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Explaining the Recent Slump in Investment: the Role of Expected Demand and Uncertainty*

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Abstract
The recent weakness in business investment among advanced economies has revived interest in investment models and opened a debate on the main drivers of the "investment slump" and what the policy response should be – if any. In particular, it is essential to assess precisely whether the investment slump stems mostly from weak aggregate demand, financial constraints or uncertainty, as these different explanatory factors have different policy implications. This paper presents an empirical investigation of the main determinants of business investment for a panel of 22 advanced economies. The main contribution is that we present results from an augmented accelerator model using vintage forecast data as a measure of expected demand and show that this forward-looking variable goes a long way in explaining the weakness in investment since the Global Financial Crisis. Moreover, our results also underline the importance of uncertainty, whereas measures of capital cost seem to play a more modest role. Finally, we show that systematically over-optimistic GDP growth forecasts since 2008 have supported business investment to a large extent.

Keywords: Business investment, aggregate demand, uncertainty, financial frictions, expectations
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1. Introduction

In recent years, total private investment has been particularly sluggish among advanced economies: its year-on-year growth rate has barely reached 2.1% between 2010 and 2014, against 3.3% during the pre-crisis period (between 1997 and 2006). This is especially surprising that one would have expected a strong rebound from the 2008-09 financial crisis, which saw a sharp fall in investment, by 2.6% in 2008 and 11.1% in 2009.[1] While part of these developments can be accounted for by housing investment, following the exuberance of the housing markets in the run-up to the 2008 crisis (Lewis et al., 2014; IMF, 2015), business investment has also been particularly sluggish. Business investment has indeed strongly declined for advanced economies during the period between 2008 and 2014 and stands 20% below pre-crisis forecasts (IMF, 2015). The weakness of business investment is a concern, not only because it is a key component of GDP and as such an important driver of short-term economic fluctuations, but also because it has a strong influence on long-term output growth. This paper therefore sets out to empirically investigate the reasons behind the weakness of business investment since the global financial crisis, for a panel of 22 OECD economies.

Indeed, it is important to fully understand the reasons behind the investment slump, as different possible explanatory factors have different implications for the appropriate policy response and for the outlook. The first reason one may put forward is that aggregate demand has been weak since 2008, which obviously does not provide strong incentives for entrepreneurs to invest significantly. In this case, the investment slump may simply reflect the weakness of aggregate demand and does not necessarily require a response that is aimed specifically at the investment sector. Looking forward, investment may rebound as the global recovery takes place, helped by the exceptionally accommodative policies put in place in key economic regions. However, other explanations should not be neglected. One of them is uncertainty. The role of uncertainty in determining investment was put forward already by Bernanke (1983) and this theme has been further developed recently by Baker et al. (2013) and Bloom (2014). In particular substantial uncertainty may deter entrepreneurs from investing now and lead them to postpone investment decisions. In addition, financial constraints may have played a role too, as the global financial crisis has reduced the supply of credits to businesses. If such frictions are strong, they may delay the recovery in investment (and the global recovery as a consequence). This is perhaps especially the case in Europe, where financing conditions have been altered substantially for so-called "periphery" countries (financial market fragmentation).

In the present paper we use annual data for a panel of 22 advanced economies, covering the time span 1996-2014 (we start the estimation in 1996 given that our private non-residential investment data is not available earlier for some countries). The reason why we focus on

[1] The source of these data is the IMF World Economic Outlook, April 2015 issue.

advanced economies is twofold. First, there is evidence that the investment slump is more pronounced among advanced countries than in emerging market economies (IMF, 2015; Magud and Sosa, 2015). Related to this, the determinants of investment in emerging countries or catching up economies are likely to differ from those of advanced countries, such that pooling heterogeneous countries together in the same panel is not appropriate. Second, data availability is wider for advanced countries, allowing a richer empirical exploration. We start our empirical estimation with a conventional specification relating the annual growth rate of business investment to a number of explanatory factors: past GDP growth, uncertainty and a measure of the cost of capital. This standard regression returns the expected signs for the coefficients of interest and possesses a relatively high explanatory power. We then modify this specification to account for expected GDP growth instead of past growth, based on the IMF World Economic Outlook (WEO) forecasts. We consider two alternative forecast horizons: the one-year-ahead WEO projections and the April edition of the WEO for the current year (referred to as "nowcast" of the current year). Overall, the results indicate that expected demand plays a major role in explaining the investment slump, leading to quite high goodness-of-fit in comparison with models using past demand. Moreover, our results also underline the importance of uncertainty while measures of capital cost seem to play a second order role for the panel of countries taken as a whole. It turns out that the overall results are also robust when we conduct a battery of robustness tests. As all three factors that we aim to evaluate are notoriously difficult to measure precisely, we test for alternative proxy variables; specifically, we use seven demand measures (testing for different lags and time horizons), six measures of uncertainty (including the VIX, the dispersion among forecasters as provided by the Consensus Forecasts, and the indicator developed by Baker et al., 2013, and Bloom, 2014) and four measures of the cost of capital. Our main findings are robust to these alternative proxy variables. Another issue tackled in the robustness test section focuses on the role of economic crises: we therefore check that our results are indeed robust when crisis times are removed from the samples (with one exception, as the coefficient of the cost of capital variable is no longer significant).

Finally, we decompose our results and show the contribution of each of our explanatory variables for the countries in the sample. The main finding that comes out of this analysis is that the business investment slowdown of 4 p.p. in our panel of advanced economies, from 4.5 % during the pre-crisis period to 0.5% over the years 2008-2014, is mainly due to expected demand (negative contribution of 3.3 p.p.), while uncertainty has also played a role (negative contribution of 0.7 p.p.). By contrast, capital costs do not appear to contribute to this drop for the countries taken as a whole. The paper shows the contributions of our explanatory variables not only for the aggregate, but also country by country, in the appendix, which yields several nuances, particularly for the so-called European "periphery". Another noteworthy consideration to underline in the context of our forward-looking model is that forecast errors have actually *supported* investment since the outburst of the crisis. Indeed, if GDP forecasts had been perfect and not systematically over-estimated, our estimates suggest that investment would have been around 12 p.p. lower: as GDP growth forecasts have been over-optimistic since the crisis, investors who base their decisions on official output forecasts would likely have invested less if they had known how weak global growth really was going to be. This is particularly true for the EU periphery countries, for which the errors have been the largest.

Our paper relates to a number of recent contributions, on which we build in several ways. The review of the literature, which we present in the first part of the paper, highlights the main theoretical models of investment and discusses the results of recent empirical studies. Most importantly perhaps, our paper is one of the first to use forecasts to account for expected demand across countries[2]. Most papers that seek to explain investment use past demand instead, which does not account for the fact that investors likely consider future (expected) demand rather than past demand. While Tobin's q model incorporates a forward looking component, the proxies used to account for the q ratio may be influenced by a variety of other factors, such that it is important to check directly the relevance of GDP forecasts. Indeed, traditional stock market based measures of Tobin's q do not seem to work well when explaining investment dynamics due to the noisiness and non-fundamental fluctuations of stock prices (Gennaioli, Ma and Shleifer, 2015): *"A constructive way to revive Q-theory is to start with data on expectations, and not on stock market valuations."* Next, we present results for the 22 countries in the sample, in contrast with most studies, which focus on a smaller number of countries. Our study includes in particular key "periphery" euro area countries such as Greece, Italy, Ireland, Spain and Portugal, which allows us to shed light on the recent European crisis in 2011-13. Our paper also relates to the recent works of Bloom (2007, 2014), and Baker et al. (2013) and lends support to the idea that uncertainty plays a role in delaying the recovery.

The rest of the paper is organized as follows. Section 2 reviews existing theoretical models of investment and recent empirical studies on the subject. Section 3 presents key stylized facts related to investment during and after the global financial crisis and to our explanatory variables. Data and estimation results are presented in Section 4, which also shows a battery of robustness checks. Section 5 concludes.

2. Review of the literature

This section contains a brief review of theoretical models that account for investment dynamics, as well as some recent results on the roots of the investment weakness after the global financial crisis.

[2] Recently, Gennaioli, Ma and Schleifer (2015) present results at the firm level for the United States.

2.1 Theoretical models for investment dynamics

The economic literature proposes three different theoretical approaches in order to explain the dynamics of fixed investment: the accelerator model, the neoclassical model and Tobin's q model. A detailed presentation of such models can be found for example in Jorgenson (1971).

Accelerator model

The accelerator approach was originally proposed by Clark (1917) and has been largely applied when analyzing business cycles. In the studies of Chenery (1953) and Koyck (1954), the simple accelerator principle assumes that the level of desired capital stock is proportional to the level of output. More precisely, changes in the actual level of capital can be explained by changes in the desired level of capital (which in turn will be proportional to changes in output). Jorgenson and Siebert (1968) use this "flexible" accelerator as a departure point in order to analyze several theories of investment behavior. They generalize the mechanism proposed by Chenery (1953) and Koyck (1954) in order to provide a wider range of possible time patterns for investment behavior. Considering the importance of the lag structure in investment, they finally add a lag function to the flexible accelerator approach as follows:

$$I_t = \alpha + \sum_{i=0}^{N} \beta_i \, \Delta K^{*}_{t-i} + \delta K_{t-1} \ ,$$

where I_t is the real business investment, K_t is the stock of capital, ΔK_t^* is the change in desired capital, which is assumed to be proportional to the change in output, i.e.: $\Delta K_t^* = \gamma \ \Delta Y_t$ and δ is depreciation rate of capital.

Neoclassical model

In the neoclassical model, investment is determined by the expected return on new capital and the cost of obtaining and using this capital. The first one depends on the marginal product of capital (MPC), which is a function of the capital/labor ratio and the technological level. The second one has three main components: interest cost, depreciation cost and capital loss.

Total spending on fixed investment (gross investment, I_t) is equal to net investment ΔK_t plus the replacement of the depreciated capital stock, that is:

$$I_t = \Delta K_t + \delta K_{t-1} \ ,$$

where net investment is a function of the marginal product of capital (MPC_t) and the user cost of capital (UCC_t). The user cost of capital is negatively related to the business investment rate through corporate profits. More precisely, a rise of the real cost of capital implies a decline on a firm's profit rate and consequently the corporate investment rate decreases. The real cost of capital can increase with the real interest rate, thereby reducing the profit rate and investment.

Tobin's q Model

Finally, another celebrated theory of investment originally published in Tobin (1969), is the so-called Tobin's q. The departure point of this idea is that the marginal product of capital (which determines a firm's profits and thus corporate investment) is not directly observable. In this case, it is possible to use the stock-market value of a firm, since it reflects the marginal benefits from investment, at least as assessed by financial markets. When comparing this value to the current cost of replacing the capital stock, it is possible to obtain a measure of the firm's incentives to invest. This measure is what is called the Tobin's q and can be written as follows:

$$q = \frac{\text{market value of installed capital}}{\text{replacement cost of installed capital}}$$

Therefore, if the market value of installed capital is bigger than its replacement cost it might be interesting for the firm to invest and raise its stock of capital.

2.2 Empirical studies on the factors behind the weakness of investment after the crisis

Several empirical studies have sought to develop a clear diagnosis of the weakness of corporate investment in order to design policies that might encourage its recovery. More precisely, they have analyzed different possible determinants of investment growth, using various econometric techniques and considering different theoretical approaches. However, no strong consensus emerged on a specific reason lying behind the disappointing performance of business investment, although the demand factor has been often put forward (see e.g. IMF, 2015).

Another recent empirical study that has widely deepened the analysis of the worrying evolution of private non-residential investment in the euro area has been recently published in an IMF working paper (Barkbu et al., 2015). The theoretical approach from this work was presented in Lee and Rabanal (2010) and builds upon Jorgenson (1971) and Bertola and Caballero (1994). The empirical approach consists in a country-specific estimation of an aggregate investment equation for a set of seven developed countries, using quarterly data over the period 1990-2013. The main results highlight the decline in output, the elevated real costs of capital —mainly for stressed countries, as a result of financial fragmentation— and the small impact of uncertainty in most countries —with the exception of the stressed economies— as the main determinants explaining the dynamics of private non-residential investment in the euro area.

Other studies such as Ruiz and Hallaert (2014) or the one presented in the "Quarterly Report on the Euro Area" of the European Commission (2013) considered a cointegration analysis to account for the adjustment coefficient of the long-term relationship between corporate investment and output. While the former focuses on a long term relationship all over the period of study, the latter highlights the presence of a structural break from 2008q1-2011q4, which disconnects investment from its long run fundamentals.

Further, the authors give special emphasis to the impact of uncertainty on economic activity as suggested by Bernanke (1983), Pindyck (1990) and Dixit and Pindyck (1994). In fact, these authors highlight that when the initial cost of investment is at least partially irreversible or "partially sunk −you cannot recover it all should you change your mind−", high uncertainty over future outcomes from the investment leads agents to "postpone action to get more information about the future" (Dixit and Pindyck, 1994, pp. 3). The results suggest that macroeconomic uncertainty has only a significant effect on investment growth during the post crisis period and that policy uncertainty has impacted both periods with an increasing coefficient after the crisis of 2008.

Another study presented by Lewis et al. (2014), considers an alternative approach that looks at measures of the gap between current investment rates and estimated steady-state investment rates, in order to account for corrections in potential output growth, slower labor force growth due to population ageing and increasing depreciation rates. Their findings suggest that investment gaps in 2013 are around 2 percentage points or more in most OECD economies. Moreover, they estimate a simple neo-classical baseline model of business investment from an unbalanced panel dataset covering 13 OECD economies with quarterly data from 1993q1 to 2013q3, considering variables such as capital cost, output growth, lagged investment, output gap, policy uncertainty and realized share price volatility as well as an equilibrium correction term in order to account for long-run adjustment of business investment. Their results highlight an important role for output growth and output gap, a smaller one for the user cost of capital and no systematic role for the available uncertainty measures. Further, the presence of large residual factors suggests considerable heterogeneity in investment behavior across countries. The main difference between our paper and the one by Lewis et al. (2014) is that we use expected output growth instead of actual or past growth.

Last, the approach presented in the IMF World Economic Outlook (IMF, 2015) includes a thorough analysis of business investment in advanced economies as well as in emerging markets. Concerning the former, the IMF has conducted two types of studies, using not only aggregate data but also firm-level data. The first one covers a panel data analysis for a set of 19 advanced economies and a country-specific analysis over the period 1990q1-2014q4. The estimation relates business investment to output via an accelerator model and the final results suggest that the decline in output is the main factor behind the decline in investment. More precisely, a slowdown of 1 percent in economic activity implies a decrease in average investment of 2.4 percent in all countries. The country-specific analysis confirms the major role of demand in investment (the accelerator effect) but it also emphasizes the significant role of financial constraints and uncertainty on the decline of business investment for the stressed countries (Greece, Ireland, Italy, Portugal and Spain).

Moreover, the firm-level data analysis was performed using a panel of 27.661 firms across 32 advanced economies over the period 2000-2013. The results suggest that firms most dependent on external funding are those whose investment has been most significantly affected over the sample period, reflecting the impact of financial constraints. Additionally, the results also highlight the effects of uncertainty in putting off investment.

Our paper relates as well to a recent literature that seeks to analyze the explanatory power of expectations data on corporate investment dynamics. For example, the paper by Gennaioli, Ma and Shleifer (2015) provides empirical evidence about the extent to which expectations affect behavior and help explain real decisions by firms, including investment and production. By using expectations on earnings growth formed by Chief Financial Officers (CFO), the authors estimate an empirical Q-theory model for the U.S. that relates growth in business investment plans (as well as in actual investment) to expectations of earnings growth. Their results point out that expectations appear to contain a substantial amount of additional information for investment plans that is not captured by equity Q. Further, they assess the role of expectations when controlling for financial frictions and uncertainty by using cash flows as a proxy of the former and stock price volatility together with economic policy uncertainty from Baker et al. (2013) as proxies of the second one. Results highlight an insignificant effect of financial constraints and a weak explanatory power of uncertainty on corporate investment dynamics. However, the authors underline the important role of expectations data: *"All in all, expectations are highly relevant for understanding corporate investment. They are not simple noise, but contain considerable information for explaining investment activities beyond a host of traditional variables"*. Recently, Bond et al. (2015) also underline the role of expectations in explaining investment dynamics in Italy, using information on firm's demand expectations. However, they downplay the impact of uncertainty on investment since the Global Financial Crisis.

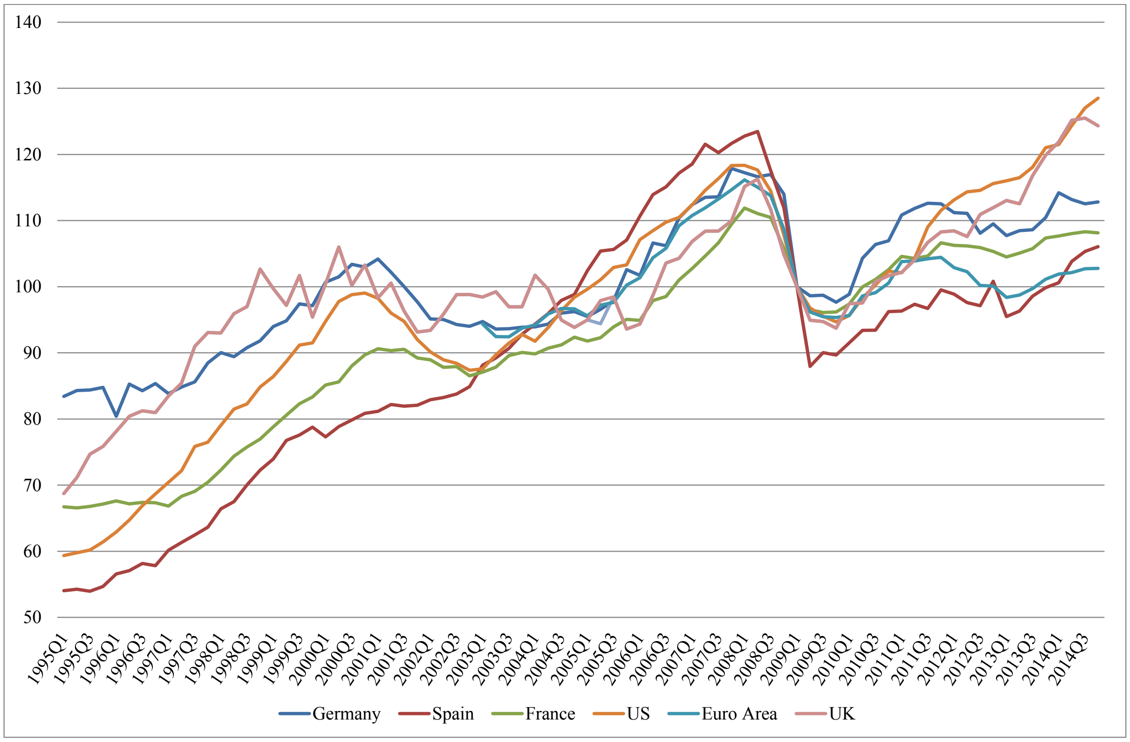
As regards micro-economic analysis, the Global Financial Stability Report (IMF, October 2014) performed a detailed econometric analysis using corporate balance sheet data in order to identify the main determinants of investment from a company's perspective. Therefore, the analysis has focused on factors that are generally considered to affect firms' investment capacity and incentives. The study builds on panel data analysis for a set of 895 companies among five developed countries over the period 1999q1-2014q2. The results are consistent with Tobin's q theory, which holds that firms invest when the expected marginal return on additional capital is higher than its costs. Evidence shows as well that firms increase capital expenditure with profitability but a measure of the impact of uncertainty on corporate investment is missing from the study.

At this stage, several recent macroeconomic contributions have pointed out the role of past demand but there is still little consensus on the specific other reasons that lie behind the weak evolution of business investment after the crisis and across regions. This could perhaps arise from the fact that different factors most likely play a different role at different times for different countries: differences in the empirical results may simply reflect different sample compositions. In this paper we highlight the evolving role of our explanatory variables over time and across countries by showing their contributions to the growth rate of investment through detailed charts that can be found in the appendix.

3. Stylized facts

In this section we consider some key stylized facts related to investment during and after the global financial crisis. First, the severe contraction in private investment during the crisis and the following weak recovery seems to be mainly a characteristic of advanced economies. Among advanced economies, euro area countries, especially those in the periphery, have been the most negatively impacted. Figure 1 shows the evolution of real private non-residential investment between 1995q1 and 2014q4 (2009q1 being equal to 100) for the United States, France, Germany, Italy, Spain, United Kingdom and the euro area as a whole. We first note that all countries experienced a large drop in business investment in 2008-09 during the Global Financial Crisis, while there is significant heterogeneity as regards the pace of the recovery starting in 2009 or 2010. We can observe that only the US and the UK have recorded a persistent strong growth rate, leading to a full recovery of business investment in the sense that the level of investment in 2014 is higher than the one in 2007. Meanwhile, GDP in the euro area not only remained below its pre-crisis level by the end of 2014, but has also declined more than in previous recessions and still lags behind the trends observed in most previous recessions (Barkbu et al., 2015). A striking observation is indeed the flat growth rate of investment observed in the euro area during the recovery, while a strong bounce-back would have been expected after the sharp fall recorded during the Global Financial Crisis.

