | 120 | 1.52 |
| Capital | 21,133 | 35,659 | 37,646 | 32,037 | 30,216 | 47,219 | 38,463 | 1.82 |
| Other Costs | 23,621 | 42,358 | 52,427 | 55,850 | 41,734 | 57,255 | 56,588 | 2.40 |
| Labour Cost Share | 18.6% | 16.9% | 16.3% | 14.6% | 14.9% | 11.9% | 12.8% | 0.69 |
| Capital Cost Share | 12.2% | 13.0% | 13.6% | 14.1% | 14.9% | 20.8% | 18.7% | 1.53 |
| Other Costs Share | 69.1% | 70.1% | 70.1% | 71.3% | 70.1% | 67.3% | 68.5% | 0.99 |
| **35 Repairing of Other Transport Equip** | | | | | | | | |
| Number of Firms | 242 | 251 | 290 | 336 | 379 | 409 | 466 | 1.93 |
| Value of Production | 13,735 | 17,947 | 16,806 | 17,736 | 23,354 | 21,840 | 24,379 | 1.77 |
| Labour Units | 137 | 163 | 169 | 165 | 161 | 151 | 146 | 1.07 |
| Capital | 23,042 | 29,859 | 31,985 | 34,944 | 34,179 | 35,828 | 38,348 | 1.66 |
| Other Costs | 32,473 | 32,005 | 31,355 | 38,777 | 39,245 | 36,333 | 32,281 | 0.99 |
| Labour Cost Share | 17.1% | 16.2% | 15.7% | 15.6% | 15.4% | 15.9% | 16.2% | 0.95 |
| Capital Cost Share | 13.8% | 16.0% | 16.7% | 14.8% | 16.0% | 18.4% | 19.4% | 1.41 |
| Other Costs Share | 69.1% | 67.8% | 67.5% | 69.6% | 68.5% | 65.7% | 64.4% | 0.93 |
| **36 Furniture** | | | | | | | | |
| Number of Firms | 572 | 595 | 806 | 1,004 | 1,202 | 1,389 | 1,591 | 2.78 |
| Value of Production | 3,803 | 5,312 | 5,085 | 5,186 | 5,904 | 6,732 | 7,722 | 2.03 |
| Labour Units | 110 | 130 | 133 | 132 | 139 | 150 | 143 | 1.30 |
| Capital | 5,571 | 7,529 | 8,149 | 7,828 | 8,853 | 10,530 | 11,608 | 2.08 |
| Other Costs | 4,062 | 6,160 | 6,940 | 7,603 | 8,613 | 9,543 | 9,902 | 2.44 |
| Labour Cost Share | 20.5% | 20.1% | 19.6% | 19.6% | 19.1% | 18.8% | 18.4% | 0.90 |
| Capital Cost Share | 13.9% | 14.8% | 15.6% | 14.7% | 15.0% | 19.5% | 19.2% | 1.38 |
| Other Costs Share | 65.6% | 65.1% | 64.7% | 65.7% | 65.9% | 61.7% | 62.4% | 0.95 |

**Table 2:** Firm Level Summary Statistics

| | Entry | Exit | State | Foreign | Invest. | IT Usage |
|---|---|---|---|---|---|---|
| 15 Food Products and Beverages | 18.23 | 13.40 | 7.54 | 6.24 | 2,568 | 0.07 |
| 17 Textiles | 16.59 | 8.98 | 7.87 | 19.37 | 5,330 | 0.08 |
| 18 Wearing Apparel | 23.71 | 13.46 | 6.08 | 19.73 | 2,687 | 0.06 |
| 19 Leather Products | 13.75 | 10.01 | 9.42 | 28.29 | 7,374 | 0.05 |
| 20 Wood and Wood Products | 19.43 | 12.87 | 3.32 | 5.26 | 1015 | 0.06 |
| 21 Paper and Paper Products | 17.88 | 10.98 | 5.58 | 6.45 | 2,435 | 0.08 |
| 22 Publishing and Printing | 34.22 | 17.75 | 16.56 | 2.27 | 1,090 | 0.23 |
| 24 Chemical and Chemical Products | 18.71 | 11.30 | 11.92 | 19.55 | 2,824 | 0.16 |
| 25 Rubber and Plastic Products | 20.88 | 10.30 | 3.08 | 15.95 | 3,374 | 0.09 |
| 26 Non-metallic Mineral | 12.24 | 10.65 | 12.83 | 5.72 | 3,351 | 0.05 |
| 27 Basic Metal | 14.88 | 7.87 | 5.84 | 8.83 | 5,712 | 0.08 |
| 28 Fabricated Metal Products | 25.71 | 14.29 | 3.78 | 9.34 | 1,729 | 0.11 |
| 29 Machinery and Equipment | 21.97 | 13.47 | 11.56 | 11.40 | 2,587 | 0.13 |
| 31 Electrical Machinery and Apparatus | 17.90 | 11.73 | 7.92 | 23.97 | 6,974 | 0.15 |
| 32 Radio and Communication Equipment | 19.65 | 12.27 | 11.75 | 31.70 | 6,455 | 0.21 |
| 33 Medical and Optical Instruments | 19.34 | 11.65 | 7.69 | 33.19 | 5,427 | 0.16 |
| 34 Assembling and Repairing Motor Vehicles | 18.58 | 14.99 | 8.84 | 24.65 | 6,298 | 0.10 |
| 35 Repairing other Transport Equipment | 14.62 | 9.86 | 15.30 | 20.02 | 10,419 | 0.08 |
| 36 Furniture | 19.99 | 13.05 | 1.83 | 17.24 | 3,003 | 0.08 |

