Housing Variables and Monetary Policy

A Study of House Prices and Residential Investment and Their Importance for Monetary Policy

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Abstract

Housing constitutes a large amount of all economic activity and plays a significant role for the business cycle, and is of great importance for monetary policy. How central banks should approach different housing variables is contended. This thesis considers two variables, house prices and residential investment, and how they are of interest for monetary policy makers.

House prices are difficult to include in inflation indices, and their developments are accordingly hard to respond to when conducting inflation targeting monetary policy. Furtermore, they are commonly associated with financial imbalances, but the exact role they play in this respect is a contended issue. House prices are found to be dealt with in varying ways among central banks, as there is a lack of consensus on the way to approach them.

Residential investment is shown to play a significant role for the U.S. business cycle by Leamer (2007). Following his analysis, I consider its importance for recessions of 17 other OECD countries. I find that, while its role is less prominent than for the U.S., residential investment contains useful information about economic turmoil, and could potentially be used as a target variable for central banks in their pursuit to stabilize the business cycle.

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Abstract

Housing constitutes a large amount of all economic activity and plays a significant role for the business cycle, and is of great importance for monetary policy. How central banks should approach different housing variables is contended. This thesis considers two variables, house prices and residential investment, and how they are of interest for monetary policy makers.

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1 Introduction

Housing is of great importance to monetary policy. It constitutes a large amount of all economic activity, and its role with respect to recessions has received renewed attention following the bursting of the U.S. housing bubble. Central banks are particularly interested in housing, both because of its role as a major consumption expenditure, but also because of the part it plays in relation to financial instability. House prices, the most monitored housing variable, is of interest in both of these respects. House prices are a nominal variable, however, and as such more easily subject to speculation and subsequent bubble formation. It could be that a variable more closely associated with the real economy includes additional information not contained in house prices. Residential investment is such a variable, mirroring economic activity linked directly to the real economy. It is an intriguing possibility that monitoring residential investment might reveal more information about the business cycle.

In recent decades, many central banks have adopted price stability targets, aiming to keep inflation low and stable. In order to conduct good monetary policy, it is thus of the highest importance to know the current price development. As a consequence, the way in which one measures inflation becomes of high relevance. One of the challenges with measuring inflation is how to deal with house prices. The Consumer Price Index (CPI) is a cost-of-living index, often used as a price stability indicator, which seeks to measure the development of prices of goods and services purchased by a representative consumer. House prices are of great importance for consumers' purchasing decisions, and should therefore be considered when making such an estimation. However, owner occupied housing has certain properties that distinguishes it from other goods and services in the index, and its pricing is not included in a straightforward manner. Different indices use different methods to handle the issue, but they are flawed in various ways. In fact, some indices exclude house prices altogether. The ramifications of the issue are unclear, but are surely something to consider.

A related discussion is the implication these difficulties carry for monetary policy. Although the CPI is a commonly used indicator of price stability, there is a question of whether it is optimal for this purpose. Critics claim that the fundamentals of the CPI are in conflict with an ideal price stability indicator, and that one should generally base monetary policy on a different indicator. The importance of owner-occupied housing and its properties as a commodity plays directly into this discussion. The need for such a debate has become prominent in recent years. Cobham (2013) discusses the way three

central banks (the Fed, BoE and ECB) viewed house prices in the run up to the financial crisis of 2007-2008. He finds that the Fed and the BoE did not put in a sufficient effort to study the development of house prices, because they were commited to the view that monetary policy should not respond to asset prices. For the case of the ECB, Cobham (2013) finds that, although being aware of irregularities in the house prices, their monetary policy response to them is hard to establish.

Complicating the matter even further, developments in house prices not only contribute to inflation, but are also sometimes considered as signs of financial instabilities. As such, the question of how to handle house price developments is not only a question of how they affect price stability, but also whether they can signalize a build-up of financial instabilities, which in turn entails instability of prices and output. That is, there is a question of whether house prices and other housing variables should be (i) treated on a day-to-day basis as part of a general business cycle indicator, (ii) be considered in the context of asset bubbles and potential financial crises, or (iii) be considered as both a business cycle indicator and a more long term indicator of financial imbalances. There is no consensus on the matter as of yet, but there are many opinions.

Residential investment is another interesting variable in relation to monetary policy. The intertemporal nature of residential investment makes the interaction with monetary policy complicated, as changes in the interest rate may alter the value of a project after an investment decision has been made. Furthermore, accounting for a large amount of the housing sector, the building of new homes is closely intertwined with the development of housing bubbles and financial instabilities. As house prices rise, so does the profitability of new house projects. The connection between housing bubbles and recessions thus makes residential investment especially interesting to study for monetary policy makers. There is a compelling possibility that residential investment could be leading recessions. In a much cited paper, Leamer (2007) argues that it is residential investment, rather than house prices, that drives the business cycle. If this is the case, central banks could hope to better control the business cycle by stabilizing the cycle of housing starts.

In the thesis I look at what role certain housing variables should play when conducting monetary policy. My approach is twofold. First, in section 2, I will look at the interaction between inflation, house prices and monetary policy. I will consider both the challenge of including house prices in a price indicator and whether house prices should be considered part of the price stability target of the central bank. Additionally, I will discuss the historical views as well as more recent theories, in particular in light of developments in the past decade. Second, in section 3, I will conduct an empirical analysis, focusing on how

residential investment may play a role as a business cycle indicator. I will replicate and expand on the analysis of Leamer (2007), as well as performing a similar analysis on 17 additional OECD countries.

In my review of house prices and monetary policy, I find that, although the problem of implementing house prices appropriately in the conduct monetary policy is receiving much attention, there is no consensus on the matter as of yet. Price indices vary in how they include housing costs, and the different approaches yield varying inflation estimates. The different estimates can imply different monetary policy responses. Furthermore, how to approach house prices in the context of financial imbalances is uncertain, but most central banks monitor developments in house prices, considering them a potential indicator of financial instability.

In my empirical analysis, I find evidence that residential investment is a variable of interest for monetary policy. There are signs that it, in many cases, could be leading recessions, serving as a driver of the business cycle. As documented by Leamer (2007), it seems to be of particular importance for the U.S. business cycle. However, it is also an interesting variable for other OECD countries.

The remainder of the thesis is organized as follows: Section 2 looks at the relation between house prices and monetary policy. Section 2.1 outlines stylized facts on inflation, house prices and monetary policy. Section 2.2 looks at how inflation should be measured, with a particular emphasis on the challenge of measuring house price developments. Section 2.3 evaluates how central banks should approach the difficulties associated with house prices. Section 3 contains the empirical analysis of the role of residential investment in relation to recessions. Section 3.1 outlines stylized facts on residential investment. Section 3.2 introduces the data used in the analysis. Section 3.3 presents the method used to conduct the analysis. Section 3.4 shows the replication of the U.S. results as well as supplementing it with new data. Section 3.5 presents the results for the 17 other OECD countries. Finally, section 4 concludes the thesis.

2 House prices and monetary policy

House prices are of particular interest in relation to monetary policy. Housing costs are a significant part of most people's spending. As such, their price developments should be included in a price index measuring changes in consumption costs. However, housing is a durable good which can be sold for financial gain after use, giving it asset-like properties. As assets traditionally are not included in price indices measuring changes in consumption costs, this gives rise to a problem of disentangling the investment part from the consumption part of a house purchase. How this issue is dealt with carries implications for inflation targeting central banks, who rely on having accurate inflation estimates when conducting monetary policy. Furthermore, excessive growth in house prices can lead to financial imbalances in the form of a housing bubble, which could, in the worst case, initiate a recession when bursting. This gives further reason for central banks to monitor and possibly try to affect developments in house prices.

In the first section of the thesis, I will look at challenges posed by house prices for monetary policy. First, I outline some stylized facts on the relationship between inflation, house prices and monetary policy. Second, in section 2.2, I take a general look at the problem of measuring inflation, and in section 2.2.1 I discuss the difficulty of including house prices in a measurement of inflation. Finally, in section 2.3, I review the considerations central banks must take when facing house prices, and in section 2.3.1 I look at how some central banks currently deal with house prices.

2.1 Stylized facts

To help motivate this part of the thesis, I briefly discuss the observed relationship between inflation, house prices, and monetary policy. Many have attributed the low interest rate of the early 2000s and the ensuing U.S. housing bubble as a major contributing factor to the financial crisis of 2007-2009. The years since the crisis have been characterised by low interest rates all over the world, and countries where a possible bubble has yet to burst are watchful. Governor Mark Carney of the Bank of England stated in July 2014 that "The Bank is well aware that a prolonged period of historically low interest rates could encourage other risks to develop" and "In the U.K., the biggest risks are associated with the housing market."[2] The consequences of asset price bubbles are both known and dire, and examples like the bursting of the Japanese asset bubble and the country's subsequent

[2] http://www.telegraph.co.uk/finance/economics/10985991/Mark-Carney-rates-must-rise-to-avoid-housing-bubble.html

economic stagnation quickly jump to the minds of monetary policy makers.

In Norway, following the national banking crisis of the early 90s, a concerning situation has developed, with house prices diverging greatly from the CPI. Figure 1 illustrates this point graphically: By 2014, nominal house prices were almost 8 times as high as in 1982, whereas the CPI only tripled in size since then. Figure 2 shows the annual growth rates of house prices and CPI, as well as the overnight lending rate offered by Norges Bank. While the lending rate seems to be quite correlated with the CPI, it is difficult to establish the same relationship with the house prices.[3] As central banks have a special interest in price stability, this apparent discrepancy between house prices, general inflation and monetary policy gives reason to investigate this relationship further.

Figure 1: Cumulative increase in Norwegian house prices and CPI 1982-2014

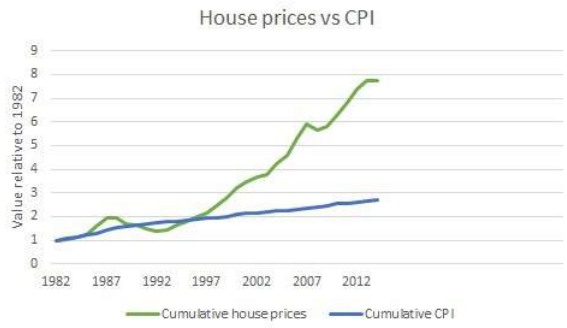
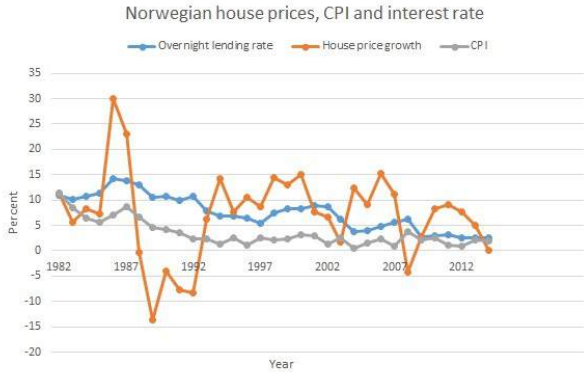


Figure 2: House prices, CPI and overnight lendring rate 1982-2014



2.2 Measuring inflation

The properties of a well constructed price index will depend on its intended use. Alchian & Klein (1973) state that "A well recognized principle is that the appropriateness of a price index depends on the question to which an answer is sought." and reference, among others, Frisch (1915) and Keynes (1923). The theoretical foundation of what a cost-of-living index should be, and how it ought to be constructed, is thoroughly discussed by Pollak (1998). He points out that, in the end, a cost-of-living index will rest on unrealistic assumptions, and that with both significant theoretical and empirical uncertainties, one should be cautious whenever modifying the CPI, to avoid weakening its credibility.

There are several challenges to overcome in order to construct an ideal price index in order to measure inflation. While the purpose, to measure the average price change of

[3]Data from Norges Bank and Statistics Norway.

some bundle of goods and services from one period to the next, is quite intuitive, there are both theoretical and practical issues to address in order to arrive at this goal. First, one must make a choice of how to calculate the index, as there are different approaches to the matter. How to weigh the importance of different components in the bundle is another concern. If trying to create a cost of living index, like the CPI, one must figure out what such a bundle should look like at a given time; as people's consumption behavior changes, so should the bundle. Actual price data must be collected, which can be a costly process. For these reasons, national statistical institutes all over the world dedicate a large amount of their resources to producing price indices.

When discussing inflation indices, the CPI is of particular interest. It is likely the most known price index, and serves as an important indicator of expected inflation in e.g. wage negotiations, firms' project analysis etc. It is also the index most inflation targeting central banks rely on as a price stability measure, although it primarily is intended to serve as a cost-of-living index. Cost-of-living indices like the CPI exclude asset prices because investment is considered saving, while the CPI only seeks to measure changes in consumption goods and services. Similarly, intermediate good and raw material prices are excluded as they are not used by the consumer directly for his or her own needs.

There are objections as to whether the CPI manages to properly depict developments in costs of living. A common criticism is that it does not deal with improvement of quality in goods in a satisfactory manner, that it fails to include new goods in a good way, and that it is inaccurate in accounting for substitution between goods (for example changing habits, complementary effects from new goods etc.). If this criticism holds, one would expect the CPI to systematically overestimate the cost of living. Complicating the issue even further are counterarguments to an upward bias of the CPI, for example that some goods may disappear and that quality may deteriorate, or even the exclusion of certain goods, implying a negative bias in the CPI (Røed Larsen 2004).

Costs related to housing are a significant part of most people's spending. In spite of this, whether to include housing costs in price indices, and how to do it, remains a debated issue. The problem can be summarized as follows. Consumer price indices are constructed to measure the development of costs of goods and services consumed by the public. The development of asset prices are not considered. A much used argument for not including house prices in price indices is that the purchase of a house is predominantly an investment, i.e. an asset purchase, and should as such not be included in inflation measurements. Although living in a domicile delivers a stream of services whose price development should be accounted for in a cost-of-living index, owning a house will have

similar properties as owning any other asset. An owned domicile is a durable good which can be resold in the future, and should in that respect be considered an investment. The challenge in measuring the development of house prices as part of a broader consumer price index, lies in disentangling the investment part from the consumption part of a house purchase. Not including housing in the CPI, but replacing it with rent, could serve as a proxy in an attempt to solve this problem. Whether this is a good solution is contended. In section 2.2.1 I discuss approaches to include housing in an inflation index.

2.2.1 The challenge of measuring house prices in an inflation index

As house prices have the characteristics of both a consumption good as well as an investment, including them in an inflation index is not trivial. If the inflation index is a cost of living index, like the CPI, asset prices should not be included. There are several approaches to dealing with this problem. In this section I present some of them.

First, the most rudimentary one is what is known as the *net-acquisition approach*. It simply treats housing as any other good in the price index. The shortcoming of this method is that it does not take into account the different nature of housing consumption compared to consumption of other goods. The durability of the housing good implies a consumption spread over time, which is overlooked. Furthermore, it does not address the asset property of user-owned accommodation. The degree to which housing is considered an investment, expected to yield a return in some future period, should not be viewed as a cost of living.

Second, a well-known, and much used, method (for instance in the construction of both the American and the Norwegian CPI) is the *rental equivalence approach*. This approach makes the assumption that the relation between the value of the service stream offered by owner-occupied housing (that is, the share of a housing purchase not considered an investment) and rental prices is the same in the long run.[4] Rental prices are used to make an estimate of owner-occupied housing's contribution to inflation (i.e. the changes in house prices that are not considered asset price fluctuations), making use of the assumed relationship between the prices. While this method is very appealing in theory, it faces some rather severe practical complications. First, there is often a big difference between housing available at the rental market and owner-occupied housing. Certain dwellings are rarely rented out, and a challenging statistical estimate correcting for these differences must be performed. If the rental market is too small, there will be a large degree of

[4]This relation is known as the Price-Earnings ratio, or the P/E-ratio.

uncertainty related to these numbers. In Norway, homeownership was at 77 per cent in 2011,[5] meaning that the rental market makes up a relatively small fraction of the housing market. Second, there can also be a significant amount of heterogeneity between home owners and tenants. In 2013, 75 percent of tenants in Norway were below 45 years.[6] Furthermore, students and work immigrants, who typically constitute low-income households, are greatly overrepresented among tenants. The type of housing that they demand is not representative of that of the population as a whole. This enhances the difficulty of performing an accurate out-of-sample prediction. In countries where homeownership rates are lower, the rental equivalence approach is more likely to yield results that are closer to the true cost development. For instance, in Switzerland, homeownership was at 38.4 per cent in 2004.(Andrews & Sanchez 2011) The Swiss CPI, the target index of the Swiss National Bank, is made using the rental equivalence approach. The issue is thus likely less detrimental for the Swiss estimate, even though there is heterogeneity between tenants and home owners, as the homeownership rate is relatively low. Finally, there is a possible endogeneity issue for cases where rental contracts have clauses in which rental prices can be adjusted with respect to the CPI, while the CPI at the same time is determined by rental prices (Beatty, Larsen & Sommervoll 2009).

Third, the *user cost approach* is intended to reflect the alternative cost of owner-occupied housing, i.e. the amount of other goods needed in compensation in order to forego housing consumption in a given period and remain at the same level of utility. Technically, this is done by calculating an annuity accounting for interest rates and currency depreciation given a change in the market value of the house. Expressed mathematically, a general formula for the annuity is:

$$A_H = P_H \left[\frac{r}{1 - (1+r)^{-N}} \right] \tag{1}$$

Where A_H denotes the annuity of the value of the housing, P_H the present value of housing, r the real interest rate and N the life time of the durable good (derived from some assumed depreciation rate). The value of the annuity is increasing in r, as a rise in the real interest rate increases the financial opportunity cost. While incorporating house prices in a meaningful way, this method suffers from a high degree of sensitivity to changes in the interest rate, yielding very volatile values, which does not match consumers' relatively slow responses in the housing market. Furthermore, in periods of large house price increases, capital gains will be large and the estimated user cost may turn out to be negative. The

[5] Population and housing census, households, 2011 (SSB)

[6] See Rental market survey, 2013 (SSB).

theoretical implication of this is infinite demand of housing, which is problematic to interpret economically (Beatty et al. 2009). As housing is a finite good, a negative price with ensuing infinite demand is not a possible equilibrium. With a negative price, buyers would "outbid" each other, lowering the price (at least) to 0. The existence of a negative price in such a market is thus difficult from a theoretical viewpoint. Moreover, this method suffers when samples are small, as certain types of dwellings easily may be overrepresented in the sales statistics in a given period. Yet another complication is the possibility of tax benefits from interest deduction, which makes it harder to establish the actual cost of interest payments. Additionally, the ratio of variable versus fixed interest payments can vary over time and will be of significance when estimating the real interest rate. Furthermore, the ratio will vary greatly among countries at a given time. Currently, the amount of loans subject to a variable rate in Norway lies around 90 percent, whereas similar figures for Sweden and Denmark lie around 50 percent and slightly below 50 percent, respectively.[7]

Fourth, as the CPI is intended to be a cost of living index, it is crucial to separate the consumption and saving properties of a housing purchase when including house prices, a property the previously discussed approaches does not have. A method seeking to address this shortcoming, labeled the *consumption cost approach*, was introduced by Beatty, Larsen & Sommervoll (2005). They leave out payments on the principal, which they argue should be classified as saving, as well as excluding capital gains (or losses) due to changes in house prices since the time of purchase, including only interest payments, maintenance costs, and transaction costs, also taking into account tax deductibility benefits and the ratios of variable and fixed-rate mortgages. One particular way of performing the estimate is expressed in Beatty et al. (2009):

$$C_t = A_t\left[\frac{1}{3}\sum_{i=t-2}^{t} tc_i + \gamma\,\frac{1}{3}\sum_{i=t-2}^{t} m_i + \Phi_t\,(1-\tau)\,\gamma\left\{(i_{L,t}) - \frac{1}{5}\sum_{i=t-4}^{t}(i_{L,t}-i_{S,t})\right\} + \Psi_t\,(1-\tau)\,\gamma\,i_{L,t}\right] \tag{2}$$

Here, C_t gives the consumption cost of owner-occupied housing in period t. A_t is the average house price in period t. tc_i and m_i are transaction costs and maintenance costs for period i, respectively. τ denotes the tax deductibility rate and γ the holding period. $i_{L,t}$ is the long-term interest rate in period t, while $i_{S,t}$ is the short-term interest rate in the corresponding period. Φ_t gives the share of variable-rate mortgages and Ψ_t the fixed-rate mortgage share. Thus, the consumption cost of housing is increasing with transaction

[7] Data extracted from Statistics Norway, Statistics Sweden and Danmarks Nationalbank

costs, maintenance costs and mortgage rates. In this specification, the variable short-term rate is computed based on the long-term rate and a moving average of the fixed-rate premium (i.e. $i_{L,t} - i_{S,t}$).

A challenge when employing the consumption cost approach is to decide on particulars in the estimation, for example how to calculate the expected variable short-term rate, how many periods to include when estimating transaction costs and so on. Nevertheless, it provides an alternative to including the consumption of owner-occupied housing in the CPI with a theoretical economic foundation.

2.3 Central banks and house prices

The last section showed that there are many ways to accommodate the issue of including house prices in price indices, and they all come with different strengths and weaknesses. The best way to do so is subject to discussion, but it remains true that the choice should depend on the purpose of the index. In this section I consider the challenges of dealing with house prices, faced by central banks. Section 2.3.1 reviews the way some central banks deal with this problem as of now.

The price indices used by most central banks today do not include asset prices. This choice is not without controversy, and some have stated that a cost-of-living index such as the CPI is not an ideal measurement of price stability. If the lack of house prices for instance leads to a downward bias of the price index, inflation may seemingly be below target, while it in reality is above. As a response to inflation rates below target, the central bank is likely to lower the interest rate which will push actual inflation even further from target. Using a particular specification of their consumption cost method on Norwegian data from 2000-2008, Beatty et al. (2009) find that inflation was 30 percent over the period, compared to the official CPI estimate of 17 percent. The difference in estimates is not negligible, and it seems evident that the two inflation measures would require different policy responses.

Regardless of what an ideal inflation index may be, a brief review of how monetary policy is conducted will be useful. Inflation targeting central banks typically operate with a loss function which they seek to minimize by controlling the key policy rate. This loss function will usually include a desired level of inflation with preferences of a stable output level and some aspiration of stability in monetary policy. Deviations from the desired levels, or *target levels*, increase the welfare loss of the central bank. A general loss

function looks something like the following expression:

$$L_t = (\pi_t - \pi^*)^2 + \lambda(y_t - y^*)^2 + \tau(i_t - i^*)^2 \tag{3}$$

where π_t is inflation, y_t is output levels and i_t encompasses the stability component in period t . π^*, y^* and i^* are their respective target levels. The terms are squared, ensuring that deviations from every target level contributes negatively to the objective, as sums of different deviations will not counteract each other. λ and τ denote the weights of output levels and stability relative to inflation. A central bank employing a loss function like this one will care about both price and output stability, while aspiring to avoid financial imbalances. The use of such a loss function highlights the importance of obtaining an accurate measure of inflation. If the central bank conducts monetary policy using an inappropriate index, it will make suboptimal choices leading to greater losses.

Alchian & Klein (1973) argue that cost-of-living indices such as the CPI are subject to a systematic bias, as they are based only on the prices of current consumption services. Their opinion is that a correct measure of inflation should consist of a vector of claims to present and future consumption, rather than simply present consumption, as consumers optimize their utility over time. When future consumption is included in the utility function, it seems essential to include asset prices in the price index, as assets provide the link between current valuation of present consumption relative to future consumption. Monetary policy is conducted using forward looking models, where agents base current choices on future periods. As assets, such as housing, are considered claims to future units of consumption, excluding them from the price index implies overlooking the expected cost of future consumption, which in turn could entail incorrect monetary policy responses. Alchian & Klein (1973) conclude, however, that to actually construct such an index will be very difficult (or rather, expensive) because determining the asset vectors that represent consumers' desired future consumption is difficult, and because "surprisingly little reliable information exists on current prices of assets".

40 years later, Goodhart (2001) and Bryan, Cecchetti & O'Sullivan (2002) expand on the analysis of Alchian & Klein (1973). They elaborate on the argument that asset prices, when used for the purpose of conducting monetary policy, should be included in inflation indicators, and that excluding them introduces a downward bias. They also provide different measures to integrate asset prices into price indices. Bryan et al. (2002) do so by using a statistical algorithm that adjusts for the volatility of asset prices, reducing the amount of noise they usually produce. The means to construct an index based on asset prices do indeed exist, and for central banks the question is now which index one thinks

is best suited for monetary policy purposes.

Mankiw & Reis (2002) find that an inflation targeting central bank should base monetary policy on what they call a *stability price index* where the weights used to construct the index differ greatly from those of a cost-of-living index. In particular, sectoral characteristics such as the cyclical sensitivity and exposure to idiosyncratic shocks play an important role in creating the index. They find that nominal wages are especially important, as they are both cyclically sensitive and not as subject to shocks as other prices, and should be given extra weight when setting the interest rate.

Complicating the matter even further, developments in house prices not only contribute to inflation, but are also sometimes considered as signs of financial instabilities. As such, the question of how to handle house price developments is not only a question of how they affect price stability, but also whether they can signalize a build-up of financial instabilities, which in turn entails instability of prices and output. That is, there is a question of whether house prices and other housing variables should be (i) treated on a day-to-day basis as part of a general business cycle indicator, (ii) be considered in the context of asset bubbles and potential financial crises, or (iii) be considered as both a business cycle indicator and a more long term indicator of financial imbalances. There is no consensus on the matter as of yet, but there are many opinions.

Before the financial crisis of 2007-2009, the majority view was that asset price bubbles are extremely hard to detect and measure, that using the interest rate to affect them would be too simplistic, and that attempting to do so might give rise to losses in price and output stability, as a byproduct.[8] Some opposed this consensus and argued that asset prices and housing markets should be given particular consideration. Among them were Cecchetti, Genberg, Lipsky & Wadhwani (2000) who claimed that the difficulties associated with detecting and measuring asset bubbles are not much different from dealing with the theoretical concepts of potential GDP and the equilibrium interest rate. They concluded that stock prices are too noisy to consider, but that house prices contain useful information about aggregate price movements.

If an asset bubble is identified, but still persists, one might consider it a *rational bubble*. Galí (2013) argues that if an asset bubble is rational, a *leaning against the wind* interest rate policy when facing it may increase its volatility.[9] He finds that, in this setting, opti-

[8] See e.g. (Bernanke 2002).

[9] An interest rate policy is said to be *leaning against the wind*, in the context of asset bubbles, when a bubble driven by over-optimistic expectations is dampened, and when financial markets are stimulated when activity is particularly low.

mal policy dictates a balance between stabilization of aggregate demand and of the bubble itself, each independently implying different monetary policy responses. In the rational bubble framework, every agent knows that the asset in question has no underlying value, but one is nevertheless in an equilibrium where it has a positive price, serving as a vessel transferring wealth between generations. It is possible to argue that a housing bubble can have this property, and in that setting the insight presented by Galí (2013) will be of value.

In order to determine how monetary policy should react to the housing market, it is essential to look at the interaction between monetary policy and the different housing variables. Calza, Monacelli & Stracca (2009) investigate the transmission mechanism between monetary policy, consumption, house prices and residential investment, and find that the interest rate structure of mortgage contracts is of significance. They construct a DSGE model which they use to show that private consumption is more responsive to monetary policy when an economy has a larger degree of variable mortgage payments. This entails different optimal responses depending on the country in question. For example, in an economy such as Norway, with a high rate of variable rate mortgages, one would expect a bigger impact from interest rate changes, whereas it is likely smaller in Sweden and Denmark.

2.3.1 How inflation-targeting central banks deal with house prices

When conducting monetary policy, central banks consider a full set of indicators. An interesting question in that respect is whether they have a stated policy of reacting to changes in housing variables, be that explicitly or implicitly, through their objective function. Some may consider the way central banks such as the ECB, the Fed and Norges Bank handle the issue of house prices unsatisfactory, not, for instance, properly taking into account the effects of changes in house prices. It is not always clear whether the banks truly remain passive to such changes. Finocchiaro & Heideken (2013) study whether the central banks of England, Japan and the U.S. did respond to changes in house prices. They found that there was evidence for house price movements playing a significant role in the policy reaction functions of all the countries, in spite of them not including house prices in their target indices, although it is not clear whether this is the result of an explicit house price targeting or not. With respect to the loss function presented in equation (3), this could also be a result of reacting to possible financial imbalances. Table 1 briefly reviews the way in which selected central banks currently deal with house prices in their objective functions for monetary policy.

Table 1: Selection of central banks and their approach to house prices

Central Bank	Target index	House prices in index	Instability indicator[10]
European Central Bank	Harmonised Index of Consumer Prices	Not included in index	No mention in latest assessment
Bank of England	U.K. consumer price index	Not included in index	Monitored as part of stability assessment
Federal Reserve	Price inflation measure for personal consumption expenditures,[11] consumer and producer price indices by the Department of Labor	Rental equivalence approach	Monitored as part of stability assessment
Norges Bank	Norwegian consumer price index and various derivations of it[12]	Rental equivalence approach	Explicit robustness criterion including house prices
Sveriges Riksbank	Swedish consumer price index	User cost approach	Monitored as part of stability assessment
Bank of Canada	Canadian consumer price index	User cost approach	No mention in latest assessment
Swiss National Bank	Swiss consumer price index	Rental equivalence approach	No mention in latest assessment
Central Bank of Iceland	Icelandic consumer price index	User cost approach	Monitored as part of stability assessment

All central banks in the selection have a consumer price index as their (primary) target index. Their approach to house prices varies, illustrating the lack of a

[10]I have examined whether, and how, the respective central banks have an explicit strategy of leaning against house prices when determining the interest rate, as part of their financial stability goals in their latest assessment, as of May 14. 2015.

[11]The PCE is produced by the Department of Commerce and covers a wide range of household spending.

[12]The other indices are 1: KPI-JAE, CPI adjusted for tax changes and excluding energy goods. 2: KPI-JA, CPI adjusted for tax changes. 3: KPI-JE, CPI excluding energy goods. 4: KPIXE, CPI adjusted for tax changes and correcting for temporary changes in energy prices(developed by NB).

consensus on the subject. However, none of them include the prices directly without some form of adjustment. Notably, ECB and BoE have excluded them altogether, which makes them subject to the criticism of an excluded goods bias: The inflation estimate will not be accurate as a measure of purchasing power, as a major consumption expense has been left out of the index. They do include rental prices, but as house price are excluded completely, a considerable share of average household expenditure is left out. However, for the past years, Eurostat has been involved in a project to include house prices in the HICP. In cooperation with many national statistical institutes, including Statistics Norway, Statistics Sweden and the U.K. Office for National Statistics, Eurostat generate an owner-occupied house price index in order to provide data for house prices at a European level. This index is based on the *net-acquisitions approach*, and is generated with a view to improve the relevance and comparability of the HICP.[13] If the owner-occupied house price index were to be included in the HICP, it would suffer from ignoring the investment property of a housing purchase, which in turn might yield an inaccurate estimate of consumer price inflation.

The *rental equivalence approach* applied in Norway, Switzerland and the U.S. is (to a varying extent) subject to the criticism of discrepancy between rental and housing markets, as described in section 2.2.1. The *user cost approach* used in Canada, Iceland and Sweden is subject to the criticism that with this method, the potential inconsistency between short-term nominal interest rates and expected capital gains can yield a statistic which may be excessively volatile. However, Bergevin (2012) reviews the Canadian CPI's sensitivity to changes in house prices, and finds that it is *insensitive* to such price changes. This implies a similarly insensitive monetary policy response, contrary to the common criticism of the user cost approach.[14] This suggests that more research on the user cost approach could be necessary.

An additional important consideration is how to proceed in the case of an implementation of a new index. If changes are to be made to the presently used price indices, a precise and credible communication of these changes is vital. A widely recognized insight in the current literature on inflation targeting is that there should be as much clarity as possible with respect to how the central bank views the current economic situation. Ideally, every agent in the economy should be aware of the central bank's view of current

[13] See (*Commision Regulation (EU) No 93* 2013).

[14] Bergevin (2012) proposes a supplementary inflation indicator based on a net-acquisitions approach. This approach, however, remains subject to the criticism that it ignores the inter-temporal nature of house purchases, thus ignoring the role played by interest rates (Beatty et al. 2005).

inflation, output, possible financial instabilities and so on, so as to align agents' future expectations with those of the central bank and achieve an optimal transmission of monetary policy.

As seen in table 1, central banks deal with housing variables in a variety of ways. The link between house prices and financial bubbles appears to be receiving particular attention.[15] Most central banks now include some review of house prices relating to financial stability in their monetary policy reports. Their approaches vary, however. Norges Bank stands out as a central bank explicitly including the development of house prices as part of a robustness criterion, where it is said that "Monetary policy should also mitigate the risk of a build-up of financial imbalances." (Monetary Policy report 1/15). Other central banks, like BoE and the Fed, simply monitor the price developments of housing, and comment on the degree to which this could be a source of financial instability. Some central banks, like the ECB, do not mention house price developments in relation to financial imbalances. These different approaches mirror the fact that there is, as of now, no consensus on what approach central banks should have to house prices.

In sum, there is still a way to go in order to establish the relationship between house prices and monetary policy. Central banks and statistical institutes are devoting more resources to the issue, and it is definitely a research field in development. In a recent paper, Galí & Gambetti (2014) claim that there seems to be no evidence that increases in interest rates can shrink the size of asset price bubbles. They state that "...understanding [the effect of interest rate changes on asset price bubbles] is a necessary condition before one starts thinking about how monetary policy should respond to asset prices.", indicating that there still are challenges to overcome before a consensus on the matter can be reached, and emphasizing the importance of only making well informed changes to how house prices are considered by an inflation-targeting central bank. As house prices are a nominal value, they are more easily subject to financial speculation. It could be beneficial for central banks to make use of a variable that has a more direct link to the real economy, as a supplementary indicator. Residential investment is such a variable, and for the remainder of the thesis, I will evaluate the contributions of residential investment to GDP growth around recessions, assessing its role in relation to the business cycle.

[15] See e.g. The Bank of England Inflation Report of February 2015 or The Fed Monetary Policy Report of February 2015.

3 Residential Investment as a recession indicator

Residential investment is another interesting variable in relation to monetary policy. The intertemporal nature of residential investment makes the interaction with monetary policy complicated, as changes in the interest rate may alter the value of a project after an investment decision has been made. Furthermore, accounting for a large amount of the housing sector, the building of new homes is closely intertwined with the development of housing bubbles and financial instabilities. As house prices rise, so does the profitability of new house projects. The connection between house price bubbles and recessions thus makes residential investment especially interesting to study in relation to economic turmoil. There is a compelling possibility that residential investment could be leading recessions. In a much cited paper, Leamer (2007) argues that it is residential investment, rather than house prices, that drives the business cycle. He argues that housing follows a volume cycle instead of a price cycle, i.e. that it is the volume in sales that is adjusted in face of economic decline, rather than house prices, because the latter is very sticky downward. The argument goes as follows: Faced with a sudden decline in demand for houses, sales *volume* is lowered, as house prices, being downward sticky, do not adjust accordingly. A lower sales volume means the existing stock of housing provides a sufficient supply, leading to less construction work and fewer jobs for construction workers and finance and real estate agents, turning the cycle and possibly initiating a recession. If this is the case, central banks could hope to better control the business cycle by stabilizing the cycle of housing starts. Leamer (2007) shows that between 1947 and 2006, 8 out of 10 U.S. recessions were preceded by significant reductions in residential investment. He claims that this documents the importance of residential investment as a *recession indicator*, and uses the result to argue in favor of a monetary policy where housing starts are given a particular emphasis. Specifically, he proposes a *modified Taylor rule* where, in addition to a long-term measure of inflation, emphasis is given to housing starts and changes in housing starts, rather than the output gap.

In this empirical section, I investigate the importance of residential investment in the lead-up to and aftermath of economic recessions. I conduct an analysis along the lines of Leamer (2007), using the same method on data from several different OECD-countries. First, I outline some stylized facts on residential investment. Second, in section 3.2, I introduce the data I have collected from the OECD database. Third, in section 3.3, I present the method used to conduct my analysis. Finally, in section 3.4, I will briefly review the results of Leamer (2007) for the U.S. before presenting the corresponding results

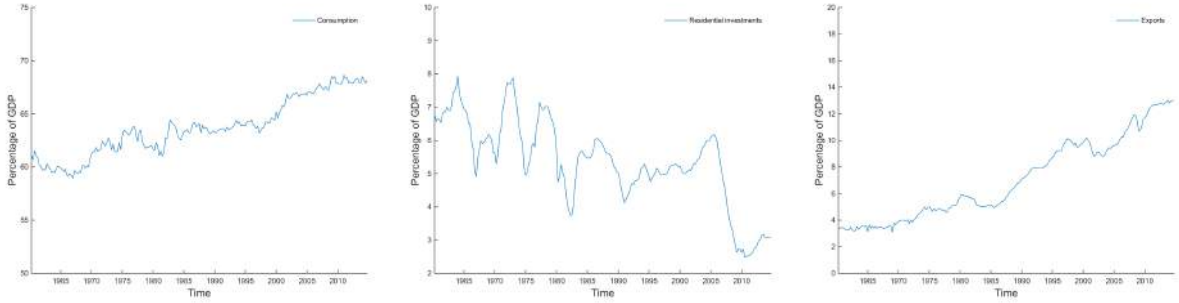
for the OECD countries in section 3.5.