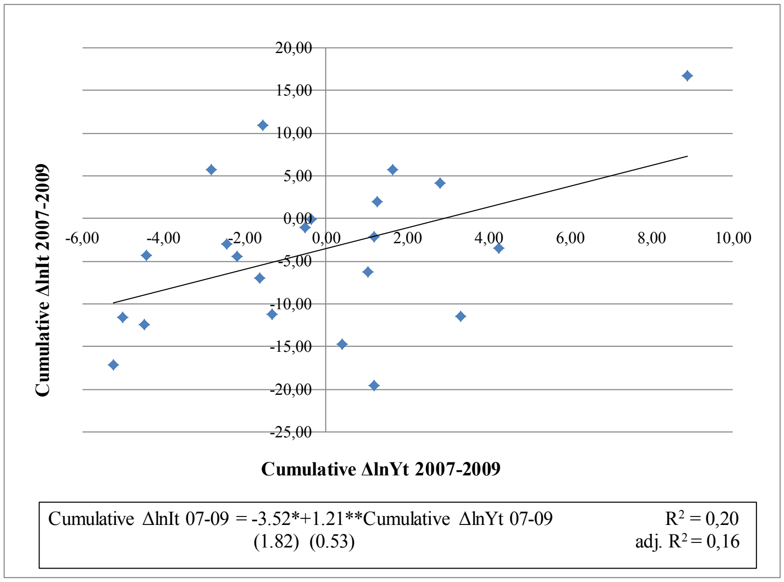
Figure 1: Real private non-residential investment between 1995q1 and 2014q4, selected economies (2009q1=100)

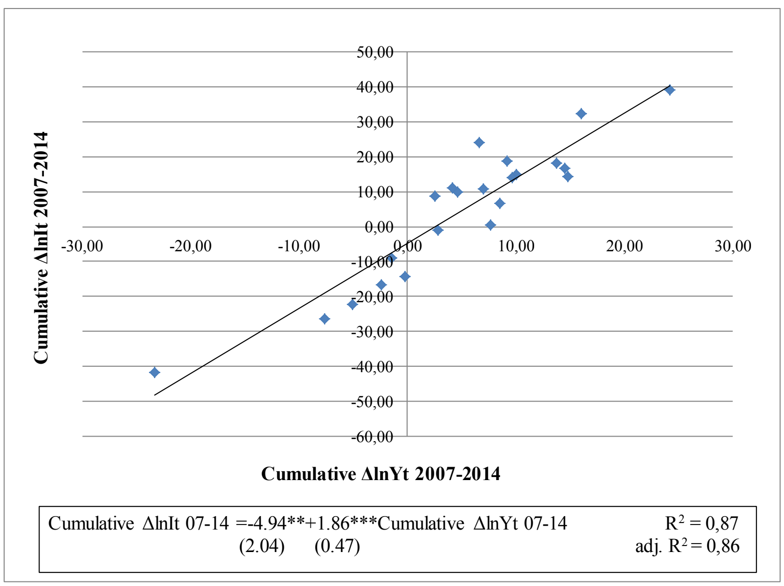


Source: OCDE, ECB

As reviewed in the previous section, several papers have put forward that the drop in investment is largely related to a lack of demand. In Figure 2 we simply look at the comparative evolution of the cumulative growth rates of investment and GDP over two different periods: 2007-09 (top panel) and 2007-14 (bottom panel). Over the whole period 2007-14, there seems to be a strong and statistically significant correlation between investment and demand, suggesting that aggregate demand is an important driver of the slump in business investment, in line with the accelerator model. However, during the crisis period 2007-09, evidence is less clear, suggesting that other factors may be at play.

Figure 2: Comparison of cumulative loss in business investment growth and in GDP growth between 2007 and 2009, then between 2007 and 2014





Source: OECD, ECB

Second, lending restrictions may have constrained investment in certain segments of the market, particularly small, medium-sized, and/or young innovative firms (Barkbu et al. 2015). Despite the lack of empirical evidence on firms reducing their investment in countries where the banking sector has reduced its leverage, there is actually evidence that firms less dependent on bank financing have reduced their investment less than those that were more dependent (EIB, 2013). More specifically, the crisis of 2008 has led to increased dispersion of interest rates on corporate loans among euro area countries, sectors and firms, implying a higher fragmentation of financial markets (EIB, 2013). Since economic theory predicts that firms invest up to the point where the expected marginal return equals the cost of financing (which includes the replacement cost), a higher user cost of capital should have a negative impact on corporate investment.

Third, a cyclical factor that has been highlighted is the widespread level of economic policy uncertainty (see e.g. Buti, 2014, and the discussion therein). More precisely, this component has been claimed to rise after the start of the global financial crisis because of business and household uncertainty about future tax, spending, regulatory, health-care and monetary policies (Baker, Bloom and Davis, 2013). Moreover, the scale of banks' deleveraging and the continuous decline in cross-border capital flows (which have led to funding difficulties and misallocation of resources), has induced companies to postpone investment projects and accumulate cash in order to insure themselves against probable external financial constraints (Dixit and Pindyck, 1994; Bernanke, 1983; Guiso and Parigi, 1999; Bloom et al., 2007). The basic idea is, for example, that "*uncertainty about a future tax rate creates uncertainty about the profitability of the investment. If the uncertainty is likely to be resolved in the not-too-distant future, the firm rationally delays committing resources to irreversible (partially sunk) projects*" (Stokey, 2013). In this context, firms choose the optimal strategy of "wait-and-see" when making an investment decision.

At this stage, the growth of business investment and its orientation towards projects that incorporate high productivity levels has become the main challenge of European economic policies. One of the European initiatives that has been proposed in order to promote economic growth is the Juncker Plan, established by the European Commission at the end of 2014 (Buti, 2014). At the same time, Valla et al. (2014) have proposed the creation of The Eurosystem of Investment Banks in order to coordinate certain activities of public investment banks in the euro area and participate in their financing capacity.

4. Results

In this section, we present the data used for the empirical analysis as well as the main results that we can draw from the modelling exercise.

4.1 Data description and basic statistics

Our empirical exploration of the determinants of private sector investment uses a dataset of 22 OECD countries, with annual data covering the period 1996-2014. Table A1 in the annex presents the selected variables and their sources and Table A2 contains the complete list of countries. The composition of the panel is motivated as follows. For the country composition we chose to focus on advanced economies only, as the fall in aggregate investment is stronger for these countries (IMF, 2015) and given that the determinants of investment in emerging market economies may be different (in addition, we suspect that the slope homogeneity restriction for panel estimation would not be respected if we were to pool advanced and emerging countries together). Moreover, advanced economies typically have longer time series, which allows a more accurate estimation.

Investment

Fixed investment refers to the investment in physical assets, for example, equipment and structures. Data for the variable of real corporate investment have been drawn from the Economic Outlook of the OECD database. Figure A1 in the appendix shows the evolution of the annual growth rate of real corporate investment for the 22 economies. We can observe the collapse in investment following the financial crisis of 2008 as well as the temporary recovery until 2010-2011. Since then, corporate investment has declined again across most of the economies (with the exception of the US and United Kingdom) and has failed to regain historical growth rates.

Uncertainty

Dealing with the macroeconomic impact of uncertainty can be done in several ways (see, e.g., Bloom, 2014, Jurado et al. 2015, or Ferrara and Guérin, 2015). Typically, uncertainty as measured by financial volatility is one of the most used approaches in empirical papers (see for example the recent paper by Lewis et al., 2014, Vu, 2015, or Gennaioli, Ma, and Shleifer, 2015). In our paper, the variable for "realized volatility", corresponding to the square root of the mean squared daily equity returns during the year[3], is used as a proxy for uncertainty. Uncertainty measures for 22 countries are presented in Figure A2 in the Appendix. We clearly observe a double-peak shape: uncertainty rises both in 2001 and 2008, namely for the last two main

[3] Mean over 259 working days. The data have been drawn from Bloomberg.

economic recessions in advanced economies. In addition, it seems that uncertainty tends to stay high after the Global Financial Crisis of 2008-09, mainly for Euro area periphery countries. An alternative measure that we use is the Economic Policy Uncertainty (EPU)[4] index proposed by Baker, Bloom, and Davis (2013), but unfortunately not all the countries of the panel database are available. For G7 countries, EPU indexes and our uncertainty measures are quite correlated (between 0.2 and 0.5), except for Canada and the UK which are 0.1 and 0.0 respectively. We also consider the dispersion among forecasters for GDP nowcast as presented in the Consensus Forecast, the VIX index measuring the implied volatility of the S&P500 index options and a "news" index measured by forecast revisions. For G7 countries, these measures and our uncertainty index are generally correlated between 0.2 and 0.9[5].

Expected demand

One of the key contributions of this paper is to consider a forward-looking augmented accelerator model in which past demand is replaced by expected demand. The underlying intuition is to consider the possibility that output growth forecasts might play a first order role in determining current changes in business investment, to the extent that firms take into account future (and not just current) aggregate demand when making investment decisions. In addition, replacing the contemporaneous GDP growth in the equation by its conditional expectation using past information circumvents the endogeneity issue that arises when using contemporaneous GDP (investment being one of the components of GDP).

The "nowcast" and "1-year-ahead forecast" GDP growth variables have been collected from the World Economic Outlook reports released in April of each year, starting from 1996 to 2014. The "nowcast" corresponds to the GDP growth that is expected in April for the current year while the "1-year-ahead forecast" corresponds to the GDP growth that is expected in April for the next year. In general, the April version of the WEO uses data that are available in the first months of the year: by the time it is released, the GDP figure of the first quarter is not known (only the GDP from the previous year is known). Figures A3 and A4 in the Appendix present the evolution of GDP growth, the nowcast, and the 1-year forecast over the period 1996-2014 for the G7 countries. As expected, the figures reveal that the nowcasts of the current year are closer to realized observations than the 1-year-ahead forecasts. We also note that the GFC has been missed by the IMF (and by other forecasters as well), which always predicted a positive GDP growth.

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[4] The EPU index measures policy-related economic uncertainty. For the United States it is constructed from three types of underlying components: the first one quantifies newspaper coverage of policy-related economic uncertainty; the second one reflects the number of federal tax code provisions set to expire in future years; and the third component uses disagreements among economic forecasters. The European index is only based on newspaper articles regarding policy uncertainty. More information available on: http://www.policyuncertainty.com/.

[5] Correlations with our indicator are: between 0.2 and 0.8 for dispersion among forecasters (except for Japan and France which are -0.1 and 0.0 respectively), between 0.8 and 0.9 for the VIX index and between 0.2 and 0.5 for the "news" index (except for Japan which is 0.1).

Capital cost

The UCC (user cost of capital) variable is widely used, e.g. by Lewis, Pain, Strasky and Menkyna (2014), Ruiz et Hallaert (2014), Lee and Rabanal, 2010) and Barkbu et al. (2015). Here the definition we use is as follows:

$$\mathrm{UCC} = (\mathrm{i} - \pi + \delta) * \left(\frac{\mathrm{INVdef}}{\mathrm{GDPdef}}\right),$$

where *i* is the long-term government 10-year bond obtained from the OECD Economic Projections database, π is the annual growth rate of the GDP deflator[6], δ is fixed capital depreciation rate from the European Commission AMECO database, computed from the consumption of fixed capital and the stock of capital, and the ratio *(INVdef / GDPdef)* corresponds to the relative price of investment goods. Both deflators come from the OECD database, as presented in table A1 of the appendix.

Figure A5 in our appendix shows the evolution of annual changes in the user capital cost for the 22 countries. The overall negative values, at least in G7 countries, point out the decline in the cost of capital over the sample period, which should have contributed to the increase in business investment in the years preceding the crisis. However, UCC has risen during the Great Recession and the euro area recession in 2011-13, mainly for stressed economies in the euro area, highlighting the presence of financial constraints. At the end of the sample, many countries still have negative growth rates of the user capital cost reflecting, at least partly, the very accommodative monetary stance adopted by central banks around the world. Nonetheless, despite the persistent decline of the user cost of capital, some studies have not found any statistically significant effect of the former on investment or have even found a positive impact (BIS, 2015).

An interesting explanation can be drawn from Summers (2014). Indeed, it seems that there has been a substantial shift in the relative price of capital goods (represented by the investment deflator to the GDP deflator ratio in the user cost of capital equation). Summers (2014) suggests that "*cheaper capital goods mean that investment goods can be achieved with less borrowing and spending, reducing the propensity for investment*." At the same time, he highlights that "*an increase in inequality and the capital income share operate to increase the level of savings (…) reduced investment demand and increased propensity to save operate in the direction of a lower equilibrium real interest rate*." Therefore, both facts play an opposite role in the analysis of the relationship between the user cost of capital and the investment rate. It is then possible to consider that the two effects compensate each other, which might help explain the negligible impact of the user cost of capital on the investment rate.

[6] Except for Canada, Luxembourg and Norway where π is the annual growth rate of the CPI from national sources.

Correlation analysis

Table A3 in the appendix shows the relationships between business investment growth and each explanatory variable for the whole panel. As expected, corporate investment growth (ΔlnI_t) and output growth (ΔlnY_t) are positively and highly correlated with each other. The change in the user cost of capital does not seem to be strongly related to the business investment growth, as previously noted, but the sign is in line with the literature. Meanwhile, the positive relationship between business investment growth and output growth nowcast ($\Delta lnY0_t$) and 1-year output growth forecast ($\Delta lnY1_t$) is already a first indication that the "forward-looking" model may find empirical support and deserves further testing.

4.2 Estimation of the benchmark "augmented accelerator" model

In order to disentangle the role of explanatory variables in the observed decline in business investment growth, we first estimate a standard accelerator model augmented with capital cost and uncertainty. One key issue with the standard accelerator model is the endogenous bias that occurs due to the contemporaneous relationship between investment and GDP. In a first attempt to avoid such a bias, we simply introduce the first lag of GDP growth into the model, and we refer to this model as the benchmark backward-looking version. Thus the following equation is estimated, for $i=1, \ldots,N$ and $t=1,\ldots,T$:

$$\Delta lnI_{it} = \alpha_i + \beta_1 \,\Delta lnY_{it-1} + \beta_2 \,\Delta UCC_{it} + \beta_3 \,UNC_{it} + \varepsilon_{it} \qquad (1)$$

where ΔlnI_{it} is the change in the log of business investment, ΔlnY_{it-1} is the past GDP growth rate, ΔUCC_{it} is the annual difference in the capital cost and UNC_{it} is the uncertainty. In addition, we assume that ε_{it} is a zero-mean error term[7].

In order to check that these variables are indeed stationary, the test of Pesaran (2003) has been applied. This test has been developed within the framework of unit root tests on panel data and takes into account heterogeneous panels as well as the different cross-sectional dependence that might exist across individuals within the panel[8]. Analogous to the Im-Pesaran-Shin test (2003), the Pesaran test (2003) is consistent under the alternative that only a fraction of the series is stationary. Table A4 presents the results of the test. We conclude that the variables are indeed stationary.

Table 1 presents estimated results for the backward-looking augmented accelerator model that also includes the user cost of capital and the uncertainty variables. In order to assess the presence

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[7] The option to account for robust estimations of the variance has been applied in order to control for heteroskedastic residuals.

[8] Several tests for cross-sectional independence (Friedman 1937; Frees 1995, 2004; Pesaran, 2004) as presented in De Hoyos and Sarafidis (2006) have been applied and confirm the presence of cross-sectional dependence (correlated errors across cross sections) in the residual terms of benchmark regressions at the 1, 5 and 10 percent confidence level.

of country fixed effects, we have run several tests and we conclude that the mean business investment growth rate is not significantly different across the economies of our panel. Therefore, we do not account for country effects in any of the results presented in the following tables, where the estimated models are specified as pooled[9]. The first column shows that when past demand is used in isolation it has the expected sign and the R^2 is already at 16%. The second column presents the estimates from equation (1), while the third column presents results from equation (1) augmented with the first lag of uncertainty. Note that we have tested for additional lags for all variables but they were not found to be significant.

Table 1. Estimates from the backward-looking benchmark accelerator model

Variables	(1)	(2)	(3)	(4)
ΔlnY_{it-1}	1.243***	1.219***	0.894***	0.861***
	(0.180)	(0.158)	(0.163)	(0.158)
ΔUCC_{it}		-1.062***	-0.919***	-0.932***
		(0.234)	(0.239)	(0.245)
UNC_{it}		-1.625***	-0.537	
		(0.330)	(0.330)	
UNC_{it-1}			-2.746***	-2.974***
			(0.383)	(0.364)
constant	0.352	0.170	0.876**	0.922**
	(0.531)	(0.465)	(0.442)	(0.446)
N	392	388	387	387
R^2	0.161	0.265	0.349	0.346
adjusted R^2	0.159	0.259	0.342	0.341
legend: * p<0.1 ; **p<0.05 ; ***p<0.01				

Robust Standard Errors in (.). Y = GDP; UCC = user cost of capital; UNC =normalized uncertainty index by subtracting the country-specific mean and dividing by country-specific standard deviation.

First, we note that the accelerator effect is statistically significant in all specifications with a coefficient ranging from 0.9 to 1.2. Another result that can be seen in the second column is that

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[9] As regards our specification, we have initially tested the significance of country effects using a Lagrange Multiplier test for random effects as in Breusch and Pagan (1980). Results confirm that at 1%, 5% and 10%, the null hypothesis that variances across countries are zero cannot be rejected. Therefore, mean business investment growth rate is not significantly different across the economies of our panel and the model should be specified as pooled. An alternative F-test for the global significance of country fixed effects confirms these results at the same confidence levels. Results for the 1st and the 4th columns of table 1 and the 1st and 2nd columns of table 3 are presented in table 5 of the Appendix.

current economic uncertainty is statistically significant with the expected negative sign. However, when throwing in the first lag in the regression (column (3)), the coefficient of the current uncertainty variable decreases and becomes non-significant. By contrast, the coefficient of the lagged uncertainty is about five times stronger in magnitude and statistically significant at the 1% level. Dropping current uncertainty (column (4)) improves the goodness-of-fit of the model compared to column (2). This result points to the lagged effect of economic uncertainty in explaining the growth of current business investment. Moreover, changes in the user cost of capital appear to have a significant negative impact on the growth rate of corporate investment in all specifications.

4.3 Estimation of the "forward-looking augmented accelerator" model

After going through the "backward-looking" analysis, we now turn to the question whether results change when replacing observed output growth by its expected values (for subsequent years). Therefore, a "forward-looking" model is specified, in order to assess whether the anticipated decline in output growth would help explain the decline in business investment.

In this respect, we estimate the following equation for $i=1, \ldots, N$ and $t=1, \ldots, T$:

$$\Delta \ln I_{it} = \alpha_i + \beta_1 \, \Delta \ln Y0_{it} + \beta_2 \, \Delta UCC_{it} + \beta_3 \, UNC_{it} + \beta_4 \, UNC_{it-1} + \varepsilon_{it} \quad (2)$$

where $\Delta \ln Y0_{it}$ is the GDP growth rate nowcast as estimated by the IMF. Table 2 shows estimated results for equation (2) and its respective augmented specifications, which include $\Delta \ln Y1_{it}$, which is our variable for 1-year-ahead forecast (column (2)) and a combination of nowcast and forecast variables (column (3)).

From Table 2, we note that the expected demand variables are correctly signed and largely significant. Comparing those results with those from Table 1 shows that the value of the accelerator coefficient reaches about twice the magnitude obtained with the backward model (with higher goodness-of-fit), suggesting that growth expectations matter more than past records in the investment decision of companies. Note also that the forward-looking model yields better goodness-of-fit measures: the R^2 is close to 45% for the nowcast while it is reaches a maximum of 35% when using backward-looking models. When both nowcast and forecast variables are introduced simultaneously in the equation (as in column (4)) only the former stays significant. This could partly reflect that both variables are positively related (GDP growth is auto-correlated). A striking feature from Table 2 is that the uncertainty coefficients have been reduced by comparison with backward-looking models, though still negative. It may be that part of the uncertainty is now accounted for by expected demand. Again, the current uncertainty effect is no longer significant, only the lagged effect still plays a role. This raises the issue of the specification as regards uncertainty. In Table 3, we show that if we leave only current uncertainty in the forward-looking model, the estimated parameter is significant. But if we keep only the lagged uncertainty, the parameter is twice stronger in magnitude. This suggests that the impact of uncertainty, as measured by the volatility of financial variables, has a leading impact on the real economy that needs to be accounted for. As we deal with annual data, this lead is not easy to assess accurately, but we decide to keep only the lagged variable in our benchmark model, as it is the specification that comes out most clearly from our statistical tests.

Table 2. Estimates from the forward-looking augmented accelerator model

Variables	(1)	(2)	(3)	(4)
$\Delta lnY0_{it}$	2.078***			2.110***
	(0.232)			(0.280)
$\Delta lnY1_{it}$		1.523***		-0.081
		(0.326)		(0.393)
Mean_(ΔlnY0it			2.490***	
and ΔlnY1it)			(0.319)	
ΔUCC_{it}	-0.669***	-1.029***	-0.819***	-0.663***
	(0.222)	(0.300)	(0.237)	(0.219)
UNC_{it}	-0.343	-0.312	-0.406	-0.337
	(0.285)	(0.326)	(0.298)	(0.288)
UNC_{it-1}	-1.169***	-3.147***	-1.773***	-1.156***
	(0.359)	(0.367)	(0.363)	(0.360)
constant	-0.915**	-0.924	-2.413***	-0.778
	(0.463)	(0.769)	(0.638)	(0.729)
N	386	386	386	386
R^2	0.461	0.326	0.429	0.462
adjusted R^2	0.456	0.319	0.423	0.454
legend: * p<0.1 ; **p<0.05 ; ***p<0.01				

Robust Standard Errors in (.); Y_0 = GDP nowcast; Y_1 = GDP forecast; UCC = user cost of capital; UNC = normalized uncertainty index by subtracting the country-specific mean and dividing by country-specific standard deviation.