**Table 3:** Sector Level Summary Statistics

| | SR | FR | CR | TI |
|---|---|---|---|---|
| 15 Food Products and Beverages | 0.3358 | 0.1518 | 0.0444 | 0.5222 |
| 17 Textiles | 0.3612 | 0.2946 | 0.1270 | 1.8556 |
| 18 Wearing Apparel | 0.2309 | 0.4336 | 0.0549 | 1.9378 |
| 19 Leather Products | 0.1102 | 0.5851 | 0.2052 | 1.8982 |
| 20 Wood and Wood Products | 0.1731 | 0.1386 | 0.0803 | 0.7703 |
| 21 Paper and Paper Products | 0.2170 | 0.1859 | 0.0944 | 0.7317 |
| 22 Publishing and Printing | 0.5499 | 0.0700 | 0.0765 | 0.1566 |
| 24 Chemical and Chemical Products | 0.4431 | 0.2269 | 0.1253 | 1.9541 |
| 25 Rubber and Plastic Products | 0.1696 | 0.3752 | 0.0875 | 0.6125 |
| 26 Non-metallic Mineral | 0.4296 | 0.1030 | 0.0588 | 0.2111 |
| 27 Basic Metal | 0.4274 | 0.1266 | 0.3629 | 2.5052 |
| 28 Fabricated Metal Products | 0.1672 | 0.3007 | 0.0644 | 0.4316 |
| 29 Machinery and Equipment | 0.3294 | 0.2018 | 0.1352 | 5.9006 |
| 31 Electrical Machinery and Apparatus | 0.1744 | 0.6655 | 0.3142 | 1.1957 |
| 32 Radio and Communication Equipment | 0.1339 | 0.7197 | 0.2447 | 1.9939 |
| 33 Medical and Optical Instruments | 0.0499 | 0.6939 | 0.4990 | 4.7435 |
| 34 Assembling and Repairing Motor Vehicles | 0.2457 | 0.5015 | 0.1687 | 0.7854 |
| 35 Repairing other Transport Equipment | 0.2970 | 0.3980 | 0.1632 | 0.5018 |
| 36 Furniture | 0.0560 | 0.4852 | 0.0888 | 0.8702 |

**Table 4**: Weighted Total Factor Productivity Growth 2000-2007

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|
| 15 Food Products and Textiles | 1.000 | 1.070 | 0.367 | 0.822 | 0.919 | 1.125 | 1.053 |
| 17 Textiles | 1.000 | 1.058 | 1.088 | 0.993 | 0.763 | 1.105 | 1.040 |
| 18 Wearing Apparel | 1.000 | 0.906 | 0.822 | 1.002 | 1.154 | 1.098 | 1.126 |
| 19 Leather Products | 1.000 | 1.098 | 0.740 | 0.991 | 1.120 | 1.185 | 1.088 |
| 20 Wood and Wood Products | 1.000 | 0.978 | 0.977 | 0.850 | 0.958 | 1.175 | 1.211 |
| 21 Paper and Paper Products | 1.000 | 0.892 | 0.998 | 0.807 | 1.048 | 1.158 | 0.914 |
| 22 Publishing and Printing | 1.000 | 1.004 | 0.793 | 1.022 | 1.058 | 1.374 | 1.105 |
| 24 Chemical and Chemical Products | 1.000 | 0.935 | 1.025 | 0.992 | 1.171 | 1.213 | 1.255 |
| 25 Rubber and Plastic Products | 1.000 | 1.001 | 0.983 | 1.139 | 1.241 | 1.345 | 1.073 |
| 26 Non-metallic Mineral Products | 1.000 | 1.072 | 0.935 | 1.119 | 0.993 | 1.187 | 1.210 |
| 27 Basic Metal | 1.000 | 1.118 | 0.730 | 0.962 | 1.043 | 0.997 | 1.187 |
| 28 Fabricated Metal Products | 1.000 | 0.890 | 0.860 | 1.062 | 1.167 | 1.330 | 1.047 |
| 29 Machinery and Equipment | 1.000 | 0.953 | 0.770 | 1.091 | 0.807 | 1.315 | 1.231 |
| 31 Electrical Machinery and App. | 1.000 | 1.015 | 1.096 | 1.122 | 1.148 | 1.092 | 1.275 |
| 32 Radio and Communication Equipment | 1.000 | 0.996 | 0.822 | 1.112 | 0.921 | 1.351 | 1.037 |
| 33 Medical and Optical Instruments | 1.000 | 1.020 | 0.769 | 1.107 | 0.710 | 1.534 | 1.345 |
| 34 Assembling/Repairing Motor Vehicles | 1.000 | 0.924 | 0.912 | 0.852 | 1.097 | 0.889 | 1.000 |
| 35 Repairing of Other Transport Equip | 1.000 | 1.190 | 0.650 | 0.657 | 1.155 | 0.834 | 1.064 |
| 36 Furniture | 1.000 | 0.998 | 0.800 | 0.917 | 1.108 | 1.156 | 1.159 |

