

Special Feature A

What Drives Private Machinery Investment in Singapore?

Introduction

Gross capital formation occupies a central role in many neoclassical theories of economic development. A high share of productive investment in GDP is often held to be a prerequisite for economic growth in developing countries. Moreover, the importance of capital formation does not diminish with economic maturity, as many studies point to the continued strategic value of machinery and equipment (MEQ) investment, for industrialised economies.

For example, De Long and Summers (1991), in an influential empirical study, found that over the period 1960-85, each additional percent of GDP invested in equipment was associated with an increase in GDP growth of one-third of a percentage point per year. Moreover, they argued that a variety of considerations would suggest that this association is causal, in that higher equipment investment drives faster growth.

According to De Long and Summers, there are good reasons for expecting MEQ spending to be a potent stimulant to economic growth. Economic historians have long noted the critical role of mechanisation in driving economic growth and augmenting labour productivity. In addition, modern endogenous growth theory emphasises spillovers as a key cause of long-term growth in per capita incomes. In this respect, cumulative equipment investment stimulates research and development, thus giving rise to external economies of scale and increasing returns to scale. Notably, Grossman and Helpman (1994) also point out that new capital goods embody the latest

technological advances, the benefits of which are realised when the investment is undertaken.

In view of its importance, this Special Feature seeks to uncover the determinants of MEQ investment in Singapore. A key objective is to examine the factors that have contributed to slower growth in MEQ investment since the Asian Financial Crisis. In the April 2006 issue of the *Review*, a similar attempt was made to understand why private investment in Singapore weakened in the years following the Asian Financial Crisis. The two main factors cited there were depressed private construction and a slow recovery in machinery and transport equipment investment after the 2001 IT Downturn. This Special Feature, however, excludes transport equipment from the analysis as it tends to be lumpy and unpredictable.

In an earlier econometric analysis, Ng and Robinson (1997) utilised the neoclassical investment framework and confirmed the importance of income and the user cost of capital in explaining MEQ spending in Singapore. Income growth, in particular, had a powerful impact on investment commitments in machinery and equipment. Later, Tan and Thia (2004) found the Hall-Jorgenson approach to be useful for modelling different types of capital investment. They observed a strong correlation between the global electronics cycle and MEQ expenditures. In contrast, this Special Feature considers a broader set of explanatory variables, including proxies for economic volatility and the relative price of labour.

A Brief Overview of Private MEQ Investment in Singapore

When Singapore attained national independence in 1965, the manufacturing sector accounted for 20% of GDP. As a result of concerted efforts by the government to industrialise the economy through foreign direct investment, this figure rose to 29% by 1973. Alongside this structural transformation, the share of private MEQ investment in GDP more than doubled to 8%. (Chart 1) Subsequently, private MEQ investment contracted in the aftermath of the 1973 oil price shock and the 1985 recession, but then quickly rebounded.

In the 1980s and 1990s, the government continued with its proactive policies to restructure the economy towards higher value-added activities as Singapore transitioned to a more mature stage of development. Apart from acquiring breadth with new players, such as petrochemical firms, manufacturing also became more capital-intensive. While the electronics industry moved up the value chain, pharmaceutical and biomedical firms expanded their presence in Singapore, bringing with them frontier research and technology. Consequently, private MEQ investment continued to trend higher over the two decades, culminating in the IT boom of the late 1990s. Since peaking at 10.6% in 2000, however, the private MEQ share has fallen and stabilised at around 9% of GDP.

Within the category of private non-residential gross fixed capital formation, the share of MEQ investment since 1965 has averaged 48%, although this masks substantial fluctuations over the years. (Chart 2) In the 1970s, for example, the rise of the aviation and shipping industries led to a surge in transport equipment outlays, which dwarfed investment in machinery and equipment.