Table 3. Estimates from the forward-looking augmented accelerator model[10]

Variables	(1)	(2)
$\Delta lnY0_{it}$	2.376***	2.068***
	(0.205)	(0.230)
ΔUCC_{it}	-0.688***	-0.677***
	(0.214)	(0.224)
UNC_{it}	-0.692**	
	(0.278)	
UNC_{it-1}		-1.310***
		(0.349)
constant	-1.446***	-0.910**
	(0.436)	(0.462)
N	387	386
R^2	0.451	0.460
adjusted R^2	0.447	0.456
legend: * p<0.1 ; **p<0.05 ; ***p<0.01		

Robust Standard Errors in (.); Y_0 = GDP nowcast; Y_1 = GDP forecast; UCC = user cost of capital; UNC = normalized uncertainty index by subtracting the country-specific mean and dividing by country-specific standard deviation.

Overall, the forward-looking model that we propose to consider as a benchmark in this paper is as follows:

$$\Delta lnI_{it} = \alpha_i + \beta_1 \Delta lnY0_{it} + \beta_2 \Delta UCC_{it} + \beta_3 UNC_{it-1} + \varepsilon_{it} \quad (3)$$

and the estimated results are presented in column (2) of Table 3. It turns out that all variables are highly significant using this forward-looking specification and we base our robustness checks in the next subsection on this specification.

4.4 Robustness checks

In this section we carry out several robustness checks on the forward-looking selected model described by equation (3).

[10] Table A5 on the Appendix presents the Lagrange Multiplier test for random effects as in Breusch and Pagan (2008) for the 1st and the 2nd columns, as well as the F test for global significance of country fixed effects (see footnote 9).

Backward-looking or forward-looking?

We start by comparing the backward-looking and forward-looking augmented accelerator models. As we already noticed, the forward-looking model possesses a stronger explanatory power than the backward-looking model. To directly test one variable against the other, we include them in the same regression, using various controls. The results presented in Table 4 below are very clear: the coefficient of the backward-looking variable $\Delta \ln Y_{t-1}$ loses significance when it is estimated together with the forward-looking variable $\Delta \ln Y0_t$. In addition, the coefficients of the other variables appear to be remarkably stable. In the remaining of the paper, we therefore follow the forward-looking approach.

Table 4. Estimates from the augmented accelerator model: Backward-Looking vs Forward-Looking

Variables	(1)	(2)	(3)
$\Delta \ln Y_{t-1}$	-0.007 (0.181)	0.058 (0.166)	0.110 (0.164)
$\Delta \ln Y0_t$	2.553*** (0.238)	2.386*** (0.231)	1.981*** (0.253)
ΔUCC_t		-0.711*** (0.216)	-0.680*** (0.221)
UNC_{t-1}			-1.331*** (0.349)
constant	-1.571*** (0.489)	-1.617*** (0.451)	-0.960** (0.470)
Number of countries	**22**	**22**	**22**
Period	**1996-2014**	**1996-2014**	**1996-2014**
N	391	387	386
R^2	0.405	0.445	0.461
adjusted R^2	0.402	0.440	0.455
legend: * p<0.1 ; **p<0.05 ; ***p<0.01			

Robust Standard Errors in (.); Y_0 = GDP nowcast; Y_1 = GDP forecast; UCC = user cost of capital; UNC = normalized uncertainty index by subtracting the country-specific mean and dividing by country-specific standard deviation.

Alternative measures of expected demand

While the estimations presented in the previous section used GDP as a measure of demand, one may wonder how the results are affected when using alternative proxies for demand. In particular, it could be interesting to disentangle domestic and foreign expected demand, and to account for the expected fiscal stance separately. Expected foreign demand, in particular, appears to be a truly exogenous variable for small open economies and therefore represents a prominent variable to consider as an alternative to domestic production.

Table 5 presents the results obtained with such alternative variables. As we could only get the data for the subset of G7 countries, the first column (1) simply reproduces our benchmark specification for this subset of countries. When dealing with the G7 sub-sample of countries, we get that all the coefficients of benchmark model (column (1)) are highly significant, except the capital cost variable. Thus, it seems that the sensitivity of business investment to capital cost is lower in G7 countries than when using the whole set of countries, reflecting the fact that some non-G7 countries have been affected by a sharp rise in the cost of capital in the wake of the global financial crisis (e.g.: Greece, Portugal …). In addition, goodness-of-fit measures tend to be higher for G7 countries, suggesting that the model seems appropriate for highly industrialized countries. The results presented in the other columns show that domestic demand expectations for the current year (DD0) always enter the specifications with a positive and significant coefficient, no matter what other control variables are included. Expected world demand (WD0), defined as the average nowcasts of imports from trading partners, is also significant with the expected sign. This result is robust when we combine nowcasts (WD0) and 1-year-ahead forecasts (WD1) of world demand (column (5)). It is noteworthy that the introduction of the expected world demand in the specification reduces the role of uncertainty, the estimated parameter being non-significant in columns (3) and (4). This could partly reflect the fact that expected world demand and uncertainty are correlated – however the coefficient of the uncertainty variable is significant in column (5). We also tested a variable that captures expected demand only for advanced economies (AE) and the coefficient is also statistically significant (see column (6)).

Table 5. Estimates from the forward-looking augmented accelerator model: the role of Global Expected Demand

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Δln$Y0_t$	2.313*** (0.235)					
Δln$DD0_{it}$		2.113*** (0.237)	1.749*** (0.248)			
Δln$WD0_{it}$			1.495*** (0.357)	2.679*** (0.418)		
Mean (Δln$WD0_{it}$ and Δln$WD1_{it}$)					3.161*** (0.939)	
Mean (Δln$AE0_{it}$ and Δln$AE1_{it}$)						3.168*** (0.487)
ΔUCC_{it}	-0.326 (0.413)	-0.191 (0.449)	-0.153 (0.390)	-0.546 (0.431)	-0.511 (0.513)	-0.407 (0.490)
UNC_{it-1}	-1.260** (0.510)	-1.678*** (0.465)	-0.444 (0.495)	-0.940 (0.655)	-1.692** (0.766)	-1.578*** (0.549)
constant	-1.262*** (0.448)	-1.087** (0.479)	-5.748*** (1.173)	-7.196*** (1.155)	-9.709*** (3.623)	-4.707*** (1.107)
Number of countries	**G7**	**G7**	**G7**	**G7**	**G7**	**G7**
Period	**1997-2014**	**1997-2014**	**1997-2014**	**1997-2014**	**1997-2014**	**1997-2014**
N	119	119	119	119	119	119
R^2	0.629	0.617	0.657	0.505	0.405	0.480
adjusted R^2	0.619	0.607	0.645	0.492	0.390	0.466
legend: * p<0.1 ; **p<0.05 ; ***p<0.01						

Robust Standard Errors in (.); DD0 = Real Total Domestic Demand nowcast; WD_0 *= Real Total World Demand nowcast;* WD_1 *= Real Total World Demand 1-year-ahead forecast;* AED_0 *= Real Total Demand nowcast for Advanced Economies;* AED_1 *= Real Total Demand 1-year-ahead forecast for Advanced Economies; UCC = user cost of capital; UNC = normalized uncertainty index by subtracting the country-specific mean and dividing by country-specific standard deviation.*

We now further explore the role of demand by focusing on the fiscal balance as a driver of business investment in G7 countries. We look at such effects by introducing in the augmented accelerator forward-looking model the expected general governement fiscal balance, expressed in percentage of GDP. The estimated parameters are presented in Table 6. It turns out that not only the coefficient of the nowcast fiscal balance (FB0) is significant (column 2), but also that of the forecast (FB1, column (3)), both being negative (implying that a higher deficit or a lower surplus would stimulate investment, ceteris paribus). In column (4) of Table 6, we report the coefficient of the average fiscal balance variable, which turns out to be negative and statistically significant. We also considered the role of the revision in the expected fiscal stance, for year t (column (5)), which can generally be seen as a measure of budget consolidation. We find that the coefficient is statistically significant, implying that when the fiscal stance becomes more expansionary it stimulates business investment. Overall, therefore, there is empirical evidence of crowding-in based on our results, even though one needs to be very cautious in the interpretation of the coefficients in terms of causality, given that we cannot truly identify shocks in this framework.

As the results presented in Table 6 suggest that the fiscal balance plays a role, we take the estimations one step further and include in the regressions distinct variables for expected private and expected public consumption stemming from the April WEO of each year. Unfortunately, such expectations are not available in the WEO reports for all the 22 countries considered in our analysis, thus we restrict again our analysis to G7 countries. Results are presented in Table 7. They indicate that expected private consumption has the correct positive sign and is statistically significant (column (2) and following columns). Moreover, the coefficient for public consumption is statistically significant at the 10% level (columns (3) and (4)) with a negative sign. This result does not change when a measure of the foreign balance is included. It is worth mentioning that the coefficients of our key variables do not change that much and are robust to alternative model specifications.

Table 6. Estimates from the forward-looking augmented accelerator model: the role of government fiscal balance forecasts

Variables	(1)	(2)	(3)	(4)	(5)
$\Delta lnDD0_{it}$	2.113*** (0.237)	2.330*** (0.255)	2.352*** (0.241)	2.362*** (0.249)	1.886*** (0.257)
ΔUCC_{it}	-0.191 (0.449)	-0.188 (0.427)	-0.203 (0.400)	-0.195 (0.415)	-0.211 (0.431)
UNC_{it-1}	-1.678*** (0.465)	-1.717*** (0.467)	-1.347*** (0.460)	-1.573*** (0.462)	-1.019* (0.529)
$FB0_{it}$		-0.288*** (0.109)			
$FB1_{it}$			-0.506*** (0.121)		
Mean ($FB0_{it}$ and $FB1_{it}$)				-0.408*** (0.117)	
$FB1_{it}$-$FB0_{it}$					-0.819*** (0.274)
constant	-1.087** (0.479)	-2.461*** (0.746)	-3.050*** (0.696)	-2.852*** (0.734)	-0.341 (0.547)
Number of countries	**G7**	**G7**	**G7**	**G7**	**G7**
Period	**1997-2014**	**1997-2014**	**1997-2014**	**1997-2014**	**1997-2014**
N	119	119	118	118	118
R^2	0.617	0.636	0.667	0.650	0.644
adjusted R^2	0.607	0.623	0.656	0.638	0.632
legend: * p<0.1 ; **p<0.05 ; ***p<0.01					

Robust Standard Errors in (.); DD_0 *= Real Total Domestic Demand nowcast;* WD_0 *= Real Total World Demand nowcast;* WD_1 *= Real Total World Demand 1-year-ahead forecast;* AED_0 *= Real Total Demand nowcast for Advanced Economies;* AED_1 *= Real Total Demand 1-year-ahead forecast for Advanced Economies;* $FB0_t$ *= General Government Fiscal Balance nowcast (in % of GDP);* $FB1_t$ *= General Government Fiscal Balance 1-year-ahead forecast (in % of GDP); UCC = user cost of capital; UNC = normalized uncertainty index by subtracting the country-specific mean and dividing by country-specific standard deviation.*

Table 7. Estimates from the forward-looking augmented accelerator model: the role of GDP growth decomposition

Variables	(1)	(2)	(3)	(4)
$\Delta lnDD0_{it}$	2.113***			
	(0.237)			
$\Delta lnPrivate\_Conso0_{it}$		1.892***	2.110***	2.252***
		(0.315)	(0.315)	(0.365)
$\Delta lnPublic\_Conso0_{it}$			-0.774*	-0.696*
			(0.396)	(0.410)
$\Delta lnForeign\_Bal0_{it}$				0.778
				(0.645)
ΔUCC_{it}	-0.191	-0.539	-0.489	-0.609
	(0.449)	(0.509)	(0.498)	(0.505)
UNC_{it-1}	-1.678***	-2.522***	-2.279***	-2.257***
	(0.465)	(0.513)	(0.509)	(0.583)
constant	-1.087**	-0.760	-0.046	-0.382
	(0.479)	(0.633)	(0.717)	(0.792)
Number of countries	**G7**	**G7**	**G7**	**G7**
Period	**1997-2014**	**1997-2014**	**1997-2014**	**1997-2014**
N	119	119	118	109
R^2	0.617	0.515	0.536	0.568
adjusted R^2	0.607	0.502	0.519	0.547
legend: * p<0.1 ; **p<0.05 ; ***p<0.01				

Robust Standard Errors in (.); DD_0 = Real Total Domestic Demand nowcast; UCC = user cost of capital; UNC = normalized uncertainty index by subtracting the country-specific mean and dividing by country-specific standard deviation; $Private\_Conso0_{it}$ = Private Consumption nowcast; $Public\_Conso0_{it}$ = Public Consumption nowcast; $Foreign\_Bal0_{it}$ = Foreign Balance nowcast (changes expressed as % of GDP in the preceding period)

Another natural question that arises from this exercise is whether our results depend on the source of the data that we have used for expected demand. In the results that we have presented so far, we have used the IMF WEO April projections for the current year (nowcast) and next year (forecast). In order to test the robustness of our results to the use of another source, we complement our analysis with data stemming from the Consensus Forecasts (CF). The results for G7 countries, presented on Table 8, leave no ambiguity: when comparing each specification, for the three pairs of columns, the coefficients are very close. This is not a surprise if one considers that most forecasting institutions typically converge towards each other, but it is comforting for our results, as they are not institution-specific (if the forecasts diverged significantly, one would wonder which institution the investors would predominantly focus on, but here this question has no empirical relevance).

Table 8. Estimates from the forward-looking augmented accelerator model: alternative forecasts (Consensus Forecasts vs. WEO forecasts)

Variables	WEO	CF	WEO	CF	WEO	CF
$\Delta lnY0_{it}$	2.228*** (0.294)	2.324*** (0.349)				
$\Delta lnY1_{it}$			0.614 (0.614)	0.950 (0.612)		
Mean_(ΔlnY0it and ΔlnY1it)					2.695*** (0.443)	2.795*** (0.509)
ΔUCC_{it}	-0.762 (0.480)	-0.827* (0.490)	-1.212* (0.711)	-1.202* (0.721)	-0.806 (0.610)	-0.885 (0.622)
UNC_{it-1}	-1.563** (0.663)	-1.649** (0.661)	-4.209*** (0.654)	-4.303*** (0.655)	-2.281*** (0.686)	-2.612*** (0.666)
constant	-1.347*** (0.476)	-1.602*** (0.554)	0.267 (1.434)	-0.464 (1.418)	-2.884*** (0.798)	-3.230*** (0.890)
Number of countries	**G7**	**G7**	**G7**	**G7**	**G7**	**G7**
Period	**2001-2014**	**2001-2014**	**2001-2014**	**2001-2014**	**2001-2014**	**2001-2014**
N	91	91	91	91	91	91
R^2	0.655	0.649	0.427	0.434	0.579	0.579
adjusted R^2	0.643	0.637	0.407	0.415	0.564	0.565
legend: * p<0.1 ; **p<0.05 ; ***p<0.01						

Robust Standard Errors in (.);Y_0 = mean GDP nowcast from Consensus Forecast; Y_1 = mean GDP 1-year-ahead forecast from Consensus Forecast; UCC = user cost of capital; UNC = normalized uncertainty index by subtracting the country-specific mean and dividing by country-specific standard deviation

Alternative measures of uncertainty

We also need to ensure that our previous results on the determinants of investment are robust when alternative measures of uncertainty are used. Obviously, uncertainty is not directly observable, and many measures of uncertainty have been put forward in the economic literature (see for instance Baker at al., 2013, or Jurado et al., 2015). Against this background, our aim is to check the robustness of our results to alternative measures of uncertainty. We consider four alternative measures: (i) an index of news in forecast revisions (as well as the square of this variable), (ii) the Economic Policy Uncertainty (EPU) index of Baker et al. (2013), (iii) the dispersion among forecasters as provided by the Consensus Forecasts and (iv) the VIX index, the widely known "fear index" of financial markets measured by the implied volatility of the S&P 500 index options.

The index of news is constructed by taking the difference between 1-year-ahead forecast of GDP growth for a given year and the nowcast for the same year. This reflects the new information that forecasters have integrated to revise their GDP growth expectations. We consider the absolute values of this index, as well as the squared values. This kind of approach has been used in the literature for example by Scotti (2013).

First, we integrate the news index in the benchmark model. Results are presented in Table 9 for all 22 countries, as well as with the VIX index. Then we integrate both the EPU index and the dispersion among forecasters. The results, which are only available for G7 countries, are presented in Table 10.

The results are clear: whatever measure of uncertainty is employed, expected demand (proxied by the nowcast) remains by far the most important variable (and the coefficient remains in the same ballpark). Interestingly as well, the coefficient of the cost of capital also remains roughly unchanged throughout the exercise. Indeed, this coefficient is always negative but stays largely significant when dealing with the whole sample of 22 countries (Table 9), while it remains non-significant when considering only the G7 countries (Table 10).

As regards the various uncertainty measures that we checked, we point out several noticeable results. First, the EPU index and the dispersion among forecasters do not seem to play an important role in explaining investment: although the former is significant at the 10% confidence level, it comes with the opposite of the expected sign, and the latter is not significantly different from zero. Then, the "news" variable itself is significant with the correct (negative) sign when considering its current values (Table 9): more uncertainty means less investment, *ceteris paribus*. Using this "news" variable as a measure of uncertainty, we also point out that the effect seems to be more contemporaneous than when using financial volatility (VIX or our uncertainty measure), reinforcing the view already expressed above that our benchmark uncertainty measure possesses a leading pattern vis-à-vis the business cycle. There seems to be a difference in the diffusion delay between macroeconomic uncertainty and financial uncertainty.

Table 9. Estimates from the forward-looking augmented accelerator model: alternative measures of uncertainty (estimation period covers 1996-2014) [11]

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta lnY0_{it}$	2.376*** (0.205)	2.068*** (0.230)	2.022*** (0.286)	2.393*** (0.208)	1.987*** (0.277)	2.400*** (0.207)	2.448*** (0.212)	2.113*** (0.219)
ΔUCC_{it}	-0.688*** (0.214)	-0.677*** (0.224)	-0.687*** (0.214)	-0.779*** (0.217)	-0.719*** (0.217)	-0.756*** (0.216)	-0.689*** (0.220)	-0.726*** (0.227)
UNC_{it}	-0.692** (0.278)							
UNC_{it-1}		-1.310*** (0.349)						
$news^2_{it}$			-1.138** (0.462)					
$news^2_{it-1}$				-0.531* (0.289)				
$\|news\|_{it}$					-1.250*** (0.438)			
$\|news\|_{it-1}$						-0.386 (0.292)		
VIX_{it}							-0.360 (0.286)	
VIX_{it-1}								-1.361*** (0.328)
constant	-1.446*** (0.436)	-0.910** (0.462)	-0.846* (0.506)	-1.511*** (0.433)	-0.792 (0.498)	-1.516*** (0.431)	-1.606*** (0.440)	-1.013** (0.457)
Number of countries	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**
N	387	386	387	387	387	387	387	387
R^2	0.451	0.460	0.454	0.449	0.456	0.447	0.447	0.468
Adj. R^2	0.447	0.456	0.450	0.444	0.452	0.442	0.442	0.464

legend: * p<0.1 ; **p<0.05 ; ***p<0.01

Robust Standard Errors in (.); Y_0 *= GDP nowcast;* Y_1 *= GDP forecast; UCC = user cost of capital; UNC = normalized uncertainty index by subtracting the country-specific mean and dividing by country-specific standard deviation; news =* $\Delta lnY1_{it} - \Delta lnY0_{it}$*;* $(news)^2_{it}$ *= normalized squared news index by subtracting the country-specific mean and dividing by country-specific standard deviation;* $|news|_{it}$ *= normalized absolute news index by subtracting the country-specific mean and dividing by country-specific standard deviation*

[11] Correlation between UNC_{it} and $|news|_{it}$ and between UNC_{it} and $(news)_{it}^2$ is 0.21 and 0.22 respectively.

