

The interaction between residential investment and economic growth in Canada:
Granger-Causality tests and cyclical patterns analysis

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Abstract

Back in the 1940s and 1950s, residential investment was labelled as a “consumer good”, and some economists even argued that residential investment is akin to a drug with respect to economic development as it may compromise the stability and the health of the domestic economy. However, the attitude towards residential investment has changed over the past few decades. The effect of residential investment on economic growth becomes crucial nowadays as some works show that the recessions and expansions of the economy are related to the booms and busts of the real estate industry. This paper examines the interaction among residential investment, non-residential investment, and economic growth in Canada by using two methods. The first method is based on Granger-causality tests, and the evidence seems to support the argument that non-residential investment predicts economic (GDP) growth when household residential investment is unadjusted for seasonal factor. On the other hand, if seasonal factors are considered, both residential and non-residential investments predict economic growth. The second method analyzes the data into cyclical patterns, and the evidence seems to support the argument that residential investment plays a more important role for economic growth. The role of debt-financed income is also considered, by adding consumer credit to residential investment in both approaches.

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I. Introduction

My paper is inspired by the changing attitude about non-residential investment and residential investment towards economic growth. The definition of residential investment or housing investment is the money that households spend on buying newly-built houses either to live or to rent out, and on home improvements. On the other hand, non-residential investment is the expenditures by business sectors on capital such as equipment and plants. Back in the 1940s and 1950s, the importance of housing investment was downplayed by some economists and the early critics claimed that investing in housing is not feasible or beneficial to domestic development. Housing investment was labelled as a “resource-absorber” and a “consumer good” at that time. Gilbert (1947) even claimed that housing investment will slow down the economy. Instead, what was favoured by the economists to improve domestic development was investing in capital formation. For example, Harrod (1939) and Domar (1947) both supported this approach as the dominant strategy backed up by theoretical works. However, in the past couple of decades, a considerable amount of literature exists that researches on the dynamic relationship between housing investment and economic growth, as housing investment consistently and substantially contributes to the business cycle. The research areas vary from developing countries to developed countries. The common question of whether or not housing investment can contribute to economic growth has generated a heated debate among economists and politicians. If the answer is positive, should countries put housing investment as their top priority and as part of their development strategy? In other words, countries should put more effort on housing investment if they attempt to control the business cycle. Wheaton and Nechayev (2010) called residential investment a Sleeping Giant in their title and believed that residential investment will become a major driver of output growth and will help to recover from depression. Arku (2006) mentioned that the practice of using housing investment to recover from depression was especially useful in wealthier societies such as the U.S, Japan, Singapore and Thailand. Moreover, he also discussed that even the World Bank shifted its attitude from non-support to being an advocate of housing as an economic development tool since the 1970s.

Some works show that residential investment can help to predict economic growth, while other works show that economic growth is predicted by non-residential investment. If economic growth is predicted by residential investment, then we say that residential investment leads the business cycle. On the other hand, if economic growth causes an increase in non-residential

investment, then non-residential investment lags the business cycle. In my study, the lead-lag pattern inherent in business cycle models is investigated by using Canadian data. Residential investment is named semi-autonomous household expenditures in my study if it is added to consumer credit; otherwise it is named household sector gross fixed investment. Non-residential investment is simply the gross fixed investment of firms. Details of the variables will be explained later. Firstly, I use Granger-causality tests to explore whether or not the growth in residential investment or non-residential investment would predict the economic growth in Canada. Secondly, I analyze the data set into cyclical patterns by using two approaches. The first approach helps me to detect whether or not non-residential investment leads economic growth. If so, the patterns of non-residential investment and GDP should exhibit clockwise cycles. If not, counter-clockwise cycles will be observed. If the second case is observed, it means that there must be another demand source that stimulates the business cycles other than non-residential investment. Hence, the patterns of residential investment and GDP will also be explored by using the second approach.

The remainder of this paper is organized as follows. Section II describes some of the literature that discusses the interaction between residential investment and economic growth, and the role of consumer credit in business cycles. Section III describes the method of Granger-causality tests, which I have separated into three cases; and it presents the results. In section IV I discuss the method of cyclical patterns analysis by using two different ways. Section V concludes.

II. Literature Review

Residential investment in developed and developing countries

Most of the studies focus on investigating housing investment in developed countries rather than developing countries. The United State is the top choice for most of the economists probably because of the comprehensive data system and the country itself being one of the strongest and leading countries in the world. Davis and Heathcote (2005, P. 1) stated that “residential investment in the U.S is more than twice as volatile as business investment and most importantly it leads the business cycle, while non-residential investment lags”. A similar finding was explored by Fisher (2007), and Burns and Mitchell (1946); they all claimed that household investment leads non-residential fixed investment over the business cycle. A more detailed

conclusion was made by Wen et al. (2001) who stated that it is the capital formation of the residential sector that Granger-causes output growth, which further leads to the capital formation of plant and equipment in the business sector.

Some works I found were focused on developing countries. The way to reduce the gap between rich and a poor country is the fundamental issue in economic development. While some economists believe in conventional theory that supports focusing on fixed investment in non-residential sectors to improve the domestic economy, others believe that residential construction can also boost the economy through hiring more employees and increasing the income for workers in the housing sector and in related sectors. In the case of Barbados, Jackman (2010) reached the conclusion that residential investment Granger-causes economic growth and vice versa. Hence, he believed that government should set up a strategy to stimulate the real estate market if it wants to expand domestic development. But he also worries that too much residential investment would lead to a decline in net international reserves as Barbados depends heavily on goods from abroad for construction. Hence, whether or not housing investment is a practical strategy in developing countries really depends on the economic conditions, the market structure of construction industries, and the domestic resources.

Use of Granger-causality tests to investigate the relationship between residential investment and economic growth

The investigation of the relationship between housing investment and economic growth can be done by different econometric methods. However, the Granger-causality test is most widely used to explore the interaction between housing investment and economic growth by economists. Previous related studies including Green (1997), Liu, Park, and Zheng (2002), Kim (2004), Shen and Liu (2004), Chen and Zhu (2008), Jackman (2010), and Chang and Nieh (2004) – all used Granger-causality tests to explore this relationship for different countries somehow in a similar way, but their empirical results contradict each other across countries and even within countries. In other words, there is disagreement about the direction of the Granger-causality relationship. Green (1997) is the most noticeable one, where he analyzed quarterly data from 1959 to 1992 in the U.S. He tested whether residential investment or non-residential investment would lead GDP, or the other way around. He found that “residential investment Granger-causes GDP, but is not caused by GDP, while non-residential investment does not cause, but is caused by GDP (Green

1997, P. 253).” A totally different result was reported by Kim (2004) who applied the quarterly data from 1970 to 2002 in Korea. He found that non-residential investment in Korea predicts economic growth, but residential investment is the follower of GDP. A few similar studies were done by using quarterly data in China. Different from other studies, Liu, Park, and Zheng (2002) take into consideration both long run and short run behavior of housing investment from 1981 to 2000 in China in their study. They reported that housing investment has both short and long run effects on economic growth, but the evidence of short run effects of non-residential investment on GDP is small. On the other hand, GDP has long run effect on both housing and non-housing investment. Chen and Zhu (2008) also considered the long and short run effect of housing investment, but with provincial data from 1991 to 2007 in China instead of using national level data. Most of the provinces showed a bi-directional Granger-causality relationship between housing investment and economic growth except for three sub-regions. In contradiction to Liu, Park, and Zheng (2002) and Chen & Zhu (2008), an opposite result was obtained by Shen and Liu (2004) who say that economic growth leads housing investment, hence housing investment is the follower of economic growth.

Use of Granger-causality tests to investigate the relationship between total construction investment and economic growth

Total construction includes both residential construction and commercial construction investment. Some studies investigated the lead-lag relationship between total construction investment and economic growth. Disagreement on the direction of the Granger-causality relationship again exists across countries. For instance, Chang and Nieh (2004) used quarterly data from 1979 to 1999 in Taiwan to explore the relationship. They reported that total construction investment has both a long and a short run unidirectional impact on economic growth. However, this result contradicts the results of the 14 Western Europe countries studied by Wigren and Wilhelmsson (2007), who claimed that GDP Granger-causes total construction, but not vice versa.

Method 1 - Use of a Granger-causality test in my own study

I also use a Granger-causality test in my study, and investigated the relationship between the expenditures of households on housing (excluding consumer durables) and economic growth in Canada. The detail of the approach will be explained in section III. Leamer (2007, P. 176) stated

that “It’s a consumer cycle, not a business cycle. The top four contributions with significant t-stats are residential investment, consumer services, consumer nondurables, and consumer durables. Business spending on equipment and software, structures, and inventories do not contribute to the prediction of GDP growth in a measurable way.” Hence, what matters in my study is the role of households’ investment in housing and the debt-financed consumption in Canada.

As Brito and Pereira (2002, P. 247) reported, “almost 70% of U.S real estate is residential and is mostly owned by families.” Housing is the largest and the most important component for most households, but why do households spend so much money on purchasing houses? Sinai and Souleles (2005) explained this by saying that owning a house provides a hedge against fluctuations in housing costs. Also, owning a house provides security to individuals as they do not have to worry about being forced to leave by landlords. Some individuals treat housing as a long term investment as they believe the value of the equity will rise over years. Whatever the reason, it is worth to explore whether or not Canadian consumption on housing contributes to economic growth, and if it does by how much. For the business sectors, housing is an investment good. For households, housing is both a consumption and an investment good.

My focus here is on how much consumers spend on housing through both past savings and debt-financed resources. The idea was inspired by Fiebiger (2014) who stated that there is a potential for workers to provide a source of macro-level profits if workers borrow from banks to finance the new houses, rather than financing by past savings or by borrowing funds from family and friends. Next, I will talk about the importance of debt-financed income.

The importance of debt-financed spending in the current economy

As reported by the Bank of Canada, household spending contributed around 65 % of total spending in Canada in 2012. The payment of these goods and services are supported by salaries, past savings, income from investments, and borrowed funds. Household borrowing has grown considerably in many countries including Canada over the past few decades due to the lower interest rates, financial innovations and rising housing prices. On the other hand, the personal saving rate has been subject to a declining trend since the early 1980s. Surprisingly, MacGee (2012) reported that the debt levels of Canadians are higher than those of American households in 2012. So, what are the contributing factors causing these high borrowing levels? According to

the review by the researchers at the Bank of Canada, Crawford and Faruqui (2015), both mortgage and non-mortgage credit have contributed to the upward trend of the aggregate debt-to-income ratio over the past 30 years, which has reached 150 % in 2011. They also mentioned that residential mortgage credit was the major component of borrowed funds before the mid-1990s in Canada, but consumer credit also played an important role since then. There is cause to worry about the excess increase in consumer credit as it is more vulnerable to adverse economic shocks, because increase in the interest rate set by the Bank of Canada would cause a higher interest rate on consumer credit faster than it would on mortgage products.

How do households spend their borrowed funds?

To understand the relationship between credit availability and real economic activity, we should pay attention to the consumption behavior of households and how they spend their borrowed funds. Bailliu, Kartashova and Meh (2011, P. 17) reported that “the sources and uses of household borrowing from 1999 to 2010 include: borrowing against equity in existing houses through increases in mortgage debt and draws on home-equity lines of credit, to finance consumer spending, outlays for home renovation, debt repayment, and financial and non-financial investments.” Among these uses, Canadians spend most of their borrowed funds on consumption and home renovation. Moreover, as reported by the Canadian Mortgage and Housing Corporation (CMHC) in 2013, housing related expenditures contributed to 17.3% of total GDP. Residential investment increased by 8.7% to \$126 billion in 2012. Hence, housing investment is one of the major components that contribute to the economic growth. According to Yuan (2009), the growth of consumption in housing is most likely to be related to people with low and median wealth. This is because mortgage and consumer credit enables the poor people to purchase houses and therefore the relaxation on borrowing constraints allows them to invest more. From the point of view of Yuan, financial resources are reallocated from business investment to residential investment.

The relationship between credit availability and real economic activity

If the credit constraint is tight, it will restrict the amount of money that households can borrow, and delay their first home purchase. Hence, to help with the financialization of the household sector and to enhance the access to credit, credit easing is an essential strategy for a country to solve the issue. But more importantly, we should understand the relationship between credit

availability and real economic activity. On one hand, credit easing can enable households to consume more and stimulate economic growth. On the other hand, excessive indebtedness and relaxed lending standards would make the financial market a risky situation if the households were not able to repay the debts. Moreover, a shock to housing prices or interest rates would have a tremendous effect on the Canadian economy. For example, Christensen (2015, P. 35) states that “the subprime mortgage crisis that began in 2007 in the U.S is an extreme example of how easing financing conditions can amplify a housing market boom and leave the financial system highly vulnerable to a bust in house prices.” Therefore, it is essential for financial institutions and their regulators to access the credit availability in financial market by carefully thinking about the risks involved and setting up rules to control and monitor the market.

Method 2 – Cyclical Patterns

Goodwin (1967) presented a model of a Marxian business cycle and stated that it is the struggles between capitalists and workers about income distribution that drives the fluctuations of business cycles. The Goodwin case can be referred to as the profit-led demand regime and the causal chain is that a higher wage share in national income would lead to a lower rate of investment by firms and would thus slow down the economy. By contrast, post-Keynesian theories as expressed by Kaleckians, claim that the positive effects of a higher real wage on consumption are greater than the negative effect on investment. Hence, the Kalecki case can be referred to as the wage-demand regime and the causal chain is such that a higher wage share, leads to higher consumption and thus higher aggregate demand. A debate thus arises about whether investment or consumption is the driving force of business cycles. Skott and Zipperer (2011) made use of U.S data to explore this question by relying variables such as employment rates, profit shares, accumulation rates, and capacity utilization rates, which are considered the most important variables from the point of view of heterodox economics. Clockwise cycles exist for (employment, profit share), (employment, utilization), and (utilization, profit), which seems to support the Goodwin case. They also claimed that their empirical results supported their Kaldorian models where firms decide to slow down the rate of investment when the economy approaches or exceeds full-capacity output (Zipperer and Skott 2010).

However, the cyclical patterns involving the profit share and the rate of capital accumulation appear to have counter-clockwise movements, as sometimes recognized by Skott and Zipperer.

This contradicts the “profit squeeze” theory of the business cycle¹. In other words, the profit share and firm investment move in opposite directions. As stated by Fiebiger (2014) , the clockwise cycles of the profit share could be explained by other sources of demand if firm investment is not the cause of the boost in profits. The first source of demand he considered is public expenditure, but he argued that the expansion of budget deficits increase aggregate demand and profit only in the initial period. His second candidate is net exports, which he believes is important feature only for small open economies. Hence, both public expenditure and net exports are not these external sources of effective demand sources², rather he believes that residential investment and debt-financed spending are the two main possibilities, and he has named this variable the ‘semi-autonomous household expenditures’.

III. Granger Causality Tests

Econometric Approach

My approach has some similarities with Wen (2007), who presented a “causal” relationship among consumption, output, and investment, and with Liu, Park, and Zheng (2002), who analysed the interaction among housing investment, non-housing investment, and economic growth. For the purpose of my study, I want to explore whether or not real investment of consumers in real estate plays an important role. If so, is there any causal relationship between housing investment by households, output, and investment by firms. In order to clarify the causal relationships among these variables, there are three relationships that I wish to explore in this paper:

Case 1 – The causal relationship among consumption (non-durables goods and services), output, and investment by firms;

Case 2 – The causal relationship among semi-autonomous household expenditures, output and investment by firms;

¹ Profit squeeze theory claims that employment increases when the economy expand, and that higher labor demand will generate wage inflation. This would lead to an increase in the real wage increase and hence an increase in the wage share. There will thus be a decrease in the profit share and thus an assumed reduction in investment and output (Tavani, Flaschel, and Taylor 2011, P. 522). Since the profit share and the rate of capital accumulation move in the same direction, the cycle patterns between them should be clockwise.

² See Fiebiger (2014, P. 9) for details.

Case 3 – The causal relationship among household sector gross fixed investment, output and investment by firms.

Granger-causality tests will be widely used in my study to test the existence of causality among these variables. The method of how to test causality was presented in the seminal paper of Granger (1969). Before I implement the Granger test, one standard unit root test is employed to test the stationarities of the time series – the augmented Dickey-Fuller (ADF) test by Dickey (1979). And then, the optimal lag length will be applied into the vector autoregression (VAR) model by the ordinary least squares (OLS) estimation method. The issue of how to choose the optimal lag length will be decided by the Akaike Information Criterion (AIC), the Likelihood Ratio (LR), and Schwarz's Bayesian information criterion (SBIC).

Data

All data were taken from the Statistics Canada CANSIM database³. The data sets employed consist of quarterly data for the period 1981Q1 to 2012Q2. Quarterly data were chosen because they provide us with a better sense of the fluctuations occurring in the business cycle compared with the annual data. To do the Granger-Causality test, five types of data were used including: aggregate consumption (C), aggregate output (Y), aggregate investment by firm (I), semi-autonomous household expenditures (H-SAE), and household sector gross fixed investment (H-GFI). Except for the H-SAE and H-GFI, all the other variables were seasonally adjusted at the annual rate by the reporting agency, and I believe that data were adjusted adequately for seasonal effects. The details of why they were chosen and how they were measured will be explained below. Moreover, all the regressions were run by applying the growth rates of the variables, and the growth rates were measured as the first difference in logs.

First, to investigate the causal relationship among aggregate consumption, output, and investment by firms, the data sets were adjusted with 2007 constant prices. Aggregate consumption was calculated by using real consumption on nondurable goods and services. Aggregate output was calculated as real gross domestic product (GDP) minus inventory investment. According to Wen (2007), excluding inventory is one of the remedies to solve the

³ See Data Source in Appendix 1 for details

problem of the crowding out effect on consumption⁴. Aggregate investment is the real business investment in non-residential structures, machinery and equipment.

Second, to investigate the causal relationship among semi-autonomous household expenditures, output, and investment by firm, aggregate output and investment by firm were measured in the same way as in the first case. Semi-autonomous household expenditures consists of two components, and was measured as proposed by Fiebiger (2014)⁵. The first component is the non-financial investment by persons, which is a flow component of aggregate demand. The second component is the flow of consumer credit. He mentioned that the limitations of using consumer credit data are justifiable and it is the key driver of economic fluctuations. Including consumer credit in the analysis is critical since debt-financed consumption has become indispensable for Canadian households as I have mentioned in the literature review.

Third, to investigate the causal relationship among household sector gross fixed investment, output, and investment by firms, aggregate output and investment by firm were measured in the same way as in the first case. Household sector gross fixed investment is simply the first component of semi-autonomous household expenditures. Using gross flow is reasonable because household consumption of fixed capital is not a deduction to firm revenues according to Fiebiger (2014). By comparing the results with case 2, we can see whether or not debt-financed consumption is important to the economic fluctuations.

One more issue has to be adjusted here. Both semi-autonomous household expenditures (H-SAE) and household sector gross fixed investment (H-GFI) were in nominal form when I collected them from the database. Hence, I have to transform nominal H-SAE and H-GFI into real terms by using the consumer price index before I run the regressions. The monthly data set of consumer price index (CPI) for all items was also taken from Statistics Canada CANSIM, and I took quarterly averages for the 1981 to 2012 period.

⁴The US data showed that consumption growth “Ganger-causes” gross domestic product (GDP) growth positively. However, by using standard general equilibrium business cycle model, the sign was negative not positive. He explained that if demand shock drives the business cycle, inventories with the information of consumption movements may mask the causal link from consumption to output. See Wen (2007, P. 196) for details.