As compared to other countries, the level of MEQ investment in Singapore, as a proportion of GDP, is significantly higher than the ASEAN-3 (Indonesia, the Philippines and Thailand) and the advanced OECD economies, and slightly above Korea and Taiwan. (Chart 3)

Chart 1
Share of Private MEQ Investment in GDP

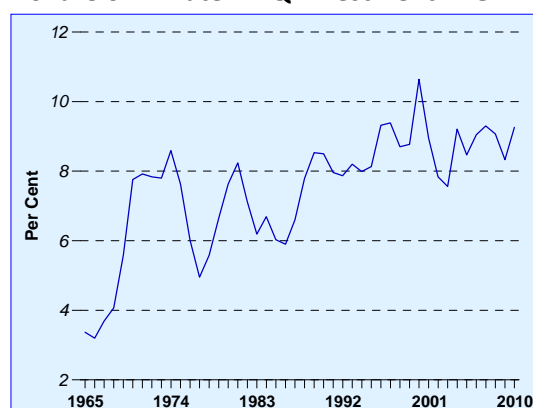


Chart 2
Share of Private MEQ Investment in Private Non-residential Investment

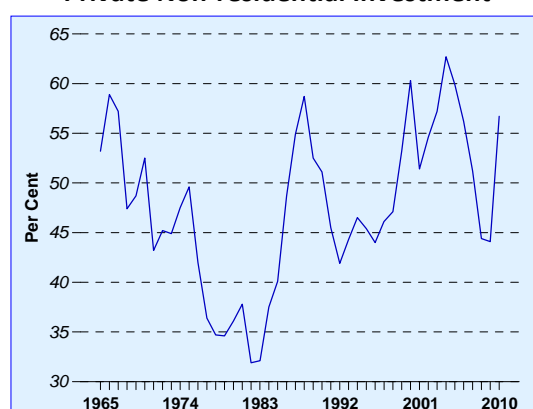
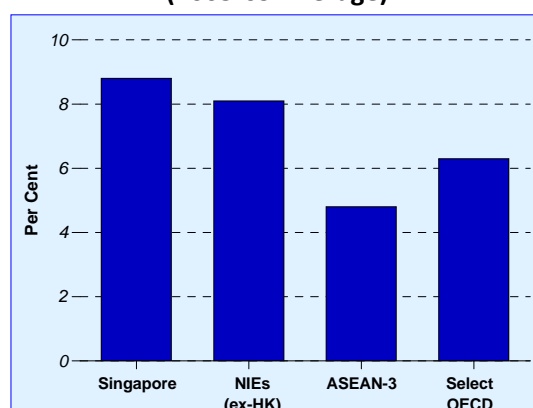


Chart 3
MEQ Investment as a Share of GDP
(2005-09 Average)



Source: CEIC and OECD Stat

Note: The figure for Singapore is private MEQ investment, for the rest it is total MEQ investment. Hong Kong and Malaysia are omitted due to data constraints. The OECD countries selected are Canada, Denmark, France, Germany, Japan, Sweden, Switzerland, UK and the US.

Determinants of Private MEQ Investment

This Special Feature adopts an eclectic approach to studying the determinants of machinery and equipment investment in Singapore. Besides incorporating key insights from earlier studies, it casts a wider net for plausible explanatory variables to include causal factors that, while not represented explicitly in current theories of investment, may be important for Singapore.

Given that investment statistics tend to be highly volatile, and since the focus here is on explaining the longer-term trends in private MEQ capital formation, the Friedman (1984) smoothing procedure is first used to remove erratic fluctuations from the investment share data and its putative explanatory variables during the period Q1 1983 - Q4 2010.

Table 1 lists the six macroeconomic variables that might be important in determining private MEQ, selected on *a priori* grounds. First and foremost is the relative size of electronics production in the Singapore economy, which is a natural proxy for the equipment investment that is attracted into the industry. Indeed, Chart 4 shows how both electronics value-added and MEQ investment (expressed as shares of real GDP), have moved closely together since the start of the period, rising up to 2000, and falling thereafter.

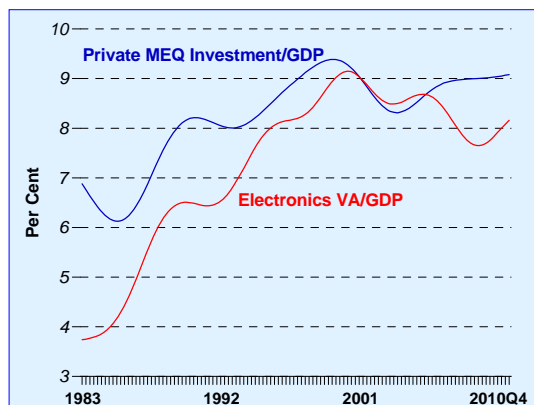
Second, the increased volatility of GDP growth in Singapore since the late 1990s could have influenced private investment decisions. Given the long-term nature of capital expenditures, firms might have delayed spending plans in times of economic and financial uncertainty. Chart 5 plots the share of private MEQ investment in GDP together with the rolling standard deviation of Singapore's real GDP growth based on a moving window of 12 quarters as a measure of economic volatility. It shows that the decline in volatility, for example in the late 1980s and again in the mid-2000s, coincided to some degree with increases in the share of private MEQ investment, although the converse is not necessarily true.