Table 10. Estimates from the forward-looking augmented accelerator model: alternative measures of uncertainty (estimation period covers 2001-2014)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta lnY0_{it}$	2.519***	2.228***	2.775***	2.736***	2.520***	2.760***	2.631***	2.001***
	(0.217)	(0.294)	(0.234)	(0.232)	(0.296)	(0.228)	(0.230)	(0.308)
ΔUCC_{it}	-0.354	-0.762	-0.023	-0.473	-0.355	-0.454	-0.374	-0.606
	(0.480)	(0.480)	(0.551)	(0.487)	(0.499)	(0.496)	(0.487)	(0.450)
UNC_{it}	-1.052**							
	(0.418)							
UNC_{it-1}		-1.563**						
		(0.663)						
EPU_Bloom_{it}			0.782*					
			(0.397)					
EPU_Bloom_{it-1}				-0.137				
				(0.361)				
$dispersionY0_{it}$					-0.464			
					(0.597)			
$dispersionY0_{it-1}$						-0.195		
						(0.487)		
VIX_t							-0.669	
							(0.417)	
VIX_{t-1}								-1.981***
								(0.622)
constant	-1.966***	-1.347***	-2.245***	-2.00***	-1.969***	-2.014***	-2.117***	-1.085**
	(0.477)	(0.476)	(0.539)	(0.522)	(0.546)	(0.519)	(0.516)	(0.470)
Number of countries	**G7**	**G7**	**G7**	**G7**	**G7**	**G7**	**G7**	**G7**
N	98	91	97	91	98	91	98	91
R^2	0.615	0.655	0.605	0.625	0.595	0.625	0.602	0.669
adjusted R^2	0.603	0.643	0.592	0.612	0.582	0.613	0.590	0.657

legend: * p<0.1 ; **p<0.05 ; ***p<0.01

Robust Standard Errors in (.); Y_0 = GDP nowcast; Y_1 = GDP forecast; UCC = user cost of capital;

UNC = normalized uncertainty index by subtracting the country-specific mean and dividing by country-specific standard deviation; EPU = normalized Economic Policy Uncertainty index (Bloom) by subtracting the country-specific mean and dividing by country-specific standard deviation; $dispersion\_Y0_{it-1}$= normalized dispersion of GDP nowcast from Consensus Forecast by subtracting the country-specific mean and dividing by country-specific standard deviation; VIX (not country-specific)= normalized Chicago Board Options Exchange Market Volatility Index by subtracting the mean and dividing by the standard deviation.

Alternative measures of financial constraints

Finally, we also submitted our cost of capital variable to similar robustness tests and checked whether alternative measures yield similar results or would lead us to reconsider the previous results. To this aim, we integrate three alternative variables in our benchmark models: credit spreads, data from the surveys carried by the European Commission[12] and the measure for the user cost of capital used in Lewis et al. (2014, equation (1) p.13), which is an extended measure of our UCC variable accounting for the corporate tax rate and the fraction of debt in corporate liabilities[13]. Credit spreads are constructed by computing the differences between long-term government bond yields for each country, respective to Germany when dealing only with European countries (EU(14) dataset) and to the US for the whole set of 22 countries and G7 sub-sample.

The main results are presented in Table 11 below. First, it is noteworthy that the sign and the coefficients of expected demand and uncertainty are broadly the same throughout the various estimations reinforcing their role in explaining investment.

When comparing both UCC and credit spreads on the same panel of 22 countries (columns (1) and (2)), we get extremely similar results, both financial variables being significant. If we focus only on the G7 subsample (columns (3) and (4)), we get that both financial constraint variables do not play any role in explaining investment. Both results underline the robustness of the model to the choice of this kind of variable.

When focusing on the EU(14) sub-sample (columns (5) to (7)), we find that the three different measures of financial constraints lead to extremely robust results. All the three estimated parameters related to capital costs are significant with the expected negative sign, while other parameters are not affected. Moreover, when considering the alternative measure for the user cost of capital put forward by Lewis et al. (2014) (column (8)), it returns similar results.

[12] The survey reports the number of respondents claiming financial constraints as the factor limiting production. Data are only available for European countries except Ireland, that is 14 countries (denoted EU(14)).

[13] This variable is only available for a subset of 13 OECD countries (see details in appendix).

Table 11. Estimates from the forward-looking augmented accelerator model: Alternative measures of financial constraints

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta lnY0_{it}$	2.068*** (0.230)	2.187*** (0.233)	2.313*** (0.235)	2.376*** (0.239)	2.465*** (0.190)	2.559*** (0.196)	2.453*** (0.218)	2.174*** (0.193)
UNC_{it-1}	-1.310*** (0.349)	-1.246*** (0.340)	-1.260** (0.510)	-1.160** (0.498)	-0.752** (0.372)	-0.720* (0.373)	-0.769** (0.386)	-1.750*** (0.379)
ΔUCC_{it}	-0.677*** (0.224)		-0.326 (0.413)		-0.858*** (0.228)			
$d\_credit\_spreads_{it}$		-0.832*** (0.307)		-0.933 (0.606)		-0.978*** (0.309)		
$d\_EC\_survey_{it}$							-0.410** (0.195)	
$\Delta UCC_{it\_Lewis\ et\ al.\ (2014)}$								-0.545* (0.292)
constant	-0.910** (0.462)	-0.994** (0.474)	-1.262*** (0.448)	-1.287*** (0.450)	-1.708*** (0.398)	-1.651*** (0.388)	-1.421*** (0.433)	-0.911** (0.420)
Number of countries	22	22	G7	G7	EU(14)	EU(14)	EU(14)	OECD(13)
Period	**1996-2014**	**1996-2014**	**1997-2014**	**1996-2014**	**1996-2014**	**1996-2014**	**1996-2014**	**1996-2013**
N	386	386	119	119	244	244	237	219
R^2	0.460	0.458	0.629	0.633	0.549	0.545	0.525	0.588
adjusted R^2	0.456	0.454	0.619	0.623	0.544	0.539	0.519	0.582

legend: * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Robust Standard Errors in (.); Y_0 = GDP nowcast; UCC = user cost of capital; UNC =normalized uncertainty index by subtracting the country-specific mean and dividing by country-specific standard deviation ; credit spreads = spreads of long_term government bonds yields relative to the United States; lending rate = maximum rate charged by commercial banks except for France and Germany which is the lending rate for new business for loans over 1 million euros at a floating rate or up to and including a one-year interest rate fixation; EC_survey = European Commission's Business and Consumer Survey (quarterly). Seasonally adjusted series are for survey of manufacturing industry: percent of correspondents listing financial constraints as the factor limiting production.

4.5 Further results

In this section we put forward some additional results that we get using the estimated model presented above.

Contributions to investment growth

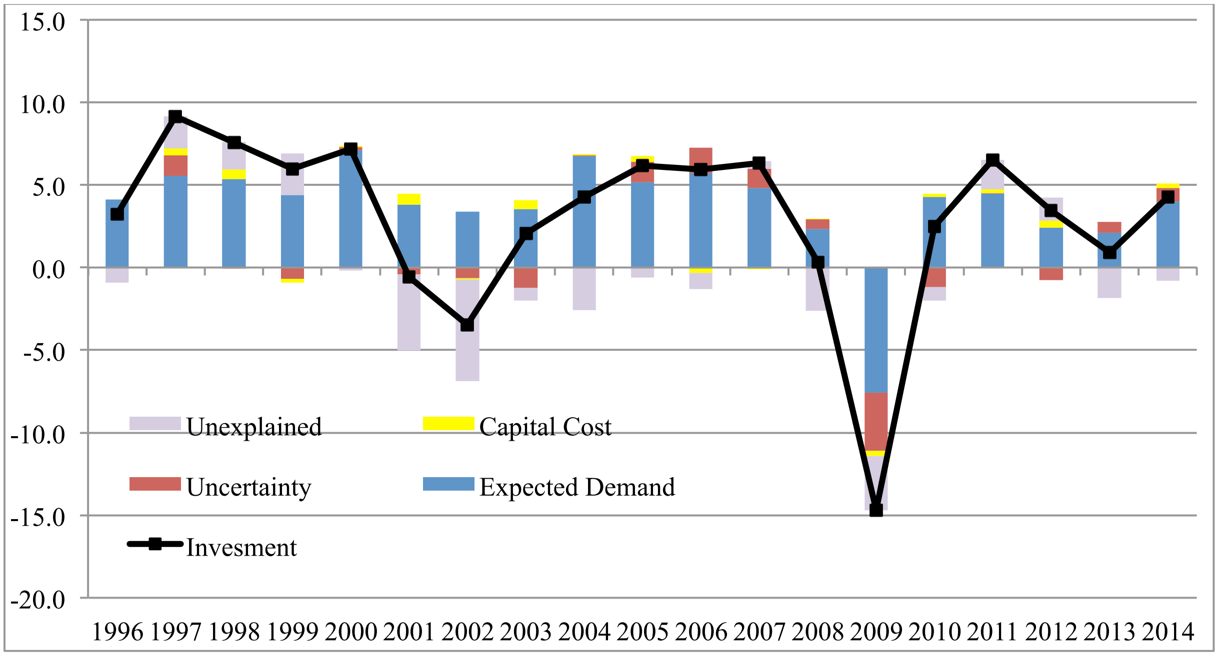
Based on previous results of the benchmark forward-looking model as given by equation (3), we first look at the contributions of each explanatory variable to investment growth.

First we compute contributions for all the 22 countries stemming from the estimated model, then we compute an aggregate using weighted averages. In this respect, we use the 2011 normalized weights based on expenditures in Gross Fixed Capital Formation in billions of USD converted using PPP (Purchasing Power Parity) exchange rates, as provided by the International Comparison Program of the World Bank. The annual contributions to investment growth are presented in Figure 3.

We observe that, on average over all the countries, expected demand always plays the largest role in explaining investment growth, while the contribution of uncertainty tends to become negative during recession periods (2001 and 2008-09). Uncertainty also played a negative role over the years 2010-12, but not to a large extent. It is also noteworthy that the role of financial constraints is always quite small.

Based on our results, the average drop in the business investment growth of around 4 p.p. in our panel of advanced economies, from 4.5% during the pre-crisis period to 0.5% over the years 2008-2014, can be mainly attributed to expected demand (negative contribution of 3.3 p.p.) and uncertainty (negative contribution of 0.7 p.p.). The capital costs do not contribute significantly to this drop.

Figure 3: Aggregated contributions to business investment growth estimated using the benchmark forward-looking model


15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
Unexplained
Capital Cost
Uncertainty
Expected Demand
Invesment
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

Is there a specific effect due to the occurrence of crises?

We check the effects of our main variables on investment when controlling for economic crises along the sample (Table 12). We define a crisis in a given year when annual GDP growth drops below zero. It turns out that since 1996 many such events occurred (Asian crisis, Internet bubble, Global Financial Crisis, European Crisis, etc…), which may bias our estimates. When dropping crisis times from the sample (which represent about one fourth of the observations), the results prove remarkably robust for the forward looking model (the first two columns of Table 12). Demand still plays a significant role in explaining investment growth, for both forward-looking and backward-looking augmented accelerator models. In the backward-looking model, the coefficients of the demand term remain in the same ballpark. However, the cost of capital is no longer significant in either the backward-looking model or in the forward-looking one, suggesting that the role of capital cost in explaining investment dynamics might be driven by crisis years.

Table 12. Effects of country-specific crisis periods on augmented accelerator models

Variables	Forward-Looking model	Forward-Looking model (without crisis)	Backward-Looking model	Backward-Looking model (without crisis)
$\Delta lnY0_{it}$	2.068***	1.711***		
	(0.230)	(0.372)		
ΔlnY_{it-1}			0.861***	0.753***
			(0.158)	(0.243)
ΔUCC_{it}	-0.677***	-0.357	-0.932***	-0.477
	(0.224)	(0.291)	(0.245)	(0.291)
UNC_{it-1}	-1.310***	-1.282***	-2.974***	-1.756***
	(0.349)	(0.413)	(0.364)	(0.433)
intercept	-0.910**	0.377	0.922**	2.198***
	(0.462)	(0.788)	(0.446)	(0.675)
Number of countries	**22**	**22**	**22**	**22**
Period	**1996-2014**	**1996-2014**	**1996-2014**	**1996-2014**
N	386	295	387	296
R^2	0.460	0.166	0.346	0.108
adjusted R^2	0.456	0.158	0.341	0.099
legend: * p<0.1 ; **p<0.05 ; ***p<0.01				

Robust Standard Errors in (.);Y = GDP; Y_0 = GDP nowcast; Y_1 = GDP forecast; UCC = user cost of capital; UNC = normalized uncertainty index by subtracting the country-specific mean and dividing by country-specific standard deviation.

One could well imagine that uncertainty behaves in a similar way as capital cost, and that it has a differentiated effect depending on the period of time. However, estimations for both models suggest that this variable plays an important role all over the period. Specially, using the forward-looking model, the estimated parameter for uncertainty stays remarkably stable if we include or not crisis periods in the sample.

Counterfactual level of investment with unbiased 1-year-ahead forecast of GDP growth

Based on previous results, we assess what the estimated growth of business investment would have been if IMF GDP growth projections were perfect, instead of being nearly consistently over-optimistic. In this respect, we ran a counterfactual calculation based on the 1-year-ahead forward-looking benchmark model. In a first step, we compute the business investment growth rate predicted by the benchmark model. In a second step we compute estimated values by using the estimated coefficients and by replacing *expected* GDP values by *observed*, ex post, GDP values (i.e.: perfect forecasts). For both steps, we computed cumulative gaps for 1-year-ahead forecasts over the period 2007-2014. The results are presented in Table 13 and the graphs are presented in the Appendix (Figure A6).

In this case, it is striking to note that investment would have been even lower than observed in almost all the countries (except Switzerland) if forecasters had achieved perfect GDP growth forecasts (first column of Table 13). This is especially true in some euro area countries where the IMF forecasts have been largely above realized growth rates. If we aggregate those differences by using the normalized weights based on PPP expenditures in GFCF as provided by the World Bank, we get that on average over all the countries, business investment growth would have been almost 12 p.p. lower than observed, in cumulative terms over the period 2007-2014. Thus, we can say that, to some extent, the over-optimistic GDP growth forecasts have contributed to support business investment, as companies have a forward forward-looking behavior.

Table 13: Cumulative gap between business investment growth as predicted by the model and the one as projected using perfect GDP forecasts vs. observed cumulative business investment growth for the period 2007-2014

	2007-2014		
Countries	*Cumulative Gap_ Forecast*	*Cumulative ΔlnIt*	*Difference*
United States	*-11,68*	*15,05*	*3,37*
Australia	*-2,03*	*47,15*	*45,12*
Austria	*-9,34*	*0,55*	*-8,79*
Belgium	*-5,48*	*10,73*	*5,26*
Canada	*-9,34*	*18,04*	*8,70*
Denmark	*-20,66*	*-16,72*	*-37,38*
Finland	*-20,46*	*-14,22*	*-34,68*
France	*-10,40*	*9,94*	*-0,46*
Germany	*-1,61*	*6,57*	*4,96*
Greece	*-53,34*	*-41,79*	*-95,13*
Ireland	*-20,89*	*8,66*	*-12,23*
Italy	*-20,16*	*-26,44*	*-46,60*
Japan	*-15,15*	*-0,95*	*-16,10*
Luxembourg	*-8,23*	*16,65*	*8,42*
Netherlands	*-9,60*	*10,96*	*1,36*
New Zealand	*-7,84*	*32,26*	*24,42*
Norway	*-11,31*	*18,71*	*7,40*
Portugal	*-15,90*	*-22,15*	*-38,05*
Spain	*-18,26*	*-8,99*	*-27,25*
Sweden	*-11,43*	*13,94*	*2,50*
Switzerland	*4,27*	*14,43*	*18,70*
United Kingdom	*-12,51*	*23,93*	*11,41*
Aggregated	***-11,73***	***8,69***	***-3,04***

5. Conclusion

This paper focuses on the determinants of business investment among advanced economies, aiming to disentangle the role of demand, uncertainty and financial conditions. We present results from an augmented accelerator model of business investment, in which we introduce expected demand, stemming from IMF WEO forecasts, while existing studies use current or even past measures of demand. This model is estimated for a panel of 22 advanced economies with annual data going back to 1996.

The results first tend to favor models using forward-looking demand rather than backward-looking demand, pointing out the forward-looking approach of entrepreneurs in their decision to invest. We find that expected demand is by far the most important factor, while uncertainty and, to a lesser extent, capital costs, have played a role as well. Moreover, our results are robust to a battery of robustness tests, checking in particular that our main findings are not affected when other proxies for expected demand, uncertainty and the cost of capital are chosen. The results are also robust to the exclusion of crisis periods from the sample, except for the unit cost of capital.

A corollary result is that the systematically over-optimist GDP forecasts since the onset of the crisis have significantly supported business investment, which would be almost 12 p.p. (in cumulative terms) lower if forecasts had been perfect.

From a policy perspective, our empirical results underline the importance of expected aggregate demand as a key driver of business investment. Thus, economic policies aiming at boosting expected demand represent the most effective tool that can be used to stimulate investment. Having said that, the role of the other factors should not be neglected. The cost of capital seems to play a more modest role for most of the countries, but our country-by-country decomposition reveals that it had an important contribution for some of the EU periphery countries. In addition, it seems that uncertainty plays a role as well. Reducing global uncertainty should lead to additional investment growth, in line with economic theory. One possible issue to highlight, however, is that uncertainty is still a somewhat elusive concept and the channels through which uncertainty can be reduced are not entirely clear. In this respect, the Juncker plan of the European Commission is a key step forward as it aims to reduce uncertainty on the supply side through the development of a more investment-friendly environment.

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Appendix

Table A1. Data description and Sources

Variables	**Description**	**Source**	**Expected Sign**
Idef	GFCF deflator (2005=100)	OECD AND ECB	
Ydef	GDP deflator (2005=100)	OECD	
I	real private non-residential GFCF (LCU)	OECD and ECB	dep. var.
r	long-term government 10 year bond	EO 96 OECD	(-)
Y	real GDP (LCU)	OECD	(+)
Y0	nowcast GDP y-o-y growth rate (%)	WEO y-o-y	(+)
Y1	1-year forecast GDP y-o-y growth rate (%)	WEO y-o-y	(+)
UNC	realized volatility[14]	author's calculations	(-)
UCC	see equation for capital cost in Section 4	author's calc ulations	(-)

LCU = local currency unit; WEO = World Economic Outlook.

[14] UNC = $\sqrt{\frac{1}{259}\sum_1^{259}(\Delta x_t)^2}$ where Δx_t are the daily equity returns during the year in local currency from country specific index.

Table A2. List of Countries

Countries	Acronym	Identification
United States*	US	1
Australia	AS	2
Austria	AU	3
Belgium*	BG	4
Canada*	CA	5
Denmark*	DK	6
Finland*	FI	7
France*	FR	8
Germany*	GE	9
Greece	GR	10
Ireland	IR	11
Italy	IT	12
Japan*	JP	13
Luxembourg	LX	14
Netherlands*	NT	15
New Zealand*	NZ	16
Norway	NR	17
Portugal	PR	18
Spain	SP	19
Sweden*	SD	20
Switzerland*	SW	21
United Kingdom*	UK	22

Source: author's calculations. Countries with a star are included in the OECD(13) subsample used by Lewis et al. (2014)

Table A3. Correlation matrix for the whole panel (387 observations)

Variables	ΔlnI_t	ΔlnY_t	$\Delta lnY0_t$	$\Delta lnY1_t$	ΔUCC_t	UNC_t
ΔlnI_t	1.00					
ΔlnY_t	0.66	1.00				
$\Delta lnY0_t$	0.65	0.86	1.00			
$\Delta lnY1_t$	0.32	0.45	0.55	1.00		
ΔUCC_t	-0.27	-0.19	-0.21	-0.01	1.00	
UNC_t	-0.24	-0.34	-0.21	-0.05	0.09	1.00

Source: author's calculations

Table A4. Pesaran (2003) panel unit root test

Variables[15]	CADF	P-value
ΔlnI_t	-9.010	0.000
ΔlnY_t	-3.057	0.000
ΔUCC_t	-14.051	0.000
UNC_t	-1.842	0.033
$\Delta lnY0_t$	-5.242	0.000
$\Delta lnY1_t$	-6.297	0.000

Because of the time series length, variables are practically smooth. Therefore, there is no suspicion of serial correlation and thus no lags have been considered when implementing the test.
Source: author's calculations

[15] All variables are annual growth rates except for UNC_t and ΔUCC_t (which is defined as $ucc_t - ucc_{t-1}$ because it is considered as a rate).

Stationarity test (Pesaran, 2003)

With no error term autocorrelation, the Pesaran unit root test consists of an augmented *"Dickey-Fuller"* model that introduces cross section averages of lagged levels and first-differences of the individual series. The model can be written as follows:

$$\Delta y_i = \alpha_i + \rho_i y_{i,t-1} + c_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + v_{i,t} + e_{i,t}$$

In the presence of error term autocorrelation, the model will be augmented in order to consider the usual terms from the specification of the *"Augmented Dickey-Fuller"* model. Therefore, lags of the dependent variable may be introduced to control for serial correlation in the errors. The order of augmentation can be estimated using model selection criteria such as Akaike or Schwartz applied as usual to the underlying time series specification.

$$\Delta y_i = \alpha_i + \rho_i y_{i,t-1} + c_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + v_{i,t} + \sum_{j=0}^{p} d_{i,j}\, \Delta \bar{y}_{t-j} + \sum_{j=0}^{p} \delta_{i,j}\, \Delta y_{i,t-j} + e_{i,t}$$

The individual *Cross-Sectionally Augmented Dickey-Fuller* (CADF) statistics will be constructed in order to test the null hypothesis of unit root for the individual i. It is important to highlight that the distribution of the statistics CADF converges towards the asymptotic distribution when the cross sectional size N and the times series T are big enough. In the case where T is fixed, however, the test should be directly applied to the difference $y_{i,t} - \bar{y}_0$ (where $\bar{y}_0$ is the initial cross section mean). Despite de small size of the present panel dataset (22 countries and 19 years), an asymptotic distribution of the CADF statistic has been considered for simplicity and a standard Pesaran unit root test has been applied. Table A4 on the Appendix presents the results of the test.