⁵From a Keynesian “perspective, consumption is mainly an induced variable, while firm investment is held to be fully-autonomous” (Fiebiger 2014, P. 2). Autonomous consumption and expenditures that are mainly debt-financed are possible demand sources to explain the clockwise cycles of profit share. (Fiebiger 2014, P. 10)

Unit Root Tests of the Stationarity of Time Series

To tackle the autocorrelation problem, Dickey and Fuller had developed a test called Augmented Dickey Fuller Test including the following three choices. 1. Intercept only 2. Trend and intercept 3. no trend, no intercept. In my study, I found it is optimal to include an intercept, but exclude the linear variable for all regression equations. It is really important to make sure that all the time series are stationary as Granger-causality tests require the use of stationary variables. I formally tested whether $\Delta \text{Ln Y}$, $\Delta \text{Ln C}$, $\Delta \text{Ln I}$, $\Delta \text{Ln H-SAE}$, and $\Delta \text{Ln H-GFI}$ are stationary, and the results are shown in Table 1. The optimal lag length of the tested variables were determined by minimizing the Akaike Information Criteria (AIC). Under the ADF test, that a time series is not stationary is the null hypothesis. Failure to reject the null hypothesis when the ADF test statistics is smaller than the 5% critical value implies that the time series has a unit root.

Table 1 shows that the ADF test statistics of $\Delta \text{Ln Y}$, $\Delta \text{Ln C}$, $\Delta \text{Ln I}$, $\Delta \text{Ln H-SAE}$, and $\Delta \text{Ln H-GFI}$ are all greater than the 5% critical value indicating that all the variables have coefficients that are significantly different from zero. In other words, all the variables are determined to be stationary time series.

Table 1: Augmented Dickey-Fuller Unit Root Tests of the Stationarity of Time Series Tests of the Stationarity of the First Differences of Times Series					
Time Series Variable	Included in the Test Equation	Lag Length	ADF Test Statistics Z(t)	5% Critical Value	Results
$\Delta \text{Ln Y}$	Intercept	1	-6.313*	-2.888	Stationary
$\Delta \text{Ln C}$	Intercept	3	-4.638*	-2.889	Stationary
$\Delta \text{Ln I}$	Intercept	1	-5.375*	-2.888	Stationary
$\Delta \text{Ln H-SAE}$	Intercept	4	-5.611*	-2.889	Stationary
$\Delta \text{Ln H-GFI}$	Intercept	4	-5.231*	-2.889	Stationary

Notes: Ln Y, Ln C, Ln I, Ln H-SAE, and Ln H-GFI are the natural logarithms of aggregate output, consumption, investment, flow of semi-autonomous household expenditures, and household sector gross fixed investment, respectively. $\Delta \text{Ln Y}$, $\Delta \text{Ln C}$, $\Delta \text{Ln I}$, $\Delta \text{Ln H-SAE}$, and $\Delta \text{Ln H-GFI}$ are the first differences of Ln Y, Ln C, Ln I, Ln H-SAE, and Ln HGFI, respectively. The distribution of the ADF test statistics is not the usual t-distribution. The appropriate lag length is selected based on the AICs.

Lag Selection

The choice of the optimal length is crucial in the VAR model as the outcomes will be based on the chosen lag order. In other words, the effect of the chosen number of lags will be large enough to change the decisions on whether to reject or accept the null hypothesis. It will further change the causal relationships when I apply the Granger-causality tests later. In contrast to previous studies which only focus on one criterion, I employed AIC, LR, and SBIC in my study. This is because I found that each of the criteria can give me slightly different outcomes, and some of them are consistent with the previous studies, while others are not.

AIC is the main criterion in my study, while LR and SBIC will be discussed partially. The results of the lag selections test are presented in Table 2. Please note that the lag with parentheses will not be discussed in this study since they will give us similar results as the main criterion AIC even if they suggest to use different lag length.

Variable Included	Optimal Lag Length based on AIC	Optimal Lag Length based on LR	Optimal Lag Length based on SBIC
$\Delta \text{Ln Y}, \Delta \text{Ln I}$	1	(7)	(1)
$\Delta \text{Ln Y}, \Delta \text{Ln C}$	No Lags	7	(No Lags)
$\Delta \text{Ln C}, \Delta \text{Ln I}$	1	(1)	(1)
$\Delta \text{Ln Y}, \Delta \text{Ln H-SAE}$	7	(10)	4
$\Delta \text{Ln H-SAE}, \Delta \text{Ln I}$	7	(10)	4
$\Delta \text{Ln Y}, \Delta \text{Ln H-GFI}$	4	6	(4)
$\Delta \text{Ln H-GFI}, \Delta \text{Ln I}$	4	7	(4)

Notes: Ln Y, Ln C, Ln I, Ln H-SAE, and Ln H-GFI are the natural logarithms of aggregate output, consumption, investment, flow of semi-autonomous household expenditures, and household sector gross fixed investment, respectively. $\Delta \text{Ln Y}$, $\Delta \text{Ln C}$, $\Delta \text{Ln I}$, $\Delta \text{Ln H-SAE}$, and $\Delta \text{Ln H-GFI}$ are the first differences of Ln Y, Ln C, Ln I, Ln H-SAE, and Ln HGFI, respectively.

Vector Autoregression Model (VAR) and Granger-Causality Tests

A vector autoregressive model can run a multivariate time-series regression to test whether or not the inclusion of past values of each dependent variable Y on lags of itself, and on the lags of other dependent variable X do or do not help in the prediction of present values of the dependent variable Y.

In my case, I can formulate the model in terms of the first difference in logs as in equations (1) and (2):

$$\Delta \text{Ln}(Y)_t = \beta_1 + \sum_{i=1}^n a_{1,i} \Delta \text{Ln} Y_{t-i} + \sum_{j=1}^n b_{1,j} \Delta \text{Ln} X_{t-j} + \varepsilon_{1,t} \quad (1)$$

$$\Delta \text{Ln}(X)_t = \beta_2 + \sum_{i=1}^n a_{2,i} \Delta \text{Ln} X_{t-i} + \sum_{j=1}^n b_{2,j} \Delta \text{Ln} Y_{t-j} + \varepsilon_{2,t} \quad (2)$$

According to Granger (1969), a variable X is said to Granger-causes a variable Y when the prediction of Y is improved after the inclusion of its own history and the history of variable X.

Empirical Results

Case 1 - Causal relationship among consumption (non-durables goods and services), output, and investment by firm

The maximum number of lags was set at 10, and AIC recommended lag 1 as the optimal lag length for the models of output & investment, and investment & consumption. LR recommended lag 7 as the optimal lag length for the model of output & consumption.

Table 3 presents the empirical results of Granger-Causality tests between real aggregate output and investment using the first difference in logs vector autoregression with AIC as selection criterion. Panel A shows that given the history of output growth, investment growth in the previous periods has explanatory power with respect to output growth in the present period. The coefficient of $\Delta \text{Ln}(I)_{t-1} = 0.068$ is positive and significant. Also, the coefficient of $\Delta \text{Ln}(Y)_{t-1} = 1.306$ is positive and significant, which indicates that given the history of investment growth, output growth in the previous periods also has explanatory power with respect to investment growth in the present. Panel B reports the short run causality relationship between these variables. Since both P-values are smaller than 0.05 (5% significant level), there exists significant bidirectional causal relationships from $\Delta \text{Ln}(Y)_t$ to $\Delta \text{Ln}(I)_t$, and from $\Delta \text{Ln}(I)_t$ to $\Delta \text{Ln}(Y)_t$.

Table 4 presents the empirical results of Granger-Causality tests between real aggregate consumption and investment using the first difference in logs vector autoregression with AIC as selection criterion. Panel A shows that given the history of consumption growth, investment growth in the previous periods has explanatory power with respect to consumption growth in the present period. The coefficient of $\Delta \text{Ln} (I)_{t-1} = 0.041$ is positive and significant. However, the past consumption growth is not significant to the present consumption growth. Also, the coefficient of $\Delta \text{Ln} (C)_{t-1} = 0.30$ is positive and significant, which indicates that given the history of investment growth, consumption growth in the previous periods also has explanatory power with respect to investment growth in the present. Panel B reports that both P-values are smaller than 0.05 (5% significant level), so there exist significant bidirectional causal relationships from $\Delta \text{Ln} (C)_t$ to $\Delta \text{Ln} (I)_t$, and from $\Delta \text{Ln} (I)_t$ to $\Delta \text{Ln} (C)_t$.

Perhaps surprisingly, AIC suggested that there should be no lag for output and consumption. Hence, a linear regression was run to explore the relationship between output and consumption, and with no Granger-causal relationship. Present consumption (output) growth has a positive and significant relationship with present output (consumption) growth.

$$\Delta \text{Ln} (Y) = 0.0025 + 0.58 \Delta \text{Ln} (C) \quad (3) \quad \Delta \text{Ln} (C) = 0.0043 + 0.28 \Delta \text{Ln} (Y) \quad (4)$$

(2.70)* (4.89)* (7.82)* (4.89)*

However, LR recommended lag 7 to be the optimal lag length. Table 5 presents the empirical results of Granger-Causality tests between real aggregate consumption and investment using the first difference in logs vector autoregression with LR as selection criterion. Panel A shows that given the history of output growth, only past consumption growth with lag 5 is negative and significant to present output growth. Moreover, past consumption growth is not a significant determinant of present consumption growth. Panel B reports that there exists a unidirectional causal relationship from $\Delta \text{Ln} (C)_t$ to $\Delta \text{Ln} (Y)_t$ at the 5% significance level.

Case 2 - Causal relationship among semi-autonomous household expenditures, output and investment by firm

The maximum number of lags was set at 10 and AIC recommended 7 lags as the optimal lag length for the models of output and semi-autonomous household expenditures, and investment and semi-autonomous household expenditures. On the other hand, SBIC recommended 4 lags as the optimal choice.

Table 6 presents the empirical results of Granger-Causality tests between real aggregate output and semi-autonomous household expenditures using the first difference in logs vector autoregression with AIC as selection criterion. Panel A shows that given the history of output growth, H-SAE growth in the previous periods has no explanatory power with respect to output growth in the present period since none of the coefficient for $\Delta \text{Ln}(\text{H-SAE})_{t-i}$ is significant to the present output growth. On the other hand, the coefficient of $\Delta \text{Ln}(Y)_{t-3} = 3.42$ is positive and significant to the present H-SAE growth given the history of H-SAE growth. Panel B reports that both P-values are greater than 0.05 (5% significance level), so there is no significant unidirectional causal relationships from $\Delta \text{Ln}(Y)_t$ to $\Delta \text{Ln}(\text{H-SAE})_t$, or from $\Delta \text{Ln}(\text{H-SAE})_t$ to $\Delta \text{Ln}(Y)_t$.

Table 7 presents the empirical results of Granger-Causality tests between real aggregate investment and semi-autonomous household expenditures using the first difference in logs vector autoregression with AIC as selection criterion. Panel A shows that taking into account past H-SAE (or investment) growth does not improve the prediction of present investment (or H-SAE) growth statistically and economically at the 5% significance level. Panel B reports that both P-values are greater than 0.05, so there is no significant unidirectional causal relationships from $\Delta \text{Ln}(I)_t$ to $\Delta \text{Ln}(\text{H-SAE})_t$, or from $\Delta \text{Ln}(\text{H-SAE})_t$ to $\Delta \text{Ln}(I)_t$.

I did the same tests for the same models by using different lag length suggested by SBIC. The empirical results are slightly different for both models. In contradiction to Table 6 which reports that neither lagged output or lagged H-SAE are significant determinants of each other's present growth rate, Table 8 says that all the lags of H-SAE are actually positive and significant to the prediction of present output growth. On the other hand, past output growth in lags 3 and 4 have an impact on present H-SAE. Moreover, Table 9 says that all the lags of H-SAE are positive and

significant as determinants of present investment, but not vice versa. This is in contrast to the results achieved with Table 7.

Case 3 - Causal relationship among household sector gross fixed investment, output and investment by firm

The maximum number of lags was set at 10 and AIC recommended 4 lags as the optimal lag length for the models of output and household sector gross fixed investment, as well as investment and household sector gross fixed investment.

Table 10 presents the empirical results of Granger-Causality tests between real aggregate output and household sector gross fixed investment using the first difference in logs vector autoregression with AIC as selection criterion. Panel A shows that given the history of output growth, H-GFI growth in the previous periods has explanatory power with respect to output growth in the present period. The coefficients of $\Delta \text{Ln (H-GFI)}_{t-1} = 0.02$ and $\Delta \text{Ln (H-GFI)}_{t-3} = 0.024$ are positive and significant. Past output growth in lag 4 has a negative and significant impact on the prediction of present H-GFI growth. One thing to be noticed here is that, most of the lagged values of past H-GFI are significant but carry a negative sign when explaining present H-GFI growth. This is probably because if consumers spent more on housing in the past, they will have less to spend today. Panel B reports that both P-values are greater than 0.05 (5% significant level), so there is no unidirectional causal relationships from $\Delta \text{Ln (Y)}_t$ to $\Delta \text{Ln (H-GFI)}_t$, or from $\Delta \text{Ln (H-GFI)}_t$ to $\Delta \text{Ln (Y)}_t$.

Table 11 presents the empirical results of Granger-Causality tests between real aggregate investment and household sector gross fixed investment using the first difference in logs vector autoregression with AIC as selection criterion. Panel A shows that given the history of investment growth, H-GFI growth in the previous periods has explanatory power with respect to investment growth in the present period. The coefficients of $\Delta \text{Ln (H-GFI)}_{t-1} = 0.10$ and $\Delta \text{Ln (H-GFI)}_{t-3} = 0.10$ are positive and significant. Past investment growth in lag 4 has a negative and significant impact on the prediction of present H-GFI growth. Panel B reports that both P-values are greater than 0.05 (5% significant level), so there is no unidirectional causal relationships from $\Delta \text{Ln (I)}_t$ to $\Delta \text{Ln (H-GFI)}_t$, or from $\Delta \text{Ln (H-GFI)}_t$ to $\Delta \text{Ln (I)}_t$.

I did the same tests for the same models by using different lag lengths as suggested by LR this time. The empirical results are slightly different for both models. In contradiction to Table 10 which reports that there is no causal relationship between output and H-GFI, Table 12 says that output growth Granger-causes H-GFI growth. On the other hand, Table 13 reports that lagged investment growth is no longer significant to explain present H-GFI growth.

Summary of Granger-Causality Tests

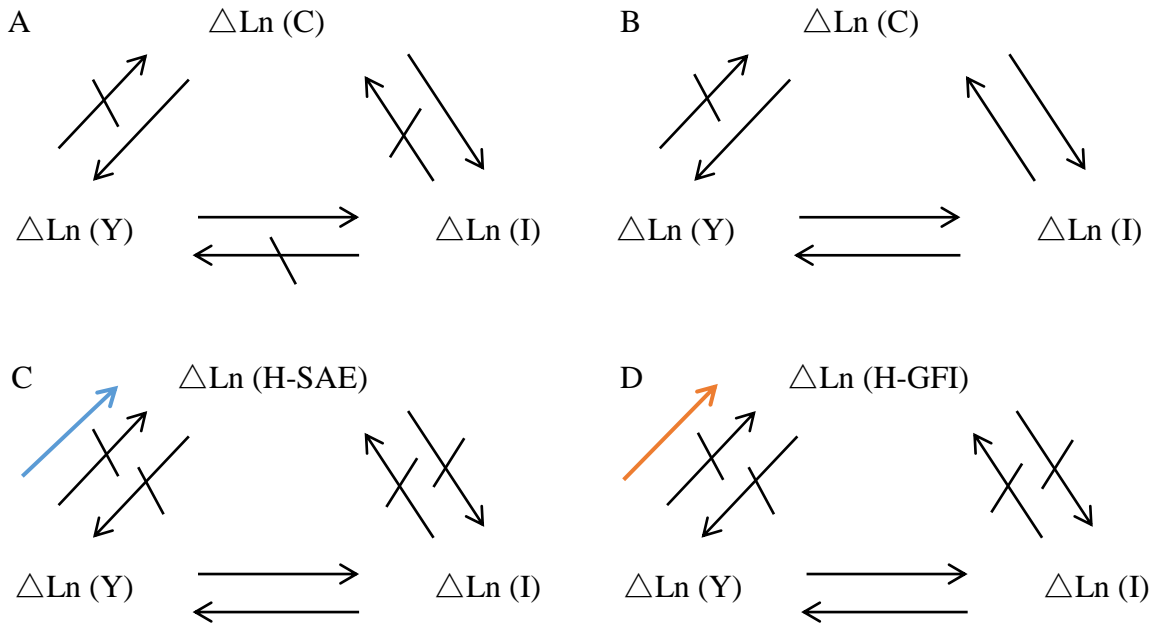
Overall, Figure 1 below helps to summarize and establish the causal chains among variables of all the three cases. The Granger-causal networks below combine the relationships by using all three lag selection criteria. Figure 1(A) shows the result study by Wen (2007), and Figures 1(B), 1(C), and 1(D) are the results of my study. “Post War U.S data show that consumption growth Granger-causes gross domestic product (GDP) growth but not vice versa, and that GDP growth in turn Granger-causes business investment growth but not vice versa.”, says Wen (2007, P. 195). He believed that consumption contains better information about the source of shocks booming/busting the economy than do output and investment. However, the results from my study are different as I found no support for the claim that consumption has better information on the prediction of economy than output and investment. Figure 1(B) shows that consumption growth Granger-causes output growth, but investment growth also Granger-causes output growth and consumption growth. In other words, there is no evidence to support that consumption growth leads to output growth, which in turn would lead to investment growth.

The dark arrow lines in Figure 1(D) show that the growth rate of the household sector gross fixed investment does not Granger-cause the growth rate of output or investment, or vice versa under the AIC criterion. Moreover, similar results (Figure 1(C)) are obtained by using semi-autonomous household expenditures, which is the household sector gross fixed investment plus consumer credit. The results are not consistent with my prediction as I thought past residential investment would predict present economic growth. In other words, I initially believed that either H-SAE or H-GFI should lead the fluctuations of the business cycles.

However, when I switch the criterion to SBIC indicated by the blue arrow line in Figure 1(C) or to LR indicated by the orange arrow line in Figure 1(D), the results are slightly different. GDP Granger-causes H-SAE and H-GFI, but not vice versa in both cases. Hence, my results are only

partially consistent with those of other studies. For instance, Liu, Park and Zheng (2002) found that housing investment influences economic growth in China in the short run, but the effect is less evident for non-housing investment. And GDP has a long run effect on both housing and non-housing investment. The other relationships between (H-SAE, I), (H-SAE, I), and (Y, I) using either SBIC or LR yield the same results as indicated by the dark arrow lines. It seems that the causal chain story in my study is that firm investment leads economic output, which in turn leads consumption. This contradicts the argument stated by Fisher (2007), and Burns and Mitchell (1946); they all claimed that household investment leads non-residential fixed investment over the business cycle.

Figure 1: Summary of the Granger-Causality tests results



The notation $\Delta \text{Ln}(C) \rightarrow \Delta \text{Ln}(Y)$ represents that the growth rate of consumption Granger-causes the growth rate of output. $\Delta \text{Ln}(Y) \not\rightarrow \Delta \text{Ln}(C)$ represents that the growth rate of output does not Granger-causes the growth rate of consumption. Similar interpretations follow for the other variables. The black arrow lines indicate the Granger-causality relationship between variables by using the AIC criterion. The blue arrow line indicates $\Delta \text{Ln}(Y)$ Granger-causes $\Delta \text{Ln}(H\text{-SAE})$ by using the SBIC criterion. The orange arrow line indicates $\Delta \text{Ln}(Y)$ Granger-causes $\Delta \text{Ln}(H\text{-GFI})$ by using the LR criterion.

Since the data for H-SAE and H-GFI are unadjusted when I took them from Statistic Canada, one problem of using these non-seasonally adjusted data is that if there are strong seasonal effects and as we don't adjust for these, the causal relationship may reflect the seasonal components of the series only. Hence, I deseasonalized the unadjusted H-SAE and H-GFI by dividing the seasonal factors, and ran the Granger-Causality tests again to see if there is any change in the result. These new results are presented in Appendix A. Unlike the results obtained by using unadjusted data, both H-SAE and H-GFI do have a causal impact on economic growth when these time series are seasonally adjusted.