**Table 5**: Dispersion in Total Factor Productivity 2001-2007

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|
| **15 Food Products and Textiles** | | | | | | | |
| 25% | -0.0125 | 0.0641 | -0.6528 | -0.2269 | -0.1126 | 0.1357 | -0.0073 |
| 50% | 0.0828 | 0.1659 | -0.5367 | -0.1277 | -0.0088 | 0.2361 | 0.0892 |
| 75% | 0.1636 | 0.2523 | -0.4462 | -0.0358 | 0.0960 | 0.3103 | 0.2097 |
| IQR | 0.1761 | 0.1882 | 0.2066 | 0.1911 | 0.2086 | 0.1747 | 0.2170 |
| **17 Textiles** | | | | | | | |
| 25% | 0.0892 | 0.1626 | 0.0161 | -0.0588 | -0.2475 | 0.1059 | -0.0012 |
| 50% | 0.2245 | 0.2770 | 0.1345 | 0.0622 | -0.1018 | 0.2300 | 0.1149 |
| 75% | 0.3259 | 0.3811 | 0.2422 | 0.1679 | 0.0003 | 0.3246 | 0.2613 |
| IQR | 0.2368 | 0.2185 | 0.2261 | 0.2267 | 0.2479 | 0.2187 | 0.2625 |
| **18 Wearing Apparel** | | | | | | | |
| 25% | 0.0319 | -0.0551 | -0.1797 | -0.0084 | 0.2049 | -0.0476 | 0.1876 |
| 50% | 0.2300 | 0.1339 | 0.0037 | 0.1637 | 0.3640 | 0.2686 | 0.2995 |
| 75% | 0.3809 | 0.3012 | 0.1537 | 0.3220 | 0.5140 | 0.4282 | 0.4634 |
| IQR | 0.3490 | 0.3563 | 0.3334 | 0.3304 | 0.3090 | 0.4758 | 0.2758 |
| **19 Leather Products** | | | | | | | |
| 25% | -0.1460 | -0.0463 | -0.2872 | -0.1848 | 0.0445 | 0.1948 | 0.0387 |
| 50% | 0.0446 | 0.1183 | -0.1405 | 0.0043 | 0.1972 | 0.3129 | 0.1938 |
| 75% | 0.1695 | 0.2434 | -0.0262 | 0.1563 | 0.3253 | 0.4429 | 0.3439 |
| IQR | 0.3155 | 0.2897 | 0.2610 | 0.3411 | 0.2808 | 0.2481 | 0.3052 |
| **20 Wood and Wood Products** | | | | | | | |
| 25% | -0.0691 | -0.1048 | -0.1561 | -0.2559 | -0.1582 | 0.0897 | 0.0478 |
| 50% | 0.0616 | 0.0273 | -0.0381 | -0.1378 | -0.0391 | 0.2005 | 0.1610 |
| 75% | 0.1805 | 0.1369 | 0.0631 | -0.0283 | 0.0716 | 0.2829 | 0.2707 |
| IQR | 0.2496 | 0.2417 | 0.2191 | 0.2277 | 0.2297 | 0.1932 | 0.2229 |
| **21 Paper and Paper Products** | | | | | | | |
| 25% | 0.0118 | 0.0503 | -0.1394 | 0.0188 | -0.2041 | 0.0233 | 0.0690 |
| 50% | 0.1006 | 0.1298 | -0.0755 | 0.0822 | -0.1222 | 0.1042 | 0.1379 |
| 75% | 0.1712 | 0.2001 | -0.0089 | 0.1486 | -0.0565 | 0.1586 | 0.2211 |
| IQR | 0.1593 | 0.1498 | 0.1305 | 0.1298 | 0.1476 | 0.1353 | 0.1521 |
| **22 Publishing and Printing** | | | | | | | |
| 25% | -0.0011 | 0.0360 | -0.3122 | -0.0262 | 0.0232 | 0.3155 | 0.0151 |
| 50% | 0.1016 | 0.1229 | -0.2286 | 0.0663 | 0.1099 | 0.3696 | 0.1119 |
| 75% | 0.2185 | 0.2236 | -0.1302 | 0.1677 | 0.2037 | 0.4381 | 0.2136 |
| IQR | 0.2196 | 0.1876 | 0.1820 | 0.1939 | 0.1804 | 0.1226 | 0.1984 |
| **24 Chemical and Chemical Products** | | | | | | | |
| 25% | 0.0857 | 0.0484 | -0.0531 | -0.0508 | 0.1338 | 0.1634 | 0.0398 |
| 50% | 0.1900 | 0.1422 | 0.0461 | 0.0731 | 0.2512 | 0.2582 | 0.1701 |
| 75% | 0.2978 | 0.2587 | 0.1529 | 0.1948 | 0.3525 | 0.3592 | 0.2949 |
| IQR | 0.2120 | 0.2103 | 0.2060 | 0.2456 | 0.2187 | 0.1958 | 0.2551 |