At the 5 percent confidence level, we can conclude that all variables (in first differences) are stationary (we reject the null hypothesis of unit root for individual i).

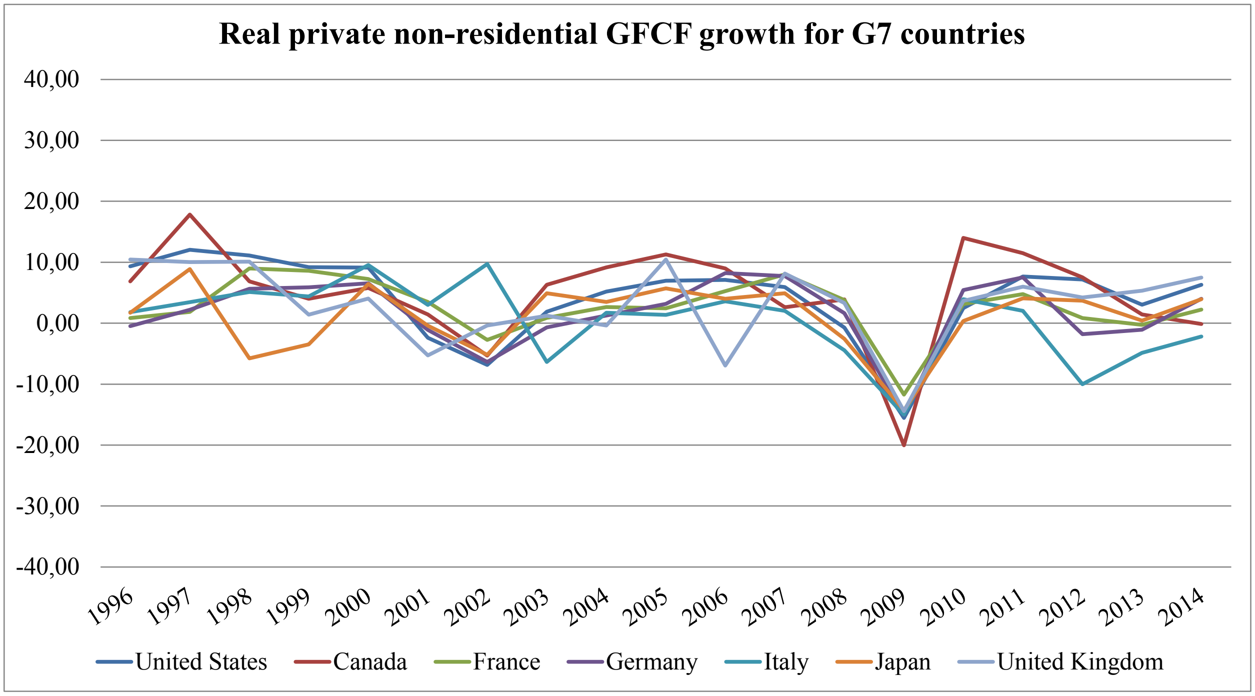
Table A5. Breusch and Pagan LM test for random effects and F test for global significance of country fixed effects

“Forward-looking” and “Backward-looking” approaches

	Chibar2(01)	p-value	F test	p-value
FL (1st column)	0.00	1.000	F(22, 362) = 0.99	0.4756
FL (2nd column)	0.00	1.000	F(22,361) = 0.62	0.9069
BL (1st column)	0.00	1.000	F(22, 369) = 0.20	1.000
BL (4th column)	0.00	1.000	F(22, 362) = 0.57	0.9403

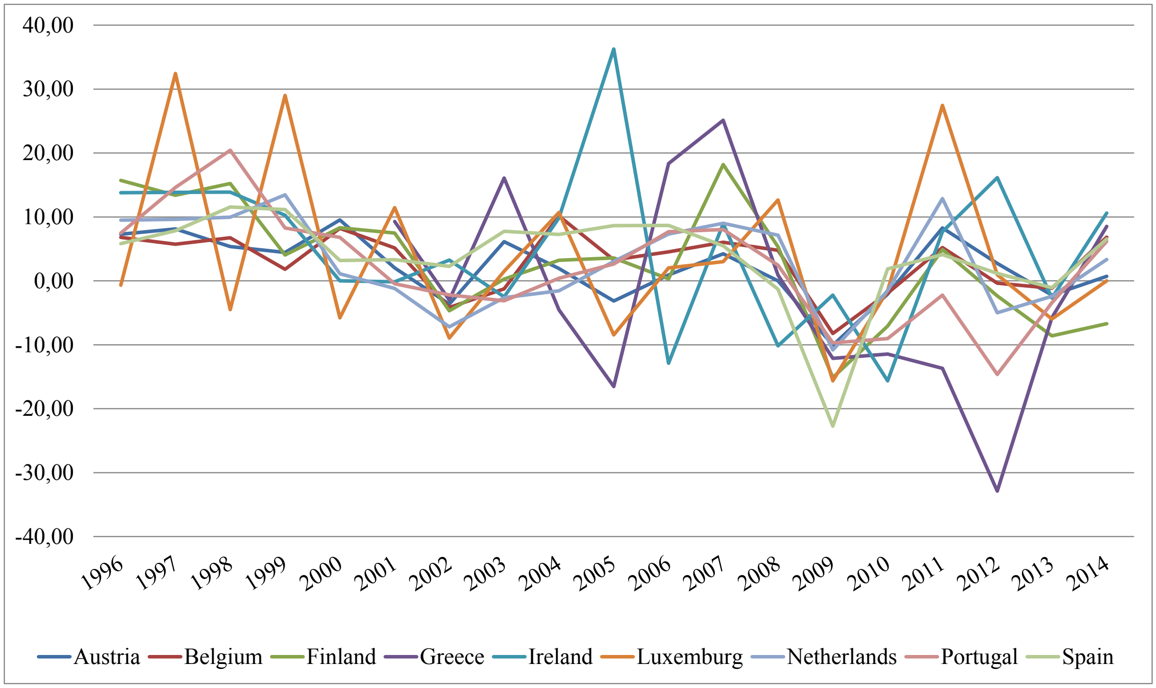
Source: author’s calculations

Figure A1: Real private non-residential GFCF growth



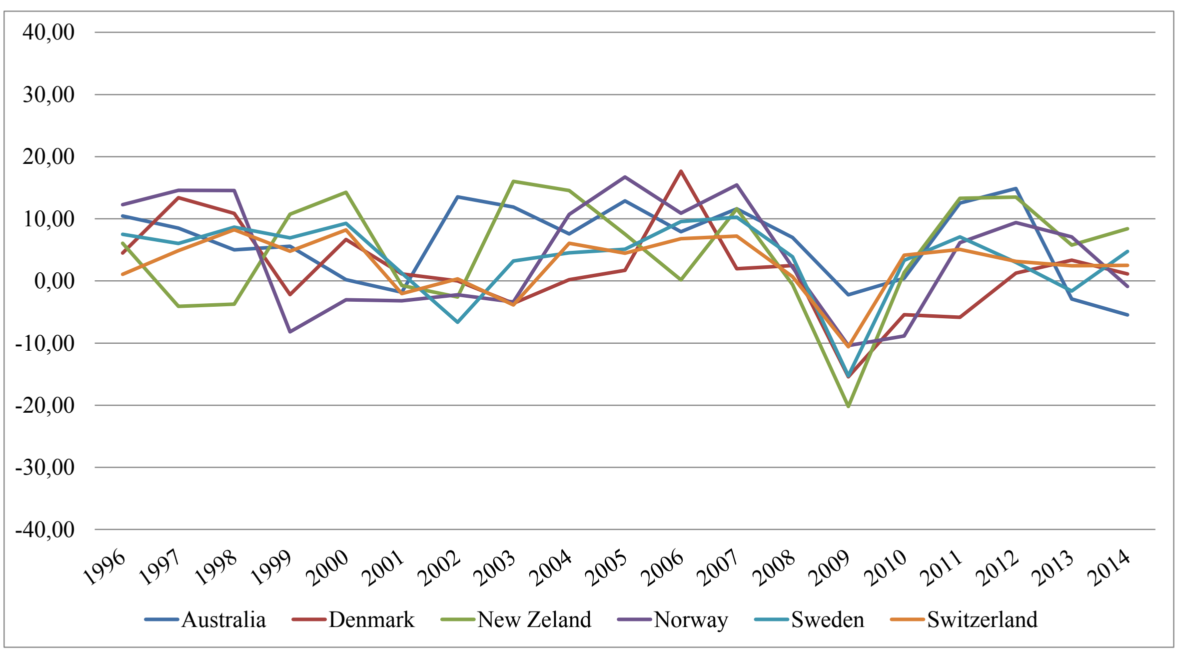
Source: OECD, ECB

Real private non-residential GFCF growth for Euro Area (non-G7) countries



Source: OECD, ECB

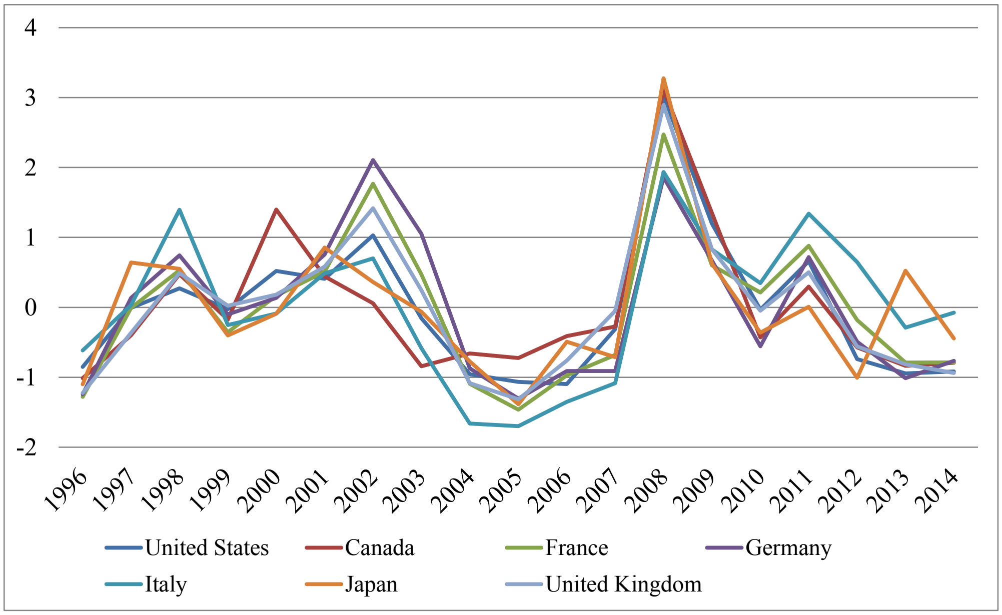
Real private non-residential GFCF growth, other countries



Source: OECD, ECB

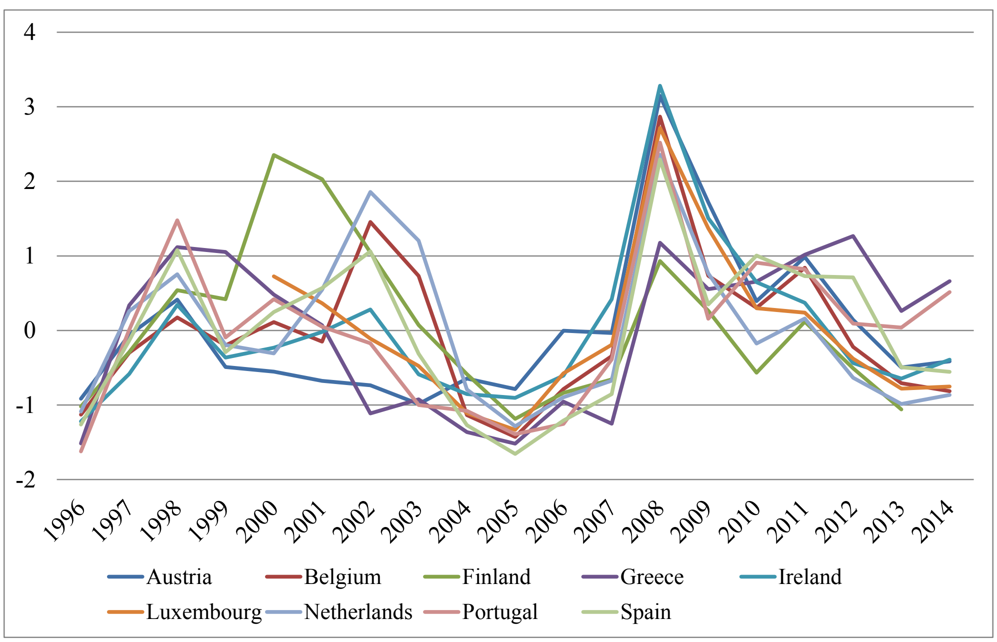
Figure A2: Economic Uncertainty proxied by the realized volatility of equity markets

G7 countries



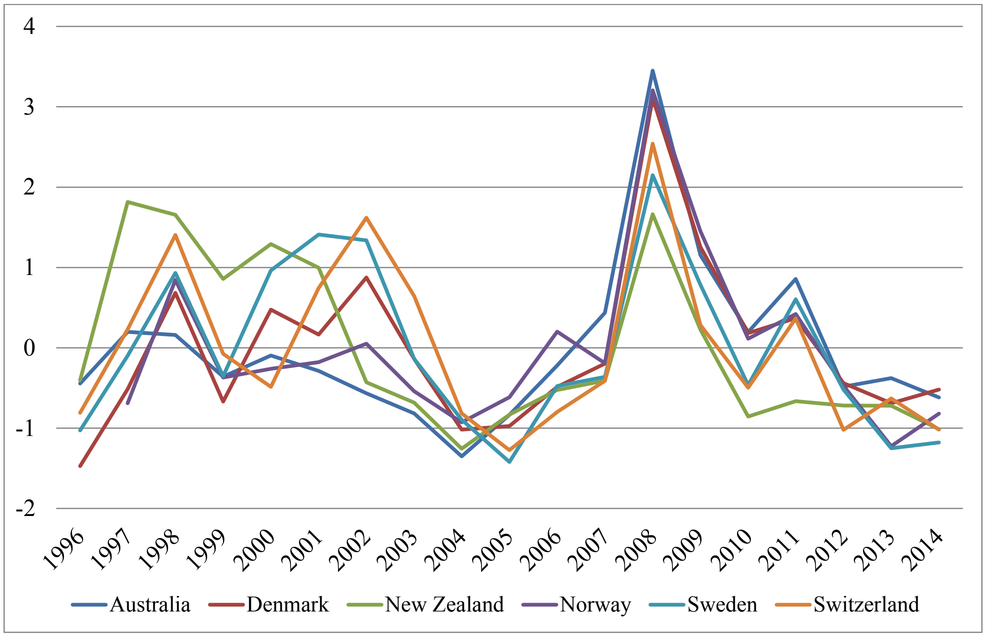
Source: author's calculations

Euro Zone (non-G7) countries



Source: author's calculations

Economic Uncertainty proxied by the realized volatility of equity markets, other countries

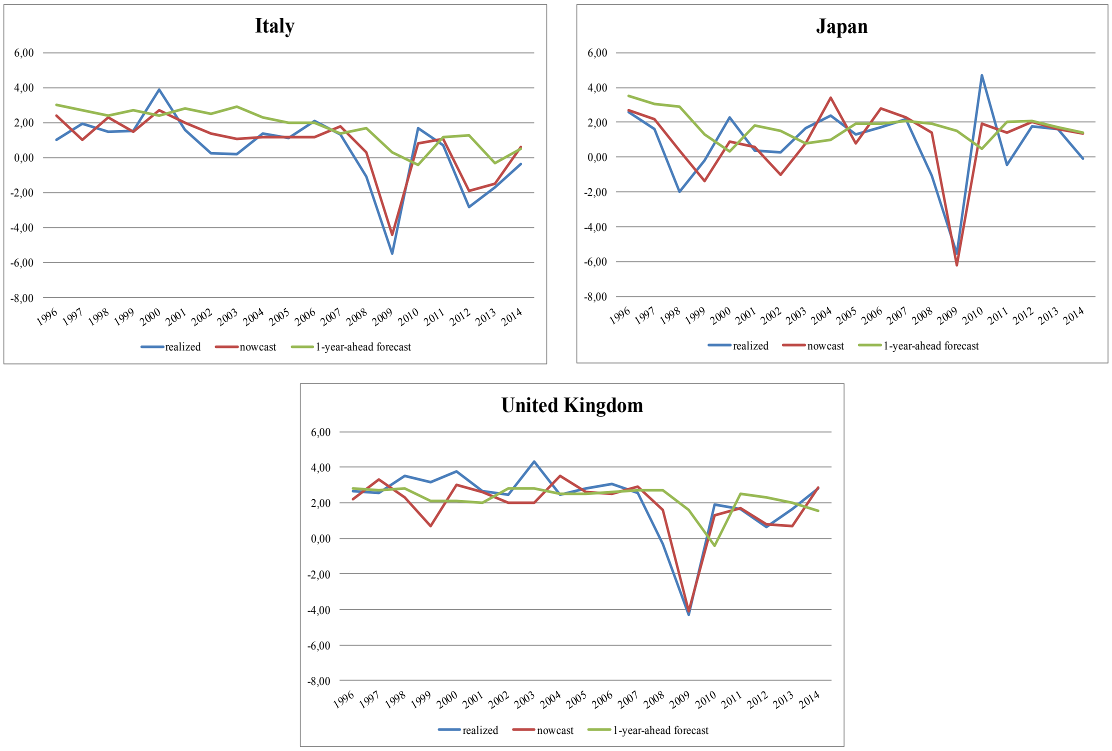


Source: author’s calculations

Figure A3: Real GDP growth, nowcast and 1-year-ahead forecasts for G7 countries

Source: WEO, IMF April issue since 1996

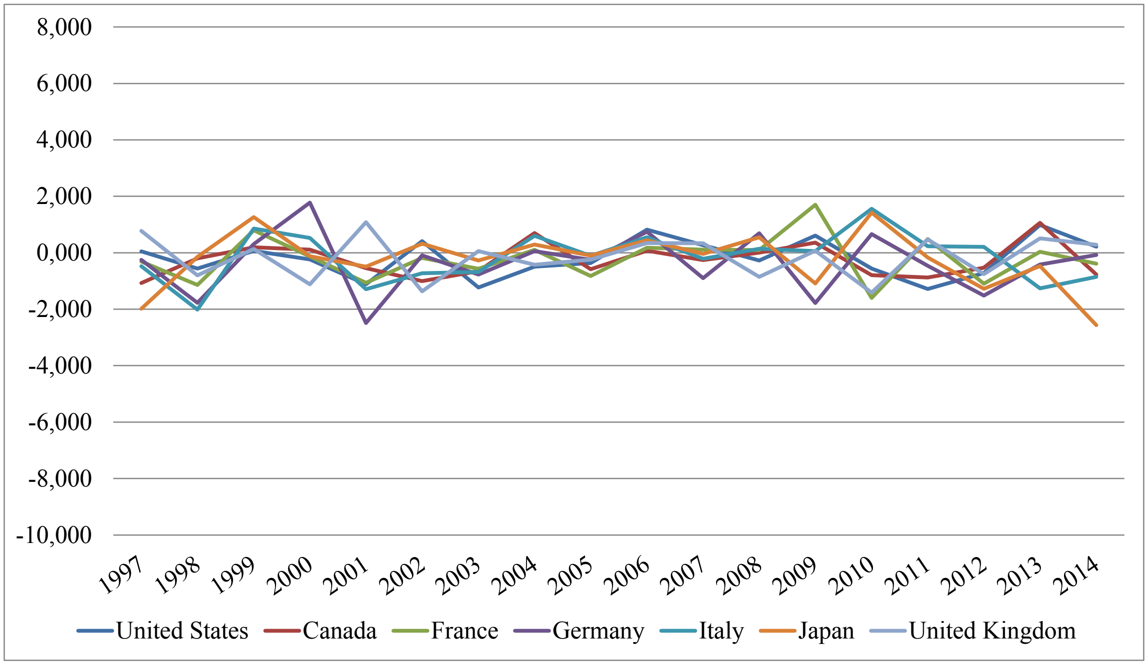
Figure A4: Real GDP growth , nowcast and 1-year-ahead forecasts for G7 countries (continued)



