Foreign investment, human capital and manufacturing sector growth in Singapore

Sajid Anwar*

International Graduate School of Business, University of South Australia,
GPO Box 2471, Adelaide, SA 5001, Australia

Abstract

Foreign investment has been long regarded as the main driver of Singapore's manufacturing sector growth. By making use of annual data for the period 1980–2005, this paper argues that in addition to foreign investment, human capital is also playing a significant role in foresting manufacturing sector growth in Singapore. Empirical analysis shows that foreign investment, human capital and value added in manufacturing are cointegrated. The paper also argues that continued growth into the future requires further diversification of the manufacturing sector and increased spending on R&D and advanced education.
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1. Introduction

Until 2003, the performance of Singaporean economy in the post-Asian crisis period was well below its pre-Asian crisis level. However, an increase in domestic demand, growth in the US economy and early signs of recovery in the Japanese economy combined with the recent increase in the price of oil have contributed to strong growth in Singapore in 2005 and 2006. While the economy has registered strong growth in recent years, rising unemployment and shrinking profit margins have increased hardship faced by the general population.[1] The

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* Tel.: +61 8 8302 9048.

  E-mail address: Sajid.Anwar@unisa.edu.au.

[1] The unemployment rate increased from 1.4% in 1997 to 4.0% in 2003. The unemployment rate in 2005 and 2006 respectively was 3.1 and 2.7% (Department of Statistics, 2007).
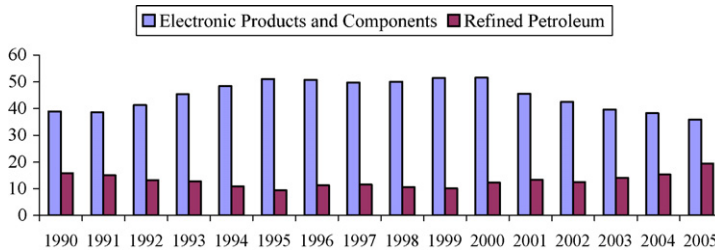
Fig. 1. Output share of selected manufacturing industries as a percentage of total (1990–2005).

national saving rate registered a steep decline in 1998–1999 and 2001–2002. It is interesting to note that Baharumshah, Thanoon, and Rashid (2003) appear to suggest that the savings rate in Singapore has not greatly influenced its economic growth. The manufacturing sector has long been regarded as the main driver of Singapore's impressive economic growth. Prior to the emergence of China as a major supplier of manufactured goods, the Singaporean manufacturing sector was facing stiff competition from regional economies such as Malaysia and Thailand. In response to increased competition and rising relative labour cost, Singapore took steps to move away from the production of low-value-added manufactured goods to high-value-added manufactured goods. At the same time, the Singaporean government significantly increased its spending on research and development which contributed to a steep increase in the number of research scientists and engineers (up from 4329 in 1990 to 21,338 in 2005).[2]

The average share of manufacturing in Singapore's GDP from 2000 to 2006 has been approximately 25%. However, the manufacturing sector is not well diversified. Fig. 1 shows that more than 50% of the manufacturing sector output consists of just two industries: (i) electronic products and components and (ii) refined petroleum.[3] Fig. 1 shows that the share of electronic products and components has been declining since 2001, whereas the opposite is true for refined petroleum.

A rapid increase in China's export of manufactured goods has implications for Singaporean manufacturing sector. This paper attempts to examine the performance of Singaporean manufacturing sector. Unlike the existing studies, this paper focuses on the real value added of Singaporean manufacturing establishments. Since registering a steep decline in 2001, the value added has been steadily rising.

While the contribution of foreign investment to Singapore's economic growth in recent years appears to have significantly declined, the manufacturing sector still relies heavily on foreign investment.[4] A number of studies, including Lucas (1988) and Romer (1990), have highlighted the importance of human capital in the process of economic growth. However, few available studies have attempted to examine the impact of human capital on Singapore's manufacturing sector growth. Up until the 1970s, Singaporean manufactured exports consisted largely of low-value-added labour intensive goods. During the 1980s, the Singaporean manufacturing sector moved towards the production of higher value-added goods. Production of such goods requires significant amount of physical as well as human capital.

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[2] While the private sector R&D expenditure as a percentage of total remains well above 50%, government spending on R&D increased from S$262.2 million in 1990 to S$1.55 billion in 2005 (Department of Statistics, 2007).

[3] This point has also been made by Leung, Tan, and Yang (2004)—they argue that Singapore government has used targeted-investment policies.

[4] MAS (2006) reports that the average contribution of foreign investment in Singaporean economic growth over the period 1998–2005 was −0.5% per annum compared to 3.8% per annum for the period 1990–1997.

The main aim of this paper is to empirically examine the impact of foreign investment and human capital on Singapore's manufacturing sector value added.[5] Statistical analysis based on Johansen's method shows that value added in manufacturing, foreign investment and human capital are cointegrated (i.e., a long-run relationship exists among these variables). This suggests that Singaporean government needs to develop policies that will ensure that foreign as well as human capital remains available to the manufacturing sector in the future in sufficient quantity.