| **Table 5** (Continued): Dispersion in Total Factor Productivity 2001-2007 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
| **25 Rubber and Plastic Products** | | | | | | | | |
| | 25% | -0.0029 | -0.0272 | -0.0872 | 0.0784 | 0.1390 | 0.2574 | -0.0190 |
| | 50% | 0.0900 | 0.0805 | 0.0040 | 0.1643 | 0.2274 | 0.3081 | 0.0549 |
| | 75% | 0.1856 | 0.1723 | 0.0791 | 0.2526 | 0.3137 | 0.3898 | 0.1279 |
| IQR | | 0.1885 | 0.1994 | 0.1663 | 0.2834 | 0.1747 | 0.1324 | 0.1469 |
| **26 Non-metallic Mineral Products** | | | | | | | | |
| | 25% | -0.0886 | -0.0082 | -0.1817 | 0.0174 | -0.1089 | 0.0741 | 0.0306 |
| | 50% | 0.0453 | 0.1342 | -0.0451 | 0.1401 | 0.0173 | 0.1867 | 0.1604 |
| | 75% | 0.1852 | 0.2615 | 0.0078 | 0.2589 | 0.1462 | 0.2929 | 0.2985 |
| IQR | | 0.2738 | 0.2697 | 0.1894 | 0.2414 | 0.2551 | 0.2188 | 0.2679 |
| **27 Basic Metal** | | | | | | | | |
| | 25% | -0.0501 | 0.0352 | -0.3531 | -0.1742 | -0.0245 | -0.0183 | 0.0973 |
| | 50% | 0.0684 | 0.1327 | -0.2563 | -0.0793 | 0.0477 | 0.0652 | 0.1887 |
| | 75% | 0.1501 | 0.2613 | -0.1855 | -0.0023 | 0.1383 | 0.1781 | 0.2722 |
| IQR | | 0.2001 | 0.2261 | 0.1676 | 0.1719 | 0.1627 | 0.1964 | 0.1749 |
| **28 Fabricated Metal Products** | | | | | | | | |
| | 25% | 0.0192 | -0.0960 | -0.2611 | -0.0880 | 0.0509 | 0.1357 | -0.0073 |
| | 50% | 0.1296 | -0.0082 | -0.1711 | 0.0121 | 0.1479 | 0.2361 | 0.0892 |
| | 75% | 0.2385 | 0.1057 | -0.0694 | 0.1256 | 0.2571 | 0.3103 | 0.2097 |
| IQR | | 0.2193 | 0.2017 | 0.1917 | 0.2136 | 0.2062 | 0.1747 | 0.2170 |
| **29 Machinery and Equipment** | | | | | | | | |
| | 25% | 0.0176 | -0.0309 | -0.2880 | -0.0227 | -0.2580 | 0.2336 | -0.0349 |
| | 50% | 0.1345 | 0.1094 | -0.1833 | 0.0874 | -0.1591 | 0.3544 | 0.0847 |
| | 75% | 0.2662 | 0.2548 | -0.0602 | 0.2117 | -0.0440 | 0.5034 | 0.2176 |
| IQR | | 0.2486 | 0.2856 | 0.2278 | 0.2344 | 0.2140 | 0.2698 | 0.2525 |
| **31 Electrical Machinery and App.** | | | | | | | | |
| | 25% | 0.0080 | 0.0676 | -0.0619 | -0.0260 | -0.0403 | -0.1361 | 0.0034 |
| | 50% | 0.0993 | 0.1715 | 0.0481 | 0.0947 | 0.0618 | -0.0314 | 0.1287 |
| | 75% | 0.2306 | 0.2602 | 0.1575 | 0.1950 | 0.1707 | 0.0486 | 0.2661 |
| IQR | | 0.2226 | 0.1926 | 0.2194 | 0.2210 | 0.2111 | 0.1847 | 0.2627 |
| **32 Radio and Communication Equipment** | | | | | | | | |
| | 25% | -0.0992 | -0.2002 | -0.3808 | -0.2115 | -0.1575 | 0.3152 | -0.0882 |
| | 50% | -0.0086 | -0.0461 | -0.2403 | -0.0368 | -0.0014 | 0.4047 | 0.0825 |
| | 75% | 0.0998 | 0.0674 | -0.1121 | 0.0776 | 0.1219 | 0.5162 | 0.2041 |
| IQR | | 0.1990 | 0.2676 | 0.2687 | 0.2891 | 0.2794 | 0.2010 | 0.2923 |
| **33 Medical and Optical Instruments** | | | | | | | | |
| | 25% | -0.0968 | 0.0644 | -0.2846 | 0.0782 | -0.6118 | 0.3389 | 0.2769 |
| | 50% | 0.0257 | 0.1701 | -0.1173 | 0.1740 | -0.4768 | 0.4875 | 0.4307 |
| | 75% | 0.1611 | 0.3092 | -0.0173 | 0.2816 | -0.3189 | 0.5846 | 0.5402 |
| IQR | | 0.2578 | 0.2448 | 0.2673 | 0.2033 | 0.2929 | 0.2457 | 0.2633 |

| **Table 5** (Continued): Dispersion in Total Factor Productivity 2001-2007 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
| | | | | **34 Assembling/Repairing Motor Vehicles** | | | | |
| | 25% | -0.0666 | -0.1776 | -0.2603 | -0.3021 | -0.0570 | -0.0674 | -0.1045 |
| | 50% | 0.0385 | -0.0614 | -0.1442 | -0.1843 | 0.0499 | 0.0257 | 0.0185 |
| | 75% | 0.1759 | 0.0475 | -0.0389 | -0.0417 | 0.1523 | 0.1194 | 0.1821 |
| IQR | | 0.2426 | 0.2251 | 0.2214 | 0.2604 | 0.2093 | 0.1868 | 0.2867 |
| | | | | **35 Repairing of Other Transport Equip** | | | | |
| | 25% | 0.0923 | 0.2668 | -0.3030 | -0.3263 | 0.2286 | -0.0982 | -0.0480 |
| | 50% | 0.2093 | 0.4065 | -0.1845 | -0.1785 | 0.3274 | 0.0241 | 0.0794 |
| | 75% | 0.3334 | 0.5375 | -0.0433 | -0.0450 | 0.4762 | 0.1589 | 0.2391 |
| IQR | | 0.2411 | 0.2706 | 0.2598 | 0.2812 | 0.2476 | 0.2571 | 0.2871 |
| | | | | **36 Furniture** | | | | |
| | 25% | -0.0389 | -0.0140 | -0.2993 | -0.1394 | 0.0860 | 0.1727 | 0.0517 |
| | 50% | 0.1081 | 0.1257 | -0.1852 | -0.0093 | 0.2143 | 0.2568 | 0.2000 |
| | 75% | 0.2431 | 0.2587 | -0.0375 | 0.1256 | 0.3302 | 0.3523 | 0.3006 |
| IQR | | 0.2820 | 0.2727 | 0.2618 | 0.2650 | 0.2441 | 0.1796 | 0.2489 |

