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Sources of growth for Singapore: 1960–1989. A disaggregated investment and savings constrained growth approach

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SOURCES OF GROWTH FOR SINGAPORE: 1960–1989
A DISAGGREGATED INVESTMENT AND SAVINGS CONSTRAINED GROWTH APPROACH

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To My Parents

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ABSTRACT

The aggregate capital constrained growth theory pioneered by Harrod is modified to investigate possible differences in the marginal contributions to growth by capital of various kinds. The Singapore economy is hypothesised to be constrained by either disaggregated sectoral investment by type or disaggregated sectoral savings by source. The former is employed to explain the shifts in the incremental output-captial ratios and the latter is used as a proxy for unavailable investment details. The *Three Stage Least Square* method is applied to both systems of simultaneous equations. Empirical results indicate significant differences among the marginal contributions of different types of capital. Such differences may be due to either cause and effect relations between each investment/saving component and growth, or the differing degree of cyclical instability among the components over the growth cycle.

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CHAPTER 1

BACKGROUND, OBJECTIVE AND SIGNIFICANCE OF THE STUDY

This chapter attempts to accomplish four goals: first, as a background, to critically examine the savings-investment scene of Singapore in the past 30 years or so, and second, to discuss how the government's involvement in the economy changes the way resources are mobilized. Third, to state the objective and the significance of the proposed study, and finally, to briefly discuss the proposed research design.

1.1 Savings and Investment Scene in Singapore

Singapore has often been described as a high-savings, high-investment society. In fact, Singapore boasts the highest gross saving rate and highest gross investment rate in the world (Table 1.1).

The savings-investment scene in Singapore exhibits the following characteristics:

1. Gross national saving (GNS) and Gross domestic capital formation (GDCF), both as a percentage of the gross domestic product (GNS/GDP and GDCF/GDP respectively) exhibited a rising trend over the last three decades. Initially, gross national saving was unable to finance gross domestic capital formation (GDCF), thus resulting in rather high net capital inflow (NCI). Net capital inflow as a percentage of gross domestic capital formation was at its peak (54.3 percent) in 1971. However, the need for foreign savings gradually diminished as Singapore quickly transformed itself into a thrifty society from the early 1970s. As a result, GNS/GDP was raised from less than 20 percent

in 1970 to a peak of 46 percent in 1984. For the period 1974-89, GNS/GDP was raised to an average of 37 percent but with an average GDCF/GDP ratio of 42 percent, net foreign capital inflow diminished. The trend, however, was reversed during the period 1985-89 when GNS/GDP increased to 42 percent and GDCF/GDP declined to 38.5 percent. Singapore has been became an exporter of savings since 1986.

2. The impressively high national savings achieved by Singaporeans did not come in the form of voluntary private savings, rather, the bulk of savings came from public savings. The average share of public savings in GNS and GDS for the period 1960 to 1989 were 47 and 40 percent respectively (Table 1.3).

The public sector in Singapore comprises the government and semi autonomous statutory boards such as the Port of Singapore Authority, the Housing and Development Board *(HDB)* and the Telecommunication Authority of Singapore. The public sector has been a consistent net-saver and has generated a net current surplus (public savings) since 1974 (Table 1.4).

3. More significantly, private savings became increasingly involuntary. The Central Provident Fund *(CPF)* – a comprehensive and compulsory forced saving scheme administered by the state, increased its share of private savings from 28 percent in 1970 to well over 50 percent during the 1980s (Table 1.5). Voluntary private savings, which consisted of voluntary household and business savings, were unstable and growth rates fluctuated greatly. On the other hand, involuntary private *CPF* savings achieved rapid positive growth rates until 1986 when Singapore encountered its first recession in 25 years and the *CPF* contribution

rate was lowered (Table 1.6). The return on *CPF* savings was determined by government.[1]

4. Accompanied by rapid growth in both public and involuntary savings relative to voluntary private savings was the changing scene in Singapore's capital formation process. Table 1.7 showed the gross domestic capital formation by both public and private sectors. The public GDCF's share of the total GDCF is significant since it averaged 35 percent for the period 1960-89 and 33 percent for the period 1974-89. This reflected heavy government involvement in the economy.

5. The high savings achieved since the mid-1970s had resulted in a small net capital inflow (Table 1.2). This, in principle, suggested that Singapore's need for foreign capital or savings had diminished as Singapore transformed itself into a high-savings, high-investment society. In reality, however, much of these savings, mostly in the form of public savings and involuntary *CPF* savings, were invested abroad by the government and did not contribute to domestic capital formation. Gross inflows of foreign savings, mostly in the form of direct foreign investment by multi-national companies, were in reality financing a major portion of Singapore's domestic capital formation (Table 1.8).

6. The disproportionately high share of total saving by the public sector was only partially transformed into domestic capital formation. The public sector's GDFCF only averaged 35 and 33 percent of the total GDFCF for the periods 1960-89 and 1974-89 respectively (Table 1.3 and 1.7). The *CPF* contri-

[1] The average real rate of returns on the *CPF* balance was 1.8 percent for the period 1961–84. This compares with a average real returns of 1.9 percent earned on a 12-month certificate of deposit for the same period of time. For a detailed discussion and sources of these data, see Lim Chong Yah, "Report of the Central Provident Fund Study Group." *Singapore Economic Review*. April 1986, pp.75–78.

butions and the public-sector surpluses were accumulated and invested abroad as foreign reserves, and therefore did not fully finance the domestic investment. The bulk of the GDCF were undertaken by the private sector and this implied that the private sector had to face a positive resource gap. The investment of both the *CPF* and public savings abroad by the government resulted in a mmassive outflow of national savings. But the private sector, with insufficient voluntary savings to finance its capital formation, was attracting large amounts of foreign savings to fill the resource gap. Clearly, behind the small net capital inflow figure suggested by Table 1.2 and item 1 above, there was a tremendous movement of resources within the economy and across the border.

7. Owing to sharp increases in both the *CPF* and public savings, the government was able to increase its investment both abroad and in the domestic economy. The public GDFCF's share of total GDFCF increased from 22.6 percent in 1974 to more than 30 percent during most of 1980s. On average, from 1960 to 1989, the public sector assumed 35 percent of total GDFCF (Table 1.7). But, the most important component of the public capital formation was in contruction, especially since 1980. Table 1.9 shows the share of construction in both public and the private sector GDFCF. For the period 1974 to 1989, public construction assumed 70 percent of its capital formation whereas private construction took on an average of only 32 percent.

8. A summary on the changing savings and investment scene for the past three decades is presented in Table 1.10. Disaggregated savings to total investment ratios is presented in the first part of the table. The public savings to investment ratio, S_{pu}/I decreased during the 1970s but increased dramatically during the 1980s. However, the change was small as compared to the changing

forced savings and foreign savings ratios, S_{cpf}/I and S_f/I. The forced savings ratio was raised for a mere 8.3 percent in the 1960s to 27.7 percent during the 1980s. The foreign savings ratio, on the other hand, decreased from about 28 percent during the 1960s and 1970s to a mere 2 percent during the 1980s. The private savings ratio, S_{pr}/I, declined slightly during the 1980s but was basically stable throughout the entire three decades.

The second part of Table 1.10 presents disaggregated investment expressed as shares of total investment. Investment was disaggregated into productive and residential construction by public (I^P_{pu} and I^H_{pu}) and private sector (I^P_{pr} and I^H_{pr}). The high public productive investment ratio, I^P_{pu}/I, during the 1960s probably reflected the leading role played by government during the early stage of economic development. During the 1980s, however, it was the private productive investment, I^P_{pr}, that accounted for the bulk of the investment. The private investment in residential construction ratio, I^H_{pr}/I declined drastically from the 1960s and public investment in residential construction, I^H_{pu}/I, gradually expanded its share of total investment.

The last part of the table disaggregated investment into productive and construction by sectors.[2] Public investment in construction, I^C_{pu}, became a very significant part of total investment as it increased its share from 14 percent in the 1960s to 24 percent in the 1980s. Also, the public investment share increased from about 28 percent in the 1970s to about 35 percent during the 1980s, obviously at the expense of private investment.

[2] Thus, productive investment is now investment net of construction instead of residential construction.

1.2 Government and Resource Mobilization in Singapore

1.21 The Central Provident Fund - CPF

To understand the complex nature of resource mobilization in Singapore, it is vital to understand the operation of the *CPF* scheme. The *CPF* scheme was adopted in 1951 by the British Colonial Government of Singapore largely because it was a self-financed scheme as compared to the social security scheme which might impose a burden on the state treasury. Under the provident fund scheme, employees and their employers contribute to the fund and their savings plus interest earned are accumulated and are made available to members when they attain retirement age. It does not constitute a drain on the state's treasury and the state merely acts as the trustee and administrator for the fund.

The *CPF* saving scheme applies almost universally to all working people, foreign or locals, in Singapore. The total number of members in the *CPF* rose from a mere 418,000 at the end of 1965 to 1,996,000 at the end of 1989, representing 94 percent of the workforce. Contributions had increased from S$47 million to S$6,107 million and the size of the fund had balooned from S$359 million to S$48,012 million over the same period of time (Table 1.11).

The enormous increases in both contributions and the size of the fund cannot be attributed simply to sheer increases in the labor force and the number of contributing members. The effective contribution rate increased from a mere 8 percent of wage income to 40 percent in 1984. The rate was revised downward during the recessionary period of 1985-86 but has since been adjusted upward.

It is projected that the rate of contributions will be 50 percent by year 1990.[3]. The change in the nominal rates of contribution is summarised on Table 1.12.

1.22 CPF Savings and Domestic Resource Flows Between Sectors

The original objective of the *CPF* scheme was to serve the old-age and retirement needs of the population. But the *CPF* scheme had been transformed by the government from a mere social security system to a mechanism whereby the state directs domestic resources to finance investment in public housing. The use of the *CPF* saving had also been greatly diversified by means of the various CPF schemes. One of the most significance scheme is the *Home Ownership* scheme.

There are two types of *Home Ownership* schemes. The *Public Housing Scheme* allows the *CPF* members to withdraw their forced savings to purchase *HDB* flats (*i.e.,* public housing), and, the *Approved Residential Properties Scheme* allows contributors to withdraw funds to purchase private housing. Table 1.13 shows residential units constructed by the *HDB* and bought and financed under the *CPF* home ownership schemes. The majority of the residential units built by the public sector were purchased by Singaporeans using their *CPF* balances. Also, the percentage of Singaporeans living in public flats has risen to about 88 percent. Table 1.14 shows the amount of funds withdrawn by *CPF* members to purchase both public and private residential properties. The withdrawals represented 68 percent of total *CPF* withdrawals during the period 1974-89.

[3] The nominal contribution rate on 1984 was 50 percent total (25 percent by employer and 25 percent by employee), the employee's contribution is calculated based on their wage earnings net of employer's *CPF* contribution. This would reduce a 50 percent nominal rate to an effective contribution rate of about 40 percent

Another important aspect of the relationship between *CPF* savings and public investment is that, *CPF* savings have not only been used to fund the public investment in residential construction, but that the government has encouraged the process by giving indirect subsidy to home purchasers of public housing. Table 1.15 records the amount of subsidies given to *HDB* which in turn sells the public flats at below cost. In addition to the annual direct subsidy given to *HDB*, the government also extends substantial amounts of low interest loans to augment its residential construction.

1.23 Macroeconomic Policy and Mobilization of Resources

Before we can analyse the dynamic relationship between the government's macroeconomic policy and its impact on resource mobilization in Singapore, we must first understand that Singapore is a very open economy. The value of its exports and imports were respectively 155 percent and 172 percent of its GNP on 1989. Second, the Singapore economy enjoys a very high degree of capital mobility since there exist no barrier to flows of capital. Third, the Singapore government sets a target exchange rate. Given the second and third facts above, there exists little or no room for independence of monetary policy. In fact, the money supply is determined endogenously by domestic money demand.[4]

The two main goals of macro-economic policy are high economic growth and price stability. The government of Singapore has several instruments to affect the macro-economy and to achieve these goals:

1. *Exchange Rate and Money Supply*

[4] An elementary exposition on the idea that the central bank and government can only either target the domestic money supply or the exchange rate, and has to relinquish control on one variable when the other is targeted can be found on Fry and Williams (1984).

The Singapore dollar has been on a managed float exchange rate system since 1973 when the US severed its ties with gold. The Monetary Authority of Singapore *(MAS)*, the *de-facto* central bank, sets a target band for the Singapore dollar and this band is calculated based on a trade-weighted basket of currencies of Singapore's major trading partners. By targeting the exchange rate *vis-a-vis* its major trading nations, the Singapore government relinquishes control on its domestic money supply but achieves relative price stability.

During inflationary periods, the *MAS* allows the Singapore dollar to appreciate against its major trading partners and thus achieves lower inflation for its domestic economy. Since the intention of the *MAS* is never explicitly made clear and there is no stated government position regarding the use of exchange rate to achieve price stability,[5] the above assertion can only be justified by looking at some statistical evidence. As shown by Table 1.16, during the seventies, commonly regarded as a high-inflation decade, the Singapore currency appreciated againist its major trading nations except Japan and West Germany. The attainment of relative price-stability *vis-a-vis* the other Asia NICs, a direct result of its exchange rate and monetary policy, is recorded in Table 1.17.

2. *The CPF Fund and Public-Sector Surpluses*

The public sector of Singapore includes the government comprised of some 14 ministries and state departments and a dozen statutory boards, which are often under close supervision by cabinet ministers or senior civil servants but are considered semi-autonomous. Table 1.4 shows the revenue and expenditure of the public sector. The public sector, as mentioned earlier, has registered con-

[5] The governent has however, occasionally made it's intentions public. Published in *The Straits Times* on August 25, 1984, the then Chairman of *MAS* states: "...So the *MAS* is probably the only central bank that does not have to watch the money supply. What then does it watch? It watches the foreign exchange rate." For a more detailed discussion on Singapore's monetary policy, see Lee (1987).

sistent current surpluses since 1960 and also recorded sizeable overall surpluses on several occasions during the decade of 1980s. This sizable overall surplus can be deposited either with the *MAS* or the domestic private banking system. If the former route is chosen, then it results in a decreased money supply. On the other hand, if the latter method is used, domestic liquidity is maintained. Table 1.18 shows years where overall public surpluses were recorded and compares those surpluses with the public sector's deposits in the domestic private banking system. It clearly demonstrates that the former route is preferred by the *MAS* and a withdrawal of liquidity occurred during the second half of the 1980s.

In addition to the public sector surpluses, the Singapore government also has the *CPF* savings at its disposal. Since Singapore is a very youthful society, the number of people entering the labor force far outnumbers the number of people retiring. As a result, the *CPF* fund experienced explosive positive net contributions during the 1970s and 1980s. As shown in Table 1.19, contributions increased from 686.7 million dollars in 1974 to 6107.4 million in 1989. Withdrawals grew from a mere 154.3 million to 3663.5 million over the same period. As a result, net contributions steadily rose from 532.4 million in 1974 to 2633.7 million in 1985, and then drastically declined due to the lowering of contribution rates during the 1985-86 recession.

The decline led to a reallocation of domestic savings by the government. The *CPF Board* is required by law to hold the bulk of its funds in the form of government securities. However, since the public sector experienced sizable surpluses during the 1980s, the money raised from selling securities to the *CPF Board* was merely accumulated. As mentioned earlier, this accumulation of

funds was not deposited with the domestic banking system but instead was used to purchase foreign assets, which mainly took the form of foreign currencies and gold.[6]

The killing of the banking reserves and the withdrawal of domestic money supply has serious economic consequences. One would expect, *ceteris paribus*, excess money demand and rising domestic interest rate, thus forcing the local financial institutions to borrow from the offshore financial markets (*i.e., Asian Dollar Market*) or abroad. The capital inflow as a result of borrowing mainly takes the form of foreign investment from abroad. This inturn would cause the Singapore dollar to appreciate and if the *MAS* desires to "manage" the exchange rate, it would then supply Singapore dollar to the foreign exchange market to buy foreign currencies and assets, resulting in the accumulation of huge foreign exchange holdings (Lee, 1987).

(3). *The Public Sector Construction*

The Singapore government has, by the end of 1989, housed 88 percent of its population. One of the main fiscal stimulatory measures implemented by the government during economic downturns was the acceleration in the public capital formation, particularly in the public construction. Table 1.20 shows the rate of growth of capital formation by the public and the private sectors in recessionary years (1974-76 and 1982-83). In these occasions, the public GDFCF generates positive increases either to offset the decline in the private GDFCF or to support the sluggish increases in the private GDFCF. It demonstrated that indeed the public capital formation has been used by the government to

[6] In the past decade, indigenous entrepreneurs of Singapore have started investing overseas, especially in the surrounding *ASEAN* countries, to take advantage of their relatively abundant supplies of land and labor. But this outflow of private savings is trivial compared to the outflow of publicly controlled resources and foreign investments received.

implement counter-cyclical aggregate demand policy. If we investigate further by looking at the composition of public residential construction's share of public GDFCF and total GDFCF (Table 1.21), it is quite clear that the public construction has had a vital role in the capital formation process, accounting for an average of 35.5 percent of public GDFCF and 11.5 percent of total GDFCF during the period 1974 to 1989.

Table 1.22 further examines the composition of residential construction by both the public and private sectors. Public residential construction's share of total construction in Singapore increased from 36.2 percent in 1973 to a peak of 60.6 percent at the end of 1986. For the period 1960 to 1989, residential construction by the public sector averaged 38.7 percent of total residential construction in Singapore, and from 1974 to 1989, it further increased to an average of 50.7 percent. In Table 1.23, on the other hand, public construction is disaggregated into residential (public housing) construction and infrastructure build-up.

More significant, the government had, *via* the public construction, built a large number of residential units for the population. Table 1.24 presents residential building statistics by both the public and private sector. The public sector accounts for, on average during 1970-89, 82.3 percent of residential housing starts and 90.5 percent of all residential housing constructed (Lee, 1987).

1.24 Summary and Evaluation

The above brief anlaysis highlights the unique relationships among the involuntary *CPF* saving scheme, the public sector surplus, and the massive resource-flows that occur domestically across sectors and externally between the Singapore and the rest of the world. Table 1.25 records the static resource

gap in both the private and public sectors. Before any external resource flow had taken place, the private resource gap (*i.e.,* voluntary private savings minus private investment) was consistently negative and averaged only 58.5 percent of investment needs for the period 1960-89. For the period 1974-89, the private resource gap deteriorated to 62.2 percent. The public sector, however, experienced consistent surpluses in resources. For the period 1960-89, its surplus resources averaged 58.2 percent of its investment needs, and for the period 1974-89, improved to 93.4 percent.

The *CPF* scheme had caused reallocation of savings from the private to the public sector and brought about an acceleration of public sector investment in residential construction. Further, persistent public surpluses fostered a low-inflationary environment caused by either a constant monetary base or monetary contraction. Last, the deliberate government policy of investing its surplus overseas necessitates the inflow of foreign investment to remedy the resource gap in the private sector.

1.3 Objective and Significance of the Proposed Study

Analysis of economic development in developing economies has assigned a central role to savings and capital formation as one of the most important determinants of the level and the rate of growth of income. There may be many causes of economic growth, but capital formation and accumulation is one of the most fundamental. The economic growth process requires an economy to raise saving and engage in capital formation *via* either by the domestic private and/or public sector, or by capital inflows from abroad. However, the ability to save and the desire to invest may not be the same and sector-specific imbalances

between saving and investment could happen. As a result, resource flows occur. Two types of resource flow are identified: first, domestic resource mobilization across sectors and second, external resource mobilization between Singapore and the rest of the world.

The savings and investment scenes of Singapore provided above illustrates both processes. On one hand, the public sector accumulates savings as its revenue exceeds its consumption and investment. While on the other hand, the private sector faces resource gaps as its voluntary savings falls short of its capital formation. The result is the inflow of foreign savings, mostly in the form of direct foreign investment, to cover the private resource deficit. Outflow of savings occurs when the public sector invests its surplus abroad. In addition, the involuntary *CPF* savings becomes an instrument to channel forced private savings into the large-scale public housing program.

Although saving has to be raised and mobilized to finance investment, if one conjectures that income growth is constrained by the accumulation of different types of capital, then it is the growth in the capital stock of various kinds that contribute to increased output. If there are differences in the marginal contributions to growth by these different kinds of capital, (*i.e.,* different internal rates of return to different kinds of capital), then disaggregation of investment is meaingful. Clearly, under the capital-constrained growth analytical framework, the change in capital stock is due to investment and the reason for disaggregation of investment is based on *a priori* expectations of differences in incremental output-capital ratios. However, the available investment breakdowns may not fully reflect differences in the contributions of capital to output growth and

the available saving breakdown may serve as a good proxy for the unavailable investment details.

Most recent theoretical and empirical studies (Singh, 1971, Vongvipanond, 1978) have concentrated on such issues as: Are differences in countries' income growth rates capable of being explained by differences in the rate of saving or investment? And what are the relative contributions to growth by domestic savings/investment *vis-a-vis* foreign savings/investment. The unique method employed by Singapore in mobilizing its resources supported the following research questions:

1. Do private and public savings and investment contribute equally to the process of income growth in Singapore or do they differ? And if they do differ, what are the sources of differences in their marginal contributions to income growth?

2. If a dominant involuntary saving scheme has been used by the government to finance massive investment in public residential construction, what is its impact on growth in Singapore?

Therefore, in the present study an attempt will be made to to investigate the above issues. The research question 1 above has been raised before and prior investigations were conducted on samples of developing nations via less detailed disaggregation of sectoral savings or investment constrained growth method. However, no study employing detailed disaggregation of savings and investment approaches has been specifically done on Singapore yet. The unique experience of Singapore, *i.e.,* the presence of a dominant involuntary saving scheme and the large scale public-housing program makes research question 2 an very important one. Does the existence of such a dominant involuntary

saving scheme and the co-existence of a massive public residential construction program foster or retard income growth?

1.4 Research Methodology

The methods of raising domestic resources, the dynamic nature of domestic and external resource flows and their combined impact income growth in Singapore merit in-depth study. Two distinct approaches are commonly employed. The first approach requires the identification of factors affecting growth and then estimates the marginal contributions of the individual factors to output growth by using either the *Single-equation estimate* or the *Systems of equation method.* The former could be applied *via* the single equation Ordinary Least Square (*OLS*) or Generalized Least Square (*GLS*) methods. The latter research design usually called for the use of the Two-Stage Least Square Method (*2SLS*) or the Three-Stage Least Square (*3SLS*) Method.

The second approach, the sources of growth accounting approach first developed by Dension (1962, 1974), is to use factor shares in national income as weights to combine the individual factor inputs and form an index of total factor inputs. That portion of output growth that cannot be explained by increases in factor inputs is thus, rather arbitrarily, labelled as the *residual.*

Using the first method and 15 years of time-series data, Pesmazoglu (1972) disaggregated savings into domestic and foreign savings, and found that in many less developed nations the domestic savings contribute relatively less than the foreign savings. Papanek (1972) took a sample of Asian nations with 31 years of time-series data and disaggregated savings into domestic savings, foreign aid and foreign private investment, and found foreign aid contributed the most and

domestic savings contributed the least to developing Asian countries. However, since single equation *OLS* estimates are employed by both, simultaneous bias would probably be present and the accuracy of their results should be suspected. A more detailed disaggregation of savings is done by Vongvipanond (1978) for six Asian nations. Using a simultaneous system of equations, he found the marginal contribution to income growth of government savings to be higher than the marginal contributions of both private and foreign savings. His result contradicts the findings of Pesmazoglu and Papanek.

Chen (1977) uses the second approach (*i.e.*, the *Sources of Growth Accounting Method*) and found that growth in both the labor force and the capital stock explains less than 50 percent of the growth rate achieved in several Asian nations (including Singapore) for the period 1957 to 1970. However, in a more recent study, Lee (1986) employs the same method and found that the growth in the capital stock explains 74.4 percent of GDP growth in Singapore from 1966 to 1972. For the period 1972 to 1982, it further explains 85 percent of GDP growth. The differences in their results may be due to measurement errors, especially for capital stock. A detailed review of these methodologies and prior empirical findings are presented in chapter two.

Lee's empirical finding that the income growth process in Singapore from the mid-1960s to the early 1980s is mainly capital-driven provides support for the proposed capital constrained growth analytical framework. Harrod and Domar types of saving and investment constrained growth models are designed based on the assumption that for the period 1960 to 1989, the income growth process of Singapore could be directly linked to the accumulation in differentiated capital stocks *via* changes in sectoral investment by types. If there are

differences in the marginal contributions, then it make sense to disaggregate investment, where the disaggregation is along the lines of *a priori* expectations of differences in incremental output-capital ratios. However, since the available investment breakdowns (*i.e.,* by sector and by type) may not fully reflect differences in contributions, accumulation in the differentiated capital stocks is also hypothesised to be directly linked to changes in sectoral savings by source. It is hoped that the disaggregated savings breakdown would act as a good proxy for unavailable investment breakdowns and help to shed more light on the issue.

The first approach is chosen since no specific study has been conducted in Singapore *via* this approach. Systems of equations modelling growth as constrained by either disaggregated sectoral savings or investment are designed to avoid simultaneous bias. Details of the models are presented in chapter three.

The detailed disaggregation of savings and investment from 1960 to 1989 requires accurate and consistent data. Details on the collection, measurement and the use of data are presented in chapter four. Empirical evidence gathered from the disaggregated savings and investment constrained growth models are discussed in chapter five. Finally, policy implications and conclusion are drawn in chapter six.

1.5 Tables

Table 1.1 Saving and Investment Ratios of Selected Countries, 1965-1988.

	Singapore	Hong Kong	S Korea	Taiwan	Japan
GDS/GDP					
1965–69	14.59	22.35	12.42	22.01	27.66
1970–79	28.03	27.82	21.48	31.33	27.61
1980–88	41.54	29.62	30.09	33.27	28.49
1965–88	30.29	27.35	22.82	30.12	27.93
GDFCF/GDP					
1965–69	22.00	20.30	21.75	24.32	31.96
1970–79	35.53	24.47	25.14	32.54	33.00
1980–88	42.07	26.56	29.95	24.21	29.04
1965–88	35.16	24.56	26.24	27.71	31.43

Sources: Department of Statistics, *Year Book of Statistics*, various years.

Table 1.2 Selected Indicators of Saving and Investment in Singapore, 1970-89.

Year	GDCF/GDP	GNS/GDP	GNS/GDCF	NCI/GDCF
1970	38.7	19.5	50.3	49.7
1971	40.2	18.4	45.7	54.3
1972	41.1	24.1	58.5	41.5
1973	39.2	26.7	68.1	31.9
1974	44.6	24.8	55.5	44.5
1975	39.2	28.8	73.5	26.5
1976	40.8	31.3	76.6	23.4
1977	36.1	31.7	87.6	12.4
1978	39.0	33.2	85.2	14.8
1979	43.3	35.6	82.0	18.0
1980	46.3	33.0	71.2	28.7
1981	46.3	35.7	77.2	22.8
1982	47.9	39.3	82.1	17.9
1983	48.9	44.4	90.8	9.2
1984	48.5	46.4	95.8	4.2
1985	42.5	42.5	99.6	0.05
1986	38.5	40.3	104.7	–4.7
1987	39.0	40.2	102.8	–2.8
1988	36.9	42.2	114.4	–14.4
1989	35.4	43.6	123.3	–23.3
Average 1960-89	33.6	26.9	79.3	20.7
Average 1974-89	42.1	37.1	88.9	11.1
Average 1985-89	38.5	41.8	109.0	–9.0

Note: Data from 1960 to 1967 are from World Bank, *World Tables.*

Source: Department of Statistics, *Year Book of Statistics*, various years.

Table 1.3 Savings by Public Sector in Singapore, 1974–1988.

Year	GNS S$m	GDS S$m	Public Sector Savings (PUSS)	PUSS/GNS (Percent)	PUSS/GDS (Percent)
1974	3102	3548	1508	48.6	42.5
1975	3851	3819	1362	35.3	35.6
1976	4580	4782	1470	32.1	30.7
1977	5079	5374	2021	39.7	37.6
1978	5928	6060	2230	37.6	36.8
1979	7300	7455	2801	38.4	37.6
1980	8282	9412	3407	41.1	36.2
1981	10483	11954	4261	40.6	35.6
1982	12855	14218	5936	46.2	41.7
1983	16306	16932	8649	53.0	51.1
1984	18596	18304	9270	49.8	50.6
1985	16543	15606	8806	53.2	56.4
1986	15589	15308	8659	55.5	57.6
1987	17108	17018	9049	52.9	53.2
1988	20832	20395	9765	46.9	47.9
1989	24128	23722	10624	44.0	44.8
Average 1960-89				46.53	39.67
Average 1974-89				44.70	43.50

Sources: Department of Statistics, *Year Book of Statistics*, various years.
Ministry of Trade and Industry, *Economic Survey of Singapore*, various years.

Table 1.4 Public Sector Revenue and Expenditure, 1974–89. (In S$millions)

	Revenue	Public Sector Expenditure			Current Surplus	Overall Surplus
		Total	Current	Development		
1974	4523	4729	3015	1714	1508	–206
1975	4607	4934	3245	1689	1362	–327
1976	5465	6159	3995	2164	1470	–694
1977	6140	6565	4119	2446	2021	–425
1978	7151	7197	4921	2276	2230	–46
1979	8111	7732	5310	2422	2801	379
1980	10592	10556	7185	3371	3407	36
1981	13140	13614	8879	4735	4261	–474
1982	16111	16664	10175	6489	5936	–553
1983	18260	16819	9611	7208	8649	1441
1984	19006	17035	9736	7299	9270	1971
1985	19459	17800	10653	7147	8806	1659
1986	18755	17323	10096	7227	8659	1432
1987	19765	19160	10716	8444	9049	605
1988	20326	21686	10561	11125	9765	–1360
1989	21024	19809	10400	9409	10624	1215

Source: Ministry of Trade and Industry, *Economic Survey of Singapore*, various years.

Table 1.5 Savings by Private Sector in Singapore, 1970–1989.

Year	GNS	GDS	Public Sector Savings	Private Sector Savings (PRSS) (GNS–PUSS) (1)	(GDS–PUSS) (2)	CPF (Involuntary PRSS) S$m (3)	(3)/(1) Percent	(3)/(2) Percent
1970	1130	1065	583	548	483	156	28.5	32.3
1971	1253	1260	601	652	659	224	34.4	34.0
1972	1962	1976	642	1321	1335	331	25.1	24.8
1973	2725	2959	1009	1716	1950	475	27.7	24.4
1974	3102	3548	1508	1594	2040	687	43.1	33.7
1975	3851	3819	1362	2489	2457	887	35.6	36.1
1976	4580	4782	1470	3110	3312	1008	32.4	30.4
1977	5079	5374	2021	3058	3353	1115	36.4	33.3
1978	5928	6060	2230	3698	3880	1352	36.5	35.3
1979	7300	7455	2801	4499	4654	1753	38.9	37.7
1980	8282	9412	3407	4875	6005	2296	47.1	38.2
1981	10483	11954	4261	6222	7693	3007	48.3	39.1
1982	12855	14218	5936	6919	8282	3901	56.4	47.1
1983	16306	16932	8649	7657	8283	4491	58.6	54.2
1984	18596	18304	9270	9326	9034	5386	57.8	59.6
1985	16543	15606	8806	7737	6800	5993	77.4	88.1
1986	15589	15038	8659	6930	6379	4778	68.9	74.9
1987	17108	17018	9049	8059	7969	4447	55.2	55.8
1988	20832	20395	9765	11067	10630	4985	45.0	46.9
1989	24128	23722	10624	13504	13098	6107	45.2	46.6
Average 1960-89							42.9	44.7
Average 1974-89							48.9	47.3

Source: Department of Statistics, *Year Book of Statistics*, various years.

Table 1.6 Growth Rates of Savings by Private Sector in Singapore, 1974–1989. (In S$ millions)

	Voluntary PRSS Growth Rates				CPF	
	(1)	Percent	(2)	Percent	(3)	Percent
1974	907		1353		687	
1975	1602	76.6	1570	16.0	887	29.1
1976	2102	31.2	2304	46.8	1008	13.6
1977	1943	–7.6	2238	–2.9	1115	10.6
1978	2346	20.7	2478	10.7	1352	21.3
1979	2746	17.1	2901	17.1	1753	29.6
1980	2579	–6.1	3709	27.9	2296	30.9
1981	3215	24.7	4686	26.3	3007	30.9
1982	3018	–6.1	4381	–6.5	3901	29.7
1983	3166	4.9	3792	–13.4	4491	15.1
1984	3940	24.4	3648	–3.8	5386	19.9
1985	1744	–55.7	807	–77.9	5993	11.3
1986	2152	23.4	1601	98.4	4778	–20.3
1987	3612	67.8	3522	119.9	4447	–6.9
1988	6082	68.4	5645	60.3	4985	12.1
1989	7397	21.6	6991	23.8	6107	22.5

Note: (1) GNS minus (PUSS+CPF)
(2) GDS minus (PUSS+CPF)
(3) CPF annual contribution

Source: Department of Statistics, *Year Book of Statistics*, various years.

Table 1.7 Gross Domestic Fixed Capital Formation by Sectors, 1974–1989. (In S$ millions)

	Public–Sector		Private–Sector	
	GDFCF	Percent Share	GDFCF	Percent Share
1974	1267.6	22.6	4324.4	77.3
1975	1428.5	27.3	3807.5	72.7
1976	1970.7	32.9	4011.3	67.1
1977	1985.8	34.2	3813.2	65.8
1978	2289.9	32.9	4667.1	67.1
1979	2253.8	25.3	6646.2	74.7
1980	2841.0	24.4	8786.9	75.5
1981	3487.3	25.6	10099.7	74.3
1982	4621.7	29.5	11037.3	70.4
1983	6024.7	33.5	11935.3	66.4
1984	6393.4	32.9	13023.6	67.1
1985	5947.7	35.9	10603.2	64.0
1986	6156.9	41.3	8738.1	58.7
1987	7369.4	44.3	9267.6	55.7
1988	7750.3	42.6	10453.7	57.4
1989	7912.5	40.4	11656.5	59.6
Average				
1960-89		35.39		64.60
1974-89		32.87		67.12

Sources: Ministry of Trade and Industry, *Economic Survey of Singapore*, various years.
Department of Statistics, *Year Book of Statistics*, various years.