Next is the role of foreign workers. On the plus side, they augment the labour force and may complement domestic employees. In this case, the availability of imported labour could be expected to have a positive effect on private MEQ spending, enabling firms to achieve their optimal capital-to-labour ratios more efficiently. In fact, Chart 6 shows a direct correlation between the share of foreign workers in total employment and the private MEQ investment share, which confirms the above theory.

Table 1
Potential Factors Driving Private MEQ in Singapore

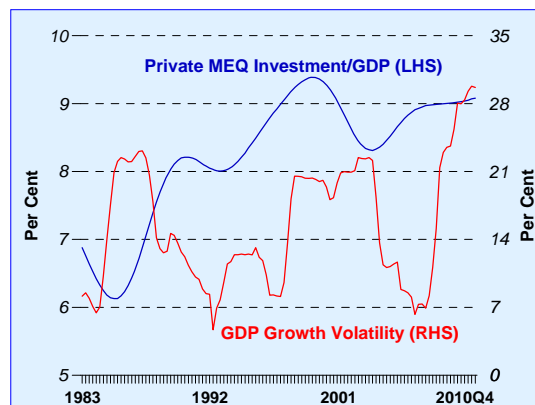
Variable	Justification	Expected Impact
Structure of the Economy		
VA Share of Electronics	Correlates closely with machinery investment as the electronics sector uses machinery and equipment intensively.	Positive
Volatility of GDP Growth	Volatile economic conditions create uncertainty for firms and may hinder their investment.	Negative
Share of Foreign Employment	Foreign workers augment the labour force and may induce firms to increase capital stock to maintain desired K/L ratios.	Positive
Prices		
Relative Price of Capital to Labour	Cheaper labour may induce firms to substitute labour for capital in production decisions.	Negative
Rate of Return to Capital	The real rate of return is a summary indicator of the profitability of investment in general.	Positive
Cost Conditions	Higher costs erode Singapore's competitiveness and may deter investment.	Negative

Chart 4
Private MEQ Investment/GDP
and Electronics VA/GDP



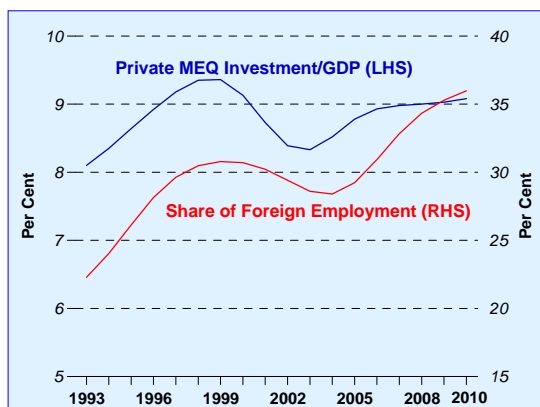
Source: EPG, MAS estimates

Chart 5
Private MEQ Investment/GDP
and GDP Growth Volatility



Source: EPG, MAS estimates

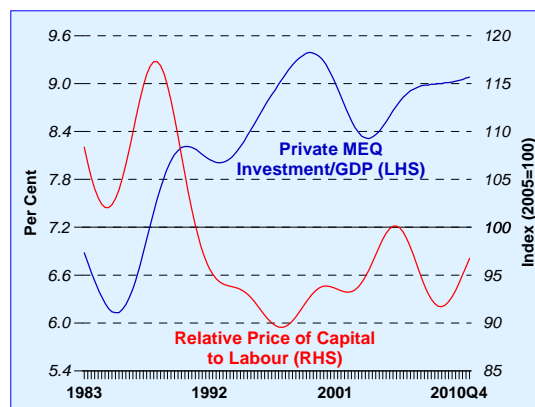
Chart 6
Private MEQ Investment/GDP
and Foreign Employment