The rest of this paper is organized as follows. The next section contains empirical investigation involving real value added in manufacturing, employment, real foreign investment and real human capital. The last section contains concluding remarks and policy implications.

2. Value added in manufacturing, foreign investment and human capital

Based on economic theory it can be argued that availability of capital and labour are the main determinant of manufacturing sector value added. Because of the small size of the domestic economy, Singapore's manufacturing sector relies heavily on foreign capital. Accordingly, this paper focuses on the impact of foreign investment per unit of manufacturing sector employment and human capital per unit of employment on value added in manufacturing per unit of employment as follows:

$$\left[\frac{V}{L}\right]_t = \alpha_0 + \alpha_1 \left[\frac{FI}{L}\right]_t + \alpha_2 \left[\frac{H}{L}\right]_t + \varepsilon_t \tag{1}$$

where V_t, FI_t, L_t and H_t respectively are the real value added of manufacturing sector, real foreign investment in manufacturing sector, employment in manufacturing sector and real human capital in period t; ε_t a random variable, which captures the combined effect of all omitted variables; α's are population regression coefficients—the slope coefficients are expected to be positive.

The above linear regression equation and the corresponding log-linear equation was estimated by making use of EViews version 6 for the period 1980–2005. In addition to providing appropriate infrastructure, the Singaporean government spends a significant amount of money on education. Existing studies such as Romer (1990) have suggested that spending on education can be used as an approximation of human capital in a country.[6] All data are annual, collected from various issues of the Year Book of Statistics (Singapore Department of Statistics, 2006) and the International Financial Statistics Year Book (IMF, 2006). Prior to estimating Eq. (1) and its log-linear version, all variables were tested for stationarity by making use of the augmented Dicky–Fuller and Phillips–Perron tests, with and without trend. While all variables were non-stationary in levels, first differences were found to be stationary. Since all variables are integrated of order 1, it is possible to test for cointegration (i.e., a long-run relationship among the dependent and independent variables). Trace and maximum Eigen value-based Johansen tests indicate the presence of a cointegration relationship. The results of Johansen's test concerning Eq. (1) are shown in Table 1.

[5] Young (1992, 1994, 1995) has argued that the economic growth in Singapore is largely due to the growth in factors of production and that the country lacks technological progress based growth. Etzkowitz and Brisolla (1999) have argued that Singapore along with other Southeast Asian Economies has relied on importing intellectual property and improving upon it through production experience gained over time. Kuruvilla, Erickson, and Hwang (2002) have shown that in recent years, the contribution of growth based on technological progress in Singapore has increased. However, in a recent study Thangavelu and Rajaguru (2004) have argued that the growth in Singaporean productivity is largely import-led.

[6] It has been suggested that the number of scientists and researchers is a better indicator of human capital in a country. However, in the case of Singapore, such information is available only from 1989 onwards and hence government spending on education is used as an indicator of human capital in Singapore.

Table 1
Johansen's cointegration test (linear model)

Number of cointegrating vectors	Eignen value test			Trace test		
	Max-Eigen value statistic	0.05 critical value	Probability[a]	Trace statistic	0.05 critical value	Probability[a]
None[b]	28.9362	21.1316	0.0033	42.7752	29.7971	0.0010
At most 1	13.8128	14.2646	0.0588	13.8390	15.4947	0.0875
At most 2	0.0263	3.84146	0.8715	0.0261	3.8415	0.8715

[a] MacKinnon–Haug–Michelis p-values.
[b] Denotes rejection of the hypothesis at the 0.05 level.

The above table confirms the existence of only one cointegration vector. This result is based on two lags.[7] Once the existence of cointegration has been established, it makes sense to estimate the corresponding vector error correction model (VECM). VECM model corresponding to Eq. (1) is as follows:

$$\Delta \left[\frac{V}{L}\right]_t = \phi_0 + \phi_1 (EC)_{t-1} + \sum_{i=1} \phi_{21} \Delta \left[\frac{FI}{L}\right]_{t-i} + \sum_{i=1} \phi_{22} \Delta \left[\frac{H}{L}\right]_{t-i} + \upsilon_t \tag{2}$$

where $(EC)_{t-1}$ is the lagged value of the corresponding error correction term, ϕ's the population regression coefficients and υ_t is a random variable.

It is well known that the estimated coefficient of the error correction term is expected to be negative but less than unity. EViews version 6 was used to estimate the above and the corresponding log-linear model. A summary of the estimated vector error correction models is shown in Table 2.