Table 1.8 Total Net Direct Foreign Investment (DFI) from Gross Domestic Capital Formation in Singapore, 1965–1988. (In US$ Millions)

	Annual Averages					Total
	1965–69	1970–74	1975–79	1980–84	1985–89	1965–89
DFI	32.7	277.1	655.2	1708.2	2879.5	5552.7
% of GDCF	8.97	20.5	25.65	26.87	27.85	25.89

Sources: DFI from IMF, *Balance of Payments Statistics Yearbook*, various issues.
GDCF and exchange rates from IMF, *International Financial Statistics*, various issues.

Table 1.9 Share of Contruction in Public and Private GDFCF, 1974–1989.
(In S$ millions)

Year	Public-Sector GDFCF (1)	Public-Sector Construction (2)	(2)/(1)	Private-Sector GDFCF (3)	Private-Sector Construction (4)	(4)/(3)
1974	1267.6	862.9	68.1	4324.4	1088.7	25.2
1975	1428.5	1089.6	76.2	3807.5	1031.0	27.1
1976	1970.7	1394.2	70.7	4011.3	981.3	24.5
1977	1985.8	1439.2	72.5	3813.2	896.6	23.5
1978	2289.9	1425.2	62.2	4667.1	881.8	18.9
1979	2253.8	1475.7	65.5	6646.2	1155.8	17.4
1980	2841.0	2049.3	72.1	8786.9	1763.5	20.1
1981	3487.3	2659.1	76.3	10099.7	3259.2	32.3
1982	4621.7	3261.6	70.6	11037.3	4312.3	39.0
1983	6024.7	5104.7	84.7	11935.3	5566.2	46.6
1984	6393.4	5674.6	88.8	13023.6	6189.3	47.5
1985	5947.7	4974.9	83.6	10603.2	4758.2	44.9
1986	6156.9	4994.2	81.1	8738.0	2525.7	28.9
1987	7369.4	3989.4	54.1	9267.6	4456.5	48.1
1988	7750.3	3729.2	48.1	10453.7	4135.6	39.6
1989	7912.5	3573.1	45.2	11656.5	3957.8	33.9
Average 1974-89			69.99			32.34

Source: Ministry of Trade and Industry, *Economic Survey of Singapore*, various years.

Table 1.10 Detailed Disaggregation of Savings and Investment, 1960-89.

	Spu/I	Scpf/I	Spr/I	Sf/I
Average				
1960-89	42.9	24.3	24.1	8.6
1960-69	36.2	8.3	26.7	28.7
1970-79	28.0	15.7	28.9	27.3
1980-89	47.8	27.7	22.5	2.0
	IpuP/I	IpuH/I	IprP/I	IprH/I
Average				
1960-89	22.9	11.3	53.9	11.8
1960-69	32.8	8.7	31.2	27.3
1970-79	18.9	9.8	59.7	11.6
1980-89	23.8	11.8	53.1	11.3
	IpuP/I	IpuC/I	IprP/I	IprC/I
Average				
1960-89	11.5	22.7	42.3	23.4
1960-69	27.4	14.1	24.4	34.0
1970-79	9.2	19.5	50.6	20.7
1980-89	11.7	24.0	40.8	23.5

Source: Department of Statistics, *Year Book of Statistics*, various years.

Table 1.11 CPF: Membership, Contributions and the Size of the Fund, Year 1965–1989.

Year	Total Members (thousand)	Total Contributions (S$million)	Size of the Fund (S$million)
1965	418	47	359
1966	442	51	416
1967	465	56	477
1968	505	68	540
1969	560	107	632
1970	639	156	777
1971	715	224	988
1972	855	331	1,316
1973	962	475	1,771
1974	1,042	687	2,414
1975	1,104	887	3,235
1976	1,178	1,008	4,066
1977	1,251	1,115	4,954
1978	1,341	1,352	5,981
1979	1,436	1,753	7,516
1980	1,519	2,296	9,551
1981	1,650	3,007	12,150
1982	1,725	3,901	15,656
1983	1,779	4,491	19,505
1984	1,829	5,390	24,895
1985	1,842	4,190	29,085
1986	1,892	3,540	32,625
1987	1,934	4,230	36,855
1988	1,947	4,985	41,905
1989	1,996	6,107	48,012

Sources: "Report Of the Central Provident Fund Study Group", *Singapore Economic Review*, Singapore, 1986, p.12-13.
CPF Annual Report, various issues.
Department of Statistics, *Year Book of Statistics*, various issues.
Department of Statistics, *Monthly Digest of Statistics*, various issues.

Table 1.12. CPF: Rates of Contributions, 1955–1989

	Contribution Rates (Percent)		Deposited Into (Percent)			
Starting	By Employer	By Employee	Ordinary Account	Special Account	Medisave Account	Total
1955	5.0	5.0				10.0
1968	6.5	6.5				13.0
1970	8.0	8.0				16.0
1971	10.0	10.0				20.0
1972	14.0	10.0				24.0
1973	15.0	11.0				26.0
1974	15.0	15.0				30.0
1977	15.5	15.5	30.0	1.0		31.0
1978	16.5	16.5	30.0	3.0		33.0
1979	20.5	16.5	30.0	7.0		37.0
1980	20.5	18.0	32.0	6.5		38.5
1981	20.5	22.0	38.5	4.0		42.5
1982	22.0	23.0	40.0	5.0		45.0
1983	23.0	23.0	40.0	6.0		46.0
1984	25.0	25.0	40.0	4.0	6.0	50.0
1985	10.0	25.0				35.0
1986	15.0	25.0				40.0
1987	20.0	25.0				45.0
1988	22.0	25.0				47.0
1989	25.0	25.0				50.0

Sources: "Report Of the Central Provident Fund Study Group", *Singapore Economic Review*, Singapore, 1986, p.12-13.
CPF Board, *Annual Report*, various issues.

Table 1.13 Residential Units Constructed and Sold by HDB, 1974–89.

Year	Flats Constructed	Flats Sold Under CPF's Housing Schemes	% of Population Living in HDB Flats
1974	29,425	15,352	49
1975	31,802	16,576	54
1976	31,025	23,345	60
1977	30,498	36,536	64
1978	29,742	25,600	68
1979	26,709	23,584	71
1980	18,421	23,234	73
1981	15,381	11,129	74
1982	19,532	21,403	75
1983	40,062	34,013	77
1984	67,017	81,823	81
1985	46,370	34,856	84
1986	38,907	30,575	85
1987	29,008	25,635	86
1988	27,091	40,688	87
1989	16,000	–	88

Note: 1989 figures are preliminary estimates only.

Source: Housing Development Board, *HDB Annual Report*, various years.

Table 1.14 Withdrawals of CPF Fund by Housing Types, 1974–89. (In S$ Millions)

Year	Public Housing (1)	Private Housing (2)	Total CPF Withdrawals	(1)+(2) as % of Total Withdrawals
1974	92.8		154.3	60.1
1975	134.8		216.9	62.1
1976	275.2		377.7	72.9
1977	383.4		503.5	76.1
1978	488.4		657.8	74.2
1979	438.6		629.3	69.7
1980	521.0		779.1	66.9
1981	652.0	39.1	1067.6	64.7
1982	540.2	256.1	1241.2	64.1
1983	726.0	396.4	1717.9	65.3
1984	2153.8	539.1	3509.2	76.7
1985	1784.9	781.5	3359.4	76.4
1986	1477.5	1169.8	3823.8	69.2
1987	1408.4	1239.1	4297.2	61.6
1988	1859.8	916.3	4010.2	69.2
1989	1343.9	1071.2	3663.5	65.9
Average 1974-89				68.47

Sources: Department of Statistics, *Year Book of Statistics*, various years.
Housing Development Board, *HDB Annual Report*, various years.

Table 1.15 Government Subsidy Received by Housing Development Board, 1960-1988. (In S$ '000)

Year	Amount Received	As Percentage of Public Sector Development Exp.
1960–74	70,980	–
1975	30,000	1.7
1976	44,631	2.1
1977	47,621	1.9
1978	69,524	3.1
1979	58,914	2.4
1980	32,886	1.0
1981	41,026	0.9
1982	6,540	0.1
1983	91,788	1.3
1984	137,841	1.9
1985	46,457	0.7
1986	1,172,971	16.2
1987	1,030,327	12.2
1988	950,164	8.5

Source: Housing Development Board, *HDB Annual Report*, various years.

Table 1.16 Foreign Exchange Rates with Six Major Trading Partners, for Year 1974–1988.

	Malaysian Ringgit	US $	Sterling Pound	Deutsche Mark	100 Japanese Yen	HK $
1974	1.015	2.437	5.694	0.941	0.835	0.484
1975	0.987	2.371	5.252	0.964	0.799	0.480
1976	0.972	2.471	4.464	0.982	0.834	0.504
1977	0.991	2.439	4.257	1.051	0.911	0.524
1978	0.982	2.274	4.361	1.135	1.089	0.486
1979	0.994	2.174	4.615	1.188	0.997	0.435
1980	0.984	2.141	4.977	1.181	0.947	0.431
1981	0.917	2.113	4.285	0.938	0.958	0.379
1982	0.917	2.140	3.745	0.883	0.862	0.353
1983	0.911	2.114	3.206	0.829	0.890	0.293
1984	0.910	2.133	2.846	0.752	0.899	0.273
1985	0.886	2.200	2.845	0.752	0.928	0.282
1986	0.884	2.177	3.196	1.007	1.301	0.279
1987	0.836	2.106	3.449	1.173	1.460	0.270
1987	0.812	2.002	3.421	1.154	1.430	0.254
1989	0.695	1.918	3.409	1.139	1.405	0.246
1990	0.671	1.701	3.334	1.124	1.316	0.219
Appreciation or Depreciation in percentage form:						
74–90	33.9	30.2	41.4	–19.4	–57.6	54.7

Sources: *The Singapore Economy Reconsidered.* ISEAS, Singapore, 1987, p.145 (Table 6.9).
Ministry of Trade and Industry, *Economic Survey of Singapore*, various years.
Asia Week, various issues.

Table 1.17 Average Annual Rates of Consumer Price Indexes, 1966–1988
(In per cent)

	1965–73	1973–79	1979–84	1984–89
Singapore	3.7	5.9	4.9	2.1
Hong Kong	6.3	7.4	12.0	6.1
Korea	11.3	18.0	12.6	6.9
Taiwan	4.5	13.0	8.2	2.5

Sources: *The Singapore Economy Reconsidered.* ISEAS, Singapore, 1987, p.139 (Table 6.5)
Department of Statistics, *YearBook of Statistics 1988/89.*
United Nations, *Statistical Yearbook for Asia and the Pacific.*
Economic Planning Board, *Korean Economic Indicators 1989.*
Council for Economic Planning and Development, *Taiwan Statistical Data Book 1989.*

Table 1.18 Change in Public Sector Deposits with Banks, Selected Years.
(In S$ millions)

	Public Sector Surplus (1)	Change in Public Sector Deposits (2)	(1) minus (2)
1979	379	–	–
1980	36	958.3	–922.3
1983	1441	1102.7	338.3
1984	3773	533.6	3239.4
1985	2424	253.4	2170.6

Sources: Monetary Authority of Singapore, *Monthly Statistical Bulletin,* various issues.
The Singapore Economy Reconsidered. ISEAS, Singapore, 1987, p.140 (Table 6.5).

Table 1.19 Net Contributions to CPF, 1974–1989.
(In S$ millions)

Year	Contributions	Withdrawals	Net Contributions
1974	686.7	154.3	532.4
1975	886.6	216.9	669.7
1976	1008.0	377.7	630.3
1977	1114.7	503.5	611.2
1978	1352.0	657.8	694.2
1979	1753.1	629.3	1123.8
1980	2296.0	779.1	1516.9
1981	3007.2	1067.6	1939.6
1982	3901.4	1241.2	2660.2
1983	4491.2	1717.9	2773.3
1984	5385.2	3509.2	1875.9
1985	5993.4	3359.4	2633.7
1986	4777.9	3823.8	954.1
1987	4446.8	4297.2	149.6
1988	4985.1	4010.2	974.9
1989	6107.4	3663.5	2353.9

Sources: *The Singapore Economy Reconsidered.* ISEAS, Singapore, 1987, p.138 (Table 6.4).
CPF Board, *Annual Report*, various issues.
Department of Statistics, *Year Book of Statistics*, various years.

Table 1.20 Gross Domestic Fixed Capital Formation by Public and Private Sectors, Selected Years. (In S$ millions)

	Public GDFCF (1)	Private GDFCF (2)	Change in (1)	Change in (2)
1974	1267.6	4324.4		
1975	1428.5	3807.5	+160.9	–516.9
1976	1970.7	4011.3	+542.2	+203.8
1981	3487.3	10099.7		
1982	4621.7	11037.3	+1134.4	+937.6
1983	6024.7	11935.3	+1403.0	+898.0
1984	6393.4	13023.6		
1985	5947.7	10603.2	–445.7	–2420.4
1986	6156.9	8738.1	+209.2	–1865.1

Source: Ministry of Trade and Industry, *Economic Survey of Singapore*, various years.

Table 1.21 Public Sector Residential Construction Share of Gross Domestic Fixed Capital Formation, 1960–89. (In S$ millions).

	Public–Sector			Total	
	Res. Constr	GDFCF		GDFCF	
	(1)	(2)	(1)/(2)	(3)	(1)/(3)
1974	481.0	1267.6	37.9	5592	8.6
1975	505.7	1428.5	35.4	5236	9.7
1976	676.0	1970.7	34.3	5982	11.3
1977	725.9	1985.8	36.6	5799	12.5
1978	732.6	2289.9	32.0	6957	10.5
1979	760.6	2253.8	33.7	8900	8.6
1980	855.8	2841.1	30.1	11628	7.4
1981	1154.7	3487.3	33.1	13587	8.5
1982	1848.7	4621.7	40.0	15659	11.8
1983	3187.1	6024.7	52.9	17960	17.7
1984	3404.4	6393.4	53.3	19417	17.5
1985	2697.6	5947.7	45.4	16551	16.3
1986	2241.7	6156.9	36.4	14895	15.1
1987	1813.4	7369.4	24.6	16637	10.9
1988	1734.5	7750.3	22.4	18204	9.5
1989	1635.3	7912.5	20.7	19567	8.4
Average 1960–89			35.54		11.51

Sources: Department of Statistics, *Year Book of Statistics*, various years.
Ministry of Trade and Industry, *Economic Survey of Singapore*, various years.

Table 1.22 Residential Construction by the Public and Private Sectors, 1974–1989.
(In S$ millions)

	Res.Constr		Rates of Growth		Composition (%)	
Year	Public	Private	Public	Private	Public	Private
1973	450.4	794.2			36.2	63.8
1974	481.0	736.2	6.8	–7.3	39.2	60.5
1975	505.7	618.2	5.2	–16.0	45.0	55.0
1976	676.0	695.0	33.7	12.4	49.3	50.7
1977	725.9	581.1	7.4	–16.4	55.5	44.5
1978	732.6	493.6	0.9	–15.1	59.7	40.3
1979	760.6	583.7	3.8	18.3	56.5	43.4
1980	855.8	876.3	12.5	50.1	49.4	50.6
1981	1154.7	1055.6	34.9	20.5	52.2	47.8
1982	1848.7	1508.9	60.1	43.0	55.1	44.9
1983	3187.1	2463.6	72.4	63.3	56.4	43.6
1984	3404.4	3250.9	6.82	32.0	51.2	48.8
1985	2697.6	2573.8	–20.8	–20.8	51.2	48.8
1986	2241.7	1456.9	–16.9	–43.4	60.6	39.4
1987	1813.4	2021.4	–19.1	38.7	47.3	52.7
1988	1734.5	2214.8	–4.4	9.56	43.9	56.1
1989	1635.3	2606.6	–5.7	17.7	38.6	61.4
Average 1960–89			29.94	23.58	39.49	60.60
Average 1974–89			11.10	11.65	50.72	49.28

Sources: Ministry of Trade and Industry, *Economic Survey of Singapore*, various years.
Department of Statistics, *Year Book of Statistics*, various years.

Table 1.23 Types of Construction by the Public Sector, 1974–1989.

	Public–Sector				
	Construction	Reside.Constr		Infrastructure	
	S$ m	S$m	Percent	S$m	Percent
1974	862.9	480.9	55.7	381.9	44.3
1975	1089.6	505.7	46.4	583.9	53.6
1976	1394.2	676.0	48.4	718.2	51.5
1977	1439.2	725.9	50.4	713.3	49.6
1978	1425.2	732.6	51.4	692.6	48.6
1979	1475.7	760.6	51.5	715.1	48.5
1980	2049.3	855.8	41.8	1193.5	58.2
1981	2659.1	1154.7	43.4	1504.4	56.6
1982	3261.6	1848.7	56.7	1412.9	43.3
1983	5104.7	3187.1	62.4	1917.6	37.6
1984	5674.6	3404.4	60.0	2270.2	40.0
1985	4974.9	2697.6	54.2	2277.3	45.8
1986	4994.2	2241.7	44.9	2752.5	55.1
1987	3989.4	1813.4	45.5	2176.0	54.5
1988	3729.2	1734.5	46.5	1994.7	53.5
1989	3573.1	1635.3	45.7	1937.7	54.2
Average 1974-89			50.3		49.7

Sources: *The Singapore Economy Reconsidered.* ISEAS, Singapore, 1987, p.148 (Table 6.11).
Ministry of Trade and Industry, *Economic Survey of Singapore*, various years.

Table 1.24 Residential Housing Statistics by Sectors, 1970–1989.
(In Units)

	Residential Housing Starts				Residential Housing Finished			
	Public		Private		Public		Private	
	Unit	Percent	Unit	Percent	Unit	Percent	Unit	Percent
1970	18347	85.9	3012	14.1	12939	88.3	1711	11.7
1971	29079	86.9	4374	14.1	17975	91.7	1630	8.3
1972	34399	83.2	6936	16.8	22938	93.3	1650	6.7
1973	36155	81.8	8020	18.2	22350	91.9	1970	8.1
1974	33020	80.4	8069	19.6	28346	91.0	2797	9.0
1975	51127	87.7	7140	12.3	29397	93.1	2174	6.9
1976	50366	88.2	6758	11.8	32336	94.1	2035	5.9
1977	51585	88.6	6650	11.4	30936	96.0	1304	4.0
1978	44833	88.0	6096	12.0	31665	92.5	2581	7.5
1979	41123	86.9	6199	13.1	27166	93.6	1872	6.4
1980	38395	84.9	6828	15.1	18614	88.6	2388	11.4
1981	58515	83.8	11326	16.2	12931	87.1	1913	12.9
1982	94190	86.1	15171	13.9	18982	87.5	2710	12.5
1983	112295	86.1	18172	13.9	36264	90.3	3914	9.7
1984	83313	84.3	15463	15.7	77387	93.0	5864	7.0
1985	64923	88.5	8419	11.5	59633	89.0	7388	11.0
1986	65120	91.7	5913	8.3	38519	88.2	5173	11.8
1987	43366	82.4	9281	17.6	32859	93.5	2295	6.5
1988	21254	58.0	15384	42.0	29149	94.5	1705	5.5
1989	16595	51.2	15801	48.8	12152	76.5	3741	23.5
Average 1970–89		82.3		17.70		90.51		9.49

Sources: *The Singapore Economy Reconsidered.* ISEAS, Singapore, 1987, p.150 (Table 6.12).
Department of Statistics, *Year Book of Statistics, Singapore*, various years.

Table 1.25 Static Sectoral Resource-Gap, 1960-1989.
(In S$ Millions)

	Private-Sector				Public-Sector			
	Saving	Investment	Res.Gap	(1)-(2) As % of	Saving	Investment	Res.Gap	(3)-(4) As % of
	(1)	(2)	(1)-(2)	(2)	(3)	(4)	(3)-(4)	(4)
1974	907	4324	-3417	79.0	2195	1268	927	73.2
1975	1602	3807	-2206	52.9	2249	1429	820	57.4
1976	2102	4011	-1909	47.6	2478	1971	507	25.7
1977	1943	3813	-1870	49.0	3136	1986	1150	57.9
1978	2346	4667	-2321	49.7	3582	2290	1292	56.4
1979	2746	6646	-3900	58.7	4554	2254	2300	102.1
1980	2579	8787	-6208	70.6	5703	2841	2862	100.7
1981	3215	10100	-6885	68.2	7268	3487	3781	108.4
1982	3018	11037	-8019	72.7	9837	4622	5215	112.8
1983	3166	11935	-8769	73.4	13140	6025	7115	118.1
1984	3940	13024	-9084	69.7	14656	6393	8263	129.2
1985	1744	10603	-8859	83.6	14799	5948	8851	148.8
1986	2152	8738	-6586	75.4	13437	6157	7280	118.2
1987	3612	9268	-5656	61.0	13496	7369	6127	83.1
1988	6082	10454	-4372	41.8	14750	7750	7000	90.3
1989	7397	11657	-4260	36.5	16731	7913	8819	111.5
Average 1960-89				58.45				58.24
Average 1974-89				62.19				93.37

Notes: 1. Private-sector saving is voluntary saving based on GNS.
2. Public-sector saving is private-sector current suplus plus CPF saving.

CHAPTER 2

THE LITERATURE REVIEW

2.1 Harrod and Domar's Capital Constrained Growth Theory

The origin of the modern theories of economic growth can be traced to the publication of Harrod's seminal essary (Harrod, 1939) followed by Domar's similar but independently derived contributions (Domar, 1946). In constrast to the "Grand" theories of economic growth of the classical economists of the eighteenth and nineteenth centuries in which a variety of political and sociological factors are intermixed to produce an all-encompassing "vision" of the long-run process of economic growth and development of society, Harrod–Domar's theory of growth is purely economic and is basically based on ideas and methods of Keynesian macroeconomics (Jones, 1975).

The aggregate production function implied by Harrod's methodology postulates labor and capital as inputs to the production function, and the two inputs are related to output *via* constant capital-output and labor-output ratios. Given a Keynesian's fixed interest rate (*i.e.,* liquidity trap) framework, it can be shown that the capital-output ratio is indeed constant. In fact, capital and labor are technically substitutable but in practice the ratios are fixed due to the inflexibility of factor prices. The model also indicates that output growth depends on the accumulation of capital, which in turn depends on savings and investment.

The maximum growth rate, or the *natural* growth rate implied in the model is the exogenous population growth rate. The *actual* growth of the economy can deviate from but cannot exceed the natural rate. Entrepreneurs in the model

determine the desired capital stock, and if the desired capital stock equals to the actual capital stock, the actual growth of the economy would follow the equilibrium (or *warranted*) growth path. Further, if actual growth is also found to equal natural growth, then the economy is at "The Golden Age" in which steady-state equailibrium growth occurs at the maximum rate. However, while steady-state growth at full employment is possible it is highly improbable since factors underlying the three growth rates are all independently determined (Jones, 1975).

2.2 The Neo Classical Growth Theory

An acceptance of Harrod-Domar position would imply that one would normally expect the economy to be in a state of depression and non-steady-state growth. Also the conclusions of their models are in conflicts with the experience of many real growing economies. Unsatisfied with these results, neo-classical growth theory was developed. By allowing perfect substitutability between inputs and assuming constant returns to scale, neo-classical growth model allow the economy to attain a steady-state growth path. (Solow, 1956; Swan, 1956). However, not only did the outcome of the neo-classical growth model come into conflict with the Harrod-Domar's capital growth theory, their relationships between inputs and growth also greatly differed. The neo-classical equilibrium growth rate only depends on population growth, which is exogenous to the system, and the growth is independent of the saving or investment rate. An increase in the saving or investment rate could only alter the level of income and consumption, and the growth rate, after accelerating during the course of the increases, resumes its original growth path (Jones, 1975).

Economists from the "Cambridge School" attack these neo-classical growth models mainly on grounds that they ignore the Keynesian "difficulties" in which entrepreneurs' formulation of expectations are unstable and cause wide fluctuation in investment spending, leading to changing output and employment. By equating *ex-ante* saving with *ex-ante* investment, argued the Cambridge economists, an investment function is necessarily absent with the consequent result of not assigning any major role to entrepreneurial expectations. In addition, they cast doubts on the existence of an aggregate production function due to existence of heterogeneous capital goods in the real world (Robinson, 1953, 1961, 1962; Champernowne, 1953, 1958; Kahn, 1958; Pasinetti, 1966, 1969; Jones, 1975). The debates between the two schools centered on the concept of capital and injected many new ideas into the input-constrained growth theories (Samuelson, 1966).

2.3 Capital as a Constraint of Growth

Any study on capital-based growth theory is not complete until one recognizies the importance of saving and the process of resource mobilization and capital accumulation. Many economists have searched for evidence of savings and investment constrained growth and such evidence has been found in both developed and developing economies. In a major comprehensive study for the United States during the period 1870-1955, Kuznets (1961) found that the major constraint of capital formation, defined as the ratio of capital formation to income, I/Y, has been the supply of savings rather than the demand for investment goods. Similar evidence has been gathered that shows that the supply of saving is a major determinant of both I/Y and income growth in the United

States (Klein, 1968, 1985). Lewis (1954) formulated the central problem of economic development as that of raising the proportion of national income saved and invested. A study by Musgrave (1969) supports the hypothesis that the major constraint on economic growth for developing economies is "insufficient productive capacity" or "aggregate supply" rather than demand. Taking it a step further, Weisskopf's empirical work lends support to the hypothesis that income growth is mainly constrained by savings and investment in many developing nations (Weisskopf, 1974; Klein, 1985). In two separate but related studies, long-run income growth of a large number of countries are again found to be constrained mainly by the availibility of capital (Chenery, 1986; Chenery and Syrquin, 1989).

The above findings, however, do not dispute the existence of the Keynesian's deficient aggregate demand as the constraint on growth (Keynes, 1936). Given the cyclical nature of aggregate demand, it was proven mathematically that growth problems could be directly linked to insufficient demand (Power, 1980). But most economists would agree that savings and investment are long-run constraints on growth whereas the problem of insufficient demand is of a more short-run and temporary nature.

2.4 Technological Change as Constraint on Growth

To relate growth with mere accumulation of tangible inputs neglects a central element in the process of economic growth: technological change. If more output can be produced given the same quantities of inputs, then technical progress has taken place. The most general method of representing the effect of technological change is to rewrite the aggregate production function,

postulating output growth as a function of inputs and time (Jones, 1975). Another common method is to model technical progress as factor-augmenting so that technical progress can shift the production function, (*i.e.*, higher output) even though the stock of capital and flow of labor service may not have increased. Factor-augmenting technical progress could be distinguished into capital-augmenting and labor-augmenting and these growth models have proliferated (Solow, 1957; Arrow, 1962; Takayama, 1965; Weizsacker, 1966; Jones, 1975).

Since the mid-1950s, a vast amount of research had been carried out on the macroeconomic aspects of technical progress and its impact on growth in a variety of countries. An early study on the United States had found that almost none of the entire increase in per-capita output from 1870 to 1955 could be accounted for in terms of increases in the stock of tangible capital or supply of labor services (Abramowitz, 1956). Some subsequent studies also confirmed that, for most countries, "the residual" or "total factor productivities" rather than the actual physical accumulation of capital and labor was responsible for the major share of observed economic growth (Dension, 1962, 1964, 1974; Chen, 1977). However, Jorgensen and Griliches (1967, 1972) have found that almost all of the observed economic growth in the United States between 1945 and 1965 can be accounted for in terms of the growth of the conventional inputs such as capital and labor. In recent years, a few studies carried out on Asian nations provided support for Jorgensen's findings (Sanchez, 1983; Tsao, 1986; Lin, 1986; Krause, 1987).

2.51 The Process of Domestic Resource Mobilization

If one could agree with the notion that economic growth is mainly constrained by savings or investment, then the process of resource mobilization becomes fundamentally important. The process of transforming savings into capital goods, or what we called resource mobilization, has three stages. First, the act of saving which is a claim on economy's real resources. Second, the mechanism to channel savings into the hands of investors, which involves financial intermediation in many instances. And third, the very act of investment, which is suppose to push the economy's production possibilities frontier outward to bring about more real resources to satisfy the claim by the savers and to benefit the entire economy. Thus, the process whereby saving is transformed into productive investment occupies a very significant role in the attainment of maximum income growth. It refers not only to the process by which resources are made available for productive investment, but also to the form that the initial mobilization may assume, and the sources of distribution of saving and investment among sectors. All three stage involves interdependent activities and an appropriate analysis of resource mobilization cannot be completed without consider the three stages simultaneously (Meier and Baldwin, 1963; Vongvipanond, 1978; Naya, James and Meier, 1987; Fry, 1988).

Savings

If income is a constraint on savings, then savings is a result of utility maximization given income. Assuming the above analysis is correct, the first step in achieving or accelerating growth over time is to engage in saving or to increase the saving rate of the economy. The aggregate domestic savings or the ratio of gross domestic savings to income in an econmy over time is determined

by: (1) ability or capacity to save, which is a function of the income level; (2) willingness to save as determined by the intertemporal preference; (3) the existence of sound financial intermediaries to facilitate saving; (4) goverment policies to distort (2) and (3).

Item (1) above receives support from Keynesians in the short-run and is consistent with life-cycle (Modigliani, 1970) and permanent income (Friedman, 1957) hypotheses in the long-run. In item (2) the real rate of interest could influence the level of saving given the aggregate intertemporal preference, *then ceteris paribus*, the higher the real rate of interest, the higher the desire to defer present consumption and hence achieve a higher present flow of savings. In item (3), the intermediary role played by financial institutions facilitates savings, and together with a positive real rate of interest, raises the domestic savings rate (Fry, 1988).

The effect that government policies may have on (2) and (3) have been widely studied. First, sound financial intermediation, in the form of positive real returns for financial assets *vis-a-vis* other forms of real assets (*i.e., precious metals, real estate*), and better and efficient financial and banking services (*i.e.,* post-office saving banks in Japan and Singapore) promoted by governments have the following effects: first, the ease in holding financial assets encourage individuals to substitute unproductive real assets, such as precious metals, for financial assets in their portfolio of wealth (Taylor, 1983). The rise in the quantity of financial assets will enable entrepreneurs willing to hold productive real assets to acquire them in a more efficient manner. Thus, sound financial intermediation will increase the efficiency of the process of saving and investment out of both current income and life time wealth. Second, the existence of

a forced saving scheme operated by government, like the *CPF* saving scheme in Singapore, could distort one's inter-temporal decision. This forced deferred consumption can be converted into current consumption only in the form of consumption of housing services, or to view it in another angle, investment in residential construction. If consumption in housing services is a good subsitute for other forms of consumption, and the real interest rate offered by *CPF* board is less than the Fisherian time preference rate of discount, then clearly economic agents would convert *CPF* saving into current consumption in housing services. Some findings (Datta and Shome, 1981; Choon and Veall, 1985), however asserts that *CPF* does not distort private consumption behavior since it is fully funded and non-redistributive, thus rendering the contributors' benefits equal to the accumulated value (principal plus interest) of their contributions. Their life time wealth postulation critically depends on whether the real returns from the *CPF* savings equal the time preference discount rate and whether individuals truly consume out of current or life time income (Koh, 1987).

A recent study shows that *CPF* saving yields average positive real returns (1961-84) of 1.8 percent (Lim, 1985). Given a positive real return on forced saving, it is less likely that economic agents would consume excessive housing services. This coupled with the fact that in Singapore real deposit rates are consistently positive and the financial sector is well developed, government policies seem to be promoting saving.

Methods of Mobilization

In the spirit of Gurley and Shaw (1967), five types of techniques have been identified to mobilize saving. They are self-finance, taxation, forced savings, financial and foreign inflows. The first three typically involve very little financial

intermediation. The first two represent common ways of mobilizing funds to finance public productive investment and the third is a common method to finance public housing investment. The fourth form is commonly employed by the private sector and a loanable fund market where savings (*i.e.,* supply of loanable funds) and investment (*i.e.,* demand for loanable funds) produces a interest rate to clear the market. The last method includes aid, grants, debts and investments from abroad.

2.52 Financial Development and Efficient Domestic Resource Mobilization

In both the developed and the developing world, the financial sector plays a major role in mobilizing domestic resources and allocating them to investment projects. In a state-controlled economy, the role played by the financial sector is greatly reduced and in many instances the financial sector is either incompetent or underdeveloped.

Without sufficient net inflows of external resources, raising domestic saving rates and mobilizing them effectively becomes vital. However, in order to effectively mobilize domestic resources, one needs to engage in financial development. In the words of Edward Shaw:

financial repression–indiscriminate distortions of financial prices including interest rates and foreign-exchange rate reduces the real rate of growth and the real size of the financial system relative to non-financial magnitudes. In all cases this strategy has stopped or greatly retarded the development process (Shaw, 1973).

Financial liberalization, or financial development, is thought by many to be the key to economic growth *via* better resource mobilization. Financial depres-

sion, in many instances, grows from financial restriction, which is a common tool used by many governments in the third world to tap resources at below-market or zero cost from the private sector (for example, reserve requirements and forced holdings of government bonds imposed on financial institutions) or to discrimate or favor certain private investment. Commonly, successful financial restriction is measured by a higher proportion of fund being transfered to the public sector.

Financial restriction is widely adopted by many developing economies mainly because of Keynes and Keyesian's doctrines. Keynes argues that the relative attractiveness of holding money as an asset instead of holding productive capital is the main cause of the inadequency in investment (Keynes, 1936). Thus, in a simple Keynes' fixed-price framework, expansionary monetary policy will reduce interest rates thus simulating investment. As long as monetary policy is accommodative, an interest rate ceiling imposed by the state will be able to simulate investment at the lower imposed interest rate. (Fry, 1973, 1988; Nichols, 1974). Clearly, the serious inflationary consequences of easy money was ignored (Friedman and Schwartz, 1963). Viewing real balance and capital as substitutes in a household's portfolio, economic growth is shown to accelerate when the relative yield on money falls (Tobin, 1965). Given an interest rate ceiling proposed by Keynes and Tobin, goverments are also able to finance the public-sector deficits at lower costs. However, as demonstrated by Friedman (1971), government revenue from taxation *via* inflation may, in fact, be less than optimum.