**Table 6**: Econometric analysis of Total Factor Productivity Growth

| Variable | (A) | (B) | (C) | (D) | (E) | (F) | (G) |
|---|---|---|---|---|---|---|---|
| constant | -0.165*** (0.121) | -0.163*** (0.012) | -0.168*** (0.012) | -0.171*** (0.012) | -0.154*** (0.012) | -0.163*** (0.012) | -0.161*** (0.012) |
| *Firm Specific* | | | | | | | |
| age | 0.006*** (0.002) | 0.006*** (0.002) | 0.007*** (0.002) | 0.009*** (0.002) | 0.007*** (0.002) | 0.006*** (0.002) | 0.0005 (0.002) |
| entry | -0.005* (0.003) | -0.005* (0.003) | -0.004 (0.003) | -0.003 (0.003) | -0.005** (0.003) | -0.005* (0.003) | -0.001 (0.003) |
| exit | 0.002 (0.002) | 0.002 (0.002) | 0.002 (0.002) | 0.002 (0.002) | 0.001 (0.002) | 0.002 (0.002) | 0.002 (0.002) |
| size | 0.021*** (0.001) | 0.022*** (0.001) | 0.021*** (0.001) | 0.021*** (0.001) | 0.021*** (0.001) | 0.021*** (0.001) | 0.020*** (0.001) |
| state | 0.005 (0.004) | -0.026*** (0.010) | -0.020*** (0.004) | 0.026*** (0.008) | 0.007* (0.004) | 0.005 (0.004) | 0.013*** (0.004) |
| foreign | 0.032*** (0.003) | 0.033*** (0.003) | 0.033*** (0.003) | 0.032*** (0.003) | -0.050*** (0.009) | 0.018*** (0.004) | -0.063*** (0.007) |
| lag_inv | 0.003*** (00004) | 0.003*** (0.0005) | 0.003*** (0.0005) | 0.003*** (0.0005) | 0.002*** (0.0005) | 0.003*** (0.0005) | 0.004*** (0.0005) |
| lag_tech_use | 0.105*** (0.009) | 0.105*** (0.009) | 0.085*** (0.010) | 0.105*** (0.009) | 0.103*** (0.009) | 0.070*** (0.011) | 0.104*** (0.009) |
| state*lag_inv | | 0.004*** (0.001) | | | | | |
| state*lag_tech_use | | | 0.380*** (0.033) | | | | |
| state*age | | | | -0.009*** (0.003) | | | |
| foreign*lag_inv | | | | | 0.011*** (0.001) | | |
| foreign*lag_tech_use | | | | | | 0.135*** (0.020) | |
| foreign*age | | | | | | | 0.059*** (0.004) |
| *Sector Specific* | | | | | | | |
| FR | 0.037 (0.038) | 0.037 (0.038) | 0.043 (0.038) | 0.038 (0.038) | 0.034 (0.038) | 0.036 (0.038) | 0.047 (0.038) |
| SR | 0.082*** (0.026) | 0.082*** (0.026) | 0.089*** (0.026) | 0.083*** (0.026) | 0.078*** (0.026) | 0.082*** (0.026) | 0.077*** (0.025) |
| CR | 0.036 (0.043) | 0.037 (0.043) | 0.034 (0.043) | 0.035 (0.043) | 0.037 (0.043) | 0.035 (0.042) | 0.037 (0.043) |
| TI | 0.045*** (0.004) | 0.045*** (0.004) | 0.046*** (0.004) | 0.045*** (0.004) | 0.045*** (0.004) | 0.046*** (0.004) | 0.046*** (0.004) |
| Year Dummy | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Activity Dummy | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Province Dummy | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| observations | 39,226 | 39,226 | 39,226 | 39,226 | 39,226 | 39,226 | 39,226 |
| $R^2$ | 0.0888 | 0.0891 | 0.0918 | 0.089 | 0.0912 | 0.090 | 0.090 |

*Standard errors are in parenthesis. *** denotes significance at the 1% level, ** at the 5% level and * at the 10% level*

**Table 7**: Econometric analysis of Total Factor Productivity Growth – Robustness Check

| Variable | (A) | (B) | (C) | (D) |
|---|---|---|---|---|
| constant | -0.136*** (0.013) | -0.194*** (0.014) | -0.156*** (0.013) | -0.225* (0.123) |
| *Firm Specific* | | | | |
| age | 0.003** (0.002) | 0.004** (0.002) | 0.004** (0.002) | 0.013*** (0.002) |
| entry | -0.008*** (0.003) | -0.008*** (0.003) | -0.006** (0.003) | -0.010*** (0.003) |
| exit | 0.002 (0.002) | 0.001 (0.002) | 0.003 (0.002) | 0.002 (0.002) |
| size | 0.020*** (0.001) | 0.021*** (0.001) | 0.021*** (0.001) | 0.021*** (0.001) |
| private | -0.022*** (0.002) | 0.051*** (0.007) | -0.0006 (0.003) | 0.007 (0.005) |
| lag_inv | 0.004*** (0.0005) | 0.011*** (0.001) | 0.003*** (0.0005) | 0.004*** (0.0005) |
| lag_tech_use | 0.110*** (0.009) | 0.108*** (0.009) | 0.272*** (0.015) | 0.112*** (0.009) |
| private*lag_inv | | -0.010*** (0.001) | | |
| private *lag_tech_use | | | -0.237*** (0.018) | |
| private *age | | | | -0.017*** (0.003) |
| *Sector Specific* | | | | |
| FR | 0.041 (0.038) | 0.037 (0.038) | 0.041 (0.038) | 0.043 (0.038) |
| SR | 0.077*** (0.026) | 0.074*** (0.026) | 0.084*** (0.025) | 0.072*** (0.026) |
| CR | 0.042 (0.043) | 0.043 (0.043) | 0.036 (0.043) | 0.045 (0.043) |
| TI | 0.045*** (0.004) | 0.045*** (0.004) | 0.046*** (0.004) | 0.045*** (0.004) |
| Year Dummy | Yes | Yes | Yes | Yes |
| Activity Dummy | Yes | Yes | Yes | Yes |
| Province Dummy | Yes | Yes | Yes | Yes |
| observations | 39,226 | 39,226 | 39,226 | 39,226 |
| $R^2$ | 0.0878 | 0.0908 | 0.0919 | 0.0887 |

*Standard errors are in parenthesis. *** denotes significance at the 1% level, ** at the 5% level and * at the 10% level*