3.1 Stylized facts

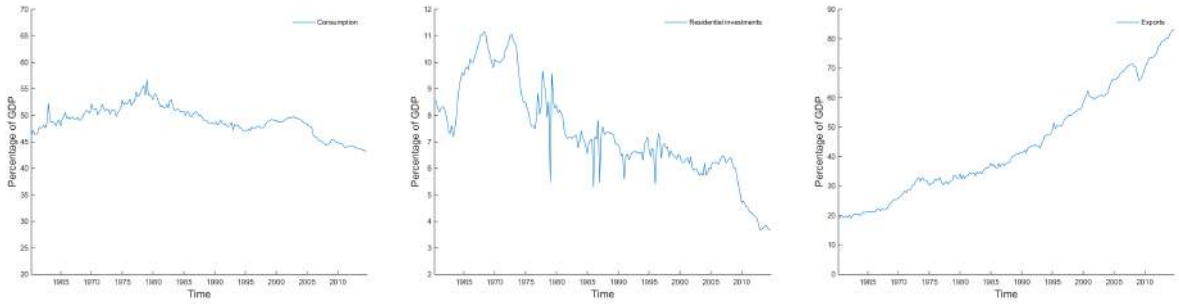
By simply glancing at the national accounts, it may not be immediately apparent why residential investment is a variable of interest. Its size as share of GDP is not particularly large and is fairly even across countries, see table 2. In my selection of countries, it typically lies between five and eight per cent of GDP, although it is slightly larger in a few cases. It is also fairly even over time, but has since the 1960s fallen somewhat in certain countries. Although accounting for a lower share of GDP than other variables in the national accounts, it is notable for being a particularly volatile variable. As it is shown in table 2, between 1960 and 2014, residential investment was on average 5.37 per cent of GDP in the U.S. over the sample period, with a standard deviation of 1.29. By comparison, consumption was at 63.66 per cent, with a standard deviation of 2.67. In smaller, more open economies, where exports typically account for a larger share of GDP, residential investment remains a highly volatile variable in relative terms. Over the same period in the Netherlands, for instance, the average share of residential investment, consumption and exports to GDP were 7.35, 48.99 and 43.76, with standard deviations of 1.81, 2.72 and 18.18, respectively. While the export share also stands out as a volatile variable, in the U.S with a mean of 7.03 and a standard deviation of 3.05, a lot of this can be attributed to growth. While the mean share of exports between 1960 and 1979 was 26.11 and 4.00 for the Netherlands and the U.S. respectively, it had grown to 68.96 and 10.92, respectively, in the period 2000-2014, with low and quite stable standard deviations in these short intervals, see tables 6-8 in the appendix. Figure 3 shows the development of these variables from 1960-2014, and the volatility of residential investment seems apparent. Particularly for the case of the U.S. the magnitude of the fluctuations is striking. Figure 14 in the appendix shows the evolution of variable shares in all countries for the six variables presented in section 3.2.

Both the causes and implications of this volatility are compelling problems. Its role is discussed by Leamer (2007), who argued for and showed that residential investment exhibits a strong pattern around recessions in the U.S., normally leading both recessions and the subsequent recoveries. Whether this relation is present in other economies is thus an interesting case to consider.

Figure 3: Variables as percentage of GDP, the U.S. and the Netherlands, 1960-2014



The United States



The Netherlands

Table 2: Variable share of GDP, mean and standard deviation: Total available period

Country	Stats	Cons.	Gov. exp.	Res. inv.	Other inv.	Imports	Exports
Australia	mean	52,02	17,23	5,53	15,87	-10,00	15,31
	sd	1,37	1,23	0,61	3,38	4,79	4,99
Austria	mean	55,77	20,78	5,82	19,64	-34,28	33,18
	sd	1,91	0,91	1,03	1,39	9,27	11,85
Belgium	mean	54,78	25,68	7,18	15,86	-50,32	50,19
	sd	2,33	1,60	2,17	2,07	17,13	18,16
Canada	mean	52,75	23,18	6,95	12,98	-19,75	23,68
	sd	1,79	2,35	0,75	2,08	8,37	8,37
Denmark	mean	49,41	25,79	5,68	12,86	-27,08	32,01
	sd	2,74	1,64	2,17	2,89	10,92	12,66
Finland	mean	51,77	26,06	7,46	18,45	-24,43	23,11
	sd	1,49	2,30	1,63	3,32	7,77	10,22
France	mean	54,48	23,02	7,09	17,10	-16,54	16,31
	sd	0,89	1,47	1,50	1,98	7,15	7,16
Germany	mean	57,72	18,66	5,48	15,50	-29,03	32,02
	sd	1,62	0,50	0,81	1,35	7,26	9,81
Ireland	mean	46,77	19,47	9,32	11,05	-69,66	71,55
	sd	2,87	2,02	4,39	3,87	15,14	23,83
Italy	mean	58,07	21,22	7,54	13,43	-16,70	16,74
	sd	2,17	1,42	2,69	1,99	6,20	6,59
Japan	mean	59,53	17,31	5,51	19,83	-9,12	8,74
	sd	2,32	2,50	1,88	2,35	2,77	4,19
Korea	mean	61,09	18,10	6,12	26,26	-27,97	24,08
	sd	9,43	4,89	1,83	5,37	11,90	15,72
Netherlands	mean	48,99	23,88	7,35	15,70	-39,63	43,76
	sd	2,72	1,75	1,81	1,70	14,94	18,18
New Zealand	mean	59,69	17,67	5,39	16,70	-23,96	24,33
	sd	2,03	1,14	1,18	3,28	8,14	7,09
Portugal	mean	66,14	17,32	6,47	14,41	-25,78	21,40
	sd	3,69	2,90	1,55	3,09	9,83	8,09
Sweden	mean	49,22	30,87	6,52	16,67	-26,12	26,36
	sd	3,35	3,21	3,23	2,38	7,52	11,09
United Kingdom	mean	57,80	23,21	9,46	6,84	-20,90	20,58
	sd	5,87	2,81	1,98	2,78	7,81	6,25
United States	mean	63,66	24,89	5,37	9,54	-8,94	7,03
	sd	2,67	4,47	1,29	2,15	4,16	3,05
Total	mean	55,54	21,91	6,68	15,48	-26,68	27,24
	sd	2,85	2,17	1,81	2,64	8,95	10,40

3.2 Data

To investigate whether the results of Leamer (2007) generalize to other economies, it is desirable to look at as many countries as possible. I have extracted data from the OECD Economic Outlook database (no. 96) of national accounts for 17 different countries. The data collected are real and nominal values for gross domestic product, private consumption, government consumption, residential investment,[16] other investments, imports of goods and services, and exports of goods and services.[17] All series are quarterly over the period Q1 1960 - Q4 2014 (some series are shorter. See full description of the data in table 5 in the appendix). An alternative would have been to use yearly data, which has its strength in not being subject to seasonality. However, quarterly data gives a more detailed picture of the business cycle, which is crucial when investigating developments in the build up to recessions.

The 17 countries used in the analysis vary in important aspects like size and location, but are all considered developed countries. They are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, New Zealand, Portugal, Sweden and the United Kingdom. The reasoning behind this selection is mainly data availability: The residential investment statistic is only available for certain countries at varying starting points in the Economic Outlook database, and the countries with series starting in 1995 or later have been excluded.[18] Norway has been exluded in spite of the residential investment statistic being available from 1960. The large size of the Norwegian petroleum sector relative to the rest of the economy hinders an analysis of partial effects on GDP growth, as the relative size of the different components in the national account fluctuates greatly alongside price fluctuations in the oil and gas markets. Statistics Norway keeps a separate account which only considers the *mainland economy* (that is, the economy excluding the petroleum sector) in order to correct for this problem. However, the values in the mainland accounts do not add up to the actual GDP growth. This in turn makes it difficult to conduct an analysis of different variables' separate con-

[16]The nominal values for residential investment were not available in the OECD database and have been calculated based on the deflator for fixed capital formation. For a thorough discussion of the impact of this approximation, see the appendix.

[17]It would have been possible to differentiate the different components of GDP in a more detailed manner, keeping separate accounts of different kinds of consumption, government expenditure and so on. However, as the idea is to take a particularly close look at the role of residential investment around recessions, this simplification serves the purpose of the exercise well.

[18]They are Chile, Czech Republic, Estonia, Luxembourg and Slovenia.

tribution to growth in GDP.[19] For the purpose of this analysis, the exclusion of Norway is an unfortunate but not serious issue, as the remaining amount of data is adequate. In addition, I have extracted data from the Bureau of Labor Statistics for the U.S. over the period 1947 - 2014. The data includes the same six variables as in the OECD data. In addition, inventories are accounted for separately, rather than counting as part of other investment. This means that a total of 18 countries are considered in the analysis.

3.3 Method

This section seeks to explain the methodology used in the thesis, which follows the methodology employed by Leamer (2007). Leamer makes use of a statistic giving variables' quarterly contributions to GDP growth. He estimates trend contributions from each variable, which he then uses to establish abnormal contributions in a given period. The abnormal contributions are cumulated and given an interpretation around recessions. First, I explain the method of calculating contributions to percentage change in GDP (CPC). Second, I explain how the kernel regression smoother is used to decompose a trend from the CPC-data. Finally, I explain how abnormal contributions to CPC from various GDP components are calculated and cumulated, and clarify how the expressions should be interpreted.

With the data from the national accounts in hand, the first step is to generate the statistic for contributions to percentage change of GDP. The CPC statistic yields a decomposition of each variable's contribution to GDP growth between two periods, allowing for an analysis of the drivers of GDP growth. The construction of the CPC statistic follows Ehemann, Katz & Moulton (2000), who generate a Fisher price index and evaluate changes in individual variables with respect to an aggregate (in my case being GDP).[20] The reason for using the CPC statistic rather than simply using variables' share of GDP, is that there can be *relative price changes* between variables from one period to another, which will give inaccurate figures for contributions to real GDP growth, as using a variable's share does not pick up this effect. The CPC statistic accounts for this problem by considering both price- and quantity effects between periods, and is given by:

$$CPC_i^t = 100 * (p_i^{t-1} + p_i^t/FPI^t)(x_i^t - x_i^{t-1})/(\mathbf{p}^{t-1} + \mathbf{p}^t/FPI^t)\mathbf{x}^{t-1} \quad (4)$$

[19] An attempt to correct for this problem is an interesting next step for further research.

[20] The Fisher price index is defined as the geometric mean of the Laspeyre and Paasche price indices, which are both given in equation 5. These 3 price indices all represent different ways of estimating aggregate price changes between periods.

Where $CPC_i{}^t$ is the contribution of the ith good to the total percentage change in real GDP from period *t-1* to period t, $p_i{}^t$ and $x_i{}^t$ are price and quantity of good i in period t respectively, and $\boldsymbol{p}^t$ and $\boldsymbol{x}^t$ are price and quantity *vectors* at time t. FPI^t is the (bilateral) Fisher price index, which is given by:

$$FPI^t = \sqrt{\frac{\sum_{i=1}^{N} P_i^t Q_t^{t-1}}{\sum_{i=1}^{N} P_i^{t-1} Q_i^{t-1}} * \frac{\sum_{i=1}^{N} P_i^t Q_i^t}{\sum_{i=1}^{N} P_i^{t-1} Q_i^t}} \tag{5}$$

$P_i{}^t$ and $Q_i{}^t$ is the price and quantity of good i in period t, respectively. Using the Fisher price index in equation (4) has the benefit of ensuring that the CPC-variables add up exactly to the real GDP growth rate (Ehemann et al. 2000).

When the CPC-numbers have been calculated, the next step is to establish a long-term trend. The reason for wanting to find a long-term trend is that GDP growth seems to adhere to a strong trend in the long run. The goal of this step is to find different variables' "normal" contribution to that long-term trend. Leamer (2007) estimates it using the *kernel regression smoother*, which he argues is better suited to picture a long-term trend, as opposed to, for instance, the Hodrick-Prescott Filter, because the former has a lower frequency.[21] The kernel regression fits a curve to a data set. A *kernel function* is defined, and is applied identically at every data point (the *target point*) in the series. It gives weight to the target point as well as declining weights to neighboring points, the size of the weights being based on the distance from the target (Rodriguez 2001). This yields a new set of data which is smoother, i.e. the estimated trend. The kernel function used for this exercise is the *Gaussian* kernel smoother, one of the more common kernel functions in use:[22]

$$K(u) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}u^2} \tag{6}$$

where u is given by

$$u = \frac{x^* - x_i}{h} \tag{7}$$

Here, x^* is the location of the target point in the sequence, and x_i represents the location of different neighboring data points. h is the kernel bandwith, also known as the *smoothing parameter*, which serves as a scale parameter. For this exercise, a bandwith of *h=30* is used, as this is the value which appears to give the closest match to the results of Leamer.

[21] Higher frequency filters like the HP-filter are more likely to pick up business cycle trends.

[22] Read more about kernel smoothing and the choice of kernel smoother in Cleveland, Cleveland, McRae & Terpenning (1990), Singh, Mandal & Basu (2005), Rodriguez (2001)

The entire weight given to each data point x_i when evaluating target point x^* is then:

$$W_i(x^*) = \frac{K(\frac{x^*-x_i}{h})}{\sum_{i=1}^{n} K(\frac{x^*-x_i}{h})} \tag{8}$$

Note that the weights at any target point x^* sum up to 1, i.e. $\sum_{i=1}^{n} W_i(x^*) = 1$. The kernel smoother for target point x^* is thus:

$$f(x^*) = \sum_{i=1}^{n} W_i(x^*) y_i \tag{9}$$

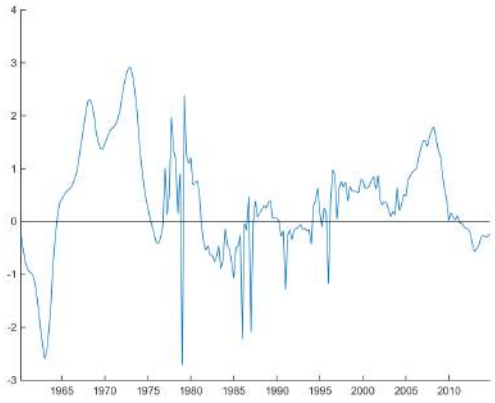
where y_i gives the ith CPC-value. Applying this technique to every variable's set of CPC-values gives the trend estimates for each variable. If in any period a variable has a contribution to growth equal to the estimated trend, this is thus considered a *normal* contribution.

When a *normal* contribution to GDP growth is established with the kernel regression, an *abnormal* contribution in a given period is calculated by subtracting the trend-component from the CPC-estimate for that period. For every period, the abnormal contributions are then cumulated into levels that express the sum of abnormal contributions leading up to that point:

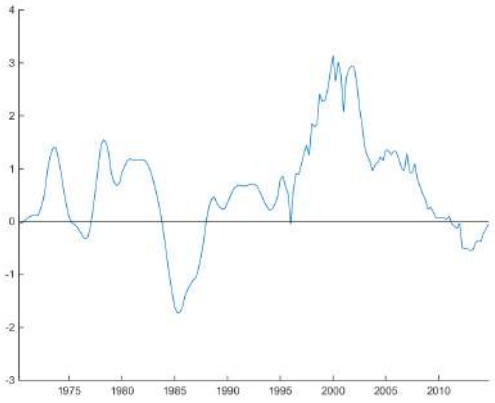
$$CAC_i^t = \sum_{s=1}^{t} A_i^s \tag{10}$$

where $A_i{}^t$ gives the abnormal contribution of variable i in period t and $s{=}1$ is the initial period of the series. These values are then plotted into curves that (by definition) oscillate around 0; one curve for each GDP component. As a result, a variable's contribution to GDP growth is *greater than normal* whenever the curve moves *up* and *less than normal* when the curve moves *down*. As an example, figure 4 shows the graph for the cumulative abnormal contribution of residential investment in the Netherlands, Portugal, Sweden and the U.K. The series all include both sustained inclines and declines in the statistic, signifying periods of consecutive abnormally high and low contributions to growth, respectively. Similar graphs for all variables and countries are found in the appendix, found in the top row of figures 15 - 32, which also have recessions highlighted.

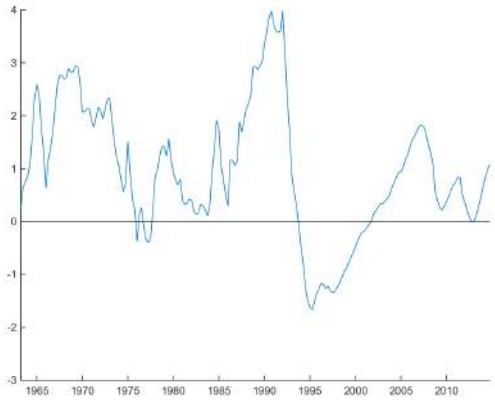
Figure 4: Cumulative abnormal contribution of residential investment



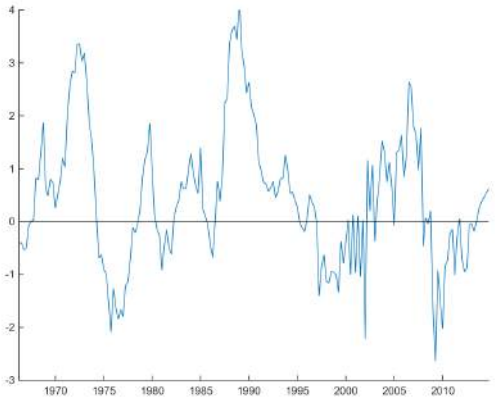
Netherlands



Portugal



Sweden



United Kingdom

The final step is to study the abnormal contributions around recessions. In order to obtain instructive results, a critical issue is how recessions are defined. As a rule, I have defined two consecutive quarters of real GDP decline as a recession. The quarter following the first real GDP decline marks the recession start, meaning that the cycle peak is the quarter in which GDP starts to fall. An economy is declared "healthy" when at least eight quarters have passed, with six of the preceding eight quarters having positive real GDP growth. When an economy is declared healthy, two new consecutive quarters of decline in real GDP initiates a new recession. [23] There are other ways to define recessions as

[23]The scheme for deciding the end of a recession may seem like an unnecessarily convoluted rule, but is what I deemed appropriate based on the evaluated data. It was necessary with a time restriction as two consecutive quarters of decline often are immediately followed by more decline, giving rise to an excessive amount of recessions. Furthermore, certain series fluctuate a great deal, rarely seeing six consecutive

well, where other variables are taken into consideration. Conducting different evaluations, such as assessing unemployment levels, or even subjectively ruling that very mild GDP declines might not be enough to initiate a recession, would likely lead to a different dating of recessions. Nevertheless, when working with 50 years of data for 17 countries it was necessary to use a consistent rule, rather than dating recessions in a less rigid manner, both for transparency and not least for reasons of simplicity. Table 3 gives an overview of all recession starts in the series.

Table 3: List of recession starts estimated by real GDP growth

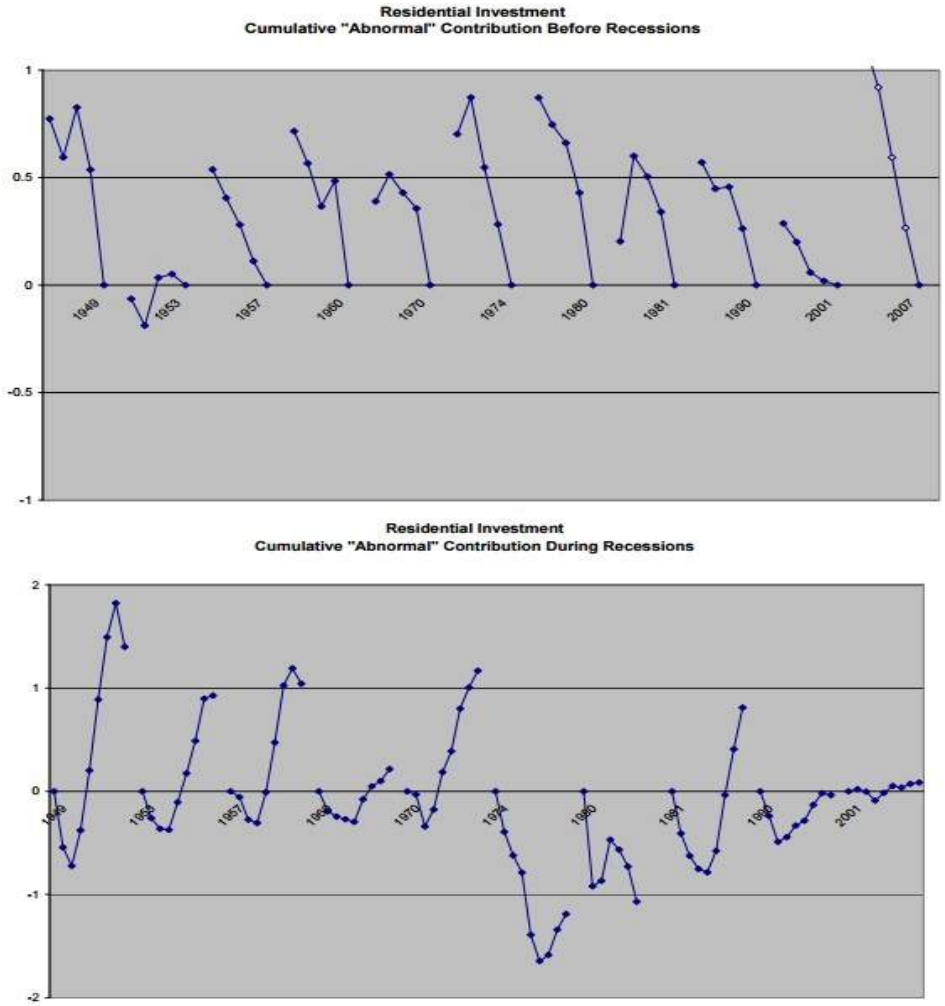
Country	Recession starts
Australia	1961Q2, 1965Q4, 1971Q3, 1975Q3, 1977Q3, 1981Q4, 1991Q1
Austria	1974Q4, 1977Q4, 1980Q3, 1984Q1, 2001Q1, 2008Q2, 2012Q4
Belgium	1976Q4, 1980Q3, 1992Q2, 2001Q2, 2008Q3
Canada	1980Q2, 1990Q1, 2008Q4
Denmark	1973Q4, 1979Q3, 1987Q2, 1992Q4, 2006Q3
Finland	1975Q2, 1980Q4, 1990Q2, 2008Q1, 2012Q2
France	1974Q4, 1990Q4, 2008Q2
Germany	1995Q4, 2002Q4, 2008Q1, 2012Q4
Ireland	2008Q1
Italy	1970Q4, 1974Q4, 1977Q2, 1980Q2, 1992Q2, 2001Q2, 2007Q3, 2011Q3
Japan	1993Q2, 2001Q2, 2008Q2
Korea	1979Q3, 1997Q4, 2003Q1
Netherlands	1962Q4, 1973Q2, 1980Q2, 2008Q2, 2011Q2
New Zealand	1967Q1, 1970Q2, 1974Q4, 1982Q4, 1986Q4, 1991Q1, 2008Q1
Portugal	1974Q4, 1982Q4, 1992Q2, 2002Q2, 2008Q2, 2010Q3
Sweden	1976Q3, 1990Q3, 2008Q1, 2012Q3
United Kingdom	1969Q4, 1973Q3, 1979Q4, 1990Q3, 2008Q2
United States[24]	1948Q4, 1953Q2, 1957Q3, 1960Q2, 1969Q4, 1973Q4, 1980Q1, 1981Q3, 1990Q3, 2001Q1, 2007Q4

Finally, I evaluate all variables' contribution to real GDP growth around recessions. The period before a recession is defined as a *cycle peak*, and I construct figures that show the contributions of a variable *before* and *after* this peak. Following Leamer (2007), I consider both the four quarters preceding a cycle peak and the eight quarters following the peak in separate figures. To illustrate this, a copy of figure 6 in Leamer (2007) is given in figure 5. The cumulative abnormal contribution of the variable in question in the cycle peak quarter is subtracted from the considered quarters in every graph, so

quarters of growth. Although being in good shape, these economies would often not be eligible for new recessions without this "six out of eight" rule.

[24]U.S. recession dates are taken from the NBER Business Cycle Dating Committee.

Figure 5: From Leamer, 2007



that they display the behavior of the variable contribution to real GDP growth *around recessions*. Hence if a line declines towards zero before a recession, it means that the contribution is abnormally *low*, i.e. the variable contributes to weaker GDP growth. If a line rises, the contribution is abnormally *high*, contributing to stronger GDP growth. It is also worthwhile to keep in mind that a *flat line* signifies a *normal* contribution to GDP growth. In section 3.4, I replicate the results of Leamer (2007). The replication is included in the thesis both to ensure that I employ the correct methodology, and to examine whether the results hold also for the most recent recession (as Leamer's result only cover the years up to 2007). In section 3.5, I examine whether the results generalize to other countries.

3.4 Replication of Leamer - with an update!

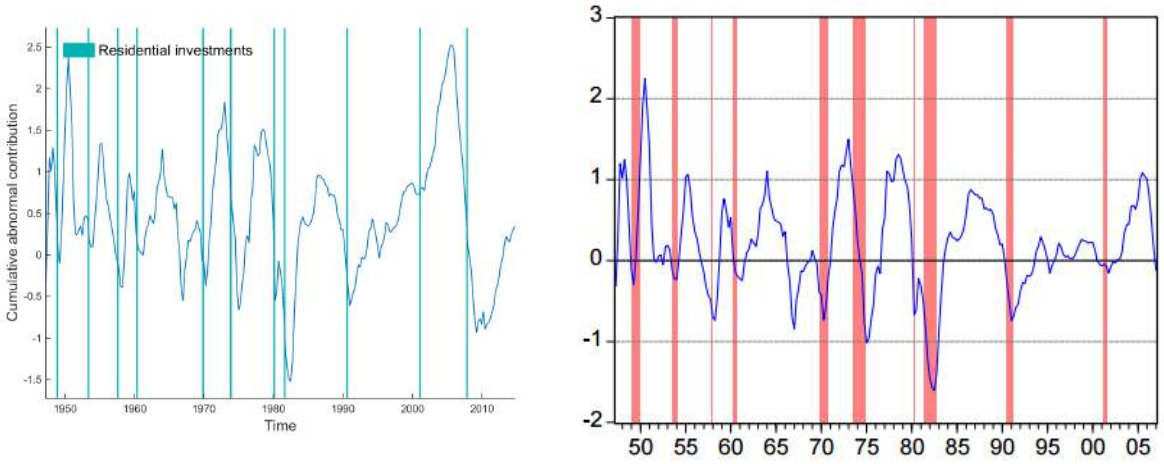
Leamer (2007) uses figure 5 to argue that residential investment typically contributes abnormally low before a recession, and abnormally high about one year into the recession, suggesting that residential investment leads the recession cycle. To replicate Leamer, the method described in the previous section is applied on US data extracted from the Bureau of Labor Statistics for the period from 1947 to 2014. As the latest data used in the paper is from 2006, this means that an additional eight years of data are included as supplements to the original analysis.[25] The mean contributions to percentage change in GDP for the total period from all variables are given in table 4, section 3.5, and are very similar to those of Leamer (2007). This is as expected, having supplemented the analysis with just eight more years of data. Over the sample period, U.S. real GDP growth has averaged 3.18 per cent. Private consumption is the main contributor to growth, followed by government expenditure and other investment, which both are at similar levels. Imports and exports are at similar levels as well. Residential investment is relatively unimportant for long run growth, contributing to only three per cent of long run growth, but is important around recessions. Figures 6 and 7 present the results from the replication for abnormal contributions from residential investment. Figure 6 compares the abnormal contributions in the replica with the abnormal contributions in Leamer (2007), while figures 7a and 7b show the abnormal contributions before and after a recession, respectively.
From figure 6, I conclude that the replica is sufficiently accurate: The abnormal contribution of residential investment is very similar. This pattern extends to all the other figures that are present in both Leamer's paper and this replication, see figure 32 in the appendix.[26]

The new data from the years after Leamer (2007) are well worth to look at. The Great Recession started in Q4 2007 in the U.S. In line with Leamer (2007), there was a large drop in the contribution to real GDP growth from residential investment in the

[25]The data used by Leamer is decomposed into more categories compared to the BLS data I have extracted. For example, in the dataset I use, consumption is represented by one single variable, whereas the dataset used by Leamer has consumption divided into three categories; durables, non-durables and services. The same goes for government expenditure, which is also divided into three subcategories. Hence, this replica gives a less detailed and not fully comparable outcome, but the main results are the same.

[26]There are some very small numerical differences between the CPC values, but it is negligible. This difference may arise from a few oddities found early in the volume data. There are a few very large residual terms, accompanied with some zero-terms, which pose a challenge for the estimation. How this is dealt with has a slight impact on the outcome.

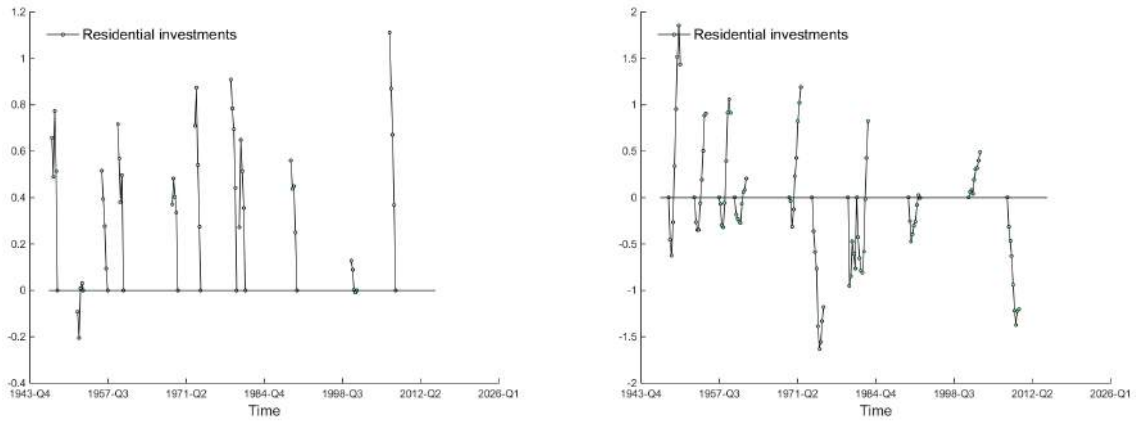
Figure 6: Cumulative abnormal contribution from residential investment, recessions highlighted



(a) Replica with update

(b) Figure from Leamer (2007)

Figure 7: Cumulative abnormal contribution from residential investment, before and during recessions



(a) Contribution *before* recession

(b) Contribution *during* recession

four preceding quarters. However, eight quarters after, residential investment had not yet picked up. According to Leamer (2007), residential investment is among the first variables to contribute to growth following a recession, however, this picture is not as clear for the Great Recession. The recovery did not commence until a long time had passed; after eight quarters the negative contribution to growth had only just stopped. Apart from government expenditure, which contributed positively to growth throughout the recession, due to massive fiscal stimulus, no variables stand out as positive contributors eight quarters

after. The non-existing V-shape, represented in the other recessions studied, could be a result of the recent recession being particularly severe, and also housing related.

3.5 Results for OECD countries

This section presents the results of the analysis for the 17 OECD countries introduced in section 3.2. First, I look at the contributions to percentage change in GDP from all variables. Then, I look at the abnormal contributions, focusing on recessions, providing an analysis of the findings.

Table 4 gives the decomposition of contributions to growth for all countries between 1960 and 2014, as well as giving the total country average for the same interval.[27] Total mean GDP growth is 3 per cent, where consumption contributed to 1.59 percentage points of this, government expenditure for 0.48 and so on. An interesting fact which generalizes well is that residential investment is of low importance for GDP growth, while maintaining a very high standard deviation. For an overview of specific periods, see tables 9-11 in the appendix.

[27] Note that the quarterly contributions have been converted to yearly rates by multiplying every quarter by 4.

Table 4: Contributions to percentage change in GDP, all available periods[28]

Country	Stats	GDP	Cons.	Gov.	Res. inv.	Other inv.	Imp.	Exp.
Australia	mean	3,48	1,97	0,59	0,30	0,76	-1,00	0,84
	sd	4,28	1,76	1,22	1,52	4,34	2,72	2,70
Austria	mean	2,35	1,27	0,37	0,10	0,41	-1,53	1,73
	sd	2,82	1,45	0,62	0,40	3,08	2,98	3,27
Belgium	mean	2,63	1,24	0,49	0,14	0,53	-2,52	2,70
	sd	2,84	1,26	0,51	1,61	1,99	4,59	4,66
Canada	mean	3,23	1,87	0,55	0,29	0,52	-1,46	1,34
	sd	3,59	1,86	0,94	1,42	3,40	2,99	3,06
Denmark	mean	2,04	0,97	0,54	0,08	0,41	-1,58	1,60
	sd	3,70	2,44	0,74	1,94	3,61	3,38	3,10
Finland	mean	2,84	1,58	0,47	0,18	0,51	-1,24	1,49
	sd	5,56	2,85	0,65	1,11	11,26	5,46	6,69
France	mean	2,86	1,57	0,60	0,19	0,44	-1,06	1,07
	sd	3,75	1,76	0,37	0,71	2,83	1,92	1,87
Germany	mean	1,22	0,61	0,30	0,06	-0,02	-1,32	1,59
	sd	3,38	1,89	0,67	0,68	2,77	2,84	3,66
Ireland	mean	4,27	1,70	0,46	0,07	0,81	-5,04	7,66
	sd	7,62	2,91	0,98	1,93	7,41	10,11	10,43
Italy	mean	2,43	1,56	0,34	0,10	0,37	-0,80	0,94
	sd	4,03	2,07	0,55	0,70	4,03	2,76	2,62
Japan	mean	3,88	1,96	0,47	0,28	1,12	-0,56	0,82
	sd	5,38	2,85	0,53	1,42	3,50	1,58	2,02
Korea	mean	6,86	3,17	0,59	0,45	2,06	-2,94	3,62
	sd	6,71	4,37	0,57	3,61	9,88	7,07	4,78
Netherlands	mean	2,77	1,36	0,55	0,15	0,46	-2,61	2,87
	sd	5,70	2,47	1,11	2,51	5,21	4,30	5,04
New Zealand	mean	2,72	1,58	0,42	0,09	0,66	-1,19	1,13
	sd	12,73	4,04	1,68	1,86	12,66	5,90	5,47
Portugal	mean	2,49	1,56	0,51	0,11	0,48	-1,46	1,28
	sd	3,87	2,92	0,64	0,91	4,44	3,84	2,54
Sweden	mean	2,40	0,98	0,49	0,04	0,55	-1,24	1,58
	sd	3,06	1,33	0,52	1,15	3,15	2,76	3,15
United Kingdom	mean	2,31	1,67	0,33	0,17	0,40	-1,08	1,05
	sd	3,86	2,71	0,85	2,64	5,77	3,25	3,48
United States[29]	mean	3,18	2,07	0,55	0,11	0,49	-0,47	0,37
	sd	3,87	2,06	1,39	0,94	1,13	1,13	1,06
Total	mean	3,00	1,59	0,48	0,16	0,61	-1,62	1,87
	sd	4,82	2,39	0,81	1,50	5,02	3,87	3,87

[28]Note that the components' contributions to real GDP growth do not always add exactly up to GDP. Rounding is the reason for most of this discrepancy. Furthermore, some of it originates from the use of an inaccurate deflator for residential investment. In addition, some series are subject to considerable residual terms which have been left out of the table.

[29]The variable "inventories", which is exclusive to the U.S. series, has been left out of the table. Its mean contribution to real GDP growth is very close to zero in all time intervals, although standing out as highly volatile. Note also that other investment is a much less volatile variable in the U.S. than in other countries, as a result of this.

Being mean values, the CPC values should be interpreted as the *normal contributions* from each variable to real GDP growth for their respective intervals. There are a lot of similarities between these values and the corresponding U.S. values presented in the previous section, but also some noteworthy differences. Consumption stands out as the most important contributor to long run GDP trend growth, and is also one of the more stable contributors. This holds well across all countries and time intervals. Similarly stable, but less important as a driver of growth, is government expenditures. Furthermore, the contribution to growth from exports and imports is in general much higher than in the U.S. This is an expected result and coincides well with the higher share of imports and exports to GDP, as discussed in section 3.1, see table 2. However, their net contribution to growth is of limited size. Naturally, as dictated by the trade balance, increasing exports allows for increased imports, and increasing imports requires increased exports, and their movements will track each other closely in the long run. As exports are a positive contributor to GDP growth and imports a negative contributor, their net contribution is thus typically somewhere close to zero. Other investment, i.e. total private investment minus residential investment, stands out as another variable fairly important for long run GDP growth, and it appears to be the most volatile variable, along with residential investment. This is somewhat different from the data for the U.S., where investments are not as volatile, but there is a reasonable explanation: Inventories, the most volatile variable in the U.S. series, is not accounted for separately in the OECD data I have used, but is rather included as part of other investments. It therefore seems reasonable to assume that a lot of the observed volatility in other investments' contribution to growth stems from this simplification. In addition, some countries, like Finland, Korea and New Zealand, have an exceptionally high standard deviation for other investment, raising the mean standard deviation by more than one. Most importantly, like in the U.S., residential investment is not a major contributor to GDP growth under normal circumstances. In fact, since 2000, it has on average contributed to a *fall* in GDP across countries, see table 11 in the appendix. The fact that it tips over on the negative side can largely be attributed to housing market crashes in Portugal and Ireland, but the weak contribution of residential investment in the remaining countries is nevertheless an interesting feature, and that residential investment stands out as a particularly volatile variable remains true in all intervals. The question is then whether this excess volatility translates into evidence for importance around recessions. That is, specifically, whether it is a leading variable for recessions, and important in recoveries, as Leamer (2007) observed it for the U.S.

Turning to the abnormal contributions to real GDP growth, especially around recessions, the upper row in figures 15 - 32 in the appendix show the *cumulative abnormal contributions to real GDP growth* of all variables and countries considered. The next three rows in the same figures show the abnormal contributions before and after recessions for the same variables.

Leamer (2007) shows that residential investment is a good indicator of recessions for the U.S., as it usually contributed negatively to GDP growth ahead of recessions. While there to some extent seems to be evidence of such a trend being present in other countries, it does not seem to generalize to the entire selection. In some cases, in particular for that of Canada, the U.S. pattern carries on remarkably well, especially before recessions, and to some extent during the recessions. It might seem as if the pattern for recovery is broken following the first recession in the series, but if we examine the entire timeline for abnormal contributions of residential investment (see figure 18), we see that the increase in contribution following the recession is temporary, followed by an even larger drop, before it quickly picks up and contributes to a recovery, and should therefore be considered in line with the pattern. The particularly interesting feature for Canada is the immensity of the drop ahead of the recession: while on average contributing to 0.29 percentage points of GDP growth *per year*, residential investment contributes to a fall in GDP of at least 0.4 percentage points in the last *quarter* preceding all Canadian recessions.