Neo-structuralists, in many ways, support the arguments of Keynesians. Tobin's portfolio framework for household asset allocation is utilized with curb

market loans, gold or currency (*i.e.,* non-productive tangible assets or inflation hedges) and bank deposits as components of household assets. Given the assumption that the official banking system is more efficient than the curb market in allocating saving to investment projects, households would substitute out of unproductive tangible assets into bank deposits when real deposit rate rises. Thus, financial liberalization would increase the real supply of credit, expand investment, and augment the economic growth rate. On the other hand, if the curb market is more efficient than the banking system in mobilizing resources, then a rising real deposit rates would cause household to substitute out of the curb market, reducing the real supply of credit, lower investment and retard income growth. It is in the latter fashion that neo-structuralists came into sharp contrast with the McKinnon-Shaw school (Taylor, 1983; Wijnbergen, 1982, 1983; Fry 1988). However, in a competitive environment, the returns paid by either market would reflect the risk adjusted profits to be earned and efficient allocation of investment can still be obtained. If efficiency is attained, then their relative sizes in the overall financial market would be determined by the relative returns in the segments in which they specialised.

The Financial Development school, led by McKinnon and Shaw, opposes the above views and asserts that economic growth in a financially repressed economy is mainly constrained by saving where investment opportunities are plentiful; and low saving is a result of financial repression. The policy prescription given is to raise the institutional interest rate or to reduce the rate of inflation. Allowing interest rates to rise to competitive levels, *ceteris paribus*, raises saving and investment to optimal levels and further increases the efficiency of aggregate investment. Thus, both the quantity and quality of investment are

increased, resulting in a higher growth rate (McKinnon, 1973; Shaw, 1973; Fry, 1988). The need to reduce the rate of inflation is linked to public-sector finance. In their view, large public deficits are invariably financed by monetary expansion, leading to either inflation or depreciation in the foreign exchange rate and are incompatible with financial development. Many researchers made revisions have made extension in the original McKinnon and Shaw models, but all view financial liberalization and development as the key to economic growth (Kapur, 1976; Galbis, 1977; Mathieson, 1980; Fry 1988).

2.53 Domestic Versus External Resource Mobilization

The inflow of foreign savings can relax domestic savings and foreign exchange constraints on growth. External capital inflows can be used to augment domestic savings, and so to raise the investment rate; or to smooth out consumption so as to avoid drastic changes in the standard of living of the population; or to contribute to both. As long as inflows of foreign savings do not cause a reduction in the aggregate domestic savings or investment, they may contribute to growth (Naya, James, Meier, 1987).

Much empirical evidence from cross-sections of developing nations indicates a negative relationship between foreign capital inflows and the domestic saving rate (Griffin and Enos, 1970). A common reason given is the "Psychological Hypothesis," which states that an increase in foreign capital inflow causes a relaxation of the government's domestic saving efforts and thus reduce domestic saving (Rahman, 1967; Griffin, 1970). In subsequent studies, many development economists question the efficiency of the use of foreign savings. (Landau, 1971; Weisskopf, 1972; Mikesell and Ziner, 1973; Chenery and Syrquin, 1975, 1989; Fry, 1977, 1984, 1988).

However, one can argue that the proper yardstick of the effectiveness of foreign savings is its effect on growth or other social objectives rather than on savings as conventionally measured. Papanek (1972) has demonstrated that the apparent negative association between capital inflow and domestic savings can be explained on purely statistical grounds. In studies conducted of several developing countries, the two-gap model demonstrated that if country has a trade constraint (*i.e.,* trade-barriers exist), or any other type of binding constraints, then, it is optimal to increase the inflow of foreign capital since its marginal productivity is very high and it also raises overall investment despite the consequent effect of rising consumption (Landau, 1971; Chenery and Strout, 1966; Chenery and MacEwan, 1966; Chenery and Carter, 1972, 1973; Papanek, 1972; Weisskopf, 1972; Naya, James, Meier, 1987; Ahmad, 1990).

It was further confirmed that in the vast majority of sample countries, where there are constraints other than savings, or where the constraints are mixed over the period under observation, then the negative relation between foreign capital and domestic savings is to be explained as a result of *ex post* savings falling below *ex ante* if the system is constrained elsewhere. In other words, the association between foreign capital and savings in these instances is not direct. However, for countries without a trade constraint (*i.e.,* free-trade regimes), the negative coefficients can be interpreted as inefficency in tranforming the capital-inflow into increased investment (Chenery and Carter, 1972, 1973; Ahmad, 1990).

However, empirical evidence provides no clear positive or negative relationship between inflows of foreign savings and domestic savings among the Asian countries (Dowling and Hiemenz, 1983; Naya, James, Meier, 1987). In a similar

study involving only six Asian nations (excluding Singapore) experiencing varying degrees of trade constraints, foreign savings was found to have a negative effect on domestic, private, and public savings (Vongvipanond, 1978).

2.6 Government Policy and Spending and Growth

2.61 Government Policy

The role of government and its policy in promoting or distorting economic growth has been widely studied. It was observed in many developing nations that at the early stages of development, production for the domestic market was usually favored, and trade barriers and a system of overvalued domestic currency prevailed. Rapid income growth and drastic structural changes took place when these following economic policies were adopted: (1) reduced protection to imports; (2) real devaluation to provide incentives for producers to shift resources toward the tradeable sectors, and (3) elimination of incentives with a bias against exporting. (Chenery and Syrquin, 1975, 1989; Krueger, 1983; Balassa, 1989).

Countries that vigorously pursued and achieved sustained growth include the Republic of Korea, Malaysia, Singapore, Taiwan, and Thailand. Common features of their experience are export growth well in excess of income growth, substantial reduction or complete removal of trade barriers, drastic reduction of the bias in incentives against exports, and foreign capital inflow to finance domestic investment (Balassa, 1981; Naya, James, Meier, 1987; Chenery, Lewis, De Melo, Robinson, 1986; Chenery and Syrquin, 1975, 1989).

In Singapore, both the public sector's share of income and investment are large. Hence, government spending and its relation to economic growth merit investigation.

In a study by Robert Barro, the public sector's productive expenditure (*i.e.,* public investment) enters the private sector's production function which is assumed to enjoy constant returns to scale. An increase in the public sector's nonproductive expenditure, *ceteris paribus*, would require the government to raise more tax, thus resulting in lower after-tax investment returns for private individuals and less incentive to invest, and the economy grows slower as a result of slower growth in capital stock (Barro, 1990).

If the above analysis is correct, then a rise in public investment, financed by higher taxation would lower the marginal contribution of private investment. On the other hand, a rise in public investment, financed by existing revenue (*i.e.,* a lower public surplus) would increase the marginal contribution of private investment.

The other aspect of the relationship between government spending and growth is that government is in a position to use its spending to implement counter-cyclical aggregate demand policy. Both the public consumption and investment could be the tool employed. If public investment is used, it is possible to observe a negative relationship between income growth and public investment. Likewise, if public savings or forced savings is being mobilized more intensively during periods of recessions to finance additional investment, a negative correlation between public/forced savings and growth can also be observed.

2.7 Different Approaches to the Study of Sources of Growth

In the past 30 years or so, studies on the relative contributions of factor inputs and technical progress to economic growth have been very numerous. There exists two distinct approaches to such studies. One is to estimate the marginal contribution of the individual factors to output growth by using mostly single equation econometric methods (Papanek, 1973; Pesmazoglu, 1973; Fry, 1985). The other approach is to use factor shares in national income as weights to combine the individual factor inputs and forming an index of total factor input. That portion of output growth which cannot be explained by increases in factor inputs is thus, rather arbitrarily, being labelled as the "residual" or "total factor productivity" (Dension, 1962, 1964, 1974; Jorgenson, 1967, 1972; Chen, 1977; Lee, 1986).

The first approach requires well-specified equations to capture the essential elements of growth. Studies have found that system of simultaneous equations, if well specified, is preferred to the single equation approach. This is especially true in a disaggregated savings or investment constrained growth framework where sector-specific or source-specific investment or savings and growth are likely to be jointly determined. A single equation that links disaggregated investment or savings to growth is really part of a system of equations and so the estimated parameters are subject to simultaneous equation bias (Pindyck and Rubinfeld, 1981; Vongvipanond, 1978). A system of simultaneous equations was used to explain growth *via* disaggreation of savings on six Asian nations (excluding Singapore) for the period 1960-73 and results in some insightful knowledge about the growth process (Vongvipanond, 1978).

A pioneer study utilizing the second approach was conducted on Singapore and other developing nations in Asia and found that growth in the labor force and capital stock explains less than 50 percent of the growth rate achieved in Singapore for the period 1957-70. Similar results were also obtained for the rest of the countries under investigation (Chen, 1977).

However, in a more recent study conducted by Lee (1986), total factor productivity (*TFP*) was found to explain only 4.8 percent of GDP growth in Singapore for the period 1966-72 while capital and labor accounted for 74.4 percent and 21.6 percent respectively. For the period 1972-80, capital accounted for 85 percent of the growth in GDP while labor and *TFP* growth accounted for 26.3 percent and –11.2 percent respectively. Two related studies conducted on *ASEAN* nations supported these results (Sanchez, 1983, Lin, 1986). The opposite results derived by Chen (1977) and Tsao (1986) point to the difficulties in accurately measuring capital stock, thus making the second approach considerably less desirable.

A major reason given by Tsao for her result is that Singapore does not have a sizeable agricultural sector and the high *TFP* observed in many countries are due either to structural transformation from low to high productive use of inputs, or the rapid increase in manufacturing sector at the expense of the agricultural sector. Another plausible reason is the liberal policy adopted in recruiting foreign labor from the period 1970–82, resulting in a four fold increase in foreign labor and raised the percentage of foreign labor force from 3 percent to 7 percent. Thus unlike the other *NICs* which experienced faster growing wage rates, the moderate rise in real wages during this period could have prevented or slowed the efforts at increasing the efficient use of labor and *TFP*.

Lee (1986) and Krause (1987) also analyze sources of growth in Singapore by allocating the contribution of capital to labor productivity, and thus growth is the result of an increase in labor inputs and in labor productivity. It was found that increases in labor productivity for the period 1966–80 were due primary to increases in capital stock per work. Although these results were obtained *via* the second approach, the studies by Lee, Krause, Sanchez and Lin provided strong support for the hypothesis that growth in Singapore, at least for most part of the 1960s and 1970s, is mainly capital-driven.

If the first approach is chosen, then one must ask the question concerning key assumptions and specification of the growth model. Also, the ability of the model to explain the real world needs to be present. The famous "stylized facts of growth" (Kaldor, 1958) refers to the long-term regularities in the relationships that seems to appear in most industrialized countries – between growth rates of output and capital and labor inputs, and between factor prices and relative income shares; and a good model needs to explain these stylized facts (Williamson, 1973). One such model is the the capital-based growth theories pioneered by Harrod and Domar. In their models, capital is related to output growth *via* the incremental output-capital ratio. The growth rate depends on the propensity to save of the economy and the incremental output-capital ratio is assumed to remain constant. Further, labor is postulated not to enter as a seperate constraint in many instances. Their assumptions of constant capital-output ratio and labor abundancy, though lacking theoretical justifications, have found empirical supports (Feller, 1954; Klein, 1968, 1985; Vongvipanond, 1978). A most relevant model developed by Vongvipanond (1978) demonstrated that if the objective of the investigation is to test the hypothesis of differences in

marginal constributions of sectoral capital, then one could disaggregate sectoral savings and link changes in capital stock by each sector directly to growth.

2.8 Optimum Saving and Investment Rates and Growth and Welfare Implications

Singapore, the nation in focus, boasts the highest saving rate, investment rate (Table 1.1) and income growth rate on earth. Clearly, the causality between capital accumulation and economic growth cannot be easily discarded. On the other hand, it is also tempting to conclude that it has "oversaved." However, the concept of oversaving is valid if only one know the *optimal* saving rate of Singapore. If one defined the optimum saving rate to be one that maximizes the present value of Singaporeans' total expected lifetime utility, then, the strong involuntary saving nature (*i.e., CPF* and public savings necessarily implies that consumption is somewhat restricted today for higher consumption tomorrow) could easily causes savers' inefficiency in allocating consumption inter-temporally and reduces savers' life time total utility (Koh, 1987).

No empirical test has been made on the above assertion since it is hard to know which factors enter Singaporean's utility function. However, on the issue of forced saving alone, a *CPF* study has concluded that the rate of contribution was in excess of the housing, life annuity, and medical needs of Singaporeans, thus suggesting that Singapore might have indeed oversaved (Lim, 1985).

Although it is hard to gather evidence *via* microeconomic analysis, from a macroeconomic standpoint, one probable measure of oversaving is the *prolonged* existence of a significant amount of excess productive capacity[1] since

[1] Short term excess capacity may result from an economic downturn or structural adjustment, neither of which necessarily imply oversaving.

it implies a lesser need for investment and savings. After being adjusted for periods of recession, there is little evidence to suggest the existence of excess capacity in Singapore (Koh, 1987). Moreover, the continuous inflow of foreign savings closing the resource gap experienced by private sector strongly suggests that oversaving does not exist in the private sector. Thus, anyone attempts to portray Singapore as an oversaved economy would have to show that the public sector has indeed oversaved and that this behavior is strong enough to render the entire economy an over-saved one.

Several important questions arise after the above brief survey. One must distinguish between maximum economic growth and maximum welfare. The existence of one does not imply the concurrent existence of the other. Second, some inconclusive evidence has suggested that Singaporeans have over-saved but it is not strong enough to discard the strong causality between capital accumulation and growth (*i.e.*, no evidence to suggest if oversaving does exist and growth is no longer constrained by adequency of capital but by availability of investment opportunities). Last, but not least, there is no evidence to suggest an underutilization of capital in Singapore. Thus, the decision to study the causality between growth and resource mobilization in Singapore remains a theoretically and empirically sound objective.

CHAPTER 3

SAVINGS AND INVESTMENT CONSTRAINED GROWTH MODELS

3.1 Objective of the Models

The background materials on Singapore in chapter one and the literature review conducted in chapter two are supported by the views below:

1. The Harrod-Domar capital-constrained growth model hypothesizes that in the long-run economic growth is constrained mainly by the availability and adequacy of capital. Since a change in capital is directly linked to investment, on *a priori* grounds, postulation of investment-constrained growth is plausible. Further, if different types of capital contribute differently to growth, then construction of a disaggregated investment constrained growth model based on differences in incremental output-capital ratios is supported. Although savings only affect potential output through investment and should not be directly linked to capital formation, the disaggregated investment details may not fully reflect differences in marginal contributions to growth and the disaggregated savings details may be used as a proxy for unavailable investment details so to further investigate the disaggregated capital-constrained growth hypothesis.

2. Singapore's high savings, high investment and rapid growing economy suggests a possible causal relation between capital and growth. Prior empirical findings based on the *sources of growth accounting* framework (Lee, 1986; Krause, 1987) also indicate that the Singapore economy is mainly driven by capital. All these support the use of a capital-constrained growth model to analyze sources of growth in Singapore.

3. The rather unique resource mobilization process in Singapore leads one to ask whether disaggregated public savings and investment yield the same marginal contribution to growth *vis-a-vis* disaggregated private savings and investment? If one cannot reject the hypothesis that marginal contributions are the same, then one possible explanation is that Singapore has the right mix of private and public resources. On the other hand, if they are not the same, then what are the sources of their differences? Can those differences be explained?

4. The answer to item 3 can also potentially explain or discredit the rational of having such a dominant involuntary *CPF* saving scheme in Singapore. Does *CPF* savings contribute more or less to growth as compared with voluntary private savings or public savings? Similarly, the answer to item 3 can also explain the rational of having such a massive public-housing program. Does public investment in residential housing contribute to income growth in Singapore? If it does then residential construction can no longer be viewed as as a form of non-productive investment. Is the marginal contribution of public investment in residential construction the same as other sector-specific investment? The models given below formally attempt to provide an analytical framework to answer the above questions and to test the propositions.

3.2 Theoretical Underpinnings of the Models

The hypothesis that income growth in the Singapore economy depends on the formation of various kinds of capital receives theoretical support from Harrod-Domar capital growth theory. The basic Harrod model (Jones, 1975) on which the disaggregated investment and savings constrained growth models are based is presented below.

The Harrod-Domar model makes the following assumptions: (1) savings, S, is assumed to be a simple proportional function of income, Y. Thus, $S = sY$ where $s =$ the average and marginal propensity to save. (2) the labor force, L is assumed to grow at a constant exogenous population growth rate n. (3) there is no technical progress and the capital stock, K, does not depreciate. Finally, the amount of capital, K, and labor, L, required to produce any given flow of output, Y, are uniquely given. Thus, the production function implied is:

$$Y = min(K/v, L/u) \tag{1}$$

where min = minimum

u = constant ratio of labor requirements to total output

v = constant capital-output ratio.

It is clear that the production of any given flow of output requires L/u units of labor. If all labor is fully employed, then the maximum flow of output is L/u. However, if the labor force is growing, then the maximum flow of output could grow but cannot exceed the population growth rate, n.

The capital-output ratio, $v = K/Y$, could be written as

$$K = vY \tag{2}$$

then, for small increments in K and Y, we derive

$$dK/dt = vdY/dt \tag{3}$$

thus, v equals the capital-output ratio, K/Y, and also equals the incremental capital-output ratio, dK/dY.

Harrod makes the crucial distinction between the *actual* incremental capital-output ratio, v, and the *desired* incremental capital-output ratio, v_r. v refers to the actual increment in the capital stock in any period divided by the actual increment in output. v_r, on the other hand, refers to the increment in the capital stock associated with an increment in output that is required by entrepreneurs if, at the end of the period, they are to be satisfied that they have invested the correct amount (*i.e.,* the new capital stock is to equal the amount that they consider appropriate for the new level of output and income). Clearly, this distinction is based on Keynesian ideas, in which expectations formed by an entrepreneur are important reasons why actual output may deviate from potential output in the real world.

Given the assumption that the capital stock does not depreciate, then, the rate of change of the capital stock, dK/dt, if positive, will equal to the flow of aggregate investment I. Thus, equation (3) can be rewritten as

$$I = vdY/dt \tag{4}$$

If aggregate planned investment must equal aggregate planned saving, *i.e.*, $I = S$, then equation (4) becomes

$$vdY/dt = S = sY \tag{5}$$

The above equation can be rewritten to give us the *actual* rate of growth of national income

$$dY/dt * 1/Y = s/v \tag{6}$$

Using symbol gY_A for the *actual* rate of growth of national income over any period of time, the fundamental equation, if viewed as a truism, is

$$gY_A = s/v \tag{7}$$

However, if v_r is used, then the fundamental equation becomes:

$$gY_W = s/v_r \tag{8}$$

where gY_W is the *warranted* rate of growth. The warranted growth essentially traces the equilibrium growth path since if the economy is growing at the warranted rate, there is no incentive for entreprenurs to alter the growth rate of output.

Equations (7) and (8) imply that

$$gY_A v = s = gY_W v_r \tag{9}$$

Thus, if the economy was to grow at the equilibrium growth path, then v must equal v_r. If output grows at the warranted rate, then the actual capital stock will conform to the desired capital stock and thus induces entrepreneurs to pursue the same growth rate in capital stock. Because the entrepreneurs have no incentive to alter current output and relative prices, the economy grows at the equilibrium warranted rate.

Given that the growth rate of the economy cannot permanently exceed that of the population growth rate, the full-employment equilibrium steady-state growth becomes

$$gY_A = gY_W = n \tag{10}$$

Equation (10) indicates the possibility of steady-state growth. However, there is no reason to believe s/v will equal s/v_r or n. In fact, s, v_r and n are all independently determined. Hence, athough steady-state growth is possible, it is highly improbable.

However, let us assume that the actual growth rate equals the warranted growth rate. Further, these rates are constantly below the natural growth rate given that the Singapore government pursues a population policy to ensure that population growth always exceed the actual and warranted rates. As a result, growth becomes constrained by either investment or savings. Since population growth is assumed to always exceed actual growth and the growth of labor is assumed to be directly dependant on population growth, the labor supply is thus not a constraint on growth.[1]

From equation (6) we derive

[1] In other words, the economy experiences surplus labor supply.

$$gY * v = s \tag{11}$$

since $v = dK/dY$, equation (11) can be rewritten as

$$gY = dY/dK(S/Y) \tag{12}$$

Equation (12) indicates that the income growth rate of the economy is a function of the savings to income ratio. Given a certain incremental output-capital ratio, the higher the savings to income ratio, the higher the growth rate. However, savings only affects potential output *via* change in investments, the actual change in capital stock is a result of change in investments, thus equation (12) becomes

$$gY = dY/dK(I/Y) \tag{13}$$

Both equation (12) and (13) are derived directly from Harrod's capital-constrained growth model and provide the basis for the disaggregated investment and savings constrained growth models to be presented in section 3.5 and 3.6. Clearly, Harrod is only concerned with the relationship between the change in aggregate capital and output growth. The change in aggregate capital is directly linked to change in either gross investment or saving *via* a single incremental output-capital ratio. Section 3.3 below would provide the assumptions needed to construct the disaggregated capital constrained growth model based on Harrod's specification.

3.3 Assumptions of the Models

1. The aggregate production function of the Singapore economy conforms to the Harrod's specification. The income growth depends on capital formation *via* the incremental output-capital ratio.

2. Different types of capital contribute to growth differently *via* the differentiated incremental output-capital ratios. Capital stock is disaggregated and its respective accumulation is due to changes in disaggregated sectoral investments by types and savings by sources. Although only disaggregated investments cause actual changes in capital stocks, the use of disaggregated savings is justified on the ground that the investment measure may be imperfect and savings measure could provide additional insight to the growth process.

3. The actual growth rate equals the warranted growth rate and the Singapore government has successfully implemented a population policy to ensure that the natural growth always exceed the warranted rate. As a result, steady-state equilibrium growth is always achieved and the income growth is due to capital accumulation given a constant incremental output-capital ratio.

4. Disaggregated sectoral savings and investment are related to output growth in a linearly fashion.

5. The growth in the supply of labor is postulated to be a seperate constraint on income growth. Prior empirical findings (Lee, 1986, Krause, 1987) indicate that the economy is mainly capital driven, and that the inclusion of labor will enable the model to test the hypothesis that labor has not served as a constraint on growth.

6. Investment opportunities are plentiful and economic growth is not hindered by shortage of investment opportunities. This will ensure that output growth is constrained by availability of capital and labor and not by invest-

ment opportunities. Further, there exists no idle or excess productive capacity. If idle capacity does exist, output growth may be a result of increasing capacity utilization rather than solely due to accumulation of investment or increase in the supply of labor service. Where in many LDCs excess capacity does exist (Winston, 1974), Singapore's near full employment environment supports the assertion of no idle capacity.

7. Both the private and the public sector act as savers, investors, producers and consumers in a neo-classical mixed economy where allocation of resources is primarily determined by market forces. The private sector's dynamic economic activities are distorted by government in only two major ways: first, the operation of a compulsory forced saving scheme, the *Central Provident Fund (CPF)*, which interferes with individual's inter-temporal decision to consume, save and invest. Second, the subsidization of public housing directs resources controlled by government to investment in public housing as opposed to other forms of public investment or consumption. In addition, it channels the involuntary *CPF* savings to public-housing *via* the home-ownership schemes implemented by the *CPF* board. Thus, under the 30-year old regime, substantial amount of private and the public savings have been directed into investment in residential construction.

3.4 The Models

The disaggregation of sectoral investment by types and savings by sources are based on the following economic concepts and identities:

Gross domestic investment, or, gross domestic capital formation, I, consists of gross private sector investment, I_{pr}, and gross public sector investment, I_{pu}.

$$I = I_{pr} + I_{pu} \tag{14}$$

Gross private sector investment, I_{pr}, disaggregated by types of investment, consists of gross private sector productive investment, I_{pr}^{P}, (gross private sector fixed investment, I_{pr}^{F}, plus gross private sector inventory investment, I_{pr}^{V}, but excludes the gross private sector investment in residential construction), and the gross private sector investment in residential construction, I_{pr}^{H}.

$$I_{pr} = I_{pr}^{P} + I_{pr}^{H} \tag{15}$$

Gross public sector investment, I_{pu}, consists of gross public sector productive investment, I_{pu}^{P}, and gross public sector investment in residential construction, I_{pu}^{H}. (Investment on military goods is classified as public sector consumption and is excluded from the figure for public sector investment).

$$I_{pu} = I_{pu}^{P} + I_{pu}^{H} \tag{16}$$

Hence, gross domestic investment can be disaggregated into sector and type specific investment:

$$I = I_{pr}^{P} + I_{pr}^{H} + I_{pu}^{P} + I_{pu}^{H} \tag{17}$$

Gross domestic saving consists of private sector voluntary savings, S_{pr}, private sector involuntary savings (the compulsory CPF contributions), S_{cpf}, public sector savings, S_{pu}, and foreign savings, S_f. Thus, the gross domestic saving is disaggregated into source-specific sectoral savings.

$$S = S_{pr} + S_{cpf} + S_{pu} + S_f \tag{18}$$

An identity relation exits between saving and investment where $I = S$, or,

$$I_{pr}^{P} + I_{pr}^{H} + I_{pu}^{P} + I_{pu}^{H} = S_{pr} + S_{cpf} + S_{pu} + S_f \tag{19}$$

The mixed and open economy of Singapore's expenditures includes private sector consumption, C_{pr}, private sector investment, I_{pr}, public sector spending, G, and foreign demand, $X - IM$, where X is export of goods and services and IM is import of goods and services.

$$Y = C + I + G + X - IM \tag{20}$$

Public sector spending, G, includes public sector consumption, C_{pu}, gross public sector productive and residential construction investment, I_{pu}^{P} and I_{pu}^{H}, respectively.

$$G = C_{pu} + I_{pu}^{P} + I_{pu}^{H} \tag{21}$$

Equation (21), the expenditure side of the econony, can now be rewritten as

$$Y = C_{pr} + C_{pu} + I_{pr}^{P} + I_{pr}^{H} + I_{pu}^{P} + I_{pu}^{H} + X - IM \tag{22}$$

The income side of the economy consists of private sector consumption, C_{pr}, private sector voluntary savings, S_{pr}, private sector involuntary savings, S_{cpf}, and tax revenue raised by government, T.

$$Y = C_{pr} + S_{pr} + S_{cpf} + T \tag{23}$$

With income equal to expenditure and thus equating (22) and (23), we have

$$I_{pr}^{P} + I_{pr}^{H} + I_{pu}^{P} + I_{pu}^{H} = S_{pr} + S_{cpf} + (T - C_{pu}) + (IM - X) \tag{24}$$

Since net capital inflow equals to current account deficit and the difference between public sector revenue and consumption being public sector savings, equation (24) thus becomes

$$I_{pr}^{P} + I_{pr}^{H} + I_{pu}^{P} + I_{pu}^{H} = S_{pr} + S_{cpf} + S_{pu} + S_{f} \tag{25}$$

Based on equation (12) and (13) which are directly derived from Harrod's capital constrained growth model, two constrained growth models, each having many inputs, are constructed where capital enters as a constraint on growth.

Differences in the capital stock are postulated and the accumulation in the disaggregated capital stocks are directly linked to changes in disaggregated sectoral savings or investment. Although accumulation of capital is due to investment, the method of disaggregating sectoral investments by type may be imperfect and the available investment breakdowns may not fully reflect differences in the marginal contribution of capital to output growth. Thus, disaggregated sectoral savings by source is used as a proxy for the unavailable investment details.

If my basic postulation concerning differences in the marginal contributions of differentiated capital is correct, then the following two fundamental growth equations would hold:

$$gY = \Omega_1 I^P_{pr}/Y + \Omega_2 I^H_{pr}/Y + \Omega_3 I^P_{pu}/Y + \Omega_4 I^H_{pu}/Y \tag{26a}$$

and

$$gY = \Omega_5 S_{pr}/Y + \Omega_6 S_{cpf}/Y + \Omega_7 S_{pu}/Y + \Omega_8 S_f/Y \tag{26b}$$

where Ω_i $(i = 1...8)$ is the differentiated incremental output-capital ratios.

Equation (26a) is the fundamental disaggregated investment constrained growth equation and equation (26b) is the fundamental disaggregated savings constrained growth equation.

3.5 The Disaggregated Investment Constrained Growth Model

3.51 The Disaggregated Investment Constrained Growth Equation

Although prior empirical findings (Tsao, 1986, Krauses, 1987) indicate that the Singapore economy is mainly capital driven, the growth of labor, gL, is postulated to enter as a seperate constraint so to test the hypothesis that it has not served as a constraint on growth in the last three decades.

Further, the growth rate of world income, gY_w, is being included in the growth equation as a key exogeneous variable. Since the Singapore economy is extremely export-oriented and its size is trivial compared to the world economy, in addition to the inputs constraints (*i.e.,* capital and labor), it is quite plausible that its growth rate is affected by the world's income growth rate.

The growth of the labor is $gL = dL/dt * 1/L$ and the growth of income is $gY_w = dY_w/dt * 1/Y_w$. Thus, from equation (26a) the disaggregated investment constrained growth equation becomes:

$$gY = \Omega_1 I^P_{pr}/Y + \Omega_2 I^H_{pr}/Y + \Omega_3 I^P_{pu}/Y + \Omega_4 I^H_{pu}/Y + \alpha gL + \beta gY_w \tag{3.1}$$

where income growth is a function of private sector investment to income ratios, I^P_{pr}/Y and I^H_{pr}/Y, public sector investment to income ratios, I^P_{pu}/Y and I^H_{pu}/Y, the growth in labor supply, gL, and the world income growth rates, gY_w.

In functional form, the disaggregated investment constrained growth equation (3.1) becomes:

$$gY = F(I_{pr}^{P}/Y, I_{pr}^{H}/Y, I_{pu}^{P}/Y, I_{pu}^{H}/Y, gL, gY_w) \tag{3.2}$$

3.52 The Private Sector Productive Investment Function

Based on the accelerator relationship, real income growth rate, gY, appropriately should enter the private productive investment function. A higher output growth would normally stimulate private productive investment (Jorgenson, 1967). On the other hand, simultaneous bias clearly exists between income growth and private investment. Private investment is by itself a component of aggregate demand and higher private investment will also raise the income level. Through multiplier effects, increasing private investment can be linked to income growth. Thus, both accelerator and multiplier effects cause the simultaneous relationship between private productive investments and income growth, holding other non-income determinants of private productive investments unchanged. The simultaneous bias should be corrected by the system of equations which endogenized both income growth and private productive investment.

The private investment in residential construction, I_{pr}^{H}, clearly affects productive investment in the private sector, I_{pr}^{P}, and vice-versa. Since they both compete for resources available for private investment purpose, one can thus conjecture a negative relation between them. A relatively better real return on I_{pr}^{P} would normally induce funds to be shifted from private residential construction sector and vice-versa.

The inclusion of public investment, I_{pu}, merits discussion. Public investment is positively related to income growth since taxes and public spending are

both positive functions of income. Holding other non-income determinants of public investment unchanged, (*i.e.,* tax rate), an increase in income will stimulate tax revenue *via* either a progressive or neutral tax structure, and will bring about an eventual increase in public spending and investment. Thus, it is quite probable that public and private investment can exhibit a positive relation given that they are both jointly determined with income. The simultaneous bias caused by the joint income effect should be corrected by the system of equations which endogenized income growth and private and public investment.

The above probable positive relation between private productive and public investment may not hold if one examines the distribution of resources between sectors. Public savings is more than adequate to finance public investments (Table 1.3 and 1.7) and thus there is no deficit financing that would otherwise crowd out the private investment. In other words, there is no direct capital market relation since there is no public borrowing from the private market. However, both types of investment compete for inputs and if the increased investment of one raises the costs of inputs for the other, lower return as a result of higher inputs costs may decrease investment for the other. In this case, the relationship between private productive investment and public investment should be unambiguously negative.

However, one may also argue that in the long-run the growth of the economy cannot be sustained without the necessary public investment since accumulated investment in social infrastructure complements private investment (Krause, Koh and Lee, 1987, Barro, 1990). Since a good social infrastructure is vital to long-term growth, one might observe a complementary relationship between public and private productive investment in the very long run. How-

ever, there is no *a priori* reason to expect a positive relation from the annual variations of investment data used in the model.

Public investment can also become a determinant of private productive investment if the latter is being simulated as a result of major infrastructure projects being undertaken by the government. Possible cases of major projects in the last 30 years include the Pan-Island Express Ways, the Changi International Airport and the Mass Rapid Transit System. A dummy, DI_{pu}, is constructed to test this hypothesis. When a major infrastructure project is announced by the government in year one, the dummy will assume a value of one in the subsequent two years. Otherwise, the dummy will take on a value of zero. If private productive investments do respond to proposed increases in public investment, private entrepreneurs are assumed to formulate their investment strategy in year one, when the plan is announced, and undertake investment projects in the subsequent two years.

The real-rate of interest in Singapore, r, is being used as the proxy for the opportunity cost of investment. The real rate of interest is determined by the supply and demand of loanable funds in Singapore. An increase in r can come from increased demand for funds and so be associated with increased investment, or from a reduction in the supply of funds, and so be associated with a decline in investment. One view is that a higher real rate of interest would normally discourage domestic private investment, causing them to seek foreign sources of funds. Thus, again, the question remains whether foreign investment could replace domestic investment that is crowded out by higher interest rates? In a fully integerated world financial market, however, it is unlikely that Singapore can enjoy persistent higher expected real returns on its

domestic investment, thus, when the real rate of interest is higher worldwide, crowding out can occur both domestically and internationally. But, when the integeration is imperfect, then foregin funds can substitute the local investments that are being crowded out by higher domestic real rates of interest.

The growth rate of the foreign reserves, $gRes$, is selected as one plausible explanatory variable since embodied in it are the policy tools used by government to mobilize domestic resources in Singapore. The real foreign reserves, Res, is derived from:

$$Res = S_{pu} + S_{cpf} - dp - I_{pu}$$

where dp = public sector deposits in the domestic banking system.

Assuming that the government prefers to invest its surplus overseas rather than to expand the domestic money supply, the higher the $gRes$, the larger is the inflow of foreign savings needed to fill the private resource gap. An increase in $gRes$ will dampen monetary expansion in Singapore to the extent that the outflow of capital is not offset by a return inflow. If this occurs, one can expect a negative coefficient between $gRes$ and private productive investment. On the other hand, if the supply of foreign savings is as elastic as the supply from the domestic banks, then $gRes$ should be independent of private productive investment.