**Table 8**: Econometric analysis of Total Factor Productivity Growth – Sector by sector analysis

| | 15 Food Products and Beverages | | | 17 Textiles | | | 18 Wearing Apparel | | |
|---|---|---|---|---|---|---|---|---|---|
| Variable | (A) | (A) | (A) | (A) | (B) | (C) | (A) | (B) | (C) |
| constant | -0.018 | -0.016 | -0.018 | -0.158 | -0.157 | -0.157 | -0.212*** | -0.213 | |
| age | 0.001 | 0.002* | 0.001 | 0.019*** | 0.021*** | 0.019*** | 0.017*** | 0.018*** | 0.017*** |
| entry | -0.001 | 0.000 | -0.001 | 0.016* | 0.018** | 0.016* | 0.0002 | 0.001 | 0.0003 |
| exit | 0.001 | 0.001 | 0.001 | -0.017** | -0.020** | -0.016** | -0.005 | -0.004 | -0.005 |
| size | 0.0002 | 0.0005 | 0.0002 | 0.026*** | 0.026*** | 0.027*** | 0.018*** | 0.018*** | 0.018*** |
| state | -0.001 | -0.013*** | -0.001 | -0.038*** | -0.069*** | -0.041*** | 0.028*** | 0.007 | 0.028*** |
| foreign | 0.007*** | 0.007*** | 0.007*** | 0.012 | 0.012 | -0.014 | 0.018*** | 0.018*** | 0.018*** |
| lag_inv | 0.001*** | 0.001*** | 0.001*** | 0.006*** | 0.006*** | 0.006*** | 0.006*** | 0.006*** | 0.006*** |
| lag_tech_use | 0.020*** | 0.014** | 0.021*** | 0.306*** | 0.272*** | 0.216*** | 0.081*** | 0.078*** | 0.079*** |
| state*lag_tech_use | | 0.224*** | | | 0.759*** | | | 1.089*** | |
| foreign*lag_tech_use | | | -0.003 | | | 0.331*** | | | 0.010 |
| observations | 6,268 | 6,268 | 6,268 | 1,949 | 1,949 | 1,949 | 3,202 | 3,202 | 3,202 |
| | 20 Wood and Wood Products | | | 21 Paper and Paper Products | | | 22 Publishing and Printing | | |
| Variable | (A) | (B) | (C) | (A) | (B) | (C) | (A) | (B) | (C) |
| constant | -0.024 | 0.006 | -0.024 | -0.034*** | -0.035*** | -0.031*** | -0.143*** | -0.139*** | -0.142*** |
| age | -0.004 | -0.004 | -0.004* | -0.004 | -0.003 | -0.004 | -0.014* | -0.014* | -0.014* |
| entry | -0.001 | -0.0001 | -0.001 | 0.001 | 0.001 | 0.0005 | -0.013 | -0.012 | -0.013 |
| exit | -0.005* | -0.006* | -0.005* | 0.002 | 0.002 | 0.002 | 0.009 | 0.010 | 0.009 |
| size | 0.003** | 0.004*** | 0.003** | 0.017*** | 0.017*** | 0.017*** | 0.061*** | 0.061*** | 0.061*** |
| state | 0.032*** | -0.001 | 0.032*** | 0.021*** | -0.010 | 0.020*** | 0.072*** | 0.036** | 0.072*** |
| foreign | 0.018*** | 0.018*** | 0.009 | 0.022*** | 0.023*** | -0.012 | -0.022 | -0.018 | -0.034 |
| lag_inv | 0.002*** | 0.002*** | 0.002*** | 0.0005 | 0.0004 | 0.0003 | -0.001 | -0.0004 | -0.001 |
| lag_tech_use | 0.060*** | 0.059*** | 0.053*** | 0.087*** | 0.083*** | 0.055** | 0.078*** | 0.037* | 0.076*** |
| state*lag_tech_use | | 1.113*** | | | 0.601*** | | | 0.197*** | |
| foreign*lag_tech_use | | | 0.140* | | | 0.309*** | | | 0.042 |
| observations | 2,166 | 2,166 | 2,166 | 2,175 | 2,175 | 2,175 | 1,900 | 1,900 | 1,900 |

*For ease of exposition standard errors are not reported. *** denotes significance at the 1% level, ** at the 5% level and * at the 10% level*
*Regional and Year dummies are included in all models.*

**Table 8 (continued)**: Econometric analysis of Total Factor Productivity Growth – Sector by sector analysis

| | 24 Chemical and Chemical Products | | | 25 Rubber and Plastic Products | | | 26 Non-metallic Mineral Products | | |
|---|---|---|---|---|---|---|---|---|---|
| Variable | (A) | (B) | (C) | (A) | (B) | (C) | (A) | (B) | (C) |
| constant | -0.126*** | -0.130*** | -0.120*** | 0.043 | -0.043 | -0.043 | -0.033 | -0.033 | -0.034 |
| age | -0.002 | -0.0002 | -0.002 | 0.007*** | 0.007*** | 0.007*** | 0.002 | 0.005* | 0.002 |
| entry | -0.014** | -0.012** | -0.014** | -0.001 | -0.0004 | -0.001 | -0.003 | -0.0004 | -0.004 |
| exit | 0.008 | 0.007 | 0.008 | -0.0001 | -0.0002 | -0.0001 | 0.0001 | -0.002 | -0.001 |
| size | 0.038*** | 0.039*** | 0.039*** | 0.017*** | 0.017*** | 0.017*** | 0.018*** | 0.017*** | 0.017*** |
| state | 0.019*** | -0.018* | 0.019*** | 0.022*** | -0.0005 | 0.022*** | 0.018*** | -0.022*** | 0.018*** |
| foreign | 0.062*** | 0.063*** | 0.045*** | 0.006* | 0.006* | 0.008* | 0.040*** | 0.043*** | 0.067*** |
| lag_inv | 0.003*** | 0.003** | 0.003** | 0.001** | 0.001** | 0.001** | 0.007*** | 0.006*** | 0.007*** |
| lag_tech_use | 0.084*** | 0.076*** | 0.054*** | 0.001** | 0.045*** | 0.053*** | 0.065*** | 0.026 | 0.129*** |
| state*lag_tech_use | | 0.385*** | | | 0.347*** | | | 1.017*** | |
| foreign*lag_tech_use | | | 0.089*** | | | -0.019 | | | -0.278*** |
| observations | 2,114 | 2,114 | 2,114 | 3,077 | 3,077 | 3,077 | 3,140 | 3,140 | 3,140 |
| | 28 Fabricated Metal Products | | | 36 Furniture | | | | | |
| Variable | (A) | (B) | (C) | (A) | (B) | (C) | | | |
| constant | -0.029*** | -0.030*** | -0.028*** | -0.086 | -0.085 | | | | |
| age | 0.003* | 0.003** | 0.003* | 0.008** | 0.008** | 0.008** | | | |
| entry | -0.004* | -0.003 | -0.004* | 0.011*** | 0.011** | 0.011** | | | |
| exit | 0.00003 | -0.0001 | 0.0003 | -0.0004 | -0.0001 | -0.0003 | | | |
| size | 0.006*** | 0.006*** | 0.006*** | 0.020*** | 0.020*** | 0.020*** | | | |
| state | 0.005 | -0.026*** | 0.004 | 0.028*** | 0.007 | 0.028*** | | | |
| foreign | 0.009*** | 0.009*** | 0.002 | 0.005 | 0.005 | 0.004 | | | |
| lag_inv | 0.002*** | 0.002*** | 0.002*** | 0.003*** | 0.003*** | 0.003*** | | | |
| lag_tech_use | 0.034*** | 0.030*** | 0.021*** | 0.050*** | 0.046*** | 0.049*** | | | |
| state*lag_tech_use | | 0.413*** | | | 0.402*** | | | | |
| foreign*lag_tech_use | | | 0.045*** | | | 0.008 | | | |
| observations | 3,779 | 3,779 | 3,779 | 2,863 | 2,863 | 2,863 | | | |