There are other cases where the predictive power of residential investment also appears to be good. Austria has a number of recessions where residential investment contributes to weaker GDP before recessions, and is abnormally stronger in the recovery. In France, too, there are strong signs of a pattern where a fall in residential investment leads recessions. Other countries where there are tendencies towards such a pattern include Finland, Germany, Ireland, Portugal and the United Kingdom (although one should be especially careful with generalizations for Ireland, having only a single, very deep recession in the entire time interval). Conversely, there are several countries in the series where it is hard to argue in favor of an existence of such a pattern. In Italy, for instance, there does not seem to be a consistent behavior for residential investment around recessions. Out of the eight recessions in the series, there are arguably only two cases where it behaves like the recession predicting variable it is for the U.S., namely the first and the last one. Other than that, contributions are mostly normal before recessions,

and neither stand out as contributing to the recovery. [30] Italy is not a sole exception in this respect. Although most countries seem to have had at least one recession preceded by a substantial drop in residential investment, this does not appear to be a feature generalizable across time and between countries. For example, in countries including, but not limited to, Belgium, Denmark, Netherlands and Sweden, residential investment does not immediately stand out as a variable of particular importance in relation to recessions. Considering the amount of countries where this feature is absent, it seems that we cannot easily generalize the results from the U.S. to other countries.

Private consumption appears to behave a lot like in the U.S. data. As mentioned, it is the most important contributor to trend growth, but it does experience fluctuations. During recessions, it can often contribute to rather large drops in GDP growth, but it normally picks up and contributes to stronger GDP within the 2 years following a recession start. For the U.S., Leamer (2007) shows that consumption durables, a lot like residential investment, was leading recessions. If a pattern like this exists, however, it is hard to establish as long as all consumption is collected in a single category. In general, it does not stand out in such a way.

Government expenditure is relatively stable measured in standard deviation, and this is largely the case around recessions as well. I have not been able to find a relation between government expenditure and recession starts, although it seemingly often contributes to growth following a recession, which is likely to reflect a counter-cyclical fiscal policy. This is particularly visible for France, where government expenditure is close to normal levels before a recession, but contributes abnormally to growth following all recessions in the series (figure 21).

Other investment stands out as a variable with very large fluctuations relative to its normal contribution to GDP growth. Generally, it does not appear to be leading recessions, but it is often a substantial drag on GDP following a recession (see e.g. Portugal, figure 29).

Imports and *exports* have, as expected, a much larger impact on growth during economic downturns. Specifically, it seems as if higher contributions to growth from imports (i.e. smaller negative contributions) helps economies recover more quickly (see e.g. Belgium, Finland and Portugal in figures 17, 20 and 29, respectively)

For the countries where residential investment seems to have some predictive

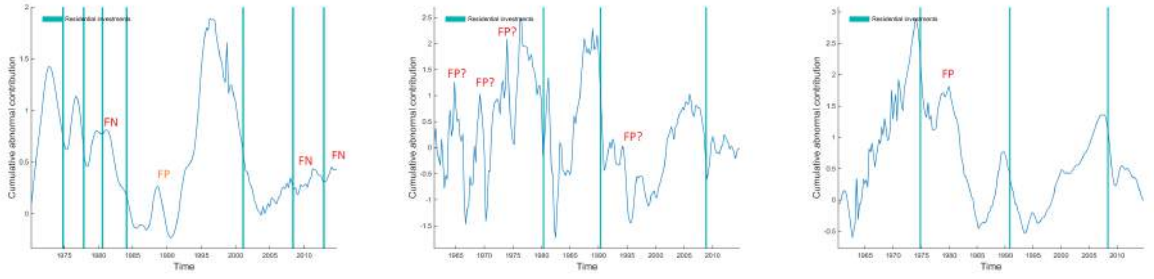
[30] In the data, Italy stands out as a particularly erratic economy, falling into more recessions than other countries and seeing relatively volatile contributions to growth from all variables.

power for recessions as in the U.S., several interesting features emerge. First, one of the most compelling traits found in the U.S. data was that, typically, the contribution to growth from residential investment in the recovery from recessions *more than counteracted* the negative contribution prior to and during the recession. This does not seem to be the case for the other countries. In almost every case, like for Finland, France and the U.K., contributions to growth turn positive only after several quarters, and these contributions are not nearly enough to make up for the preceding fall. Perhaps this is an indication of the U.S. economy being more dynamic and transitioning faster following economic downturns; that a typical U.S. recession simply is shorter than those of other countries.

3.5.1 False positives and false negatives

Leamer (2007) discusses the presence of false positives and false negatives in the data. A *false positive* from a variable is said to occur if the cumulative abnormal contributions drop sharply without initiating a recession, represented by a deep trough in the timeline for cumulative abnormal contributions. A *false negative* is simply when a recession starts without any indication from the variable on beforehand, an undesirable occurence for a prospective leading variable. Leamer (2007) finds only two false positives and two negatives in a 60-year span for residential investment in the U.S. I find that for Austria, Canada and France, residential investment does quite well with respect to false negatives. Looking at the timelines for these countries gives more information about the possibility of false positives. Figure 8 shows the cumulative abnormal contributions to growth from residential investment for Austria, Canada and France, and highlights the possible presence of false positives and negatives. For *Austria*, there are a few false negatives in

Figure 8: False positives and negatives from residential investment



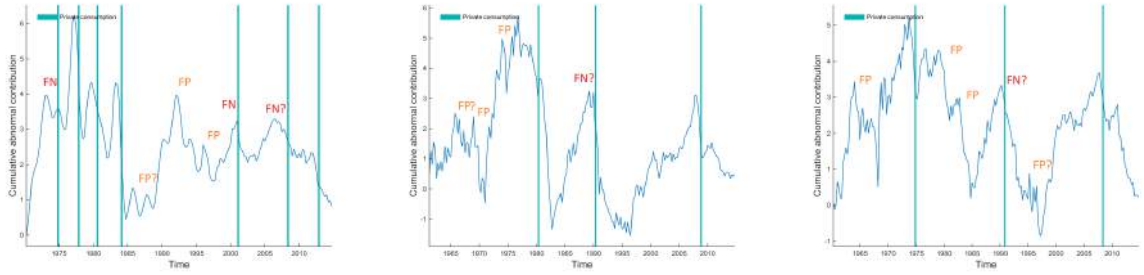
Austria Canada France

the series, but a majority of the recessions remain "predicted" by abnormally low contributions to growth from residential investment. There appears to be only one single false

positive around 1990, meaning that an abnormal drop in residential investment correctly has predicted an Austrian recession four out of five times. *Canada* has a sharp decline in contributions to growth from residential investment ahead of all three recessions, and is as such void of false negatives. There are, however, a few candidates for false positives early in the series, as well as one following the 1990 recession.[31] Like for Canada, residential investment serves as a good recession indicator for *France*, correctly predicting all three recessions in the series. The timeline only gives an indication of a single potential false positive following the 1974 recession.

Repeating the same exercise for private consumption, which, for the U.S., for consumption durables in particular, was shown to have a similar pattern to that of residential investment, is instructive. Figure 9 shows that for the three countries discussed above, the difference in "predictive power" between the variables is seemingly not that great, as the movements in their abnormal contributions are similar. Generally, there appears to be a higher number of false positives from private consumption and, at a first glance, no more false negatives. However, upon closer inspection it seems that residential investment often

Figure 9: False positives and negatives from private consumption



Austria Canada France

is slightly ahead of consumption in contributing negatively to GDP growth. Both in the Canadian and French 1990 recessions, drops in contributions from residential investment precedes drops from consumption by a quarter or two. It should also be noted that the magnitude of the reduced contributions to growth relative to the normal contribution is greater for residential investment than for consumption. For instance, in Canada, their mean contribution to growth is respectively 0.29 and 1.87, separated by a factor of six. In the year before the 1980 recession, they both contributed to a fall of around 1.3 per-

[31] It should be kept in mind, however, that using the fixed capital formation deflator likely overestimates the contributions, particularly early in the series. This gives rise to larger fluctuations, and the degree to which these are false positives is unclear.

cent of GDP from trend levels, making the impact relative to normal levels six times as large for residential investment, a rather large difference. This is a representative case, as the relative impact of residential investment ahead of "predicted recessions" typically is larger than that of consumption. These are some of the reasons why residential investment stands out as a particularly interesting variable to consider in relation to recessions, also outside of the U.S.

3.5.2 Explanations for a weaker link between residential investment and recessions

Like in the U.S., residential investment appears to serve as a recession predictor in many cases, but there is also a large number of cases where it does not. There are several possible explanations for why the U.S. pattern is not found in much of the OECD data. An alluringly simple one is that the result is a mere coincidence, and that we should not expect to find a similar pattern elsewhere. However, this explanation is likely too simplistic, if not outright false. For one thing, Leamer (2007) thoroughly documents the importance of residential investment in relation to recessions in the U.S., and the fact that it seemingly does not generalize to all other countries does not dismantle that evidence. Furthermore, there appears to be some evidence in the data for such a trend to exist in certain countries, and it seems too convenient to blame it all on coincidence. Another possible explanation is that the way in which recessions are dated could be overly simplified. This could entail that the pattern is there, and would have been found if recession starts had been determined in a more refined manner.[32] Regardless, determining a recession start by 2 consecutive quarters of negative GDP growth is a common method, and changing the dating scheme will likely not alter the recession starts too much. In addition, there is no guarantee that minor changes of recession dates would grant other results. It seems probable that the answer lies elsewhere.

A more plausible explanation is that not all recessions are the same, and that they can be caused for a variety of reasons. It could be the case that while residential investment is more likely to initiate domestic recessions, some recessions are of global character and are not likely to be preceded by significant reductions from residential investment in a given country. For instance, many of the considered countries entered recessions around 2001, following the bursting of the U.S. dotcom bubble. None of these were preceded by significant reduced contributions to growth from residential investment, as they emerged

[32]For instance, the NBER defines U.S. recessions based on a number of indicators, such as real GDP, real income and employment(National Bureau of Economic Research 2015).

as a result of global economic turmoil. Similarly, several European countries entered recessions following the 2011 euro crisis. Many of these, including those in Italy, Netherlands and Portugal, were preceded by reduced contributions to growth from government expenditure rather than residential investment, possibly indicating that reduced government spending was the cause of the downturns. It seems likely that many other recessions could be explained with a narrative not including residential investment. Without having full knowledge of the economic history for each country, it is difficult to weave a history around the recessions, but it could be the case that the 17 OECD countries differ significantly from the U.S. in how their recessions come about.

Furthermore, Leamer (2007) suggests that smaller open countries who are more dependent on trade, could be "importing" the business cycle via reduced exports or through turbulence in the exchange rate, while larger countries like the U.S. are less affected by this kind of turmoil and can "sustain their own cycle". If a recession is imported, one transmission mechanism could be that as demand for exported goods drops, a country sees a drop in the contribution to growth from exports. If the effect is strong enough, this initiates a recession, both from the direct effect on GDP growth of reduced income from exports, as well as secondary multiplier effects. The magnitude and duration of the negative contributions following the recession start will depend on, among other things, the severity of the imported recession. One way to approach this idea is to group the countries in the selection by size, and check for evidence that the smaller countries import recessions while larger countries' cycles develop independently.

To investigate the importance of openness and country size, I rank countries by population size. I then look at whether there is a difference in how residential investment and exports contribute to GDP around recessions, depending on the country size.[33] Including the U.S., there are 18 countries which can be divided into three groups of six, ranked by population. The *six largest countries* are the U.S., Japan, Germany, France, United Kingdom and Italy. The *middle six* are Korea, Canada, Australia, Netherlands, Belgium and Portugal. The *smallest six* are Sweden, Austria, Denmark, Finland, Ireland and New Zealand.[34]

In the largest group, both the United States, Germany, France and the United Kingdom have to varying extents seen residential investment work as a recession predictor.

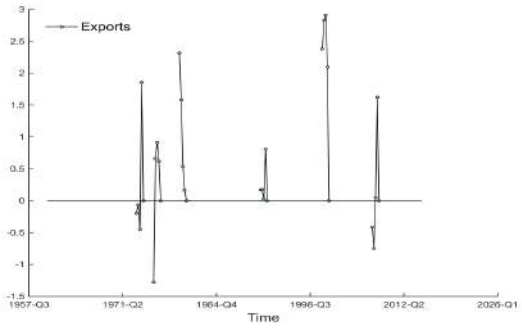
[33] A different way to rank countries could have been based on exports as share of GDP, but this would not substantially change the groups.

[34] The ranking is based on United Nations population data from 2012. Coincidentally, the smallest group has countries with population sizes below 10 million, the middle group between 10 and 50 million, while the largest group has populations above 50 million.

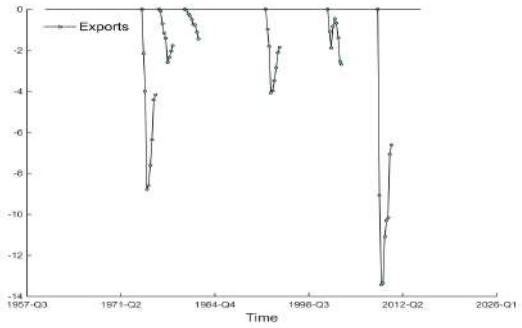
While it is harder to argue that case for Japan, and certainly difficult for Italy, it seems that the findings of Leamer (2007) holds fairly well for the largest group. The role of exports seems to be different, as there are only certain instances where it appears to stand out, such as the 2001 recession in Japan and the 1980 recession in Italy, who appear to be preceded by large negative contributions to growth from exports. Exports do not seem to lead recessions for either of these countries in a systematic manner.

In the middle group, only Canada and Portugal have a clear trend of residential investment leading recessions. In Korea, Netherlands and Belgium, there does not seem to be such a trend present, whereas the picture is somewhat unclear for Australia. The role of exports is markedly different, and for the case of Belgium it might appear as if it, to some extent, leads recessions, as seen in figure 10. Furthermore, it typically contributes more than other variables in the recovery. That this occurs for Belgium is particularly interesting, as it is the country in the series with the highest exports as share of GDP. However, in this manner Belgium is alone, as such a consistent role cannot be attributed to exports for the other countries in this group. There are a few singular incidents where it does appear to stand out, like before the 1974 recession in Portugal and the 2008 recession in Canada.

Figure 10: Abnormal contributions from exports around recessions, Belgium



Contribution before recession

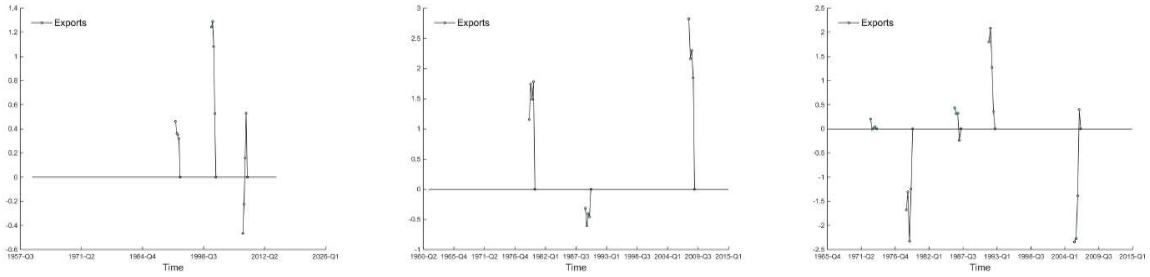


Contribution during recession

In the smallest group, residential investment appears to lead recessions both in Austria, Finland and Ireland, while it does not in Sweden, Denmark nor New Zealand. Again, there appears to be a number of singular instances where recessions are preceded by a significant reduction in exports (e.g. Denmark 1992, Finland 1975, Ireland 2008), but exports do not seem to be leading recessions in general. This is perhaps a surprising result, as this group of relatively small countries seems likely to be the most susceptible to such an effect, should it exist.

All in all, exports seem to provide an explanation for occasional economic downturns, as illustrated by figure 11, but there does not appear to be a systematic connection between the initiation of recessions and reduced growth contributions from exports. To sum

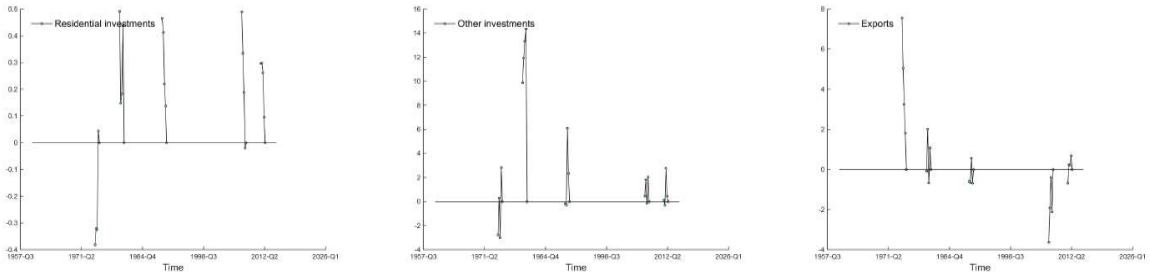
Figure 11: Abnormal contributions by exports before recessions



Japan Canada Denmark

up, residential investment seems to take a less prominent role as a predictor for recessions in the 17 OECD countries considered than in the U.S. Some recessions are caused by booms followed by drops in residential investment, some by sharp reductions in government spending, others through reduced income from exports, etc. For instance, consider the case of Finland, with five recessions during the time period considered, see figure 12. The first recession is preceded by a large drop in contribution to growth from exports, the

Figure 12: Abnormal contributions before recessions, Finland



Residential investment Other investment Exports

second by a massive drop in other investment (although not being a very deep recession at all, seeing only two quarters of mild real GDP decline), and the remaining three by substantial drops in residential investment. Similar explanations can be found for most recessions in the data sample. Nevertheless, the data suggests that residential investment should be paid particular attention to. As has been discussed above, it does stand out,

more than other variables, as a variable with a negative impact on growth before recessions, indicating that it should not be discarded as a potential key variable to gain control of in order to obtain economic stability.

4 Conclusion

In the thesis, I have studied the relation between two different housing variables and monetary policy. First, I have considered the approach inflation-targeting central banks should have to house prices. I have looked at the problems of including house prices in a price index. This is a complicated subject, as housing has the properties of both an asset and a consumption good, due to its nature as a durable good. As of now, how different central banks handle house price developments in the context of inflation targeting varies. Furthermore, excessive house price growth can be considered a sign of financial imbalances. In the past, there was disagreement on whether central banks should pay special attention to house prices at all, as there was uncertainty on (i) whether one could detect problematic developments in relevant variables, (ii) whether such developments could be affected by policy, and (iii) if intervening would do more good than harm. Now, there appears to be agreement that house prices should be monitored, with an ongoing discussion related to how they should be approached. The challenge of house prices is thus to what extent they should be considered with respect to financial imbalances (i.e. as a recession indicator), and whether they should be treated on a day-to-day basis, as part of a general business cycle indicator. I have found that a consensus has yet to be reached on the subject, and that more research is necessary to draw a conclusion.

Moreover, I have performed an empirical analysis on the importance of residential investment in relation to recessions. With a remarkable connection between residential investment and the U.S. business cycle as backdrop, I have evaluated 17 other OECD countries in a similar manner. The results show that the connection is not as strong in general, but that residential investment remains an interesting variable for monetary policy makers. For instance, in countries like Austria, Canada and France, there was a clear link between residential investment and their respective business cycles. In other countries the connection is not as consistent, but there appears to be evidence for residential investment playing an important part around certain recessions. While my results do not affirm a dominant position of residential investment as a recession indicator, they indicate that it is of some usefulness.

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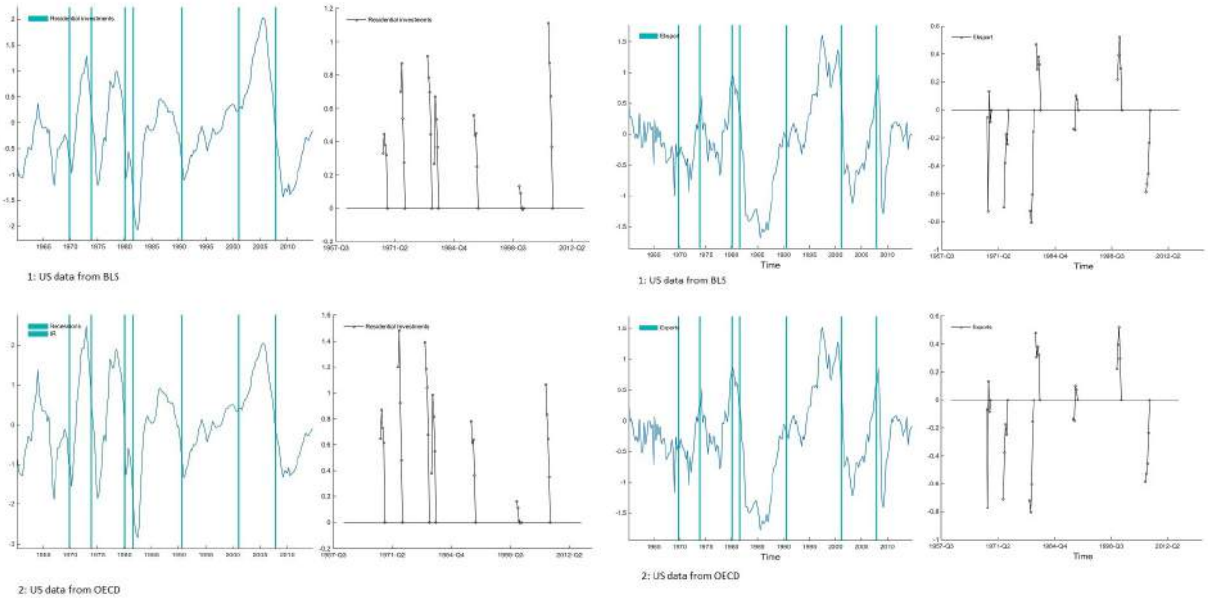
Appendix

Figure 13 illustrates the impact of using the fixed capital formation deflator as a proxy for residential investment. The top panels in both figures are generated based on a correct deflator from the Bureau of Labor Statistics, whereas the bottom panels are generated using the proxy. The impact is significant on residential investment for the earlier recessions, as the applied deflator is too big. The resulting contributions from residential investment are overestimated in absolute value, giving larger fluctuations. The problem diminishes the closer the series gets to the base year (which is fairly late in the series). Apart from this, the resemblance of the figures is uncanny, and the interpretation of the results would be the same in both cases. The spill-over effect on exports and other variables is completely negligible, as illustrated by figure X. This leads to the conclusion that, although the data produced for residential investment is somewhat inaccurate, we can nevertheless conduct a meaningful analysis, keeping this fact in mind.

Figure 13: Impact of using deflator for fixed capital on residential investment



Residential Investments

Exports

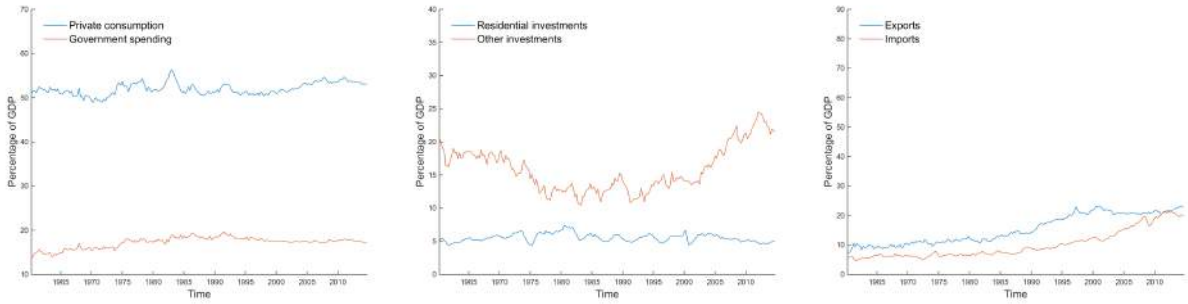
Table 5: Description of data collected from OECD EO96[35]

Abbr.	Variable name	Comments
CG	Government final consumption expenditure, value, GDP expenditure approach	This and all other variables except IHV missing before 1970 for Austria
CGV	Government final consumption expenditure, volume	
CP	Private final consumption expenditure, value, GDP expenditure approach	
CPV	Private final consumption expenditure, volume	
GDP	Gross domestic product, value, market prices	
GDPV	Gross domestic product, volume, market prices	
IHV	Gross fixed capital formation, housing, volume	Available from Q1 1960 for Australia, Austria, Belgium, Finland, France, Italy, Japan, Netherlands. Missing for Canada before 1961, Denmark before 1966, Germany 1991, Ireland 1990, Korea 1970, New Zealand Q3 1961, Portugal 1970, Sweden 1963, United Kingdom 1966.
IT	Gross fixed capital formation, total, value	
ITV	Gross fixed capital formation, total, volume	
MGS	Imports of goods and services, value, National Accounts basis	
MGSV	Imports of goods and services, volume, National Accounts basis	
PIT	Gross total fixed capital formation, deflator	Used as proxy for capital formation, housing, value
XGS	Exports of goods and services, value, National Accounts basis	
XGSV	Exports of goods and services, volume, National Accounts basis	

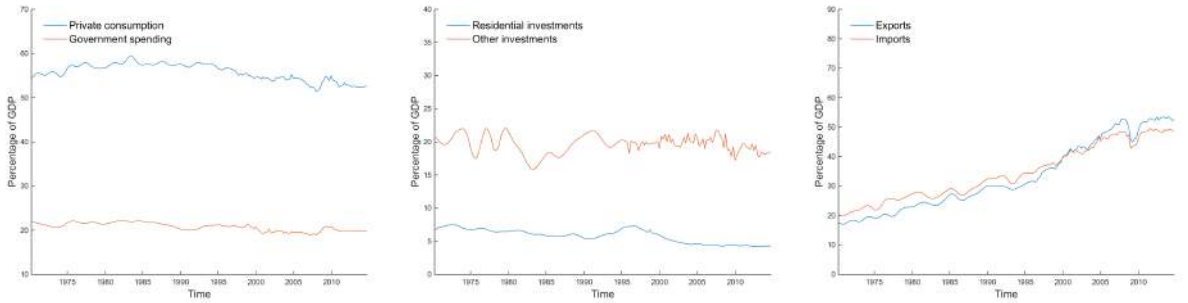
[35]All U.S. data is extracted from the Bureau of Labor Statistics.

Figure 14: Evolution of variable share of real GDP

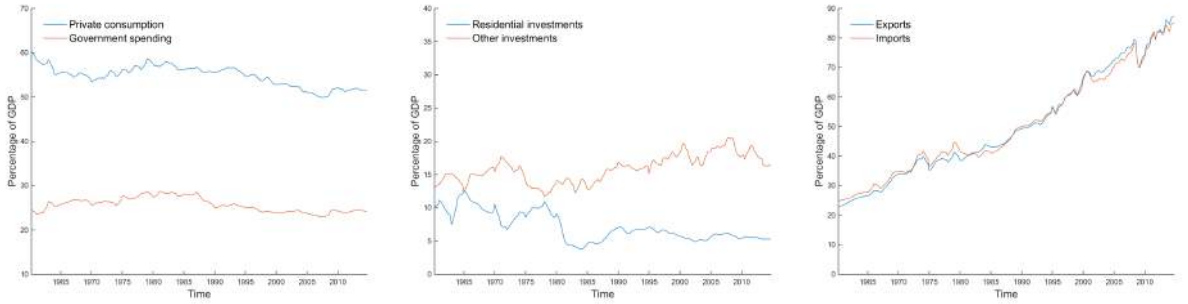
Australia



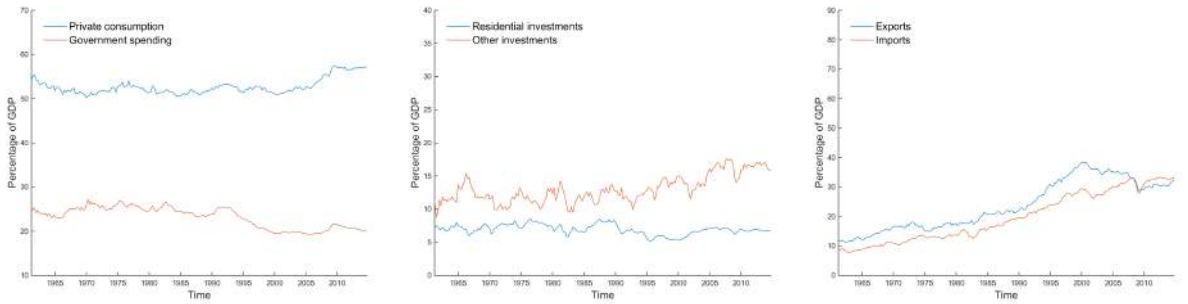
Austria



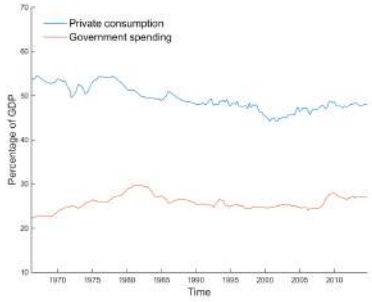
Belgium

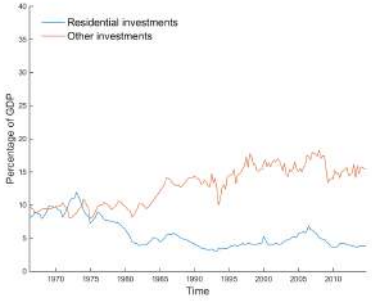


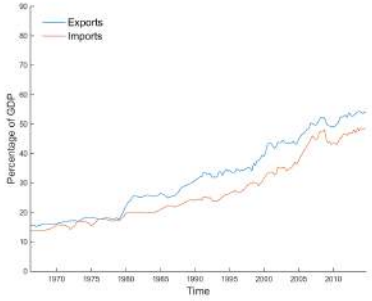
Canada



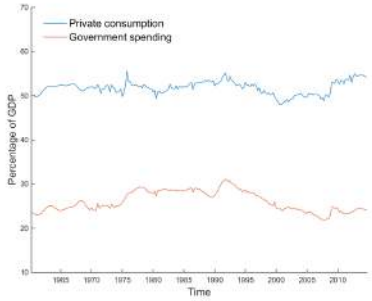
Denmark

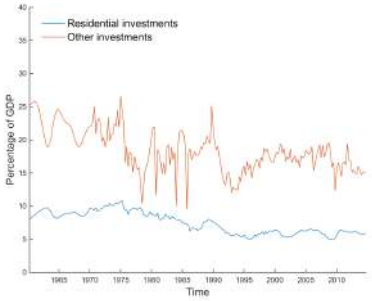


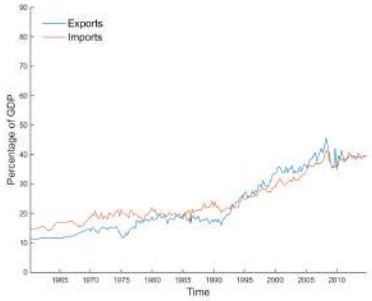




Finland







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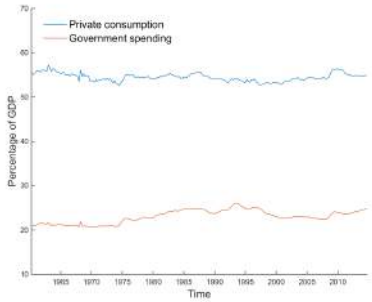
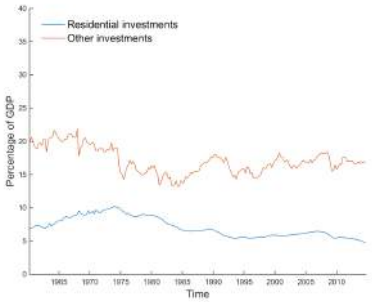
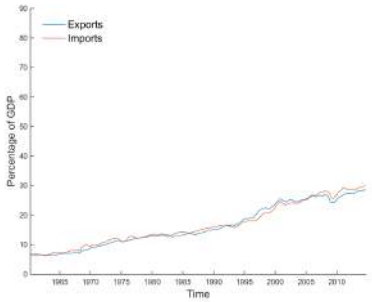
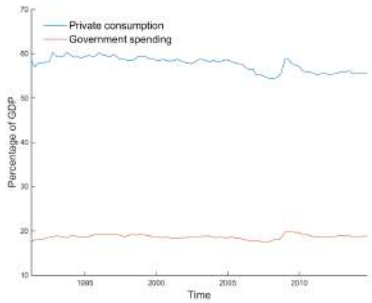
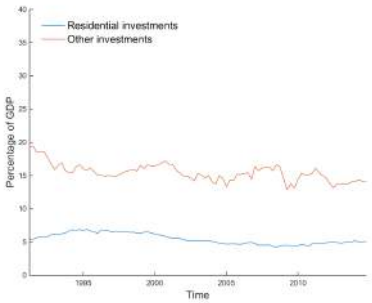


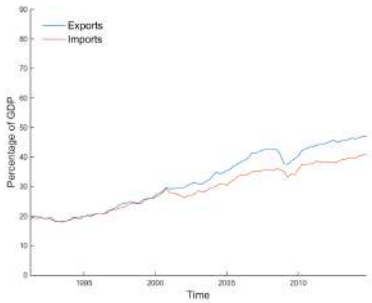




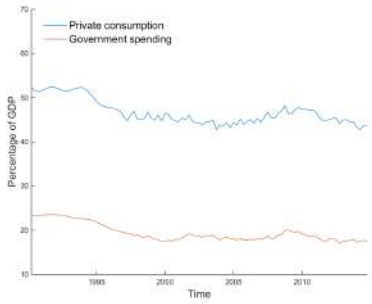
Germany

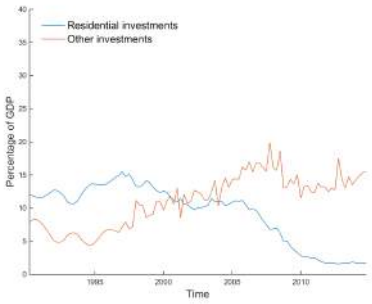


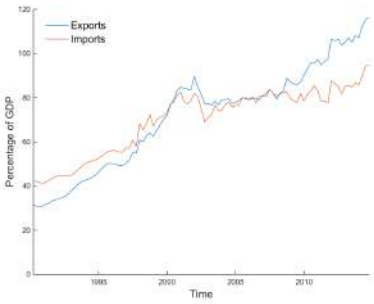




Ireland







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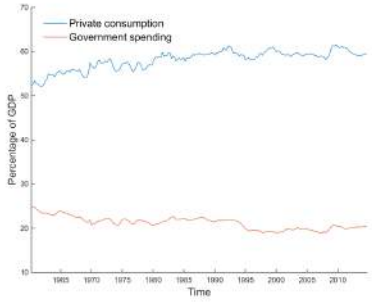
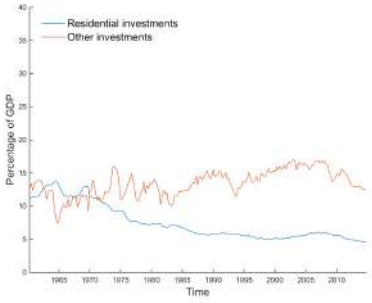
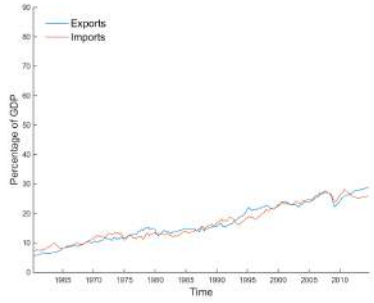
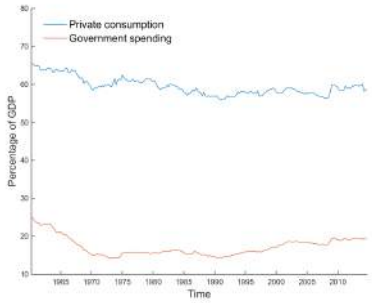
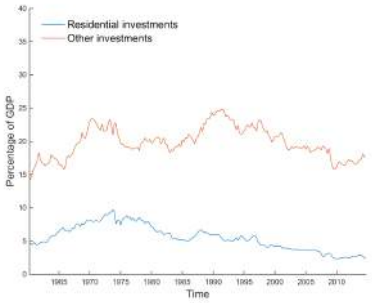


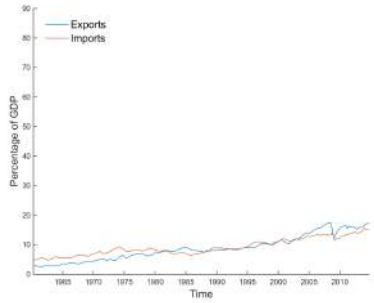




Japan







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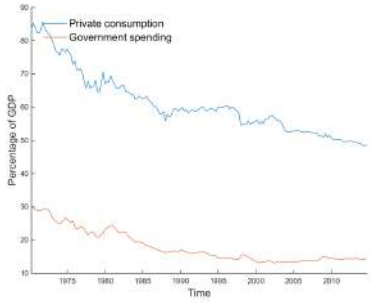
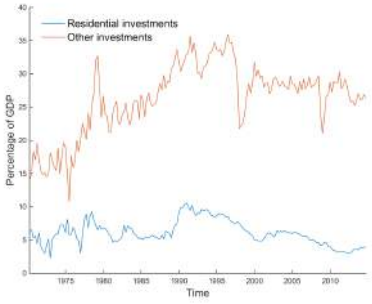
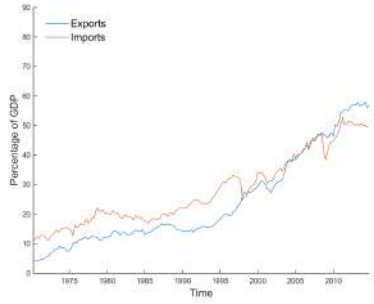
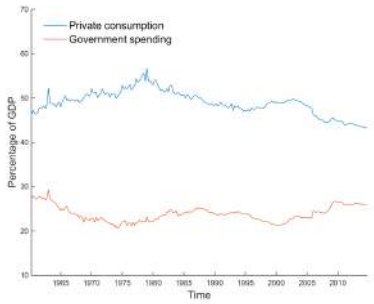
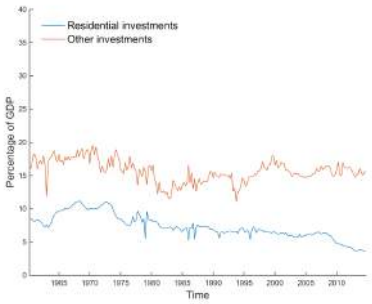