IV. Cyclical Patterns

The methods of how to study the cyclical patterns of the Canadian business cycles are inspired by the recent works of Fiebiger (2014) and Skott and Zipperer (2011). Fiebiger investigated the bivariate cyclical patterns for the profit share (Π), net fixed investment (NFI), capacity utilization (u), semi-autonomous household expenditures (H-SAE), and household sector gross fixed investment (H-GFI) in the U.S sector. From his study, he found that (Π, u), (H-SAE, u) and (H-GFI, u) exhibit clear and strong clockwise cycles, but (NFI, u) exhibits counter-clockwise cycles. On the other hand, Skott and Zipperer analyzed the cyclical patterns among the variables: output growth (Y^{\wedge}), accumulation (K^{\wedge}), profit share (Π), capacity utilization (u), and employment rates (e). The empirical evidence that they found essentially showed that the interactions among these variables for the U.S data are clockwise.

The relationship between Canada and U.S has spanned more than two centuries, and they match up closely together economically and culturally. The economies of Canada and the U.S are highly integrated, and hence I guess there should be similar findings for Canada, as Canada's homeownership rates have broadly followed those of the U.S, while both mortgage debt and consumer debt have increased significantly in Canada in recent years. However, these two countries are different from each other with respect to politics, the environment, and the government system. For example, trends in exports may play a larger role in driving the business cycle as exports comprise a huge percentage of Canada's output. Hence, using the similar approach to study Canadian data may lead to different findings.

Data

To do the cyclical patterns analysis, all the data sets were collected from the Statistics Canada CANSIM database except for the unemployment rate which is collected from the OECD database. Quarterly data were employed. This study utilizes time-series data from 1981Q1 to 2012Q2 for the variables: real gross domestic product (Y), real gross fixed investment (K[^]), and employment rate (e); and times-series data from 1962Q1 to 2012Q2 for the variables: capacity utilization (u), rates of profit share (Π), nominal H-SAE, nominal H-GFI, nominal gross fixed investment (GFI), and nominal output (Y). I deseasonalized the unadjusted nominal H-SAE and nominal H-GFI by dividing the seasonal factors⁶, and all the other variables were seasonally adjusted at the annual rate by the reporting agency.

Real gross fixed investment was used as a proxy for the accumulation and capital capacity because the information of capital stock is unreliable. “To give insight into the factors generating the flow of profits, a flow measure of firm investment is required.” (Fiebiger 2014, P. 10). The growth rates of real Y and K with 2007 constant prices were measured as quarter over previous year quarter growth rates so that there would be a focus on average around cyclical turning points.

To obtain the profit share was complicated as Statistics Canada has changed the way the national accounts are presented, and has not yet updated all its series to conform to the new system. The share of profit from 1981Q1 to 2015Q2 (set A) was drawn from the 1968 income-based system of National Accounts (SNA) (table 380-0500), provided by Statistics Canada. The profit share was computed by the following formula:

$$\Pi = \frac{\text{Gross Operating Surplus}}{\text{Gross Operating Surplus} + \text{compensation of employee}}$$

The share of profit from 1947Q1 to 1997Q2 (set B) was drawn from income-based SNA (table 380-00630), provided by Statistics Canada. The profit share was computed by the following formula:

⁶ If the time series includes a seasonal component, the trend will exhibit similar magnitude and direction during the same time period each year. Removing these recurring seasonal components from time series can lead to better analysis. I used Excel to remove the seasonal components for H-SAE and H-GFI. Firstly, I developed seasonal factors for each of these variables by using the AVERAGEIF() function. Then I divided the unadjusted H-SAE and H-GFI by the corresponding seasonal factors by using the VLOOKUP () function.

$$\Pi = \frac{X}{X + \text{Wages, salaries and supplementary labour income}}$$

Where X = Corporation profits before taxes + Interest and miscellaneous investment income + Inventory valuation adjustment + Capital consumption allowances

To obtain the time series from 1962Q1 to 2012Q2, I had to combine these two samples into one. Since set A is from 1981Q1 to 2015Q2 and set B is from 1947Q1 to 1997Q2, they have some common years (1981Q1 to 1997Q2), and the values of the common years are slightly different. To merge the common years, I used each value of the common years in set A minus the corresponding values in set B, and took the average of the differences. Then, I added the average number to set B from 1947Q1 to 1980Q4, and kept all the numbers in set A from 1981Q1 to 2015Q2. By doing so, I obtained a time series for profit share from 1947Q1 to 2015Q2.

Because of data availability, the sample periods for capacity utilization span from 1962Q1 to 1992Q1 (set C) by the Bank of Canada calculated series, and 1987Q1 to 2015Q1 (set D) by North American Industry Classification System (NAICS). For Skott and Zipperer (2011) and Fiebiger (2014), utilization rates are for the manufacturing sector. For Canada, utilization rates are for the total industrial. The method to adjust and to obtain the time-series from 1962Q1 to 2012Q2 is the same as above. Since set C is from 1962Q1 to 1992Q1 and set D is from 1987Q1 to 2015Q1, they have some common years (1987Q1 to 1992Q1), and the values of the common years are slightly different. To merge the common years, I used each value of the common years in set C minus the corresponding values in set D, and took the average of the differences. Then, I added the average number to set C from 1962Q1 to 1992Q1, and kept all the numbers in set A from 1992Q2 to 2015Q1. By doing so, I obtained a time series for profit share from 1962Q1 to 2015Q1.

The unemployment rate time-series I found from the database is for all persons with age 15 and over for the short term labour market. Hence, the employment rate was obtained by subtracting the unemployment rate from one.

The definitions of H-SAE, HGFI, and GFI are the same as I have mentioned before, but they are all in nominal term in this case. Nominal output (Y) is simply the gross domestic product.

Bivariate Cyclical Patterns – First Case: Short Run Trends

In this section, my approach is similar to Skott and Zipperer (2011). All the figures represent the short run cyclical trends, and each of the figures contains two panels. The top panel was drawn by using the actual quarterly observations without adjustment, hence the patterns in the top panel may be hard to observe. However, each dot is identified as the first quarter of each year. The bottom panel is the slightly smoothed version by using a simple four-quarter moving average. The cycles are easily distinguished in the latter case. If the pattern of variable A (y-axis) and variable B (x-axis) exhibits clockwise cycles, we say that variable A leads variable B. In other words, variable A predicts the growth of variable B. If the pattern is counter-clockwise cycles, then variable A lags variable B.

First, I examined the two time-connected scatterplots of the profit share (Π), employment rate (e), and capacity utilization (u). In Figure 2, the employment rate is laid on the x-axis, and the profit share is laid on the y-axis. The movement of the cycles are strongly clockwise. In Figure 3, the employment rate is laid on the x-axis, and capacity utilization is laid on the y-axis. The patterns on the northeastward are not clear, but we can still see clear strong clockwise cyclical patterns on the westward side. In Figure 4, capacity utilization lays on the x-axis, and the profit share lays on the y-axis. The movement resembles that of Figure 2.

Second, I took the output growth (Y^\wedge) and accumulation growth (K^\wedge) into consideration with Π , e , and u . Please refer to the smoothed cycles of (e, Y^\wedge) , (Π, Y^\wedge) , and (u, Y^\wedge) from Figures 5 to 7. The cycles are visible when output growth is taken into consideration, but the patterns fluctuate more compared with the previous three cases. However, we can still clearly identify that the short run trends are in clockwise patterns. The motion is a bit more complex when considering accumulation growth. Please refer to the smoothed cycles of (e, K^\wedge) , (Π, K^\wedge) , and (u, K^\wedge) from Figures 8 to 10. The cycles are less consistent than they were in Skott and Zipperer (2011). Moreover, the rotations display both clockwise and counter-clockwise trends. For example, counter-clockwise rotations exist in panel (u, K^\wedge) and (Π, K^\wedge) .

Bivariate Cyclical Patterns – Second Case

In this section, my approach is similar to that of Fiebiger (2014). Besides the profit share (Π), the other variables including nominal H-SAE, nominal H-GFI, and nominal gross fixed investment (GFI) were all calculated as percentages of nominal output, and in spaces vis-à-vis utilization rates. As explained by Fiebiger (2014, P. 11) “rates of capacity utilization can provide an indication of the cyclical position of the economy. Utilization data is used here to provide a cyclical context for movements in the other variables.” Utilization rates were smoothed by a simple two-quarter moving average so that the cyclical trends will be smoother and easier to observe.

The Table below lists the dates and the duration of economic recessions in Canada⁷.

	Duration in Canada
February 1960 to March 1961	14 months
March 1970 to June 1970	4 months
January 1975 to March 1975	3 months
February 1980 to June 1980	5 months
July 1981 to October 1982	16 months
April 1990 to April 1992	25 months
October 2008 to May 2009	8 months

According to the recessions' periods, time-series of 1962Q1 to 2012Q2 cover 6 business cycles from trough to trough, but the periods were separated into 9 panels⁸. The average over the periods for H-SAE is 2.04%, with a maximum of 3.6% and a minimum of 0.54%. The ratio of H-GFI is similar to H-SAE with an average of 1.72%, a maximum of 3.29%, and a minimum of 0.82%. For GFI, the mean is 11.42% and the ratios are much higher than H-SAE and H-GFI. It means that investment by firms comprises a higher percentage of output than the spending by household in the real estate market. The maximum ratio of GFI reaches 15.57%, and the

⁷ Sources from Lavoie (2014). Please note that this is not the complete timetable

⁸ If the cycle is long, I separate the periods into half. For example, from 1962Q1 to 1970Q2, two panels are presented. One is from 1962Q1 to 1966Q1, the other one is 1966Q1 to 1970Q2. The short cycle over 1980Q2 to 1982Q2 are added to the longer cycle over 1982Q2 to 1992Q3, and then separate into half. Lastly, the period of 1992Q3 to 2009Q2 is separated into two panels. One is from 1992Q3 to 2000Q3, the other one is from 2000Q3 to 2009Q2.

minimum ratio is 8.15%. For the profit share, the average is 32% with a maximum of 38%, and a minimum of 26%. The profit shares are relatively stable, and do not fluctuate too much over the periods.

Figure 11 reports the quarterly observation for variables % GDP (y-axis) vis-à-vis utilization rates (x-axis), which are quite different from the previous study by Fiebiger (2014). Instead of having strong clockwise cycles in (H-SAE, u) and (H-GF, u) space, my study shows that during the periods of 1966Q1 to 1986Q2, the trends exhibit both clockwise and counter-clockwise cycles. For example, the panels from 1975Q1 to 1980Q2 exhibit counter-clockwise cycles in the initial periods, then switch to clockwise cycles in the later periods. However, a consistent clockwise pattern starts from 1986Q2, and last to 2012Q2. The dots are the actual quarterly observations, and the first quarter of every year is at the bottom of the cycle loop. It seems that residential investment by households is strongest during the second and the third quarters in each year, and starts moving downward in quarter four. This behavior is also presented in Figure 12, which shows the time trend of H-SAE/H-GFI as % of GDP. Also, the two series fluctuate less starting with the late 1980s. Another evidence worth to highlight is that the patterns of H-SAE and H-GFI are pretty similar. As I have mentioned before, the only difference between these two variables is that the former one contains consumer credit, while the latter one does not. Adding consumer credit to H-GFI does not change the patterns too much, meaning that the effect of consumer credit is not large. In the case of the U.S, the distinction between H-SAE and H-GFI was significant, and could be observed clearly.

The counter-clockwise cycles for GFI are consistent with Fiebiger's observation. However, the patterns for the profit shares are only partially consistent with his findings, where the U.S have clockwise cycles for all the periods. The counter-clockwise cycles occur over 1970Q2 to 1980Q2 and 2000Q3 to 2009Q3 for the profit shares in Canada. The patterns of cycles are summarized in Table 15. One thing to be highlighted is that Figure 13 shows a decreasing trend of GFI as percentage of output from 1962Q2 to 2012Q2, and the investment to GDP ratio is maintained around 10% starting from 1983Q1. This ratio drops from the maximum 15.57% in the 1966Q1 to around the average of 10% nowadays and in the past 30 years.

	H-SAE	H-GFI	GFI	Profit share
1962Q1-1966Q1	clockwise	clockwise	counter-clockwise	clockwise
1966Q1-1970Q2	clockwise, counter-clockwise	clockwise, counter-clockwise	counter-clockwise	clockwise
1970Q2-1975Q1	clockwise, counter-clockwise	clockwise, counter-clockwise	counter-clockwise	counter-clockwise
1975Q1-1980Q2	clockwise, counter-clockwise	clockwise, counter-clockwise	counter-clockwise	counter-clockwise
1980Q2-1986Q2	clockwise, counter-clockwise	clockwise, counter-clockwise	counter-clockwise	clockwise
1986Q2-1992Q3	clockwise	clockwise, counter-clockwise	counter-clockwise	clockwise
1992Q3-2000Q3	clockwise	clockwise	counter-clockwise	clockwise
2000Q3-2009Q3	clockwise	clockwise	counter-clockwise	counter-clockwise
2009Q3-2012Q2	clockwise	clockwise	counter-clockwise	clockwise

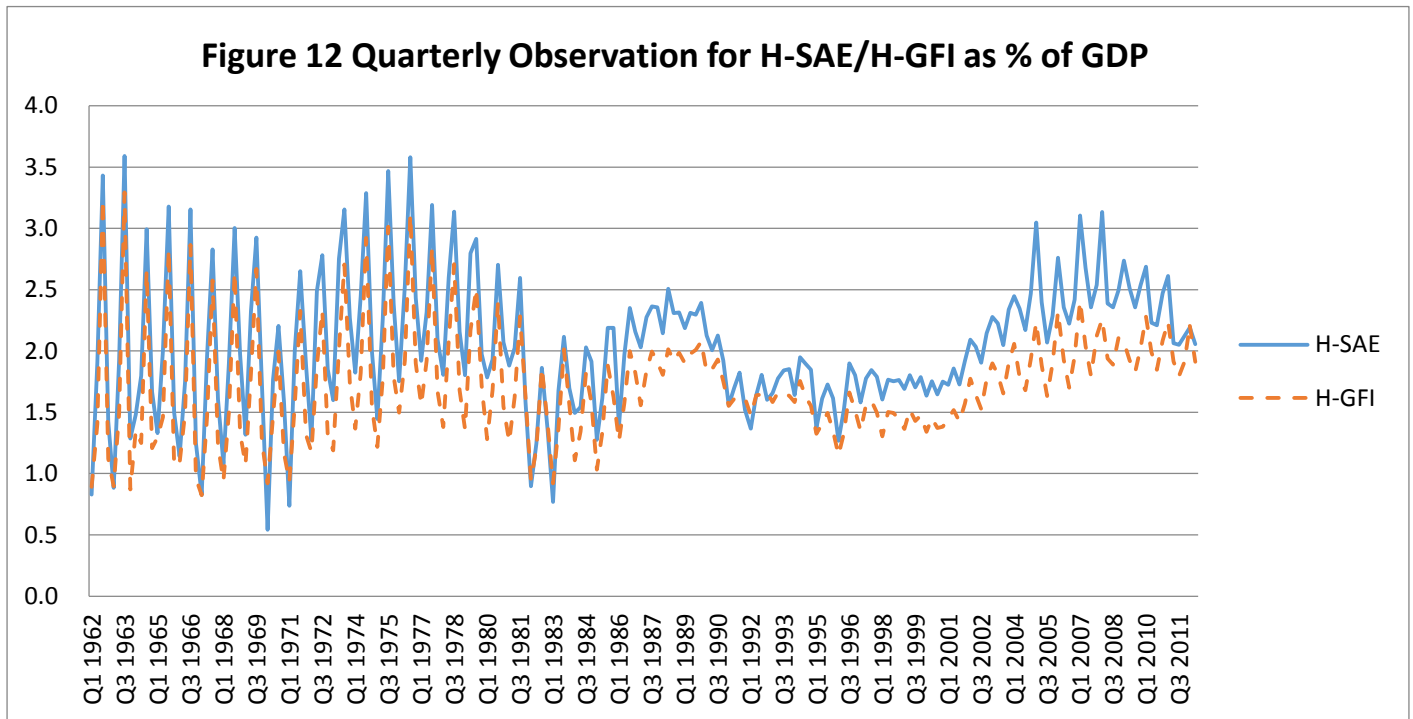


Figure 13 Quarterly Observation for GFI as % of GDP



Leamer (2007) argued that housing leads the business cycle as his study shows that in the past fifty years in the U.S, seven out of nine recessions are associated with sustained and substantial problems in housing. Precisely, there were severe reductions in housing investment before the recessions. Similar findings were observed by Claessens, Kose and Terrones (2009). They showed that recessions tend to last longer (shorter) if they coincided with housing busts (no housing busts). If the recession is associated with a housing bust, the average cumulative loss to GDP is roughly three times larger than the recessions without financial stresses.

In Canada, the recessions and expansions are also related to the real estate booms and busts reported by the Bank of Canada. The first one was in the mid-1970s, and the other one was in the late 1980s. Canada was in a recession during 1975 January to March for 3 months, and the real estate boom was during the mid-1970s, which indicates that the increase in spending in the real estate market helped Canada get out of the recession quickly. Moreover, the boom in real estate during the mid-1970s can be explained by the increase in debt-financed resources. The mortgages and non-mortgage debts secured by real estate have risen from 35% to 57% of total private sector credit outstanding since the late 1960s to present (Christensen 2015). The bust in real estate in the late 1980s was caused by the large losses on mortgage loans by trust companies. Inspection of Figure 12 reveals that the fluctuations and the levels of residential investment during the 1980s are much smaller compared with those of the previous periods. Hence, the reduction of spending on real estate by households led to the recession in the early 1990s.

V. Conclusion

This paper examined the relationships among residential investment, non-residential investment and economic growth. The methods I have applied to investigate these relationships are Granger-Causality tests, and a cyclical patterns analysis. The Granger-causality tests explored the short run relationship among gross domestic product, housing investment (with or without consumer credit), firm investment, and consumption (non-durable goods and services). The augmented Dickey-Fuller (ADF) tests showed that all the time-series variables are stationary, and the lag selection tests helped me to find the optimal lag length. A VAR model was employed to detect the Granger-causality relationships, and my findings suggested that the growth of unadjusted housing investment (with or without consumer credit) in Canada does not predict the growth in GDP in the short run, while such an effect is more evident for firm investment. My empirical findings seem to be consistent with those of Kim (2004) who found that non-residential investment leads the economic fluctuations in Korea. However, they contradict Green (1997), Liu, Park, and Zheng (2002), Chen and Zhu (2008), and Jackman (2010) who argued that housing investment Granger-causes economic growth. Moreover, my study also showed that the growth of consumption (non-durable goods and services) predicts the growth of GDP, but not vice versa. This is consistent with Wen (2007)'s finding, but firm investment does not Granger-cause output in the U.S, while this is the case in Canada. Overall, my study for Canada data seems to support DeLong and Summers (1992) who believed that fixed investment in non-residential sectors is the key to economic growth when household residential investment is non-seasonally adjusted. However, if the H-SAE and H-GFI are deseasonalized, both household residential investment and firm investment do appear to Granger-cause GDP growth in Canada.

By using a vector autoregressive model (VAR), we consider Granger-causality relationship for the short run only. We could also have considered the long run behavior between housing investment and GDP as long run economic growth may guide the long run behavior of housing investment. This could have been done by using cointegrated tests to find the cointegrated variables, and then apply the Granger-Causality test for the cointegrated variables by using error correction models. We will leave this for further research.

The other limitation of our approach is that it does not guarantee true causality relationships, but only the predictability between the time-series variables, as pointed out by Chen and Zhu (2008).