*For ease of exposition standard errors are not reported. *** denotes significance at the 1% level, ** at the 5% level and * at the 10% level*
*Regional and Year Dummies are included in all models.*

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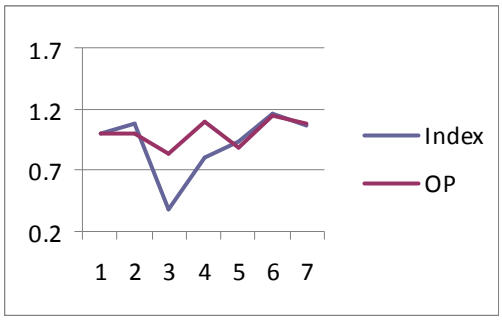
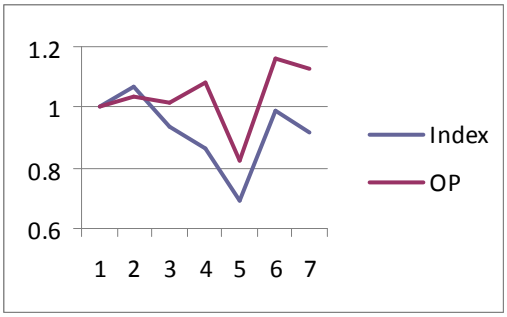
**Appendix**

Trend in Productivity Growth 2001-2007 – Estimates from Index Number Approach compared with estimates from Olley and Pakes' (1996) approach