Given the above analysis, one could write the private productive investment function as

$$I_{pr}^{P}/Y = H(gY, I_{pr}^{H}/Y, I_{pu}/Y, DI_{pu}, r, gRes) \tag{3.3}$$

3.53 The Private Sector Investment in Residential Construction

The growth rate of real income, gY, is postulated to be a determinant of the private investment in residential construction. One would normally expect higher income growth to stimulate demand for private-housing and in turn raises the private investment in residential construction.[2]

As mentioned earlier, although there is no direct market relation between public and private investment since the public sector does not borrow from the private sector, a probable supply-side relationship does exist. If an increase in public investment raises the costs of inputs, private investment may be discouraged, resulting in a negative relation between private investment in housing and public investment. Thus, I_{pu} is selected to enter as an explanatory variable of the private housing investment function.

On the other hand, a proposed major infrastructure project to be carried out by the government may stimulate speculative private sector building. Hence, the dummy for a public infrastructure project used in the private productive investment function, DI_{pu}, is again selected to test the hypothesis that the announcement of a major infrastructure project by the government will encourage lagged speculative private construction.

The change in the number of households, $dHhold$, is selected to be another plausible explanatory variable of the investment function. A bigger positive change in the number of households will normally stimulate the demand for all types of housing, including the demand for private residential properties. If the

[2] Clearly, such a positive relation exists if the supply of private housing is driven by the demand for private housing.

investment in private housing is driven by demand, then private investment in residential construction can be stimulated.

The mortgage rate, on *a priori* grounds, is a better determinant of the private housing investment function. However, since the mortgage rates are not available for the entire three decades, the real rates of interest are used as proxies. One would normally expect an inverse relationship between the real rate of interest and the demand for private housing.

Again, the growth rate of the real foreign reserve, $gRes$, is chosen to determine the impact of government's resource mobilization policy on private investment. If investing abroad by the government contracts the domestic money supply, and in the short run the decreased in money supply is not fully met by capital inflow, then one may observe a negative relation between $gRes$ and private housing investment. On the other hand, if the supply of funds from abroad is as elastic as the local banking system, then the grow in $gRes$ would not deter the formation of private housing stock.

Given the above, the private investment function in residential construction can be written as

$$I_{pr}^{H}/Y = H(gY, I_{pu}/Y, DI_{pu}, dHhold, r, gRes) \tag{3.4}$$

3.54 The Public Sector Productive Investment Function

The decision by government to undertake public investments is complex and is clearly unexplainable by private investment behavior alone. Policy variables, in addition to economic variables, need to be investigated.

The idea of including the growth rate of real income, gY, continues to be entertained. On theoretical grounds, one would expect a positive relation between taxes and public investment since public spending is usually a positive function of tax revenue. Given that the tax structure in Singapore is either progressive or at least neutral, if taxes are also positively related to income, then gY can exhibit a complementary relation to public productive investment. The inclusion of taxes as an explanatory variable of public investment is inappropriate since taxes, public spending and investment are all jointly determined by income. Unless taxes are also endogenized, the simultaneous bias among taxes, public investment and income cannot be corrected. On the other hand, gY alone should capture the simultaneous effects since the system of simultaneous equations has already endogenized both income growth and public investment, and any simultaneous bias between them should be corrected.

The above simultaneous relations clearly exist, given the progressive tax structure in Singapore. A change in one of the non-income determinants of public investment, *i.e.,* an increase in the corporate tax rate, holding income unchanged, will increase public investment *via* higher public revenue and in turn crowded out private investment. If the positive functional relationship between private investment and income holds, lower income will occur with a time lag and eventually lower tax revenue. If the decreasing income is strong enough to bring about an eventual reduction in public investment, then a positive relation between private and public investment will still occur. Again, gY seems to be capturing the impact of a tax change, and given that gY, private and public investment are endogenized in the system of equations, simultaneous bias among them should be corrected.

The probable complementary relationship between growth and public productive investment can be further reinforced by the fact that in the long run, the growth of an economy cannot be sustained without sufficient accumulated investment in social infrastructure (Krause, Koh and Lee, 1987; Barro, 1990). However, this positive relation will only exist in the very long run and may not show up in a model that employs only annual variations in growth and investment.

However, the ability of government to use its spending, in which productive investment is an important component, to pursue counter-cyclical activities cannot be ignored. If such aggregate demand policy is being frequently pursued during periods of slow growth or recessions, there will surface a negative relation between growth and public productive investment.

The relationship between private and public investment cannot be ignored. If both private investment and taxes are positively related to income, then given a positive functional relation between tax revenue and public investment, and holding all non-income determinants of private investment unchanged, private investment will be positively related to public investment. Again, even though both income growth and private investment are postulated to be independent determinants of public productive investment, simultaneous relations exist among them. However, the employment of a system of equations which endogenized growth and private and public investment should correct for these simultaneous biases.

The above probable complementary relationship between private and public investment exists *via* income effects. But a possible supply relation is also present. An increase in private investment, *ceteris paribus*, can raise the cost of

inputs for public investment and affects its incentive to invest. Although public investment may not be fully motivated by profit considerations, a negative correlation between public and private investment *via* supply and input costs considerations is still probable.

Since public investment in residential construction, I_{pu}^{H}, also competes for public savings, one would expect it to be inversely related public productive investment. On the other hand, this argument cannot be fully supported since public saving is more than adequate to finance both types of public investments. However, it is quite clear from chapter one that investing abroad is a policy objective of the government, and if the government desires to consistently invest a certain portion of its saving abroad, then a negative relation between these two types of public investment might occur since they must now compete for public savings net of investment abroad, which is much smaller than the gross public savings.

The plausible short-run negative relation between I_{pu}^{P} and I_{pu}^{H} presented above may not hold in the long run since the task of housing close to 90 percent of its population cannot be accomplished without providing the people living in the public flats with the necessary social infrastructure. But, again, it is doubtful whether the employment of annual growth and investment data would reveal this long-run relation. Thus, I_{pu}^{H} should enter the public productive investment function and *a prior* negative relation is expected.

Knowing that plausible policy variables may not be fully incorporated into the model, one can write the public productive investment function as

$$I_{pu}^{P}/Y = J(gY, I_{pr}/Y, I_{pu}^{H}/Y,) \tag{3.5}$$

3.55 The Public Sector Residential Construction Investment Function

In Singapore, higher income is expected to raise the demand for all types of housing. Public and private housing are substitutes because most people either opt for government flats or private residential properties. An increase in income will generate demand for private housing more than for public housing. If the income effect dominates the substitution effect, gY will be positively related to the demand for public housing. However, if the substitution effect overpowered the income effect, the demand for public housing can decrease given a sufficiently large increase in income. One usually expects the former effect to prevail, and if investment in public housing is driven by demand, the dominating income effect can thus render a positive relation between growth and public housing investment.

However, the government can clearly use its spending to pursue counter-cyclical activities and its investment in residential construction is one possible tool. Again, if such aggregate demand policy is being frequently executed during periods of slow growth or recessions, a negative relation between growth and public housing investment can occur.

Private residential construction, I_{pr}^{H}, should enter as one of the explanatory variable in the investment function. First, based on supply considerations, if investment in private housing drives up the costs of inputs; public investment in housing could be discouraged. Second, if both types of housing investment are demand driven, and both types of housing are substitutes, then, a higher

private investment in residential construction could mean a lower demand for public housing and cause a reduction in public housing investment.

The other component of public investment, public productive investment, I^P_{pu}, can influence the level of public residential construction in two ways. First, they both compete for funds generated by the public sector, thus making them substitutes. Second, as mentioned above in the public productive investment function, public investment in housing cannot be sustained in the long run without the necessary investment in social infrastructure. Since the annual variations in growth and investment data are unlikely to capture the latter long run effect, *a priori* negative relation between public productive and housing investment is expected.

The lagged rate of *CPF* contribution, $R_{(cpf,-1)}$, is clearly a plausible explanatory variable since a higher rate of contribution will enable a faster accumulation of *CPF* savings and raise the affordability of public housing. The lagged contribution rate is preferred over the current rate since accumulation of forced savings for downpayments is necessary and an immediate rise in the contribution rate may not raise the demand for public housing at once.[3]

Last, the change in the number of households, $dHhold$, is selected. It is normally expected that the greater the change in the number of households, the higher the demand for public housing. If public investment in housing is demand driven, then a bigger positive change in the number of households should stimulate public investment in residential construction.

[3] The *HDB* requires a downpayment equals to 10 percent of the purchase price of government flat. The entire downpayment and subsequent mortgage payment can be paid with *CPF* balances.

The public residential construction investment function can thus be written as

$$I_{pu}^{H}/Y = K(gY, I_{pr}^{H}/Y, I_{pu}^{P}/Y, R_{(cpf,-1)}, dHhold) \tag{3.6}$$

3.56 The Growth in the Labor Supply Function

The real income growth rate, gY, is postulated to affect the growth rate of labor supply. Assuming that wage is positively related to income, given the presence of both the income and the substitution effects, when the former dominates the latter, gY will be positively related to growth in the labor supply, gL (Varian, 1978).

An important exogenous demographic variable, the growth rate of the population aged 15-64, $gPop_{15-64}$, is selected as another plausible variable. One can expect growth in the working-age population to be positively related to growth in the labor supply.

Since the marginal income tax rate cannot be easily calculated, the nominal change in the personal income tax rate for the highest taxable income bracket is used as the proxy.[4] This proxy, T_m (excluding the CPF contribution rate), is selected to examine the impact of tax policy on the growth of labor supply. An increase in the tax rate will, *ceteris paribus*, reduce the supply of labor service and vice-versa.

[4] For example, in 1986, taxable personal income exceeding $S40,000 is tax at the top rate of 38 percent. Since tax rates for different levels of taxable income tend to move in the same direction, the change in the top rate may well capture the effect of a marginal income tax change.

Last, the rate of *CPF* contributions, R_{cpf}, is included to examine the impact of forced savings on the supply of labor. Since a higher *CPF* rate implies lower take-home pay for workers, *CPF* contributions can be viewed as a form of taxation on wages and may adversely affect the incentive to work. On the other hand, *CPF* savings are the largest individual tax shelter and an important mechanism used by Singaporeans to convert future consumption into present consumption (*i.e.,* buying *HDB* flats can be viewed as present consumption on housing services), R_{cpf} could have significant impact on the growth in the labor supply.

The growth in the labor supply function can be written as

$$gL = L(gY, gPop_{15-64}, T_m, R_{cpf}) \tag{3.7}$$

Identities Contained in the Disaggregated Investment System

In addition to the endogenous variables gY, I^P_{pr}/Y, I^H_{pr}/Y, I^P_{pu}/Y, I^H_{pu}/Y, and gL that are already been modelled into the system of equations, I_{pr}/Y

and I_{pu}/Y are clearly variables determined within the system. The following identity relations would be added to the model to endogenize both variables.[5]

$$I_{pr}/Y = I_{pr}^{P}/Y + I_{pr}^{H}/Y \tag{3.8}$$

$$I_{pu}/Y = I_{pu}^{P}/Y + I_{pu}^{H}/Y \tag{3.9}$$

[5] The fact that equation (3.8) and (3.9) are identities should not be a cause of concern. The identity differs from the previous behavioral equations only in that all its coefficients are known to be equal to 1 but the endogenising process would enable the system to identified all the correct endogenised variables, including I_{pr}/Y and I_{pu}/Y (Pindyck and Rubinfeld (1981), pp. 321).

3.6 The Disaggregated Savings Constrained Growth Model

3.61 The Disaggregated Savings Constrained Growth Equation

The disaggregated sectoral savings to income ratios and the growth in labor supply, gL, are postulated to enter as constraints on growth. The reason for the inclusion of growth of labor is to test the hypothesis that it has not served as a constraint on growth in the last 30 years.

Further, the growth rate of world income, gY_w, is being used as a key exogenous variable. Since the Singapore economy is extremely export-oriented and the size of its economy is trivial compared to the world economy, in addition to the inputs constraints, it is quite plausible that its growth rate is affected by world's income growth rate.

Thus, from equation (26b), the growth equation becomes

$$gY = \Omega_5 S_{pr}/Y + \Omega_6 S_{cpf}/Y + \Omega_7 S_{pu}/Y + \Omega_8 S_f/Y + \alpha gL + \beta gY_w \tag{3.10}$$

where the real income growth is a function of the disaggregated savings to income ratios (S_{pr}/Y, S_{cpf}/Y, S_{pu}/Y, S_f/Y), the growth in the labor supply, gL, and the growth rate of world income, gY_w.

In functional form, the disaggregated savings constrained growth equation can be written as

$$gY = F(S_{pr}/Y, S_{cpf}/Y, S_{pu}/Y, S_f/Y, gL, gY_w) \tag{3.11}$$

3.62 The Voluntary Private Sector Savings Function

Consistent with the neo-classical school's life-cycle (Modigliani, 1966) and permanent income (Friedman, 1957) hypotheses, higher income, keeping tax rates, interest rates and intertemporal preferences unchanged would stimulate aggregate saving. Since components of domestic savings (S_{pr}, S_{cpf} and S_{pu}) are all functions of income, a rise in income, holding other non-income determinants of voluntary private savings (*i.e.,* tax rate, *CPF* contribution rate, intertemporal preference) unchanged will bring about a rise in voluntary private savings, together with other components of domestic savings. Thus real income growth, gY, is selected as an explanatory variable of the voluntary private savings function.

The relation between voluntary private and *CPF* savings deserves further investigation. Voluntary private savings, S_{pr}, consists of both household and business savings. Its relationship with *CPF* savings has several notable aspects. First, both components of voluntary savings are potentially affected by forced saving since the *CPF* contribution is levied on both households and businesses. Households contribute to the scheme based on their pre-tax gross wage income and their flow of *CPF* contributions plus interest earned is not taxable. The businesses are required to contribute to the scheme separately for each worker based on their individual gross wage bill, which by itself is a component of business costs being used to offset taxable profit.[6]

[6] For example, in 1984 the nominal contribution rate is set at 50 percent, 25 percent for employer and 25 percent for employee. If a firm intends to pay a worker $1,000, the contribution by employer is thus $250. Thus the total wage bill to the employer is $1,250. The worker receives $1,000 as pre-tax and pre-*CPF* income. He is then required to pay to *CPF* 25 percent on $1,000 which is $250. A gross wage of $1,250 would require combined contribution amounting to $500. The effective rate is thus 40 percent.

Second, the interest earned from *CPF* savings has been tax exempted for 30 years, and has rendered the *CPF* saving scheme the largest individual tax shelter. Third, the only practical way for most Singaporeans to convert their future consumption into present consumption is to utilize their *CPF* savings to purchase residential properties, since borrowing on future earnings is difficult in Singapore.

To clearly examine the simultaneous relationship between voluntary private and *CPF* savings, one must distinguish between the income effect, caused by an initital change in income which simultaneously changes both the voluntary private and the *CPF* savings because of their functional relations to income, and the non-income effect, initiated by a change in one of the non-income determinants of *CPF* savings, which in turn brings about a change in the flow of forced savings and affects the voluntary private savings. The latter effect is described below.

If one of the non-income determinants of the *CPF* savings change in such a way so to raise the flow of *CPF* savings, (*i.e.,* an increase in the *CPF* contribution rates levied on both households and businesses) then, *ceteris paribus*, private household income net of *CPF* contributions will certainly be depressed. Further, business savings can be cut if prices are not flexible upward.[7] The reduction in wage income net of *CPF* contribution plus the probable reduction in business savings will certainly guarantee a reduction in voluntary private savings. Further, any crowding out of voluntary private savings by the higher *CPF* savings will have repercussions on public savings since both consumption and

[7] If the *CPF* contribution rate for businesses is raised, gross wage bills will increase and unless firms are able to pass the higher costs to customers in the form of higher prices, their profits and hence business savings will be adversely affected.

income tax revenue are affected. The impact on public savings are described below.

First, life cycle theory indicates that people consume out of their life time income and wealth, and both stocks of *CPF* saving and voluntary private saving are components of wealth to individuals. Thus, if a rise in the *CPF* savings crowd out proportionately less voluntary private savings, then life time wealth may increase and cause higher present private consumption and in turn increase consumption tax revenue. If however the *CPF* savings crowd out proportionately more voluntary private savings, individuals perceived lower wealth may lower present private consumption and result in lower consumption tax revenue. But, because businesses pay income tax based on their profits net of *CPF* contribution, higher contribution will, *ceteris paribus*, lower corporate tax revenue. Similarly, households with lower wage income net of *CPF* contribution will also pay less income tax. As a result, income tax revenue will be unambiguously lowered. If the reduction in income tax revenue is complemented by a lower consumption tax revenue (*i.e.,* the lower life time wealth scenario), total tax revenue will be unambiguously lowered and could bring about a reduction in public savings. Alternatively, if a decrease in income tax revenue is accompanied by a higher consumption tax revenue (*i.e.,* the higher life time wealth scenario), two possible outcome could emerge. On the one hand, if the reduction in income tax revenue overpowers the increase in consumption tax revenue, total tax revenue will still decline and lower public savings. On the other hand, if the reverse occurs, total tax revenue can increase and augment the flow of public savings.

Second, if one assumes that present private consumption is only depends on present private income, then the lower private income caused by higher *CPF* savings will unambiguously lower private consumption. The reduction in income tax revenue will be reinforced by a decline in consumption tax revenue, and the impact on total tax revenue, and hence on public savings is unambiguously negative. Either way, the simultaneous relations among different components of domestic savings are dynamic and strong.

Empirically, using financial savings rather than real savings, Datta and Shome (1981) found inclusive evidence on the crowding out of S_{pr} by the S_{cpf}. On the other hand, single equation estimates of S_{pr} using disposal income and S_{cpf} as explanatory variables found S_{cpf} to possess a significant negative coefficient and a dollar of forced savings crowded out one and a quarter dollar of voluntary private savings (Wong, 1986). Using the rate of *CPF* contribution as the explanatory variable, Wong (1986) also found that the *CPF* contribution rate lowered the share of the voluntary private savings to the total private savings. Both equations, which are subject to simultaneous bias, show that compulsory savings has crowded out voluntary savings in the private sector. Hence, given the theoretical considerations and prior empirical findings above, S_{cpf} is chosen as an explanatory variable in the private voluntary savings function.

The economic relationship between private and public savings deserve investigation. On theoretical grounds, since components of domestic savings are increasing functions of income, holding other non-income determinants of savings (*i.e.,* tax rate, *CPF* contribution rate, inter-temporal preference) constant, both voluntary private and public savings should change together along with in-

come and thus render a complementary relationship between private and public savings. For other relation to exist, one of the non-income determinants for one of these types of savings must change. The earlier discussion focused on the inclusion of forced savings as a probable determinant of voluntary private savings, and thus highlighted the simultaneous relations among the three components of domestic savings. On the simultaneous relation between the voluntary private and the public savings alone, a change in one of the non-income determinants of public savings can affect the voluntary private savings behavior. The relation is presented below.

If the marginal tax rates on wage and corporate income were to be raised, (*i.e.,* a change in one of the non-income determinants of public savings), *ceteris paribus*, the transfer of household and corporate income to the government will increase public savings at the expense of voluntary private savings. This will render an unambiguous negative relation between public and voluntary private savings.[8]

The increase in public savings as a result of a tax change at the margin can also further influence the level of voluntary private savings if additional public savings is being converted, in whole or in parts, into public consumption, and thus varies aggregate income. The change in aggregate income over time will take place *via* both income and money multiplier effects. First, the aggregate income can be raised and indirectly stimulated private income and savings through the multiplier effects if the government directly engages in spending. Similarly, if the increased in public savings is being deposited at domestic finan-

[8] This unambiguous negative relation would hold for at least one time period if the government is assumed to increase its saving by the full amount of the additional tax revenue. If the government varies public consumption instead, the simple negative relation would be distorted.

cial institutions and the money creation is not being sterilized by the central bank, income can still be stimulated and thus augmented the private savings.

However, if the government elects to invest public savings abroad and thus dampen the domestic money supply (provided the supply of foreign savings is not as elastic as the domestic credit), then over time private savings can be reduced as a result of lower aggregate income *via* the negative income and money multiplier effects.

The above simultaneous relations among income, public and private savings clearly can impact the economy beyond the confinement of one time period since it involved income feedbacks *via* income and money multiplier effects. Thus, strong short run simultaneous biases among income growth and components of domestic savings are clearly present. The system of equations should correct for these simultaneous biases if the endogenized variables are correctly specified.

The above simultaneous relationships among income and private and public savings are further complicated by two factors: first, the process of money creation or destruction can bring about changing interest rates, and if voluntary private savings is interest sensitive, lower interest rates caused by monetary expansion can lower voluntary private savings and *vice-versa*. Second, the rise and fall in voluntary private savings affects consumption tax revenue, and if consumption tax revenue is an important component of total tax revenue, public savings can again be affected by changing private savings. For example, higher voluntary private savings, *ceteris paribus*, will lead to lower private consumption and lower consumption tax revenue to the public. The three main sources of non-income tax revenue in Singapore, in order of its size, are one-time tariffs imposed on imported automobiles, annual road-tax (levied on every automobile

owner) and sin taxes (liquor and cigarette). All three taxable items are luxury consumer durables or luxury goods. Hence, lowering private consumption, given the relative demand-inelasticities nature of other normal goods and necessities, would require the consumption of these luxuries to decrease proportionately more than the other goods (Varian, 1978). As a result, the public sector can experience lower consumption tax revenue. Again, the above simultaneous relations clearly involve both initial and subsequent effects.

Empirically, using a system of equations that takes into account the simultaneous relationships among income growth, public and private savings ratios, the initial finding by Singh (1971) and subsequent findings by Vongvipanond (1978) and Fry (1981) show private and public savings to be substitutes. However, very little explanation was offered to explain their negative relations. In the context of the Singapore economy, the public sector has assumed an increasing role in the past 30 years or so and examination of the disaggregated saving data revealed that it has increased savings at a faster rate than it increased its share of the national output. Given the above, it is quite likely that S_{pu}/Y has crowded out S_{pr}/Y since S_{pr}/Y has shrunken as a result of the lower share of the private sector in national output.

Gathering thoughts from both theoretical and empirical considerations discussed above, the inclusion of the public savings to income ratio for the voluntary private savings function is clearly justified, and will enable further exploration of the complex relationships.

On theoretical grounds, the net flow of foreign savings depends on the supply and demand of foreign savings. The former are affected by relative returns in domestic investment *vis-a-vis* investment world wide (*i.e.,* relative returns

for productive real assets) and the ratio of domestic real interest rates versus world real interest rates (*i.e.,* relative returns for financial assets). The demand for foreign savings, however, depends on the resource gap of the private sector, which in turn depends on voluntary private savings and investment, changes in domestic deposits at financial institutions, net public surpluses or deficits, and changes in foreign reserves by the government. Clearly, since voluntary private savings is one of the determinants of the demand for the foreign savings function, there is a probable cause and effect relationship between these two variables.

Most empirical findings indicate that foreign savings are substitute for domestic savings (Landau, 1971; Weisskopf, 1972; Chenery and Syrquin, 1975; Fry, 1977; Vongipanond, 1978; Fry and Mason, 1982). Rahman (1967) and Griffin (1970) argue that a rise in the inflows of foreign savings will lower a country's incentive to save domestically. Since our dependable variable is the voluntary private sector savings rather than the domestic savings, the inclusion of S_f/Y will enable us to further examine this relationship.

The real deposit rate, rd, is chosen as another determinant. The complementarity between money and capital has been established by McKinnon (1972). Other empirical evidence suggest that the real deposit rate is a significant determinant of income growth (Vongvipanond, 1978: 79-81; Fry, 1988). However, in a seperate study, Wong (1986) uses a single equation estimate and found that the real interest rate had a weak but positive effect on voluntary private savings for the period 1974 to 1983. However, rd is clearly only one of the many returns open to private savings and may greatly understate the opportunity costs of consumption and of forced savings.

The impact of demographic changes on saving behavior has been well researched. A pioneering simulation study was carried out by Tobin (1967), whereby household consumption, savings and earnings are postulated to vary by age. A high population growth rate generates age profiles tilted toward younger, thriftier households and raises the overall savings rate. In actual empirical work, Leff (1969) found that both the young and the old dependency ratio affects saving behavior in a large sample of countries. Gupta (1971), on the other hand, found these dependency ratios to be significant determinants of savings only in middle-income and high-income countries but not in low-income countries. Employing the *Variable Rate of Growth Effect* model, the dependency ratio was again found to have a significant adverse impact on savings (Mason, 1981; Fry and Mason, 1982; Fry, 1984). In light of the above findings, both the young and the old dependency ratios, $YDep$ and $ODep$, are included as explanatory variables in the voluntary private sector savings function.

Gathering the above, the private voluntary savings function is written as

$$S_{pr}/Y = H(gY, S_{cpf}/Y, S_{pu}/Y, S_f/Y, rd, YDep, ODep) \tag{3.12}$$

The need to select S_{cpf}/Y, S_{pu}/Y, and S_f/Y as explanatory variables of voluntary private savings function is due to the basic hypothesis that income growth is constrained by disaggregated sectoral savings ratios,[9] and the probable simultaneous relations among savings components and income growth. However, possible cyclical associations among growth and savings components

[9] The hypothesis outlined earlier relates growth to disaggregated capital accumulation. Disaggregated capital accumulation in turn is due to investment of various kinds, and disaggregated sectoral savings ratios are being used as proxies of the unavailable investment details.

cannot be satisfactorily accounted for since both dependent and independent variables are determined by third variables in or out of the equation, and the set of linear simultaneous equations cannot make the necesary adjustment. Without having to model these simultaneous relations among growth and disaggregated savings ratios, a theoretically more satisfactorily way of specifying the voluntary private savings function is to replace the forced savings ratio with the *CPF* contribution rate, public savings ratio with taxes and net foreign savings ratio with gross foreign supply of fund.

3.63 The CPF Savings Function

The *CPF* saving scheme is, in a nutshell, an economic *cum* social/politic policy instrument of the Singapore government. The involuntary savings finances in part or full 90 percent of the existing residential housing stock in Singapore (Table 1.13 and 1.14), contributes toward health expenditure and prepares senior citizens for retirement. *CPF* saving is clearly a function of the real income growth rate. The forced contributions are levied on the workers based on their pre-tax gross wages, and on employers based on their gross wage bills. Given a constant contribution rate, income growth will augment the flow of funds from both business and household components of the private sector to the scheme. Thus, the real income growth rate, gY, appropriately should be a determinant of the forced savings function. Probable simultaneous bias clearly exists between growth and *CPF* savings. By endogenizing both variables, the simultaneous bias *via* income feedbacks is likely to be handled by the system of equations.

The importance of demographic factors should be considered. The forced savings to income ratio, S_{cpf}/Y, clearly is affected by both the young and the old dependency ratios. As both the young and the old dependency ratios decline, more people out of a given population size become part of the labor force, and unless labor force participation rates drastically decline, more working people will be contributing to the forced saving scheme.

Similarly, the contribution rate of *CPF*, R_{cpf}, clearly enters the *CPF* savings function. As R_{cpf} is raised, *ceteris paribus*, the flow of savings to *CPF* scheme increases and vice-versa.

Taking account of the above, the specification of *CPF* savings function is

$$S_{cpf}/Y = J(gY, YDep, ODep, R_{cpf}) \tag{3.13}$$

3.64 The Public Sector Savings Function

The decision undertaken by the public sector to consume and save marks a departure from the traditional Wicksellian inter-temporal framework. Similarly, the lify cycle or the permanent income hypothesis seem inadequate to explain the consumption or saving behavior of governments. First, governments in present day democracies are not perpetual entities and given its relative short life-span, the public savings function specificed under the life cycle or the permanent income are clearly unsuitable. Second, given government's limited time horizon, and in terms of vote winning strategy, present public consumption is preferred to deferred public consumption. In other words, is government a social-welfare maximizer or merely an economic agent maximizing its own

welfare (Arrow, 1951; Arrow and Hahn, 1971, Bucanan and Tullock, 1972)? Third, even if government or a succession of governments ruling the same economy can be viewed as an indefinite entity, are lifetime planning of public sector consumption and saving appropriate given uncertainty in expected lifetime tax revenue? In other words, can the life cycle or the permanent income hypothesis be adopted in formulating the public savings function?

The nature of the politics and the domination of one-party government since 1959 lend some support to the third scenario described above. In one of his political speech, Prime Minister Lee expressed his concern about his successor's ability to resist the voting public's demand to increase public expenditure (*i.e.*, social-welfare spending). And in 1989, a bill was passed in the legislature to enable a elected President to have veto power over the government budget, a device installed to protect the huge saving/foreign reserves accumulated by the 31-year old regime. However, given the complexity of the problem, economic variables rather than non-economic variables would only enter our specifications.

The growth rate of real income, gY, is deemed a suitable explanatory variable because given a progressive tax structure, such as the one prevailing in Singapore, one will expect tax revenue to climb with higher income. The income earned by the statutory boards and state companies, the other components of the public sector, is also likely to increase with income growth. Thus, both tax and non-tax revenue, and hence public savings, is likely to exhibit a positive functional relation to income growth. However, such an unambiguous positive relation between growth and public savings can change if simultaneous relations occur between public and private savings.

Private voluntary savings ratio, S_{pr}/Y, is chosen as one of the determinant. As discussed in the voluntary private savings function, both private and public savings are positive functions of income. Holding other non-income determinants of these savings unchanged, (*i.e.,* tax rates, the *CPF* contribution rate or intertemporal preference), both private and public savings should change together along with income. A change in one of these non-income determinants can alter this simple functional relationships and cause further simultaneous biases among income and these savings ratios. For example, if the marginal income rate is raised for both businesses and households, it will, *ceteris paribus*, raise public savings *via* higher tax revenue at the expense of private income. This will then render a negative relation between public and private savings. Again, simultaneous bias should be corrected by endogenizing both variables.

Further simultaneous relations, as discussed earlier in the voluntary private savings, involved growth, voluntary private and public savings. Again, if private income, and hence voluntary private savings is lowered as a result of a positive income tax change at the margin, aggregate income can be lowered *via* the income multiplier effect to the extent that the increase in the public savings is not being used to generate public consumption or money creation *via* the domestic banking system. Again, these dynamic and simultaneous biases can be corrected by endogenising proper variables in the systems of equations.

The *CPF* saving ratio, S_{cpf}/y, itself a function of income, is also included due to reason above. If the change in *CPF* savings is solely due to income, (*i.e.,* holding the *CPF* contribution rate and other non-income determinants of the forced savings function unchanged), a rise in income will increase forced savings together with public and voluntary private savings. This unambiguous

complementary relation between the *CPF* and public savings generated by the pure income effect can again be altered if one of the non-income determinants of the forced savings function changes.

To illustrate, a rise in the compulsory *CPF* savings solely due to a change in the *CPF* contribution rate, *ceteris paribus*, will lead to lower after *CPF* income for households and higher wage bills for businesses. This will in turn depress both household and business savings, resulting in the crowding out of voluntary private savings by the higher forced contributions. The indirect relation between the *CPF* and public savings will then take shape *via* lower private income caused by crowding out. Holding the marginal tax rate on wages and corporate income unchange, the lower private income will lower the income tax revenue to government and thus lower public savings. Further, a reduction in private savings is likely to lower private consumption, depress the consumption tax-revenue, and further reduce public savings.

The ratio of public investment to public spending, I_{pu}/G, emerges as another plausible variable. The desire to invest is a very strong motive for the public sector to save. Considering the fact that the government of Singapore, during most of the period from 1960 to 1989, generated sizeable savings and the size of her public-debt was trivial, then investment must be funded either by the current flow of savings or by selling assets accumulated by the government. No evidence suggests the selling of either foreign or domestic assets owned by the government, thus rendering the desire to invest a strong motive to save. The same variable is used and found to be a significant explanatory variable of the government savings function (Vongvipanond, 1978). I_{pu}/G can thus be viewed as a crude proxy for the government's effort directed at economic development.

The massive social infrastructure build-up in Singapore in the past quarter of a century provides further support for its inclusion.

Gathering thoughts from the above, the public sector savings function takes the form

$$S_{pu}/Y = L(gY, S_{pr}/Y, S_{cpf}/Y, S_f/Y, I_{pu}/G) \tag{3.14}$$

Similar to the voluntary private savings function, the above public savings function employed the other three savings ratio, S_{pr}/Y, S_{cpf}/Y and S_f/Y as explanatory variables due to the capital constrained growth hypothesis. The employment of a system of simultaneous equations to correct for probable simultaneous biases among growth and disaggregated saving ratios means that possible cyclical assocations among growth and savings components cannot be satisfactory investigated since both the dependent and independent variables are determined by third variables in or out of the equation. The set of linear simultaneous equations is unlikely to make the needed adjustment. A theoretically more satisfactorily way of specifying the public savings function would be to replace the forced saving ratio with the *CPF* contribution rate and the net foreign savings ratio with the supply of foreign funds.

3.65 The Growth In Labor Supply Function

Similar to the growth in the labor supply function under the system of equations for the disaggregated investment constrained growth model, real income growth, gy, the growth rate of the population aged 15-64, $gPop_{15-64}$, the

proxy for marginal income tax, T_m, and the rate of CPF contributions, R_{cpf} are selected as explanatory variables.

The growth in labor supply function is written as:

$$gL = N(gY, gPop_{15-64}, T_m, R_{cpf}) \tag{3.15}$$

Identities Contained in the Disaggregated Savings System

The foreign savings to income ratio is simply the residual between gross investment to income ratio, I/Y, and gross domestic savings ratios. The foreign savings identity is

$$S_f/Y = I/Y - (S_{pr}/Y + S_{cpf}/Y + S_{pu}/Y) \tag{3.16}$$

The gross investment to income ratio, I/Y, on the other hand, is the summation of the disaggregated savings ratios.[10] The gross investment identity is

$$I/Y = S_{pr}/Y + S_{cpf}/Y + S_{pu}/Y + S_f/Y \tag{3.17}$$

[10] When gross investment exceeds gross domestic savings, the foreign saving inflow is positive and represents the difference between the two.