Source: WEO, IMF April issue since 1996

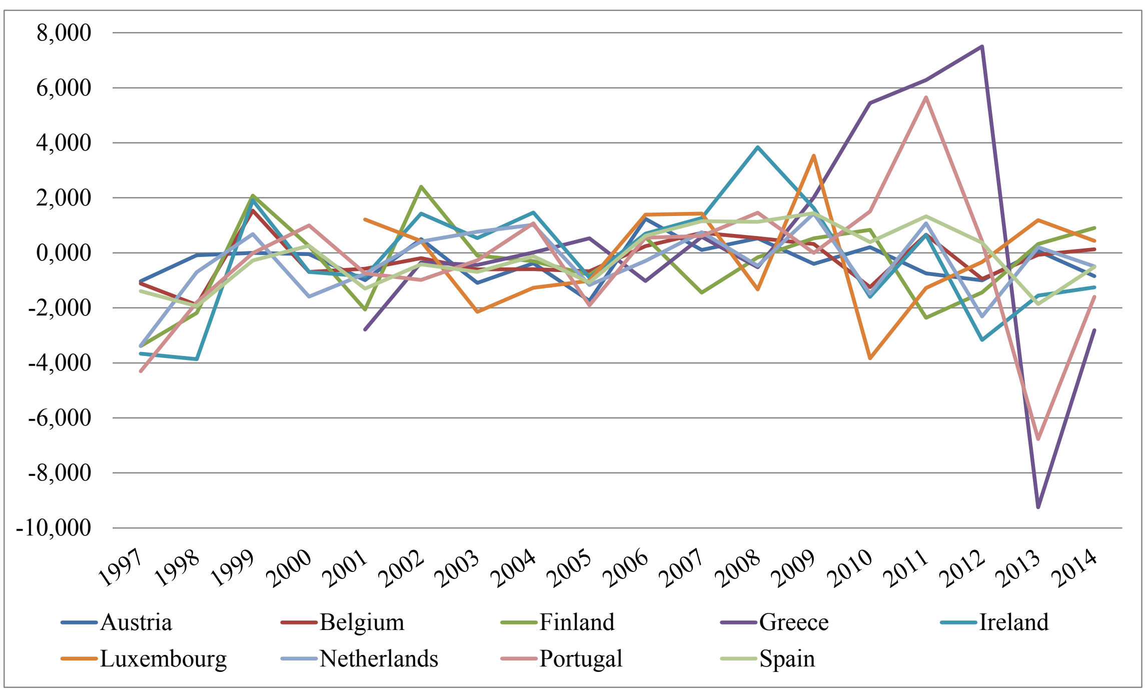
Figure A5: Changes in the user cost of capital

G7 countries



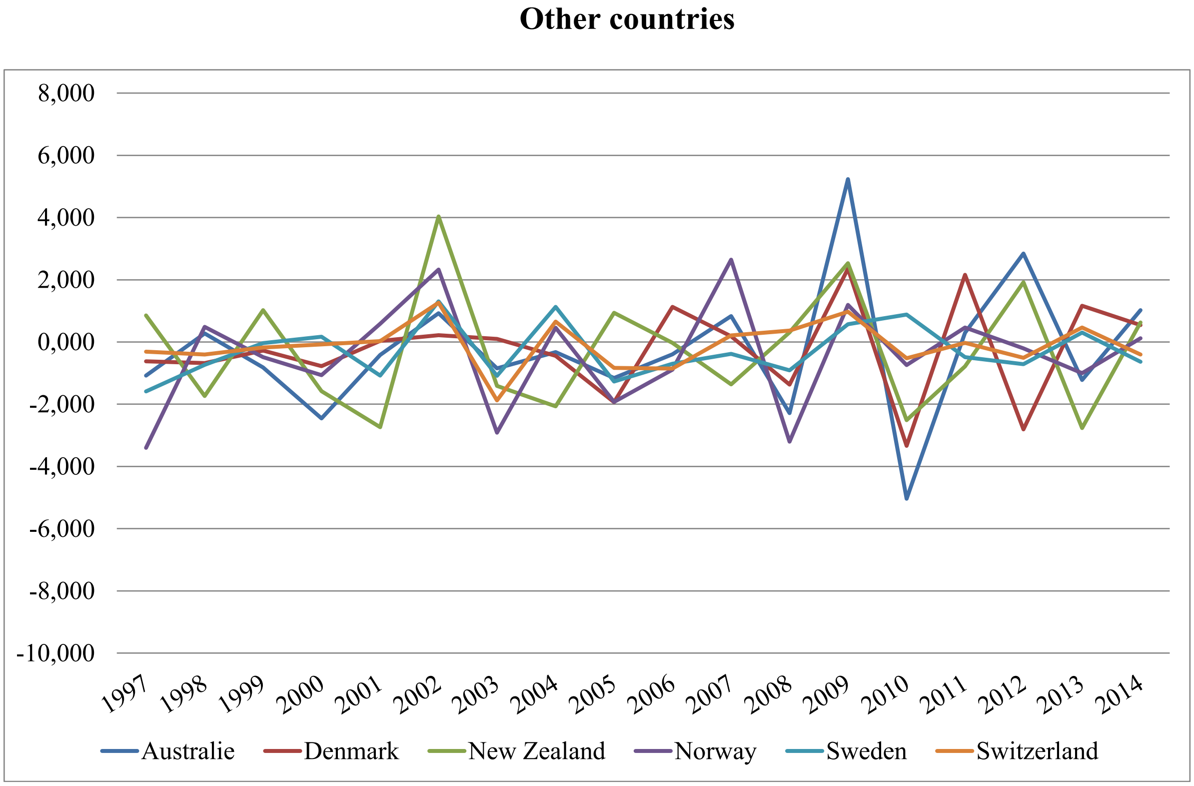
Source: OECD, ECB, AMECO (EC) and author's calculations

Euro Zone (non-G7) countries



Source: OECD, ECB, AMECO (EC) and author's calculations

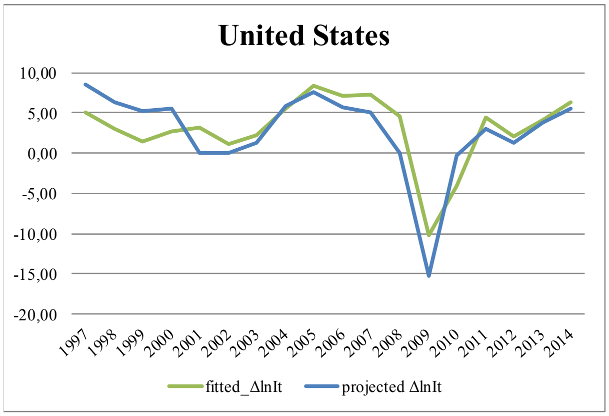
Figure A5: Changes in the user cost of capital

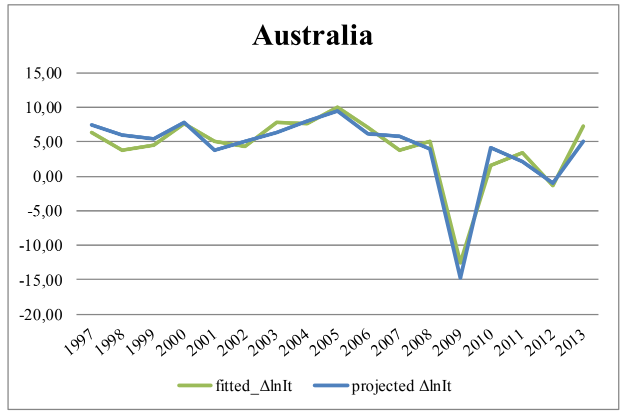


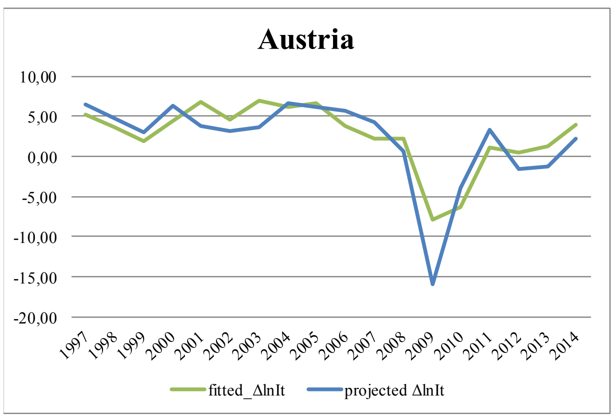
Source: OECD, ECB, AMECO (EC) and author's calculations

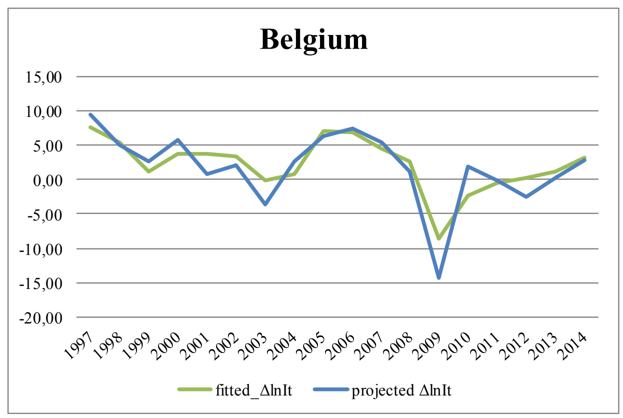
Figure A6: Counterfactual level of investment with unbiased 1-year-ahead forecast of GDP growth.

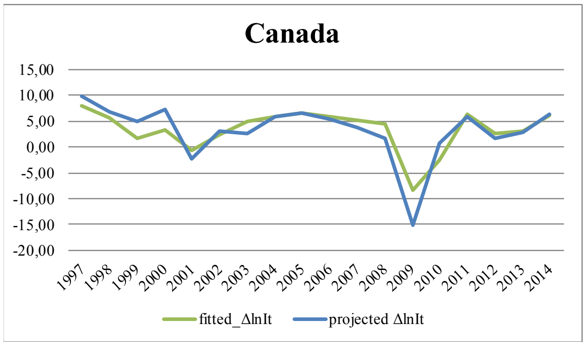
Predicted investment (green lines) and predicted without any forecasting errors on GDP growth (blue lines) for all 22 countries







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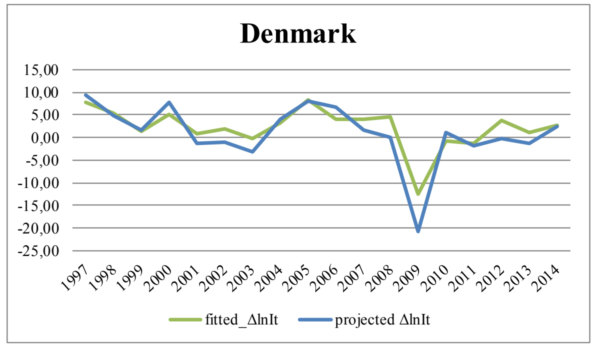
projected ΔlnIt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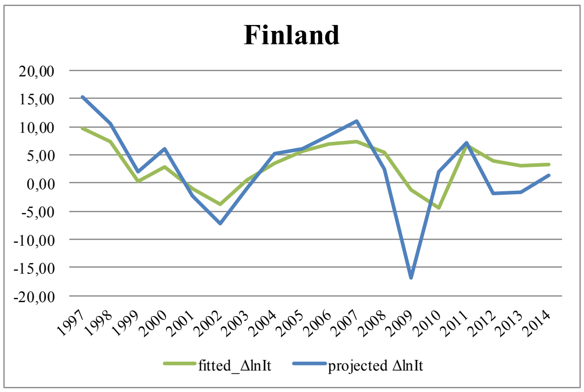
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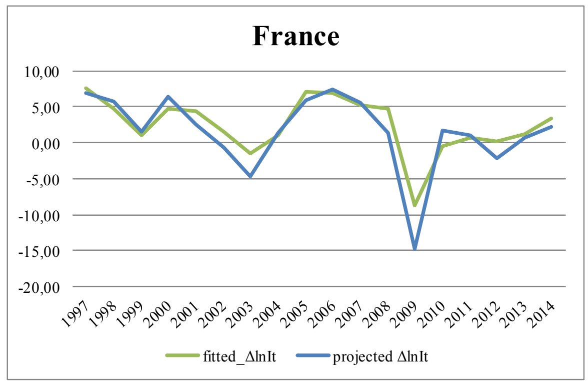
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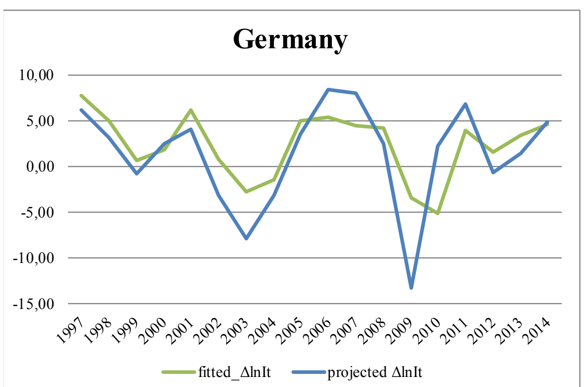
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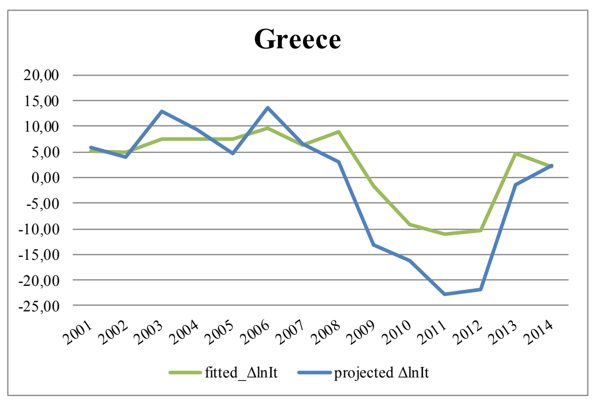
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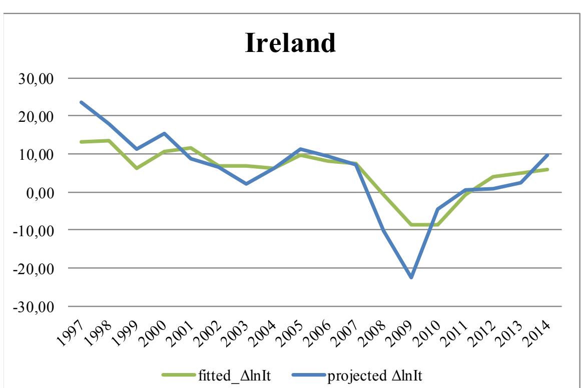
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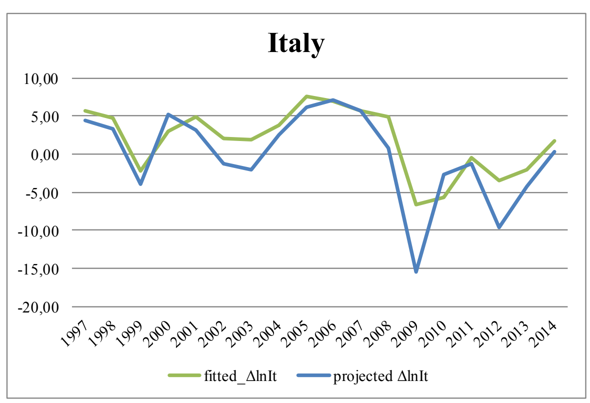
projected ΔlnIt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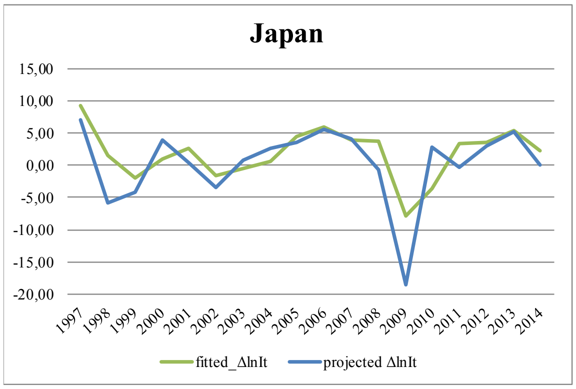
projected ΔlnIt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1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
fitted_ΔlnIt
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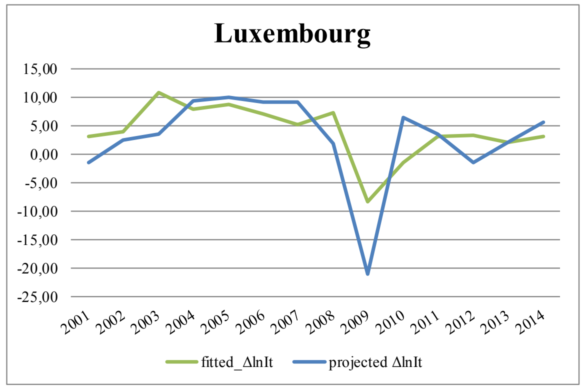
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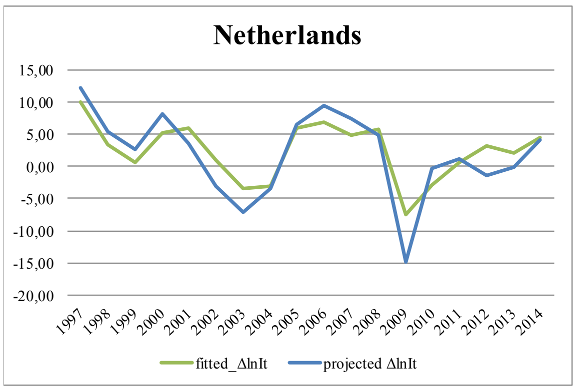
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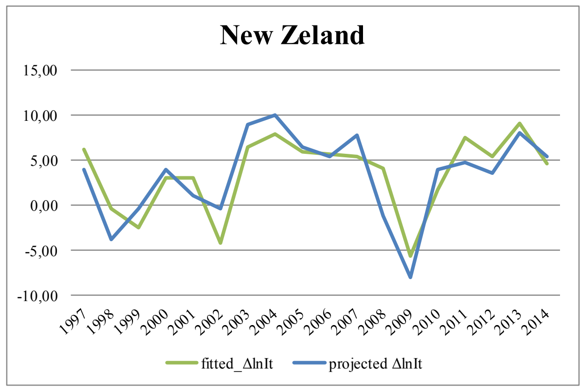
New Zeland
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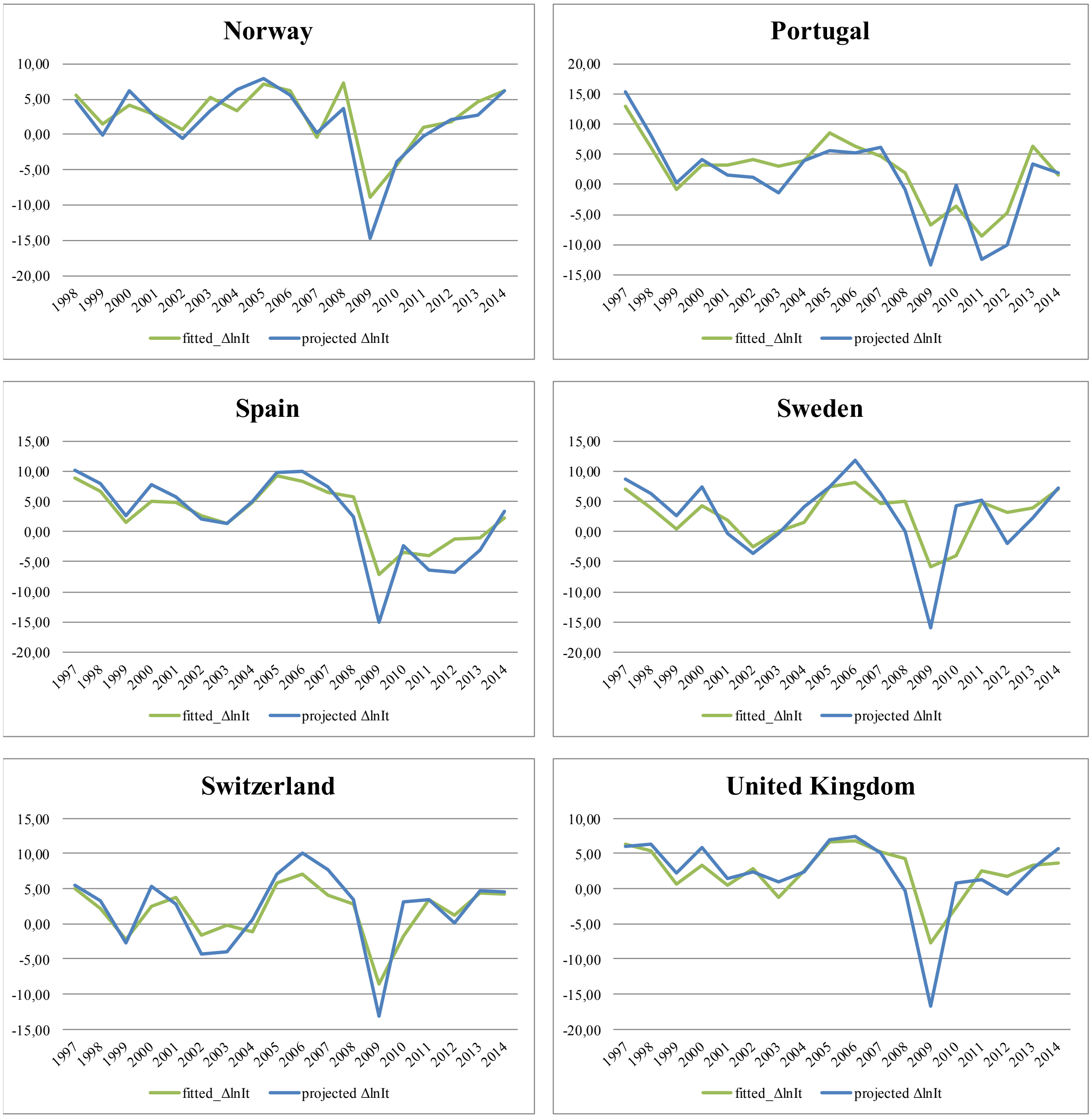
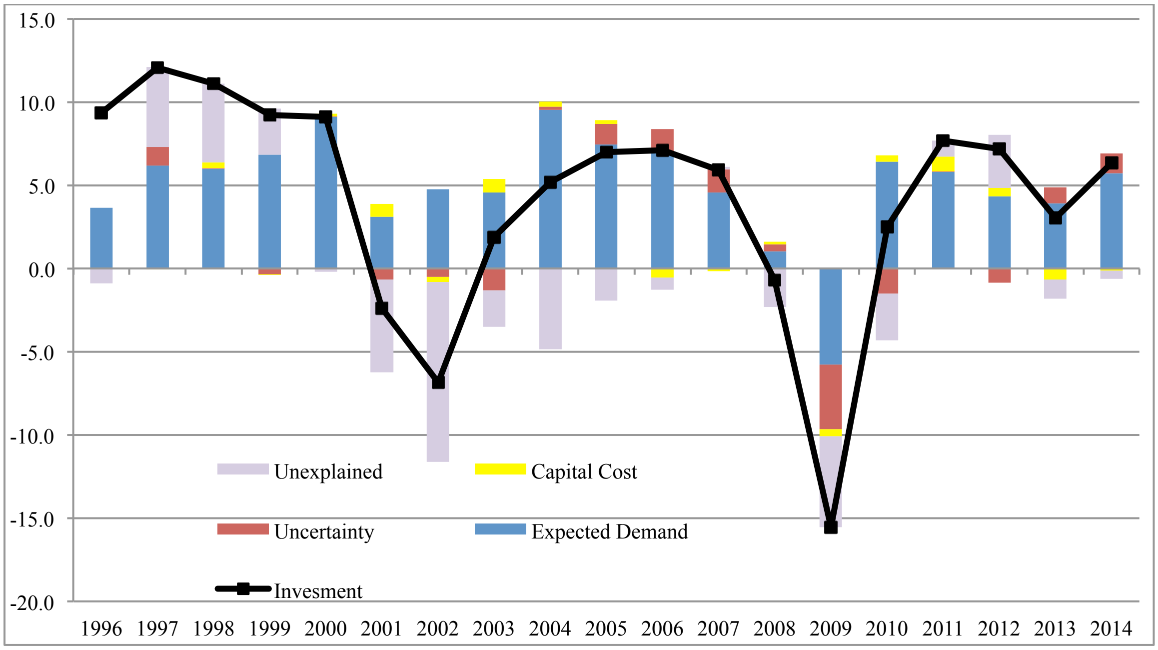
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
fitted_ΔlnIt
projected ΔlnIt