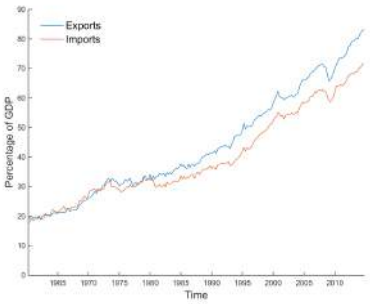




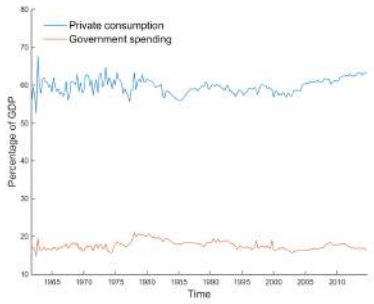
Netherlands

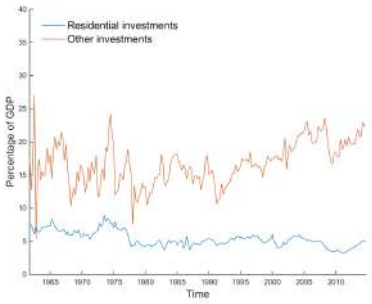


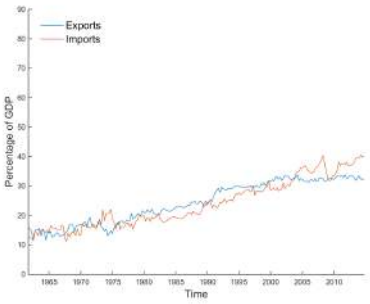




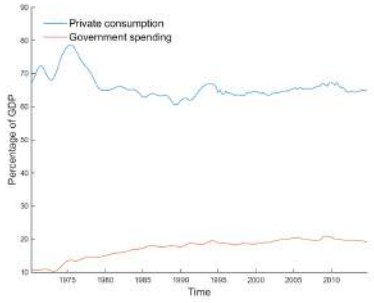
New Zealand

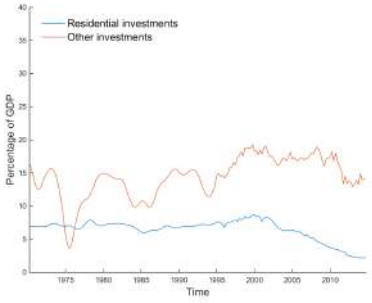


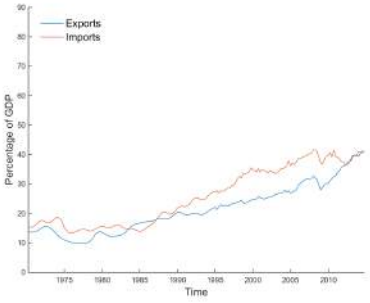




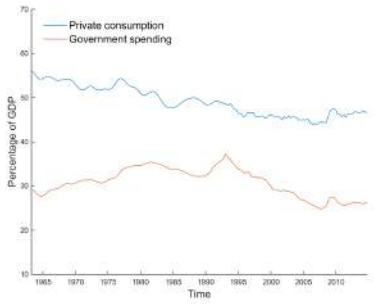
Portugal

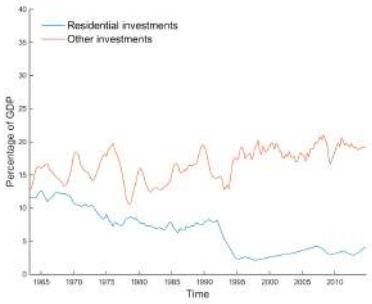


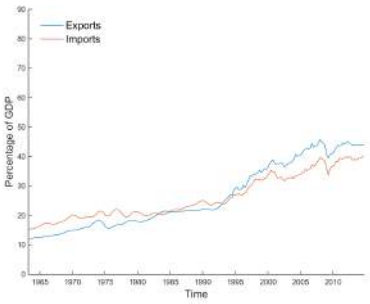




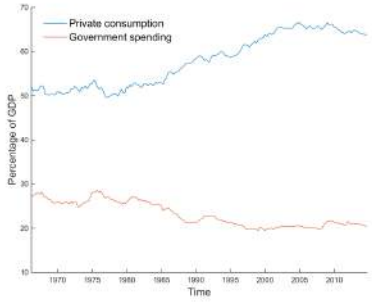
Sweden

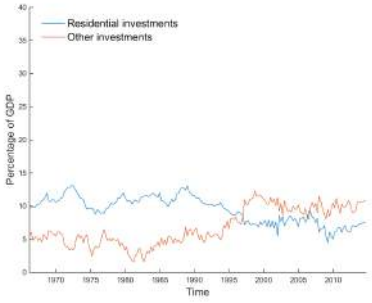


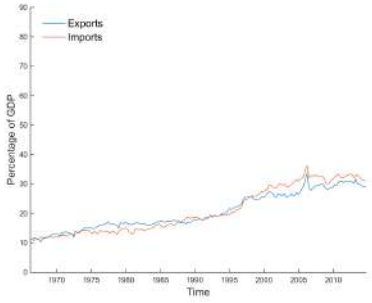




United Kingdom







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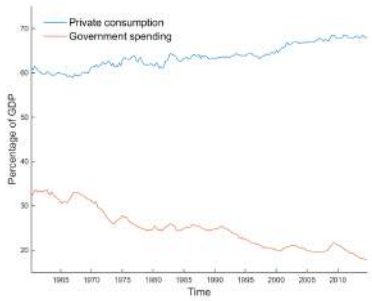
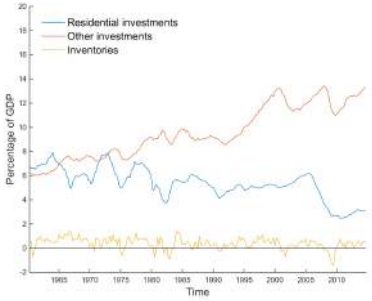




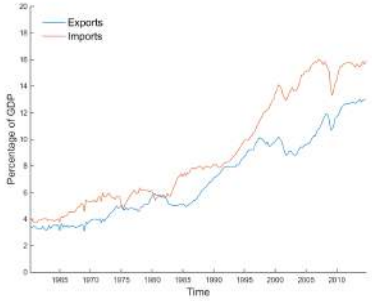


Table 6: Variable share of GDP, mean and standard deviation: Q1 1960 - Q4 1979

Country	Stats	Cons.	Gov. exp.	Res. inv.	Other inv.	Imports	Exports
Australia	mean	51,41	16,01	5,54	16,38	-6,16	10,23
	sd	1,30	1,14	0,61	2,31	0,60	1,15
Austria	mean	56,19	21,47	6,90	20,37	-23,23	19,49
	sd	1,07	0,43	0,35	1,31	2,22	1,70
Belgium	mean	56,06	26,30	9,67	14,53	-33,82	32,33
	sd	1,61	1,19	1,31	1,48	6,01	5,83
Canada	mean	52,29	25,03	7,38	11,66	-11,03	15,01
	sd	1,04	1,03	0,54	1,26	1,88	2,13
Denmark	mean	53,00	24,90	8,77	9,54	-15,94	17,20
	sd	1,23	1,69	1,23	0,68	1,47	1,11
Finland	mean	51,75	25,54	9,25	20,92	-17,78	13,69
	sd	0,93	1,77	0,66	3,32	2,06	2,00
France	mean	54,74	21,42	8,69	18,71	-9,58	9,06
	sd	0,95	0,70	0,95	1,99	2,34	2,24
Germany	mean	n/a	n/a	n/a	n/a	n/a	n/a
	sd	n/a	n/a	n/a	n/a	n/a	n/a
Ireland	mean	n/a	n/a	n/a	n/a	n/a	n/a
	sd	n/a	n/a	n/a	n/a	n/a	n/a
Italy	mean	55,67	22,35	10,66	12,01	-10,66	10,15
	sd	1,62	1,13	1,96	1,72	1,97	2,77
Japan	mean	61,92	17,98	7,21	19,24	-6,86	4,56
	sd	1,91	3,44	1,46	2,40	1,34	1,42
Korea	mean	75,37	25,51	6,01	19,06	-15,49	8,83
	sd	6,73	2,96	1,64	4,81	3,18	2,93
Netherlands	mean	50,54	23,74	9,22	17,05	-25,86	26,11
	sd	2,30	2,27	1,23	1,36	4,64	5,11
New Zealand	mean	59,96	17,59	6,53	15,68	-16,03	16,09
	sd	2,34	1,30	1,06	3,58	2,37	2,26
Portugal	mean	71,58	12,61	7,09	11,87	-15,66	12,45
	sd	4,06	1,71	0,32	3,65	1,60	2,00
Sweden	mean	53,32	30,99	10,18	15,50	-19,01	15,30
	sd	1,24	1,94	1,69	2,13	1,92	2,08
United Kingdom	mean	51,15	26,55	10,70	4,91	-12,98	13,98
	sd	0,90	0,99	1,13	0,92	1,09	1,93
United States	mean	61,12	29,62	6,52	7,33	-5,00	4,00
	sd	1,38	3,08	0,76	0,79	0,83	0,67
Total	mean	57,25	22,98	8,15	14,67	-15,32	14,28
	sd	1,91	1,67	1,06	2,11	2,22	2,33

Table 7: Variable share of GDP, mean and standard deviation: Q1 1980 - Q4 1999

Country	Stats	Cons.	Gov. exp.	Res. inv.	Other inv.	Imports	Exports
Australia	mean	51,83	18,23	5,67	12,97	-8,72	15,80
	sd	1,27	0,56	0,63	1,21	1,66	3,50
Austria	mean	57,23	21,20	6,21	19,28	-31,22	28,75
	sd	1,02	0,63	0,52	1,49	3,74	3,98
Belgium	mean	55,88	26,34	5,93	15,43	-49,28	49,29
	sd	1,17	1,56	1,17	1,55	7,43	7,23
Canada	mean	51,93	23,72	6,73	12,33	-19,94	24,68
	sd	0,73	1,74	0,90	1,26	4,67	6,02
Denmark	mean	48,86	26,39	4,31	12,97	-23,97	30,13
	sd	1,22	1,62	0,76	2,23	3,25	4,38
Finland	mean	52,15	28,31	6,84	17,07	-22,61	21,50
	sd	1,16	1,26	1,14	2,87	2,97	4,79
France	mean	54,17	24,42	6,48	15,57	-15,93	16,22
	sd	0,74	0,71	0,98	1,24	2,50	3,13
Germany	mean	59,07	18,75	6,35	16,38	-21,13	21,28
	sd	0,75	0,48	0,43	1,33	2,43	2,53
Ireland	mean	49,17	21,25	12,95	7,06	-53,41	46,17
	sd	2,92	2,07	1,25	1,90	9,69	11,65
Italy	mean	59,30	21,16	6,04	13,46	-16,33	16,93
	sd	0,84	1,15	0,72	1,39	2,87	3,25
Japan	mean	58,01	15,63	5,53	21,55	-8,52	8,62
	sd	1,15	0,70	0,70	1,73	1,37	0,86
Korea	mean	60,53	17,48	7,16	28,62	-23,34	16,94
	sd	3,48	2,93	1,70	4,22	4,75	4,37
Netherlands	mean	49,45	23,68	6,91	14,35	-37,48	42,50
	sd	1,78	0,92	0,57	1,45	5,98	7,28
New Zealand	mean	58,82	18,27	4,94	15,25	-23,20	25,81
	sd	1,30	0,95	0,52	1,93	3,92	3,67
Portugal	mean	64,12	17,83	7,13	14,02	-21,95	18,78
	sd	1,50	1,12	0,57	2,39	6,27	3,64
Sweden	mean	48,39	33,72	5,76	16,02	-24,49	24,35
	sd	1,69	1,48	2,26	2,21	3,72	5,25
United Kingdom	mean	57,02	22,85	10,29	5,89	-18,58	19,19
	sd	3,45	2,28	1,55	2,68	3,71	3,07
United States	mean	63,48	23,83	5,09	9,69	-8,43	7,14
	sd	0,81	1,74	0,53	1,07	2,00	1,73
Total	mean	55,52	22,39	6,68	14,88	-23,81	24,12
	sd	1,50	1,33	0,94	1,90	4,05	4,46

Table 8: Variable share of GDP, mean and standard deviation: Q1 2000 - Q4 2014

Country	Stats	Cons.	Gov. exp.	Res. inv.	Other inv.	Imports	Exports
Australia	mean	53,07	17,51	5,33	19,04	-16,85	21,44
	sd	0,95	0,21	0,53	3,37	3,33	0,86
Austria	mean	53,57	19,75	4,57	19,62	-45,72	48,21
	sd	0,98	0,48	0,41	1,10	3,13	4,37
Belgium	mean	51,61	23,95	5,53	18,22	-73,71	75,22
	sd	0,89	0,44	0,34	1,22	6,33	6,10
Canada	mean	54,41	20,13	6,68	15,51	-30,54	33,33
	sd	2,38	0,69	0,48	1,52	2,19	2,82
Denmark	mean	46,78	25,81	4,62	15,80	-41,63	48,33
	sd	1,30	1,20	0,84	1,15	5,65	4,33
Finland	mean	51,30	23,77	5,90	17,01	-35,72	37,82
	sd	2,21	0,82	0,43	1,52	3,55	2,81
France	mean	54,53	23,30	5,80	17,00	-26,64	26,09
	sd	0,88	0,68	0,44	0,68	2,10	1,31
Germany	mean	56,91	18,61	4,95	14,97	-33,76	38,46
	sd	1,45	0,51	0,44	1,07	4,52	6,21
Ireland	mean	45,16	18,29	6,90	13,72	-80,50	88,47
	sd	1,28	0,68	4,05	2,18	4,89	11,62
Italy	mean	59,64	19,80	5,39	15,26	-25,25	25,26
	sd	0,79	0,51	0,43	1,40	1,48	2,00
Japan	mean	58,36	18,64	3,23	18,33	-12,95	14,45
	sd	1,00	0,67	0,61	1,40	1,10	2,18
Korea	mean	52,33	13,97	4,79	27,91	-42,45	43,75
	sd	2,58	0,48	1,10	1,75	6,68	9,95
Netherlands	mean	46,32	24,34	5,44	15,69	-60,85	68,96
	sd	2,30	1,74	0,99	0,69	5,50	7,14
New Zealand	mean	60,53	16,97	4,57	19,90	-34,77	32,54
	sd	1,99	0,65	0,80	1,85	3,62	0,67
Portugal	mean	65,20	19,78	5,16	16,63	-37,64	30,85
	sd	0,98	0,57	2,05	1,70	2,48	4,87
Sweden	mean	45,68	26,92	3,38	18,87	-36,34	41,56
	sd	0,95	1,38	0,45	1,06	2,71	2,82
United Kingdom	mean	65,06	20,57	7,21	9,92	-31,40	28,58
	sd	0,81	0,53	1,00	0,86	1,77	1,97
United States	mean	67,29	19,98	4,22	12,29	-14,87	10,92
	sd	0,93	0,94	1,33	0,70	0,96	1,46
Total	mean	54,87	20,67	5,20	16,98	-37,87	39,68
	sd	1,37	0,73	0,93	1,40	3,44	4,08

Table 9: Contributions to percentage change in GDP, earliest available quarter - Q4 1979

Country	Stats	GDP	Cons.	Gov.	Res. inv.	Other inv.	Imp.	Exp.
Australia	mean	4,03	2,22	0,65	0,54	0,50	-0,64	0,78
	sd	5,83	2,11	1,23	1,67	5,05	2,95	3,58
Austria	mean	3,67	2,33	0,54	0,26	0,85	-1,95	1,77
	sd	2,97	1,86	0,26	0,44	3,31	2,45	2,01
Belgium	mean	4,17	2,06	0,81	0,42	0,82	-2,75	2,75
	sd	3,20	1,30	0,56	2,35	2,07	4,08	3,77
Canada	mean	4,77	2,58	0,90	0,53	0,66	-1,45	1,42
	sd	4,01	2,29	1,24	1,83	3,81	2,39	2,68
Denmark	mean	3,16	1,65	1,02	0,32	0,34	-1,70	1,53
	sd	3,62	2,90	0,54	3,10	2,41	3,28	2,00
Finland	mean	4,18	2,34	0,73	0,40	0,74	-1,43	1,49
	sd	5,83	3,41	0,30	1,16	8,73	5,04	4,48
France	mean	4,80	2,56	0,86	0,54	0,72	-1,26	1,27
	sd	5,10	2,03	0,30	0,98	3,81	2,15	1,97
Germany	mean	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	sd	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ireland	mean	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	sd	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Italy	mean	4,69	3,02	0,58	0,28	0,76	-1,16	1,39
	sd	4,77	1,73	0,26	0,99	5,51	3,22	2,59
Japan	mean	7,18	3,57	0,57	0,83	2,38	-0,87	1,28
	sd	5,24	2,84	0,62	2,00	4,32	1,64	1,68
Korea	mean	9,16	4,53	0,64	0,97	3,15	-4,07	4,10
	sd	8,01	6,35	0,69	6,93	15,00	8,48	5,53
Netherlands	mean	4,21	2,55	0,60	0,41	0,73	-3,09	3,04
	sd	8,08	3,09	1,40	3,22	7,02	4,61	5,83
New Zealand	mean	2,94	1,62	0,51	-0,05	0,54	-1,03	1,10
	sd	20,66	5,77	1,28	2,25	20,16	7,96	8,35
Portugal	mean	4,73	2,91	0,94	0,42	0,98	-1,09	0,80
	sd	4,86	3,95	0,51	0,82	7,60	4,19	2,96
Sweden	mean	3,10	1,27	0,85	0,16	0,69	-1,09	1,22
	sd	2,35	1,13	0,41	1,38	3,16	1,85	1,58
United Kingdom	mean	2,62	1,57	0,44	0,37	-0,05	-1,00	1,29
	sd	5,71	3,83	0,89	1,91	6,48	3,50	4,45
United States	mean	3,73	2,25	0,77	0,18	0,51	-0,29	0,23
	sd	4,56	2,47	1,84	1,12	1,18	0,98	1,20
Total	mean	4,45	2,44	0,71	0,41	0,90	-1,55	1,59
	sd	5,92	2,94	0,77	2,01	6,23	3,67	3,42

Table 10: Contributions to percentage change in GDP, earliest available quarter - Q4 1999

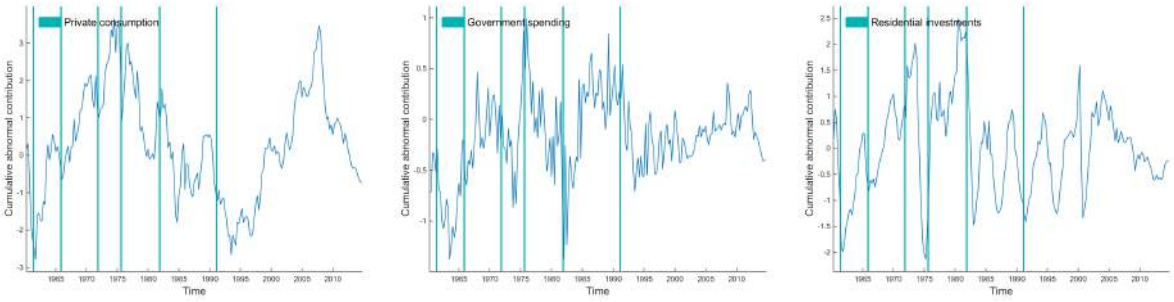
Country	Stats	GDP	Cons.	Gov.	Res. inv.	Other inv.	Imp.	Exp.
Australia	mean	3,33	1,84	0,62	0,23	0,70	-1,19	1,02
	sd	3,67	1,72	1,56	1,42	4,42	2,53	2,25
Austria	mean	2,35	1,21	0,41	0,12	0,32	-1,48	1,79
	sd	1,70	1,32	0,46	0,44	1,95	2,03	2,09
Belgium	mean	2,08	0,90	0,30	-0,07	0,54	-2,55	2,91
	sd	2,02	1,07	0,47	1,17	1,79	3,30	3,30
Canada	mean	2,61	1,43	0,30	0,09	0,50	-1,88	2,05
	sd	3,42	1,70	0,79	1,40	3,45	3,25	3,23
Denmark	mean	2,28	0,85	0,37	0,03	0,74	-1,55	1,83
	sd	3,57	2,20	0,71	1,27	3,97	2,29	2,99
Finland	mean	2,68	1,29	0,38	0,05	0,59	-1,13	1,86
	sd	5,18	2,29	0,79	1,27	15,67	6,23	6,25
France	mean	2,20	1,19	0,49	-0,02	0,37	-1,05	1,18
	sd	1,81	1,45	0,38	0,37	2,18	1,52	1,55
Germany	mean	1,48	0,94	0,46	0,21	-0,04	-1,24	1,18
	sd	2,88	2,50	0,87	0,89	2,28	2,06	2,50
Ireland	mean	6,93	2,93	0,62	0,93	0,77	-7,76	11,02
	sd	6,50	3,15	0,64	1,76	3,93	9,16	8,62
Italy	mean	1,96	1,27	0,28	0,01	0,38	-0,85	0,88
	sd	2,50	1,83	0,51	0,41	3,28	2,38	2,55
Japan	mean	2,91	1,46	0,48	0,02	0,75	-0,36	0,57
	sd	4,22	2,33	0,47	0,94	2,97	1,18	1,03
Korea	mean	7,81	3,65	0,56	0,43	2,53	-2,82	3,52
	sd	7,04	4,05	0,57	2,14	8,70	5,73	4,26
Netherlands	mean	2,56	1,09	0,53	0,08	0,45	-2,56	3,01
	sd	3,80	1,92	0,75	2,55	4,54	4,18	4,55
New Zealand	mean	2,73	1,34	0,32	0,24	0,74	-1,24	1,40
	sd	5,56	3,06	2,39	1,90	6,03	4,81	3,15
Portugal	mean	3,08	1,97	0,62	0,35	0,76	-2,38	1,65
	sd	2,85	2,21	0,55	0,82	2,86	3,04	1,84
Sweden	mean	2,06	0,74	0,34	-0,18	0,53	-1,38	1,95
	sd	2,63	1,47	0,56	1,25	3,16	2,07	2,58
United Kingdom	mean	2,49	2,14	0,19	0,06	0,89	-1,40	1,13
	sd	2,88	2,26	0,83	1,89	6,15	2,85	2,13
United States	mean	3,22	2,23	0,43	0,12	0,64	-0,78	0,54
	sd	3,12	1,69	0,74	0,77	1,08	1,09	0,73
Total	mean	3,04	1,58	0,43	0,15	0,67	-1,87	2,19
	sd	3,63	2,12	0,78	1,26	4,36	3,32	3,09

Table 11: Contributions to percentage change in GDP, Q1 2000 - Q4 2014

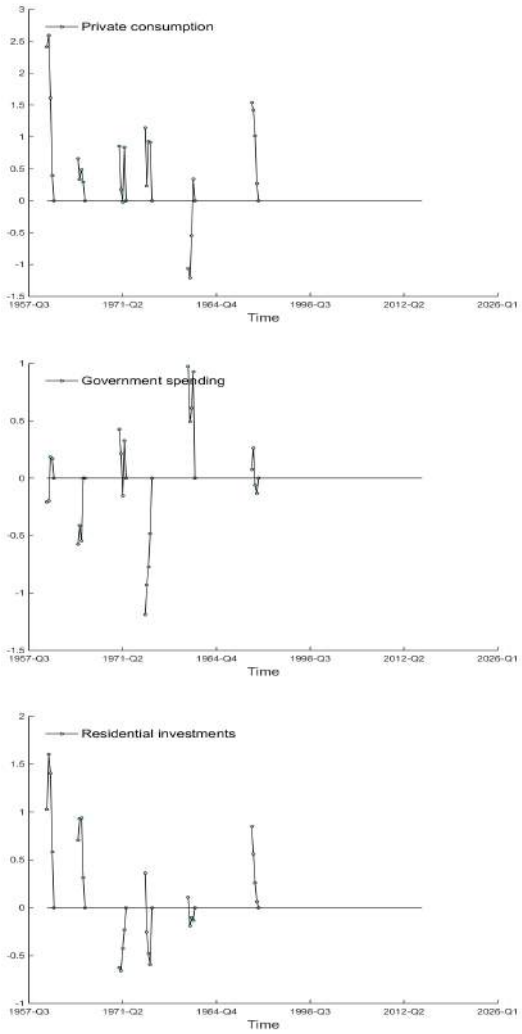
Country	Stats	GDP	Cons.	Gov.	Res. inv.	Other inv.	Imp.	Exp.
Australia	mean	2,93	1,82	0,49	0,07	1,21	-1,24	0,66
	sd	1,90	1,19	0,49	1,42	3,03	2,65	1,69
Austria	mean	1,44	0,63	0,21	-0,05	0,25	-1,31	1,61
	sd	3,54	0,76	0,90	0,23	4,04	4,18	4,91
Belgium	mean	1,31	0,58	0,31	0,04	0,11	-2,19	2,36
	sd	2,32	0,77	0,22	0,41	2,08	6,45	6,88
Canada	mean	2,08	1,57	0,45	0,25	0,37	-0,90	0,27
	sd	2,42	0,97	0,37	0,62	2,75	3,26	3,05
Denmark	mean	0,67	0,50	0,32	-0,07	0,04	-1,50	1,37
	sd	3,58	2,15	0,73	1,09	4,04	4,56	4,00
Finland	mean	1,23	0,93	0,24	0,04	0,07	-1,14	1,00
	sd	5,32	2,46	0,66	0,73	6,14	4,94	9,33
France	mean	1,11	0,73	0,37	-0,01	0,17	-0,81	0,65
	sd	2,05	0,94	0,20	0,32	1,93	2,06	2,07
Germany	mean	1,07	0,41	0,20	-0,03	0,00	-1,37	1,85
	sd	3,66	1,39	0,49	0,50	3,04	3,24	4,21
Ireland	mean	2,46	0,87	0,35	-0,52	0,84	-3,20	5,38
	sd	7,84	2,42	1,14	1,84	9,07	10,38	10,98
Italy	mean	0,02	-0,02	0,09	-0,04	-0,17	-0,23	0,39
	sd	2,90	1,39	0,74	0,43	2,10	2,50	2,70
Japan	mean	0,74	0,47	0,30	-0,09	-0,08	-0,41	0,53
	sd	4,55	2,46	0,43	0,52	2,16	1,91	3,09
Korea	mean	4,00	1,60	0,59	0,12	0,68	-2,34	3,42
	sd	3,77	2,24	0,49	1,02	6,48	7,69	4,95
Netherlands	mean	1,08	0,11	0,53	-0,12	0,11	-2,01	2,46
	sd	2,75	1,12	1,07	0,73	2,57	4,01	4,54
New Zealand	mean	2,44	1,86	0,44	0,04	0,72	-1,32	0,82
	sd	3,50	2,22	0,71	1,16	4,98	4,02	2,84
Portugal	mean	0,18	0,10	0,08	-0,43	-0,24	-0,45	1,12
	sd	3,11	2,31	0,57	0,86	3,09	4,30	2,99
Sweden	mean	2,05	0,98	0,28	0,18	0,40	-1,24	1,48
	sd	4,07	1,28	0,35	0,53	3,15	4,15	4,80
United Kingdom	mean	1,77	1,14	0,41	0,14	0,17	-0,73	0,69
	sd	2,68	1,73	0,84	3,87	4,43	3,50	3,91
United States	mean	1,89	1,48	0,20	-0,07	0,25	-0,45	0,43
	sd	2,65	1,29	0,62	0,65	1,07	1,42	1,09
Total	mean	1,58	0,87	0,33	-0,03	0,27	-1,27	1,47
	sd	3,48	1,62	0,61	0,94	3,68	4,18	4,34

Figure 15: Cumulative abnormal contributions, Australia

Timeline with recessions



Contribution before recession



Contribution during recession

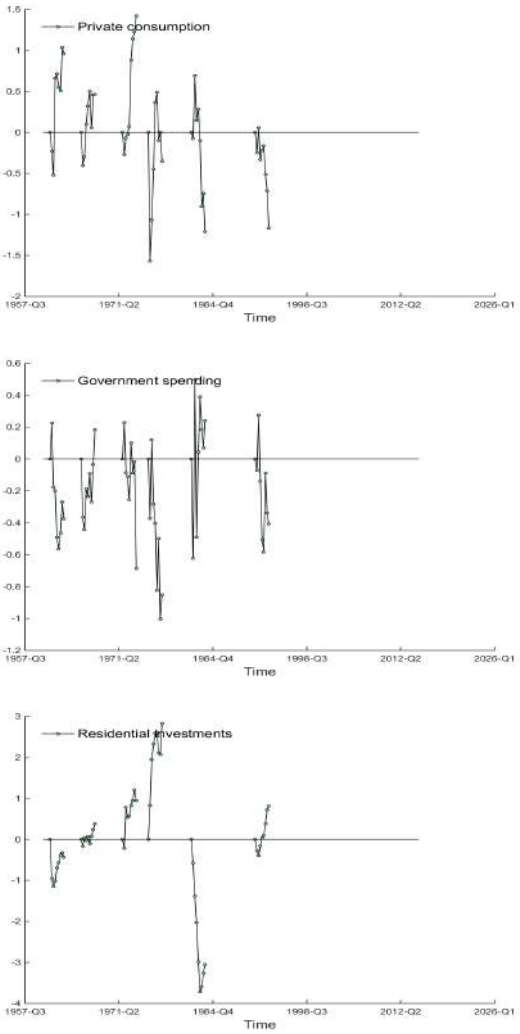
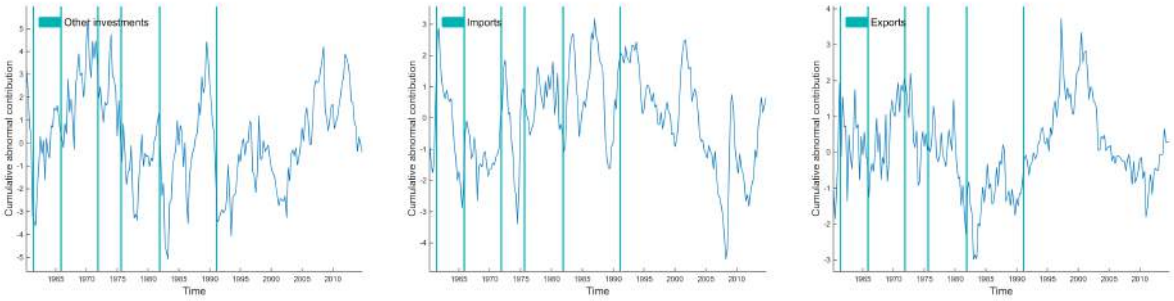
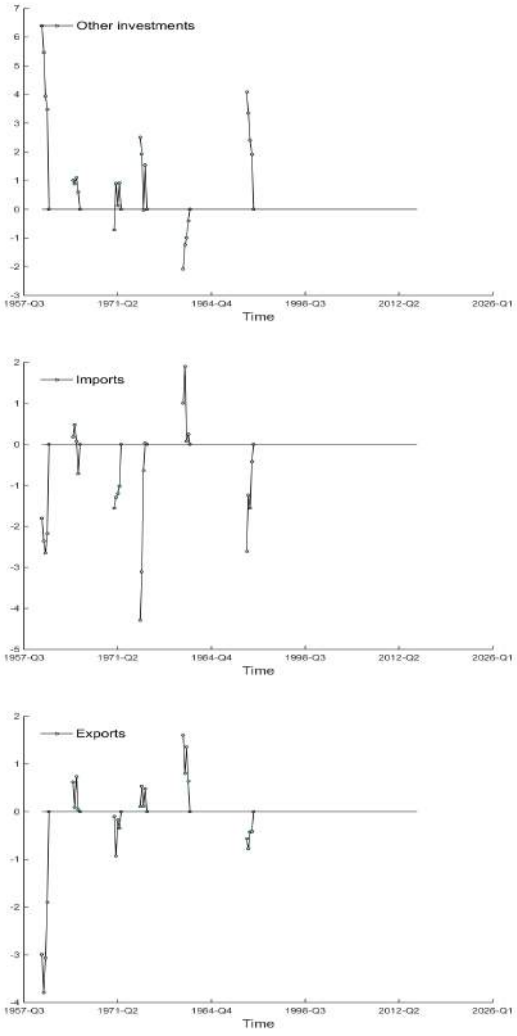


Figure 15: Cumulative abnormal contributions, Australia



Timeline with recessions

Contribution before recession



Contribution during recession

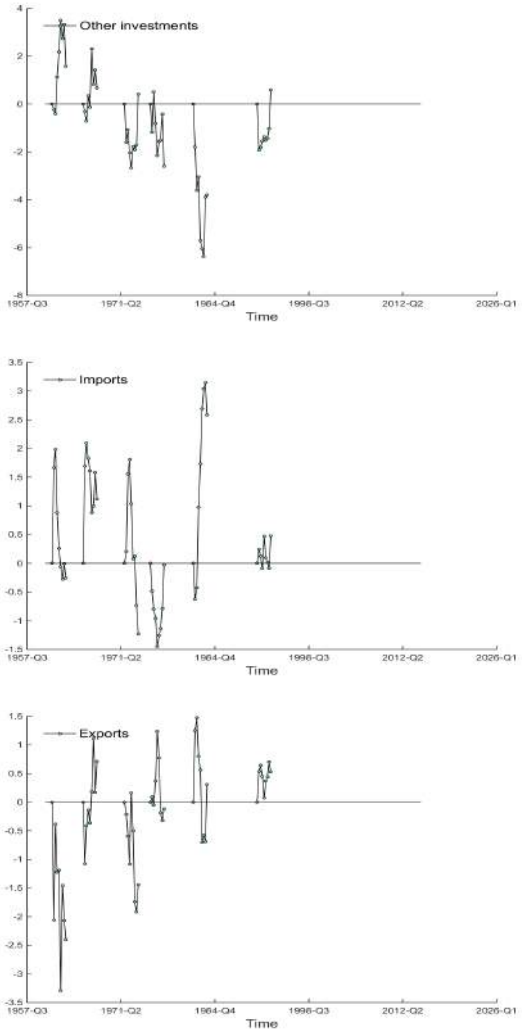
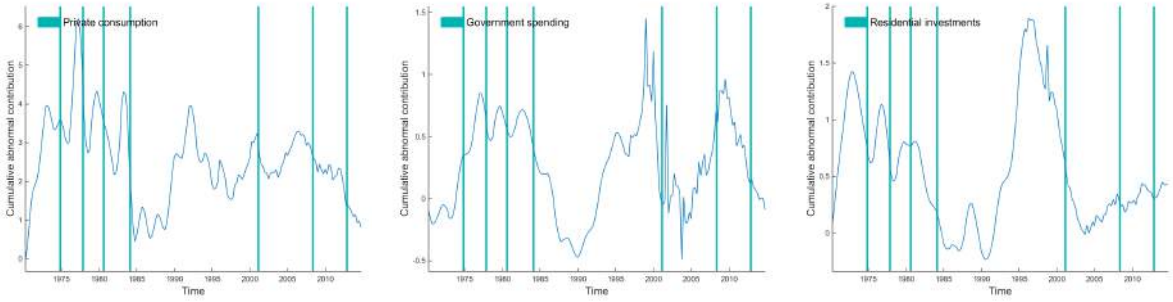
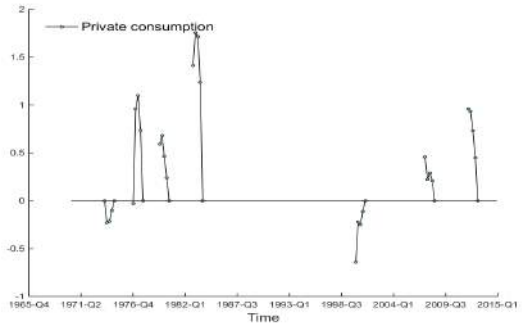


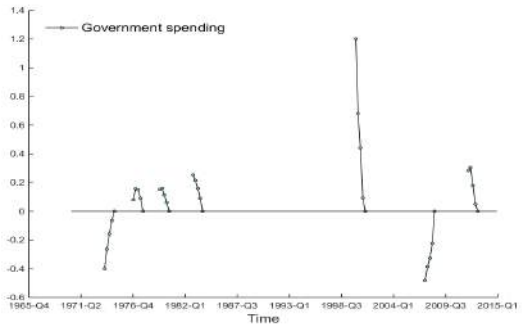
Figure 16: Cumulative abnormal contributions, Austria