3.7 Justifications for Variables Exogenous to the Investment System

System of Equations for Disaggregated Investment Model

The disaggregated investment constrained growth model consists of the following system of equations:

$$gY = F(I^P_{pr}/Y, I^H_{pr}/Y, I^P_{pu}/Y, I^H_{pu}/Y, gL, gY_w) \tag{3.2}$$

$$I^P_{pr}/Y = H(gY, I^H_{pr}/Y, I_{pu}/Y, DI_{pu}, r, gRes) \tag{3.3}$$

$$I^H_{pr}/Y = H(gY, I_{pu}/Y, DI_{pu}, dHhold, r, gRes) \tag{3.4}$$

$$I^P_{pu}/Y = J(gY, I_{pr}/Y, I^H_{pu}/Y,) \tag{3.5}$$

$$I^H_{pu}/Y = K(gY, I^H_{pr}/Y, I^P_{pu}/Y, R_{(cpf,-1)}, dHhold) \tag{3.6}$$

$$gL = L(gY, gPop_{15-64}, T_m, R_{cpf}) \tag{3.7}$$

and identities:

$$I_{pr}/Y = I^P_{pr}/Y + I^H_{pr}/Y \tag{3.8}$$

$$I_{pu}/Y = I^P_{pu}/Y + I^H_{pu}/Y \tag{3.9}$$

The endogenous variables contain within the system are: gY, I_{pr}^{P}/Y, I_{pr}^{H}/Y, I_{pu}^{P}/Y, I_{pu}^{H}/Y, gL, I_{pu}/Y and I_{pr}/Y.

The exogenous variables are: gY_w, DI_{pu}, r, $gRes$, $dHhold$, $R_{(cpf,-1)}$, R_{cpf}, $gPop_{15-64}$ and T_m.

Thus, all the equations in the systems are over-identified.

The World Income Growth Rate

Since the size of the Singapore economy is very small relative to the world economy, the world income growth rate is thus exogenous to the growth equation and the system of equations.

Dummy for Major Public Infrastructure Project

Although public investment is an endogenous variable, the announcement of plans to undertake major public infrastructure projects can be treated as exogenous since these are policy decisions.

Real Rate of Interest

Assuming that Singapore is well integrated with the world financial market and enjoys perfect capital mobility with the rest of the world, r could be treated as exogenous.

The Growth of Foreign Reserves

Although the net government surplus is jointly determined by S_{pu}, S_{cpf} and I_{pu} which are all clearly endogenized, the decision to deposit the net surplus in the domestic banking system or to invest abroad is clearly exogenous to the

system. Hence, the growth of foreign reserves, $gRes$, a policy tool of government's resource mobilization strategy, is treated as exogenous to the system.

The Change in the Number of Households

Harrod's capital constrained growth model explicitly assumed that growth in population is exogenous to the system, and our models further modified it to be a policy variable, in which the government manipulates population policy to ensure that population growth stays above the warranted growth rate. Given this, it is quite reasonable to assume that the change in the number of households to be an appropriate exogenous variable.

The CPF Contribution Rate

Although complex economic reasons may be involved in formulating government's decision to alter the rate, it is largely a policy tool used by the government to affect resource distribution and mobilization.

The Lagged CPF Contribution Rate

Similar to the above, the rate could be treated as an exogenous variable.

The Growth in Population aged 15-64

Again, the theoretical model explicitly assumed that the growth in population to be exogenous, and it was further modified to be a policy variable.

Income Tax Rate

Changes in the tax rate clearly affects saving decisions and growth. However, the decision to alter nominal tax rates at the margin rests with the policy maker. It is thus justifiable to treat it as exogenous but we do recognize that the ultimate outcome of the tax change is determined within the system.

3.8 Justifications for Variables Exogenous to the Saving System

System of Equations for Disaggregated Savings Model

The disaggregated savings constrained growth model consists of the following system of equations:

$$gY = F(S_{pr}/Y, S_{cpf}/Y, S_{pu}/Y, S_f/Y, gL, gY_w) \tag{3.11}$$

$$S_{pr}/Y = H(gY, S_{cpf}/Y, S_{pu}/Y, S_f/Y, rd, YDep, ODep) \tag{3.12}$$

$$S_{cpf}/Y = J(gY, YDep, ODep, R_{cpf}) \tag{3.13}$$

$$S_{pu}/Y = L(gY, S_{pr}/Y, S_{cpf}/Y, S_f/Y, I_{pu}/G) \tag{3.14}$$

$$gL = N(gY, gPop_{15-64}, T_m, R_{cpf}) \tag{3.15}$$

and identities

$$S_f/Y = I/Y - (S_{pr}/Y + S_{cpf}/Y + S_{pu}/Y) \tag{3.16}$$

$$I/Y = S_{pr}/Y + S_{cpf}/Y + S_{pu}/Y + S_f/Y \tag{3.17}$$

The endogenous variables contained in the system are: gY, S_{pr}/Y, S_{pu}/Y, S_{cpf}/Y, gL, S_f/Y and I/Y.

The exogenous variables are: gY_w, rd, $YDep$, $ODep$, R_{cpf}, I_{pu}/G, T_m, and $gPop_{15-64}$.

Thus, all the equations in the system are over-identified.

The World Income Growth Rate

Since the size of the Singapore economy is trivial compare to the world economy, the world income growth rate is thus exogenous to the growth equation and the system of equation.

The Real Deposit Rate

Real deposit rate, rd, is indirectly determined by the demand and supply of bank deposits which in turn is a function of the real interest rate. If Singapore is assumed to enjoy perfect capital mobility with the rest of the world, then the real rate of interest, and hence the real deposit rate, is exogenously given.

The Young and Old Dependency Ratios

Both demographic variables, $YDep$ and $ODep$, are frequently treated as exogenous variables. Since population growth in the models is exogenously determined, it is quite appropriate to treat these two dependency ratios as exogenous to the system of equations.

The CPF Contribution Rate

As justified earlier, although it has economic consequences, the decision to alter the rate is undertaken by policy makers.

The Ratio of Public-Investment to Government Spending

The ratio, I_{pu}/G, is used as a proxy for the government's crude efforts directed at economic development. Although public investment is endogenized and government spending may not be completely exogenous to the sytem, the decision to alter the ratio again rests with the policy maker and is thus considered exogenous.

The Income Tax Rate

As mentioned earlier, a marginal change in tax rates affects decisions to save and income. However, the ability to alter tax rate at the margin rest with the policy maker. Again, it is recognized that the outcome of the tax change has serious economic consequences and may not be independent of the endogenous variable it is supposed to determined.

The Growth in the Population aged 15-64

As spelled out earlier, growth in the population is assumed to be exogenous to both the theoretical and empirical models.

CHAPTER 4

DATA

4.1 Sources, Concepts and Measurement of Data

Good econometric results cannot be obtained unless the data is accurate. Unlike many other less developed countries, the government agencies of Singapore collect and maintain accurate economic data. Though the possibility of measurement error is still present, the nature of the error is not known to me.

Five main sources of data are utilized: first, the *Year Book of Statistics* published annually by the Department of Statistics of Singapore, from 1967 to 1989. Second, the *Economic Survey of Singapore*, published first by the Ministry of Finance, from 1974 to 1979, and then by the Ministry of Trade and Industry, from 1981 to 1989. Third, the *World Tables*, published by the World Bank which include data on Singapore, from 1967 to 1988. Fourth, the *International Financial Statistics Year Book*, and fifth, the *Balance of Payment Statistics Year Book*, both published by International Monetary Fund containing data from 1960 to 1989. In addition, annual reports of various statutory boards were consulted.

The following discussion will focus on both conceptual and empirical definitions as used in the estimation.

4.2 Saving Data

As defined by Goldsmith (1955; 23-25), each disaggreated sectoral saving would meet the following definition:

saving = increase in assets minus increase in liabilities

or,

saving = increase in tangible and intangible assets minus increase in liabilities

or,

saving = increase in net worth

Since each sector's saving does not equal its own capital formation, the resulting difference between saving and investment is thus the net change in financial assets. However, when we aggregate sectoral saving the change in financial claims should cancel out for the domestic sector, leaving only the change in net worth, which is a summation of the change in domestic reproductable wealth and the change in net foreign balances. The above also implies that aggregate investment equals aggregate saving (Vongvipanond, 1978; 59-61).

Careful examination revealed that the *Year Book of Statistics*, the *Economic Survey of Singapore* and the *World Tables* all utilized and adhered to the above concept of saving and thus they become the primary sources of our sectoral saving data used in this paper.

4.21 GNS and GDS

The GNS and the GDS are directly obtained from the *Year book of Statistics*. The 1967 issue recorded both the GNS and the GDS for the period 1960 to 1967. Annual issues from 1968 to 1989 recorded both the GNS and the GDS from 1968 to 1989. It was not unusual that the later issue revised statistics published in the preceeding years, and when this occurred, the revised GNS and GDS figure were used.

4.22 Public Savings

The public sector savings is defined by the World Bank as the current surplus (*i.e.,* total revenue minus current expenditures) of the public sector. In the case of Singapore, both the government and the statutory boards' current surpluses were added up to produce the public sector savings. The *Year Book of Statistics* record detailed government's revenue and expenditure data from 1960-1973, and statutory boards' revenue and expenditure from 1962 to 1970. For the period 1973 to 1989, the detailed publication of these data was undertaken by the Ministry of Finance and the Ministry of Trade and Industry and were recorded in the *Economic Survey of Singapore.*

Thus, what emerged from the above is the absence of detailed data on savings for the statutory boards from 1960 to 1961 and from 1971 to 1973. The annual reports of these statutory boards which contained financial data for these years were analysed and the statutory boards' current surplus figures derived.

4.23 CPF Savings

Detailed annual contributions to the *CPF Board* for the period 1960 to 1989 are recorded in the *Year Book of Statistics.*

4.24 Voluntary Private Savings

Two series of voluntary private sector savings data are collected. One is obtained by subtracting public sector savings from the GNS, and the other one is derived by subtracting public sector savings from the GDS.

4.25 Foreign Savings

Since the above three types of sectoral savings plus the foreign savings would add up to produce either the GNS or the GDS (it depends on which voluntary private sector savings definition is used), foreign savings is thus derived by subtracting the GNS or the GDS from the summation of the public sector, the *CPF* and voluntary private sector savings.

4.3 Investment Data

Investment, or capital accumulation, is defined by the World Bank as total spending on reproducible capital goods which typically include spending on producers' durables, inventories and construction. The spending approach as adopted by the World Bank is deemed more favorable to the supply-side approach (which typically derived investment data from trade statistics rather from the expenditure side) especially in a developed economy where spending is more accurately recorded. Careful examination revealed that the *Year Book of Statistics* and the *Economic Survey of Singapore* basically adopted such a spending approach but their detailed methods on the derivation of investment figures remained somewhat unclear.

4.31 Gross Domestic Capital Formation

Gross Domestic Capital Formation (GDCF) data for the period 1960 to 1989 are gathered from various issues of the *Year Book of Statistics*. Earlier published GDCF figures are frequently revised by the later issues. Since the revised versions contained more up-to-date information on expenditure, the revised figures are used.

4.32 Gross Public Productive and Residential Construction Investment

The detailed gross public investment in residential construction from 1960 to 1972 are recorded in the *HDB Annual Report*, and from 1973 to 1989, they are recorded in the *Economic Survey of Singapore*. The *HDB* figures for the period 1960 to 1972 are compared with the *Year Book of Statistics* which published only the gross investment in residential construction from 1960 to 1972. Differences between these two sources are reconciled.

Gross public productive investment is obtained by subtracting the gross public investment in residential construction derived above from the gross public capital accumulation that is recorded in the *Year Book of Statistics* from 1960 to 1973 and in the *Economic Survey of Singapore* from 1974 to 1989. Again, frequent revision of these investment figures are observed and the latest revised figures are used. The summation of the grosss public productive and residential construction investment produces the gross public investment.

4.33 Gross Private Productive and Residential Construction Investment

Since the gross investment in residential construction is recorded in the *Year Book of Statistics* from 1960 to 1972, gross private investment in residential construction is obtained by subtracting gross public investment in residential construction derived above from total investment in residential construction. For the period 1973 to 1989, the *Economic Survey of Singapore* reported gross private investment in residential construction and they are being used directly.

Gross private productive investment is obtained by subtracting the figures obtained above from the gross private investment reported by the *Year Book*

of Statistics from 1960 to 1973 and by the *Economic Survey of Singapore* from 1974 to 1989.

Similarly, the summation of gross private productive and residential construction investment produces gross private investment.

4.4 Income and Output Data

Since income growth is the primary endogenous variable in our system of equations, measurement of income from 1960 to 1989 becomes vital.

4.41 GNP and GDP

Both the GNP and the GDP figures are accurately reported in the *World Tables* from 1960 to 1987 and in the *Year Book of Statistics* from 1967 to 1989. Since both publishers utilize the same expenditures approach to derive these income data, the minor differences in their data from 1967 to 1987 are noted. A careful examination revealed that the differences are within 0.8 percent of the figures they reported. Since detailed private and public consumption figures are also reported by the *Year Book of Statistics*, they are thus used to derived revised GNP and GDP figures based on the World Bank data from 1960 to 1966. From 1967 onward, the GNP and the GDP are taken from the *Year Book of Statisitcs* directly.

4.42 World GNP

World income is obtained from the *World Tables*. Each country's real GNP series is used to derive the total for the world.

4.5 Price and Financial Data

Accurate figures on nominal average prime lending rates; nominal average 3-month, 6-month and 12-month bank deposit rates; nominal saving rates and Post-Office saving rates are recorded in the *Year Book of Statistics* from 1968 to 1989. These are supplemented by the *Economic Survey of Singapore* and the *World Tables* which recorded data from 1960 to 1967. The Consumer Price Index (CPI) and the Producer Price Index (PPI) are taken from the *Year Book of Statistics* for the period 1960 to 1989.

4.51 Real Rate of Interest

The benchmark real rates of interest are obtained by subtracting the CPI from the nominal prime lending rates and thus represent the real rate of interest faced by firms in Singapore with the best credit-rating.

4.52 Real Deposit Rate

The real deposit rates are derived by subtracting the CPI from the nominal average yield of 12-Month deposit rates.

4.53 The Nominal Level of Income Tax Rate

Only the nominal corporate tax rate (a flat rate) and the nominal levels of personal income tax rate are available from the Inland Revenue department of Singapore. Since it is hard to produce an overall marginal income tax rate, the nominal personal income tax rate for the top taxable income bracket is used to serve as the proxy for marginal income tax rate.

4.6 Other Data

4.61 Export

Export figures from 1960 to 1989 are collected from the *Year Book of Statistics*. Two sets of export figures are available: total exports, which include re-exports, and domestic exports.

4.62 Tax Revenue

Tax revenue is defined as taxes from income, production and expenditures. The first cateogory includes both the personal income tax and the corporate income tax. The second cateogory includes excise tax, value-added duties on goods and services, motor-vehicle registration tax, stamp duties, estate duties, etc. Tax revenue from 1960-89 are collected from the *Year Book of Statistics* from 1960 to 1989.

4.63 CPF Contribution Rate

The rates from 1960 to 1984 are directly obtained from the *Report of the Central Provident Fund Study Group* published by the *Singapore Economic Review*. Rates from 1985 to 1989 are taken from the *CPF Annual Report*, 1985 to 1989.

4.64 Population

Population data are recorded in the *Year Book of Statistics* from 1960 to 1989. Data from 1960 to 1969 are estimates based on demographic data collected from 1957 census. Likewise, data of 1971 to 1979, and data of 1981 to 1989 are estimates based on population census on 1970 and 1980. Whenever a

census is taken (*i.e.*, 1970 and 1980), the actual census figures are used. Since detailed population figures by age-group are also available, both the annual growth rate of population aged 15-64 and the annual change in population are derived.

4.65 *Dependency Ratios*

The young dependency ratio, $YDep$, and the old dependency ratio, $ODep$, are used in the systems of equations. The *Year Book of Statistics* reports population figures by age and sex group. The young dependency ratio is defined as the ratio of the population age 0 to 14 divided by the population age 15 to 64. The old dependency ratio is defined as the population age 60 and above divided by population aged 15 to 64.

4.66 *Supply of Labor*

The *Year Book of Statistics* routinely reports the labor force and unemployment figures. The supply of labor figures used in the models are actual number of people employed. The actual man hours are not used because during the period 1960-69 and from the period 1987 onward actual work hours are not reported. Also, after consulted the annually reported average work hours, very little change in working hours is observed.

4.67 *Foreign Reserves*

The amount of foreign reserves accumulated by Singapore is published both in the *Year Book of Statistics* and in the *World Tables*. Small discrepancies between them are observed probably due to fluctuations in the foreign exchange rates since the former reports reserves in Singapore dollars and the latter publishes reserves in American dollars.

CHAPTER 5

ECONOMETRIC METHOD AND THE EMPIRICAL EVIDENCE

5.1 The Econometric Method

As mentioned in chapter one, the correction of simultaneous biaseS between income growth and disaggregated investments or savings to income ratios require the employment of A *system of simultaneous equations.* In a system of simultaneous equations all the endogenous variables are random variables – a change in any disturbance term changes all the endogenous variables since they are determined simultaneously.

Two methods, the *Two-Stage Least Squares (2SLS)* and the *Three-Stage Least Squares (3SLS)*, ought to be given consideration because in both methods, the instrumental variable technique is used. The method of instrumental variables involves the search for a new variable that is both highly correlated with the independent variable and at the same time uncorrelated with the error term in the equation (as well as the errors of measurement of both variables). By applying the technique, an appropriate instrumental variable can be found for each endogenous variable that appears as a regressor in a simultaneous equation. Since exogenous variables in the system of simultaneous equations are assumed to be correlated with the endogenous variables (through the interaction of the simultaneous system) and are uncorrelated with the disturbances, they are the natural candidates.

5.11 The Two-Stage Least Squares (2SLS)

The *2SLS* is a special case of the instrumental variable technique in which the "best" instrumental variables are used. Most exogenous variables employed in the equations are good candidates for instrumental variables. The *2SLS* employs the following procedures:

Stage 1

Regress each endogenous variable acting as a regressor in the equation being estimated on all the exogenous variables in the system of simultaneous equations (*i.e.*, estimate the reduced form), and calculate the estimated values of these endogenous variables;

Stage 2

Employ these estimated values as instrumental variables for these endogenous variables or simply use these estimated values and the included exogenous variables as regressors in an *OLS* regression. Both versions would yield identical results.

Since the *2SLS* estimator is a legitimate instrumental variable estimator, it is consistent and is usually insensitive to the presence of other estimating problems such as multicollinearity and specification errors.

5.12 The Three-Stage Least Squares 3SLS

Unlike the *2SLS* which estimates the structural parameters of each equation separately, the *3SLS* utilizes all available information within the system when estimating the structural parameters. The *3SLS* procedure can be summarised as follows:

Stage 1

Calculate the *2SLS* estimates of the identified equations.

Stage 2

Employ the *2SLS* estimates to estimate the structural equation's errors and then use these to estimate the contemporaneous variance–covariance matrix of the structural equation's errors.

Stage 3

Apply *GLS* (*i.e., Generalized Least Squares*) to the large equation representing all the identified equations of the system.

The *3SLS* estimator is shown to be consistent and in general is asymptotically more efficient than the *2SLS* estimator. It is preferred over the *2SLS* because it correct the inconsistency when disturbances in the different structural equations are correlated.[1] Further, the use of a small data set (the data used in the model consists of 30 annual observations per variable) involves only a small computational cost. After taking the above into considerations, the *3SLS* method was chosen. (Theil, 1971; Pindyck and Rubinfeld, 1976; Kennedy, 1979; Judge and Hill, 1985, 1988).

[1] The *2SLS* assumes that disturbances in the different structural equations are uncorrelated, and that it is appropriate to apply the *OLS* estimation directly.

The Empirical Evidence

Descriptive statistics of data used in both investment and saving system are presented in appendix A and B at the end of the chapter.

5.2 The Disaggregated Investment Constrained Growth Behavior

The disaggregated investment constrained growth equation is presented below

Eq 5.1 Dependent Variable = gY.

Independent Variable	Estimated Coefficient	Standard Error	t-value
I^P_{pr}/Y	0.24559	0.02652	9.2606
I^H_{pr}/Y	0.26115	0.02981	8.7605
I^P_{pu}/Y	0.53928	0.09207	5.5573
I^H_{pu}/Y	-0.80182	0.12233	-6.5546
gL	0.14520	0.97660	0.1486
gY_w	0.55608E-01	0.10605	0.52436
Constant	0.31295E-01	0.11466E-01	2.7293

$R^2 = 0.6797 \qquad DW = 1.8692$

The overall fit of the equation is reasonably good as indicated by the R^2. The Durbin-Watson (DW) test produces a test value of 1.8692 which is above the critical value of 1.83 (for 30 observations and six explanatory variables, excluding the constant term) at the 95 percent confidence level. Thus, one can conclude that serious serial correlation does not exist.[2]

[2] Serial correlation occurs when errors corresponding to different observations are correlated. Frequently in time series, error terms from different time periods are correlated. The Durbin-Watson test involves the calculation of a test statistic based on the residuals from the ordinary least-squares regression part of the $3SLS$ procedure.

The positive and significant coefficients of I_{pr}^{P}/Y, I_{pr}^{H}/Y and I_{pu}^{P}/Y, and the negative and significant coefficient of I_{pu}^{H}/Y indicate that the marginal contributions of different types of investment may be different. Since the negative and significant coefficient of public housing investment is opposite to the coefficients of the other three investment components, it is reasonable to conclude that the marginal contribution of I_{pu}^{H}/Y is significantly different from the other three types of sectoral investment.

For a system of simultaneous equations, the F test is inappropriate and thus the t test is employed to ascertain whether the coefficients of the explanatory variables are the same or not.

The test statistic can be written as

$$t = \frac{\hat{\beta}_1 - \hat{\beta}_2}{S_{\hat{\beta}_1 - \hat{\beta}_2}}$$

where S = sample variance

$\hat{\beta}_1$ = estimated coefficient of variable 1

$\hat{\beta}_2$ = estimated coefficient of variable 2

A t-test is employed to determine whether the coefficient of the private productive investment, I_{pr}^{P}/Y, is statistically different from the private investment in residential construction, I_{pr}^{H}/Y. The hypothesis for the t-test is that both coefficients are the same. The calculated t-value is

$$t_{I_{pr}^{P}/Y, I_{pr}^{H}/Y} = \frac{0.24559 - 0.26155}{\sqrt{0.00070344 + 0.0008886 - 2(-0.00074147)}}$$

= -0.01596/0.0554508

= -0.2878227

The calculated t-value (–0.288) is greater than the critical t-statistic of –2.064 with 24 degrees of freedom (six explanatory variables and 30 observations) at the 95 percent confidence level. Thus, one cannot reject the hypothesis and conclude that the coefficients of productive and housing investment in the private sector are not statistically different.

Another t-test is employed to determine whether the coefficient of private productive investment, I^P_{pr}/Y, is statistically different from public productive investment, I^P_{pu}/Y. The hypothesis is, again, that both coefficients are the same. The calculated t-value is

$$t_{I^P_{pr}/Y, I^P_{pu}/Y} = \frac{0.24559 - 0.53928}{\sqrt{0.00070344 + 0.008477 - 2(-0.00031046)}}$$

= -0.29369/0.099001

= -2.9665356

The calculated t-value (–2.967) is less than the critical t-statistic of –2.064. Thus, one can reject the hypothesis and conclude that the coefficients of the private and the public productive investment are statistically different.

An additional t-test is applied on private housing investment and public productive investment based on the same hypothesis. The calculated t-value is

$$t_{I^H_{pr}/Y, I^P_{pu}/Y} = \frac{0.26115 - 0.53928}{\sqrt{0.0008886 + 0.008477 - 2(-0.0041012)}}$$

= -0.27813/0.1325443

= -2.0983927

The calculated t-value (–2.098) is less than the critical t-statistic of –2.064 at the 95 percent confidence level. Thus, one can reject the hypothesis and conclude that the coefficients possessed by the private housing and the public productive investment are statistically different.

Hence, even though one cannot differentiate statistically the marginal contribution between productive and housing investment in the private sector, the marginal contributions of productive and housing investment in the public sector are statistically different from their counterparts in the private sector, and between themselves. Thus, to explain income growth in Singapore *via* sectoral disaggregation of investment by type is meaningful.

The estimated parameters, 0.24559, 0.26115, 0.53928 and –0.80182 from equation 5.1 are all statistically significant at the 95 percent confidence level and may be interpreted as the marginal contributions of these disaggregated sectoral investments. Since the coefficients of both types of private investment are the same, answers need to be provided for the differences in marginal contributions among private, public productive and housing investment.

A one percent growth in either type of private investment to income ratios stimulated income growth by about a quarter of a percent. On the other hand, a similar one percent growth in the public productive investment ratio raised growth rate by slightly more than half a percent. One plausible explanation is that when public productive investment is raised (*i.e.,* major social infrastructure projects are undertaken), both types of private investment will greatly respond to increasing investment opportunities and returns, and *via* multiplier effects on income, cause higher income growth. In other words, the comple-

mentary effect of public investment on private investment and income growth causes higher marginal contribution to be associated with public productive investment.

The negative marginal contribution possessed by the public investment in housing suggests the possible use of housing investment as a tool to execute counter-cyclical aggregate demand policy during periods of slow growth and recession.[3]

Some indirect evidence[4] suggests the use of investment in public construction by the government to pursue counter-cyclical activities:

$R^2 = 0.2735 \qquad DW = 0.9519$

$$I^C_{pu}/Y = 0.13778 - 0.27114gY$$

$$(-1.4637)$$

$R^2 = 0.2733 \qquad DW = 0.9639$

$$I^H_{pu}/Y = 0.13683 - 0.27067gY$$

$$(-1.9610)$$

The above OLS estimates show that the ratio of the public investment in construction to income, I^C_{pu}/Y, and the ratio of public investment in residential construction to income, I^H_{pu}/Y, are both negatively correlated to income growth rates. The operations of counter-cyclical activities are further supported by finding both ratios negative and significantly correlated to the income growth rates lagged one period, gY_{-1}.

[3] There have been only two recessions in the republic during the entire three decades (1960-89). One occured in 1963-64, and the other one in 1984-85. However, government can also implement counter-cyclical policy during periods of slow growth.

[4] These are OLS estimates and are obtained separately from the system of simultaneous equations.

$R^2 = 0.2123 \qquad DW = 0.9650$

$$I^C_{pu}/Y = 0.14043 - 0.33506gY_{-1}$$

(-2.0478)

$R^2 = 0.2441 \qquad DW = 0.9822$

$$I^H_{pu}/Y = 0.14191 - 0.37961gY_{-1}$$

(-2.0358)

These negative coefficients suggest that the lower the growth last period, the higher the public construction and residential construction ratios this period.

The above analysis concentrates on probable cause and effect relations between each investment component and growth. However, plausible correlations not based on the cause and effect relation clearly exist. First, over the growth cycle it would be expected that all investment components would change more than proportionately and in the same direction as income. However, both types of private investment, I^P_{pr} and I^H_{pr}, would be more volatile than public productive investment since private entrepreneurs are usually more sensitive to changing business conditions. Thus, both types of private investment when divided by income would more closely track the income growth rates, gY.

On the other hand, public spending typically is less responsive to cyclical conditions that is private spending, thus it is expected that public productive investment would be less volatile than private investment. As a result, a given change in public productive investment would be connected with a larger change

in income growth rates than would a similar size change in either type of private investment.

Public investment in housing would, on the other hand, probably change less than proportionately with income since this component of public investment is typically the least responsive to business cycles. Hence, the ratio of public investment in housing to income, I_{pu}^{H}, would be falling as growth rates increase and vice-versa, resulting in a negative correlation.

The coefficient possessed by the growth in labor supply is positive but insignificant at the 95 percent confidence level. In other words, the growth process in Singapore cannot be accounted for by the sheer increases in the supply of labor. Lee (1986) applied the *sources of growth accounting approach* developed by Dension (1962) to Singapore and found that the change in capital stock explains 75 to 85 percent of the income growth for the period 1966 to 1982. On the other hand, the change in labor earnings accounts for only 22 to 26 percent of income growth. Although the employed labor force rather than labor earnings is used here, the low and insignificant coefficient (0.14520) roughly confirmed Lee's finding. However, evidence presented by Lee (1986) and Krause (1987) also show that increases in labor productivity from the period 1966-80 were due mainly to increases in capital stock per worker. Evidence presented in chapter 6 provides further support for the findings of Lee and Krause.

The coefficient possessed by the growth in world income is positive but insignificant at the 95 percent confidence level. Although it is insignificant, it nevertheless suggests a probable correlation between the growth of the Singapore economy and the growth rate of the world. The constant term is significant

at the 95 percent confidence level. Holding all other explanatory variables unchanged, the annual income growth of Singapore will still be about 3.1 percent. This suggests that the growth of Singapore cannot be accounted for by sheer increases in capital inputs and that other factors, *i.e.,* technical progress, are probably present. This relatively large "residual" somewhat contradicts the finding of Tsao (1986) in which *TFP* is estimated to be negative for the period 1966 to 1980.

5.21 The Behavior of Private Sector Productive Investment

Eq 5.2 Dependent Variable = I^P_{pr}/Y

Independent Variable	Estimated Coefficient	Standard Error	t-value
gY	4.1750	0.49087	8.5053
I^H_{pr}/Y	-3.7307	0.68703	-5.4302
I_{pu}/Y	2.9259	0.30947	9.4545
DI_{pu}	0.7715E-01	0.011679	6.6058
r	-0.5938E-03	0.78024E-03	-0.7610
$gRes$	-0.2643E-05	0.48766E-05	-0.5419
Constant	-0.23421	0.47809E-01	-4.8989

$R^2 = 0.6614$ $DW = 1.9544$

The overall fit of the equation is reasonably good as suggested by the R^2. The DW test yields a test value of 1.9544 which is greater than the critical test statistic of 1.83 at the 95 percent confidence level (for 30 observations with six independent variables, excluding the constant term), thus suggesting the avoidance of serious auto-correlation.

Income growth is a positive and significant determinant of private productive investment. A 1 percent increase in growth will raise private productive investment ratio by about 4 percent. Although the accelerator effect is better explained by the positive relation between income growth lagged by a time period and current private investment, the above result has probably encompassed such effects.

The negative and significant coefficient possessed by private investment in residential construction ratio indicates that the two components of private investment are substitutes. One plausible reason for this is that they both compete for private resources and their respective real returns determine the flow of resources to each types of investment.

Public investment, I_{pu}/Y, on the other hand, exhibits a complementary relation to private productive investment. The coefficient possessed by I_{pu}/Y indicates that 1 percent increase in the public investment ratio stimulates private productive investment ratio by about 2.9 percent. This provides support for the complementary effect hypothesis of productive public investment on private investment put forward in the earlier section. Also, in the long run, private investment and growth cannot be sustained without the necessary accumulation of investment in social infrastructure. However, it is doubtful whether the latter effect can be captured by the model, which employs only annual variations in investment and growth data.[5]

The complementary relation rejects the supply-side consideration put forward earlier in chapter three. One will normally expect higher public investment

[5] The model employed annual variations in data cannot be expected to satisfactorily provides clues for long-term and stable relations. Some moving average of growth rate and investment data may be more appropriate. Further, 30 years may not be long enough to capture such a long term complementary relationship.

to drive up the cost of inputs and lower the incentive for the private sector to invest. However, such a negative relation was not found.

The positive and significant coefficient possessed by the dummy of major social infrastructure projects, DI_{pu}, provides further support for the complementary effect hypothesis. The higher marginal contribution enjoyed by public productive investment, *vis-a-vis* the private investment may be due to the fact that private investment did react positively to proposed large-scale social infrastructure spending, and growth was fostered during the process.

The coefficient for the real rate of interest turned out to be negative but insignificant. Given the tremendous inflow of foreign capital, the domestic real rate of interest may not be a significant factor in determining capital formation in the private sector.

At the 95 percent confidence level, the growth in foreign reserves, $gRes$, exhibits a negative but insignificant relation to private productive investment. Clearly, the larger the $gRes$, the bigger the inflow of foreign savings that is needed to remedy the private resource gap. The insignificant relation suggests somewhat that the supply of foreign savings is as elastic as the domestic banking system, and no crowding out of private productive investment has occurred.

5.22 The Behavior of Private Sector Investment in Residential Construction

The overall fit of the equation is reasonably good. The DW test yields a test value of 1.8837 which is above the 1.83 critical test statistic at the 95 percent confidence level. This indicates that any serious auto-correlation has been largely avoided.

Eq 5.3 Dependent Variable = I_{pr}^{H}/Y

Independent Variable	Estimated Coefficient	Standard Error	t-value
gY	0.24854	0.12303	2.0202
I_{pu}/Y	0.79828	0.14022	5.6931
DI_{pu}	0.83317E-02	0.47547E-02	1.7523
$dHhold$	0.83123	0.41778	2.3936
r	-0.57642E-04	0.40419E-03	-0.14261
$gRes$	-0.85794E-06	0.22623E-05	-0.37923
Constant	0.11238E-02	0.12478E-01	0.90063E-01

$R^2 = 0.5426 \qquad DW = 1.8837$

The growth rate of income, gY, as expected, is a positive and significant determinant of the private housing investment ratio. Also, similar to the behavior of private productive investment, public investment again exhibits a complementary relation to private investment. A 1 percent rise in the public investment ratio augments private investments in housing ratio by about 0.8 percent. Again, one plausible reason is the complementary effect of public investment on private investment. A rise in public investment will potentially generate higher income and better returns to private ventures, and since there is no market relation between public and private investment (public investment does not crowd out private investment since the public saving exceeds investment and thus no borrowing from the private sector), if private investment does respond favorably to prospect of higher aggregate demand and returns, then a positive relation can result.

Another plausible reason can be the long-run complementary relations among private investment, accumulated investment in social infrastructure and growth. Since private investment and long term growth cannot be sustained

in the long run without good social infrastructure, the complementary relation seems probable. However, as discussed before, it is doubtful whether the kind of annual data used in the model could capture this long term complementary effect.

The above complementary relation between public investment and private investment again rejects the plausible negative relation due to supply-side considerations outlined in chapter three. One will normally expect higher public investment to drive up the costs of inputs and lower the incentive for private entrepreneurs to invest. However, such a negative relation was not found.

The positive and near significant coefficient of the public investment dummy, DI_{pu}, indicates somewhat the private investment in residential construction is stimulated by proposed spending in large scale social infrastructure projects. Again, like the positive relationship between DI_{pu} and private productive investment, private entrepreneurs in residential construction anticipate higher demand and better returns for private residential properties during and after the construction of these social infrastructure projects.[6] This will increase private investments and in turn foster a faster growth rate for the economy.

The coefficient for the change in the number of households, $dHhold$, is positive and significant at the 95 percent confidence level. It indicates rather conclusively that a bigger positive change in the number of households will generate higher demand for private housing, and thus simulate higher private housing investment.[7]

[6] For example, private properties near subway stations usually experience higher demand, resulting in higher prices. Speculative residential construction is thus common and plausible.