Source: author's calculations

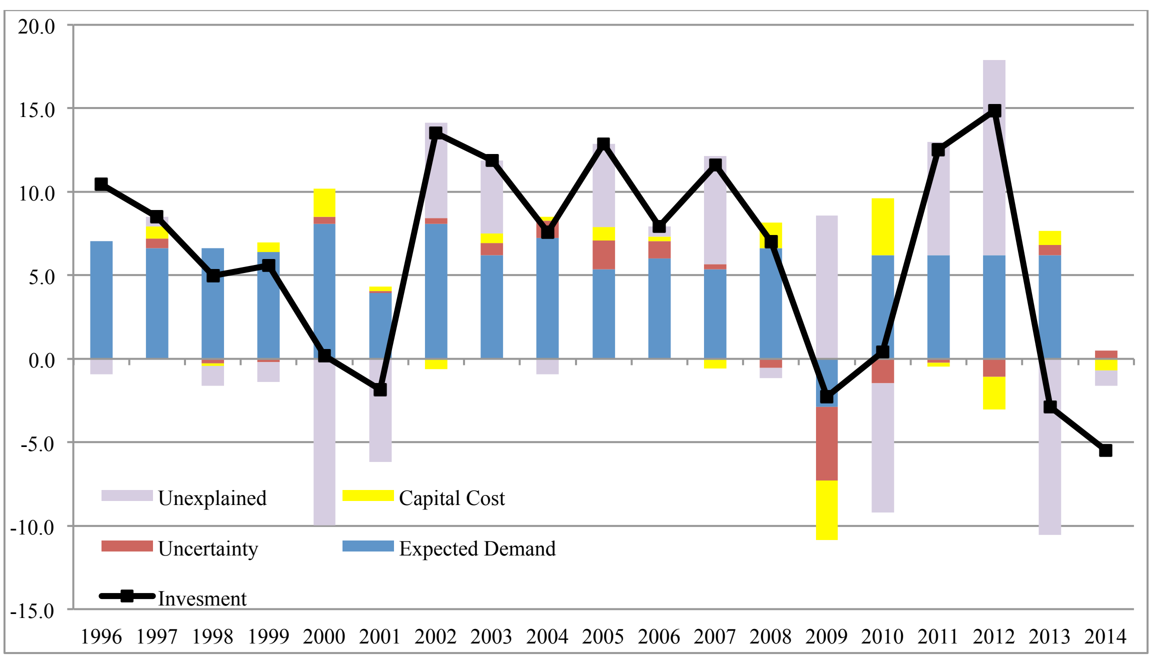
Figure A7: Contributions of the Forward Looking model[16]

US



Source: author's calculations

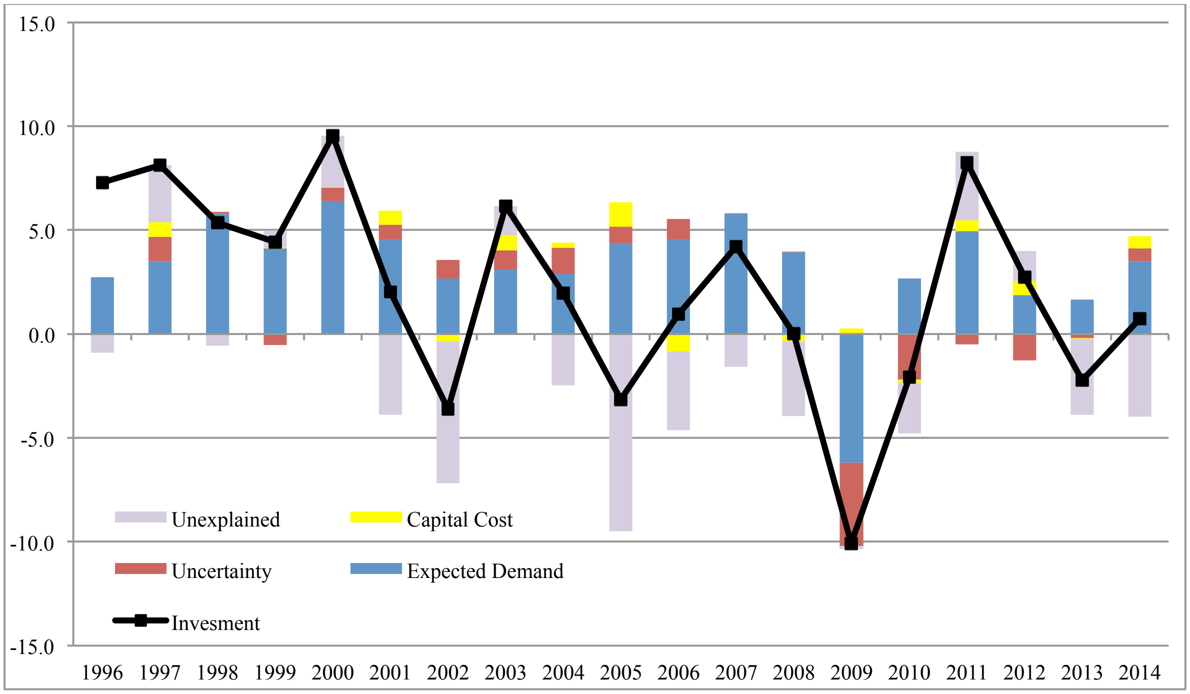
Australia



Source: author's calculations

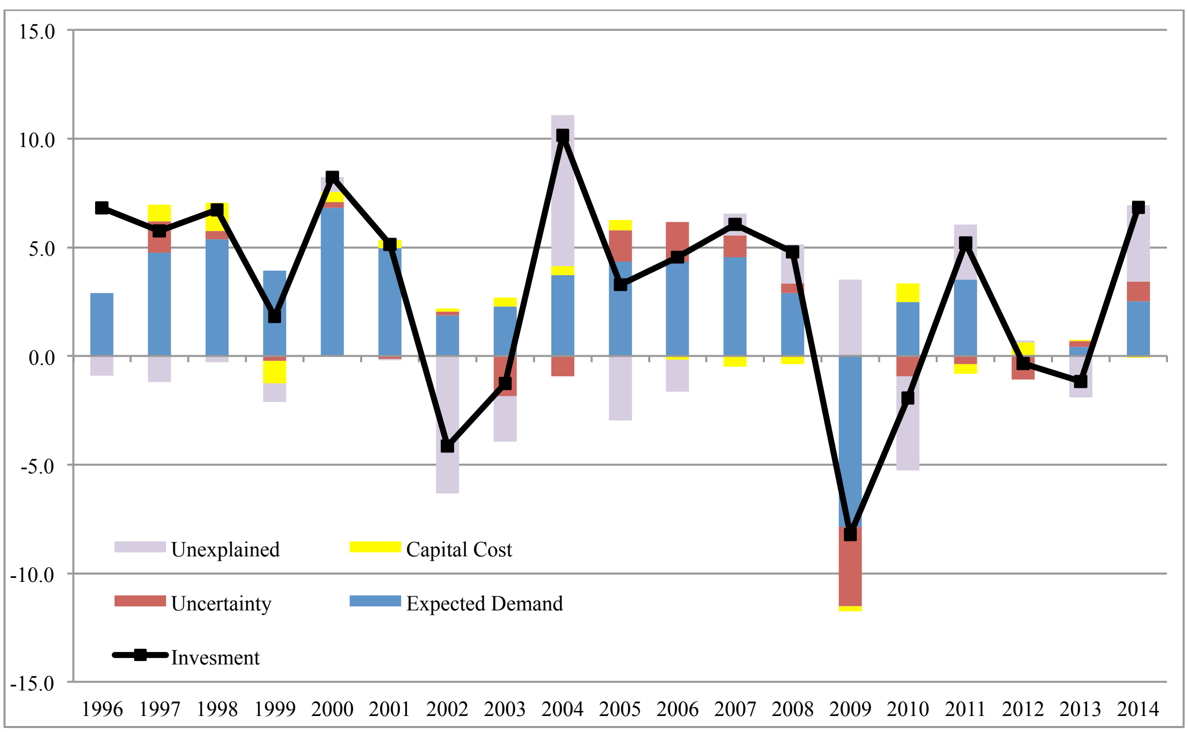
[16] Data for residuals, capital cost and uncertainty are unavailable for several countries for the years 1996 and 2014.