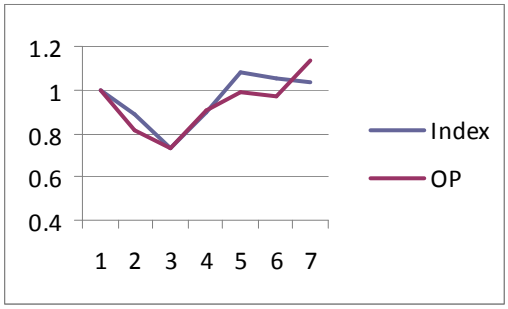
15 Food Products and Beverages



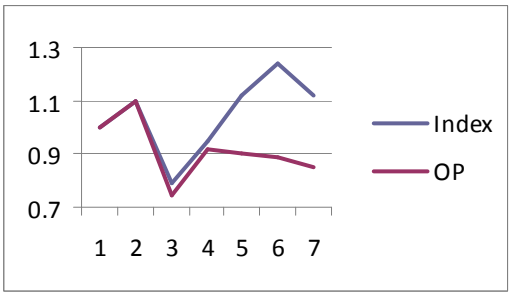

17 Textiles



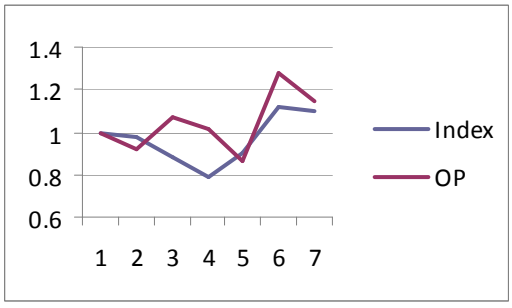

18 Wearing Apparel



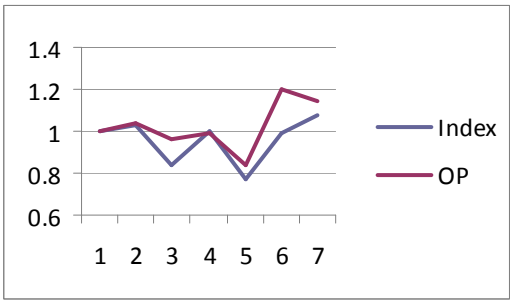

19 Leather Products



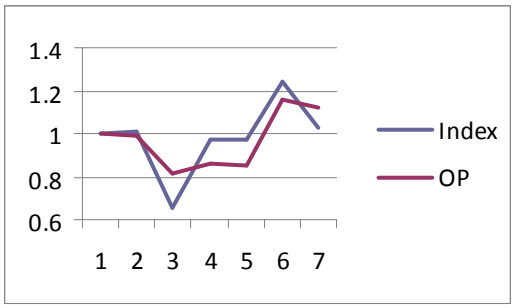

20 Wood and Wood Products



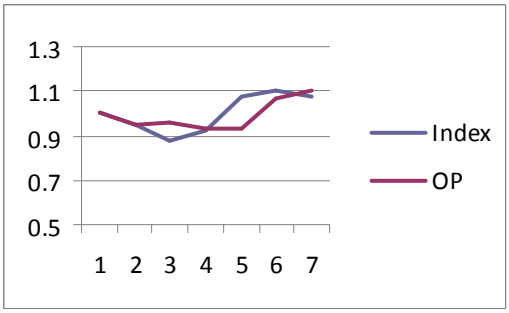

21 Paper and Paper Products



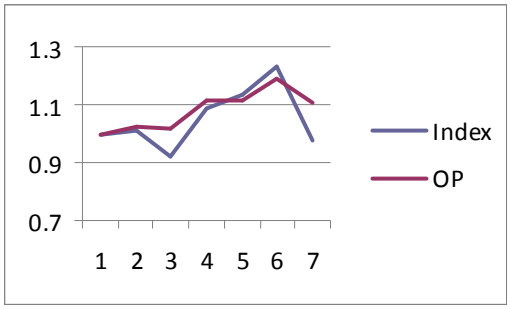

22 Publishing and Printing



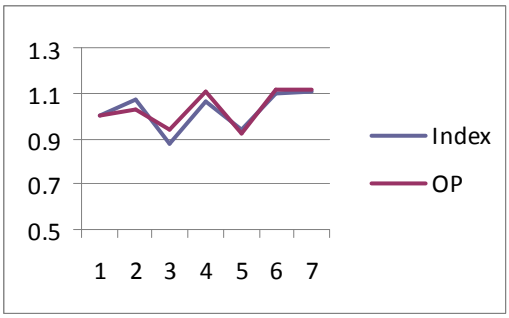

24 Chemical and Chem. Products



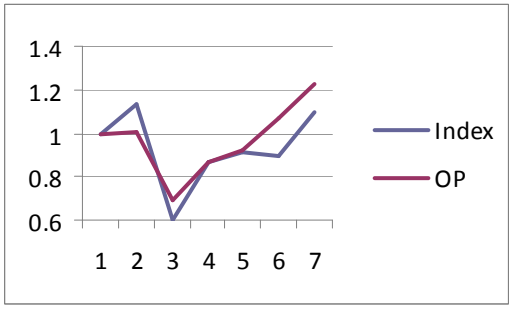
25 Rubber and Plastic Products



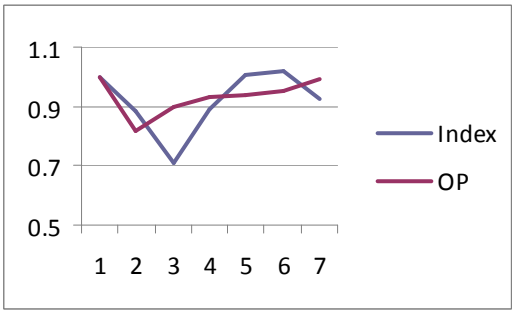

26 Non-metallic Mineral



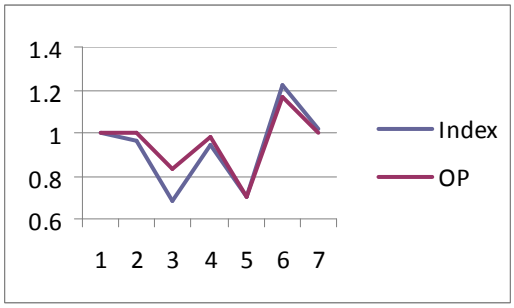

27 Basic Metal



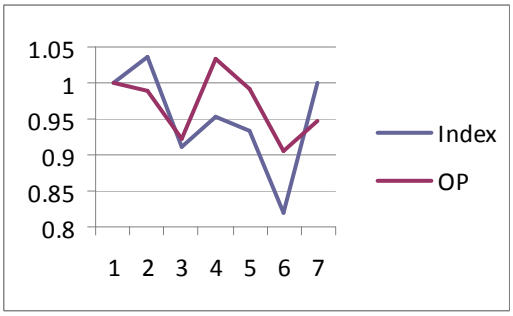

28 Fabricated Metal Products



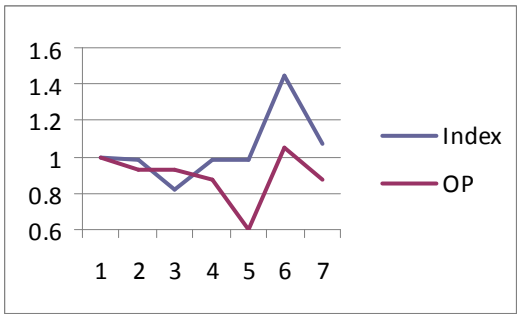

29 Machinery and Equipment



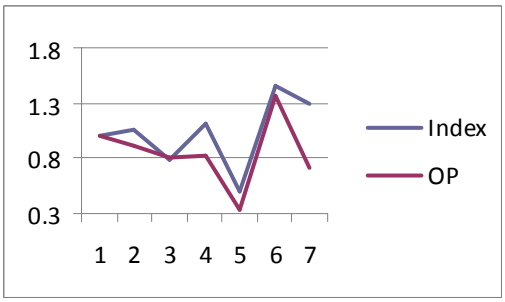

31 Electrical Machinery and App.



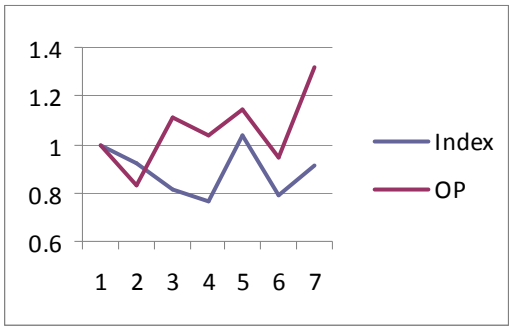

32 Machinery and Equipment



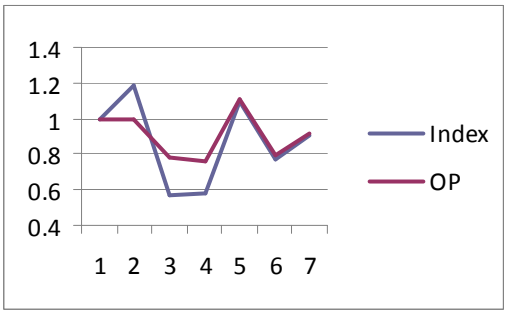

33 Medical and Optical Inst.



34 Assem and Repair Motor Vehicles




35 Repair of Other Transport Equip




36 Furniture