But Granger-causality tests are fair enough to give us some sense of the interaction between these variables, and we may use the trend of housing investment to forecast the business cycle and generate a strategy to help with domestic development. Another concern is that some unobserved factors could cause the co-movements in GDP and housing investment. Last but not least, my study was conducted by using national level data, which may cause a problem of aggregation bias.

The second method is the cyclical patterns analysis. In the first case, the empirical short run bivariate cyclical patterns among the variables of output growth (Y^{\wedge}), accumulation (K^{\wedge}), profit share (Π), capacity utilization (u), and employment rates (e) seem to be consistent with Skott and Zipperer (2011)'s study. Strong evidence of clockwise short term cycles exist for (e, Π), (e, u), and (u, Π), while (e, Y^{\wedge}), (Π, Y^{\wedge}), and (u, Y^{\wedge}) also exhibit clockwise patterns, but with more fluctuation. (e, K^{\wedge}), (Π, K^{\wedge}), and (u, K^{\wedge}) are also less consistent in my case as (u, K^{\wedge}) and (Π, K^{\wedge}) exhibit counter-clockwise rotations. Hence, the profit share and capital accumulation move in opposite directions. The clockwise cycles for profit shares cannot be explained by the counter-clockwise cycles for capital accumulation. There must be another demand source to explain the clockwise cycles for the profit share, which leads to my second case study. My second case was inspired by Fiebiger, and he suggested that residential investment (with or without consumer credit) may be a possible explanation for the clockwise cycles of the profit share. In Fiebiger's study, (Π, u), (H-SAE, u) and (H-GFI, u) exhibit clockwise cycles, and (NFI, u) exhibit counter-clockwise cycles. By applying the Canadian data in my study, H-SAE/HGFI does not always exhibit clockwise cycles, and counter-clockwise cycles appear sometimes during 1966Q1 to 1986Q2. Hence, we cannot say for certain that household residential investment is the key to economic growth in Canada as it lags the business cycle for some periods. GFI on the other hand exhibits counter-clockwise cycles for all the periods. It means that growth in corporate gross fixed investment responds to GDP growth at all times. Lastly, the profit share exhibits clockwise cycles for most of the periods, but counter-clockwise cycles also appear occasionally. Therefore, using the method of cyclical trend shows that investment by firms does not lead GDP growth, whereas household residential investment leads GDP growth.

In conclusion, the two different methods give us slightly different conclusions on the relationships among residential investment, non-residential investment, and GDP growth even

though they use the same data set. On one hand, the results gained by applying Granger-causality tests seem to support the argument that non-residential investment predicts economic growth when household residential investment is unadjusted for seasonal factors. On the other hand, if seasonal factors are considered, both residential and non-residential investments predict economic growth. The results gained by drawing the cyclical patterns seem to support the argument that residential investment plays a more important role for economic growth in Canada, but the results are less consistent than those achieved by Fiebiger when he studied the U.S case.

Reference

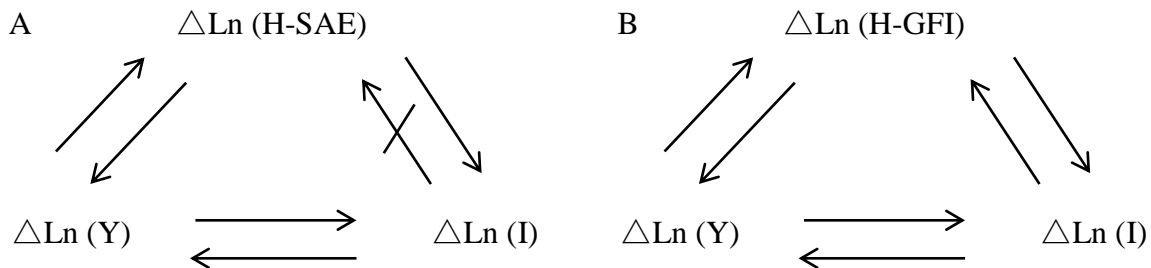
- Arku, Godwin. 2006. "The Housing and Economic Development Debate Revisited: Economic Significance of Housing in Developing Countries." *Journal of Housing and the Built Environment* 21 (4): 377–95. doi:10.1007/s10901-006-9056-3.
- Bailliu, Jeannine, Katsiaryna Kartashova, Césaire Meh, and others. 2011. "Household Borrowing and Spending in Canada." *Bank of Canada Review* 2011 (Winter): 16–29.
- Brito, Paulo M.B., and Alfredo M. Pereira. 2002. "Housing and Endogenous Long-Term Growth." *Journal of Urban Economics* 51 (2): 246–71. doi:10.1006/juec.2001.2244.
- Burns, Arthur F., and Wesley C. Mitchell. 1946. "Measuring Business Cycles." *NBER*, January. <http://papers.nber.org/books/burn46-1>.
- Chang, Tsangyao, and Chien-Chung Nieh. 2004. "A Note on Testing the Causal Link between Construction Activity and Economic Growth in Taiwan." *Journal of Asian Economics* 15 (3): 591–98. doi:10.1016/j.asieco.2004.04.003.
- Chen, Jie, and Aiyong Zhu. 2008. "The Relationship between Housing Investment and Economic Growth in China: A Panel Analysis Using Quarterly Provincial Data." Working Paper, Department of Economics, Uppsala University. <http://www.econstor.eu/handle/10419/82613>.
- Christensen, Ian. 2015. "Bank of Canada Review - Summer 2011." Accessed October 24. <http://www.bankofcanada.ca/2011/08/boc-review-summer-2011/>.
- Claessens, Stijn, M. Ayhan Kose, and Marco E. Terrones. 2009. "What Happens during Recessions, Crunches and Busts?" *Economic Policy* 24 (60): 653–700. doi:10.1111/j.1468-0327.2009.00231.x.
- Crawford, Allan, and Umar Faruqui. 2015. "Bank of Canada Review - Winter 2011-2012." Accessed October 24. <http://www.bankofcanada.ca/2012/02/boc-review-winter-2011-2012/>.
- Davis, Morris A., and Jonathan Heathcote. 2005. "Housing and the Business Cycle*." *International Economic Review* 46 (3): 751–84.
- DeLong, J. Bradford, and Lawrence H. Summers. 1992. "Equipment Investment and Economic Growth: How Strong Is the Nexus?" *Brookings Papers on Economic Activity* 23 (2): 157–212.
- Dickey, David A., and Wayne A. Fuller. 1979. "Distribution of the Estimators for Autoregressive Time Series With a Unit Root." *Journal of the American Statistical Association* 74 (366): 427–31. doi:10.2307/2286348.
- Domar, Evsey D. 1947. "Expansion and Employment." *The American Economic Review*, 34–55.
- Fiebiger, Brett. 2014. "Semi-Autonomous Household Expenditures as the Causa Causans of Post-War U.S Business Cycles."
- Fisher, Jonas D. M. 2007. "Why Does Household Investment Lead Business Investment over the Business Cycle?" *Journal of Political Economy* 115 (1): 141–68. doi:10.1086/511994.
- Goodwin, Richard M. 1967. "A Growth Cycle." *Socialism, Capitalism and Economic Growth* 5458. <http://orion.math.iastate.edu/driessel/14Models/1967growth.pdf>.
- Granger, Clive WJ. 1969. "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods." *Econometrica: Journal of the Econometric Society*, 424–38.
- Green, Richard K. 1997. "Follow the Leader: How Changes in Residential and Non-Residential Investment Predict Changes in GDP." *Real Estate Economics* 25 (2): 253–70. doi:10.1111/1540-6229.00714.
- Harrod, R. F. 1939. "An Essay in Dynamic Theory." *The Economic Journal* 49 (193): 14. doi:10.2307/2225181.
- Jackman, Mahalia. 2010. "Investigating the Relationship between Residential Construction and Economic Growth in a Small Developing Country: The Case of Barbados." *International Real Estate Review* 13 (1): 109–16.
- Kalecki, Michal. 1971. *Selected Essays on the Dynamics of the Capitalist Economy 1933-1970*. CUP Archive.
- Kim, Kyung-Hwan. 2004. "Housing and the Korean Economy." *Journal of Housing Economics* 13 (4): 321–41. doi:10.1016/j.jhe.2004.09.001.

- Lavoie, Marc. 2014. *Post-Keynesian Economics*. Edward Elgar Publishing.
<http://www.elgaronline.com/view/9781847204837.xml>.
- Leamer, Edward E. 2007. "Housing Is the Business Cycle." Working Paper 13428. National Bureau of Economic Research. <http://www.nber.org/papers/w13428>.
- Liu, Hongyu, Yun W. Park, and Siqi Zheng. 2002. "The Interaction between Housing Investment and Economic Growth in China." *International Real Estate Review* 5 (1): 40–60.
- MacGee, James. 2012. *The Rise in Consumer Credit and Bankruptcy: Cause for Concern*. Toronto, ON: C.D. Howe Institute.
- Shen, Y, and H.Y Liu. 2004. "The Relationship between Housing Investment and GDP in China." *Journal of Tsinghua University Science and Technology (in Chinese)* 9.
- Sinai, Todd, and Nicholas S. Souleles. 2005. "Owner-Occupied Housing as a Hedge Against Rent Risk." *The Quarterly Journal of Economics* 120 (2): 763–89. doi:10.1093/qje/120.2.763.
- Tavani, Daniele, Peter Flaschel, and Lance Taylor. 2011. "Estimated Non-Linearities and Multiple Equilibria in a Model of Distributive-Demand Cycles." *International Review of Applied Economics* 25 (5): 519–38.
- Wen, Yi. 2007. "Granger Causality and Equilibrium Business Cycle Theory." *Review*, no. May: 195–206.
- Wen, Yi, and others. 2001. "Residential Investment and Economic Growth." *Annals of Economics and Finance* 2 (2): 437–44.
- Wheaton, William C, and Gleb Nechayev. 2010. "Residential Investment: A Sleeping Giant."
- Wigren, Rune, and Mats Wilhelmsson. 2007. "Construction Investments and Economic Growth in Western Europe." *Journal of Policy Modeling* 29 (3): 439–51.
doi:10.1016/j.jpolmod.2006.10.001.
- Yuan, Yufei. 2009. "Explaining Residential Investment over the Business Cycle: The Importance of Information and Collateral Constraints."
- Zipperer, Ben, and Peter Skott. 2010. "An Empirical Evaluation of Three Post Keynesian Models." *Economics Department Working Paper Series*, September.
http://scholarworks.umass.edu/econ_workingpaper/103.
- . 2011. "Cyclical Patterns of Employment, Utilization, and Profitability." *Journal of Post Keynesian Economics* 34 (1): 25–58.

Appendix A:

In this appendix, the Granger-Causality tests results were obtained by using the seasonally-adjusted real H-SAE and H-GFI. Only the results that are different from using the unadjusted data will be discussed in this section. The augmented Dickey-Fuller (ADF) tests showed that both adjusted time-series variables are stationary. The maximum number of lags was set at 10 and SBIC recommended 3 lags as the optimal lag length for the models of output and semi-autonomous household expenditures, and investment and semi-autonomous household expenditures. On the other hand, AIC recommended 4 lags as the optimal lag length for the models of output and household sector gross fixed investment, as well as investment and household sector gross fixed investment. Figure A.I below helps to summarize and establish the causal chains among these variables. Details of the regressions between adjusted H-SAE and output, and adjusted H-GFI and output will be presented in Table 16 and Table 17 (Appendix C).

Figure A.I: Summary of the Granger-Causality tests results



The notation $\Delta \text{Ln} (I) \rightarrow \Delta \text{Ln} (Y)$ represents that the growth rate of investment Granger-causes the growth rate of output. $\Delta \text{Ln} (I) \not\rightarrow \Delta \text{Ln} (H\text{-SAE})$ represents that the growth rate of investment does not Granger-causes the growth rate of HSAE. Similar interpretations follow for the other variables. Figure A.I (A) indicates the Granger- causality relationship among variables by using the SBIC criterion. Figure A.I (B) indicates the Granger- causality relationship among variables by using the AIC criterion.

The original (unadjusted) data shows that there is no significant bidirectional causal relationships between $\Delta \text{Ln} (Y)_t$ and $\Delta \text{Ln} (H\text{-SAE})_t$, and $\Delta \text{Ln} (H\text{-GFI})_t$ and $\Delta \text{Ln} (Y)_t$. In other words, household residential investment (with or without consumer credit) does not help with predicting economic growth. However, when the data are seasonally-adjusted, we observed bidirectional

causal relationships between $\Delta \ln (Y)_t$ and $\Delta \ln (H\text{-SAE})_t$, and $\Delta \ln (Y)_t$ and $\Delta \ln (I)_t$ (Figure A.I (A)). Similarly, we also observed bidirectional causal relationships between $\Delta \ln (Y)_t$ and $\Delta \ln (H\text{-GFI})_t$, $\Delta \ln (Y)_t$ to $\Delta \ln (I)_t$, and $\Delta \ln (I)_t$ and $\Delta \ln (H\text{-GFI})_t$ (Figure A.I (B)). Therefore, when the seasonal effects are adjusted, household residential investment (with or without consumer credit) can help with predicting the economic growth in Canada. We can see that seasonal effects do have an impact on the causal relationships. However, since firm investment also leads the business cycle, it is hard to conclude which investment plays a more important role in leading GDP growth.

Appendix B:

Data Sources

Variables	Period	Frequency	Series number	Resources	Scaling factor
Real Aggregate Consumption	1981Q1 - 2012Q2	Quarterly	380-0064	CANSIM	Millions
Real Gross Fixed Investment	1981Q1 - 2012Q2	Quarterly	380-0064	CANSIM	Millions
Real Gross Domestic Product	1981Q1 - 2012Q2	Quarterly	380-0064	CANSIM	Millions
Nominal Gross Domestic Product	1. 1947Q1-1997Q2 2. 1981Q1-2015Q2	Quarterly	1. 380-0501 2. 380-0064	CANSIM	Millions
Nominal H-SAE/H-GFI	1962Q1 - 2012Q2	Quarterly	378-0081	CANSIM	Millions
Consumer Price Index	1981Jan – 2012Jun	Monthly	326-0020	CANSIM	Units
Profit Share	1. 1947Q1-1997Q2 2. 1981Q1-2015Q2	Quarterly	1. 380-0500 2. 380-0063	CANSIM	Millions
Capacity Utilization	1. 1962Q1-1992Q1 2. 1987Q1-2015Q1	Quarterly	1. 176-0058 2. 028-0002	CANSIM	Units
Unemployment Rate (Short-Term Labour Market Statistics: Unemployment Rates by age and gender)	1981Q1 - 2012Q2	Quarterly	N/A	OECD	Units

Appendix C: Tables for Granger-Causality Tests

Table 3: Granger-Causality tests between real aggregate output and investment using the first difference in logs vector autoregression with AIC as selection criteria		
Panel A. First difference vector autoregression between real aggregate output and investment		
	Dependent Variable	
	$\Delta \text{Ln}(Y)_t$	$\Delta \text{Ln}(I)_t$
Intercept	0.0048 (5.96)*	-0.0025 (-0.70)
$\Delta \text{Ln}(Y)_{t-1}$	0.107 (1.21)*	1.306 (3.38)*
$\Delta \text{Ln}(I)_{t-1}$	0.068 (3.53)*	0.31 (3.71)*
Panel B. Granger causality tests		
Null Hypothesis	F-test	P-value
$\Delta \text{Ln}(I)$ does not Granger Cause $\Delta \text{Ln}(Y)$	12.463*	0.0006
$\Delta \text{Ln}(Y)$ does not Granger Cause $\Delta \text{Ln}(I)$	11.418*	0.0010
<p>Note: Ln Y and Ln I are the natural logarithms of aggregate output and investment. $\Delta \text{Ln} Y$ and $\Delta \text{Ln} I$ are the first differences of Ln Y and Ln I. All series are in 2007 constant prices. In Panel A, t-values are in parentheses, asterisk indicates rejection of the null hypothesis at the 5% significance level is +/- 1.96. The lag length of 1 is from the optimal lag analysis reported in Table 2. The second column of Panel B shows the F-test tests of the null hypothesis that the lag coefficient of the causal variable is equal to zero.</p>		

Table 4: Granger-Causality tests between real aggregate consumption and investment using the first difference in logs vector autoregression with AIC as selection criteria

Panel A. First difference vector autoregression between real aggregate consumption and investment

	Dependent Variable	
	$\Delta \text{Ln} (C)_t$	$\Delta \text{Ln} (I)_t$
Intercept	0.0052 (7.62)*	-0.0084 (-2.04)*
$\Delta \text{Ln} (C)_{t-1}$	0.080 (0.89)	0.30 (3.72)*
$\Delta \text{Ln} (I)_{t-1}$	0.041 (3.06)*	2.309 (4.33)*

Panel B. Granger causality tests

Null Hypothesis	F-test	P-value
$\Delta \text{Ln} (I)$ does not Granger Cause $\Delta \text{Ln} (C)$	9.3379*	0.0028
$\Delta \text{Ln} (C)$ does not Granger Cause $\Delta \text{Ln} (I)$	18.749*	0.0000

Note: Ln C and Ln I are the natural logarithms of aggregate consumption and investment. $\Delta \text{Ln} C$ and $\Delta \text{Ln} I$ are the first differences of Ln C and Ln I. All series are in 2007 constant prices. In Panel A, t-values are in parentheses, asterisk indicates rejection of the null hypothesis at the 5% significance level is +/- 1.96. The lag length of 1 is from the optimal lag analysis reported in Table 2. The second column of Panel B shows the F-test tests of the null hypothesis that the lag coefficient of the causal variable is equal to zero.