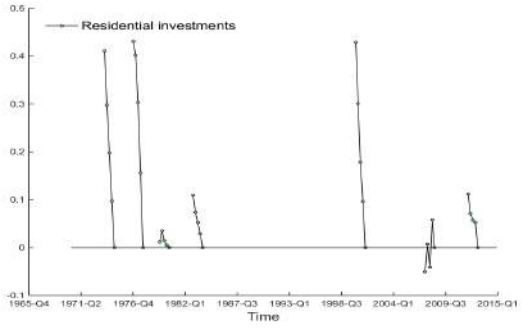
Timeline with recessions



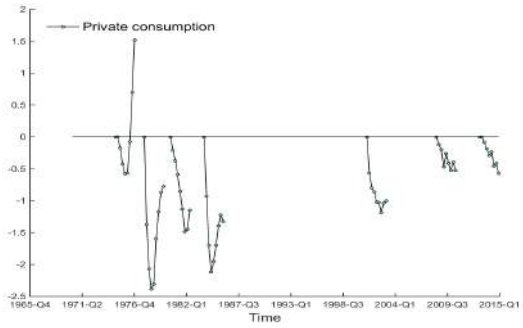
Contribution before recession

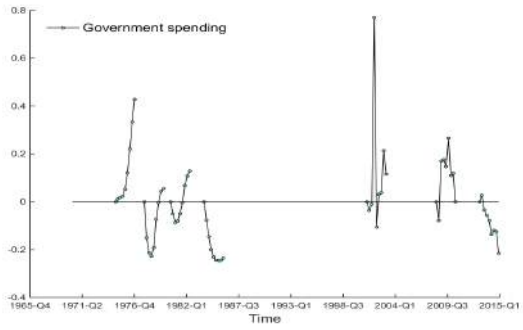






Contribution during recession





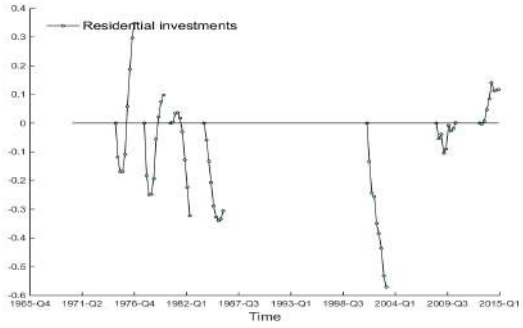
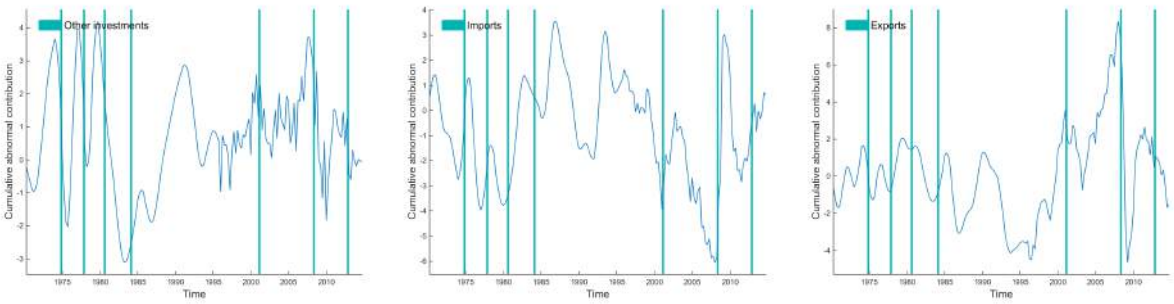
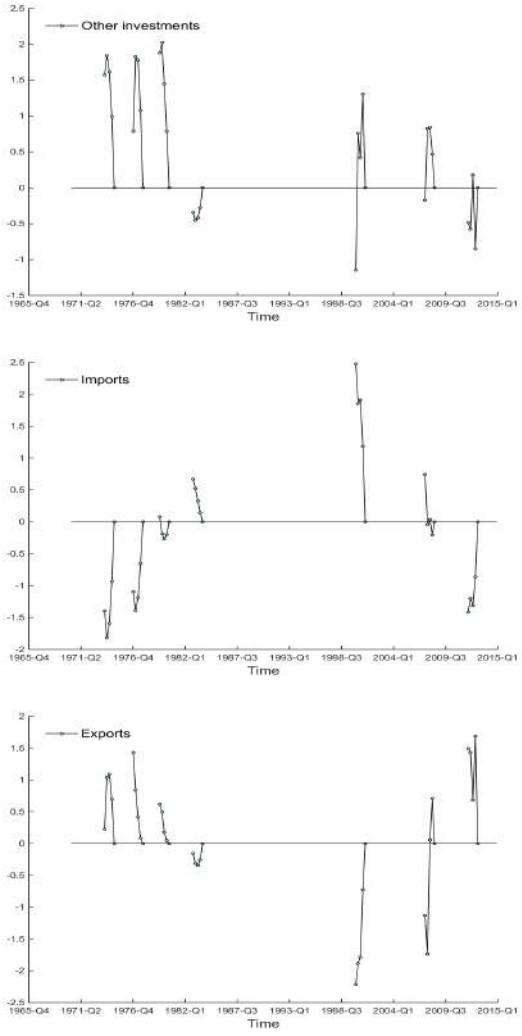


Figure 16: Cumulative abnormal contributions, Austria



Timeline with recessions

Contribution before recession



Contribution during recession

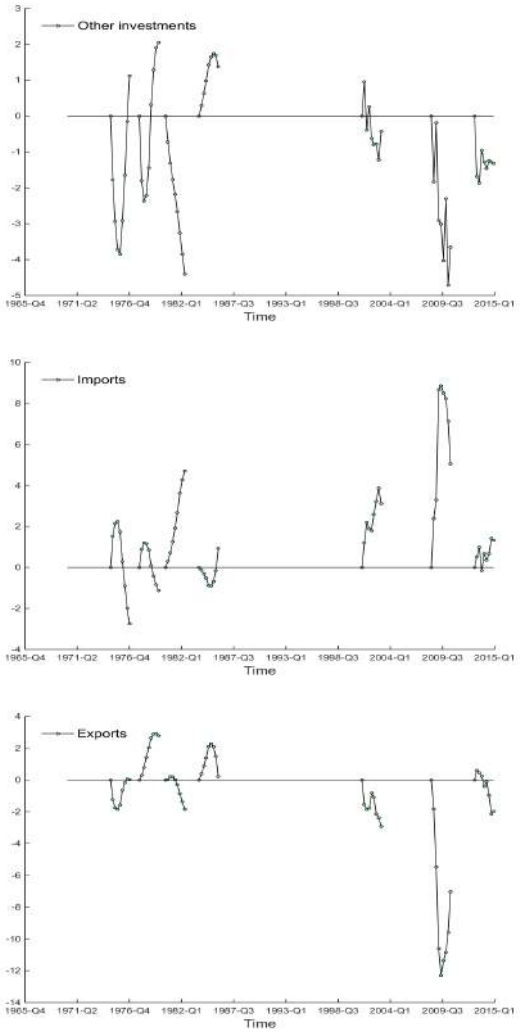
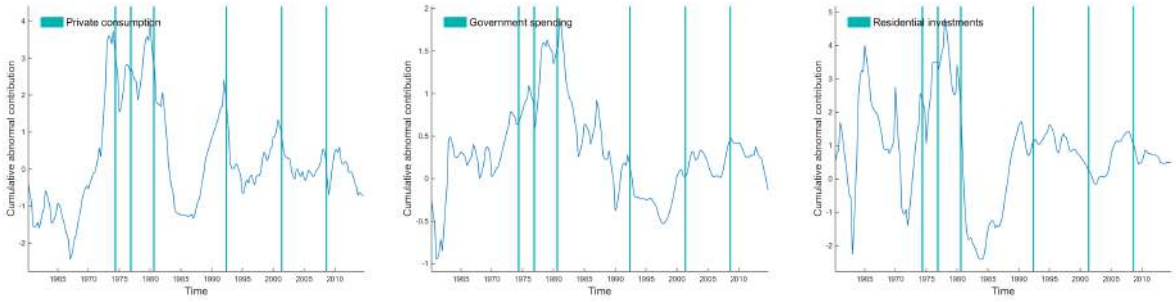
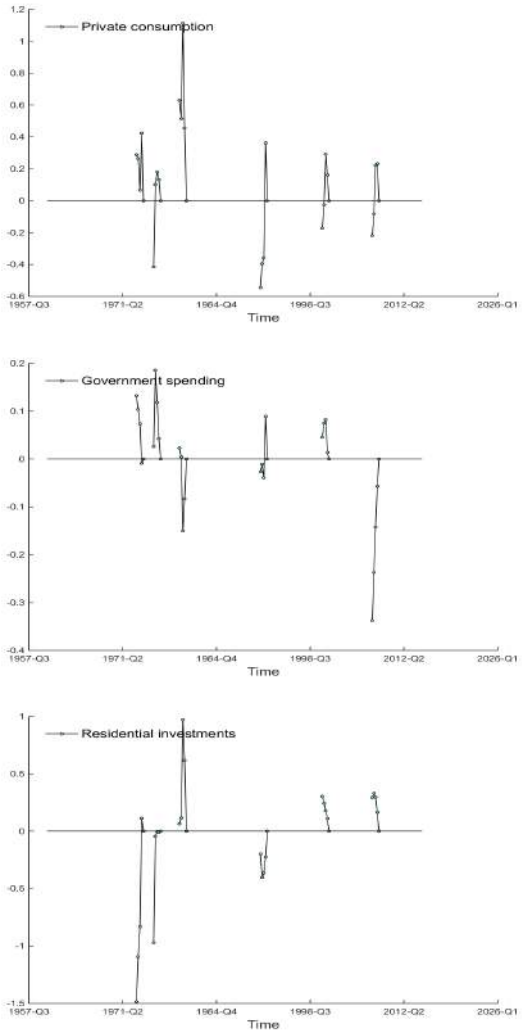


Figure 17: Cumulative abnormal contributions, Belgium

Timeline with recessions



Contribution before recession



Contribution during recession

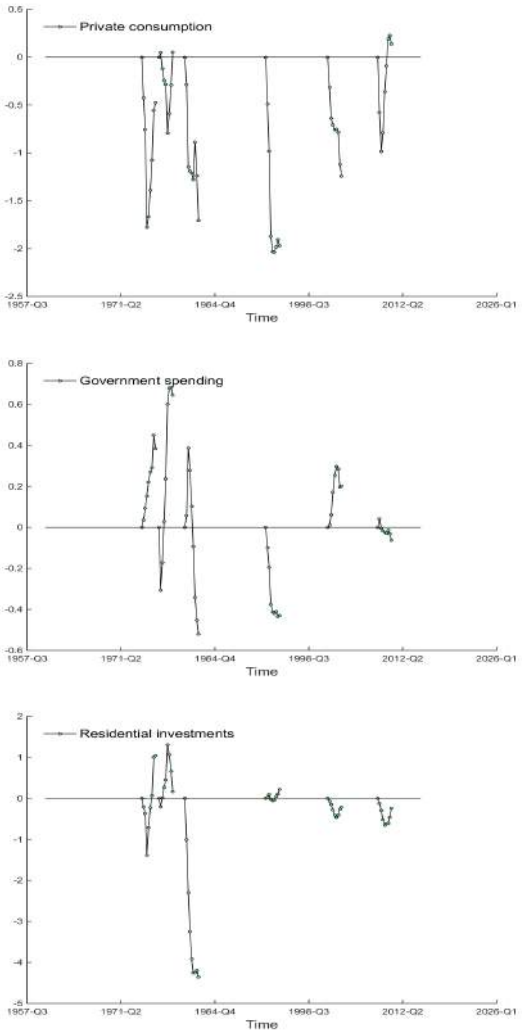
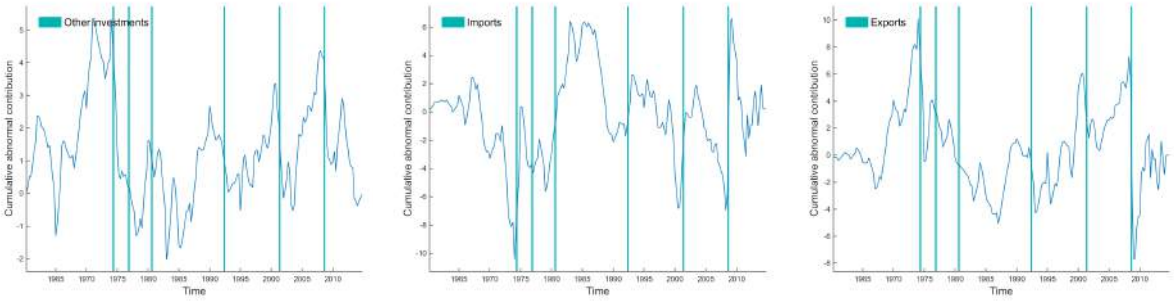
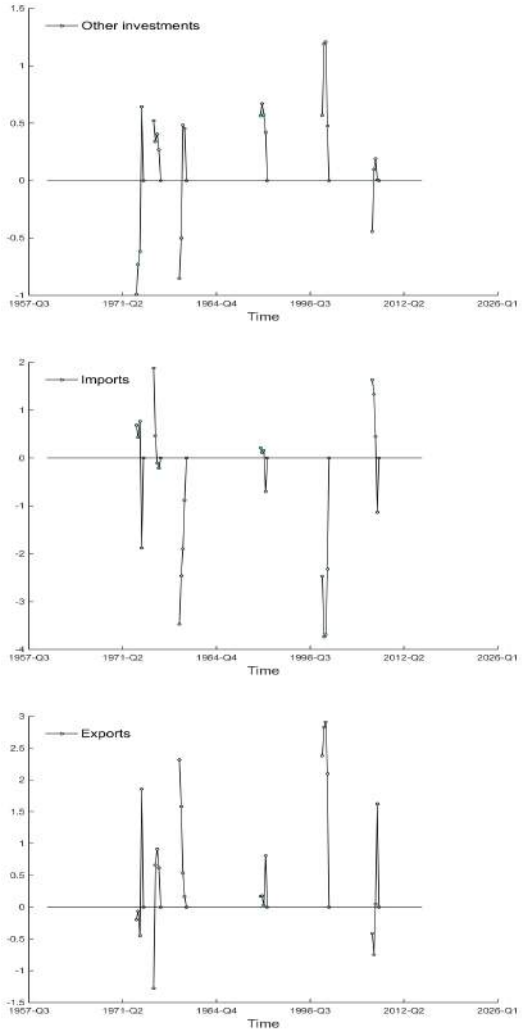


Figure 17: Cumulative abnormal contributions, Belgium



Timeline with recessions

Contribution before recession



Contribution during recession

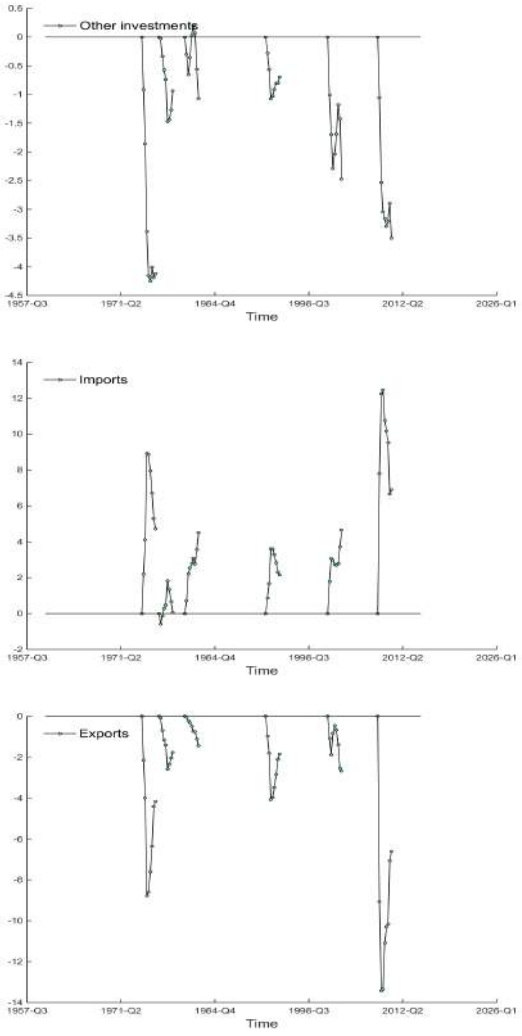
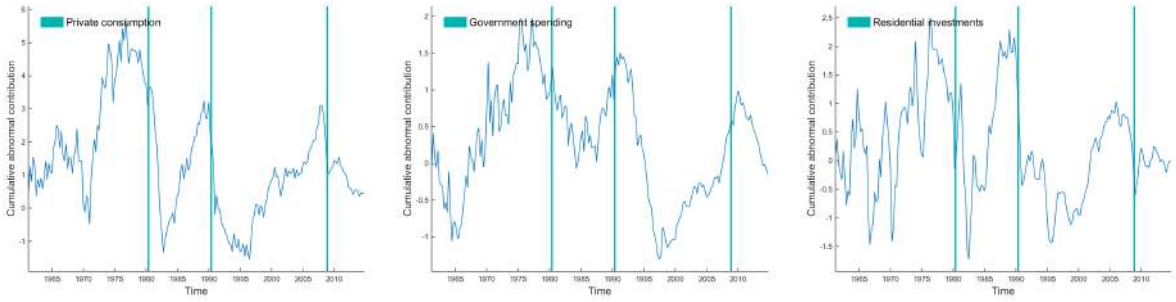
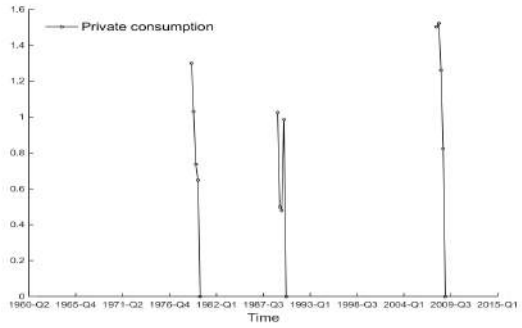


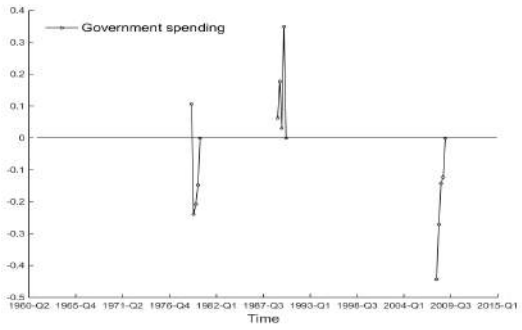
Figure 18: Cumulative abnormal contributions, Canada

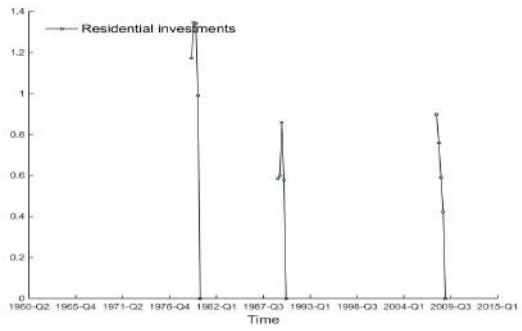
Timeline with recessions



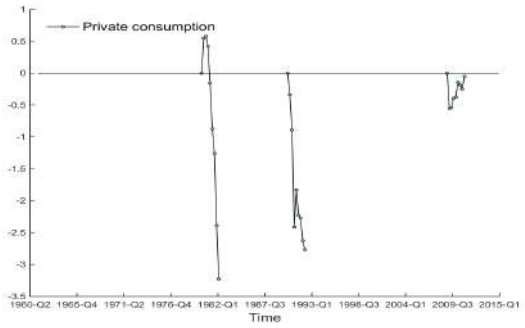
Contribution before recession

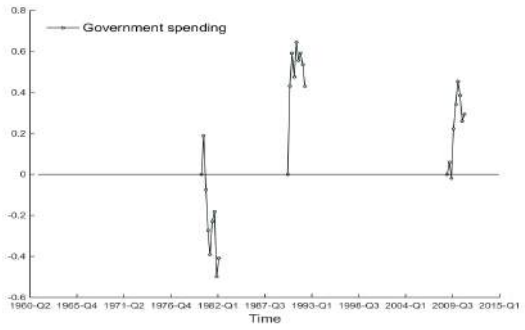






Contribution during recession





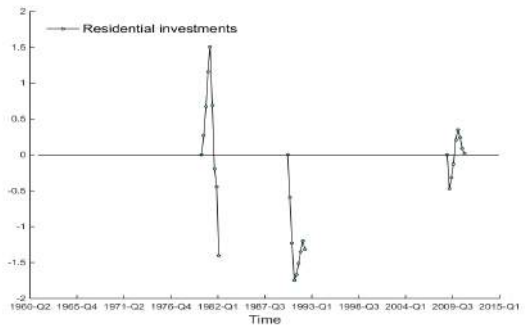
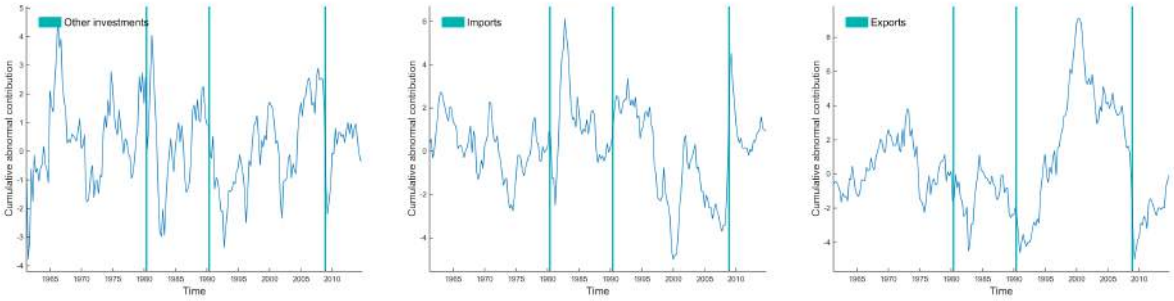
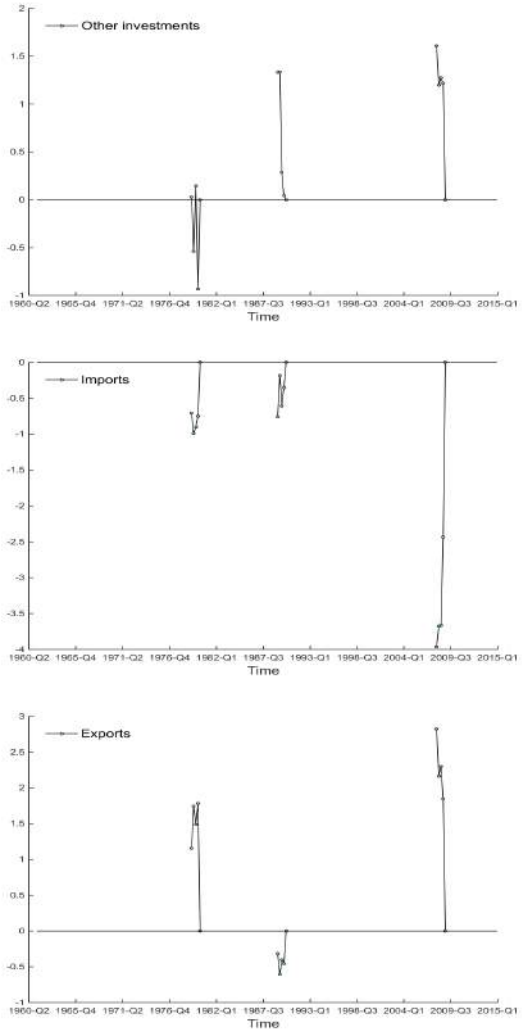


Figure 18: Cumulative abnormal contributions, Canada



Timeline with recessions

Contribution before recession



Contribution during recession

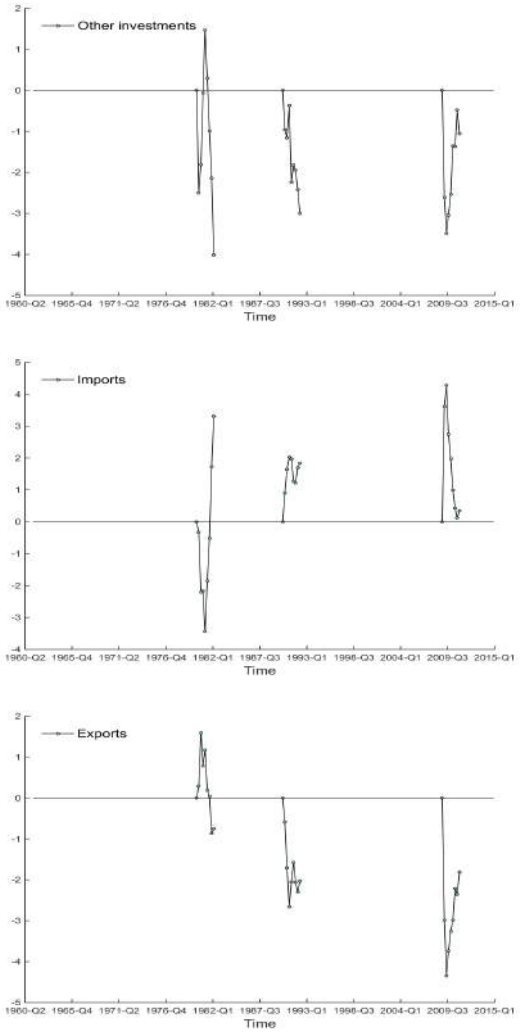
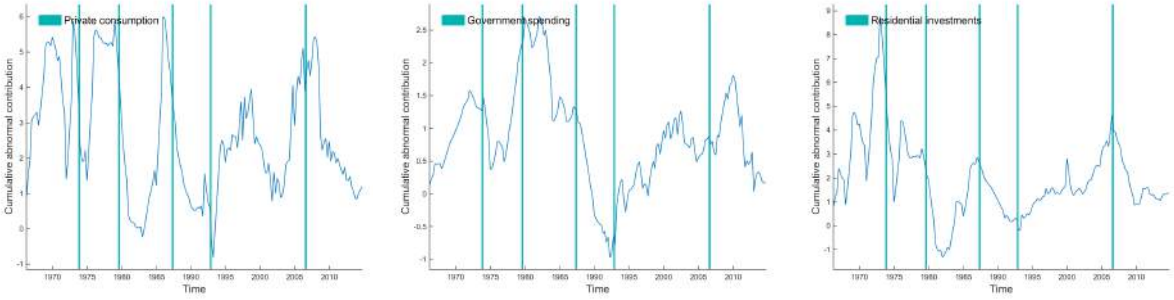
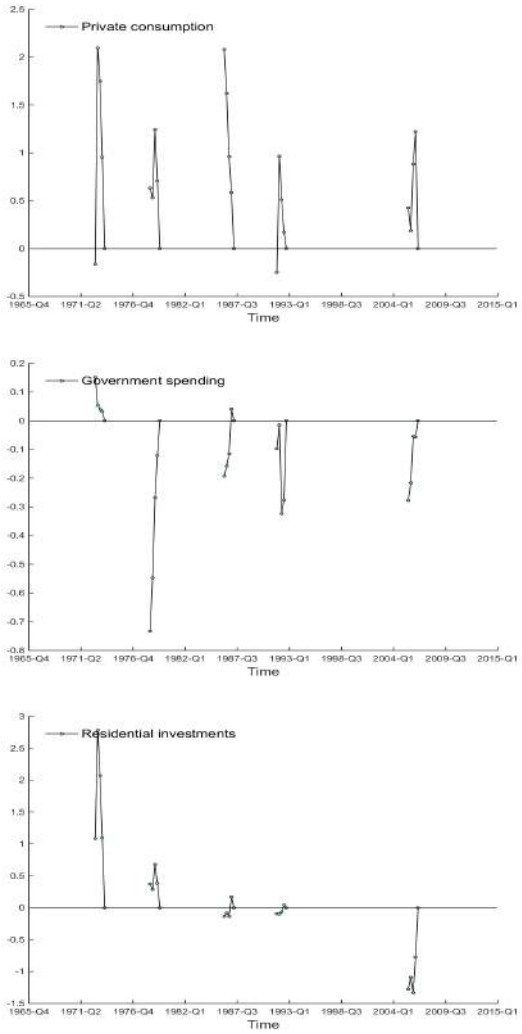


Figure 19: Cumulative abnormal contributions, Denmark

Timeline with recessions



Contribution before recession



Contribution during recession

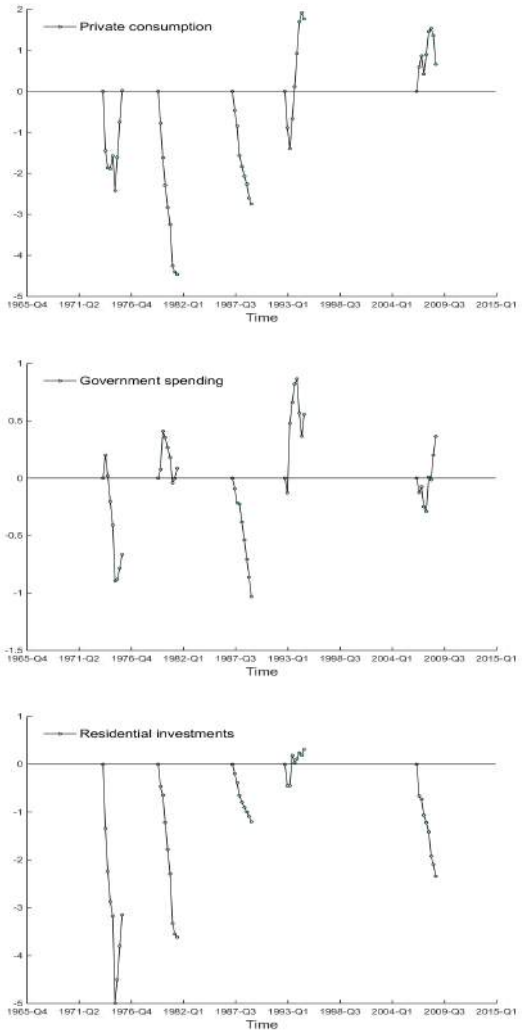
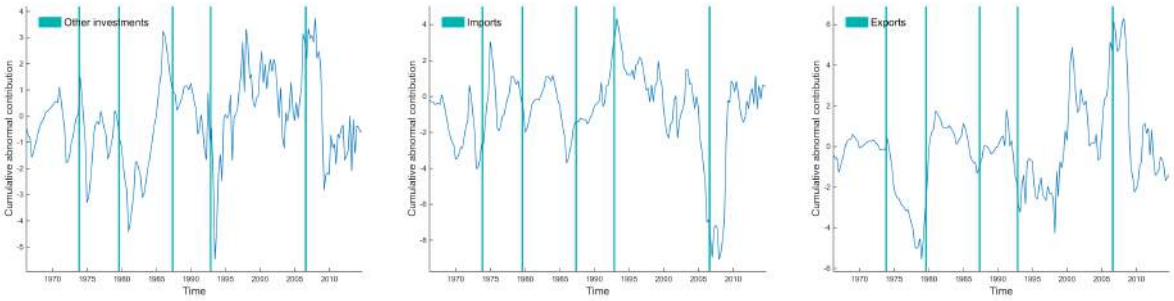
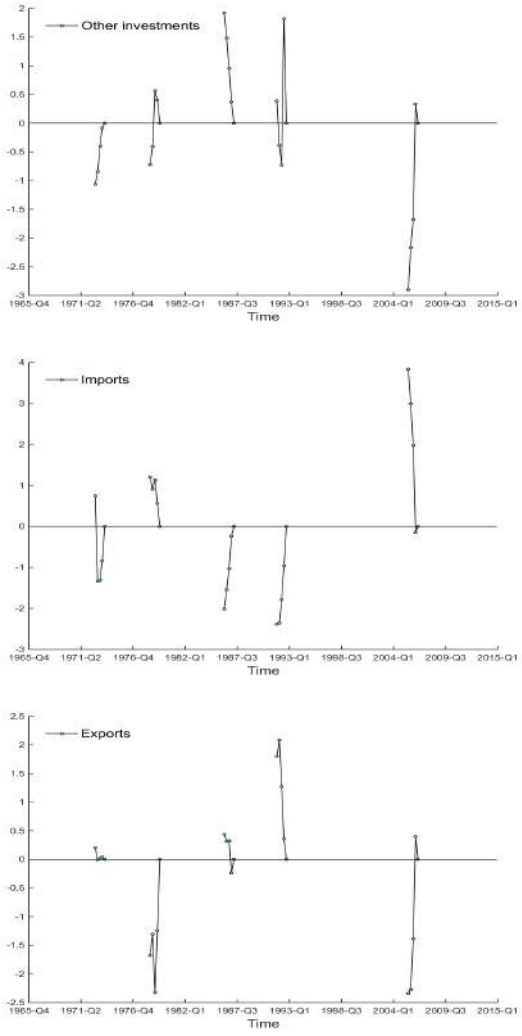


Figure 19: Cumulative abnormal contributions, Denmark



Timeline with recessions

Contribution before recession



Contribution during recession

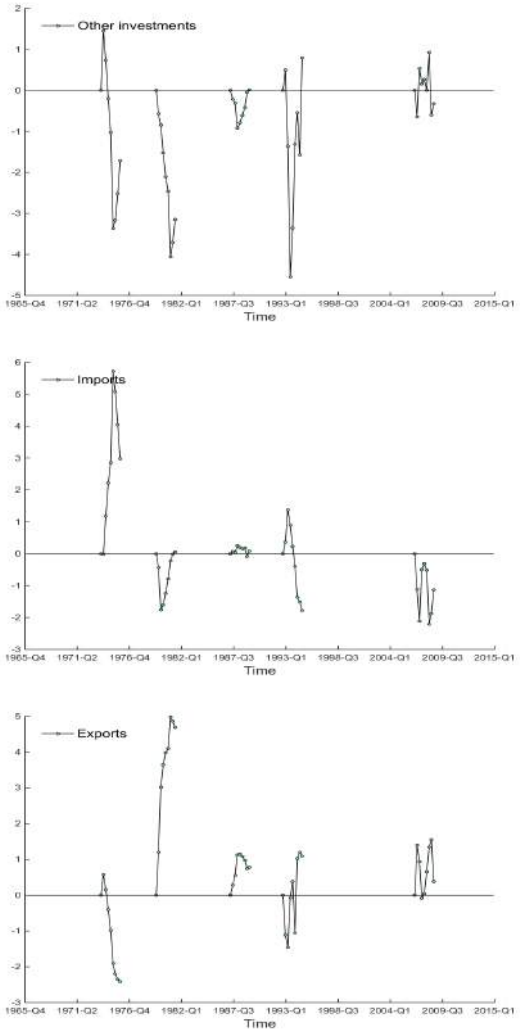
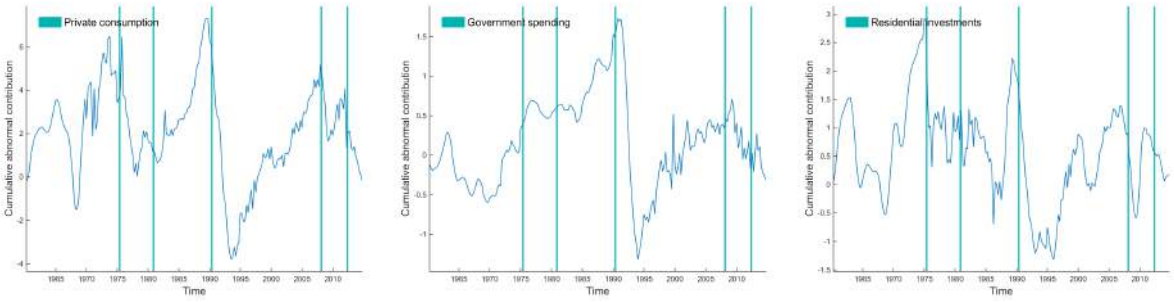
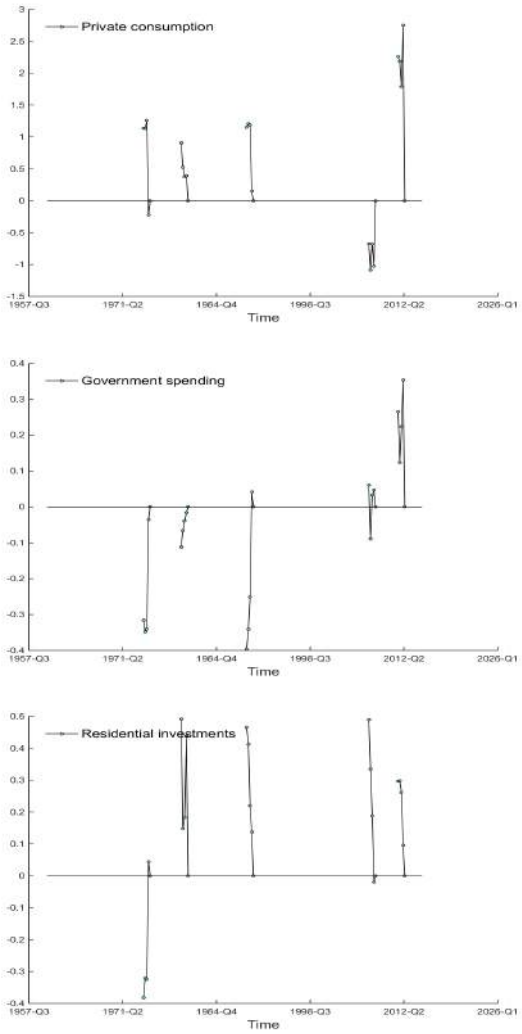