[7] In order for higher demand in private housing to translate into higher investment in private housing, the investment (or supply) has to be driven by demand. It is quite plausible for such positive association to exist in the private market for housing.

The coefficient for the real rate of interest, r, turned out to be negative but insignificant. Again, it is quite probable that the real rate of interest is not a good proxy for the mortgage rate, but since they tend to move in the same direction, nevertheless the right sign is obtained. Further, liberalization in the use of *CPF* savings to purchase private residential properties since the late 1970s may have some bearing on this insignificant variable. As discussed in chapter one, up to 80 percent of the *CPF* balance is allowed to be used to purchase private properties, thus since the liberalization, the withdrawals for such purposes have exploded. Mortgage loans and interest payments in this instance could become less significant in the purchase decision since less private mortgage borrowing is required.

The coefficient for the growth rate of foreign reserves, $gRes$, the proxy for the government's resource mobilization policy, is again insignificant but negative. This further suggests that the deliberate policy of increasing investment abroad by the government, which will require a larger inflow of foreign capital to fill the private resource gap, had very little impact on private capital formation. It is thus quite plausible to suggest that the supply of foreign savings is almost as elastic as the private banking system.

5.23 The Behavior of Public Sector Productive Investment

The fit of the equation is good as indicated by the R^2. However, the DW test yields a slightly low test value, 1.5193, and is below the critical value of 1.65 at the 95 percent confidence level (for 30 observations with three independent variables, excluding the constant term). This indeterminate test result indicates that one cannot conclude serial correlation has been avoided.

Eq 5.4 Dependent Variable = I^P_{pu}/Y

Independent Variable	Estimated Coefficient	Standard Error	t-value
gY	0.70517	0.22523	3.1308
I_{pr}/Y	0.19648	0.07846	2.4813
I^H_{pu}/Y	-0.17793	0.10293	-1.7286
Constant	0.09467	0.01547	6.1195

$R^2 = 0.5107$ $DW = 1.5193$

The real growth rate, gY, is found to significantly determine the public productive investment. A 1 percent growth in income augments the public productive investment ratio by about 0.7 percent. Again, the non cause and effect relations put forward in chapter three seems plausible. Since taxes are positively related to income (given the progressive tax structure in Singapore), and if public spending and investment is positively related to taxes, a complementary relation can thus be observed between growth and public productive investment.

A change in one of the non-income determinants of private investment, (*i.e.,* a lowering in the tax rate) should, *ceteris paribus*, stimulate private investment, lower public revenue and hence lower public investment. However, as shown by the behavior of public productive investment, a rise in the private investment ratio will augment the public productive investment ratio. Again, private investment may be simulated by proposed large-scale social infrastructure projects. The increase in private investment will in turn foster faster growth and stimulate public spending, which includes public productive investment. Further, in the very long run, the complementary relation seems probable given that private investment and growth cannot be sustained without sufficient

accumulated investment in social infrastructure. The above complementary relation between public productive and private investment again rejects the probable negative relation based on supply-side considerations discussed in chapter three.

Public investment in housing is found to exhibit a negative relation to public productive investments (significant at the 80 percent confidence level). Again, reasons outlined in chapter three seems probable. Since both are financed by public resources, and the government has consistently invested abroad, both types of public investment thus have to compete for public savings net of investment abroad.

5.24 The Behavior of Public Sector Investment in Residential Construction

Eq 5.5 Dependent Variable $= I^H_{pu}/Y$

Independent Variable	Estimated Coefficient	Standard Error	t-value
gY	-0.21670	0.090237	-2.4014
I^H_{pr}/Y	0.72598	0.11323	6.4113
I^P_{pu}/Y	-0.21696	0.087748	-2.4726
$R_{(cpf,-1)}$	0.12295	0.012852	9.5666
$dHhold$	-0.26665	0.15612	-1.70798
Constant	0.60150E-02	0.10306E-1	0.58365

$R^2 = 0.7929 \qquad DW = 1.8781$

The overall fit of the equation is quite satisfactory as shown by the R^2. The DW test yields a test value of 1.8781 which is again greater than the critical value of 1.83 at the 95 percent confidence level. This suggests the avoidance of any serious serial correlation.

Similar to results obtained under the disaggregated investment constrained growth equation in section 5.2, the income growth rate, gY, is found to exhibit a negative and significant relation (at the 95 percent confidence level) to the private investment in housing ratio. Because the demand for public housing is positively related to income and normally the income effect dominates the substitution effect, the significant and negative coefficient could either due to a dominating substitution effect[8] or the execution of counter-cyclial policy by government using public housing investment. Indirect evidence presented in section 5.2 suggests the probable execution of such counter-cyclical policy. However, such negative correlation may purely be a result of a differing degree of cyclical instability between investment component and growth and thus embodied no cause and effect relation. If public investment in housing is less responsive to the growth cycle, then it would change less proportionately with income and thus its ratio would be falling as growth rates increase and vice-versa, yielding a negative correlation.

Private investment in residential construction is found to exhibit a positive relation to public investment in residential construction. The positive relation is plausible since they are all positively related to income and if income effect dominates the substitution effect (both types of housing are substitutes given a certain level of income), higher income growth will augment both and thus render a positive relation between the two. Further, private investment in housing may also be stimulated by higher public investment in housing if the

[8] Public and private housing are substitutes. A large increase in income should increase demand for both types of housing but it could also cause substitution of public housing for private housing. Thus, if the substitution effect overpowers the income effect, a negative relation between income growth and public housing could result.

latter is positively related to the construction of major social infrastructure projects.

However, the positive association between the two not based on cause and effect relationship is clearly plausible also. Both sectoral housing investments may tend to move counter-cyclically and thus render a positive correlation between the two. Private investment in housing moves counter-cyclically because of credit availability and the public investment in housing moves in the opposite direction of the growth path either due to its relative stability or government's counter-cyclical policy.

Similar to the findings in the public productive investment behavior, both types of public investment exhibit a negative correlation. Apparently, both compete for public savings net of investment abroad and the increase of one will lead to the decrease of the other.

As expected, the coefficient for the lagged rate of *CPF* contributions is positive and significant. A 1 percent rise in the lagged rate stimulates investment in public housing by about 0.123 percent. Again, the reason put forward in chapter three is supported. The higher rate of contribution augments the flow of *CPF* savings and raises the affordability of public housing.

The coefficient for the change in the number of households, *dHhold*, turned out to be negative and near significant at the 95 percent confidence level. Clearly, bigger and positive change in the number of household occurred during the 1960s and early 1970s, where the investment in public housing was still minimal,[9] and smaller positive change in household population took place during the late seventies and eighties where investment in public housing had

[9] The public housing program was launched in the early 1960s. However, its full expansion was not realised until the late 1970s.

drastically increased. This is in sharp contrast with the positive and significant relation exhibited between the private housing investment and the change in the number of households presented in section 5.22.

Time series information for estimated and actual disaggregated sectoral investment components and growth rates are presented in figure 5.1 to 5.4.

Figure 1.

Figure 5.1 Estimated and Actual IprP/Y Movement

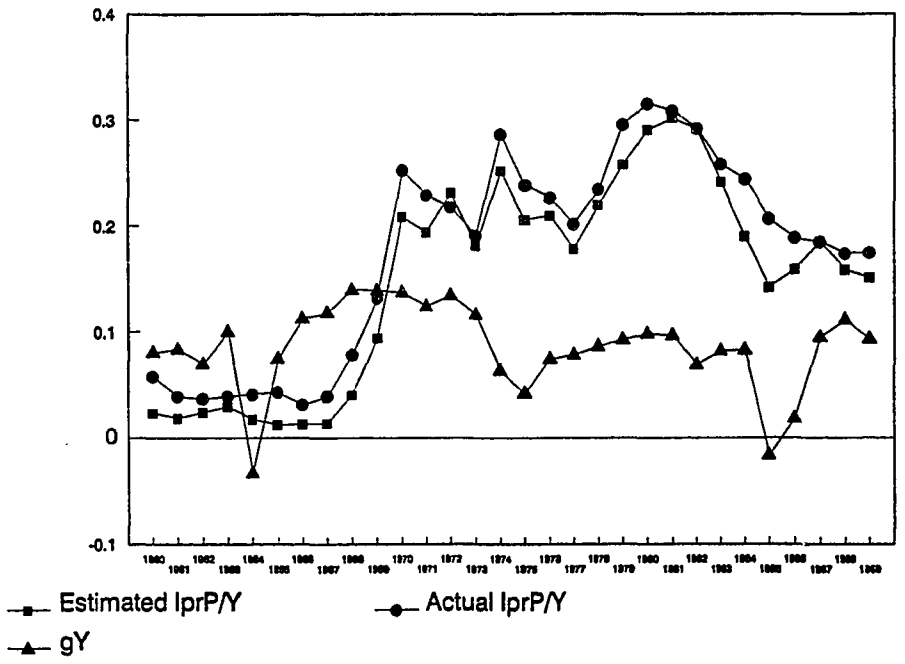


Figure 5.2 Estimated and Actual IprH/Y Movement

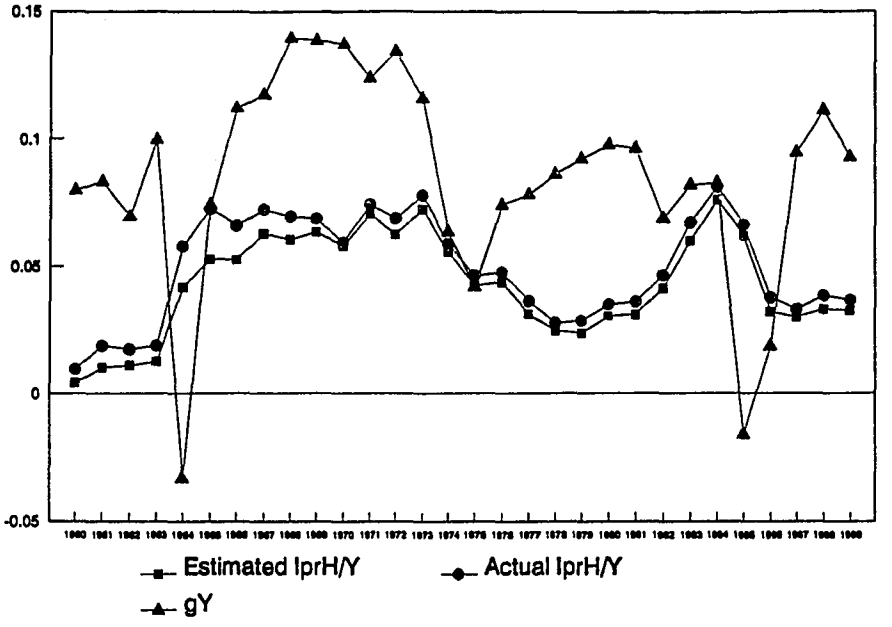


Figure 5.3 Estimated and Actual IpuP/Y Movement

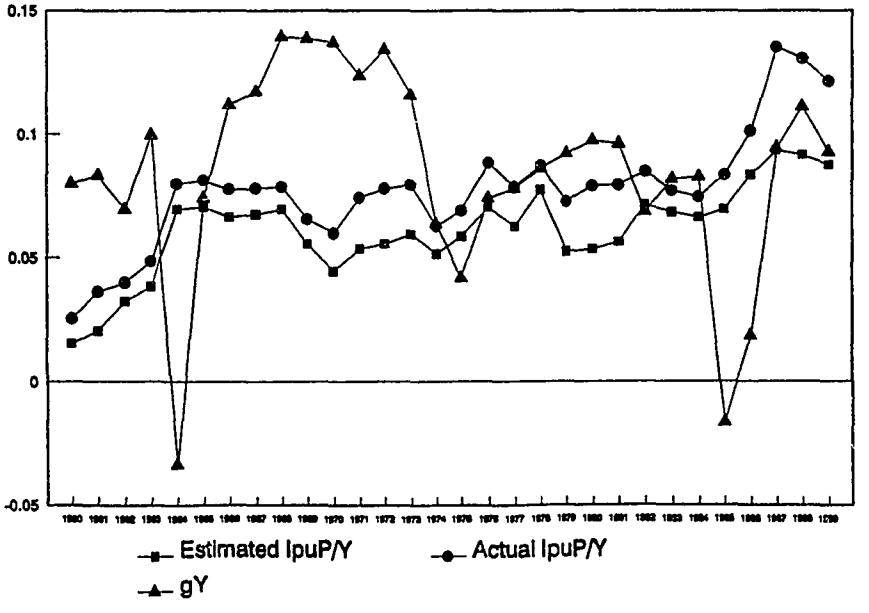
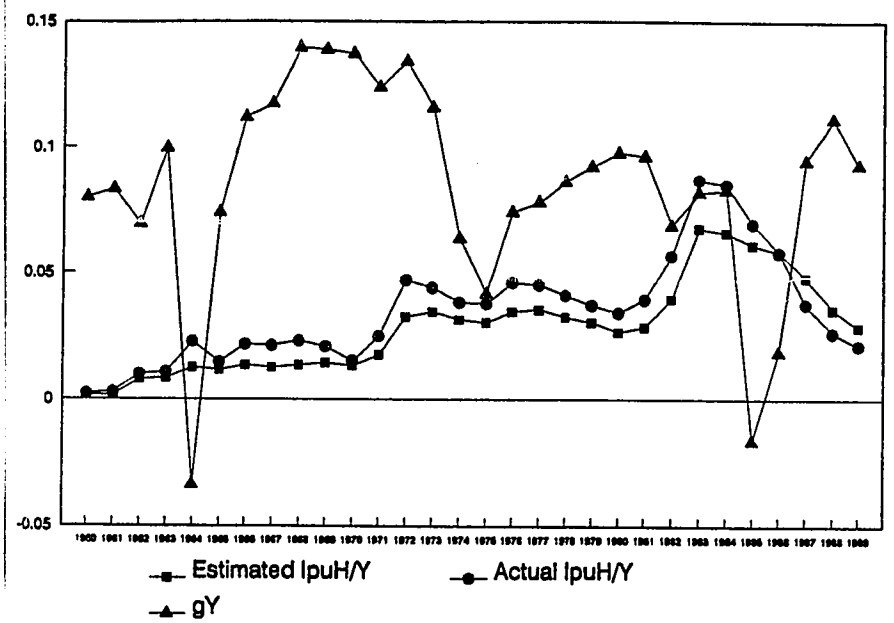


Figure 5.4 Estimated and Actual IpuH/Y Movement



An explanation not based on the cause and effect relationship can be offered for the different estimated coefficients of the investment components to growth is the differing degree of cyclical instability among different types of investment.

First, as mentioned earlier, over the growth cycle it is expected that all investment components would vary in the same direction as and more than proportionately than income, and either type of private investment would be more volatile than public productive investment since private entrepreneurs are quick to respond to the changing business climate. Thus, either type of private investment when divided by income, as shown in figures 5.1 and 5.2, had more closely tracked the income growth path.

On the other hand, figure 5.3 shows that public productive investment is less volatile than either type of private investment. Hence, when divided by

income, a given change in public productive investment is associated with a larger change in growth rates compared with either type of private investment.

Public housing investment, on the other thand, would probably change less than proportionately with income since it belongs to the component of public spending that is the least sensitive to growth cycle. Thus, when divided by income, the public housing investment ratio would be falling as growth rates increase and vice-versa, yielding a negative relation. Figure 5.4, to a certain degree, confirmed the above.

5.25 The Behavior of the Growth in Labor Supply Function

Eq 5.6 Dependent Variable = gL

Independent Variable	Estimated Coefficient	Standard Error	t-value
gY	0.63770	0.17010	3.7490
$gPop_{15-64}$	1.23270	0.51221	2.40663
T_m	-0.46144E-02	0.59197E-02	-0.77951
R_{cpf}	-0.46316E-01	0.28921E-01	-1.6015
Constant	-0.20694E-01	0.21328E-01	-0.97027

$R^2 = 0.5134 \qquad DW = 1.7744$

The overall fit of the equation is good, and the DW test yields a test value of 1.8744, which is greater than the critical value of 1.74 at the 95 percent confidence level (based on 30 observations and four independent variables, excluding the constant term). Thus, no serious serial-correlation has been detected.

Higher income growth will normally augment positive changes in real wages, thus, the positive correlation between income growth and growth in the labor supply is quite plausible.

The growth in the population aged 15-64, $gPop_{15-64}$, turned out to be a significant determinant of the labor supply function. A 1 percent increase in the working population growth rate augments labor growth by about 1.23 percent. Since contract foreign laborers are excluded from the working-age population time series, the larger than one response is plausible.

Coefficients for both the income tax rate, T_m, and the rate of CPF contributions, R_{cpf}, are both negative but insignificant at the 95 percent confidence level. The former independent variable is likely to correlate with the income growth rate (another independent variable) and since the tax variable is not endogenized, probable simultaneous bias could result. Thus, the growth rate might pick up the effect of the tax rate on labor supply.

Although the CPF contribution is a levy on wage income, its impact on the supply of labor may not be purely negative. Although the contribution reduces current income, it represents accumulated wealth and under a life cycle framework, the overall impact on the supply of work hours and efforts may be minimal.

5.3 The Disaggregated Savings Constrained Growth Behavior

Eq 5.7 Dependent Variable = gY

Independent Variable	Estimated Coefficient	Standard Error	t-value
S_{pr}/Y	0.29452	0.14236	2.0688
S_{cpf}/Y	-0.60277	0.30253	-1.9924
S_{pu}/Y	0.48274	0.14813	3.2588
S_f/Y	0.32648	0.11001	2.9677
gL	0.25212	0.27053	0.9319
gY_w	0.51623E-01	0.11245	0.4591
Constant	0.23262E-01	0.02199	1.0577

R^2=0.6214 DW = 1.8698

The overall fit for the structural equation is reasonably good as indicated by its R^2. The DW test yields a test value of 1.8698 which is greater than the critical value of 1.83 at the 95 percent confidence level (for 30 observation and six independent variables, excluding the constant term). Thus, no serious serial correlation exists in the growth structural equation.

The negative and significant coefficient (at the 95 percent confidence level) for S_{cpf}/Y indicates that the marginal contribution of forced savings to income ratio is statistically different from the other components of savings which possessed positive and significant coefficients.

Since the F test is inappropriate for hypothesis testing involving system of simultaneous equations, t-tests for individual pairs of coefficients are selected.

A t-test is employed to test the hypothesis that the coefficient of the voluntary private savings is not statistically different from the foreign savings ratio.

The calculated t-value is

$$t_{S_{pr}/Y,S_f/Y} = \frac{0.29452 - 0.32648}{\sqrt{0.020581 + 0.012102 - 2(-0.0076194)}}$$

= -0.03196/0.2189104

= -0.1459958

The calculated t-value (–0.146) is greater than the critical t-statistic of –2.064 at the 95 percent confidence level (with 24 degrees of freedom). Thus one can not reject the hypothesis and can reasonably conclude that the marginal contributions between voluntary private and foreign savings are the same.

Another t-test is employed to test the hypothesis that the coefficients for voluntary private and public savings are the same.

The calculated t-value is

$$t_{S_{pr}/Y,S_{pu}/Y} = \frac{0.29452 - 0.48274}{\sqrt{0.020581 + 0.0219424 - 2(0.018654)}}$$

= -0.18822/0.0722177

= -2.6062862

The calculated t-value (–2.606) is less than the critical t-statistic of –2.064 at the 95 percent confidence level. Thus one can reject the hypothesis and conclude that the marginal contributions of voluntary private and public savings are statistically not the same.

A further t-test is applied on public and foreign savings ratios. Again, the hypothesis is that both coefficients are statistically the same.

The calculated t-value is

$$t_{S_{pu}/Y,S_f/Y} = \frac{0.48274 - 0.32648}{\sqrt{0.0219424 + 0.0121022 - 2(0.015245)}}$$

$= 0.15626/0.0596204$

$= 2.6209149$

The calculated t-value (2.621) is greater than the critical t-statistics of 2.064 at the 95 percent confidence level. The hypothesis is hence rejected and one can reasonably conclude that the marginal contribution between public and foreign savings are statistically different.

The above t-tests demonstrate that beside between voluntary private and foreign savings, the marginal contributions are different among the disaggregated savings components and thus to explain growth *via* sectoral disaggregation of savings is meaningful.

The estimated parameters, 0.29452, -0.60277, 0.48274 and 0.32648 from equation 5.7 are all statistically significant and may be interpreted as the marginal contributions of voluntary private savings, *CPF* savings, public savings and foreign savings to output growth.

The relatively higher marginal contribution by public savings, *vis-a-vis* private and foreign savings, may again result because of the complementary effects betwen public and private investment. If one of the non-income determinants of public savings (*i.e.,* the tax rate) is increased, and the public savings is augmented, and that such an increase in public savings is used to finance increases in public investment, mainly in the forms of highly publicized infrastructure projects, then private investment can be encouraged, and cause a multipler ef-

fect on income growth. Such a positive relation between public savings and growth can exist, as long as there is complementary effect of public investment on private investment, and there are positive associations between public revenue and savings, and between public savings and investment.

The above suggests a positive relation between private investments and highly publicized investments in social infrastructure. Such an increase in social infrastructure may be motived by political or economic considerations. However, it may also be initiated because of high public savings.[10]

The negative marginal contribution of the *CPF* savings suggests that its incremental output to capital ratio is negative and the accumulation of the *CPF* savings will actually result in lower output growth. Clearly, the reason put forward earlier to explain the negative marginal contribution of public investment in housing may have some bearing here. The finance of investments for public housing is made possible by the wholesale buying of government securities by the *CPF* Board, and its ability to purchase government securities critically depends on its surplus, which in turn is the difference between the gross *CPF* contributions and withdrawals.[11] There seems to be no way an increase in the public housing investment not associated with an increase in the *CPF* rates can have this kind of negative effect on income growth. Hence, in the process of executing counter-cyclical demand policy *via* higher investment in public housing, the flow of *CPF* savings is also raised *via* higher contribution rate. However, careful examination of the annual data reviewed during the entire three decades, with the exception of 1986, the contribution rate continued to be raised, even

[10] Examples of countries that undertook huge social infrastructure projects due to the government's excessive savings are numerous. Both Taiwan and Hong Kong recently embarked on big infrastructure buildups and the need to spend excessive public surplues are cited by both as reason. However, political and social considerations clearly exist.

[11] The operation expenses of *CPF* Board is trivial compared with its revenue.

during periods of slow growth and recession. The first downward adjustment in rates occurred in 1986, after two years of recession (1984-85) but subsequently the rate was again revised upward.[12]

The above results, *i.e.,* higher marginal contributions by public savings *vis-a-vis* the private and foreign savings ratios, contradict the findings of Papanek (1972) and Pesmazoglu (1973). Both studies had found both foreign and private savings more productive than the public savings. However, owing to the simultaneous biases between income growth and sectoral savings, their single equation estimates are suspect. However, Vongvipanond (1978) uses *2SLS* method and found public savings to be more productive than private savings in six developing Asian nations. However, it must be noted that all the above empirical studies employed gross private savings and no distinction between voluntary private and forced private savings were made.

The above analysis concentrates on probable cause and effect relations between each disaggregated sectoral savings component and growth. However, plausible associations between each saving component and growth may arise without any cause and effect relations. First, over the growth cycle, it is expected that all saving components would change more than proportionately and in the same direction as income. However, the voluntary private savings would be more volatile than both the public and forced savings, thus when divided by income, the voluntary private savings to income ratio would more closely track the income growth rate.

[12] As a result, such an increase in the contribution rate and hence the flow of forced savings cannot be considered counter-recessionary since the rate was almost constantly adjusted upward during the entire three decades.

On the other hand, public savings would also change with the growth rate but its change is less volatile than the voluntary private savings. Hence, a given change in public savings, when divided by income, would be associated with a larger change in income growth rates than would a similar size change in voluntary private savings.

Since the flow of *CPF* savings is based on wage income, and as long as the wage is sticky, than when growth slows, wages would fall less than growth. Thus, when divided by income, the forced savings to income ratio would increase in a slowdown and decrease in an expansion, giving it a negative annual relation to growth.

Similar to the result obtained *via* the disaggregated investment constrained growth method, the coefficient associated with the rate of growth in the labor supply is positive and insignificant. This again confirmed the findings by Tsao (1986) and Krause (1987) and suggests the growth of the Singapore economy in the last three decades was indeed capital driven. Also, similar to the result obtained *via* the investment constrained growth model, the growth rate of world income, gY_w, is found to possessed a positive but insignificant relation to growth.

5.31 The Behavior of Voluntary Private Sector Savings

On the whole, the fit of the equation is good as indicated by the R^2. The *DW* test yields a test value of 2.1167. This is greater than the critical value of 1.83 at the 95 percent confidence level (for 30 observation with five or more independent variables, excluding the constant term) and thus one can conclude that serial correlation is not present in the structural equation.

Eq 5.8 Dependent Variable = S_{pr}/Y

Independent Variable	Estimated Coefficient	Standard Error	t-value
gY	1.3253	0.60502	2.1905
S_{cpf}/Y	0.4824	0.28407	1.6982
S_{pu}/Y	-1.6885	0.38785	-4.3534
S_f/Y	-0.5574	0.34477	-1.6167
rd	-0.6027E-04	0.11364E-02	-0.5297E-01
$YDep$	-1.1043	0.36578	-3.0190
$ODep$	0.06724	1.66045	0.04049
Constant	0.37185	0.18478	2.01239

$R^2 = 0.7712 \qquad DW = 2.1167$

As expected, the income growth rate is significant (at the 95 pecent confidence level) and positively correlated with the voluntary private savings to income ratio. On the average, a 1 percent rise in the growth rate will raise the voluntary private savings ratio by about 1.32 percent. Given that components of domestic savings are a function of income, the positive relation is plausible. The estimated coefficient is closed to those found in cross-section studies on developing countries that have values above one, such as Swamy (1968), Singh (1971) and in time-series studies conducted by Fry and Mason (1982), but somewhat higher than the values 0.277 to 0.528 found by Vongvipanond (1978). However, the dependable variable in the estimates of Swamy and Singh was the ratio of domestic savings to income, and in Fry and Mason's estimate, it was the ratio of national savings to income and finally in Vongvipanond's estimate, the dependable variable is the ratio of private savings to income.

The positive and near significant coefficient of the *CPF* savings ratio indicates the complementary relation between forced and voluntary private savings.

On theoretical grounds, there exists two plausible relationships. One is the income effect, in which rising income raises all components of domestic savings, including both voluntary private and *CPF* savings, thus rendering an unambiguous positive relation between the two. The other is the substitution relation, in which higher forced savings caused by a change in one of its non-income (*i.e.,* contribution rate) crowds out voluntary private savings because of the lower private income caused by the additional forced transfer of private income to the *CPF* scheme.[13] Clearly, if the income effect dominates the substitution effect,[14] a complementary relation between voluntary private and *CPF* savings can be expected.[15]

The above result is in sharp contrast with some prior empirical findings. Wong (1986) reported the *CPF* savings have significantly crowded out the voluntary private savings *via* the single equation method. The single equation estimate by Datta and Shome (1981), on the other hand, employed financial savings rather than real savings, and it was found that the nominal *CPF* savings did not crowd out the nominal voluntary private savings. However, their estimates were statistically inconclusive, given the simultaneous biases existing in their single equation estimates.

The public savings ratio is found to possess a negative coefficient significant at the 95 percent confidence level. One percent increases in the public sav-

[13] As discussed in chapter three, both households and businesses contribute to the *CPF* scheme, and it is likely that a higher contribution rate would, *ceteris paribus*, reduce both household and business income, and render an unambiguous negative relation between *CPF* and voluntary private savings.

[14] As discussed in chapter three, a better explanatory variable for this purpose would be the *CPF* contribution rate rather than the forced savings ratio. Since both the contribution rate and growth would affect the relation between voluntary private and forced savings, by controlling for income growth, the coefficient for the contribution rate would then more accurately indicate the relation between forced and voluntary private savings.

[15] However, the system of equations should allow us to analyze the impact of changing *CPF* savings on voluntary private savings given that the simultaneous relation between *CPF* savings and growth had been corrected.

ings have crowded out about 1.69 percent of voluntary private savings. Again, on theoretical grounds, holding all non-income determinants (*i.e.,* tax rate) of public savings unchanged, public and voluntary private savings can exhibit a complementary relation if rising income augments all components of domestic savings. However, if a change in the non-income determinants of public savings occur,[16] for example, a rise in the corporate and wage income tax, then *ceteris paribus*, additional private income will be transfered to the public sector, resulting in higher public savings[17] and an unambiguous negative relationship between the two. Given the significant negative coefficient and the correction of simultaneous bias between public savings and growth, one can reasonably assume the substitution relation had prevailed.[18]

Empirically, the negative and significant coefficient of the public savings ratio supports the initial finding by Singh (1971) of the substitution relation between private and public savings. His estimate, in which a rise of a percent of public savings reduces the private savings by about half a percent, is smaller than our estimate.[19]

By reviewing the actual time-series data, the negative relation is probably due to both income and substitution effects mentioned above. The public sector had assumed a larger role in the economy over the three decades and had increased its savings at a faster rate than it had in its share of the national in-

[16] As discussed in chapter three, taxes would be a better explanatory variable than the public savings ratio. After controlling for growth, the coefficient possessed by taxes should unambiguously disclose the relation between government revenue (and indirectly, public savings) and voluntary private savings.

[17] Holding public spending unchanged or only changing proportionately with higher public revenue.

[18] Given the actual growth that Singapore has experienced in the past three decades, income effects surely exist. But, both public savings and growth are already endogenized, thus, even though they both appear as independent variables in the private savings function, their simultaneous relation should be corrected.

[19] Singh did not differentiate between voluntary and involuntary private savings.

come. As a result, S_{pu}/Y had crowded out S_{pr}/Y as the latter shrunk because of a lower private sector's share of the national income. This explanation is supported by findings of Wong (1986) in which he estimated the growth elasticity of public revenue with respect to GDP is 1.5 and that of public current expenditure is 1.3. Thus, the public savings had grown over time and taken up an increasing share of national savings at the expense of voluntary private savings.

The negative and near significant coefficient of the foreign savings ratio suppported findings by Landau (1971), Weisskopf (1972), Chenery and Syrquin (1975), Fry (1977) and Vongvipanond (1978). In these findings, a 1 percent of additional foreign savings crowded out private savings by about 0.2 to 0.8 percent. This is consistant with our estimate, in which a 1 percent rise in the foreign savings ratio will crowd out about 0.5 percent of voluntary private savings ratio.

Our estimate further indicates that the real deposit rate is not a significant determinant of private voluntary savings at 95 percent confidence level. Since the real deposit rate is only a proxy of the returns for private savings, and there exist many other forms of returns, the insignificant relation should not be of great concern. The result is also consistant with the findings of Abe (1975) and Fry (1977), where both found the real deposit rate to be a positive but insignificant determinant of private savings.

The young dependency ratio, $YDep$, is negative and significant at the 95 percent confidence level. This indicates that demographic changes have affected household saving behavior. Lowering the young dependency ratio will reduce

household expenditures, increase labor force participation rates, and augment the flow of household savings.

The insignifcant coefficient possessed by the old dependency ratio suggests, inconclusively, that the presence of an older population did not reduce voluntary savings. One plausible reason is that older people are allowed to withdraw their *CPF* balances after retirement, and this will normally be converted, in whole or in part, into voluntary household savings.

5.32 The Behavior of CPF Savings

Eq 5.9 Dependent Variable = S_{cpf}/Y

Independent Variable	Estimated Coefficient	Standard Error	t-value
gY	-0.34177	0.09038	-3.7815
$YDep$	-0.32295	0.10227	-3.1578
$ODep$	-1.26728	0.57556	-2.2018
R_{cpf}	0.23844	0.02846	8.3781
Constant	0.22857	0.07783	2.9367

$R^2 = 0.7819 \qquad DW = 1.7536$

The overall fit of the forced savings structural equation is good. The DW test resulted in a test value of 1.7536, which is greater than the critical test statistic of 1.74 at the 95 percent confidence level (for 30 observations and four independent variables, excluding the constant term). Again, there is no evidence on the presence of any serious auto-correlation.

As confirmed by the disaggregated savings growth equation, the growth rate of income, gY, is negative and significantly related with the *CPF* savings

ratio. As disucssed in chapter three, on theoretical ground, if wage is downward sticky, then a fall in the growth rate can cause wages to fall less than growth. Thus, the *CPF* savings, which is based on wages, to income ratio can increase in a slowdown and decrease during an expansion, giving it a negative relation to growth.

Further, as discussed earlier in the disaggregated investment constrained growth behavior, if government does engage in counter-cyclical operations using its investment in residential construction, than the possibility of also raising the forced contribution rate during periods of slow growth so to finance the purchase of public housing is even higher. Careful examination of the data has revealed that the rate of contribution were constantly adjusted upwards from 1960 to 1985, and from 1987 to 1989, even during periods of slow growth and recessions.[20]

Both coefficients for the dependency ratios, $YDep$ and $ODep$, are negative and significant at the 95 percent confidence level. As the dependency ratios decline, the labor force participation rate, especially those of females, increases, and the flow of *CPF* savings increases.

As expected, the rate of *CPF* contributions is a positive and significant determinant of the forced savings ratio. If the rate is raised by 1 percent, the share of the *CPF* savings to income will be raised by 0.23 percent. However, since the rate of contribution is not endogenized (it enters the forced savings function together with income growth as independent variables), any simulta-

[20] However, increase in the *CPF* rate, and hence the flow of forced savings during periods of slow growth and recession is not considered a counter-recessionary move since the rate is also raised during periods of high growth.

neous relation between growth and contribution rates would not be corrected by the system method.

5.33 The Behavior of Public Sector Savings

Eq 5.10 Dependent Variable = S_{pu}/Y

Independent Variable	Estimated Coefficient	Standard Error	t-value
gY	1.2369	0.51760	2.3896
S_{pr}/Y	-0.2273	0.10509	-2.1629
S_{cpf}/Y	1.1719	0.22443	5.2217
S_f/Y	-0.6130	0.21632	-2.8337
I_{pu}/G	0.3329E-03	0.57258E-03	0.5814
Constant	0.4209E-02	0.27432E-01	0.1534

$R^2 = 0.7102 \qquad DW = 1.9125$

The coefficient for the income growth rate, gY, is positive and significant at the 95 percent confidence level. A 1 percent increase in growth will raise the public savings ratio by about 1.23 percent. The large and positive response clearly is a result of the positive income effect between income growth and public savings. As income grows, public revenue climbs *via* the progressive tax structure and augments public savings. However, such a large positive response is plausible only if changes in taxes initially go to increase or decrease public savings. Since public savings are only a small portion of taxes, the ratio of public savings to income will increase more than the initial change in income growth. Also, Wong (1986) has empirically found that the growth elasticity of public revenue with respect to GDP is 1.5, and that of public current expenditure is 1.3 (the difference between revenue and current expenditure is public saving).