Table 5: Granger-Causality tests between real aggregate output and consumption using the first difference in logs vector autoregression with LR as selection criteria

Panel A. First difference vector autoregression between real aggregate output and consumption		
	Dependent Variable	
	$\Delta \text{Ln} (Y)_t$	$\Delta \text{Ln} (C)_t$
Intercept	0.0057 (3.28)*	0.0053 (4.39)*
$\Delta \text{Ln} (Y)_{t-1}$	0.026 (0.25)	-0.023 (-0.32)
$\Delta \text{Ln} (Y)_{t-2}$	0.031 (0.32)	0.12 (1.76)
$\Delta \text{Ln} (Y)_{t-3}$	0.084 (0.87)	0.026 (0.38)
$\Delta \text{Ln} (Y)_{t-4}$	0.051 (0.51)	0.077 (1.12)
$\Delta \text{Ln} (Y)_{t-5}$	0.029 (0.31)	0.011 (0.16)
$\Delta \text{Ln} (Y)_{t-6}$	0.31 (3.21)*	0.030 (0.43)
$\Delta \text{Ln} (Y)_{t-7}$	0.12 (1.23)	0.11 (1.53)
$\Delta \text{Ln} (C)_{t-1}$	0.14 (0.98)	-0.015 (-0.16)
$\Delta \text{Ln} (C)_{t-2}$	0.036 (0.26)	0.023 (0.24)
$\Delta \text{Ln} (C)_{t-3}$	0.22 (1.61)	0.097 (1.02)
$\Delta \text{Ln} (C)_{t-4}$	-0.15 (-1.06)	-0.18 (-1.83)
$\Delta \text{Ln} (C)_{t-5}$	-0.32 (-2.29)*	-0.15 (-1.52)
$\Delta \text{Ln} (C)_{t-6}$	-0.22 (-1.60)	-0.48 (-0.49)
$\Delta \text{Ln} (C)_{t-7}$	-0.24 (-1.72)	0.11 (1.08)
Panel B. Granger causality tests		
Null Hypothesis	F-test	P-value
$\Delta \text{Ln} (C)$ does not Granger Cause $\Delta \text{Ln} (Y)$	2.4379*	0.0236
$\Delta \text{Ln} (Y)$ does not Granger Cause $\Delta \text{Ln} (C)$	1.0709	0.3875
<p>Note: Ln Y and Ln C are the natural logarithms of aggregate output and consumption. $\Delta \text{Ln} Y$ and $\Delta \text{Ln} C$ are the first differences of Ln Y and Ln C. All series are in 2007 constant prices. In Panel A, t-values are in parentheses, asterisk indicates rejection of the null hypothesis at the 5% significance level is +/- 1.96. The lag length of 7 is from the optimal lag analysis reported in Table 2. The second column of Panel B shows the F-test tests of the null hypothesis that the lag coefficient of the causal variable is equal to zero.</p>		

Table 6: Granger-Causality tests between real aggregate output and semi-autonomous household expenditures using the first difference in logs vector autoregression with AIC as selection criteria

Panel A. First difference vector autoregression between real aggregate output and semi-autonomous household expenditures

	Dependent Variable	
	$\Delta \text{Ln}(Y)_t$	$\Delta \text{Ln}(H\text{-SAE})_t$
Intercept	0.0043 (3.07)*	0.0046 (0.24)
$\Delta \text{Ln}(Y)_{t-1}$	0.054 (0.52)	0.49 (0.33)
$\Delta \text{Ln}(Y)_{t-2}$	0.016 (0.15)	-1.08 (-0.76)
$\Delta \text{Ln}(Y)_{t-3}$	0.92 (0.91)	3.42 (2.40)*
$\Delta \text{Ln}(Y)_{t-4}$	-0.11 (-1.08)	-1.14 (-0.77)
$\Delta \text{Ln}(Y)_{t-5}$	-0.053 (-0.53)	-1.36 (-0.97)
$\Delta \text{Ln}(Y)_{t-6}$	0.25 (2.46)*	1.70 (1.21)
$\Delta \text{Ln}(Y)_{t-7}$	0.025 (0.25)	-0.16 (-0.11)
$\Delta \text{Ln}(H\text{-SAE})_{t-1}$	0.011 (1.69)	-0.51 (-5.39)*
$\Delta \text{Ln}(H\text{-SAE})_{t-2}$	0.013 (1.61)	-0.31 (-2.86)*
$\Delta \text{Ln}(H\text{-SAE})_{t-3}$	0.013 (1.52)	-0.042 (-0.36)
$\Delta \text{Ln}(H\text{-SAE})_{t-4}$	0.013 (1.70)	0.52 (5.03)*
$\Delta \text{Ln}(H\text{-SAE})_{t-5}$	0.022 (0.29)	0.069 (0.64)
$\Delta \text{Ln}(H\text{-SAE})_{t-6}$	-0.00017 (-0.02)	-0.12 (-1.26)
$\Delta \text{Ln}(H\text{-SAE})_{t-7}$	0.0014 (0.23)	-0.36 (-4.23)*

Panel B. Granger causality tests

Null Hypothesis	F-test	P-value
$\Delta \text{Ln}(H\text{-SAE})$ does not Granger Cause $\Delta \text{Ln}(Y)$	0.71331	0.6608
$\Delta \text{Ln}(Y)$ does not Granger Cause $\Delta \text{Ln}(H\text{-SAE})$	1.3137	0.2513

Note: Ln Y and Ln H-SAE are the natural logarithms of aggregate output and flow of semi-autonomous household expenditures. $\Delta \text{Ln} Y$ and $\Delta \text{Ln} H\text{-SAE}$ are the first differences of Ln Y and Ln H-SAE. All series are in 2007 constant prices. In Panel A, t-values are in parentheses, asterisk indicates rejection of the null hypothesis at the 5% significance level is +/- 1.96. The lag length of 7 is from the optimal lag analysis reported in Table 2. The second column of Panel B shows the F-test tests of the null hypothesis that the lag coefficient of the causal variable is equal to zero.

Table 7: Granger-Causality tests between real aggregate investment and semi-autonomous household expenditures using the first difference in logs vector autoregression with AIC as selection criteria

Panel A. First difference vector autoregression between real aggregate investment and semi-autonomous household expenditures

	Dependent Variable	
	$\Delta \text{Ln} (I)_t$	$\Delta \text{Ln} (\text{H-SAE})_t$
Intercept	0.005 (1.5)	0.018 (1.72)
$\Delta \text{Ln} (I)_{t-1}$	0.30 (3.05)*	-0.09 (-0.28)
$\Delta \text{Ln} (I)_{t-2}$	0.12 (1.18)	0.41 (1.27)
$\Delta \text{Ln} (I)_{t-3}$	0.01 (0.10)	-0.53 (-1.63)
$\Delta \text{Ln} (I)_{t-4}$	-0.15 (-1.43)	-0.071 (-0.21)
$\Delta \text{Ln} (I)_{t-5}$	-0.019 (-0.19)	0.71 (0.52)
$\Delta \text{Ln} (I)_{t-6}$	-0.006 (-0.06)	-0.16 (-0.49)
$\Delta \text{Ln} (I)_{t-7}$	0.072 (0.77)	-0.19 (-0.61)
$\Delta \text{Ln} (\text{H-SAE})_{t-1}$	0.028 (1.02)	-0.53 (-5.91)*
$\Delta \text{Ln} (\text{H-SAE})_{t-2}$	0.042 (1.32)	-0.38 (-3.72)*
$\Delta \text{Ln} (\text{H-SAE})_{t-3}$	0.027 (0.80)	-0.0014 (-0.01)
$\Delta \text{Ln} (\text{H-SAE})_{t-4}$	0.043 (1.55)	0.56 (6.17)*
$\Delta \text{Ln} (\text{H-SAE})_{t-5}$	0.027 (0.86)	0.12 (1.21)
$\Delta \text{Ln} (\text{H-SAE})_{t-6}$	-0.0028 (-0.10)	-0.02 (-0.19)
$\Delta \text{Ln} (\text{H-SAE})_{t-7}$	0.025 (1.01)	-0.36 (-4.46)

Panel B. Granger causality tests

Null Hypothesis	F-test	P-value
$\Delta \text{Ln} (I)$ does not Granger Cause $\Delta \text{Ln} (\text{H-SAE})$	0.6935	0.6773
$\Delta \text{Ln} (\text{H-SAE})$ does not Granger Cause $\Delta \text{Ln} (I)$	0.8959	0.5128

Note: Ln I and Ln H-SAE are the natural logarithms of aggregate investment and flow of semi-autonomous household expenditures. $\Delta \text{Ln} I$ and $\Delta \text{Ln} \text{H-SAE}$ are the first differences of Ln I and Ln H-SAE. All series are in 2007 constant prices. In Panel A, t-values are in parentheses, asterisk indicates rejection of the null hypothesis at the 5% significance level is +/- 1.96. The lag length of 7 is from the optimal lag analysis reported in Table 2. The second column of Panel B shows the F-test tests of the null hypothesis that the lag coefficient of the causal variable is equal to zero.

Table 8: Granger-Causality tests between real aggregate output and semi-autonomous household expenditures using the first difference in logs vector autoregression with SBIC as selection criteria

Panel A. First difference vector autoregression between real aggregate output and semi-autonomous household expenditures

	Dependent Variable	
	$\Delta \text{Ln}(Y)_t$	$\Delta \text{Ln}(H\text{-SAE})_t$
Intercept	0.0049 (4.31)*	0.015 (0.85)
$\Delta \text{Ln}(Y)_{t-1}$	0.071 (0.70)	-0.062 (-0.04)
$\Delta \text{Ln}(Y)_{t-2}$	0.032 (0.35)	-0.41 (-0.29)
$\Delta \text{Ln}(Y)_{t-3}$	0.14 (1.56)	4.32 (3.13)*
$\Delta \text{Ln}(Y)_{t-4}$	-0.084 (-0.90)	-3.55 (-2.50)*
$\Delta \text{Ln}(H\text{-SAE})_{t-1}$	0.012 (2.40)*	-0.39 (-5.27)*
$\Delta \text{Ln}(H\text{-SAE})_{t-2}$	0.011 (2.18)*	-0.41 (-5.49)*
$\Delta \text{Ln}(H\text{-SAE})_{t-3}$	0.013 (2.63)*	-0.36 (-4.94)*
$\Delta \text{Ln}(H\text{-SAE})_{t-4}$	0.011 (2.23)*	0.54 (7.29)*

Panel B. Granger causality tests

Null Hypothesis	F-test	P-value
$\Delta \text{Ln}(H\text{-SAE})$ does not Granger Cause $\Delta \text{Ln}(Y)$	1.7606	0.1418
$\Delta \text{Ln}(Y)$ does not Granger Cause $\Delta \text{Ln}(H\text{-SAE})$	3.5202*	0.0096

Note: Ln Y and Ln H-SAE are the natural logarithms of aggregate output and flow of semi-autonomous household expenditures. $\Delta \text{Ln} Y$ and $\Delta \text{Ln} H\text{-SAE}$ are the first differences of Ln Y and Ln H-SAE. All series are in 2007 constant prices. In Panel A, t-values are in parentheses, asterisk indicates rejection of the null hypothesis at the 5% significance level is +/- 1.96. The lag length of 4 is from the optimal lag analysis reported in Table 2. The second column of Panel B shows the F-test tests of the null hypothesis that the lag coefficient of the causal variable is equal to zero.

Table 9: Granger-Causality tests between real aggregate investment and semi-autonomous household expenditures using the first difference in logs vector autoregression with SBIC as selection criteria

Panel A. First difference vector autoregression between real aggregate investment and semi-autonomous household expenditures

	Dependent Variable	
	$\Delta \text{Ln} (I)_t$	$\Delta \text{Ln} (H\text{-SAE})_t$
Intercept	0.0049 (1.63)	0.018 (1.7)
$\Delta \text{Ln} (I)_{t-1}$	0.30 (3.20)*	0.17 (0.51)
$\Delta \text{Ln} (I)_{t-2}$	0.10 (1.09)	0.42 (1.20)
$\Delta \text{Ln} (I)_{t-3}$	-0.011 (-0.12)	-0.63 (-1.80)
$\Delta \text{Ln} (I)_{t-4}$	-0.097 (-1.07)	-0.14 (-0.41)
$\Delta \text{Ln} (H\text{-SAE})_{t-1}$	0.052 (2.71)*	-0.42 (-5.96)*
$\Delta \text{Ln} (H\text{-SAE})_{t-2}$	0.043 (2.21)*	-0.43 (-6.11)*
$\Delta \text{Ln} (H\text{-SAE})_{t-3}$	0.048 (2.52)*	-0.38 (-5.49)*
$\Delta \text{Ln} (H\text{-SAE})_{t-4}$	0.044 (2.27)*	0.52 (7.41)*

Panel B. Granger causality tests

Null Hypothesis	F-test	P-value
$\Delta \text{Ln} (I)$ does not Granger Cause $\Delta \text{Ln} (H\text{-SAE})$	1.256	0.2916
$\Delta \text{Ln} (H\text{-SAE})$ does not Granger Cause $\Delta \text{Ln} (I)$	1.8496	0.1243

Note: Ln I and Ln H-SAE are the natural logarithms of aggregate investment and flow of semi-autonomous household expenditures. $\Delta \text{Ln} I$ and $\Delta \text{Ln} H\text{-SAE}$ are the first differences of Ln I and Ln H-SAE. All series are in 2007 constant prices. In Panel A, t-values are in parentheses, asterisk indicates rejection of the null hypothesis at the 5% significance level is +/- 1.96. The lag length of 4 is from the optimal lag analysis reported in Table 2. The second column of Panel B shows the F-test tests of the null hypothesis that the lag coefficient of the causal variable is equal to zero.

Table 10: Granger-Causality tests between real aggregate output and household sector gross fixed investment using the first difference in logs vector autoregression with AIC as selection criteria

Panel A. First difference vector autoregression between real aggregate output and household sector gross fixed investment

	Dependent Variable	
	$\Delta \text{Ln} (Y)_t$	$\Delta \text{Ln} (\text{H-GFI})_t$
Intercept	0.0047 (4.21)*	0.013 (1.25)
$\Delta \text{Ln} (Y)_{t-1}$	0.10 (1.03)	0.49 (0.56)
$\Delta \text{Ln} (Y)_{t-2}$	0.015 (0.17)	0.52 (0.63)
$\Delta \text{Ln} (Y)_{t-3}$	0.12 (1.34)	0.96 (1.17)
$\Delta \text{Ln} (Y)_{t-4}$	-0.08 (-0.84)	-2.34 (-2.85)*
$\Delta \text{Ln} (\text{H-GFI})_{t-1}$	0.022 (2.83)*	-0.19 (-2.56)*
$\Delta \text{Ln} (\text{H-GFI})_{t-2}$	0.0093 (1.12)	-0.35 (-4.64)*
$\Delta \text{Ln} (\text{H-GFI})_{t-3}$	0.024 (2.96)*	-0.17 (-2.38)*
$\Delta \text{Ln} (\text{H-GFI})_{t-4}$	0.0093 (1.14)	0.61 (8.27)*

Panel B. Granger causality tests

Null Hypothesis	F-test	P-value
$\Delta \text{Ln} (\text{H-GFI})$ does not Granger Cause $\Delta \text{Ln} (Y)$	2.328	0.0605
$\Delta \text{Ln} (Y)$ does not Granger Cause $\Delta \text{Ln} (\text{H-GFI})$	2.321	0.0612

Note: Ln Y and Ln H-GFI are the natural logarithms of aggregate output and household sector gross fixed investment, respectively. $\Delta \text{Ln} Y$ and $\Delta \text{Ln} \text{H-GFI}$ are the first differences of Ln Y and Ln HGFI. All series are in 2007 constant prices. In Panel A, t-values are in parentheses, asterisk indicates rejection of the null hypothesis at the 5% significance level is +/- 1.96. The lag length of 4 is from the optimal lag analysis reported in Table 2. The second column of Panel B shows the F-test tests of the null hypothesis that the lag coefficient of the causal variable is equal to zero.

Table 11: Granger-Causality tests between real aggregate investment and household sector gross fixed investment using the first difference in logs vector autoregression with AIC as selection criteria

Panel A. First difference vector autoregression between real aggregate investment and household sector gross fixed investment

	Dependent Variable	
	$\Delta \text{Ln (I)}_t$	$\Delta \text{Ln (H-GFI)}_t$
Intercept	0.0042 (1.40)*	0.013 (2.04)*
$\Delta \text{Ln (I)}_{t-1}$	0.29 (3.07)	0.15 (0.79)
$\Delta \text{Ln (I)}_{t-2}$	0.82 (0.86)	0.21 (1.05)
$\Delta \text{Ln (I)}_{t-3}$	-0.016 (-0.17)	-0.15 (-0.75)
$\Delta \text{Ln (I)}_{t-4}$	-0.12 (-1.33)	-0.44 (-2.43)*
$\Delta \text{Ln (H-GFI)}_{t-1}$	0.10 (2.99)*	-0.20 (-2.93)*
$\Delta \text{Ln (H-GFI)}_{t-2}$	0.63 (1.86)	-0.34 (-4.92)*
$\Delta \text{Ln (H-GFI)}_{t-3}$	0.10 (2.89)*	-0.19 (-2.77)*
$\Delta \text{Ln (H-GFI)}_{t-4}$	0.064 (1.91)	0.61 (8.55)*

Panel B. Granger causality tests

Null Hypothesis	F-test	P-value
$\Delta \text{Ln (I)}$ does not Granger Cause $\Delta \text{Ln (H-GFI)}$	2.359	0.0577
$\Delta \text{Ln (H-GFI)}$ does not Granger Cause $\Delta \text{Ln (I)}$	2.305	0.0627

Note: Ln I and Ln H-GFI are the natural logarithms of aggregate investment and household sector gross fixed investment, respectively. $\Delta \text{Ln I}$ and $\Delta \text{Ln H-GFI}$ are the first differences of Ln I and Ln HGFI. All series are in 2007 constant prices. In Panel A, t-values are in parentheses, asterisk indicates rejection of the null hypothesis at the 5% significance level is +/- 1.96. The lag length of 4 is from the optimal lag analysis reported in Table 2. The second column of Panel B shows the F-test tests of the null hypothesis that the lag coefficient of the causal variable is equal to zero.

Table 12: Granger-Causality tests between real aggregate output and household sector gross fixed investment using the first difference in logs vector autoregression with LR as selection criteria

Panel A. First difference vector autoregression between real aggregate output and household sector gross fixed investment

	Dependent Variable	
	$\Delta \text{Ln} (Y)_t$	$\Delta \text{Ln} (\text{H-GFI})_t$
Intercept	0.0038 (3.04)*	0.011 (0.97)
$\Delta \text{Ln} (Y)_{t-1}$	0.096 (0.99)	0.28 (0.32)
$\Delta \text{Ln} (Y)_{t-2}$	0.054 (0.55)	1.11 (1.26)
$\Delta \text{Ln} (Y)_{t-3}$	0.052 (0.54)	0.62 (0.70)
$\Delta \text{Ln} (Y)_{t-4}$	-0.12 (-1.28)	-2.30 (-2.71)*
$\Delta \text{Ln} (Y)_{t-5}$	0.01 (0.11)	-1.02 (-1.18)
$\Delta \text{Ln} (Y)_{t-6}$	0.22 (2.33)*	1.40 (1.63)
$\Delta \text{Ln} (\text{H-GFI})_{t-1}$	0.033 (3.02)*	-0.18 (-1.85)*
$\Delta \text{Ln} (\text{H-GFI})_{t-2}$	-0.0013 (-0.11)	-0.39 (-3.70)*
$\Delta \text{Ln} (\text{H-GFI})_{t-3}$	0.022 (2.25)*	-0.21 (-2.42)*
$\Delta \text{Ln} (\text{H-GFI})_{t-4}$	0.014 (1.41)	0.62 (6.96)*
$\Delta \text{Ln} (\text{H-GFI})_{t-5}$	-0.011 (-1.07)	-0.051 (-0.54)
$\Delta \text{Ln} (\text{H-GFI})_{t-6}$	0.014 (1.41)	0.049 (0.52)

Panel B. Granger causality tests

Null Hypothesis	F-test	P-value
$\Delta \text{Ln} (\text{H-GFI})$ does not Granger Cause $\Delta \text{Ln} (Y)$	2.1089	0.0582
$\Delta \text{Ln} (Y)$ does not Granger Cause $\Delta \text{Ln} (\text{H-GFI})$	2.2417*	0.0447

Note: Ln Y and Ln H-GFI are the natural logarithms of aggregate output and household sector gross fixed investment, respectively. $\Delta \text{Ln} Y$ and $\Delta \text{Ln} \text{H-GFI}$ are the first differences of Ln Y and Ln HGFI. All series are in 2007 constant prices. In Panel A, t-values are in parentheses, asterisk indicates rejection of the null hypothesis at the 5% significance level is +/- 1.96. The lag length of 6 is from the optimal lag analysis reported in Table 2. The second column of Panel B shows the F-test tests of the null hypothesis that the lag coefficient of the causal variable is equal to zero.