Figure 20: Cumulative abnormal contributions, Finland

Timeline with recessions



Contribution before recession



Contribution during recession

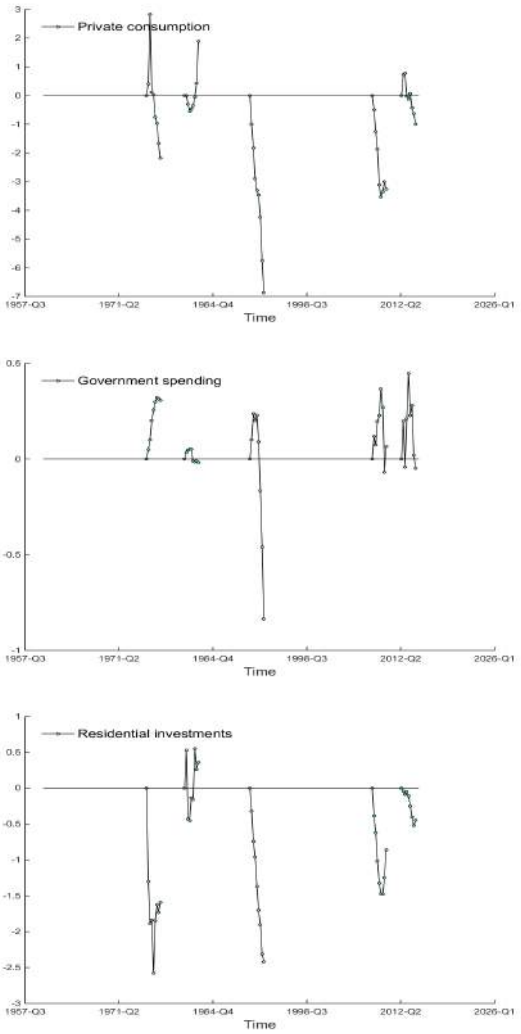
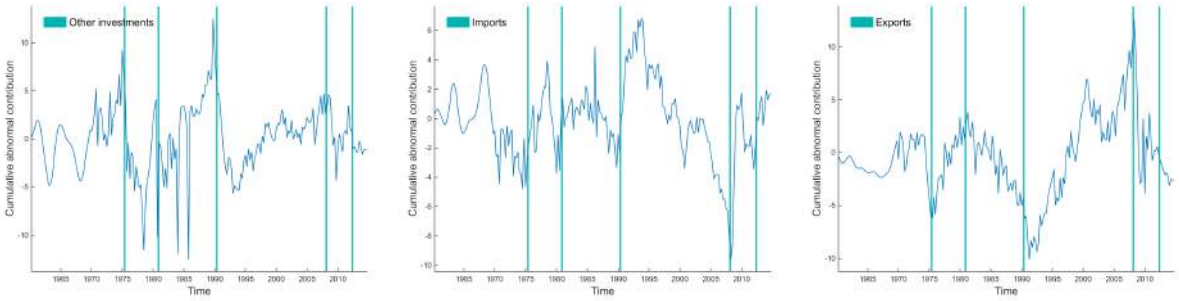
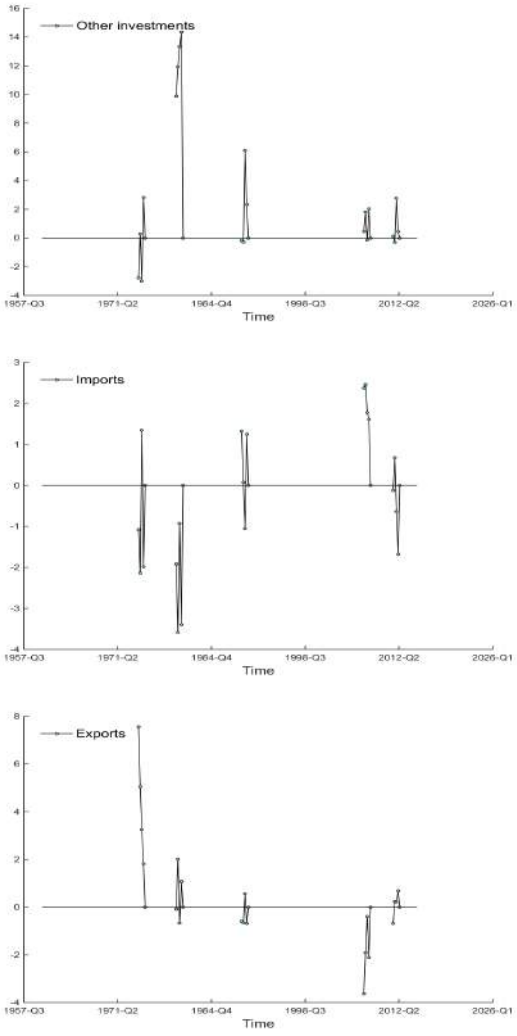


Figure 20: Cumulative abnormal contributions, Finland



Timeline with recessions

Contribution before recession



Contribution during recession

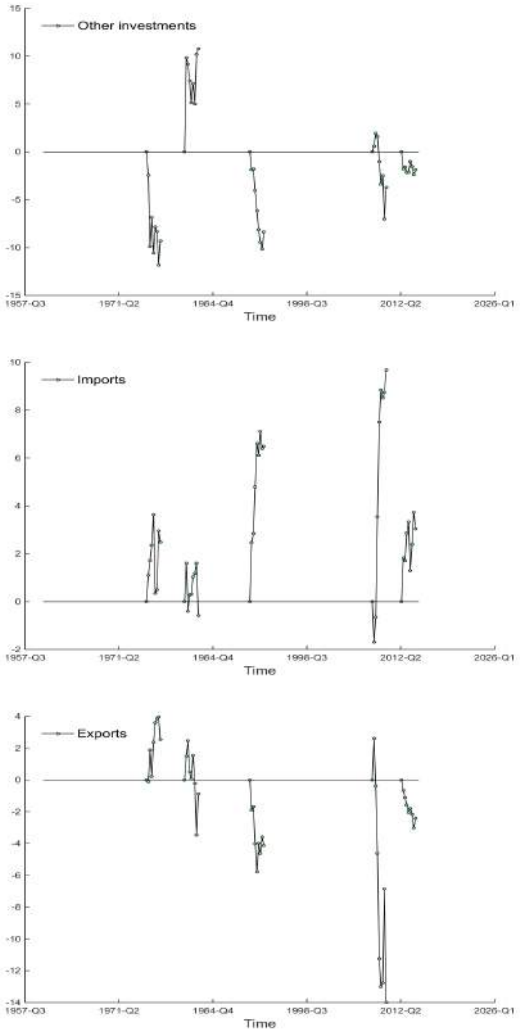
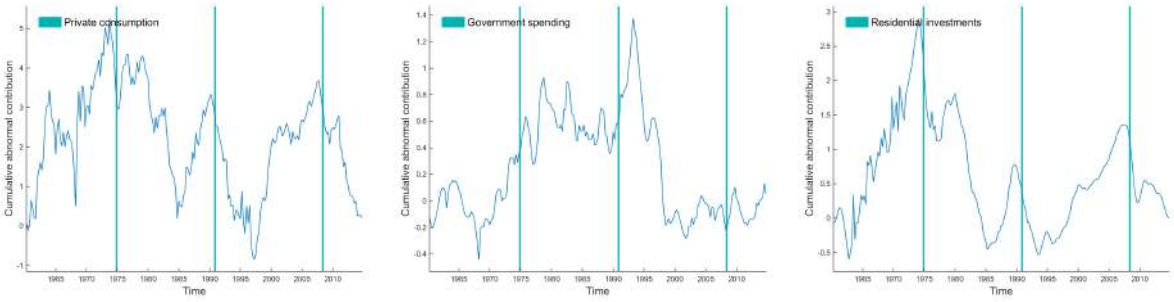
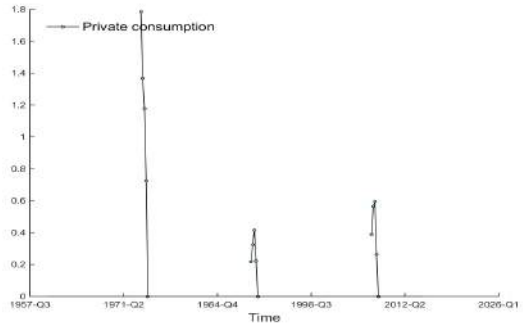


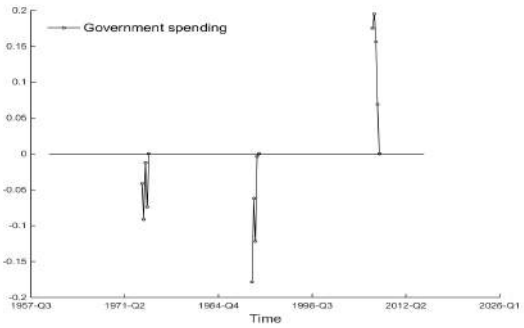
Figure 21: Cumulative abnormal contributions, France

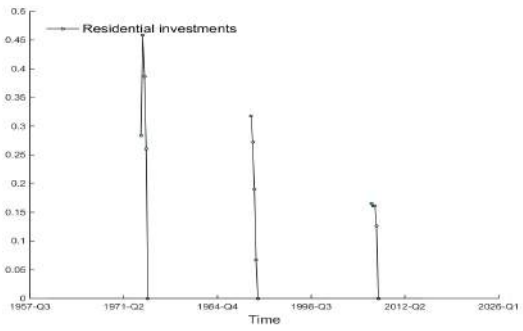
Timeline with recessions



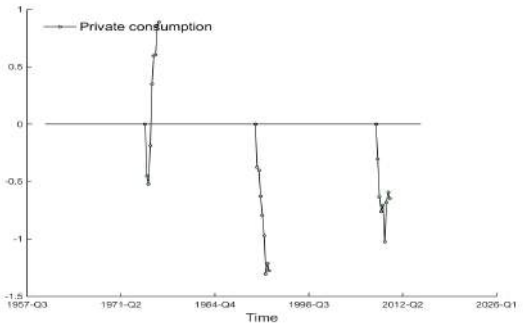
Contribution before recession

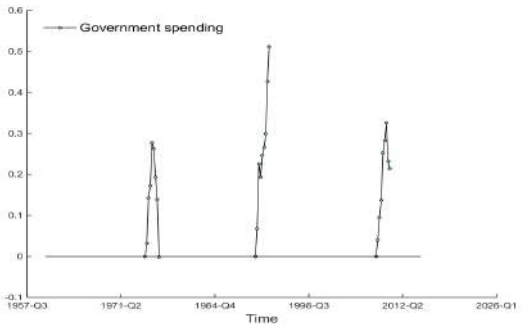






Contribution during recession





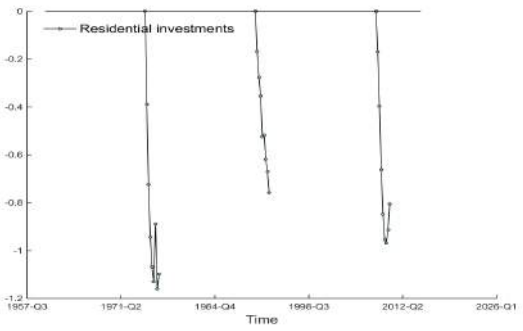
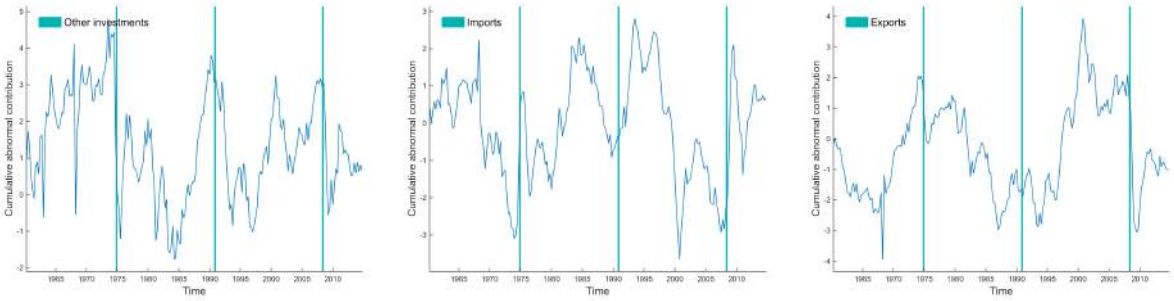
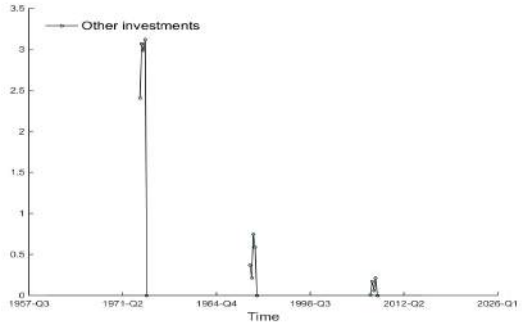


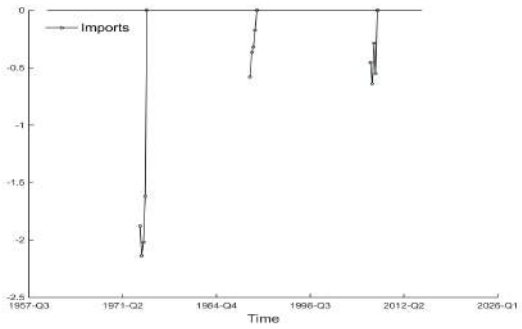
Figure 21: Cumulative abnormal contributions, France

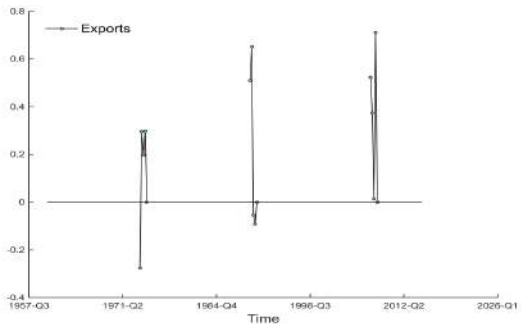


Timeline with recessions

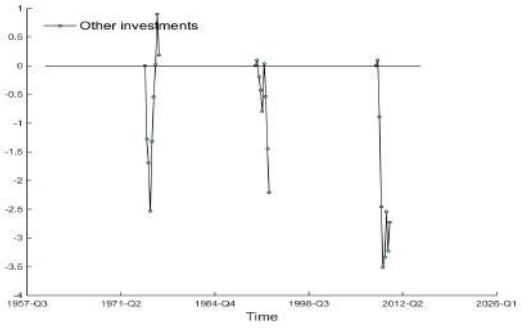
Contribution before recession

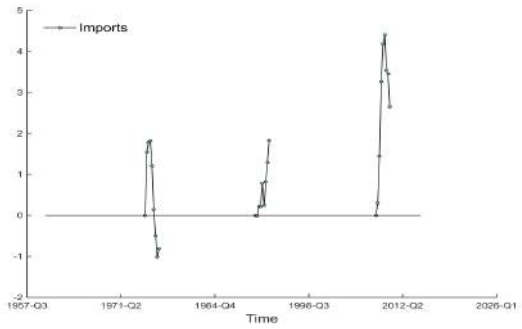






Contribution during recession





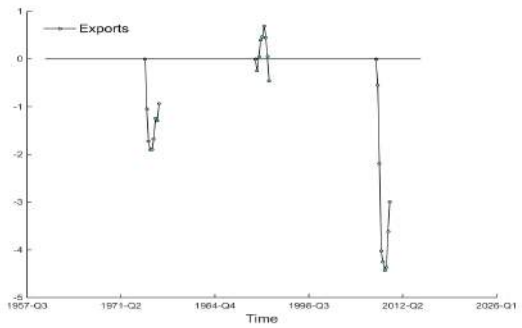
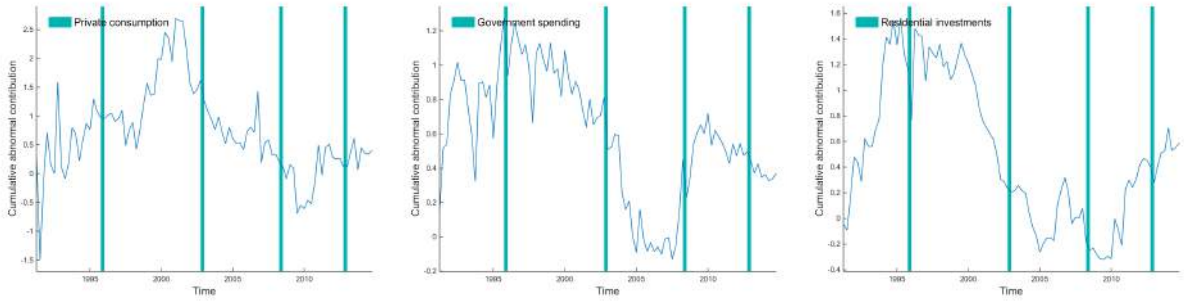
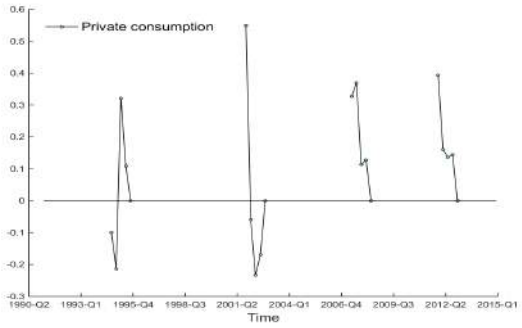


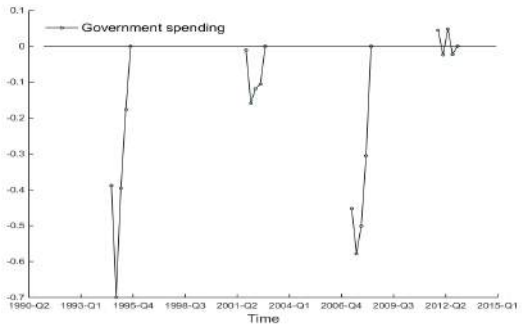
Figure 22: Cumulative abnormal contributions, Germany

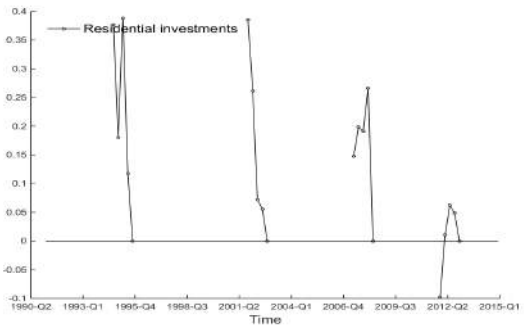
Timeline with recessions



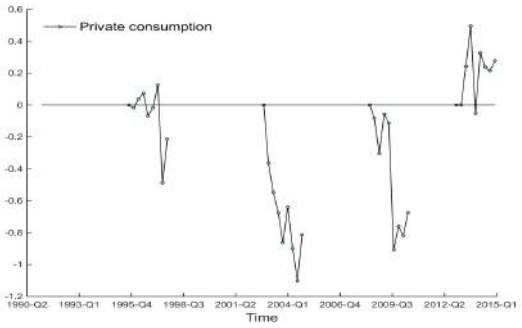
Contribution before recession

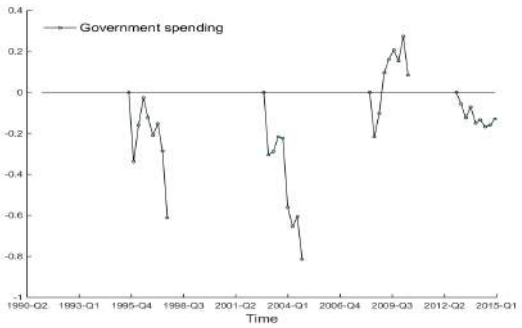






Contribution during recession





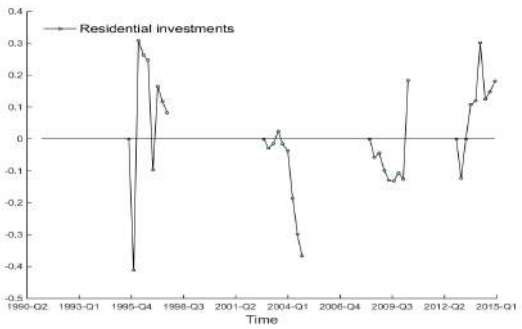
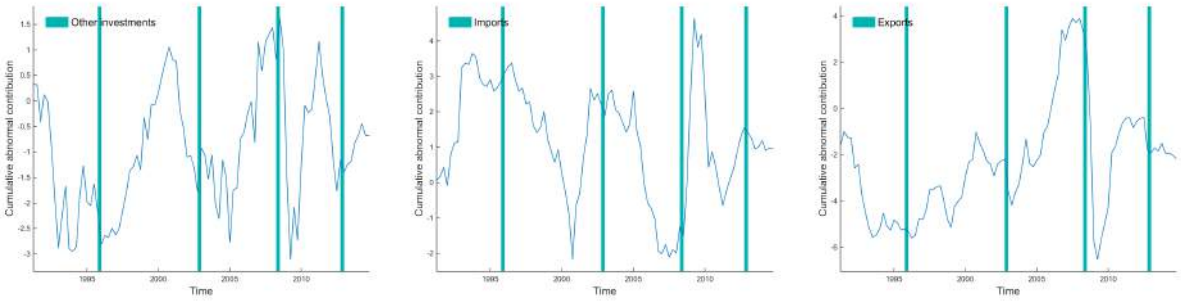
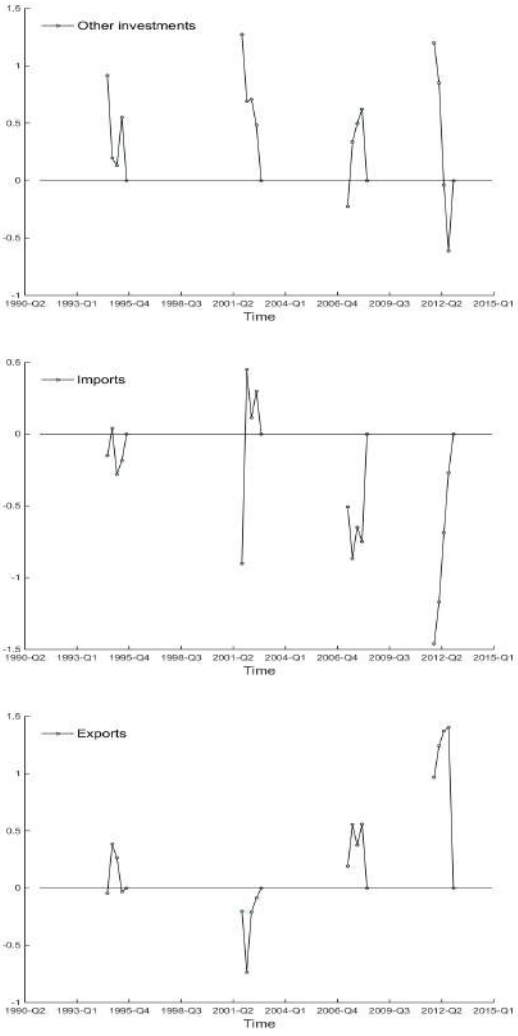


Figure 22: Cumulative abnormal contributions, Germany



Timeline with recessions

Contribution before recession



Contribution during recession

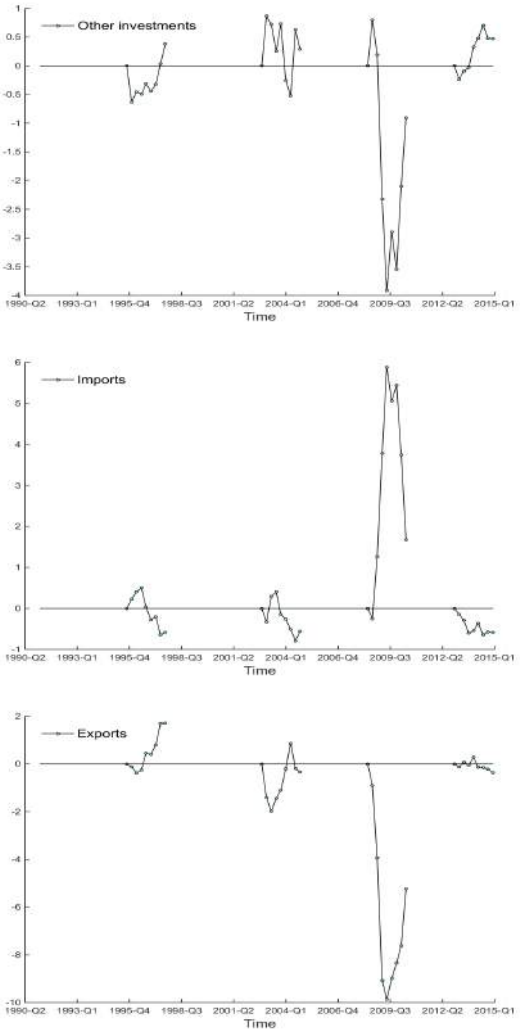
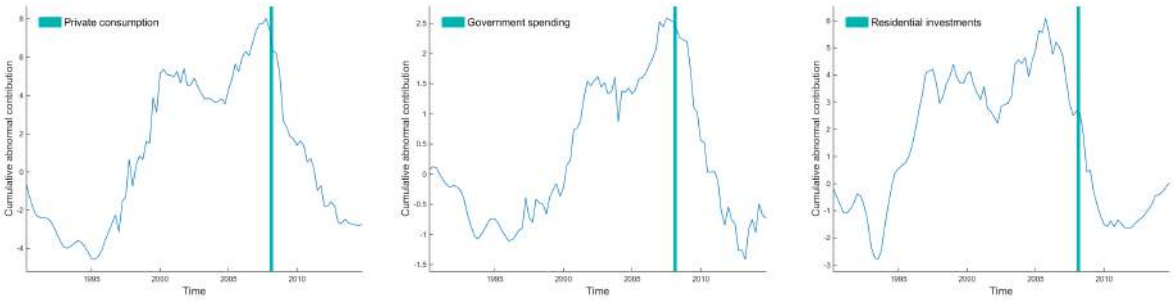
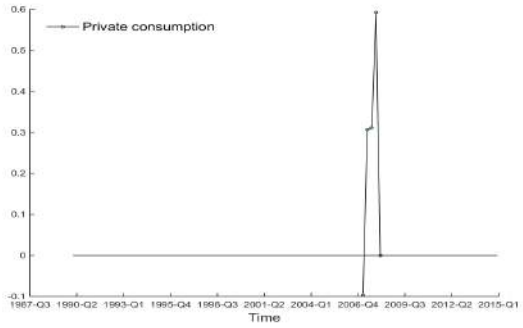


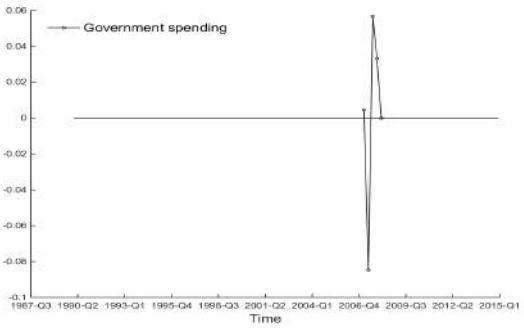
Figure 23: Cumulative abnormal contributions, Ireland

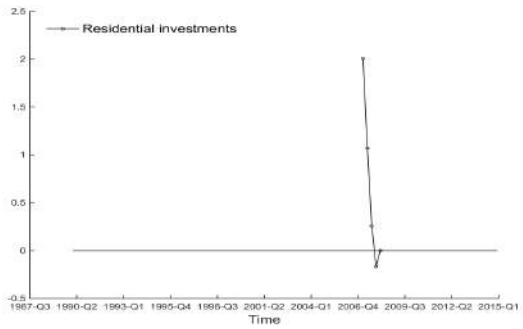
Timeline with recessions



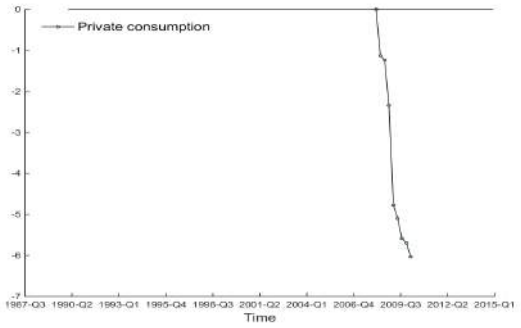
Contribution before recession

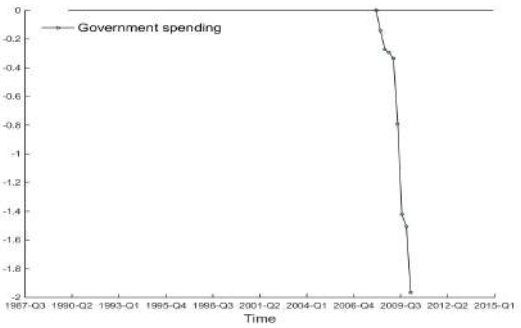






Contribution during recession





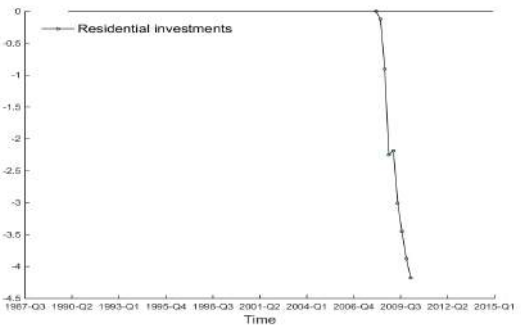
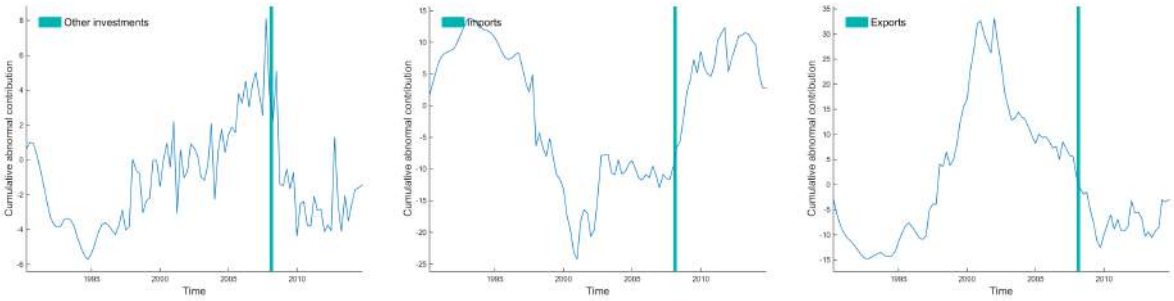
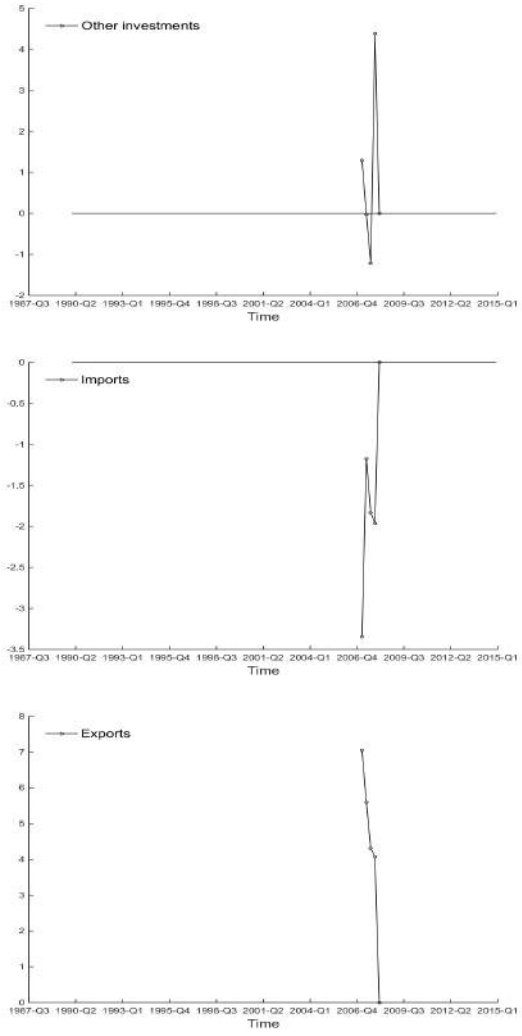


Figure 23: Cumulative abnormal contributions, Ireland



Timeline with recessions

Contribution before recession



Contribution during recession

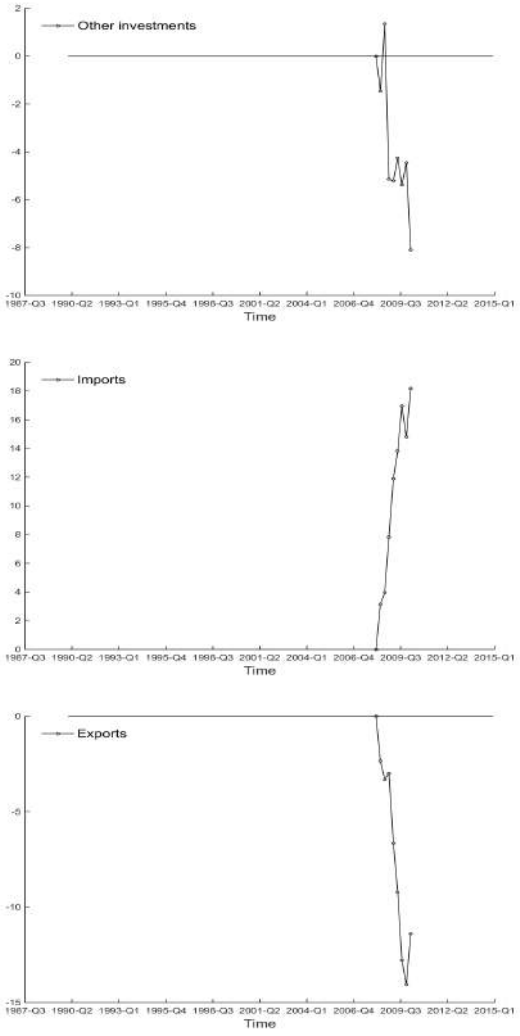
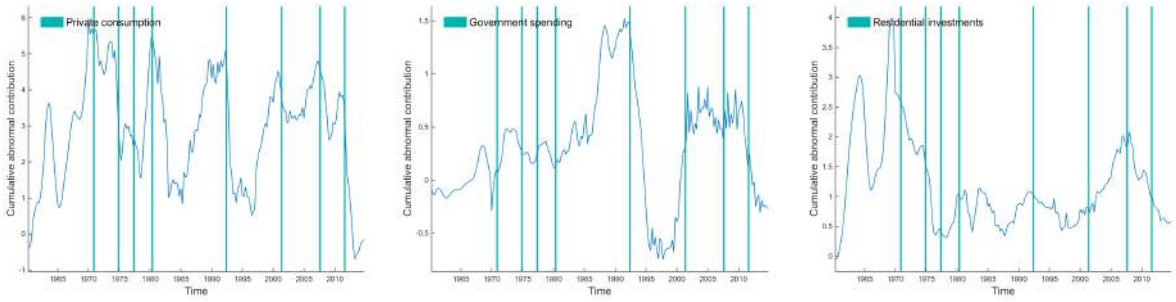
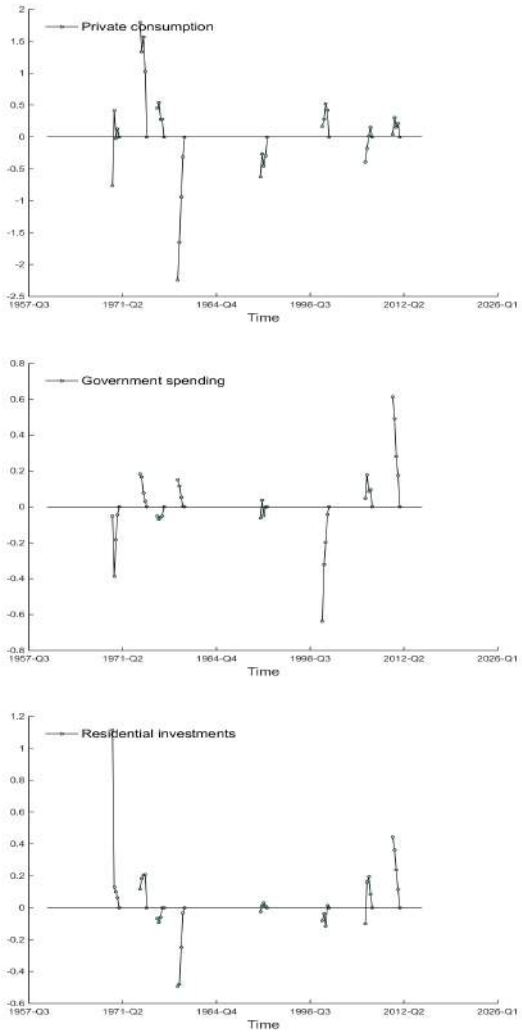


Figure 24: Cumulative abnormal contributions, Italy

Timeline with recessions



Contribution before recession



Contribution during recession

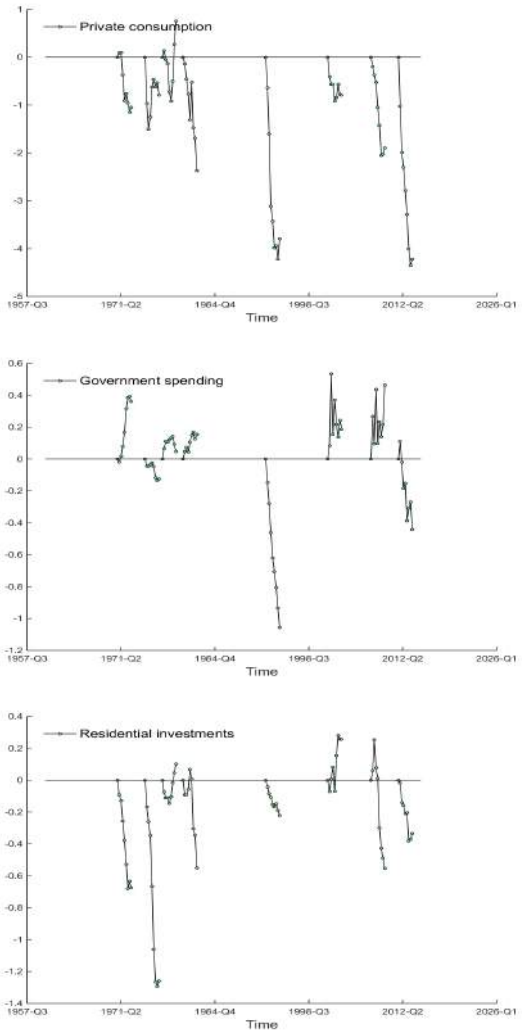
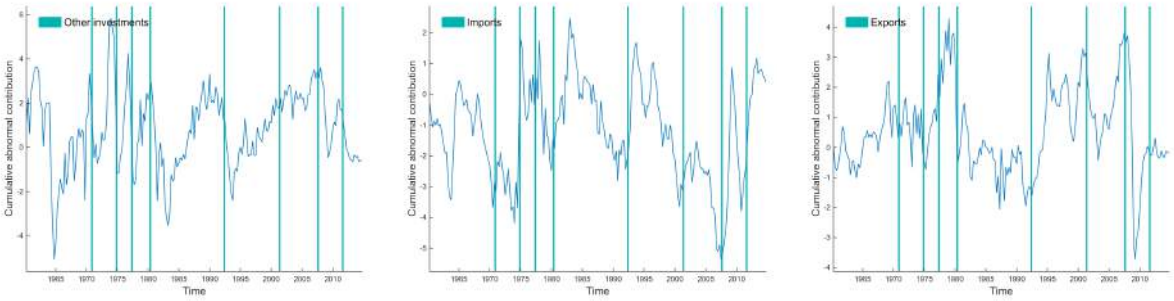
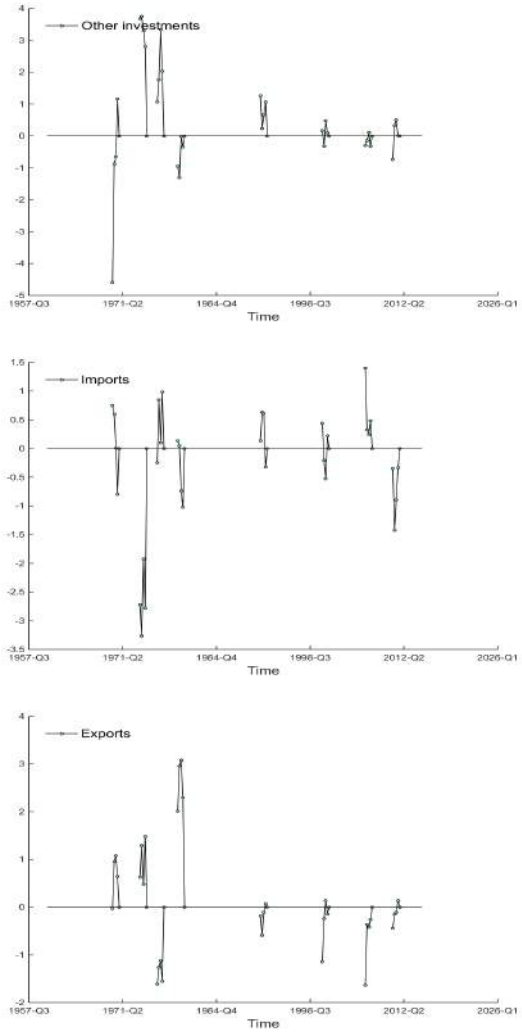