Thus, a positive coefficient greater than one is both theoretically and empirically plausible.

In concert with the behavior of voluntary private savings discussed earlier, an increase in voluntary private savings is expected to crowd out public savings. Again, based on theoretical reasoning, if income is unchanged, and an initial reduction in the private savings ratio is caused by a change in one of its non-income determinants, (*i.e., income tax rate is raised*), then, additional transfer of income from the private to the public sector will augment public savings and reduce voluntary private savings. This unambiguous negative relation and relatively small response also received empirical supports from Singh (1971) and Vongvipanond (1978). Both have found private savings negatively related to public savings.

On the other hand, the drastic rise of the involuntary *CPF* savings in Singapore has apparently complemented public savings. The estimate shows that a 1 percent rise in the *CPF* savings ratio raises the public savings ratio by slightly more than 1 percent. Clearly, in terms of income effect, since all components of domestic savings are functions of income, their complementary relations are plausible. However, non-income effects can also generate this positive relation. If the dependency ratio was lowered (one of the non-income determinants of *CPF* savings function), then the flow of *CPF* savings will increase *via* a constant contribution rate, and public savings will also be augmented *via* either a progressive or neutral tax system.

From a policy viewpoint, clearly, the desire to increase the availability of the domestic resources has caused the government to resort to two routes simultaneously: first to increase its own savings (*i.e.,* public sector) largely through

the accumulation of surpluses by the statutory boards and the government, and second, to force the private sector to contribute more to the *CPF* saving scheme.

The positive and insignificant coefficient of I_{pu}/G indicates, somewhat inconclusively, that the government's commitment to investment and development as indicated by the ratio is a motive for it to increase saving. However, eventhough the variable is postulated to be a policy variable, I_{pu} and G are probably correlated with income growth, which is another independent variable in the structural equation. Since I_{pu}/G is assumed to be exogenous to the system of equations, its simultaneous relation to gY cannot be corrected.

Time series information for both estimated and actual disaggregated sectoral saving components and their associations with growth rates are presented in figures 5.5 to 5.7

Figure 5.5 Estimated and Actual Spr/Y Movement

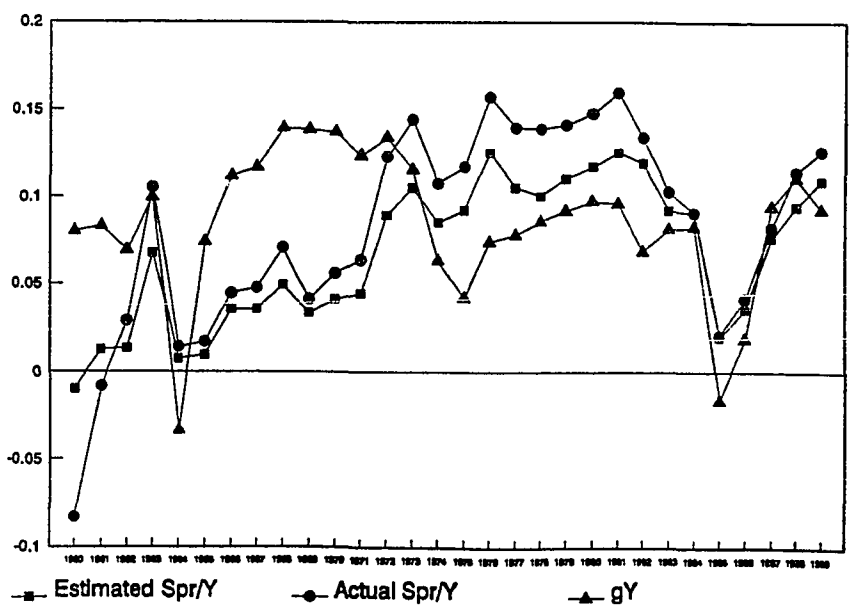


Figure 5.6 Estimated and Actual Scpf/Y Movement

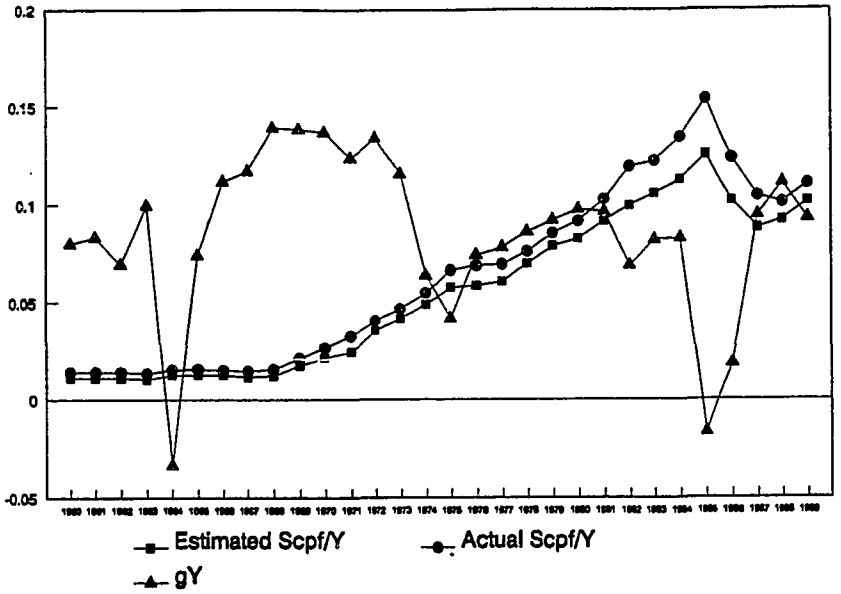
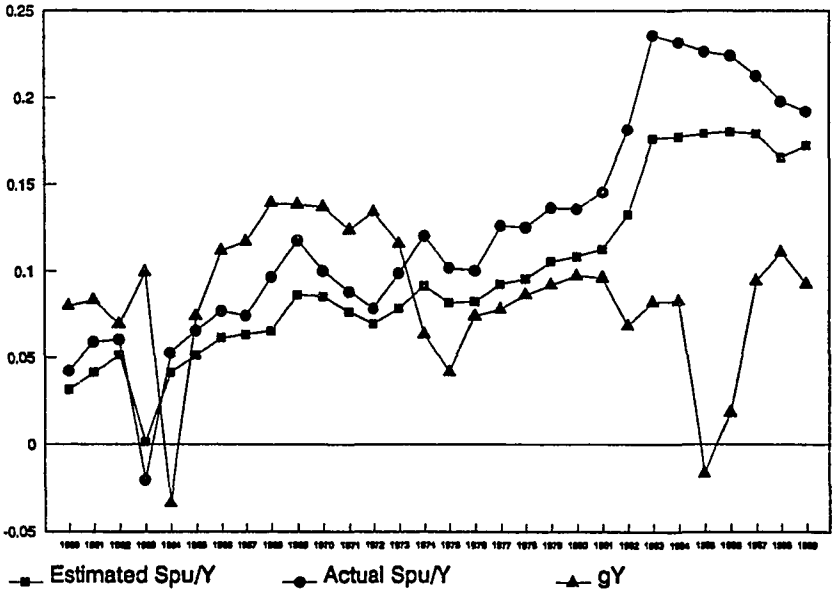


Figure 5.7 Estimated and Actual Spu/Y Movement



A probable explanation not based on cause and effect relation can be offered for the different estimated coefficients of the saving components is the differing degree of cyclical instability among the saving components.

First, due to income effects, all components of domestic savings would rise with income. Thus over the growth cycle, it is expected that all saving components would vary in the same direction as and more than proportionately than income. Since voluntary private savings is more volatile than both public and forced savings, thus, when divided by income, as shown in figure 5.5, the ratio of voluntary private savings to income would more closely track the income growth movement.

Public savings, on the other hand, is less volatile than voluntary private savings, thus, when divided by income, as shown in figure 5.6, a given change in public savings ratio would be associated with a larger shift in growth rate as compared to the private savings ratio

Forced savings, as discussed earlier, are likely to exhibit a counter-cyclical trend since they are based on wage income. As long as wages are sticky, then when growth slows, wages would fall less than growth. Thus, when divided by income, as indicated by figure 5.7, the forced savings ratio falls as the growth rate increase and vice-versa, yielding a negative relation.

5.34 The Behavior of the Growth of Labor Supply Function

The coefficients in the structural equation are similar to the one obtained under the disaggregated investment system of equations. Both income and population growth are significant at the 95 percent confidence level and are

Eq 5.11 Dependent Variable = gL

Independent Variable	Estimated Coefficient	Standard Error	t-value
gY	0.71561	0.21623	3.3094
$gPop_{15-64}$	2.15347	0.60879	3.5373
T_m	-0.10568E-01	0.70566E-02	-1.4976
R_{cpf}	-0.24626E-01	0.29962E-01	-0.8219
Constant	-0.42078E-01	0.27539E-01	-1.5279

$R^2 = 0.5162 \qquad DW = 1.6810$

positively related to income. These suggest that higher wage income and faster population growth promote labor supply growth in Singapore.

5.4 Exploration on the Roles of the *CPF* Contribution Rate

Many of the savings relations discussed above are somewhat unsatisfactory since possible cyclical associations cannot be clearly accounted for. The problem arises when both dependent and independent variables are in many instances determined by third variables in or out of the equation and the system of linear simultaneous equations does not make the necessary adjustment.

Several *OLS* regressions are run using the *CPF* contribution rate as the independent variable. The results are presented below:

$R^2 = 0.183 \qquad DW = 1.1414$

$$gY = 0.93740\text{E-}01 - 0.41815\text{E-}01 R_{cpf}$$

$$(5.3314) \qquad (-1.72225)$$

The above regression yields a negative relation (significant at the 85 percent confidence level) between income growth and the rate of *CPF* contributions. A

one percent increase in the rate of contribution lowers income growth by about 0.04 percent. On the other hand, the system of simultaneous equations method presented on section 5.3 shows that a 1 percent increase in the *CPF* savings ratio reduces income growth by about 0.06 percent.

$R^2 = 0.9212 \qquad DW = 0.9871$

$$S/Y = 0.13644\text{E-}01 + 0.94465R_{cpf}$$

$$(18.093) \qquad (0.86048)$$

The above regression yields a positive relation (significant at the 99 percent confidence level) between gross domestic saving to income ratio and the rate of *CPF* contribution. A 1 percent increase in the rate of contribution would increase the gross domestic saving ratio by about 0.9 percent.

$R^2 = 0.3369 \qquad DW = 0.6607$

$$S_{pr}/Y = 0.18532\text{E-}01 + 0.23880R_{cpf}$$

$$(0.96374) \qquad (3.7715)$$

The above regression yields a positive correlation (significant at the 95 percent confidence level) between the voluntary private savings ratio and the *CPF* rate of contribution. A 1 percent increase in the rate of *CPF* contribution will increase the voluntary private savings ratio by about 0.24 percent. This compares to the result derived from the system of equation method, in which a 1 percent increase in the forced saving ratio raises the voluntary private savings ratio by about 0.48 percent. As discussed in chapter three, since all components of domestic savings are functions of income, one will expect, on *a priori* grounds,

a positive relation. However, if one could effectively control for income growth, then an unambiguous negative relation between voluntary and forced savings should result because of the crowding out effect of forced savings on private savings. It is quite clear that the *OLS* regression presented above did not correct for the income effect and the income effect had overpowered the substitution effect. However, the system of equation also shows a positive relation between voluntary private and forced savings ratios despite the fact that income growth has been controlled and simultaneous relations among growth and components of domestic savings are being corrected. One plausible explanation is that the system of equations on savings constrained growth had been misspecified.

$R^2 = 0.9440 \qquad DW = 0.5613$

$$S_{cpf}/Y = \text{-}0.20029\text{E-}01 + 0.30705R_{cpf}$$

$$(\text{-}4.6668) \qquad\qquad (21.727)$$

As expected, the rate of *CPF* contribution and the forced savings ratio exhibits a positive relation. A 1 percent increase in the rate augments the forced savings ratio by about 0.3 percent. The result is very similar to the one derived *via* the system method where a 1 percent increase in the rate raises the forced savings ratio by about 0.24 percent.

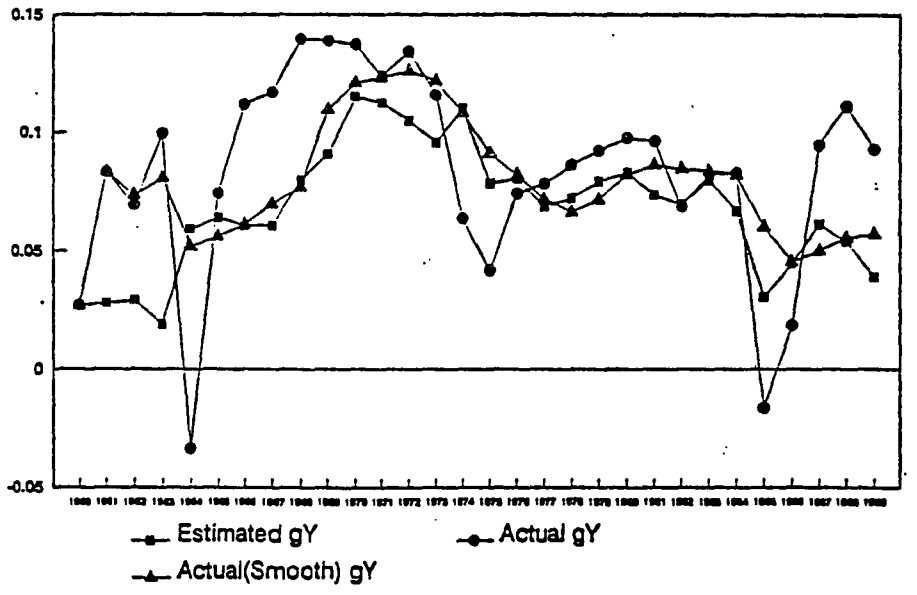
5.5 Growth Simultation Using Different Savings Results

Two sets of simultation are carried out using results from both the system and single equation method. First, coefficients of savings components derived from the system method are used to simulate the income growth movement. The

result of the simulation is presented in figure 5.7. The simulated gY movement closely matched that of actual (massaged) gY movement. Further, it displays close association with the actual (unmassage) gY movement.

Replacing the coefficient of S_{cpf}/Y (system method) with the coefficient of R_{cpf} (single equation method) and again simulate the gY movement, figure 5.8 demonstrates that single equation method which does not correct for simultaneous bias is perhaps less desirable since the estimated gY movement tracks the actual gY cycle less closely as compare to the system method.

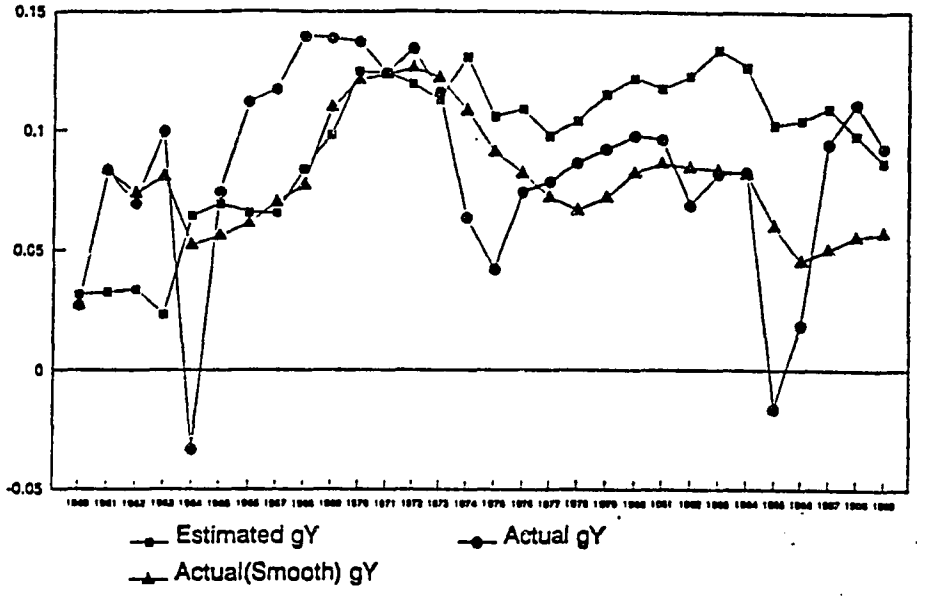
Figure 5.8 Estimated and Actual gY Movement
Using Estimated Coefficients of Saving Components



The actual(smooth) gY represents 5-Year Moving Average of Actual Growth Rate.

5.6 Cross Examination of the Growth Behaviors

Figure 5.9 Estimated and Actual gY Movement
Using Estimated Coefficients of Rcpf and other Saving Components



Eq 5.12 Comparative Growth Behaviors

Investment Behavior	Estimated Coefficient	Saving Behavior	Estimated Coefficient
I^P_{pr}/Y	0.24559	S_{pr}/Y	0.29452
I^H_{pr}/Y	0.26115	S_f/Y	0.32648
I^P_{pu}/Y	0.53928	S_{pu}/Y	0.48274
I^H_{pu}/Y	-0.80182	S_{cpf}/Y	-0.60277
gL	0.14520	gL	0.25212
gY_w	0.55608E-01	gY_w	0.51623E-01
Constant	0.31295E-01	Constant	0.23262E-01

The above table summarizses the differences in marginal contributions of disaggregated sectoral savings by source and disaggregated sectoral investment by type.

The capital constrained growth model presented in chapter three directly linked accumulation in capital to growth *via* the theoretical and analytical

framework laid down by Harrod and Domar. The accmulation in the capital stock, however, is only directly linked to disaggregated investment. But, such rather *ad hoc* disaggregation of investment by types may be imperfect and sectoral disaggreation of savings by source is employed to see whether it will provide additional clues to the reseach question.

Since voluntary private and foreign savings are being used to finance both private productive and housing investment, it is not surprising to find that statistically there are no differences in the marginal contributions between these two savings and investment ratios. Further, their marginal contribution rates remained remarkably stable across models.

The stable contribution is also present in both the public savings and productive investment ratios. The marginal contribution of public savings is significantly higher than that of both voluntary private and foreign savings, and similarly, the marginal contribution of the public productive investment is significantly higher than that of private investment. Again, the higher marginal contributions possessed by public saving and public productive investment suggest probable complementary effect of public investment on private investment. The complementary effect can be initiated in two plausible ways: first, private investment is stimulated by major infrastructure projects undertaken by government and the positive response by the private entrepreneurs causes multiplying effects on income and growth. Second, higher public savings are positively associated with public investment and higher public investment stimulates private investment and causes multiplying effects on income. The significant coefficients possessed by the dummy for major social infrastructure projects in both types of private investment functions partially supported the above hypothesis.

Public investment in residential construction and forced savings were both found to possess negative and significant marginal contributions to income growth, even though their coefficients are some what differentiated. If public investment is used to implement counter-cyclical aggregate demand policy, then the negative contribution by public housing investment is plausible. Further, if *CPF* savings was raised during almost the entire three decades, even during periods of slow growth and recession to ensure financing of the additional investment in public housing, its negative contribution is also probable.

Coefficients of the other independent variables, gL, remained positive and insignificant across models, suggesting the Singapore economy is indeed mainly driven by capital accumulation.

5.7 Descriptive Statistics for Data Used in the Systems

Descriptive Statistics for Data Used in Investment System.

Name	Mean	St.Dev	Variance	Minimum	Maximum
gY	0.82450E-01	0.43725E-01	0.19119E-02	-0.33517E-01	0.13937
I_{pr}^{P}/Y	0.17506	0.96167E-01	0.92481E-02	0.31201E-01	0.31528
I_{pr}^{H}/Y	0.49072E-01	0.20683E-01	0.42780E-03	0.94930E-02	0.81176E-01
I_{pu}^{P}/Y	0.77179E-01	0.23935E-01	0.57287E-03	0.25500E-01	0.13528
I_{pu}^{H}/Y	0.34760E-01	0.21337E-01	0.45526E-03	0.23260E-02	0.86764E-01
gL	0.43516E-01	0.26036E-01	0.67789E-03	-0.24847E-02	0.10152
gY_w	0.29447E-01	0.30540E-01	0.93270E-03	-0.27514E-01	0.52613E-01
I_{pu}/Y	0.11194	0.37281E-01	0.13899E-02	0.27826E-01	0.17295
DI_{pu}	0.36667	0.44978	0.20230	0.00000	1.00000
r	3.2838	5.2448	27.508	-12.149	8.60580
$gRes$	0.96044E-01	0.85833E-01	0.73674E-02	-0.29851E-01	0.31209
$dHhold$	8925	3127	0.97782E+08	11273	6725
I_{pr}/Y	0.22413	0.99980E-01	0.99960E-02	0.54234E-01	0.35020
$R_{(cpf,-1)}$	0.25500	0.14547	0.21162E-01	0.00000	0.50000
$gPop_{15-64}$	0.16723E-01	0.75393E-02	0.56841E-04	0.00000	0.37404E-01
T_m	0.15146	0.47394	0.22462	-1.86460	1.26600
R_{cpf}	0.27000	0.14142	0.19998E-01	0.10000	0.50000

Descriptive Statistics for Data Used in Saving System.

Name	Mean	St.Dev	Variance	Minimum	Maximum
gY	0.82450E-01	0.43725E-01	0.19119E-02	-0.33517E-01	0.13937
S_{pr}/Y	0.83007E-01	0.58183E-01	0.33852E-02	-0.82930E-01	0.15972
S_{cpf}/Y	0.62873E-01	0.44690E-01	0.19972E-02	0.13620E-01	0.15397
S_{pu}/Y	0.12282	0.64742E-01	0.41915E-02	-0.20179E-01	0.23546
S_f/Y	0.67369E-01	0.67582E-01	0.45673E-02	-0.75085E-01	0.21750
gL	0.43516E-01	0.26036E-01	0.67789E-03	-0.24847E-02	0.10152
gY_w	0.29447E-01	0.30540E-01	0.93270E-03	-0.27514E-01	0.52613E-01
rd	1.59410	4.73450	22.4150	-13.3990	7.1358
$YDep$	0.34680	0.93008E-01	0.86506E-02	0.23077	0.52090
$ODep$	0.61998E-01	0.15217E-01	0.23157E-03	0.30353E-01	0.85536E-01
R_{cpf}	0.27000	0.14142	0.19998E-01	0.10000	0.50000
I_{pu}/G	34.3740	8.45390	71.4680	17.8090	60.4070
$gPop_{15-64}$	0.16723E-01	0.75393E-02	0.56841E-04	0.00000	0.37404E-01
T_m	0.15146	0.47394	0.22462	-1.86460	1.26600

CHAPTER 6

POLICY IMPLICATIONS AND CONCLUSION

The high saving and investment rates achieved by Singapore and the other Asian *NICs* (Newly industrialized nations), and their sustained high economic growth leads one to ponder the probable casual relation between capital accumulation and economic growth.

The Singapore economy has achieved high saving basically *via* two routes: first, the existence of a dominant compulsory saving scheme (*CPF*), and second, the fiscal conservatism practiced by the government. The former transfers control of resources from private hands to the government, and the latter produces consistent public surpluses. Both imply a high concentration of resources at the disposal of the government. On the other hand, with the exception of investment in residential construction, the private sector still carrys out the bulk of capital formation. The above, coupled with a public policy of investing abroad, results in massive capital inflow to fill the large private resource gap.

The probable causal relation between capital accumulation and the unique resource mobilization method motivates the postulation of a disaggregated capital constrained growth model. Relying on the capital constrained growth theory pioneered by Harrod and Domar, aided with the assumption that government has successfully manipulated the population growth to stay above warranted growth, and thus growth is constrained by capital accumulation, the models postulate growth being constrained by either disaggregated sectoral investment or savings. Since capital accumulation is caused by investment, the former approach is theoretically valid. However, the employment of the second approach

is also supported since saving components may provide additional clues not captured by the investment details.

Since simultaneous bias occurrs among growth and investment, and among growth and savings, the separate construction of two systems of simultaneous equations are called for. The first one endogenized growth and disaggregated investment components, and the second one endogenized growth and saving details. The *3SLS* method is chosen because its estimator is shown to be consistent and asymptotically more efficient than the *2SLS* method. Further, it also corrects for inconsistencies when disturbances in the different structural equations are correlated.

Major empirical findings from the separate execution of the two models, and some of their implications are discussed below:

6.1 *CPF* Savings and Public Housing Investment

Perhaps the most important result obtained from both models is the negative marginal contributions to income growth by the investment in residential construction and by the *CPF* savings. The probable cause and effect explanation seems to be the frequent use of public housing construction as a tool to implement *counter-cyclical aggregate demand policy.* Indirect evidence supporting the above assertion is presented in chapter five, along with the results from the models. This indirect evidence, derived from *OLS* estimates, found that both construction and residential construction to income ratios by public sector exhibit significant negative relations with income growth and lagged behind income growth rates. On the other hand, the *CPF* contribution rate was constantly raised from 1960 to 1985 and from 1987 to 1989. As a result, the

flow of *CPF* savings basically increased during the entire three decades, even during periods of slow growth and recession.

Plausible non-cause and effect relations between public investment in housing and growth, and between forced savings and growth are clearly also present. Since public investment in housing is one least volatile components of public spending, it tends to vary less than proportionately with income as compared to private spending. Thus when divided by income, the ratio of public investment to income would be falling as growth rates increase and vice-versa, resulting in a negative correlation. Similarly, the flow of *CPF* savings is based on wage income and given some degree of wage stickiness, when growth slows, wages would fall less than growth, and thus the ratio of forced savings to income would increase in a slowdown or recession, and decrease in an expansion, resulting in a negative annual relation to growth.

Despite the negative relation between public housing investment and growth, and the negative correlation of the *CPF* savings to growth, there is wide agreement in Singapore that the *Central Provident Fund* is an institution of very considerable social and economic importance. It is a reflection of the sincere concern of the government for the economic security of the population and the fund is often praised for its self-supporting nature, without imposing burden on the state's treasury, and its avoidance of intergenerational transfers, whereby each generation contributes to the support of its predecessors. However, critics have argued that the *CPF*, by absorbing a huge proportion of individual's incomes, has detered individual's ability to access their own financial resources, and weaken their economic initiative and entrepreneurial spirit (Lim, 1985). Also, given the nature of the forced saving scheme, the only practical way for

most savers to convert future consumption into present consumption is to use accumulated forced savings to purchase public flats, and some have raised the question of excessive consumption of housing services by Singaporeans. Under the present scheme, up to the whole amount of the Ordinary Account, constituting 80 percent of one's *CPF* contribution, is at the disposal of forced savers for the purpose of purchasing residential properties. If the members are induced to upgrade their housing without restraint, there is the danger of their putting an excessive amount of their savings into real estate. The study conducted by the *CPF* Study Group (1985) argued that the ability to finance old age livelihood after such excessive consumption of housing services might be seriously impaired, given the longer life expectancy and rapidly rising standard of living.

Although the negative marginal contributions suggest investment in public housing and *CPF* savings are growth retarding, it may well reflect only a short-run relationship since annual variations of data are used. In fact, if the government uses such a counter-cyclical policy to adjust actual output to equate potential output, it may well be growth promoting in the long run.

Nevertheless, the negative marginal contributions to output growth suggest in principle that Singapore could achieve a higher growth rate if the *CPF* contribution rate was lowered and the investment in public residential construction were diverted to other types of investment. Simultations are designed and carried out based on this proposition.

First, the study of the *CPF* scheme undertaken by the *CPF* Study Group (1985) is consulted in which they estimate that a contribution rate of between 36 to 39 percent is optimal. Taking 1989 as the base year, the *CPF* contribution rates are separately set at 35, 40, 45 and 50 percent of wage income.

A contribution rate of 50 percent would have existed if Singapore had not run into a recession during 1985-86, causing government to revise contribution rates downward from a peak of 50 percent on 1985. Contribution rates of 35 and 40 percent in turn represent the optimal rates suggested by the *CPF* study group.

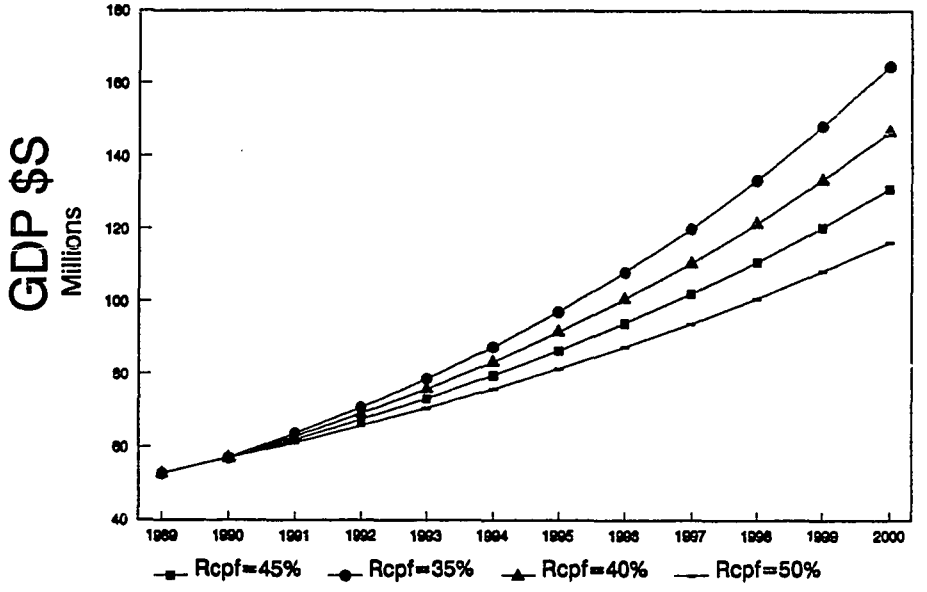
Several assumptions were applied to these simulations which run from 1990 to year 2000:

First, the four disaggregated savings ratios are calculated based on their average ratios from 1980 to 1989. Since during the 1980s Singapore realized an average *CPF* contribution rate of about 45 percent, these savings ratios are to remain constant for the 45 percent scenario. However, for the other three scenarios, the *CPF* savings are to be adjusted based on their respective contribution rates.

Second, 20 percent of the increase or decrease of *CPF* savings due to rates deviating from the benchmark of 45 percent are to be applied to both public savings, S_{pu}, and voluntary private savings, S_{pr}. The reason being that the marginal propensity to consume out of the GDP in Singapore is approximately 0.6, thus any decrease in the *CPF* savings would result in an increase consumption by 60 percent of the changing amount. The reason for voluntary private savings and public savings to split the remaining amount is given higher take home pay due to reduction in contribution rate, a proportion of it would be saved voluntarily. In addition, higher wage income net of *CPF* is taxable, and would result in higher tax revenue and higher public savings.

Third, the gross investment rate is to remain at about 40 percent of GDP which was the average ratio for the 1980s. The net inflow of foreign saving, S_f, would be adjusted accordingly since $S_f = I$ minus $(S_{pr} + S_{cpf} + S_{pu})$.

Figure 6.1 Simulated GDP Movement From Year 1990 to 2000 Based on Different CPF Contribution Rates



The simulation result (figure 6.1) suggests that if the rate of *CPF* contribution was set at 35 percent of nominal wage income, the Singapore economy would grow at an annual rate of 10.9 percent in the next decade. If the rate was 40 percent instead, the annual growth would be 9.75 percent. These two projected average growth rates compared favorably with the 8.6 and 7.4 percent growth if the rate of contributions were to stay rigidly high at 45 percent and 50 percent respectively.

6.2 Public Sector Savings and Productive Investment

Public saving and productive investment are shown to contribute the most to income growth in Singapore. Several reasons based on cause and effect relations are put forward to explain their higher marginal contributions *vis-a-*

vis the voluntary private and foreign savings and private investment. First, the complementary effect between public and private investment. When public investment is raised *via* construction of major social infrastructure projects, both types of private investment, in anticipation of higher aggregate demand, respond positively to increasing investment opportunities and returns. Higher growth is than augmented *via* multiplying effects.

Second, there is positive association between public savings, public productive investment and growth. A rise in the public savings in Singapore will typically cause higher public investment, and in turn private entrepreneurs responds positively by increasing private investment, causing a multiplying effect on income and growth.

On the other hand, plausible non-cause and effect relations alone are also capable of explaining the higher coefficients possessed by both public productive investment and public savings. Given that both productive investment and savings by the public sector are less volatile than investments and savings by the private sector, a given change in public produtive investment and savings ratios would be associated with a larger change in income growth rates than would a similar size change in either type of private investments and voluntary private savings ratios.

6.3 Voluntary Private/Foreign Savings and Private Investment

Voluntary private savings, together with the inflow of foreign savings, are mobilized to finance private investment in Singapore. The empirical results obtained from chapter five *via* the two models indicate, statistically, that there is no difference between the marginal contributions of the voluntary private and

foreign savings, and between the marginal contributions of private productive and housing investment to output growth. Further, their coefficients across models remained remarkably stable.

The fact that both private savings and investment are statistically significant in affecting growth means the financial sector is providing fairly efficient links between voluntary private/foreign savings and private investments. One measure of the pace of financial development is the declining velocity of money and quasi-money. As demonstrated by the financial development models, as financial deepening occurs, lower money creation first squeezes credit and causes the velocity of money to rise and brings about recession in the short run, but, as inflation expectations fall, the real cost of holding money declines, raising the real money demand, reducing the velocity of money, and producing stronger economic growth in the long run (Kapur, 1976; Galbis, 1977). Using centered monthly average money stock, Singapore experienced a declining annual velocity of circulation of about negative 8.95 percent for the period 1960 to 1989.

The financial sector both indirectly and directly contributes to growth *via* the process of resource mobilization. The more efficient the financial intermediation, the more private sector resource mobilization contributes to growth. In the following *OLS* regressions, the nominal deposit rate, nd, and the real deposit rate, rd, are both shown to be positive and significantly related to the income growth rate, gY.