The above table shows the estimated cointegration vectors for the linear and the corresponding log-linear models. Values in parenthesis adjacent to the estimated coefficients are t-values. The above table shows that an increase in foreign investment per unit of employment increases the value added in manufacturing per unit of employment. In addition, an increase in human capital per unit of employment in manufacturing also increases the real value added per unit of employment. The estimated error correction terms indicate that the real value added per unit of employment adjusts to its long-run value at a fairly fast rate (approximately 52.6% per year for the linear and 47.2% for the log-linear model). The results presented in Table 2 support the view that there is a long-run relationship among the real value added in manufacturing, real foreign investment and real human capital in Singapore. This suggests that the Singaporean government needs to take steps to ensure that the manufacturing sector continues to attract significant foreign investment in the future. The decrease in domestic saving in recent years appears to suggest that local investment is unlikely to increase significantly and hence Singapore will continue to rely heavily on foreign investment while local savings rates are insufficient to support necessary national investment. Because of increased competition from China and India, Singapore needs to further develop and increase its human capital. Increased availability of human capital through increased spending on advanced education and training will also help Singapore to continue to attract foreign investment. While increased spending on R&D in recent years has generated some rewards (Toh & Ng, 2002),

[7] It is well known that the results of Johansen's test are sensitive to the number of lags, see Davidson and MacKinnon (2004) and Vogelvang (2005). A good discussion of the exclusion tests can be found in Kim and Ratti (2006).

Table 2
Estimated vector error correction (linear and log-linear) models

Dependent variable	$[FI/L]_t$	$[H/L]_t$	$Log[FI/L]_t$	$Log[H/L]_t$	Error correction term	$\bar{R}^2$	Lag length
$[V/L]_t$	4494.33 (7.7707)	4.0426 (1.4727)			−0.5257 (−3.5965)	0.5272	1–2
$Log[V/L]_t$			0.1953 (2.1849)	0.6318 (6.0864)	−0.4716 (−1.5885)	0.1610	1–3

more needs to be done to increase the contribution of technological progress in overall economic growth.[8]

In order to remain competitive, Singapore needs to substantially increase its spending on R&D and advanced education (it is interesting to note that while R&D spending in Singapore now accounts for more than 2% of GDP, there has been a decline in government spending on education). This will help the economy to gain comparative advantage in human capital-intensive goods. Singapore's economic growth in the future is dependent on broadening of its base of manufacturing exports. While the economy has greatly benefited from the growth of the manufacturing sector, the share of the services sector in the GDP has been quite stable from 1991 to 2006, which reflects the fact that the structure of the economy has remained unchanged. The Singaporean government needs to take steps to encourage the growth of its services sector, which includes banking, financial, education, health, IT and tourism services.[9] Singapore's financial and business services sector accounts for just over 25% of GDP. A further expansion in the services sector would reduce the level of dependency on export growth. Further deregulation and opening up of the financial system would help the economy to take full advantage of emerging opportunities. It can be argued that the maturity and transparency of the Singaporean financial system were responsible for its ability to withstand the Asian financial crisis.[10] However, growing economic integration fuelled by the push for globalisation requires further deregulation and opening up of the financial sector. In other words, further liberalisation rather than tighter regulation is required.

3. Concluding remarks

Since the Asian financial crisis of 1997–1998, Singapore's economy has gone through some periods of difficulty—the economic growth rate was negative in 2001 and below 4% in 2002 and 2003. This can be attributed to weakness in the US economy as well as the lack of growth in the Japanese economy. The Singaporean economic growth is highly dependent on its manufacturing sector, which heavily relies on foreign investment. This paper argues that in addition to foreign investment, human capital is also playing a significant role in foresting Singaporean manufacturing sector growth. Statistical analysis presented in this paper shows that human capital, foreign investment and value added in manufacturing are cointegrated. The estimated long-run relationship suggests that adjustment to long-run equilibrium takes place at a fairly fast rate.

Given the small size of the domestic economy and a declining saving rate, it is likely that the Singaporean manufacturing sector will remain dependent on foreign investment at least in the near future. Since the early 1990s, there has been a significant increase in spending on R&D in Singapore, which provides some preliminary foundations for future development. However, more needs to be done. At present, private firms are not spending much on developing intangible assets such as human capital. Private sector spending on intangible assets is approximately 9% of private non-residential investment (MAS, 2006). Increased spending on R&D and advanced education and training are also likely to contribute to increase in the supply of human capital which will help Singapore to gain comparative advantage in higher value-added human capital-intensive goods.

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[8] Koh and Wong (2005) have examined the role of science and technology in Singapore's transition to an innovation-based growth strategy.

[9] There has been a significant increase in employment in the services sector in 2004 and 2005. In 2003, the manufacturing, financial and business services sectors employed 17.9, 5.14 and 11.95% of the total labour force, respectively. In overall terms, the services sector accounts for more than 68% of total employment since 2003 (Department of Statistics, 2007).

[10] For a recent analysis of the Asian financial crisis, see Kim and Ratti (2006).

Singaporean manufacturing sector is facing stiff competition from China. In order retain its market share, Singapore needs to further diversify its manufacturing export base. Finally, the relative size of the services sector in Singapore remains well below the size of the same sector in Hong Kong.

Acknowledgements

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