Figure 24: Cumulative abnormal contributions, Italy



Timeline with recessions

Contribution before recession



Contribution during recession

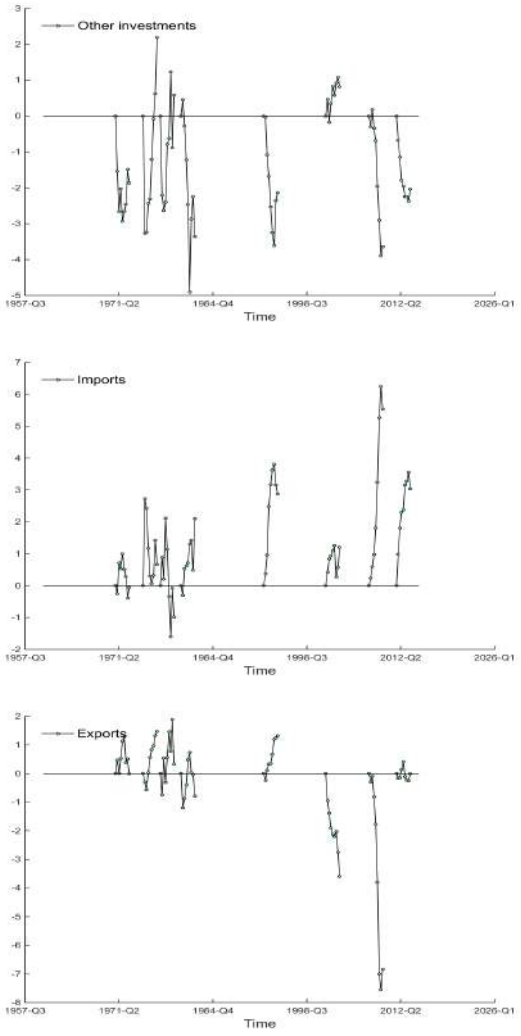
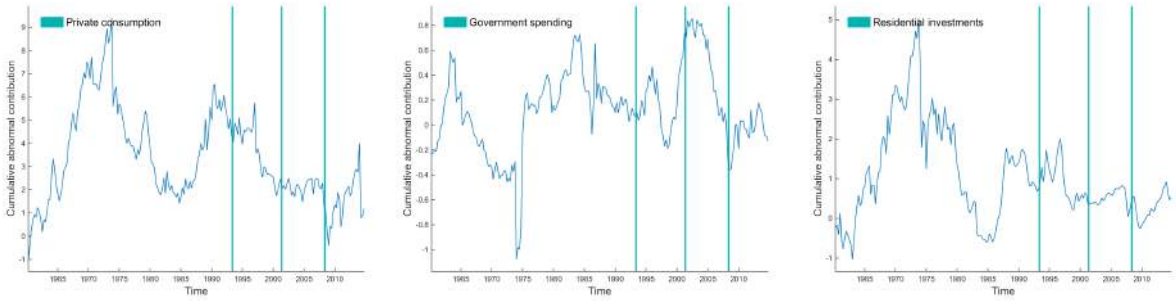
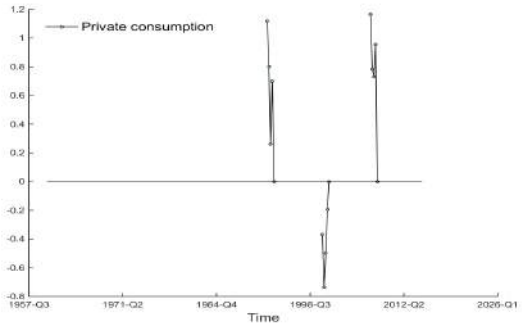


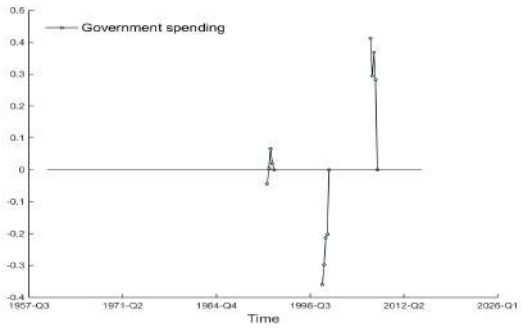
Figure 25: Cumulative abnormal contributions, Japan

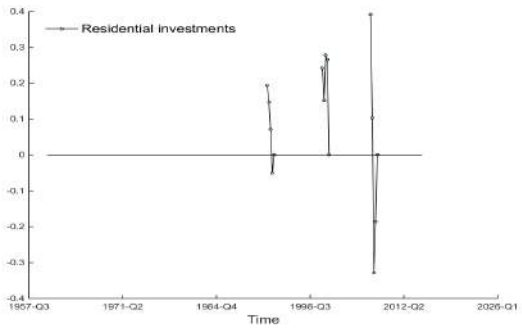
Timeline with recessions



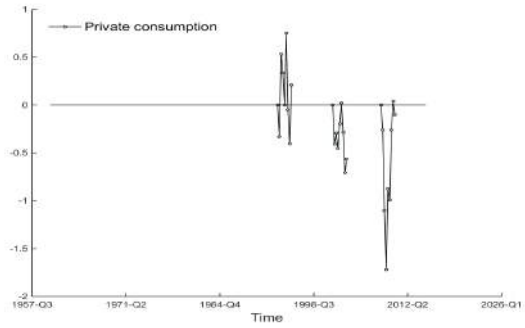
Contribution before recession

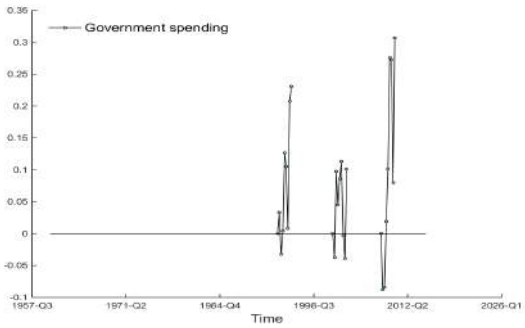






Contribution during recession





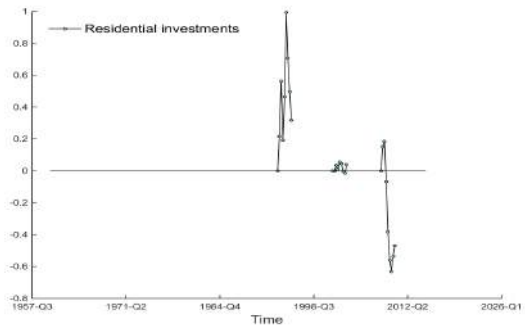
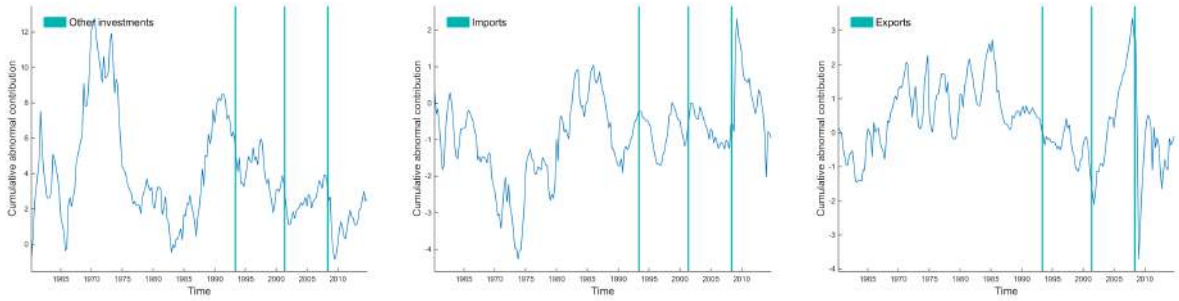
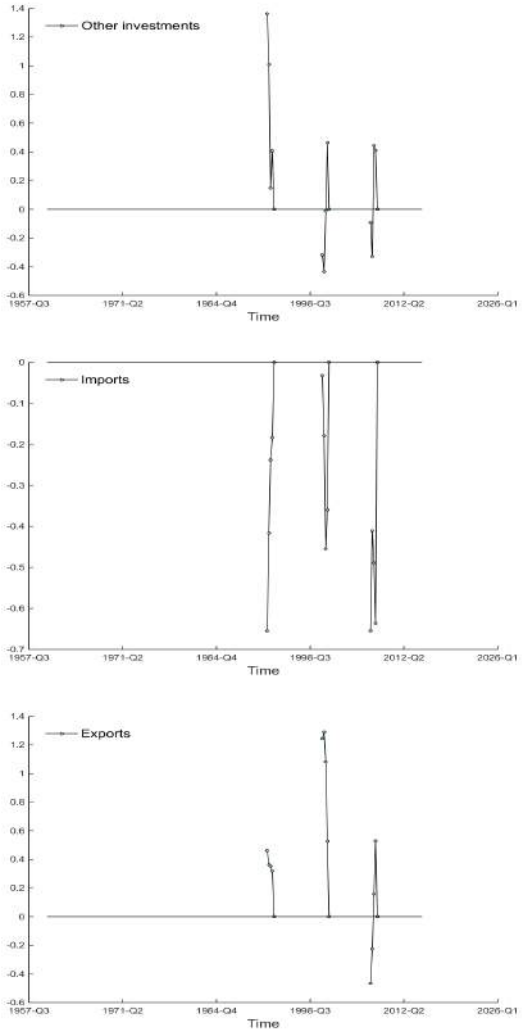


Figure 25: Cumulative abnormal contributions, Japan



Timeline with recessions

Contribution before recession



Contribution during recession

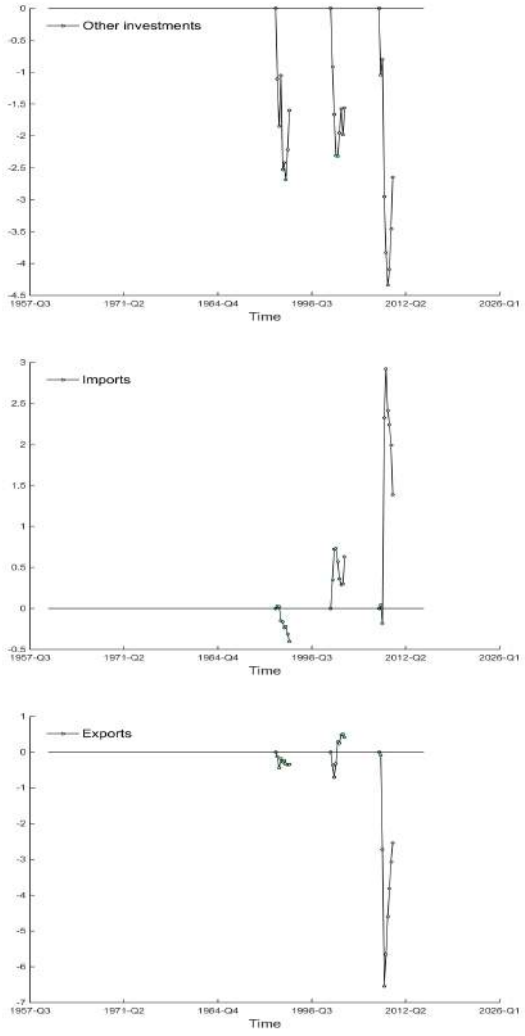
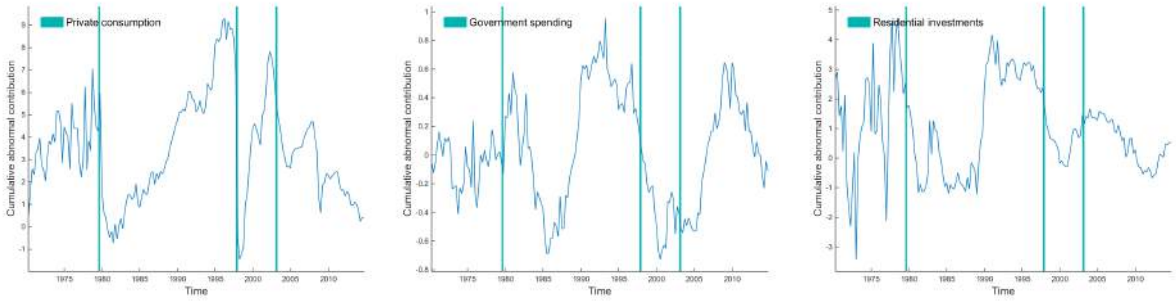
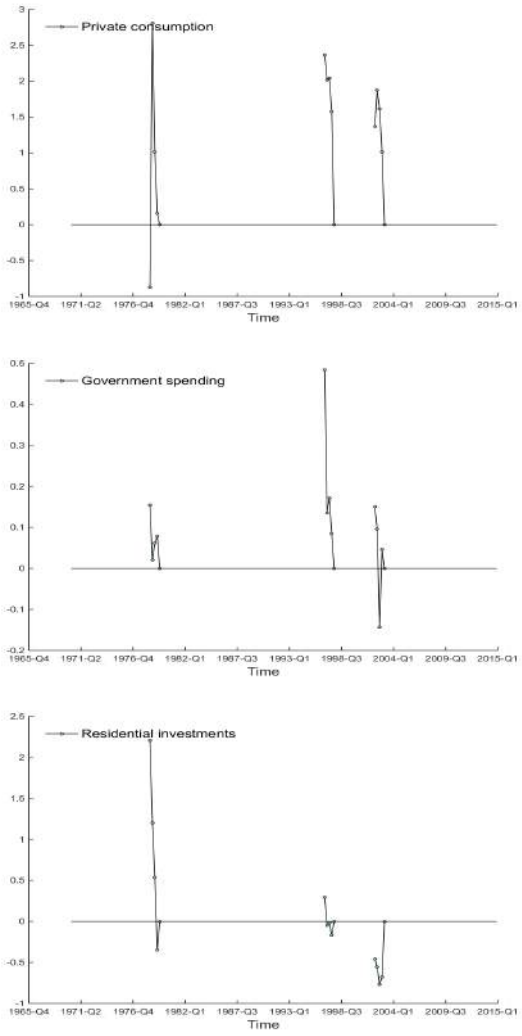


Figure 26: Cumulative abnormal contributions, Korea

Timeline with recessions



Contribution before recession



Contribution during recession

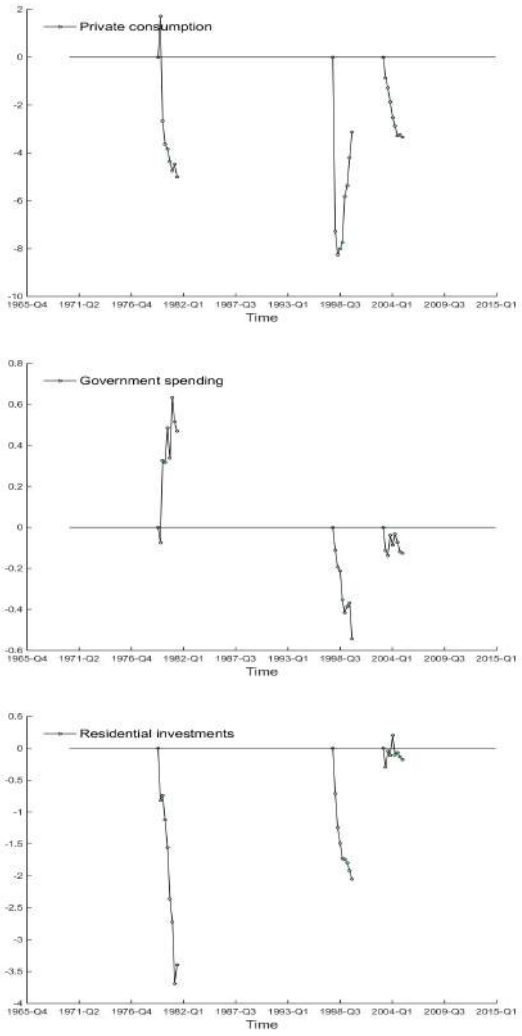
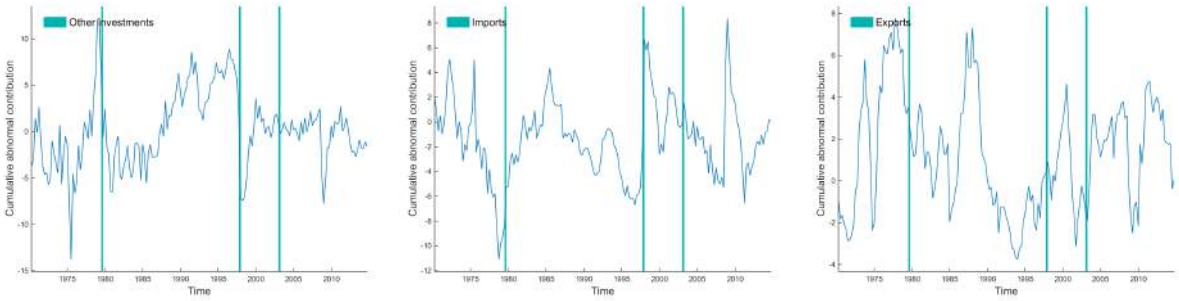
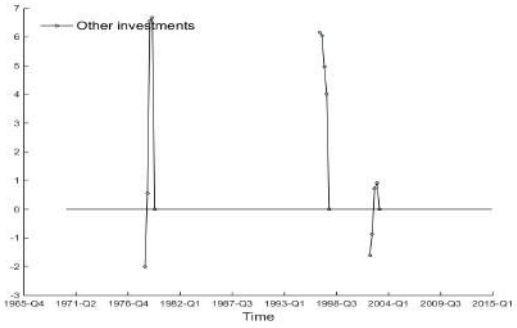


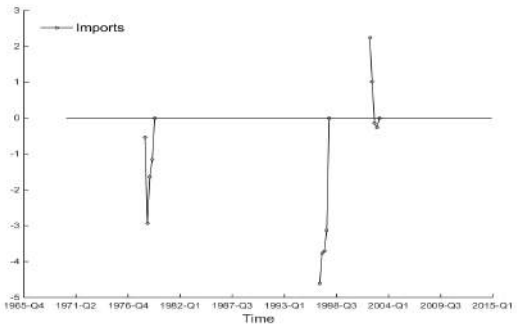
Figure 26: Cumulative abnormal contributions, Korea

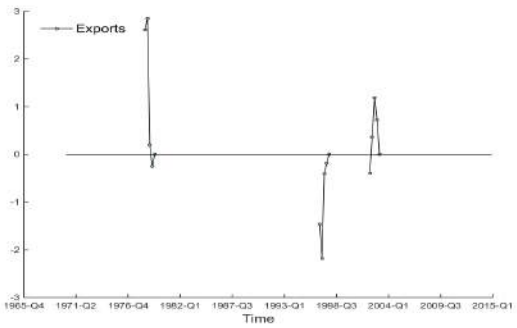


Timeline with recessions

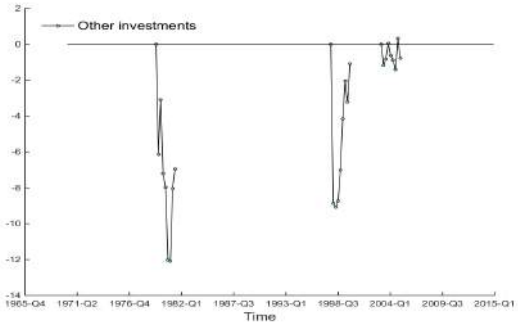
Contribution before recession

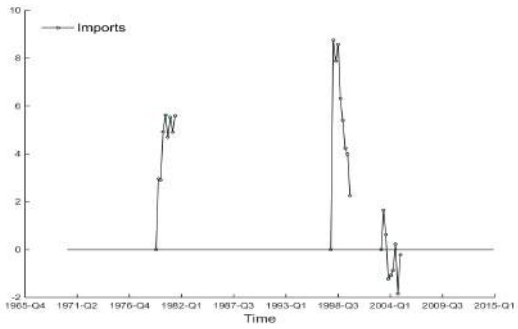






Contribution during recession





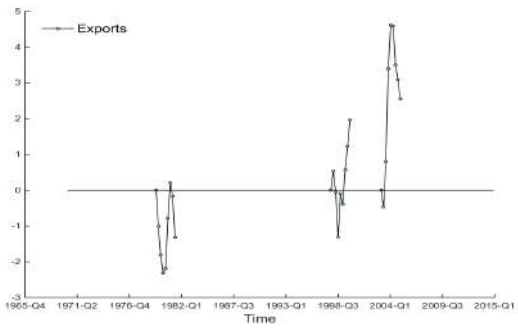
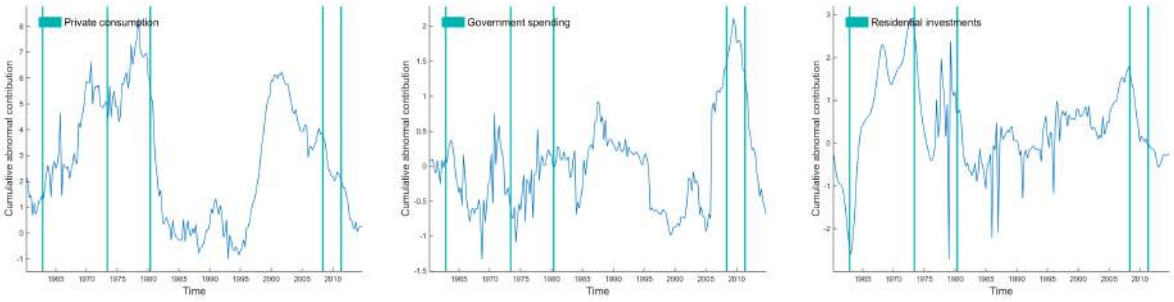
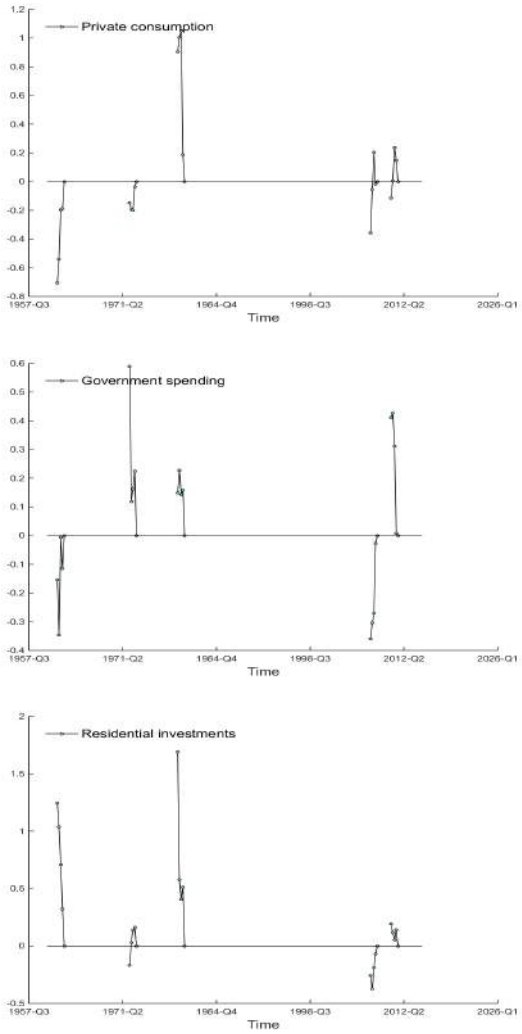


Figure 27: Cumulative abnormal contributions, Netherlands

Timeline with recessions



Contribution before recession



Contribution during recession

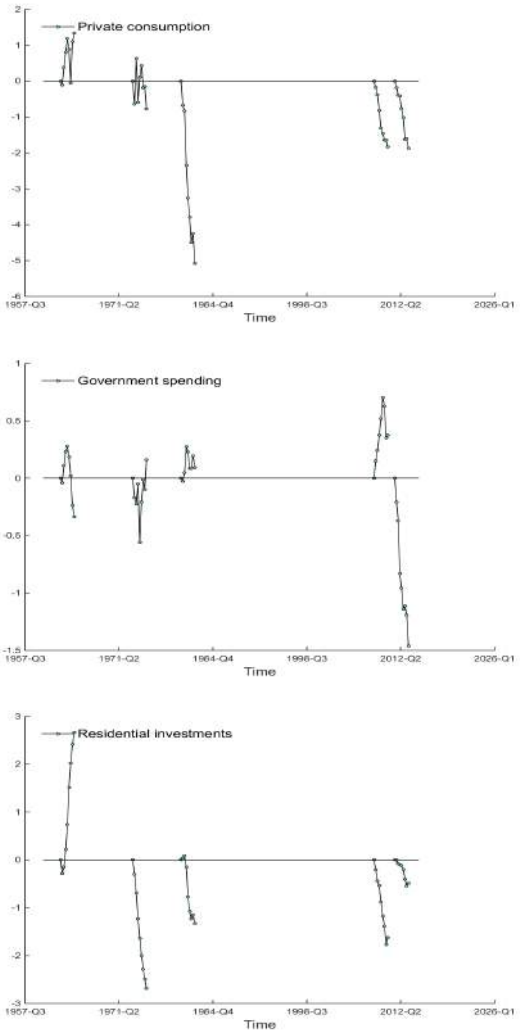
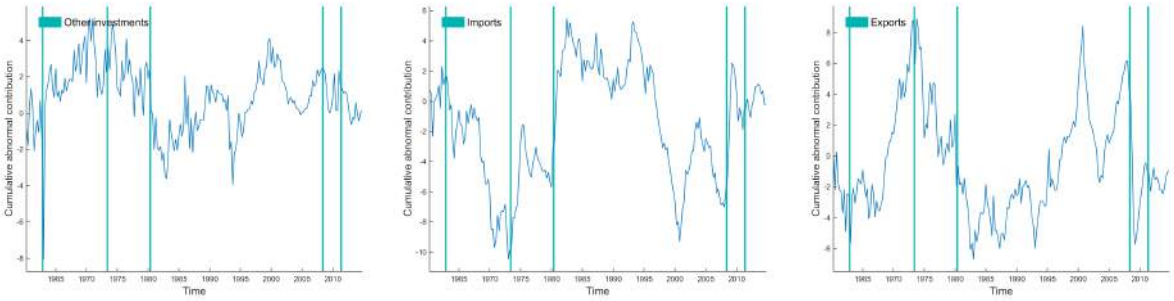
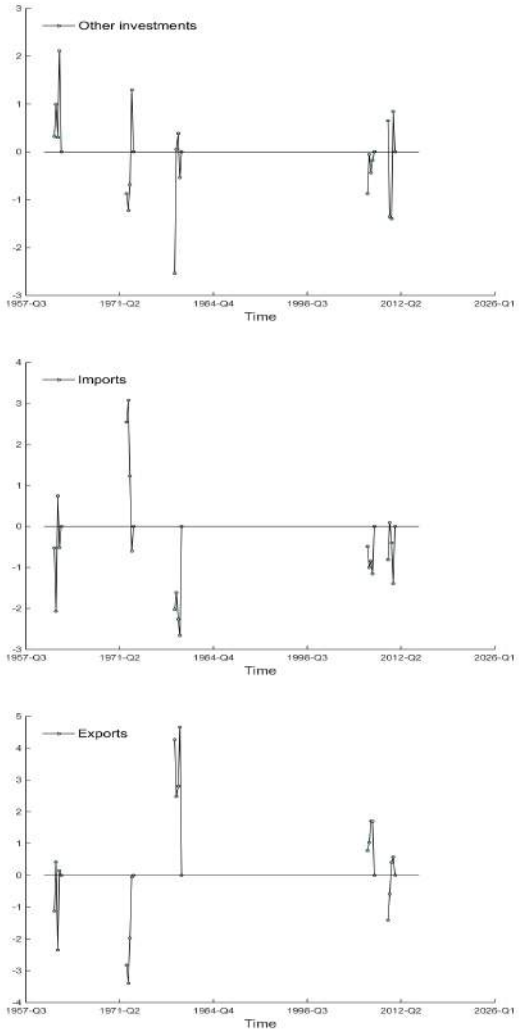


Figure 27: Cumulative abnormal contributions, Netherlands



Timeline with recessions

Contribution before recession



Contribution during recession

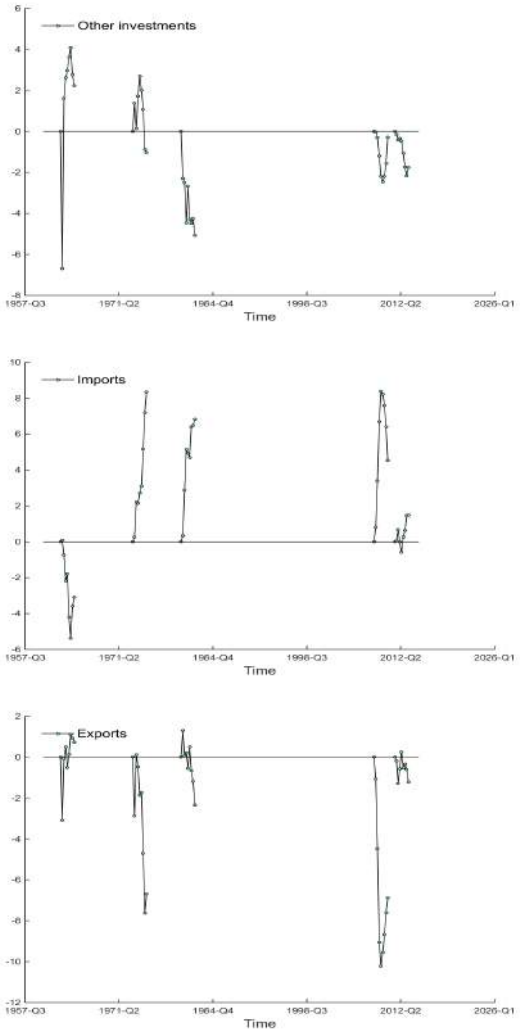
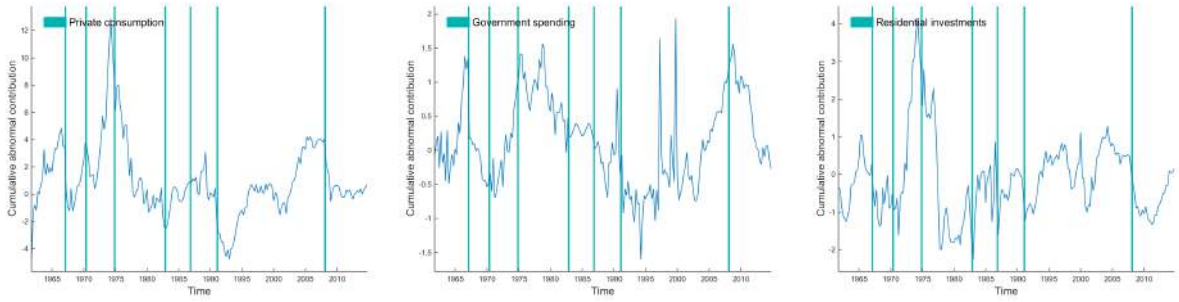
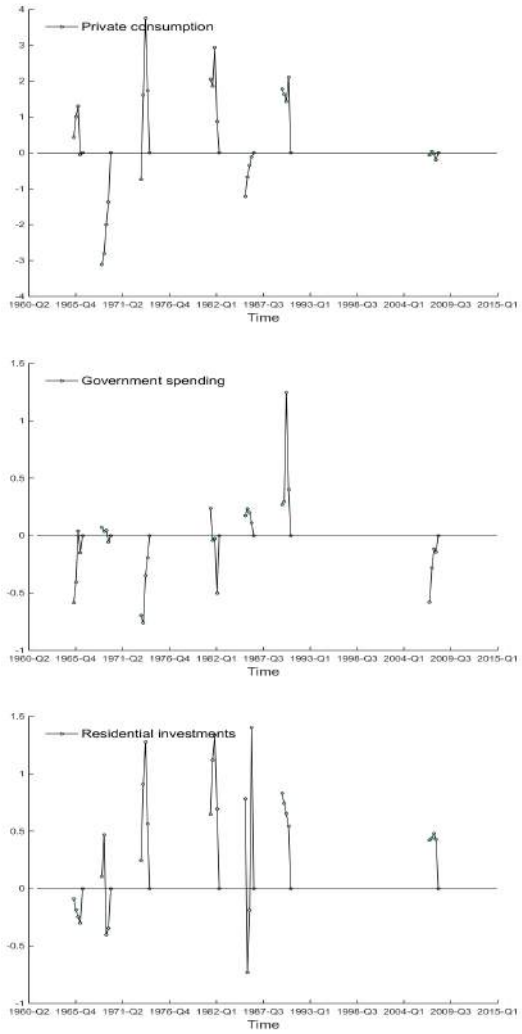


Figure 28: Cumulative abnormal contributions, New Zealand

Timeline with recessions



Contribution before recession



Contribution during recession

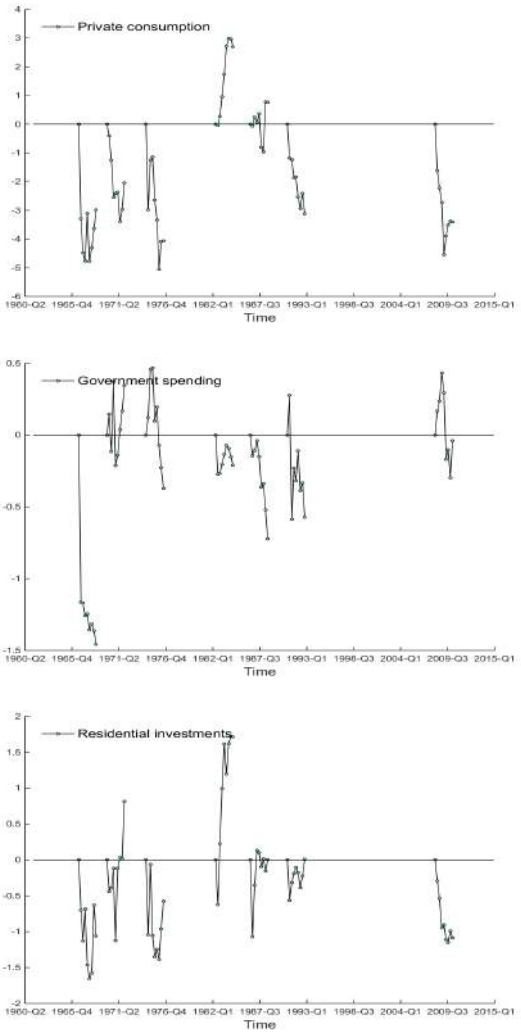
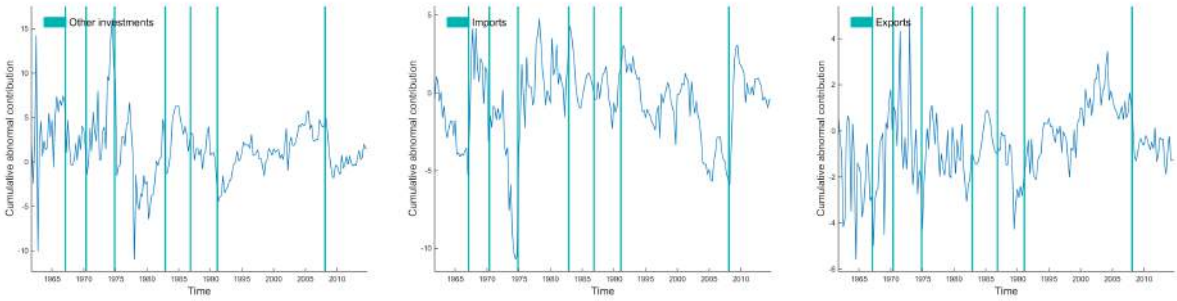
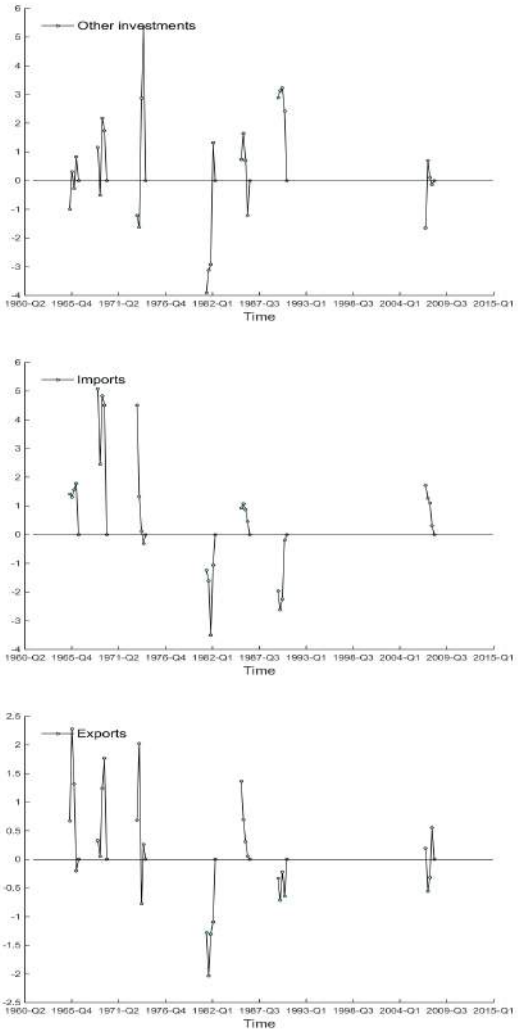