Table 13: Granger-Causality tests between real aggregate investment and household sector gross fixed investment using the first difference in logs vector autoregression with LR as selection criteria

Panel A. First difference vector autoregression between real aggregate investment and household sector gross fixed investment

	Dependent Variable	
	$\Delta \text{Ln (I)}_t$	$\Delta \text{Ln (H-GFI)}_t$
Intercept	0.0043 (1.30)	0.013 (2.03)*
$\Delta \text{Ln (I)}_{t-1}$	0.29 (2.96)*	0.12 (0.64)
$\Delta \text{Ln (I)}_{t-2}$	0.13 (1.26)	0.18 (0.91)
$\Delta \text{Ln (I)}_{t-3}$	-0.0050 (-0.05)	-0.12 (-0.62)
$\Delta \text{Ln (I)}_{t-4}$	-0.16 (-1.55)	-0.29 (-1.47)
$\Delta \text{Ln (I)}_{t-5}$	-0.0075 (-0.07)	0.084 (0.43)
$\Delta \text{Ln (I)}_{t-6}$	-0.0064 (-0.06)	-0.17 (-0.87)
$\Delta \text{Ln (I)}_{t-7}$	0.056 (0.59)	0.20 (1.08)
$\Delta \text{Ln (H-GFI)}_{t-1}$	0.085 (1.78)	-0.16 (-1.77)
$\Delta \text{Ln (H-GFI)}_{t-2}$	0.054 (1.11)	-0.44 (-4.62)*
$\Delta \text{Ln (H-GFI)}_{t-3}$	0.032 (0.59)	0.019 (0.18)
$\Delta \text{Ln (H-GFI)}_{t-4}$	0.057 (1.33)	0.57 (6.89)*
$\Delta \text{Ln (H-GFI)}_{t-5}$	0.016 (0.32)	-0.15 (-1.52)
$\Delta \text{Ln (H-GFI)}_{t-6}$	-0.0019 (-0.04)	0.057 (0.64)
$\Delta \text{Ln (H-GFI)}_{t-7}$	0.065 (1.44)	-0.31 (-3.50)

Panel B. Granger causality tests

Null Hypothesis	F-test	P-value
$\Delta \text{Ln (I)}$ does not Granger Cause $\Delta \text{Ln (H-GFI)}$	0.8659	0.5361
$\Delta \text{Ln (H-GFI)}$ does not Granger Cause $\Delta \text{Ln (I)}$	1.2011	0.3089

Note: Ln I and Ln H-GFI are the natural logarithms of aggregate investment and household sector gross fixed investment, respectively. $\Delta \text{Ln I}$ and $\Delta \text{Ln H-GFI}$ are the first differences of Ln I and Ln HGFI. All series are in 2007 constant prices. In Panel A, t-values are in parentheses, asterisk indicates rejection of the null hypothesis at the 5% significance level is +/- 1.96. The lag length of 7 is from the optimal lag analysis reported in Table 2. The second column of Panel B shows the F-test tests of the null hypothesis that the lag coefficient of the causal variable is equal to zero.

Table 16: Granger-Causality tests between real aggregate output and adjusted semi-autonomous household expenditures using the first difference in logs vector autoregression with SBIC as selection criteria

Panel A. First difference vector autoregression between real aggregate output and adjusted semi-autonomous household expenditures

	Dependent Variable	
	$\Delta \text{Ln}(Y)_t$	$\Delta \text{Ln}(H\text{-SAE})_t$
Intercept	0.004 (3.91)*	-0.023 (-1.30)
$\Delta \text{Ln}(Y)_{t-1}$	0.13 (1.41)	2.17 (1.37)
$\Delta \text{Ln}(Y)_{t-2}$	0.075 (0.82)	0.68 (0.43)
$\Delta \text{Ln}(Y)_{t-3}$	0.11 (1.22)	3.64 (2.32)*
$\Delta \text{Ln}(H\text{-SAE})_{t-1}$	0.0088 (1.77)	-0.37 (-4.27)*
$\Delta \text{Ln}(H\text{-SAE})_{t-2}$	0.00054 (0.15)	-0.73 (-11.50)*
$\Delta \text{Ln}(H\text{-SAE})_{t-3}$	0.015 (3.08)*	-0.32 (-1.30)

Panel B. Granger causality tests

Null Hypothesis	F-test	P-value
$\Delta \text{Ln}(H\text{-SAE})$ does not Granger Cause $\Delta \text{Ln}(Y)$	3.3492*	0.0216
$\Delta \text{Ln}(Y)$ does not Granger Cause $\Delta \text{Ln}(H\text{-SAE})$	3.0716*	0.0306

Note: Ln Y and Ln H-SAE are the natural logarithms of aggregate output and flow of semi-autonomous household expenditures. $\Delta \text{Ln} Y$ and $\Delta \text{Ln} H\text{-SAE}$ are the first differences of Ln Y and Ln H-SAE. All series are in 2007 constant prices. In Panel A, t-values are in parentheses, asterisk indicates rejection of the null hypothesis at the 5% significance level is +/- 1.96. The optima lag length is 3. The second column of Panel B shows the F-test tests of the null hypothesis that the lag coefficient of the causal variable is equal to zero.

Table 17: Granger-Causality tests between real aggregate output and adjusted household sector gross fixed investment using the first difference in logs vector autoregression with AIC as selection criteria

Panel A. First difference vector autoregression between real aggregate output and adjusted household sector gross fixed investment

	Dependent Variable	
	$\Delta \text{Ln} (Y)_t$	$\Delta \text{Ln} (\text{H-GFI})_t$
Intercept	0.0046 (4.21)*	0.0104 (1.09)
$\Delta \text{Ln} (Y)_{t-1}$	0.13 (1.38)	1.08 (1.27)
$\Delta \text{Ln} (Y)_{t-2}$	0.024 (0.27)	0.42 (0.53)
$\Delta \text{Ln} (Y)_{t-3}$	0.12 (1.36)	0.87 (1.10)
$\Delta \text{Ln} (Y)_{t-4}$	-0.097 (-1.08)	-2.34 (-2.95)*
$\Delta \text{Ln} (\text{H-GFI})_{t-1}$	0.027 (2.99)*	-0.12 (-1.47)
$\Delta \text{Ln} (\text{H-GFI})_{t-2}$	0.000055 (0.01)	-0.43 (-5.21)*
$\Delta \text{Ln} (\text{H-GFI})_{t-3}$	0.033 (3.79)*	-0.067 (-0.88)
$\Delta \text{Ln} (\text{H-GFI})_{t-4}$	0.0013 (0.15)	0.45 (5.61)*

Panel B. Granger causality tests

Null Hypothesis	F-test	P-value
$\Delta \text{Ln} (\text{H-GFI})$ does not Granger Cause $\Delta \text{Ln} (Y)$	4.0009*	0.0045
$\Delta \text{Ln} (Y)$ does not Granger Cause $\Delta \text{Ln} (\text{H-GFI})$	2.6327*	0.0379

Note: Ln Y and Ln H-GFI are the natural logarithms of aggregate output and household sector gross fixed investment, respectively. $\Delta \text{Ln} Y$ and $\Delta \text{Ln} \text{H-GFI}$ are the first differences of Ln Y and Ln HGFI. All series are in 2007 constant prices. In Panel A, t-values are in parentheses, asterisk indicates rejection of the null hypothesis at the 5% significance level is +/- 1.96. The optimal lag length is 4. The second column of Panel B shows the F-test tests of the null hypothesis that the lag coefficient of the causal variable is equal to zero.

Appendix D: Figures for Cyclical Patterns

Figure 2 – Actual and Smoothed cycles in the (e, Π) planes

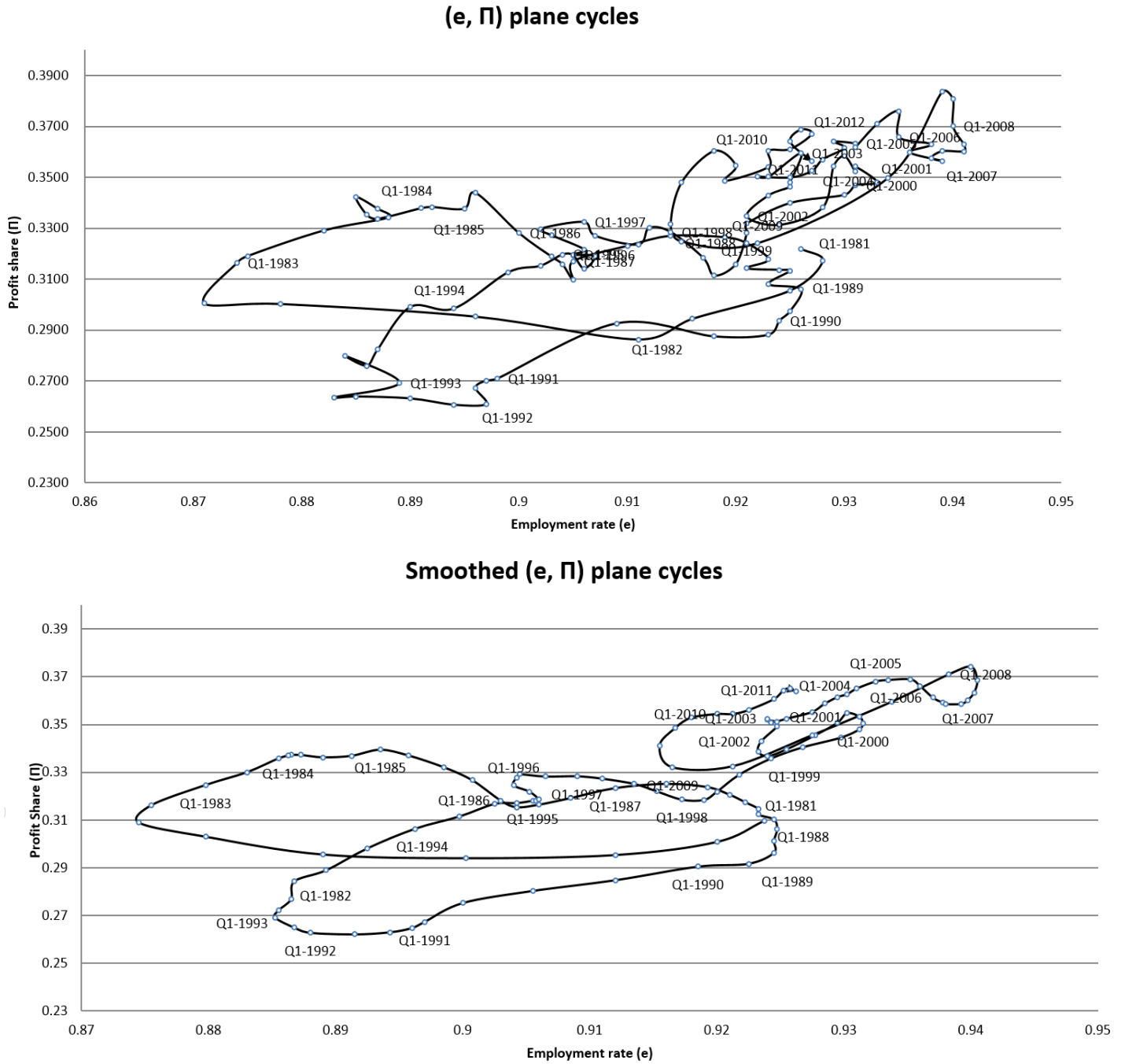


Figure 3 – Actual and Smoothed cycles in the (e, u) planes

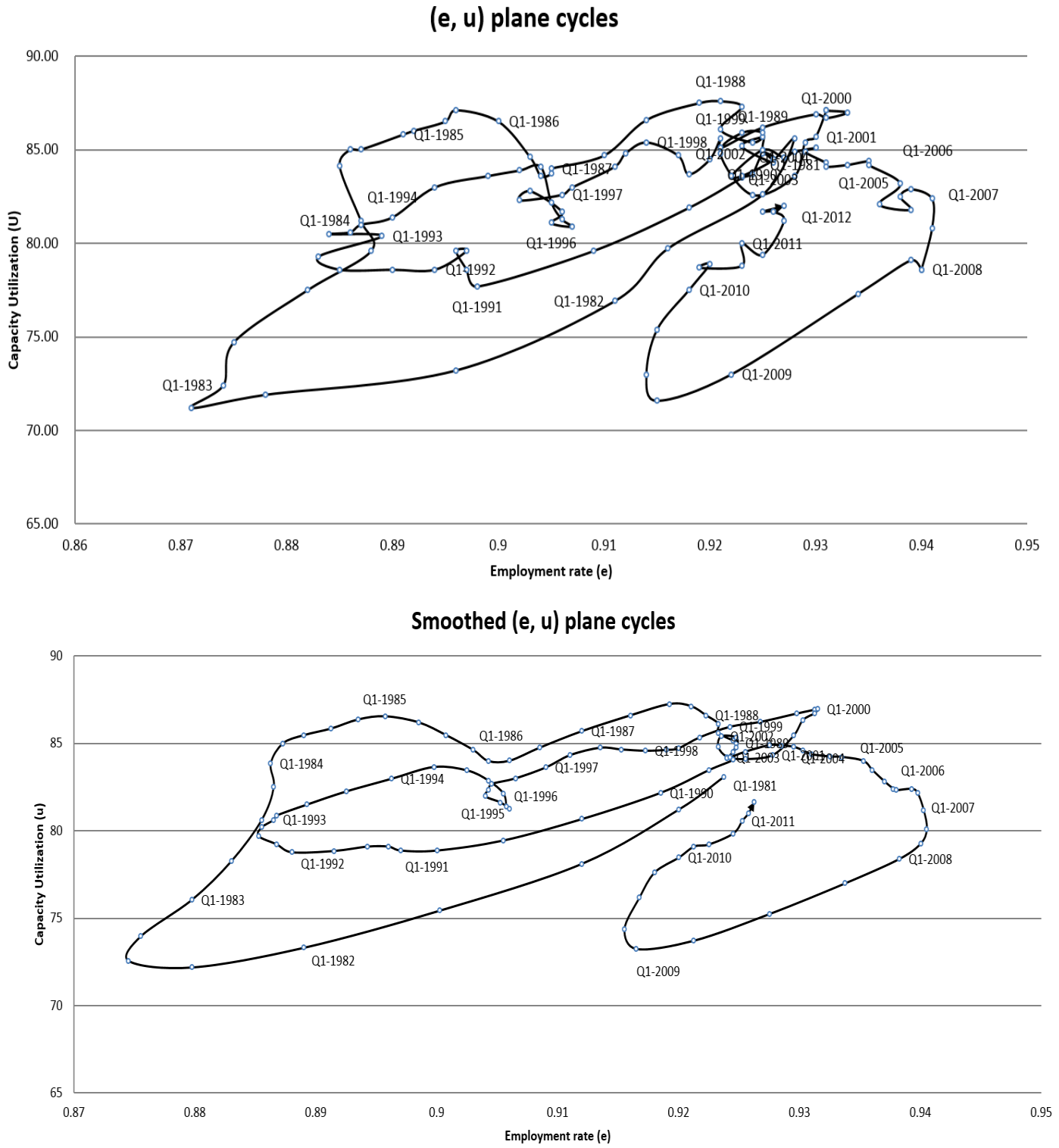
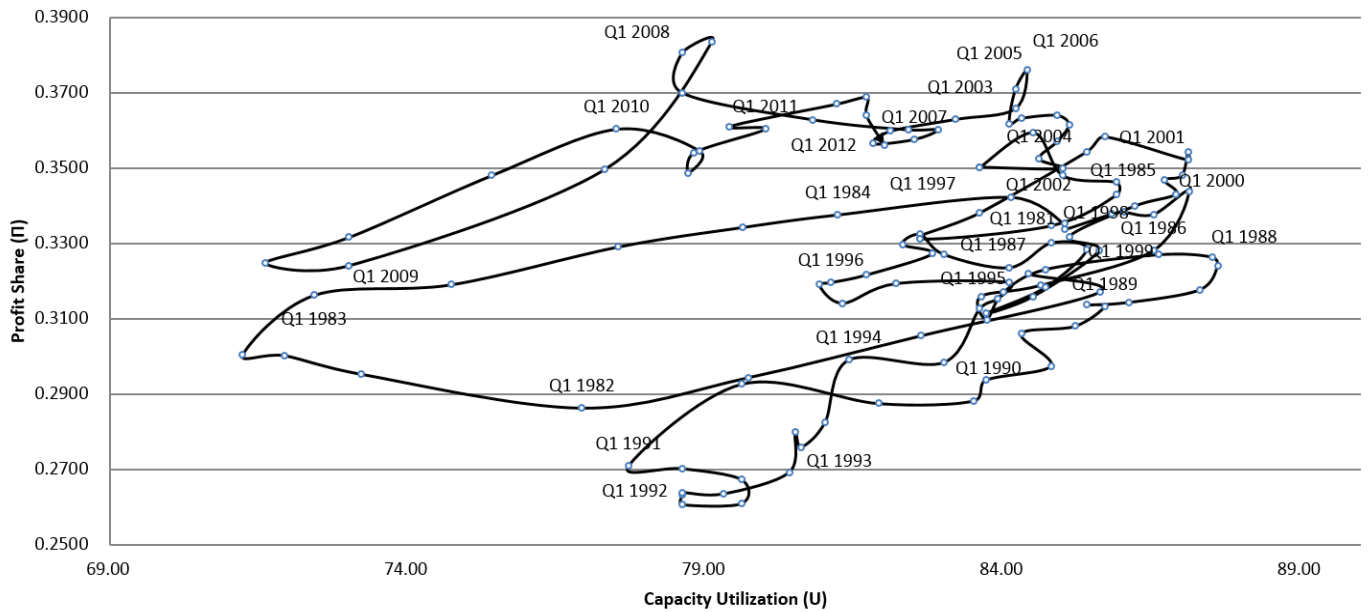