Source: EPG, MAS estimates

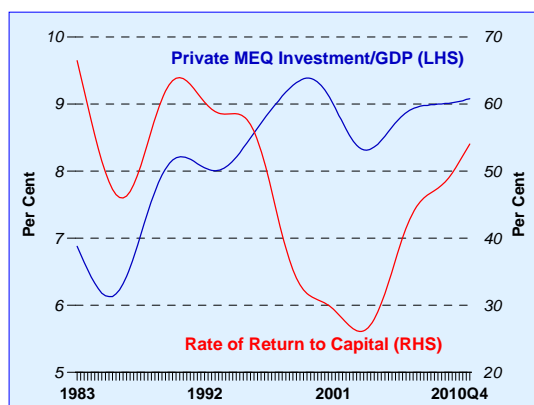
Note: Data used in this chart are in annual frequency.

Chart 7
Private MEQ Investment/GDP
and Relative Factor Costs



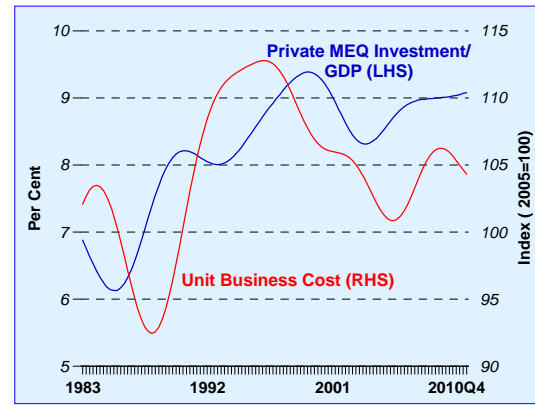
Source: EPG, MAS estimates

Chart 8
Private MEQ Investment/GDP
and the Real Rate of Return to Capital



Source: EPG, MAS estimates

Chart 9
Private MEQ Investment/GDP
and Cost Conditions



Source: EPG, MAS estimates

Nonetheless, some observers argue that a large inflow of foreign workers into Singapore increases the relative cost of capital *vis-à-vis* labour,¹ leading firms to employ more labour in their production processes, and thus inhibit capital investment. Some evidence to support this is depicted in Chart 7, which shows that the increase in the relative price of capital during the early to mid-2000s was also accompanied by a fall in the private MEQ share of GDP.

The real rate of return to capital, which is the fifth variable in Table 1, serves as a general indicator of the profitability of investment in Singapore. Extracted from the MMS, it is the component in the Tobin-*q* ratio measuring the returns to capital services, net of the replacement cost of capital. Chart 8 shows that private MEQ investment does appear to track movements in the real rate of return to capital during the 1980s and 2000s.

The last variable captures the impact of changes in domestic costs² on private MEQ expenditures. Higher costs not only dent the profits of firms, but also erode the competitiveness of the economy. Although it is difficult to discern any correlation between domestic costs and MEQ accumulation in Chart 9, this variable turns out to be statistically significant and correctly signed in the regression analysis reported below.

Historical Decomposition

To reinforce the informal correlation analysis above and to isolate partial effects, we carried out a multiple regression analysis using q-o-q changes in the smoothed ratio of private MEQ investment to GDP as the dependent variable and the independent variables listed in Table 2. The results show that all six independent variables are statistically significant at the 1% level and correctly signed. Together, they explain almost 85% of the total variation in private MEQ spending over the sample period.

Based on the regression estimates, Chart 10 shows the relative importance of each explanatory variable by decomposing the historical changes in MEQ investment over four different periods. The main conclusions are as follows:

- Over the period 1986-96, private MEQ investment benefited mainly from the rapid expansion of the electronics sector and a higher intake of foreign workers. In subsequent periods, the electronics sector played a much smaller role in explaining private MEQ spending.
- During the crisis years of 1997-2003 and 2009, a reduction in business costs as well as countercyclical fiscal policy, staved off further declines in private MEQ investment.
- The rebound in MEQ investment in the mid-2000s was due primarily to improved returns to capital amid a favourable environment of strong corporate profits and generally benign cost conditions.
- As expected, economic volatility had a negligible influence on private MEQ investment during the early boom period, but served to dampen capital expenditures in subsequent periods, and especially during the recent crisis.
- Foreign workers had two opposing effects over the period 2004-08. On the positive side, they seem to have complemented local workers and encouraged firms to increase their stock of machinery and equipment. However, the attendant rise in the relative cost of capital, as noted earlier, may have blunted firms' incentive to invest in machinery and automation. The regression results suggest that the former effect dominated the latter in this period.