Figure 28: Cumulative abnormal contributions, New Zealand



Timeline with recessions

Contribution before recession



Contribution during recession

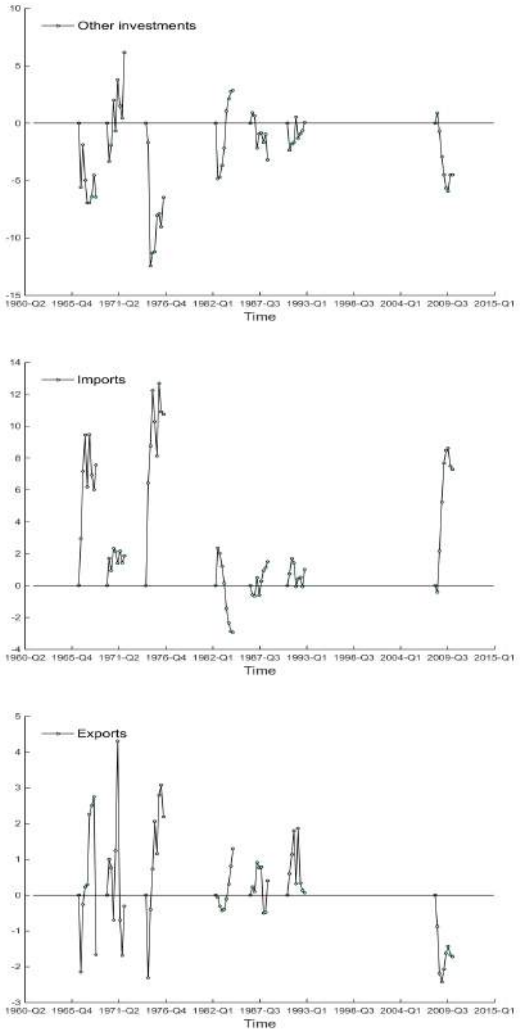
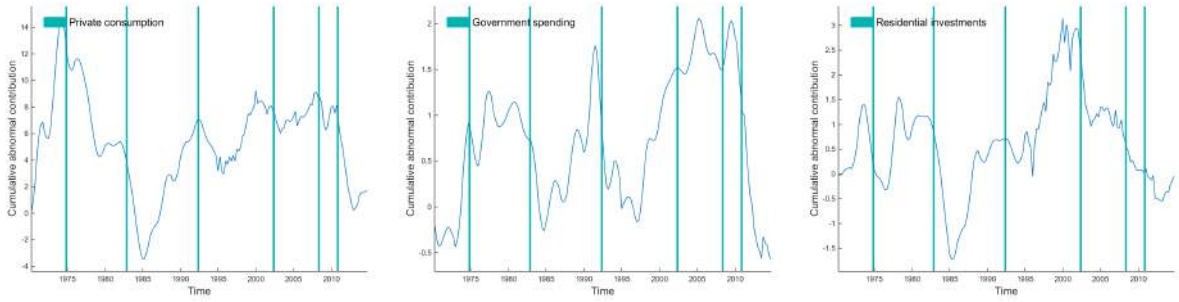
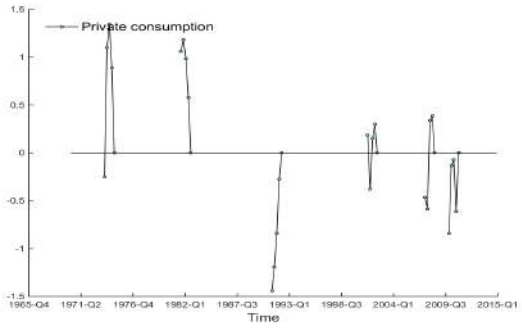


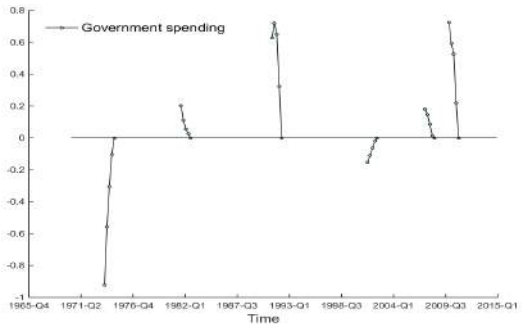
Figure 29: Cumulative abnormal contributions, Portugal

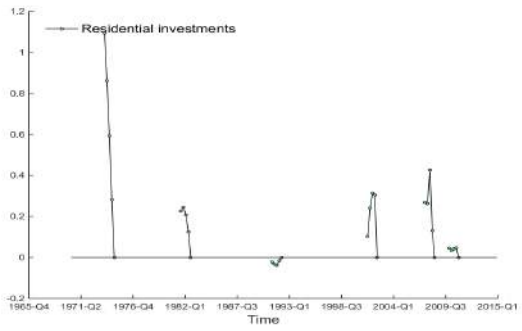
Timeline with recessions



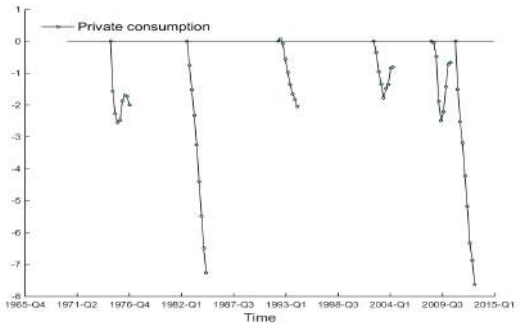
Contribution before recession

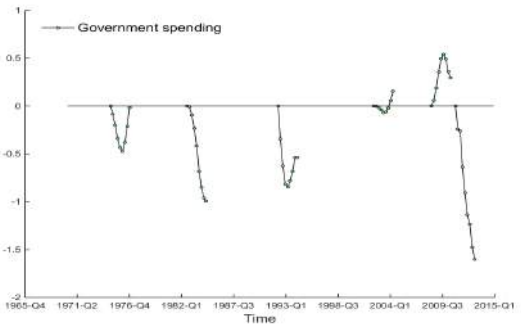






Contribution during recession





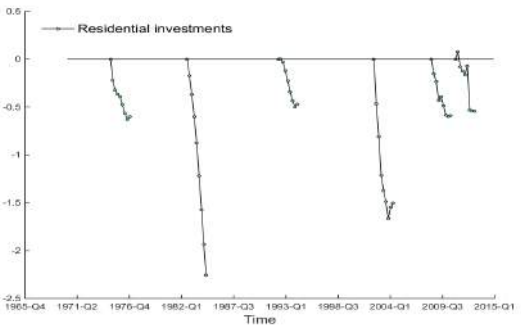
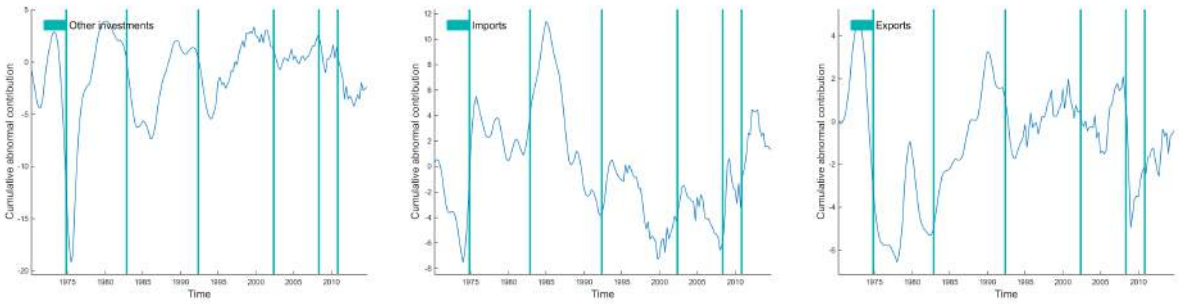
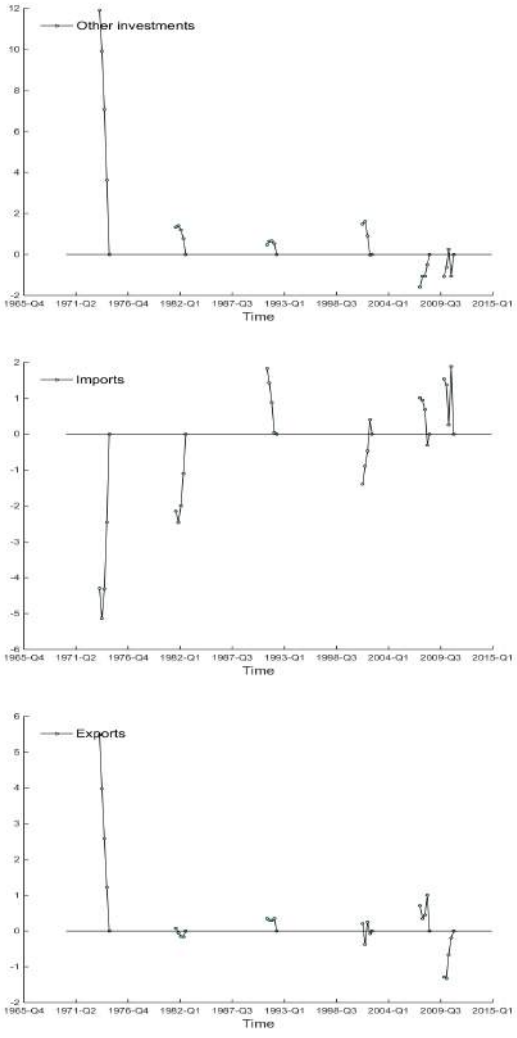


Figure 29: Cumulative abnormal contributions, Portugal



Timeline with recessions

Contribution before recession



Contribution during recession

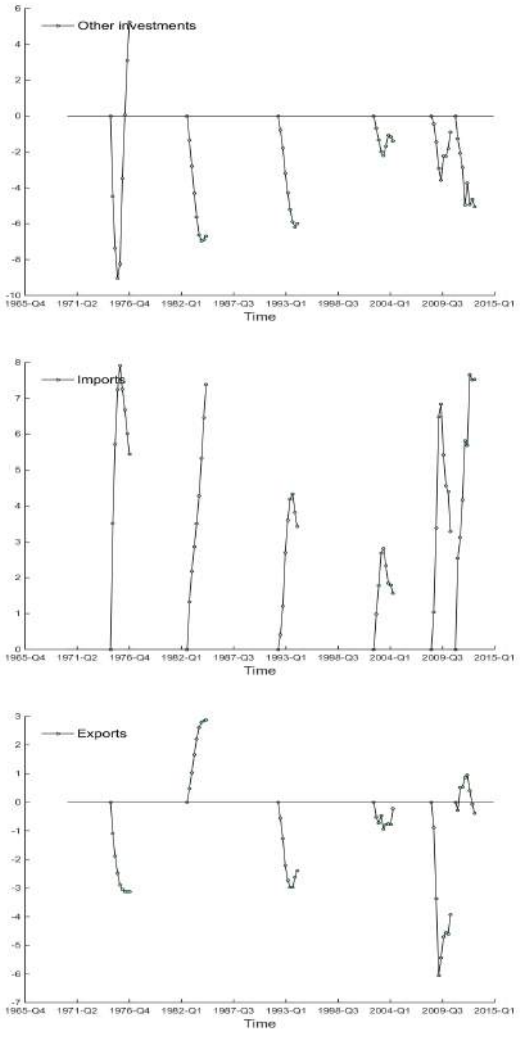
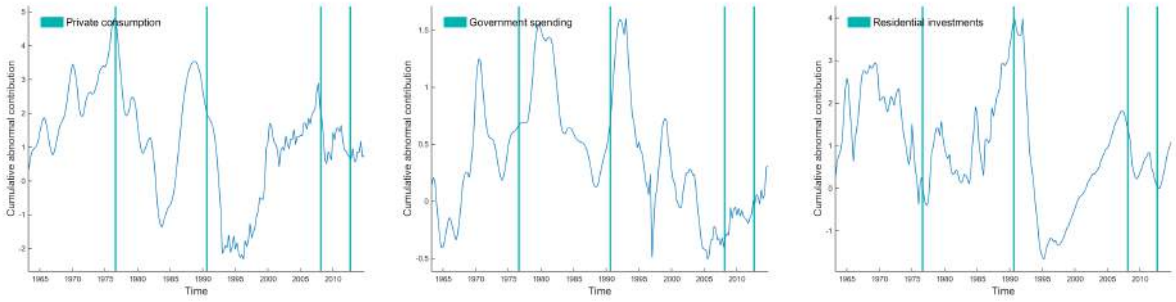
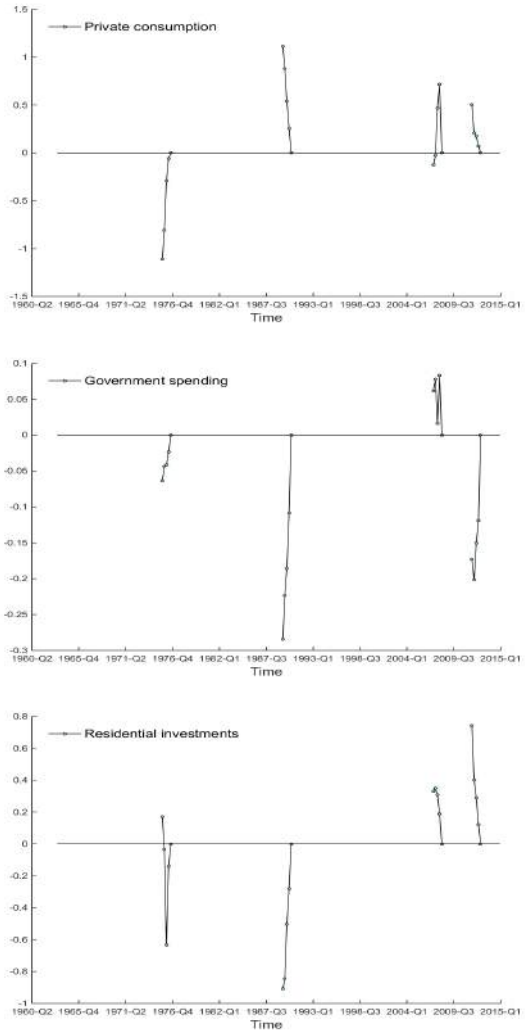


Figure 30: Cumulative abnormal contributions, Sweden

Timeline with recessions



Contribution before recession



Contribution during recession

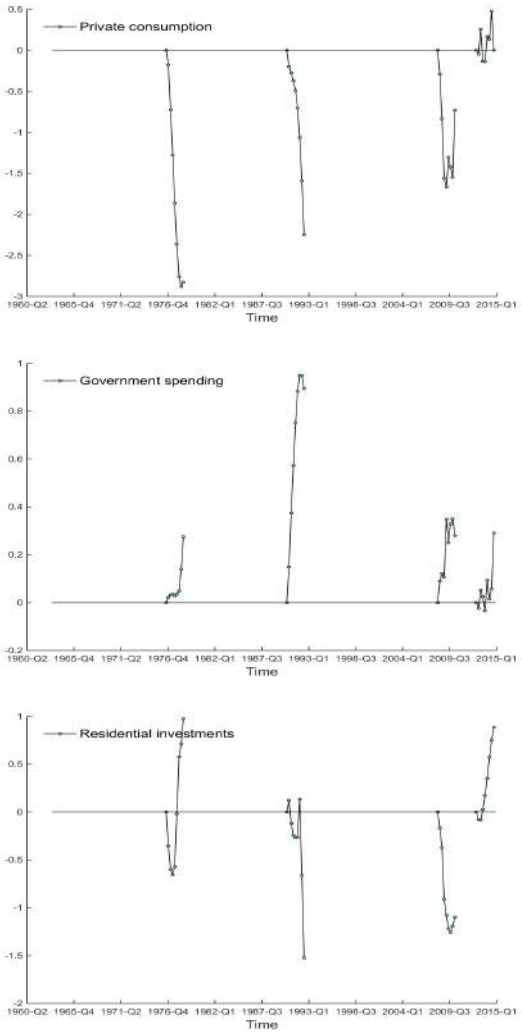
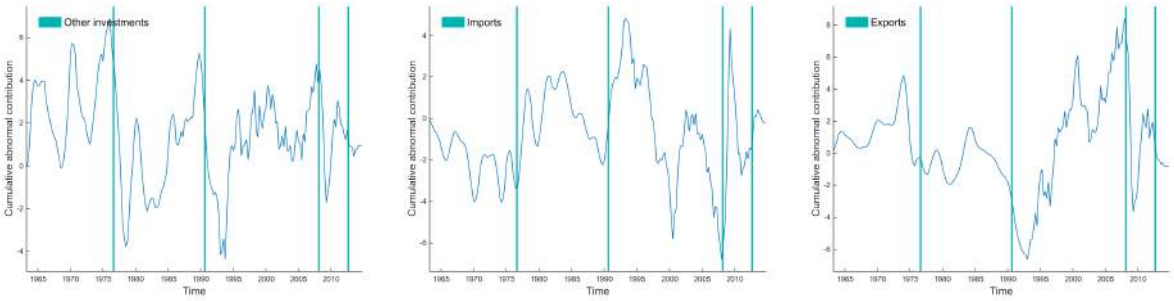
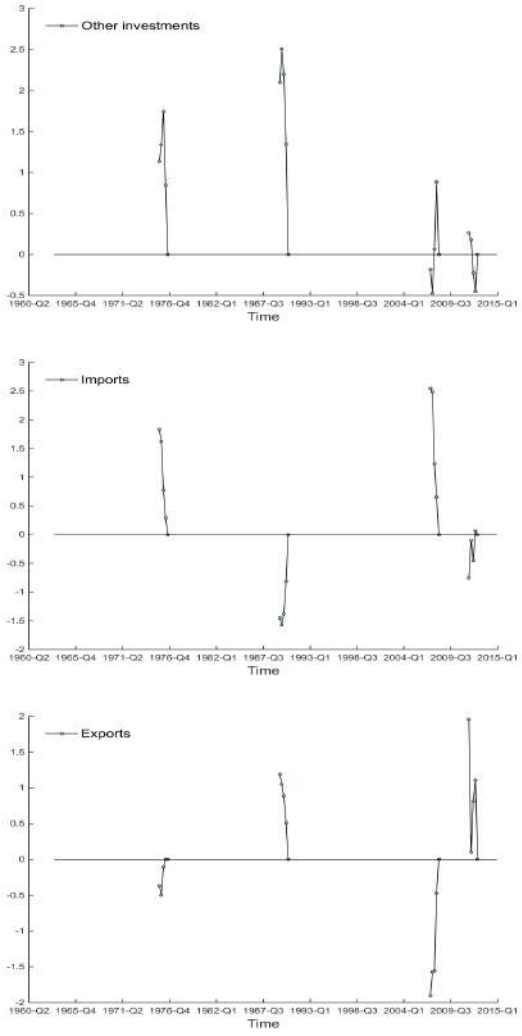


Figure 30: Cumulative abnormal contributions, Sweden



Timeline with recessions

Contribution before recession



Contribution during recession

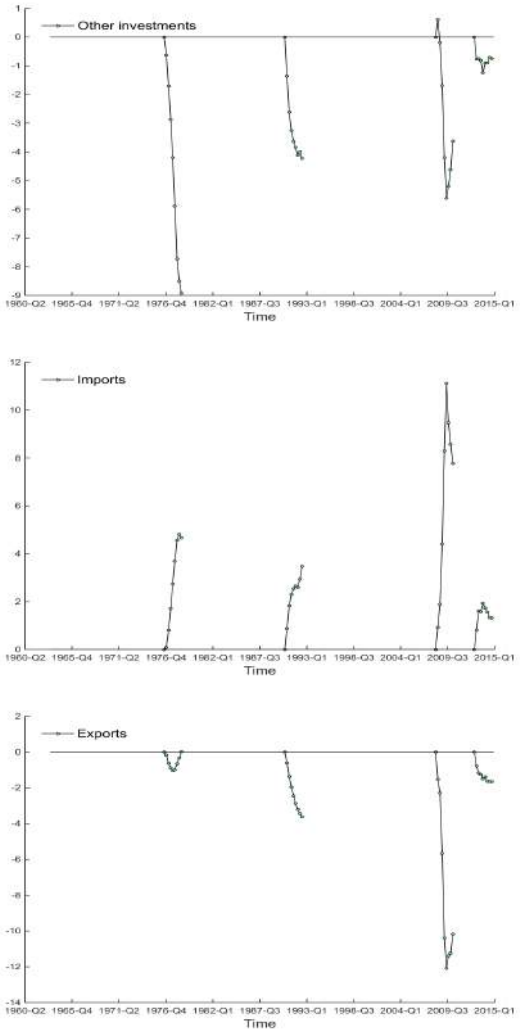
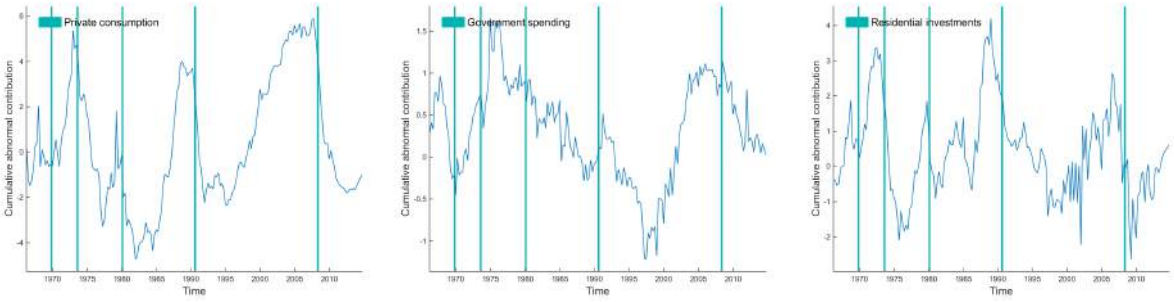
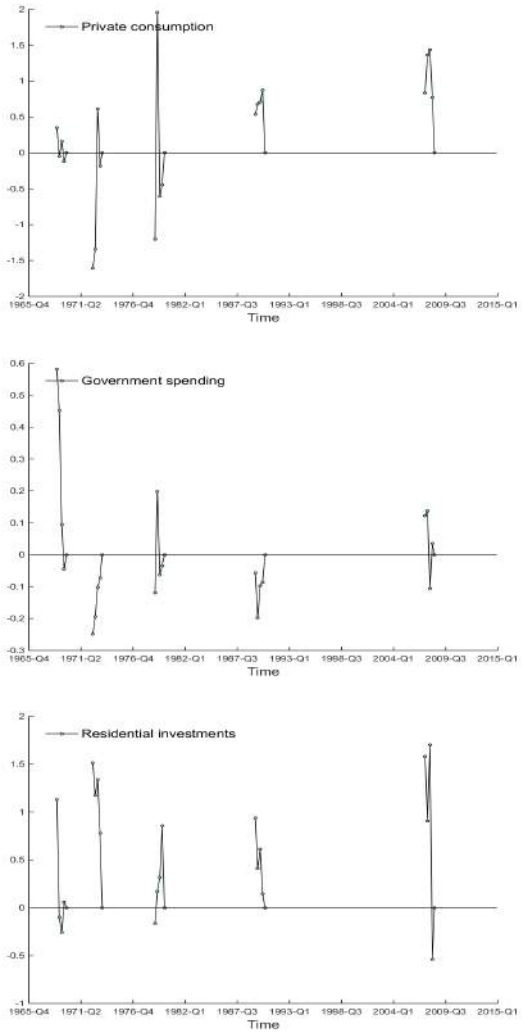


Figure 31: Cumulative abnormal contributions, United Kingdom

Timeline with recessions



Contribution before recession



Contribution during recession

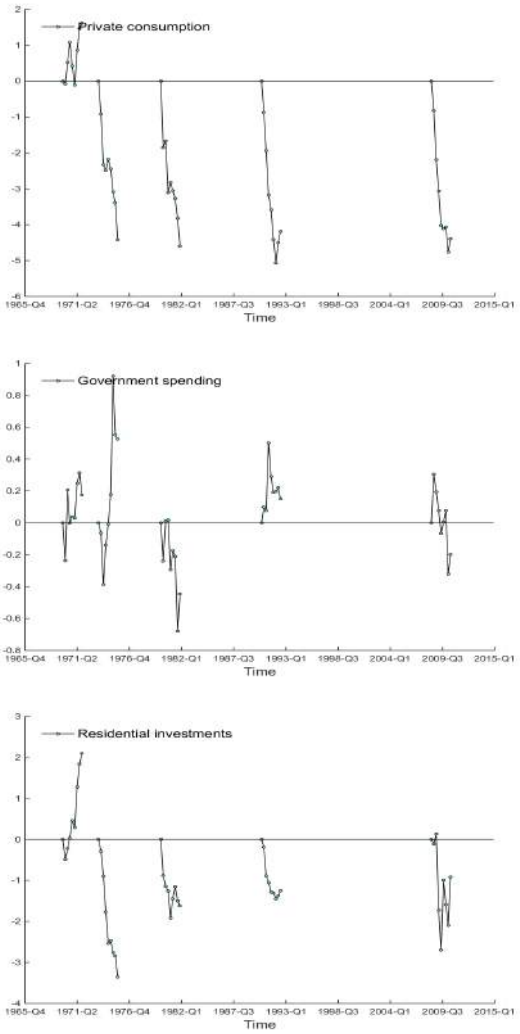
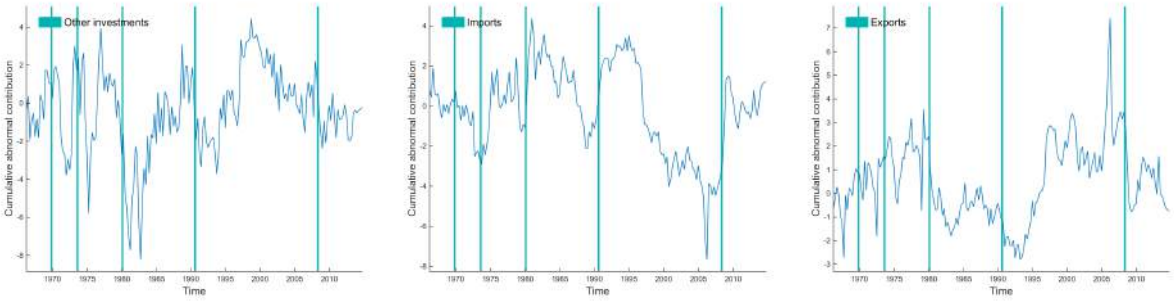
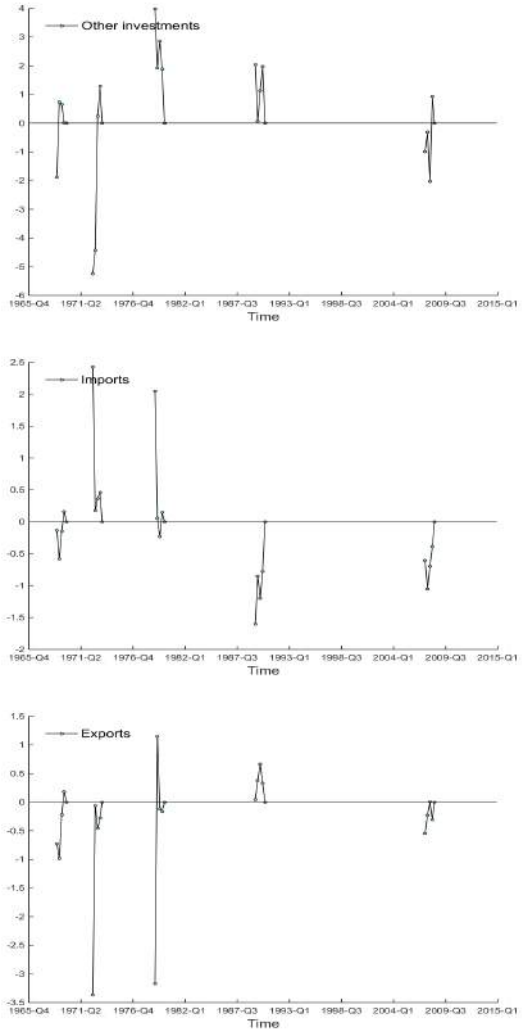


Figure 31: Cumulative abnormal contributions, United Kingdom



Timeline with recessions

Contribution before recession



Contribution during recession

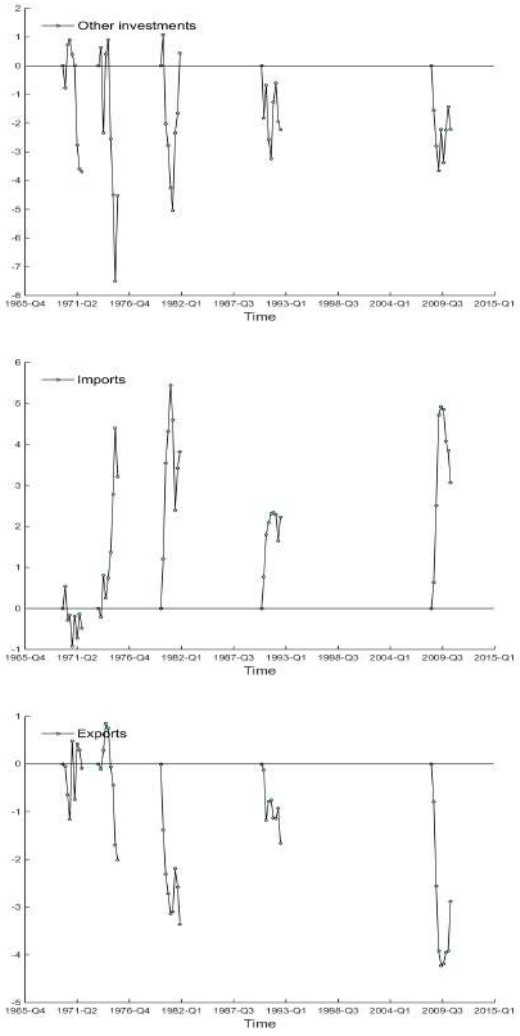
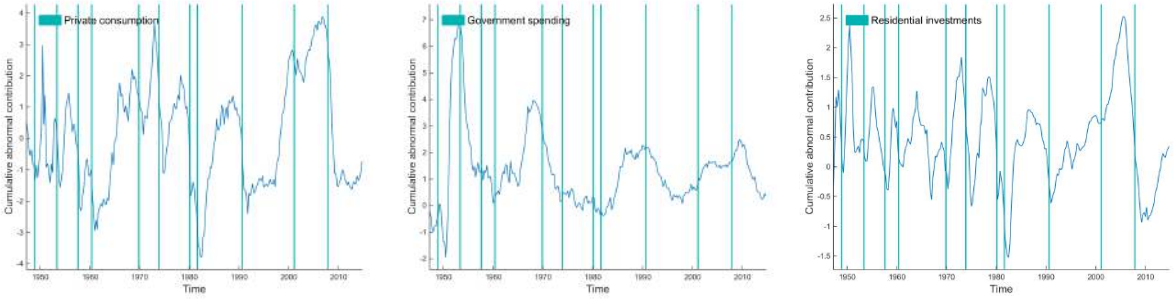
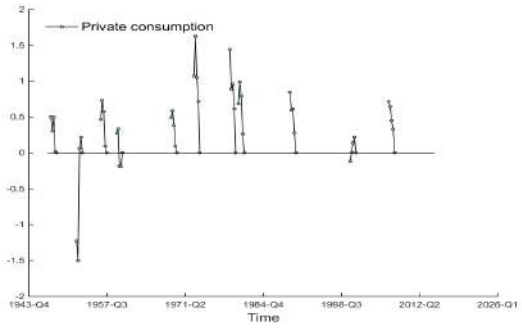


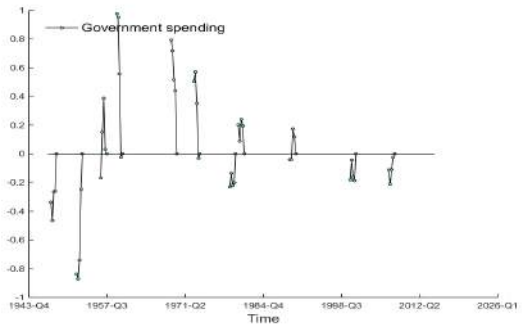
Figure 32: Cumulative abnormal contributions, United States

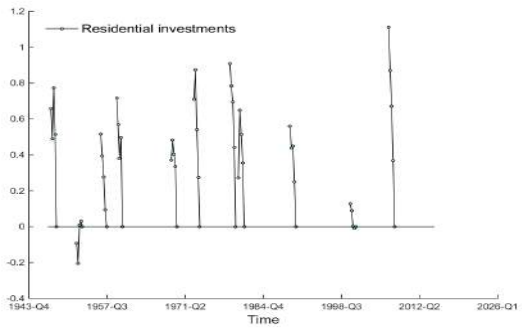
Timeline with recessions



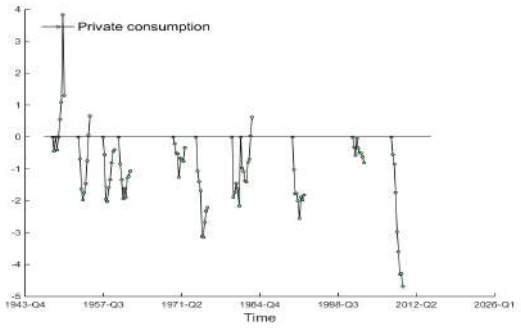
Contribution before recession

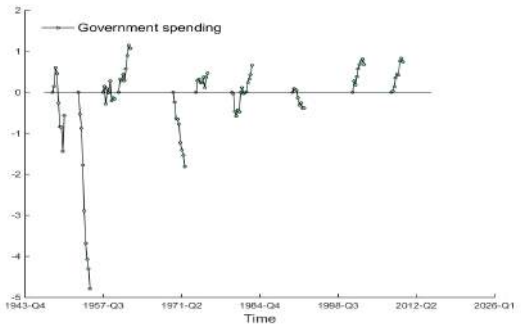






Contribution during recession





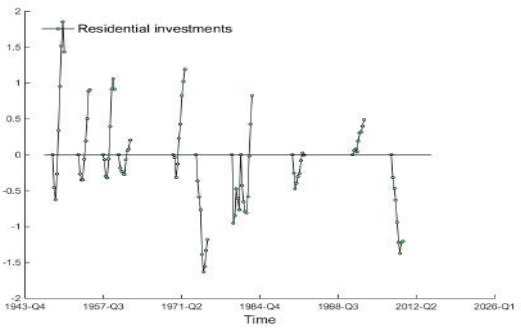
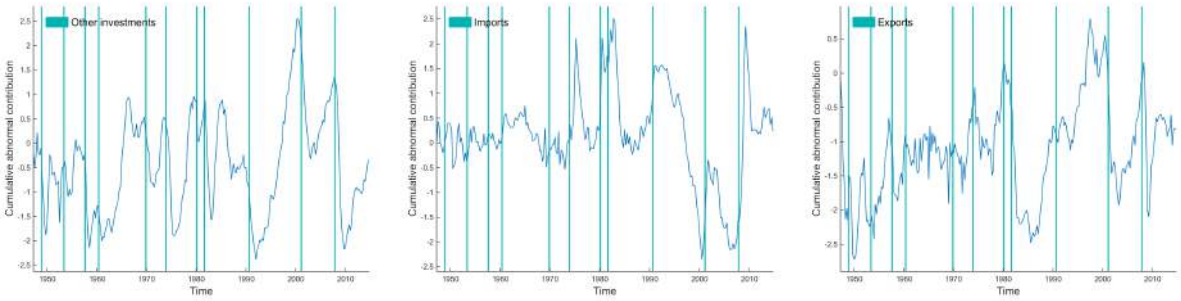
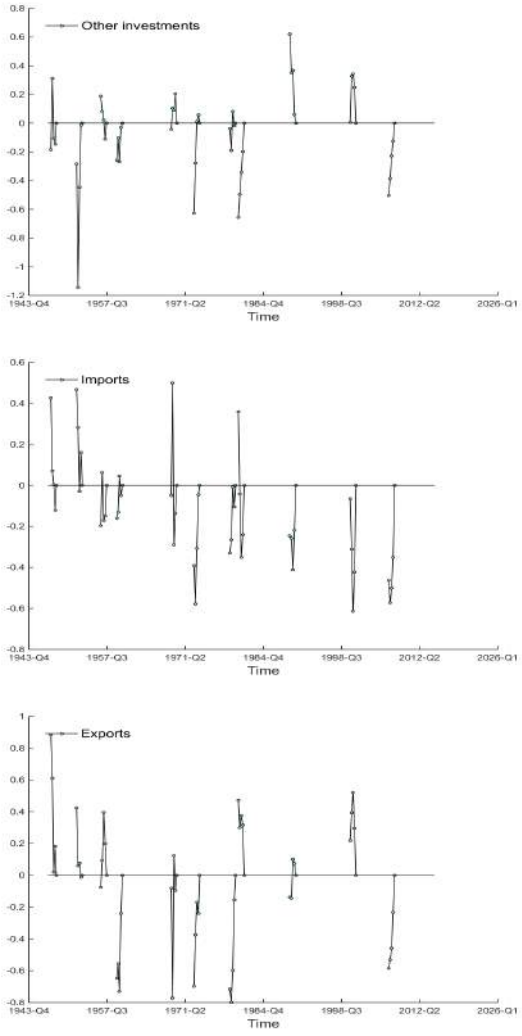


Figure 32: Cumulative abnormal contributions, United States



Timeline with recessions

Contribution before recession



Contribution during recession