Figure 4 – Actual and Smoothed cycles in the (u, Π) planes

(U, Π) plane cycles



Smoothed (U, Π) plane cycles

图表区

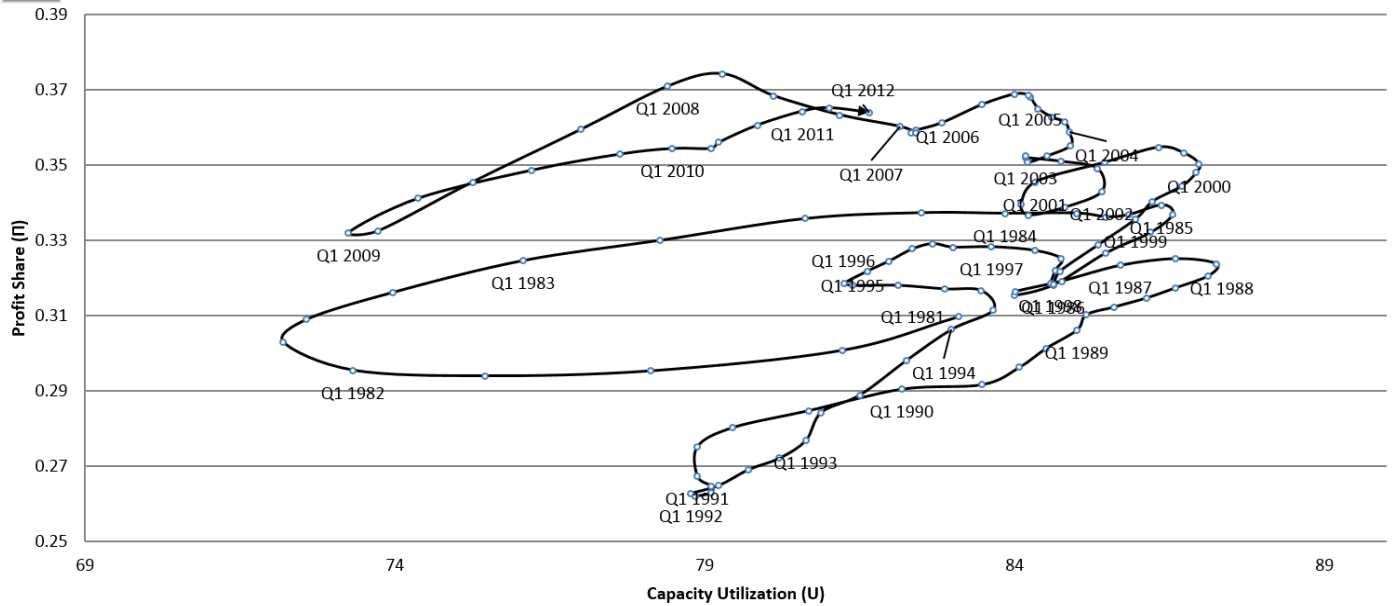


Figure 5 – Actual and Smoothed cycles in the (e, Y[^]) plane

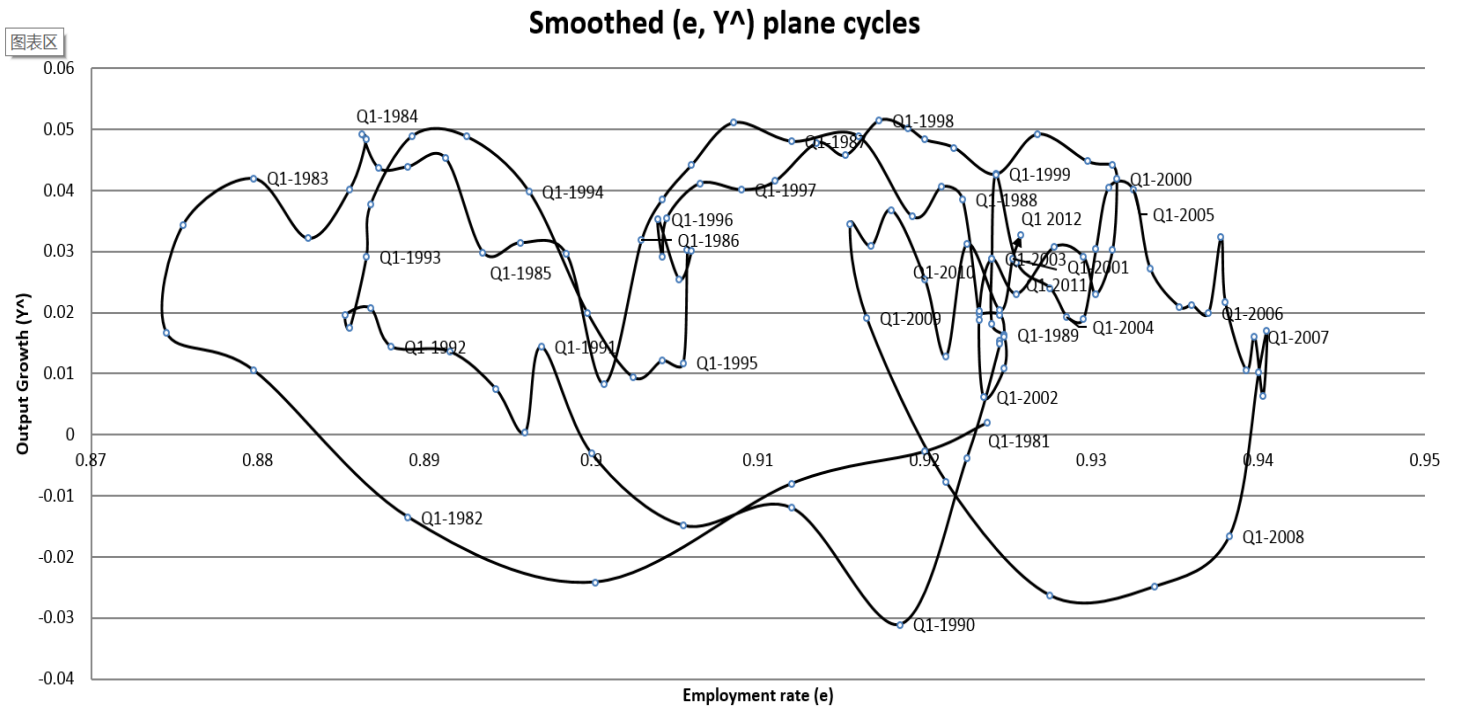
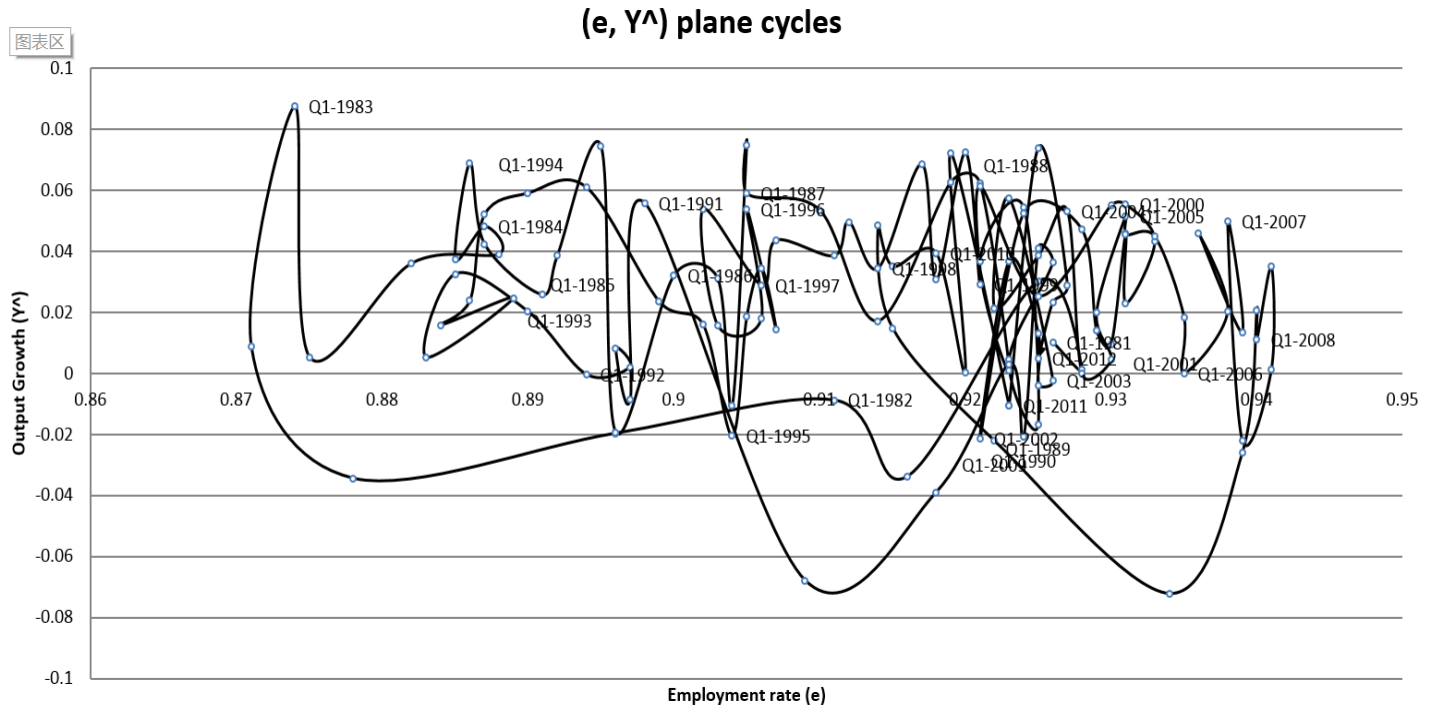
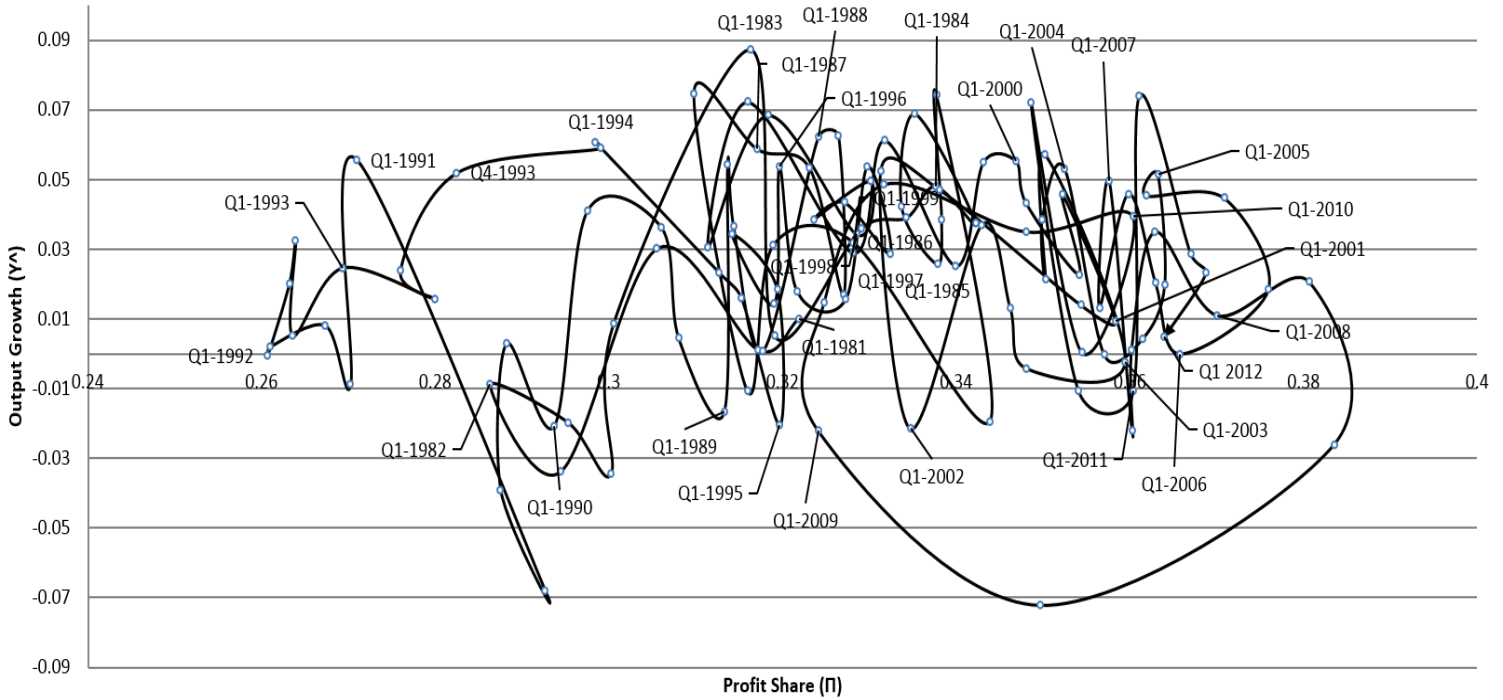


Figure 6 – Actual and Smoothed cycles in the (Π, Y^{\wedge}) planes

(Π, Y^{\wedge}) plane cycles



Smoothed (Π, Y^{\wedge}) plane cycles

图表区

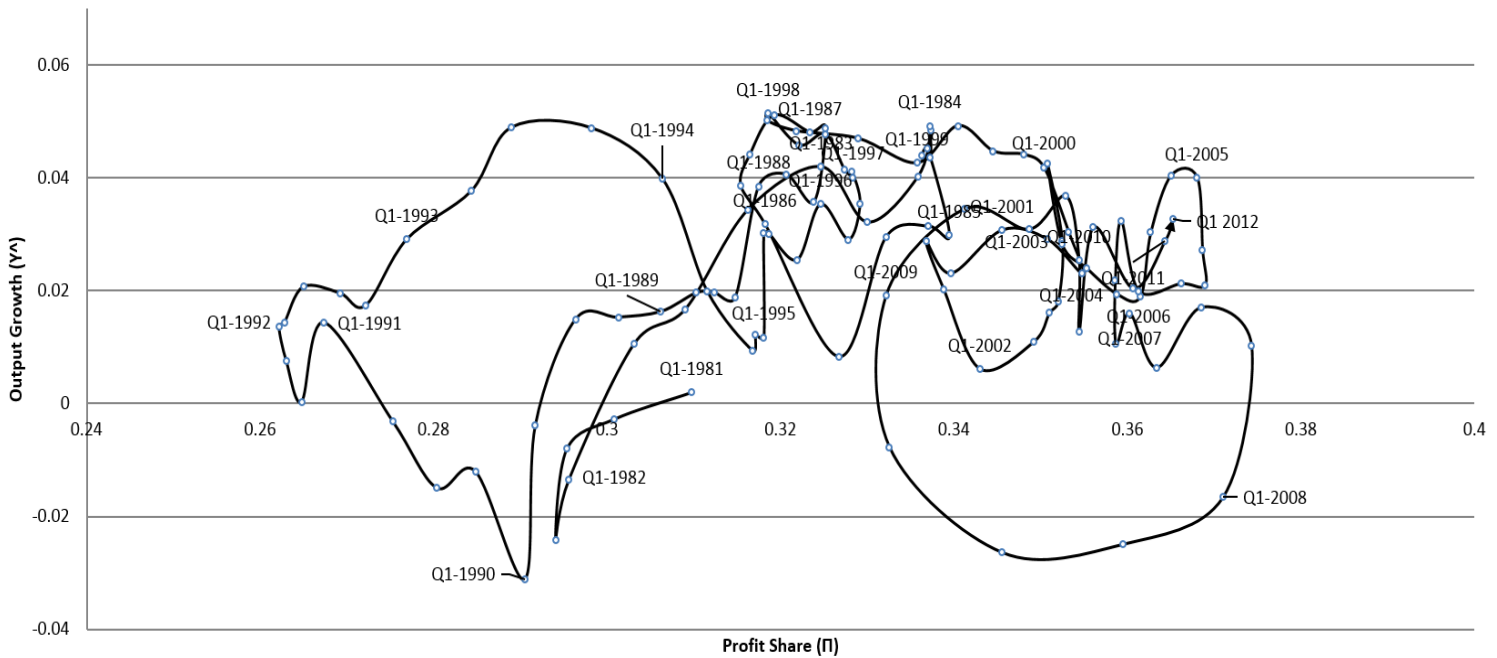


Figure 7 – Actual and Smoothed cycles in the (u, Y[^]) planes

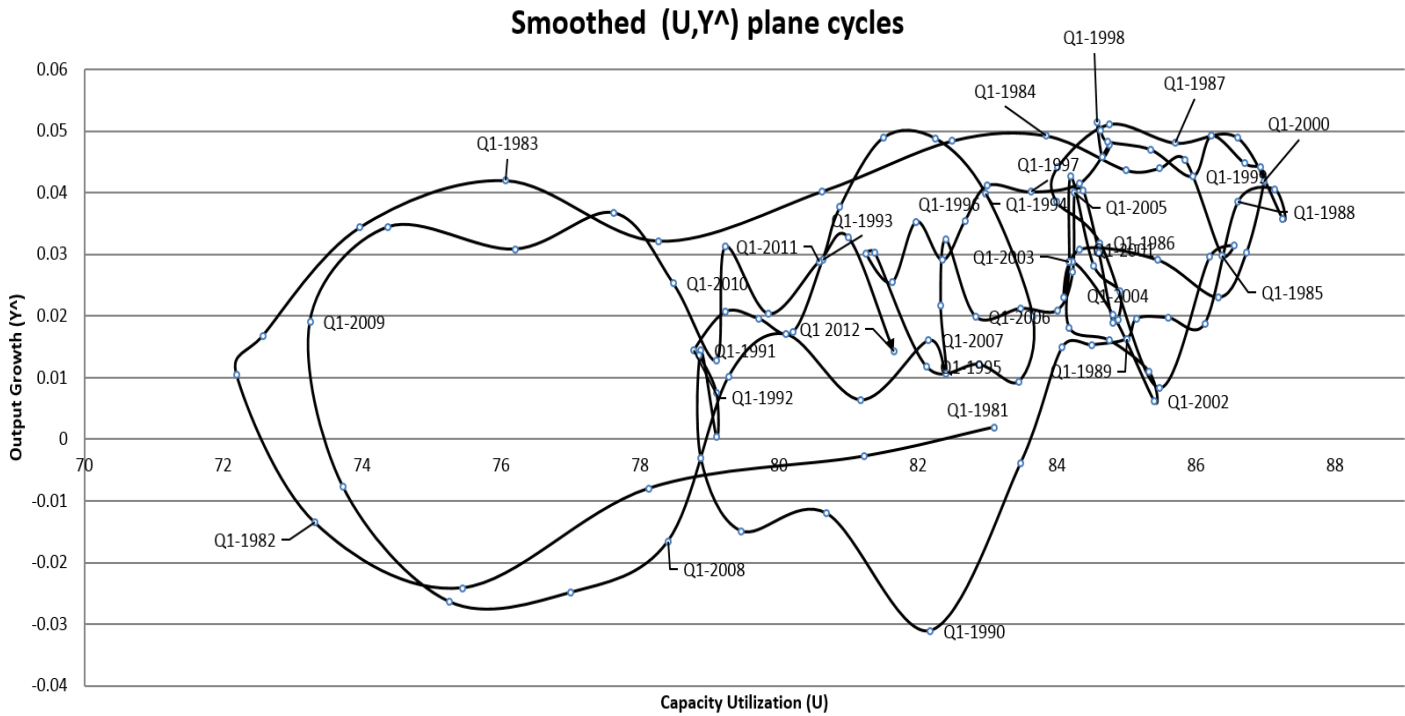
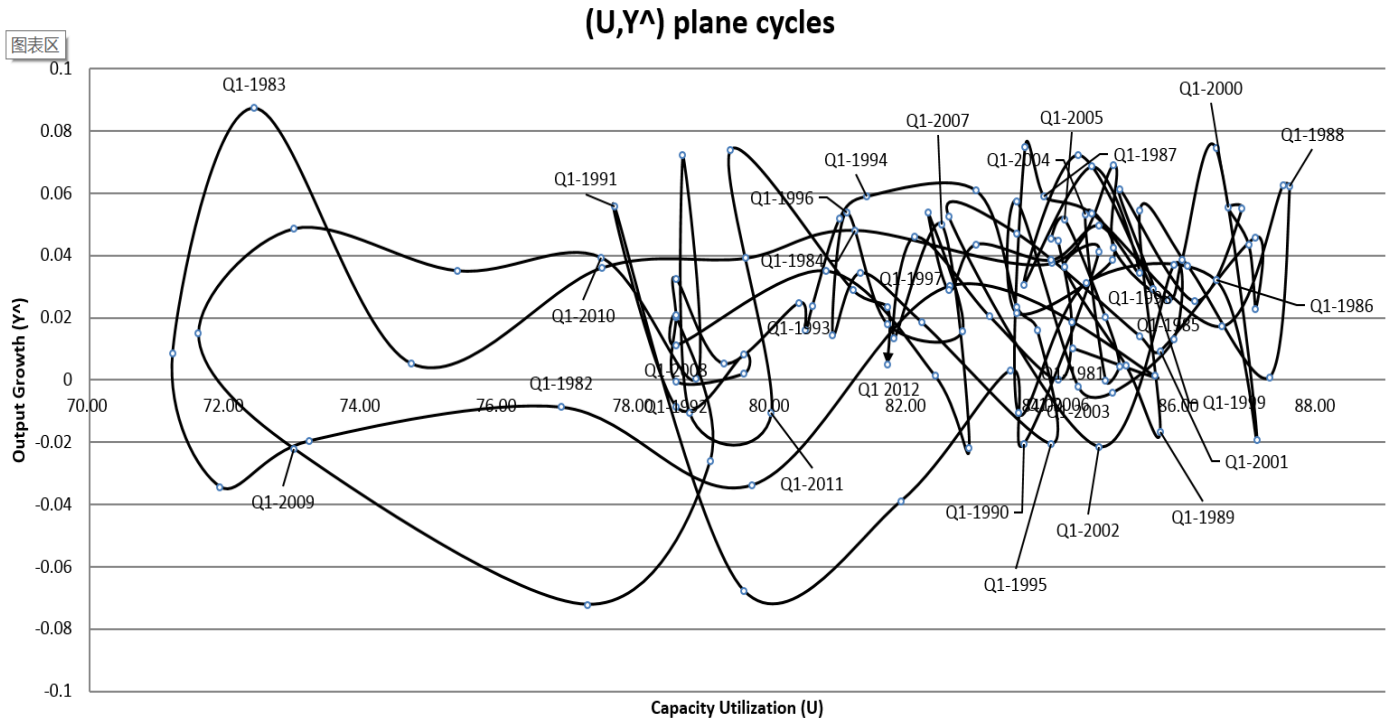