¹ Private MEQ investment deflator divided by the manufacturing Unit Labour Cost index.

² This refers to the Unit Business Cost (UBC) index of the manufacturing sector. There is no UBC index for the whole economy.

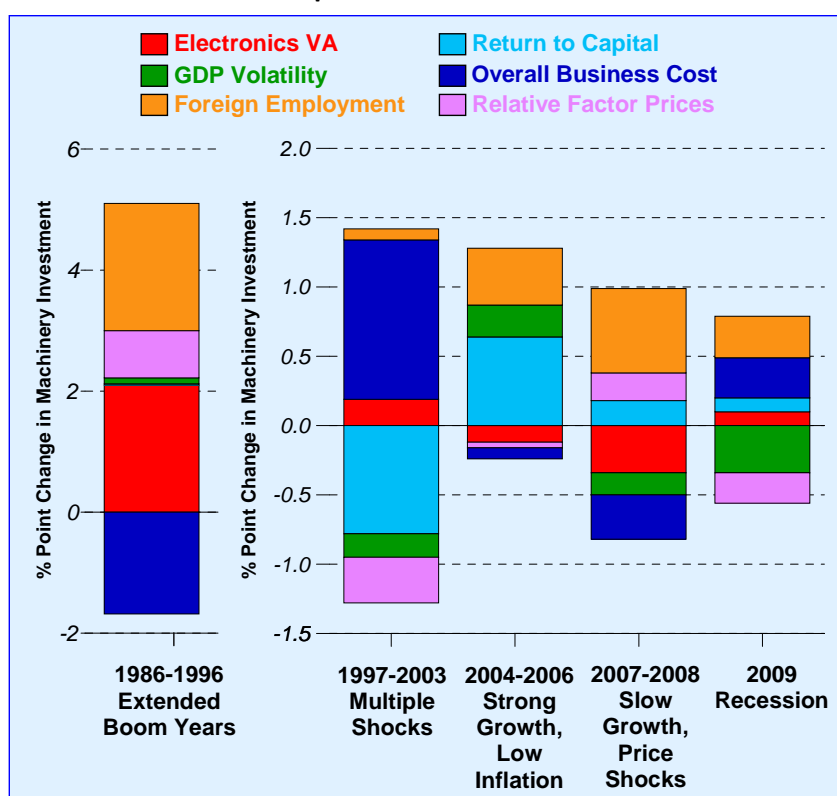
Table 2
OLS Regression Results: Q1 1983 to Q4 2010

Dependent Variable: $\Delta(\text{MEQ}/\text{GDP})$		
Change in Explanatory Variable	Coefficient*	Standard Error [^]
Electronics VA	0.56	0.042
GDP volatility	-0.02	0.003
Foreign employment	0.18	0.013
Relative factor prices	-0.05	0.013
Return to capital	0.04	0.004
Overall business costs	-0.12	0.019
Diagnostics		
Adjusted R-squared	0.838	
Standard error of regression	0.028	
No. of observations	110	

[^] White heteroskedasticity-consistent standard error.

* All coefficients are statistically significant at the 1% level.

Chart 10
Historical Decomposition of Private MEQ Investment



Source: EPG, MAS estimates

Sum-up

This Special Feature has identified six factors potentially driving real private MEQ investment in Singapore: the size of the electronics sector, volatility of GDP growth, the share of foreign employment in the workforce, the price of capital relative to labour, the rate of return to capital, and domestic cost conditions. Both graphical and statistical analyses confirm that these variables are important, and, when taken together, explain a large fraction of the longer-term changes in the share of private MEQ investment in GDP. Furthermore, a historical decomposition shows that the relative importance of these factors varies in an intuitive manner over the last three decades.

As far as future research is concerned, it would be useful to quantify the relationship between private MEQ investment and labour productivity growth in Singapore. As articulated by the 2010 *Report of the Economic Strategies Committee* and reinforced by recent government budgets, Singapore will depend increasingly on capital deepening and innovation to support medium-term economic growth. Furthermore, as the Singapore economy becomes more services-oriented in the longer run, the relationship between services development and private MEQ investment is a potentially important area of research.

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