$R^2 = 0.6234 \qquad DW = 0.9214$

$$gY = \text{-}0.024236 + \underset{(4.1526)}{0.75970nd} - \underset{(2.2248)}{0.15537p^e} + \underset{(-1.4909)}{0.21754Y/N}$$

$R^2 = 0.5093 \qquad DW = 1.1766$

$$gY = 0.15942 + 0.15623rd + 0.401522Y/N$$

$$(2.2236) \qquad (2.6021)$$

where p^e is expected inflation and Y/N the per capita income.

Using incremental capital to output (ICOR) ratio as a crude measure of investment productivity, another set of single equation econometric estimates suggests that an increase in the real deposit rate of interest is associated with a declining incremental capital/output (ICOR) ratio. Three seperate measures of ICORs are used: first, the ratio of the change in overall capital stock (*i.e.*, gross investment) to the change in real GDP, $I/dY = ICOR$, second, the ratio of the change in private productive capital stock to change in real GDP, $I^P_{pr}/dY = ICOR^P_{pr}$, and third, the ratio of the change in private housing capital stock to change in real GDP, $I^H_{pr}/dY = ICOR^H_{pr}$. The OLS regression results are presented below:

$R^2 = 0.206 \qquad DW = 2.7342$

$$ICOR = 3.7611 - 0.75874rd$$

$$(-1.39539)$$

$R^2 = 0.3776 \qquad DW = 1.3993$

$$ICOR^P_{pr} = 4.2195 - 0.42147rd$$

$$(-2.4150)$$

$R^2 = 0.4758 \qquad DW = 1.6668$

$$ICOR_{pr}^{H} = 0.82501 - 0.16576rd$$

$$(-2.5482)$$

If lower $ICORs$ do imply higher investment efficiency, the negative and mostly significant coefficients of real deposit rate, rd, suggests improving financial intermediation leads to higher productivity in investment. Since voluntary private and foreign saving are the intermediate links in the process of growth, their positive contributions to growth will depend on the existence of efficient financial intermediation. The fact that voluntary private/foreign saving and private investment make significant contributions to income growth means that some of these factors, (*i.e.,* various modes of efficient financial intermediation) must exist.

Although the above concentrates on using effective financial intermediation as the reason for the positive marginal contributions to growth by either type of private investment and voluntary private savings, there are plausible non-cause and effect explanations based on the differing degree of cyclical instability among growth and investment and saving components. Since either type of private investment is more volatile than public productive investment over the growth cycle, when divided by income, the private investment to income ratios would more closely track the income growth path. As a result, as compared to public productive investment, a given change in either private investment ratios would be associated with a smaller change in the growth rate. The same non-cause and effect relation applies to voluntary private savings and growth, and as a result, a given change in voluntary private savings ratio would be connected with a smaller change in the growth rate as compared to the public savings ratio.

6.4 Labor Productivity and Growth

The empirical results from both models in chapter five indicate that the growth in labor supply is not a significant explanatory factor of income growth. This somewhat confirmed the finding by Tsao (1986). Using the *sources of growth accounting approach* developed by Dension (1962), she found that the Singapore economy was mainly driven by growth in capital stock. However, a somewhat more familiar method of analyzing sources of growth involves allocating the contribution of capital to labor productivity, and thus growth is the result of an increase in labor inputs and in labor productivity. Based on Tsao's finding, Krause (1987)'s empirical result is provided below:

Table 6.1 Labor Productivity in Singapore, 1966-1980, In Percent.

Period	Total Labor Productivity	Composition of Labor	Composition of Capital	Stock per Man-Hour	TFP
1966-72	6.9	0.2	0.5	5.6	0.6
1972-80	3.2	0.3	–0.1	3.9	–0.9

As seen in table 6.1 and consistent with the findings of Tsao, the increase in average labor productivity in the 1966-72 period of 6.9 percent was due mainly to increase in capital stock per worker. The 3.2 percent increase in labor productivity during the 1972-80 period was even more dependent on the increase in capital per worker.

Assuming capital stock accumulates by the amount of gross investment, the capital stock per labor, K/L, is found to be positive and significantly related to GDP per labor, Y/L.

$R^2 = 0.8566 \qquad DW = 0.2977$

$$Y/L = 0.0282386 + \underset{(11.719)}{0.92550}K/L$$

The above *OLS* regression result supports the findings by Tsao (1986) and Krause (1987), and further suggests that the income growth process in Singapore is mainly driven by endowing labor with more and better capital stock.

6.5 Empirical and Methodological Contributions

The quantitative evidence derived from the systems of equations in chapter five, and further evidence and analysis presented above points to a few empirical contributions:

First, based on the empirical results obtained from the two systems of simultaneous equations, the Harrod and Domar's capital constrained growth model can be meaningfully applied to Singapore since the evidence indicates that growth in Singapore in the last three decades is indeed constrained by capital accumulation.

Second, the empirical evidence supports the modification of Harrod's original model, *i.e.,* to take into account the possible differences in productivities of capital of various kinds. On the basis of statistical testing, postulation of growth constrained by various kinds of capital is valid since detailed disaggre-

gation of investment and savings yield differences in marginal contribution to growth. Disaggregation of investment found that public productive investment contribute more to growth *vis-a-vis* private investment, and public housing investment retarded growth. As a proxy for the unavailable investment details, disaggregation of savings obtained very similar results. Public savings was found to contribute more to growth *vis-a-vis* private and foreign savings, and forced savings retarded growth. However, as discussed earlier, these correlations between disaggregated investment components and growth, and between saving details and growth may be due to non-cause and effect relations, and are simply the results of the differing degrees of cyclical instability between growth movement and each investment and saving components.

Third, the coefficients remained remarkably stable across models, demonstrating that one could measure contributions of capital stock to growth either by detailed disaggregation of savings or investment. Thus, in the case of Singapore, sectoral disaggregation of savings by source serves as a good proxy for sectoral disaggregation of investment by types.

Fourth, the growth of labor supply is not a significant explanatory factor of growth in Singapore. This provides support for the finding by Tsao (1986), in which the result is obtained *via* a different approach. However, empirical evidence presented earlier also suggests the growth in per labor income is closely correlated with increase in capital stock and the growth of the Singapore economy is indeed propelled by endowing labor with more and better capital stock.

Fifth, public savings and productive investments have provided higher marginal contributions to growth. A probable cause and effect relation is the complementary effect between private investment and major social infrastruc-

ture projects, where private investment is stimulated by the prospect of higher aggregate demand and caused multiplying effects on growth. Also, if higher public savings are positively associated with higher public investment, then, again, private investment could be encouraged by prospects of higher public investment and causes multiplying effects on growth. However, the above does not preclude the existence of plausible non-cause and effect relation. Since both public productive investment and public savings tend to be less volatile than private investment and savings, thus, when divided by income, a given change in public productive investment and the public savings ratio would be associated with a larger change in the growth rate as compared to both types of private investment and voluntary private savings ratios.

Sixth, the growth retarding process by the public housing investment attests the use of such spending by government as a tool to execute counter-cyclical policy during periods of slow growth and recession. However, since annual data are used, the negative relation is thus only short-run. In fact, if such counter-cyclical policy could adjust actual output to equate potential output, then it could be growth promoting in the long run. Such cause and effect relations may not be the only factor in causing the negative correlation. Plausible non-cause and effect relation could be again caused by the differing degree of cyclical instability between each investment component and growth. Since investment spending on public housing is probably the least volatile of the investment components, and would probably change less proportionately with income, then, when divided by income, public housing investment ratio would be falling as growth rates climb and vice-versa, causing a negative relation. The negative relation between *CPF* savings and growth is also likely to be a result

of a similar non-cause and effect association. Since forced savings are based on wage income, and if there is some degree of stickiness in wage movement, then, when growth slows, wages would fall less than growth and the ratio of forced saving to income would increase during periods of slow growth and recession, and decline during an economic expansion, giving a negative annual relation to growth.

In the area of methodology, postulation of growth being constrained by disaggregated capital accumulation is valid since the models reveal statistical differences in marginal contributions among investment and savings compoents. The results of the models also indicate that Harrod and Domar's aggregate capital constrained growth framework is applicable to a real growing economy such as Singapore's.

Further, sectoral disaggregation of savings by source yields results that are very similar to those obtained from the investment model. Hence, it will be proper for future research to use saving details as a proxy for investment details when the latter is not available.

In terms of the direction for future research, similar models can be applied to the other high savings and fast growing economies of Asian *NICs*. Since these economies rely on different means to raise and mobilize resources, the marginal contributions of disaggregated capital may differ across countries.

6.6 Policy Implications

The pervasive presence of government in economic activities is accompanied by another phenomenon: the lack of private local entrepreneurs.[1] Again, the deliberate policy of investing abroad by government resulted in massive capital inflow to finance the resource gap of private sector, and these foreign ventures mainly took the form of investments by big multinational corporations which usually leave very little room for domestic investors to participate. Since indigenous household savings are mostly tied up with the forced saving scheme, and the remaining voluntary private saving is grossly inadequate to finance the needs for private investment, indigenous entreprenuership is severely curtailed.

On a recent study conducted on local entrepreneurship in Singapore, Lee and Low (1990) found inclusive evidence regarding the lack of local entrepreneurship in the aggregate in Singapore *vis-a-vis* the other Asian *NICs*. The lack of local entrepreneurship must stem from the fact that there is significant foreign and public ownership, and the combination of the two has crowded out local entrepreneurship. The inconclusive evidence includes:

First, based on the notion that the number of entrepreneurs in a country depends on the number of businesses, the study found that Singapore, together with Taiwan, had the least number of business establishments per thousand people. The ratios are 27.3 for Singapore and Taiwan, 29.8 for Hong Kong and 35.4 for South Korea.[2]

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[1] In definitional terms, private local entrepreneurs refer to businesses owned by citizens or permanent residents (Lee and Low, 1990)

[2] The study includes the manufacturing, commerce and services sectors. Other sectors, noticeably agricultural, are excluded. Further, manufacturing establishments with less than 10 workers are also excluded. One would suspect that if all sectors are included, the ratios would be higher for Taiwan, Hong Kong and Korea, and smaller for Singapore.

Second, Singapore has the second lowest number of self-employed in the Asian *NICs*. As a percentage of work force, the ratios are 10.8 for Hong Kong, 13.8 for Singapore, 21.4 for Taiwan and 25.5 for South Korea.

Third, as compared to other Asian *NICs*, the sectoral study inconclusively shows that local private entrepreneurs are not lacking in sectors like commerce, transportation and communications, finance and business services and social services. However, conclusive evidence, indicating crowding out of local private businesses, is found in manufacturing sector.

Although in the aggregate, inconclusive evidence did point to a general weakness in private local entrepreneurship in Singapore as compared to its peers, however, the conclusive evidence on the dominance of foreign ownership in Singapore should not come as a surprise. The massive capital inflow over time, caused by government's deliberate and persistent policy of investing abroad, is mainly concentrated in manufacturing.

Hence, the problem that needs to be addressed by government is not merely to encourage private local entrepreneurship, but, specifically to promote indigenous industrial entrepreneurship. In the earlier section, discussion was made on the reduction of *CPF* contribution and further liberalization in the use of *CPF* savings. If providing its citizen with low-cost and quality housing is the political and social objective of the government, the fact that today, government has successfully housed 89 percent of the population in public housing, and turned Singapore into a 90 percent houseowner society, the goals of the government has been largely achieved, and the need for such a dominant forced saving scheme has greatly diminished.

A lowering in the rate of contribution will, in general, encourage diversification of the private saver's portfolio, ease the problem of raising start-up capital for small businesses, and in general promote private initiatives and entrepreneurial spirit. The *CPF* study group (1985) has recommended a combined contribution rate of 35 percent to enable an average Singapore household to take care for the needs of housing, medical and old-age retirement.[3] Clearly, such a contribution rate would fulfill the need of a *risk-adverse* individual. Further liberalization should allow the use of up to 40 percent of *CPF* balance for approved investment and business ventures. Guidelines may be drawn up to ensure that the flow of such savings are mainly channeled into manufacturing, where local private entrepreneurship is truly lacking, and not to commerce and other service-oriented industries, where there is no evidence of any severe shortage of local owners.

[3] Of the 35 percent contribution rate, 16 percent is recommended to go into purchase of annuities for retirement purposes. Thus, the annuities for retirement purpose actually accounts for 40 percent of total contributions.

BIBLIOGRAPHY

G. Abbott, "A Survey on Savings and Financial Development in Asian Developing Countries." *Savings and Development.* 1985, pp.395–419.

S. Abe, M. Fry, B. Min, P. Vongvipanond and T. Yu, "Financial Liberalisation and Domestic Saving in Economic Development: An Empirical Test for Six Countries." *Pakistan Development Review.* Autumn 1977, pp.298–308

S. Abe, M. Fry, B. Min, P. Vongvipanond and T. Yu, "The Demand for Money in Pakistan: Some Alternative Estimates." *Pakistan Development Review.* Summer 1975, pp.249–257.

M. Abramovitz, "Resources and Output Trends in U.S. since 1870." *American Economic Review: Papers and Proceedings*, May 1956, pp.5–23.

G. Adams and S. Wachter, *Savings and Capital Formation: The Policy Options.* Lexington Books (Lexington), 1985.

I. Adelman and C. Morris, *Society, Politics and Economic Development: A Quantitative Approach.* Johns Hopkins University Press (Baltimore), 1967.

S. Ahmad, "Foreign Capital Inflow and Economic Growth: A Two Gap Model for the Bangladesh Economy." *The Bangladesh Development Studies*, March 1990.

Asian Development Bank, *Domestic Resource Mobilization through Financial Development.* Asian Development Bank Economic Office (Manila), February 1985.

Asian Development Bank, *Improving Domestic Resource Mobilization through Financial Development.* Asian Development Bank Economic Office (Manila), September 1985.

K. Arrow, "An Extension of the Basic Theorems of Classical Welfare Economics." In *Readings in Mathematical Economics* edited by P. Newman. John Kopkins University Press (Baltimore), 1951.

K. Arrow and F. Hahn, *General Competitive Analysis.* Holden-Day (San Francisco), 1971.

M. Bailey, "The Welfare Cost of Inflationary Finance." *Journal of Political Economy.* April 1956, pp.93–110.

B. Balassa, "Developing Country Debt: Policies and Prospects." *World Bank DRD-149.* World Bank (Washington D.C.), July 1985.

B. Balassa and D. McCarthy, "Adjustment Policies in Developing Countries, 1979–83." *World Bank Staff Working Paper No. 675.* World Bank (Washington D.C.), November 1984.

B. Balassa, "Outward Orientation." In *Handbook of Development Economics* edited by Chenery and Srinivasan. Vol.2, North Holland (Amsterdam), 1989.

B. Bijan and M. Khan, "Government Deficits and the Inflationary Process in Developing Countries." *International Monetary Fund Staff Papers.* September 1978, pp.383–416.

B. Bijan and M. Khan, "Inflationary Finance and the Dynamics of Inflation: Indonesia, 1951–72." *American Economic Review.* June 1977, pp.390–403.

J. Bhagwato and A. Krueger, "Exchange Control, Liberalization and Economic Development." *American Economic Review: Papers and Proceedings*, May 1973, pp.419–27.

H. Bruton, "The Two–Gap Approach to Aid and Development." *American Economic Review.* June 1969, pp.439–446.

D. Champernowne, "The Production Function and the Theory of Capital: A Comment." *The Review of Economics and Statistics.* April, 1954. pp.112–35.

D. Champernowne, "Capital Accumulation and the Maintenance of Full Employment." *The Economic Journal*, 1958, pp.221–44.

E. Chen, "Factor Inputs, Total Factor productivity and Economic Growth: The Asian Case." *The Developing Economies.* 1977, pp.121–143.

H. Chenery and N. Carter, "Internal and External Aspects of Development Performance." *World Bank Discussion Paper No. 141.* December, 1972.

H. Chenery and N. Carter, "Foreign Assistance and Development Performance, 1960–1970."*American Economic Review.* May 1973, pp. 459–68.

H. Chenery and MacEwan, "Optimal Patterns of Growth and Aid: The Case of Pakistan." In *The Theory and Designs of Development* edited by Adelman and Thorbecke. Baltimore, 1966.

H. Chenery and M. Syrquin, *Patterns of Development 1950-70.* Oxford University Press (London), 1975.

H. Chenery and M. Syrquin, *Patterns of Development 1950-83*, *World Bank Discussion Papers.* No.41, 1989.

H. Chenery and A. Strout, "Foreign Assistance and Economic Development." *American Economic Review.* September 1966, pp.679–733.

H. Chenery, S. Robinson and M Syrquin, *Industrialization and Growth, A Comparative Study.* Oxford University Press (World Bank), 1986.

H. Chenery and M. Syrquin, "Typical Patterns of Transformation." In *Industrialization and Growth* edited by Chenery, Robinson and Syrquin. Oxford University Press (World Bank), 1986, pp.37–84.

H. Chenery and M. Syrquin, "The Semi-Industrial Countries."In *Industrialization and Growth* edited by Chenery, Robinson and Syrquin. Oxford University Press (World Bank), 1986, pp.84-118.

H. Chenery, J. Lewis, J. DeMelo and S. Robinson, "Alternative Routes to Development." In *Industrialization and Growth* edited by Chenery, Robinson and Syrquin. Oxford University Press (World Bank), 1986, pp.311-47.

H. Chenery and M. Syrquin, "Three Decades of Industrialization." *World Bank Economic Review.* May 1989.

H. Cheng, "Structure of the Banking Industry in Singapore." *Manchester.* Center for Business Research (Manchester), April 1984.

H. Cheng, "Financial Deepening in Pacific Basin Countries." *Federal Reserve Bank of San Francisco Economic Review.* Summer 1980, pp.43–56.

C. Choon and M. Veall, "A Note on Social Security and Private Savings in Singapore." *Public Finance.* Vol.40, no.2, 1985.

G. Datta and P. Shome, "Social Security and Household Savings: Asian Experience.' *The Developing Economies.* 1981, pp.143–60.

E. Denison, "The Unimportance of the Embodied Question." *The American Economic Review.* 1964, pp.90–4.

E. Denison, "The Sources of Economic Growth in the U.S. and the Alternatives before Us." *Accounting for the Economic Growth in the U.S., 1929-69.* Brookings Institution (New York), (1962) 1974.

E. Domar, "Capital Expansion, Rate of Growth and Employment." *Econometrica.* 1946, pp.137–47.

E. Domar, "Expansion and Employment." *American Economic Review.* 1947, pp.34–55.

E. Domar, *Essays in the Theory of Economic Growth.* Oxford University Press (New York), 1957.

E. Domar, "The Capital-Output Ratio in the United States: Its Variation and Stability." In *Theory of Capital* edited by F. Lutz. Macmillan (London), 1961.

R. Dornbusch and S Fischer, *Macroeconomics.* 4th Edition. McGraw-Hill (U.S.), 1987.

J. Dowling and U. Hiemenz, "Aid, Saving, and Growth in the Asian Region." *The Developing Economies.* March 1983.

E. Drandakis and E. Phelps, "A Model of Induced Invention, Growth and Distribution." *Economic Journal.* 1966, pp.823–40.

G. Feder, "On Exports and Economic Growth." *Journal of Development Economics.* March/April 1983, pp.59–73.

G. Feder, "Growth in Semi-Industrial Countries: A Statistical Analysis." In *Industrialization and Growth* edited by Chenery, Robinson and Syrquin. Oxford University Press (New York), 1986.

W. Fellner, "Long-Term Trends in Private Capital Formation." *Long-Range Economic Projections.* National Bureau of Economic Research, 1954.

M. Friedman and A. Schwartz, *A Monetary History of the United States, 1867-1960.* Princeton University Press (New York), 1971.

M. Friedman, "Government Revenue from Inflation." *Journal of Political Economy.* August 1971, pp.846–56.

M. Fry, "Manipulating Demand for Money." In *Essays in Modern Economics* edited by M. Parkin. Longman (London), 1973.

M. Fry, "Financial Development Models: Theory and Empirical Test for Selected SEANZA Countries." In *SEANZA Lectures: 1978* edited by the Bank of Korea. Bank of Korea (Seoul), 1979.

M. Fry, "Interest Rates In Asia: An Examination of Interest Rates Policies in Burma, India, Indonesia, Korea, Malaysia, Nepal, Pakistan, the Philippines, Singapore, Sri-Lanka, Taiwan and Thailand." *Asian Development.* International Monetary Fund (Washington D.C.), 1981.

M. Fry, "Saving, Financial Intermediation and Economic Growth in Asia." *Asian Development Review.* 1984, pp.82–91.

M. Fry and A. Mason, "The Variable Rate-of-Growth effect in the Life-Cycle Saving Model." *Economic Inquiry.* Vol.20, no.3., July 1982.

M. Fry and R. Williams, *American Money and Banking.* John Wiley and Sons (New York), 1984.

M. Fry, *Money, Interest, and Banking in Economic Development.* The Johns Hopkins University Press (Baltimore), 1988.

V. Furstenberg, *The Government and Capital Formation.* Ballinger (Cambridge), 1980.

V. Galbis, "Financial Intermediation and Economic Growth in LDCs." IMF Discussion Paper 74/103. International Monetary Fund (Washington D.C.), 1974.

V. Galbis, "Financial Intermediation and Economic Growth in Less-Developed Countries: A Theoretical Approach." *Journal of Development Studies, 13(2).* 1977, pp.58–72.

K. Gupta, "Dependency Rates and Saving Rates: Comment." *American Economic Review.* June 1971, pp.469–80.

J. Gurley and E. Shaw, "Financial Aspects of Economic Development." *American Economic Review.* September 1955, pp.515–38.

J. Gurley and E. Shaw, "Financial Structures and Economic Development." *Economic Development and Culture Change.* April 1967, pp.257–68.

R. Harrod, "An Essay in Dynamic Theory." *The Economic Journal.* 1939, pp.14–33.

R. Harrod, *Towards a Dynamic Economics.* Macmillan (London), 1954.

F. Hahn and R. Matthews, " The Theory of Economic Growth: A Survey." *The Economic Journal.* 1964, pp.779–902.

J. Hicks, *The Theory of Wages.* Oxford University Press (Oxford), 2nd.Ed., 1963.

J. Hicks, *Capital and Growth.* Oxford University Press (Oxford), 1965.

K. Inada, "On the Stability of Growth Equilibria In Two-Sector Models." *Review of Economic Studies.* 1964, pp.127–42.

D. Jorgenson, "The Embodiment Hypothesis." *Journal of Political Economy.* 1966, pp.1–17.

D. Jorgenson and Z. Griliches, "The Explanation of Productivity Change." *Review of Economics and Statistics.* 1967, pp. 249–83.

D. Jorgenson and Z. Griliches, "Issues in Growth Accounting: A Reply to Edward Denison." *Survey of Current Business.* 1972, pp. 65–94.

H. Jones, *An Introduction to Modern Theories of Economic Growth.* Thomas Nelson and Sons (London), 1975.

R. Kahn, "Exercises in the Analysis of Growth." *Oxford Economic Papers.* 1959, pp.143–56.

H. Kanamori, "Economic Growth and Exports." In *Economic Growth: The Japanese Experience Since the Meiji Era* edited by L. Klein and K. Ohkawa. Irwin-Dorsey (Ontario), 1968, pp.303–325.

B. Kapur, "Monetary Growth Models of Less Developed Economies." Unpublished Ph.D. thesis. Stanford Univeristy (Stanford), 1974.

B. Kapur, "Alternative Stabilization Policies for Less Developed Economies." *Journal of Political Economy, 84(4,i).* 1976, pp.777-795.

B. Kapur, "Two Approaches to Ending Inflation." In *Money and Finance in Economic Growth and Development: Essays in Honor of Edward Shaw* edited by Ronald McKinnon. Marcel Dekker (New York), 1976, pp.199–221.

J. Kearl, *Inflation-Induced Distortions of the Real Economy: An Econometric and Simulation Study of Housing and Mortgage Innovation.* MIT Press (Mass), 1975.

C. Kennedy, "Induced Bias in Innovation and the Theory of Distribution." *Economic Journal.* 1964, pp.541–7.

C. Kennedy and A. Thirlwall, "Technical Progress: A Survey." *Economic Journal.* 1972, pp.11–72.

J. Keynes, *The General Theory of Employment, Interest and Money.* Harcourt, Brac and World Inc (New York), 1936, pp.31 and 219–220.

L. Klein, *Economic Growth: The Japanese Experience since the Meiji Era.* Irwin-Dorsey Limited (Ontario), 1968.

L. Klein, *Economic Theory and Econometrics.* Basil Blackwell (London), 1985.

Y. Kubo, S. Robinson and M. Syrquin, "The Methodology of Multisector Comparative Analysis." *Industrialization and Growth.* Oxford University Press (New York), 1986, pp.121–147.

M. Kurz, "A Two-Sector Extension of Swan's Model of Economic Growth: The Case of No Technical Change." *The International Economic Review.* 1963, pp.68–79.

S. Kuznets, "Quantitative Aspects of Economic Growth of Nations; Capital Formation Proportions: International Comparisons for Recent Years." *Economic Development and Cultural Change.* July 1960, Part II, pp.3–21.

S. Kuznets, *Capital in the American Economy, Its Formation and Financing.* Princeton University Press (Princeton), 1961.

A.T. Koh, "Linkages and the International Environment." In *The Singapore Economy Reconsidered* edited by Krause, Koh and Lee. Institute of Southeast Asian Studies (Singapore), 1987, pp.21–53.

A.T. Koh, "Saving, Investment and Entrepreneurship." In *The Singapore Economy Reconsidered* edited by Krause, Koh and Lee. Institute of Southeast Asian Studies (Singapore), 1987, pp.78–106.

L. Krause, "Thinking About Singapore." In *The Singapore Economy Reconsidered* edited by Krause, Koh and Lee. Institute of Southeast Asian Studies (Singapore), 1987, pp.1–19.

A. Krueger, *Trade and Employment in Developing Countries, Vol.3, Synthesis and Conclusions.* University of Chicage Press (Chicago), 1983.

L. Landau, "Saving Functions in Latin America." In *Studies in Development Planning* edited by H. Chenery. Harvard University Press (Mass.), 1971, pp.299–321.

Y. Lee, "The Government in Macro-economic Management." In *The Singapore Economy Reconsidered* edited by Krause, Koh and Lee. Institute of Southeast Asian Studies (Singapore), 1987, pp.128–173.

Y.P. Lee, "Inflation Hedges and Economic Growth in a Monetary Economy." Unpublished Ph.D. thesis. Stanford University (Stanford), 1980.

N. Leff, "Dependency Rates and Saving Rates." *American Economic Review.* December 1969, pp.886-95.

W. Leontief, "Lags and the Stability of a Dynamic System: A Rejoinder." *Economic Journal.* October, 1961.

A. Lewis, "Development with Unlimited Supplies of Labor." *The Manchest School.* May 1954, pp.139-191.

C. Lim, "Report Of the Central Provident Fund Study Group." *The Singapore Economic Review.* Stamford Press (Singapore), 1985.

K. Lin, "Productivity in ASEAN Manufacturing." Institute of Southeast Asian Studies, 1986.

D. Mathieson, "Financial Reform and Stabilization Policy in a Developing Economy." *Journal of Development Economics, 7(3).* 1980, pp.359-395.

R. McKinnon, *Money and Capital in Economic Development.* Brookings Institution (Washington D.C.), 1973.

R. McKinnon, "Financial Policies." In *Policies for Industrial Progress in Developing Countries* edited by J. Cody, H. Hughes and D. Wall. Oxford University Press (London), 1980.

R. Mikesell and J. Zinser, "The Nature of the Savings Function in Developing Countries: A Survey of the Theoretical and Empirical Literature." *Journal of Economic Literature.* March 1973, pp.1-26.

F. Modigliani, "The Life Cycle Hypothesis of Saving, the Demand for Wealth, and the Supply of Capital." *Social Research.* June 1966, pp.160–217.

F. Modigliani, "Life Cycle, Individual Thrift, and the Wealth of Nations. " *American Economic Review.* June 1986, pp.297–313

Monetary Authority of Singapore, *Papers on Monetary Economics.* Singapore University Press (Singapore), 1981.

M. Morishima, *Theory of Economic Growth.* Oxford University Press (Oxford), 1969.

R. Musgrave, *The Theory of Public Finance.* McGraw-Hill (New York), 1959.

S. Naya, W. James and G. Meier, *Southeast Asian Economic Development.* University of Hawaii Press (Hawaii), 1987.

V. Neumann, "A Model of General Equilibrium." *Review of Economic Studies.* Vol. *XIII*, 1945–46.

D. Nichols, "Some Principles of Inflationary Finance." *Journal of Political Economy No 82(2).* 1974, pp.423-430.

C. Ow, "The Role of Government in Economic Development: The Singapore Experience." In *Singapore: Resources and Growth* edited by Lim Chong-Yah and Peter Lloyd. Oxford University Press (Singapore), 1986.

G. Papanek, "The effect of Aid and other Resource Transfers on Savings and Growth in Less Developed Countries." *Economic Journal.* September, 1972, pp.934–950.

L. Pasinetti, "Changes in the Rate of Profit and Switches of Techniques." *Quarterly Journal of Economics.* 1966, pp.503–17.

L. Pasinetti, "Switches of Technique and the "Rate of Return" in Capital Theory." *The Economic Journal.* 1969, pp.508–31.

H. Patrick, "The Financing of the Public Sector in Postwar Japan." In *Economic Growth: The Japanese Experience Since the Meiji Era* edited by L. Klein and K. Ohkawa. Irwin-Dorsey (Ontario), 1968, pp.326–355.

E. Phelps, "Models of Technical Progress and the Golden Rule of Research." *Review of Economics and Statistics.* 1966, pp.133–45.

R. Pindyck and D. Rubinfeld, *Econometric Models and Economic Forecasts.* McGraw Hill (U.S.), 1981.

J. Power, *The Economics of Keynes.* Academic Press (New York), 1980, pp.321-360.

J. Poterba, "Tax Subsidies to Owner-Occupied Housing: An Asset-Market Approach." *Quarterly Journel of Economics.* 1984.

J. Robinson, "The Production Function and the Theory of Capital." *The Review of Economics and Statistics.* April 1953, pp. 81–106.

J. Robinson, "Equilibrium Growth Models." *American Economic Review.* 1961, pp.360–9.

J. Robinson, *Essays in the Theory of Economic Growth.* Macmillan (London), 1962.

P. Samuelson, "A Theory of Induced Innovation along Kennedy-Weisacker lines." *Review of Economics and Statistics.* 1965, pp.343–56.

P. Samuelson, "Rejoinder, Agreements, Disagreements, Doubts and the Case of Induced Harrod-Neutral Technical Change." *Review of Economics and Statistics.* 1966, pp.444–8.

P. Samuelson, "A Summing Up." *Quarterly Journal of Economics.* 1966, pp.568–83.

P. Samuelson, "Paradoxes in Capital Theory: A Symposium." *Quarterly Journal of Economics.* November 1966.

A. Sanchez, "Capital Measurement and Total Factor Productivity Analysis." Unpublished Ph.D. dissertation. School of Economics, University of the Philippines, 1983.

J. Schumpeter, *Capitalism, Socialism and Democracy*, 5th Ed., Allen and Unwin (London), 1952.

E. Shaw, *Financial Deepening in Economic Development.* Oxford University Press (New York), 1973, pp.2-5.

E. Shaw, "Inflation, Finance and Capital Markets." *Federal Reserve Bank of San Francisco Economic Review.* December 1975, pp.5–20.

R. Solow, "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics.* August 1957, pp.312–320.

R. Solow, "A Contribution to the Theory of Economic Growth." *Quarterly Journal of Economics.* 1956, pp.65–94.

R. Solow, "Investment and Technical Progess." In *Mathematical Methods in the Social Sciences* edited by Arrow, Karlin and Suppes. Stanford University Press (Stanford), 1960, pp.89–104.

T. Swan, "Economic Growth and Capital Accumulation." *The Economic Record.* 1956, pp.334–61.

C. Tai, *Housing Policy and High-Rise Living: A Study of Singapore's Public Housing.* Chopmen (Singapore), 1988.

A. Takayama, "On a Two-Sector Model of Economic Growth with Technical Progress." *Review of Economics and Statistics.* 1965, pp.251–62.

A. Tan and C. Ow, "Singapore." In *Development Strategies in Semi-Industrial Economies* edited by Bela Balassa and Associates. John Hopkins University Press (Baltimore), 1982, pp.907–917.

L. Taylor, *Structuralist Macroeconomics: Applicable Models for the Third World.* Basic Books (New York), 1983.

J. Tobin, "Money and Economic Growth." *Econometrica, 33(4).* 1965, pp.671-684.

Y. Tsao, "Sources of Growth Accounting for the Singapore Economy." In *Singapore: Resources and Growth* edited by Lim Chong Yah and Peter Lloyd. Oxford University Press (Singapore), 1986.

H. Uzawa, "On a Two-Sector Model of Economic Growth." *Review of Economic and Statistics.* 1962, pp.40-7.

H. Uzawa, "On a Two-Sector Model of Economic Growth II." *Review of Economic and Statistics.* 1963, pp.105–18.

H. Varian, *Microeconomic Analysis.* W W Norton (New York), 1978.

P. Vongvipanond, *The Disaggregation of Saving and Economic Growth: An Empirical Study for Six Asian Countries.* Unpublished Doctoral Dissertation, Department of Economics, University of Hawaii at Manoa, 1978.

T. Weisskoph, "The impact of Foreign Capital Inflows on Domestic Savings in Underdeveloped Countries." *Journal of International Economics.* Vol.2, February 1972, pp.25–38.

V. Weizsacker, "Tentative Notes On a Two–Sector Model with Induced Technical Progress." *Review of Economic Studies.* 1966, pp.245–51.

B. William, *Macroeconomic Theory and Policy.* Harper and Row (New York), 1972, pp.366-97.

J. Williamson, "Income Growth and Savings." *Philippines Economic Journal.* First Semester, 1969, pp.54–74.

V. Wijnbergen, "Stagflationary Effects of Monetary Stabilization Policies: A Quantitive Analysis of South Korea." *Journal of Development Economics, 10(2).* 1982, pp.133–169.

V. Wijnbergen, "Credit Policy, Inflation and Growth in a Financially Repressed Economy. " *Journal of Development Economics, 13(1-2).* 1983, pp.45–65.

K. Wong, "Saving, Capital Inflow and Capital Formation." In *Singapore: Resources and Growth* edited by Lim Chong Yah and Peter Lloyd. Oxford University Press (Singapore), 1986.