Figure 8 – Actual and Smoothed cycles in the (e, K^{\wedge}) planes

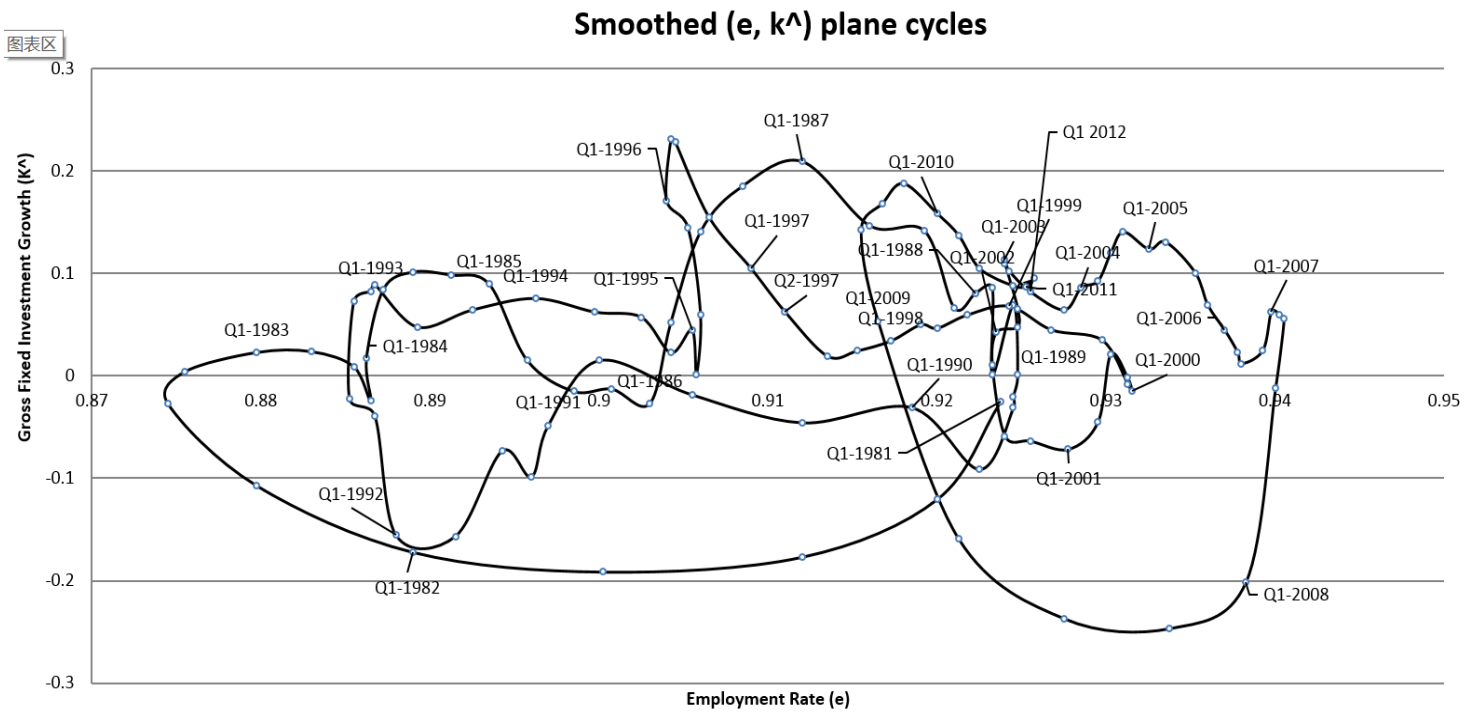
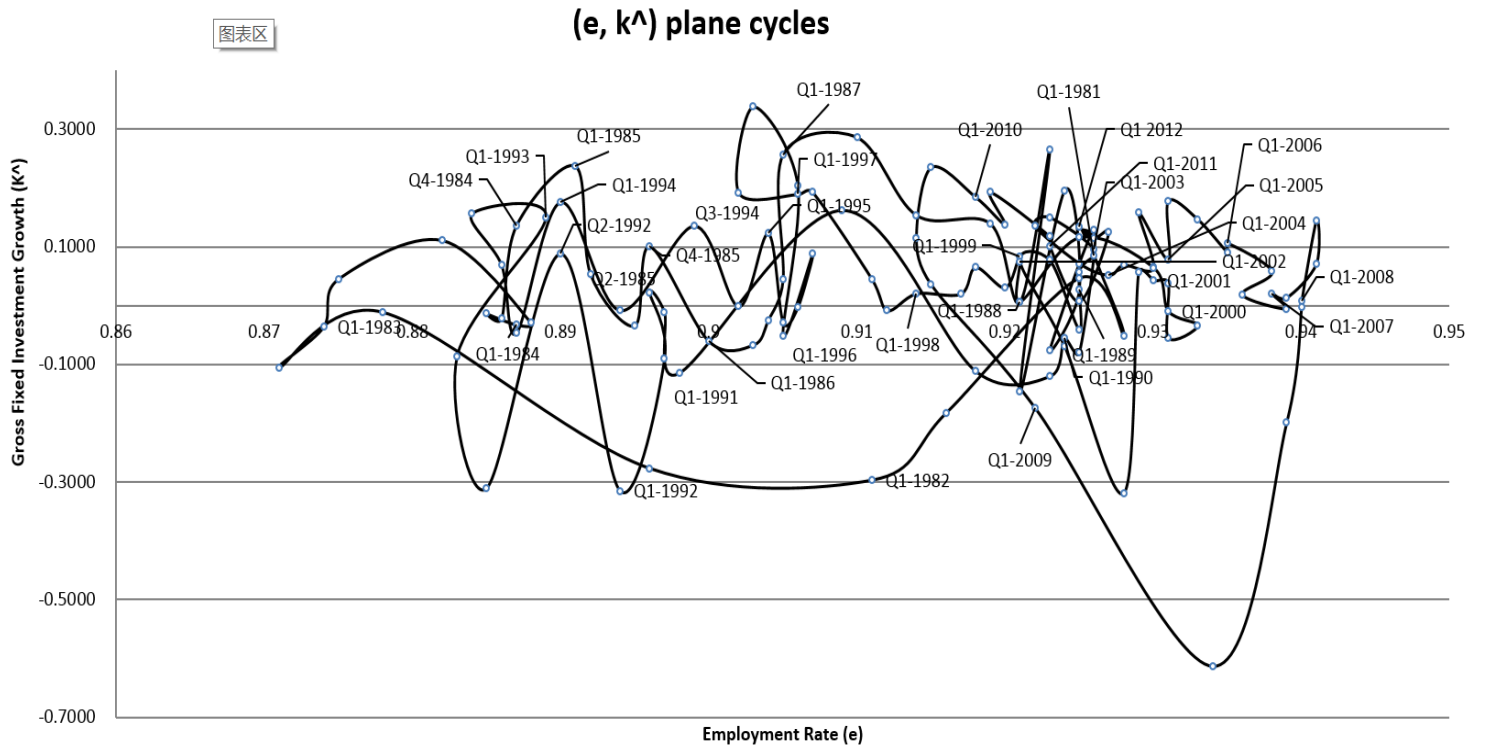
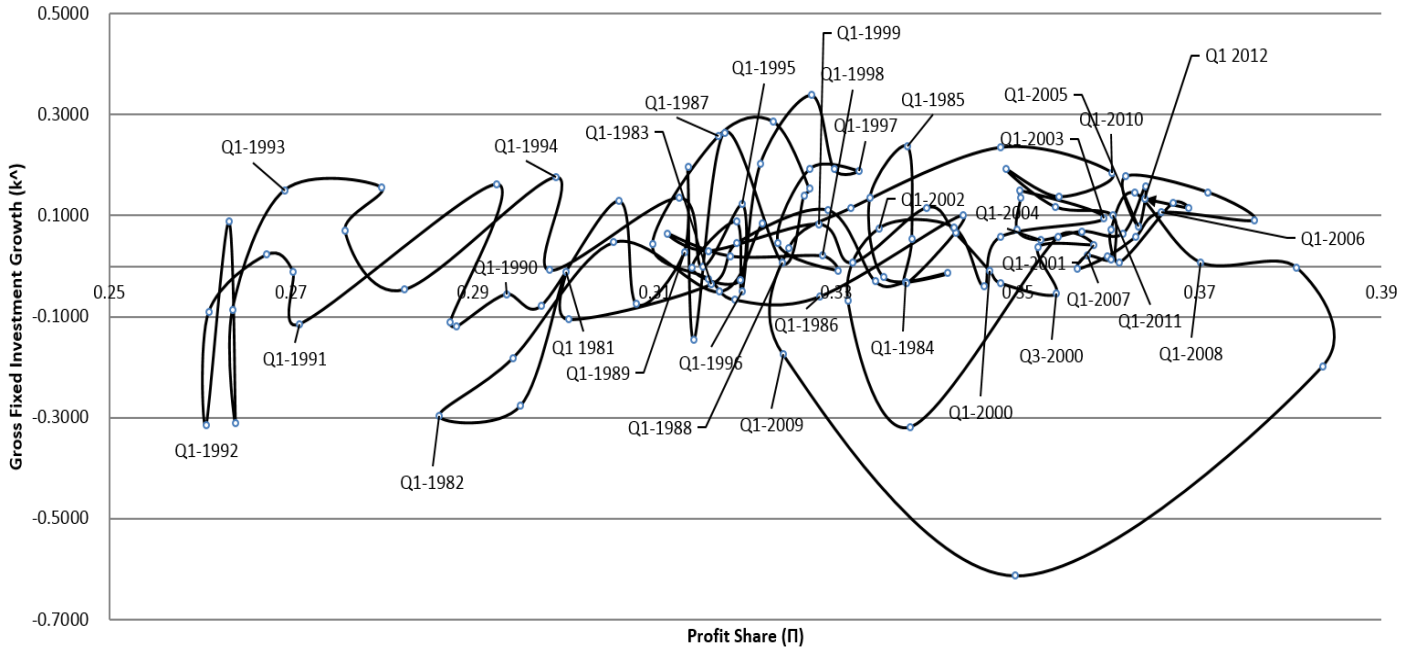


Figure 9 – Actual and Smoothed cycles in the (Π , K^{\wedge}) planes

图表区

(Π , k^{\wedge}) plane cycles



Smoothed (Π , k^{\wedge}) plane cycles

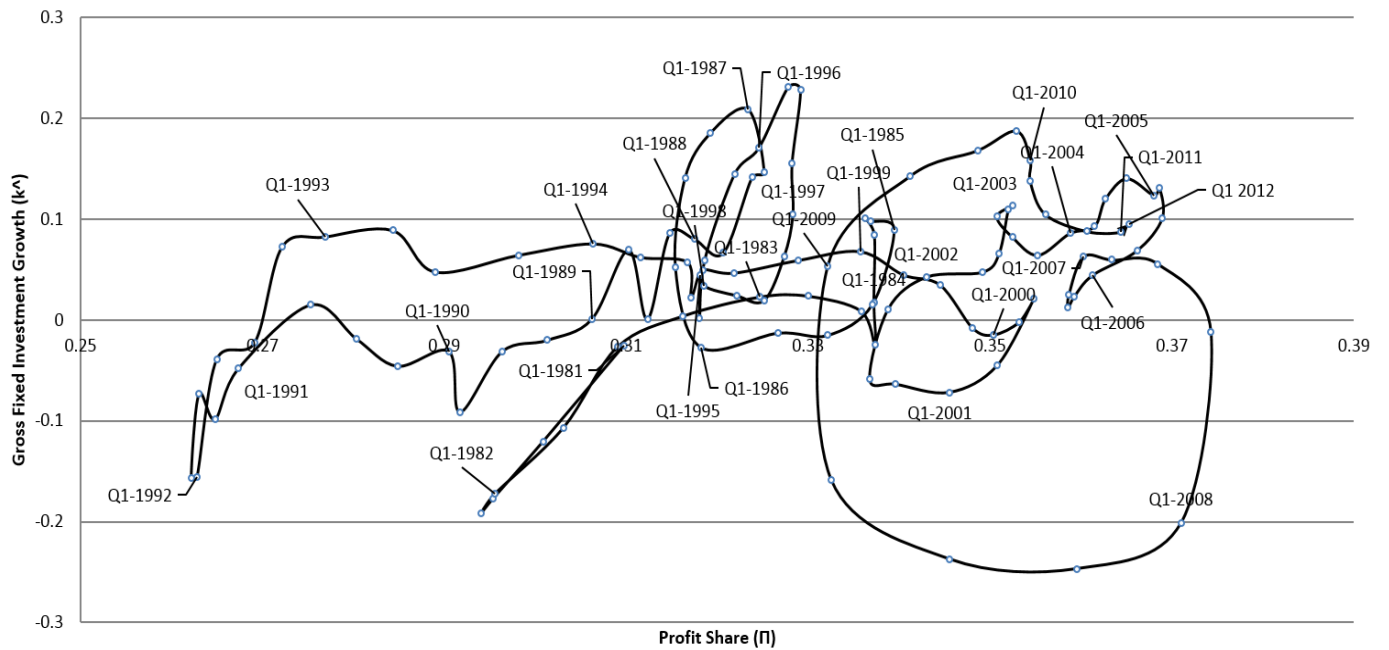
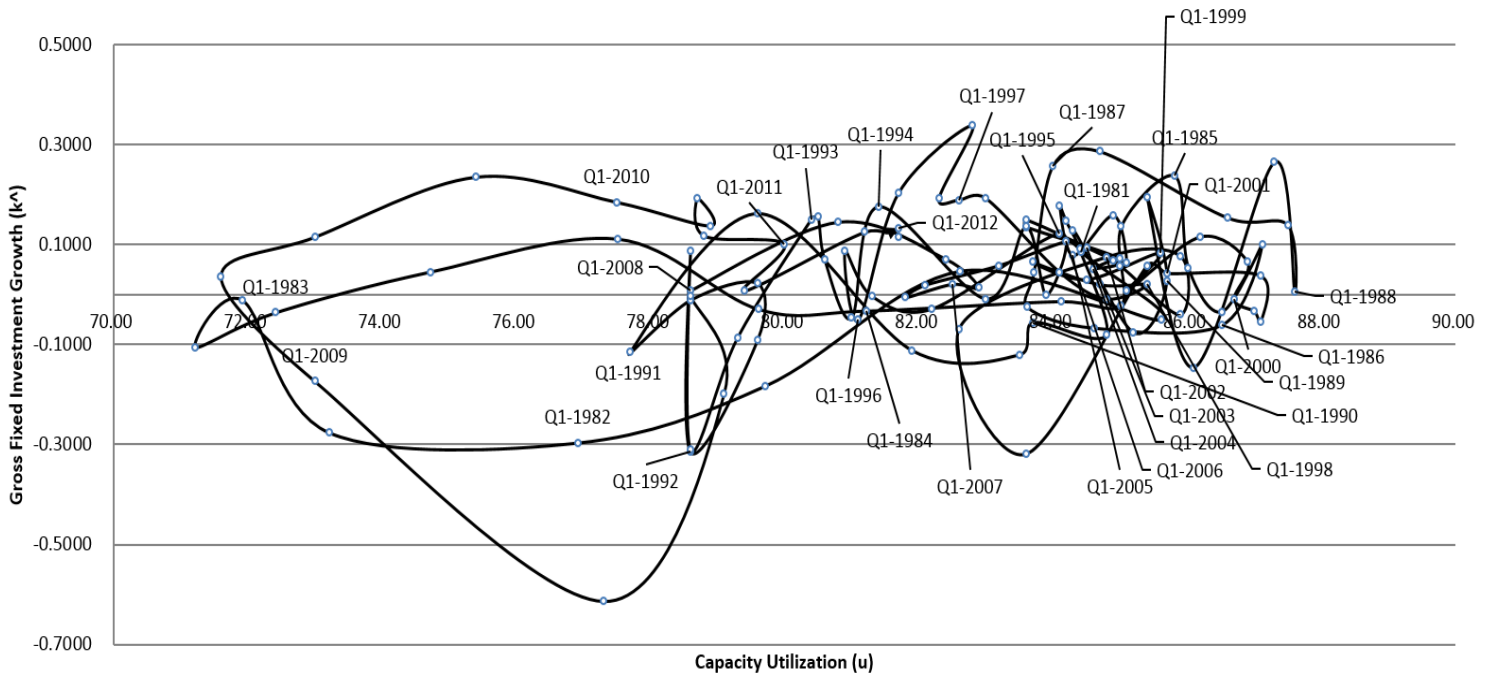


Figure 10 – Actual and Smoothed cycles in the (u, K^{\wedge}) planes

(u, k^{\wedge}) plane cycles



Smoothed (u, k^{\wedge}) plane cycles

图表区

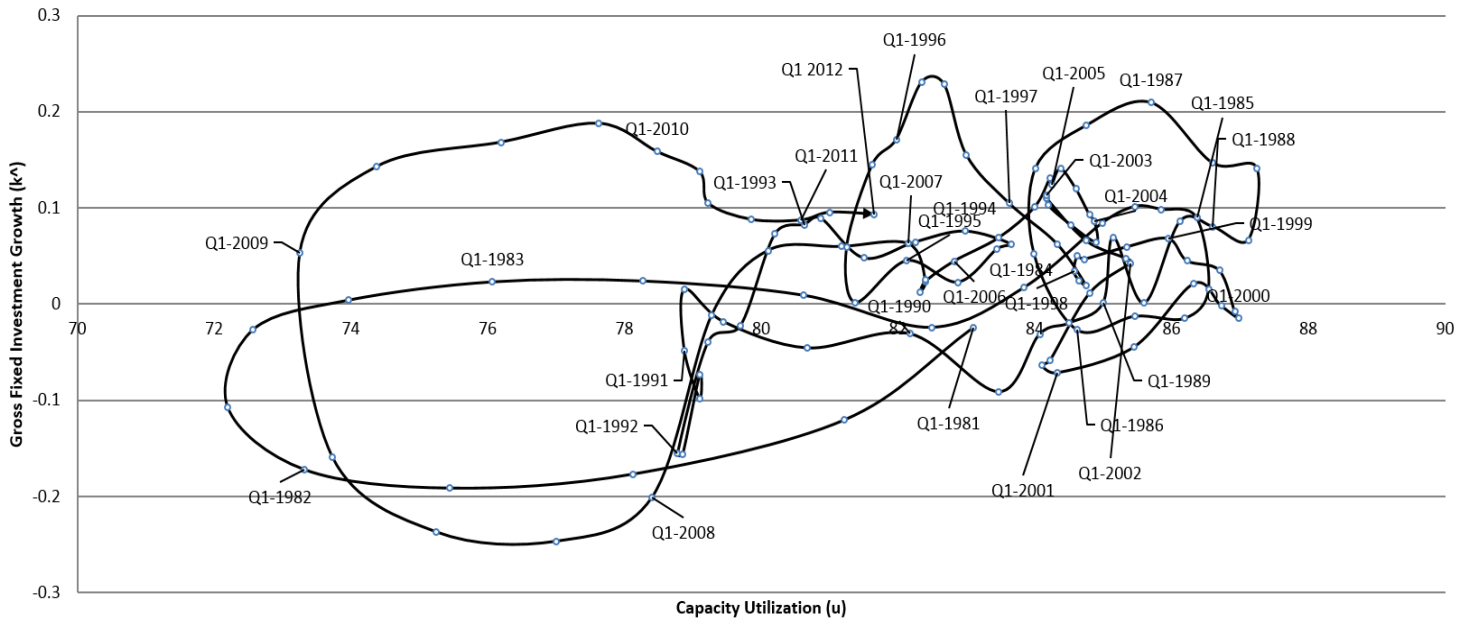


Figure 11: Quarterly Observation for Variables % GDP (V-Axis) vis-à-vis Utilization Rates (H-Aixs)