Austria



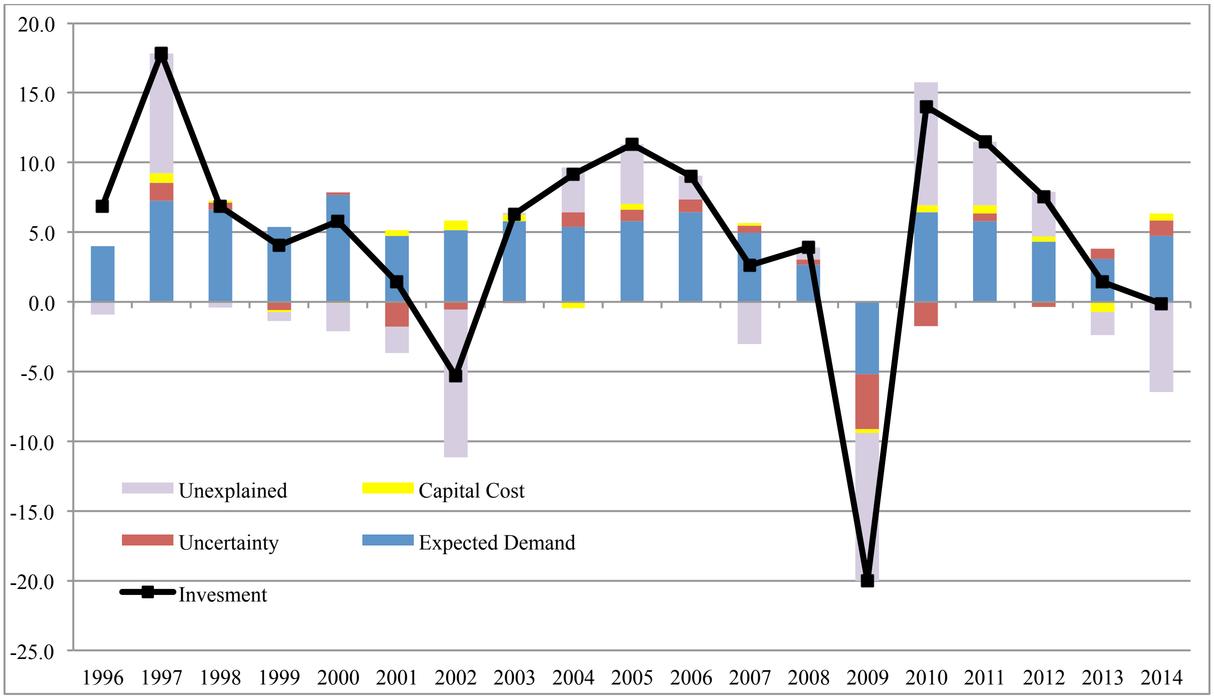
Source: author's calculations

Belgium



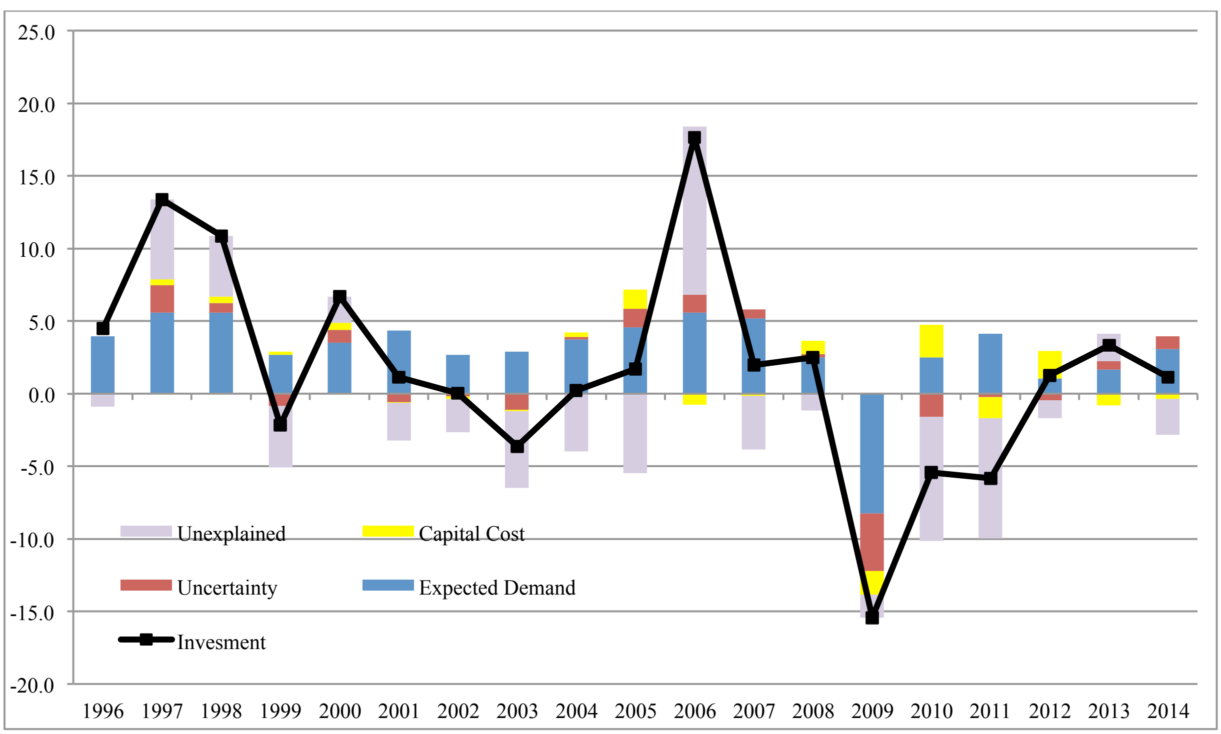
Source: author's calculations

Canada



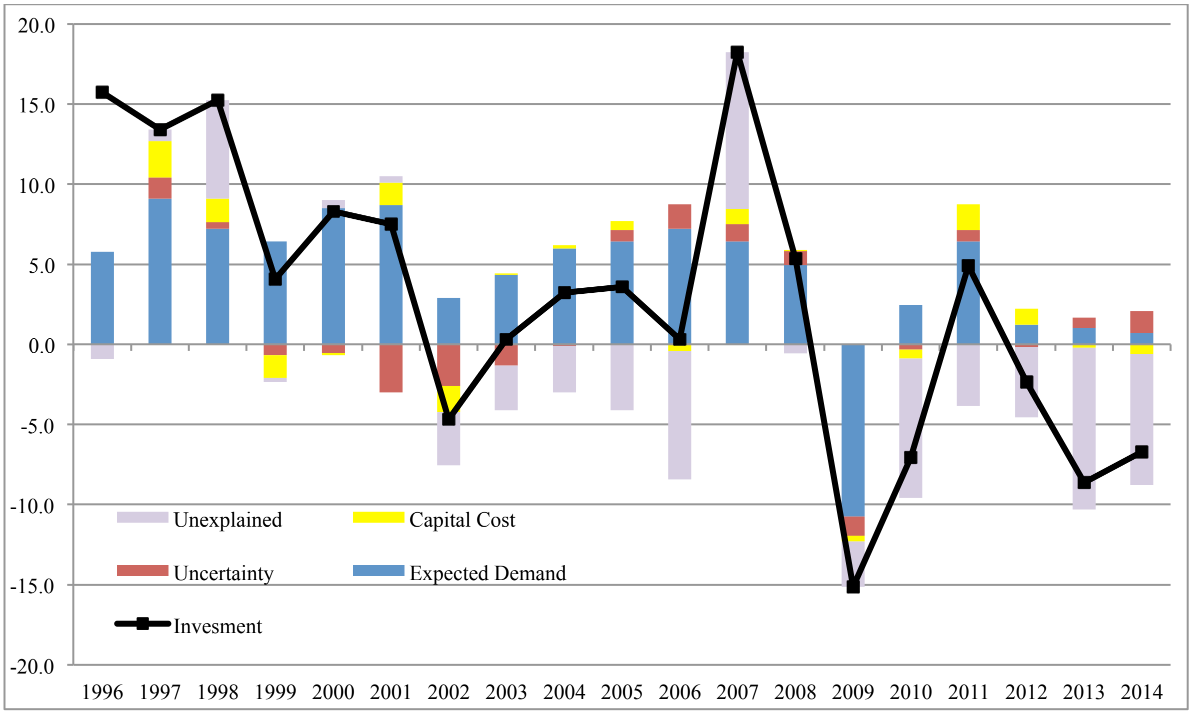
Source: author's calculations

Denmark



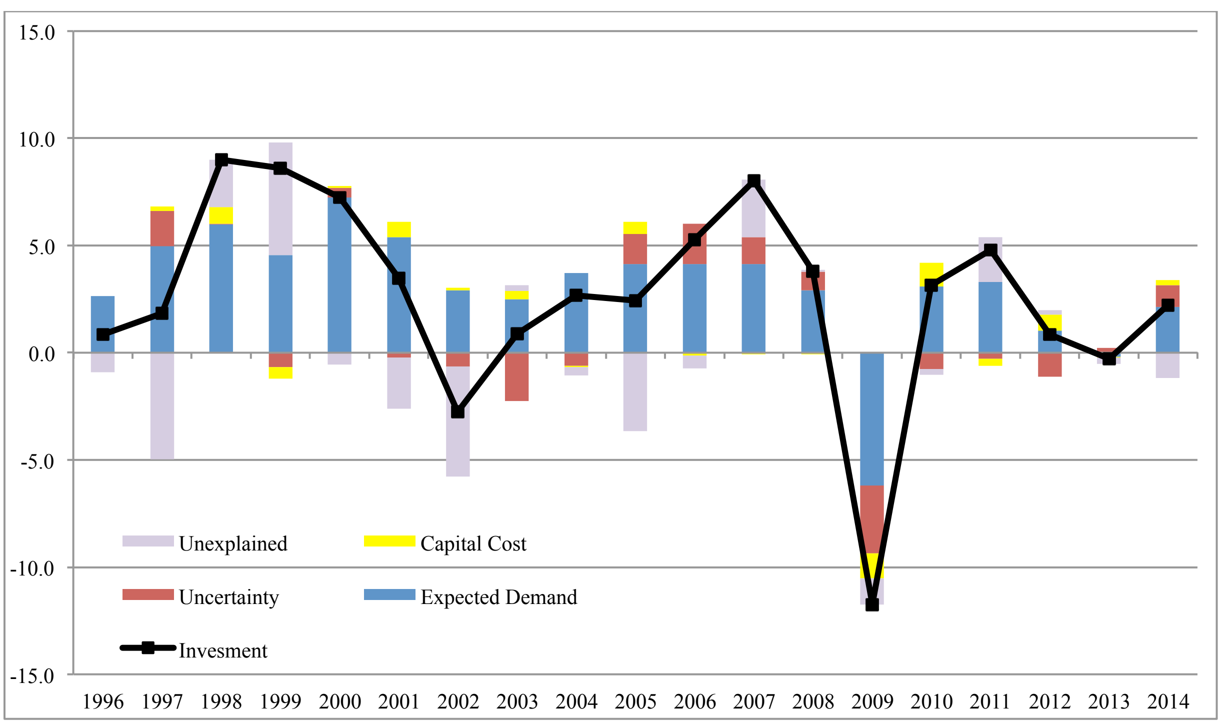
Source: author's calculations

Finland



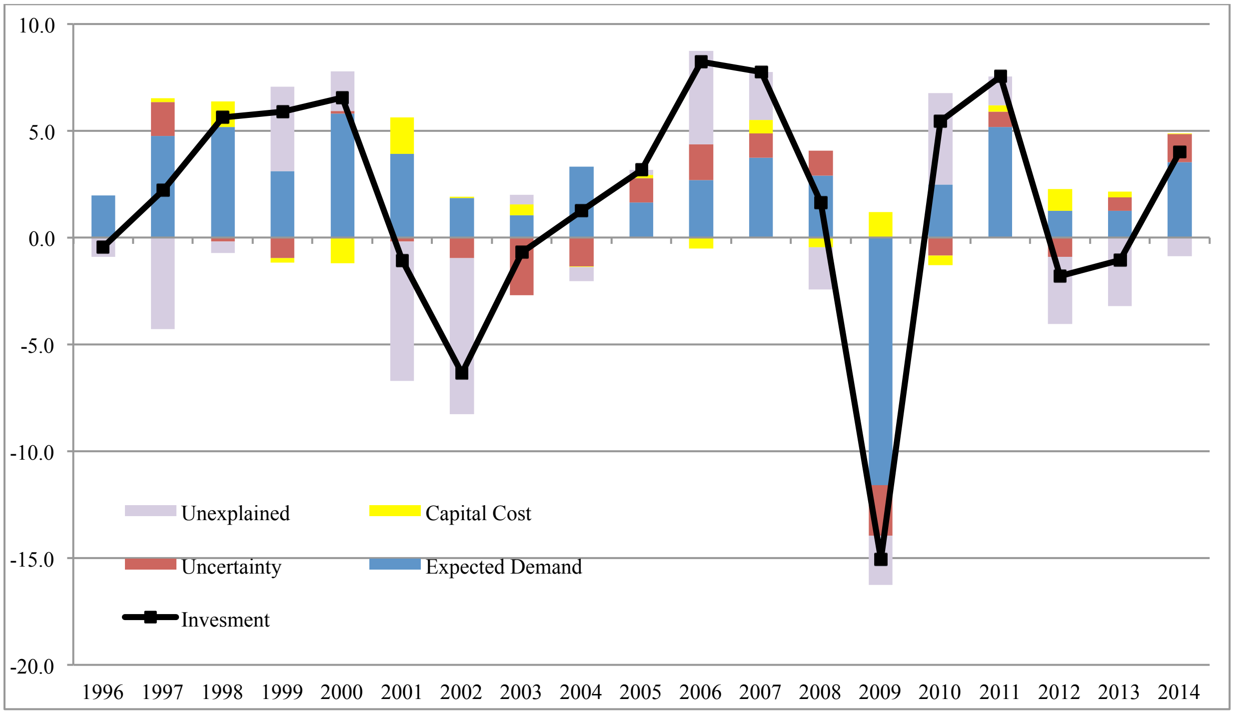
Source: author's calculations

France



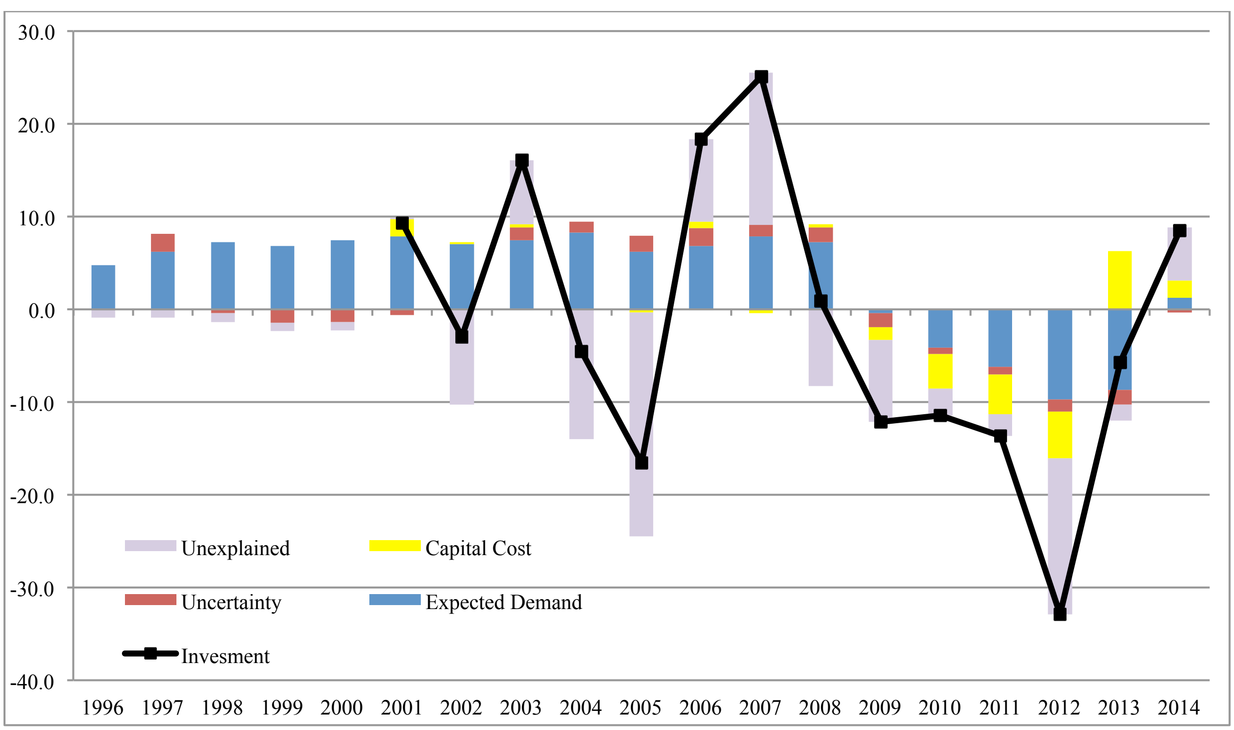
Source: author's calculations

Germany



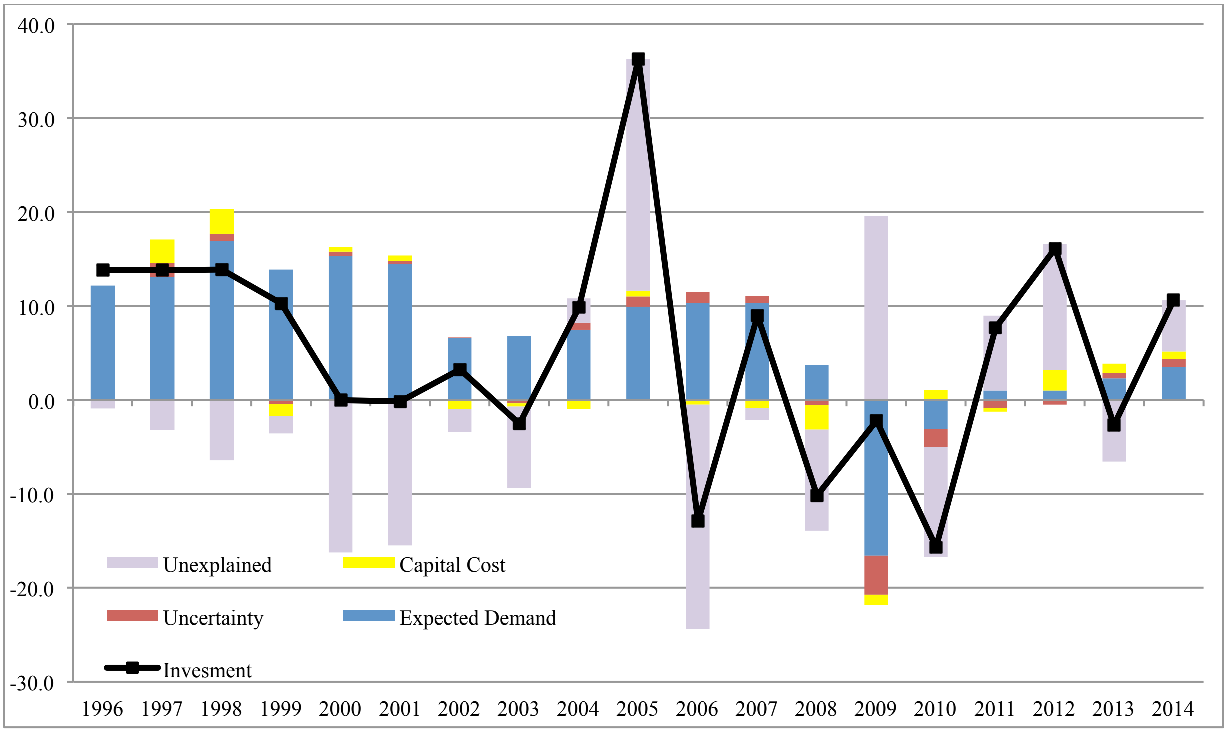
Source: author's calculations

Greece



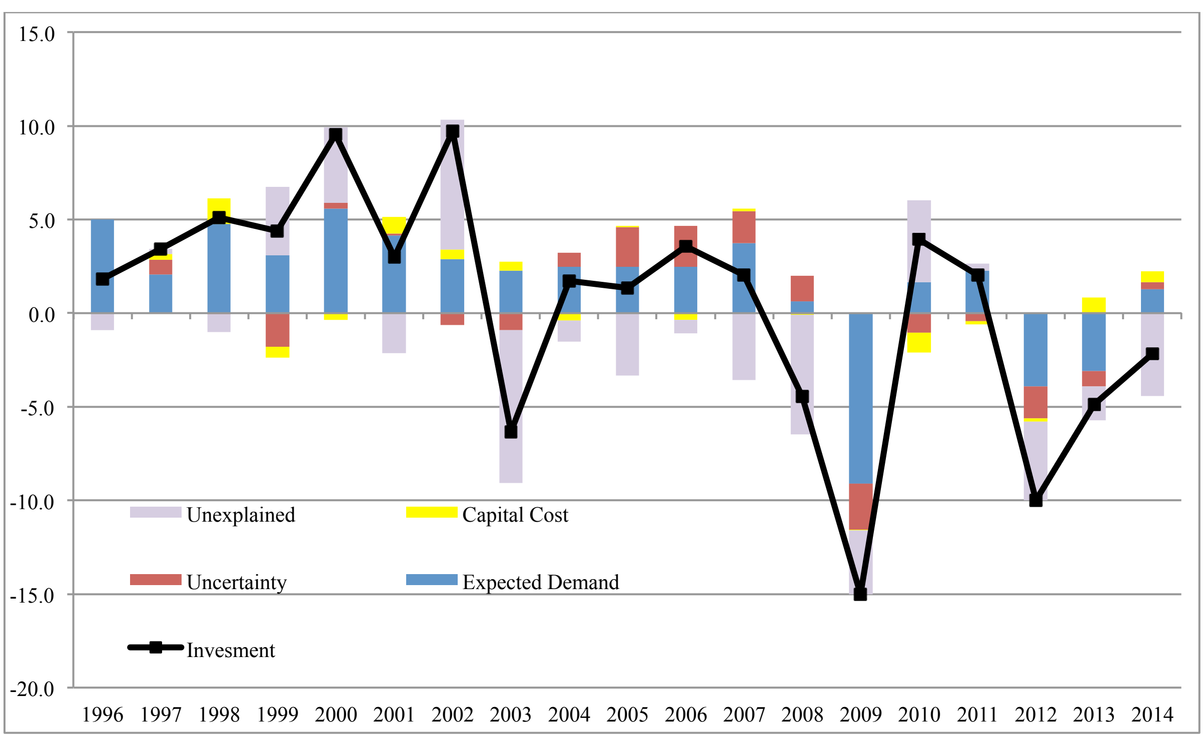
Source: author's calculations

Ireland



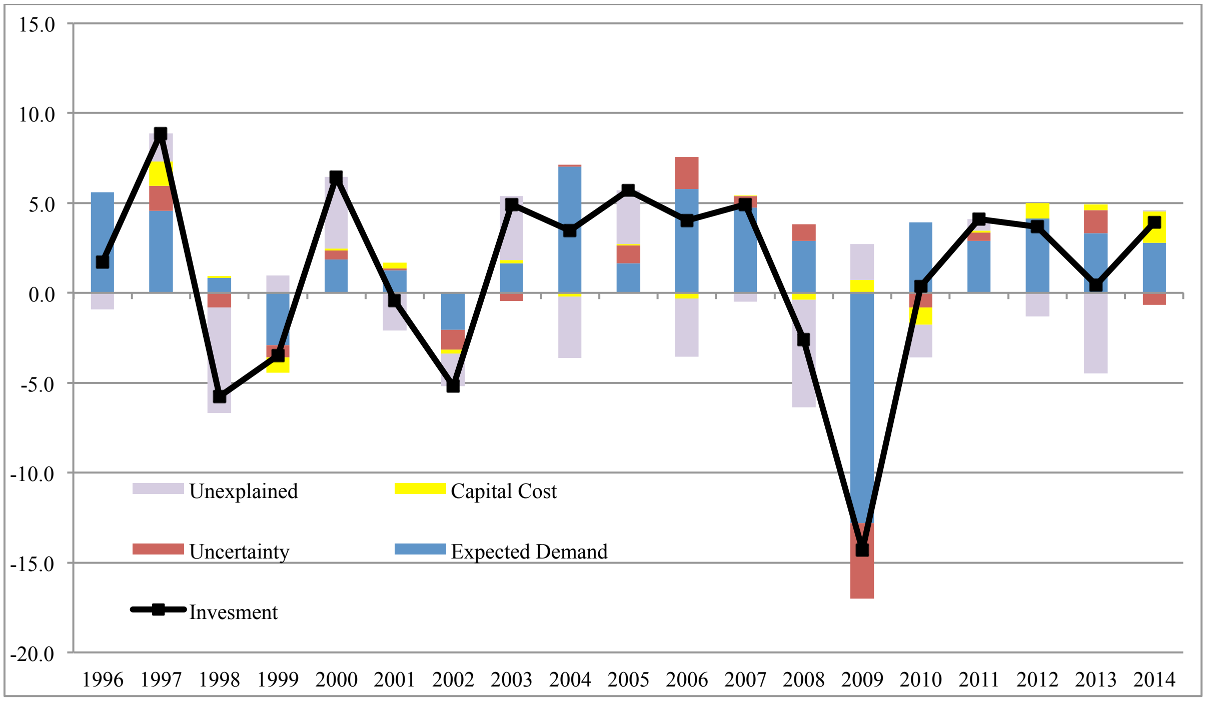
Source: author's calculations

Italy



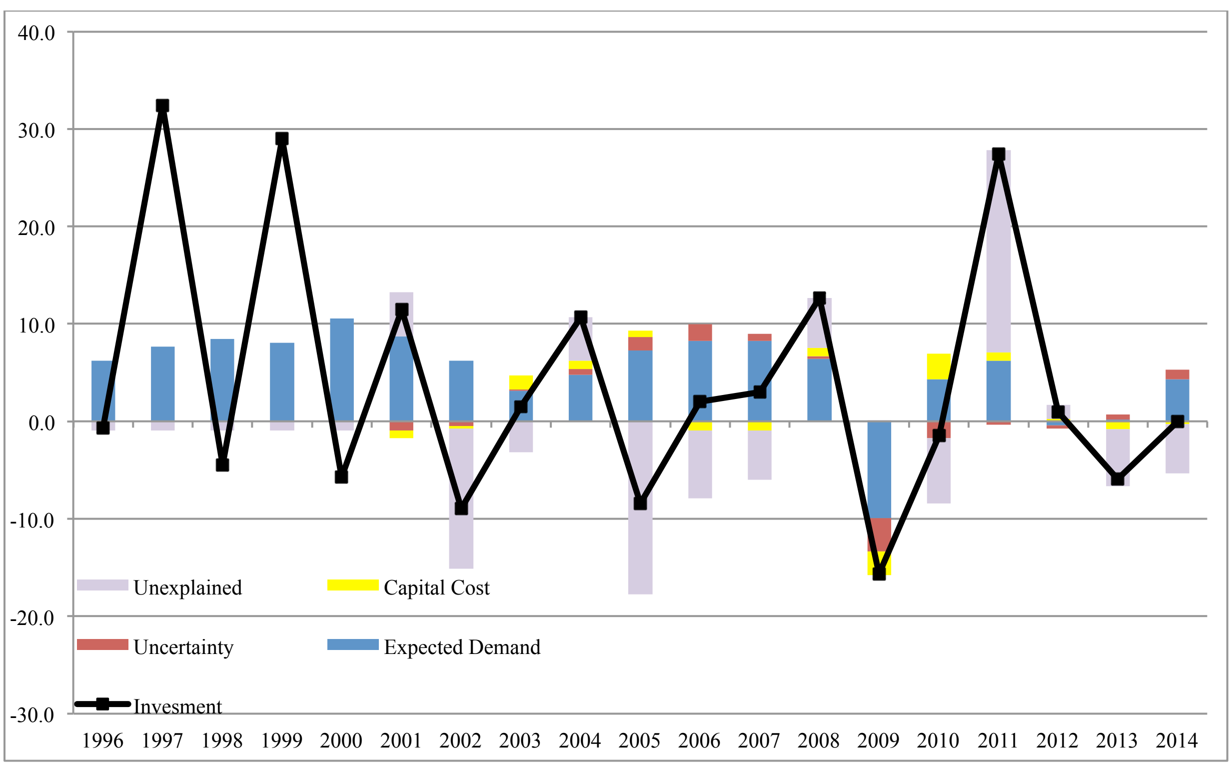
Source: author's calculations

Japan



Source: author's calculations

Luxembourg



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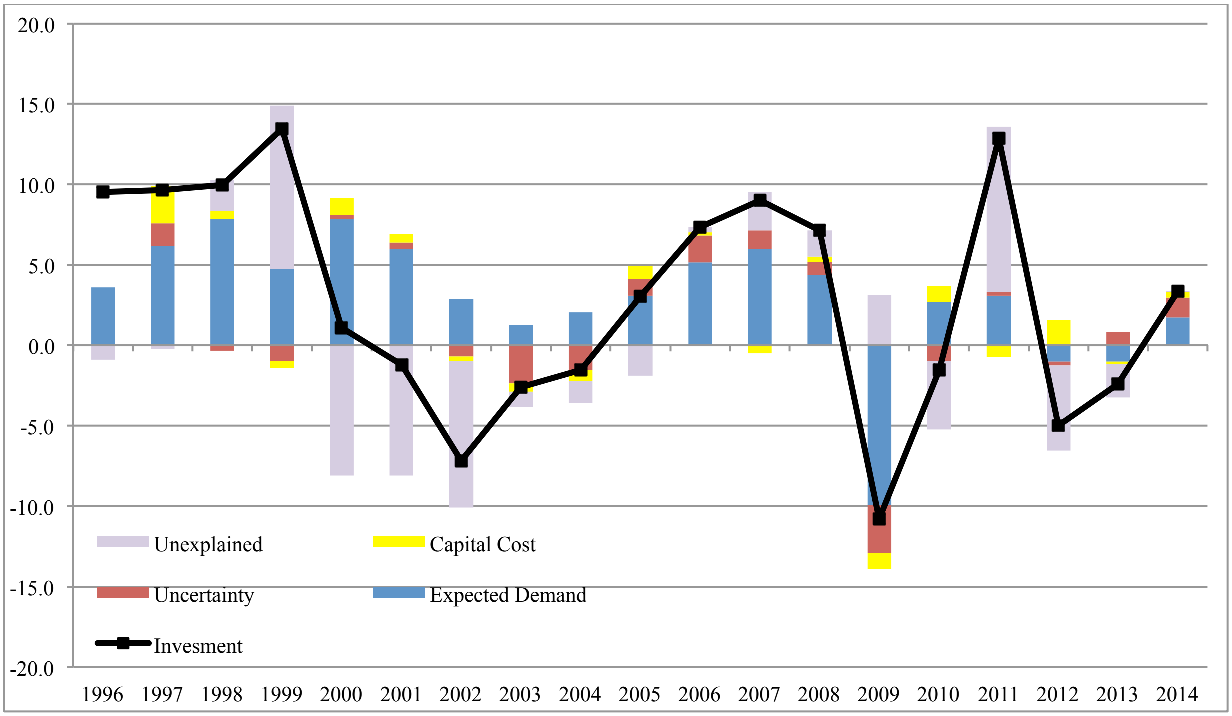
Netherlands



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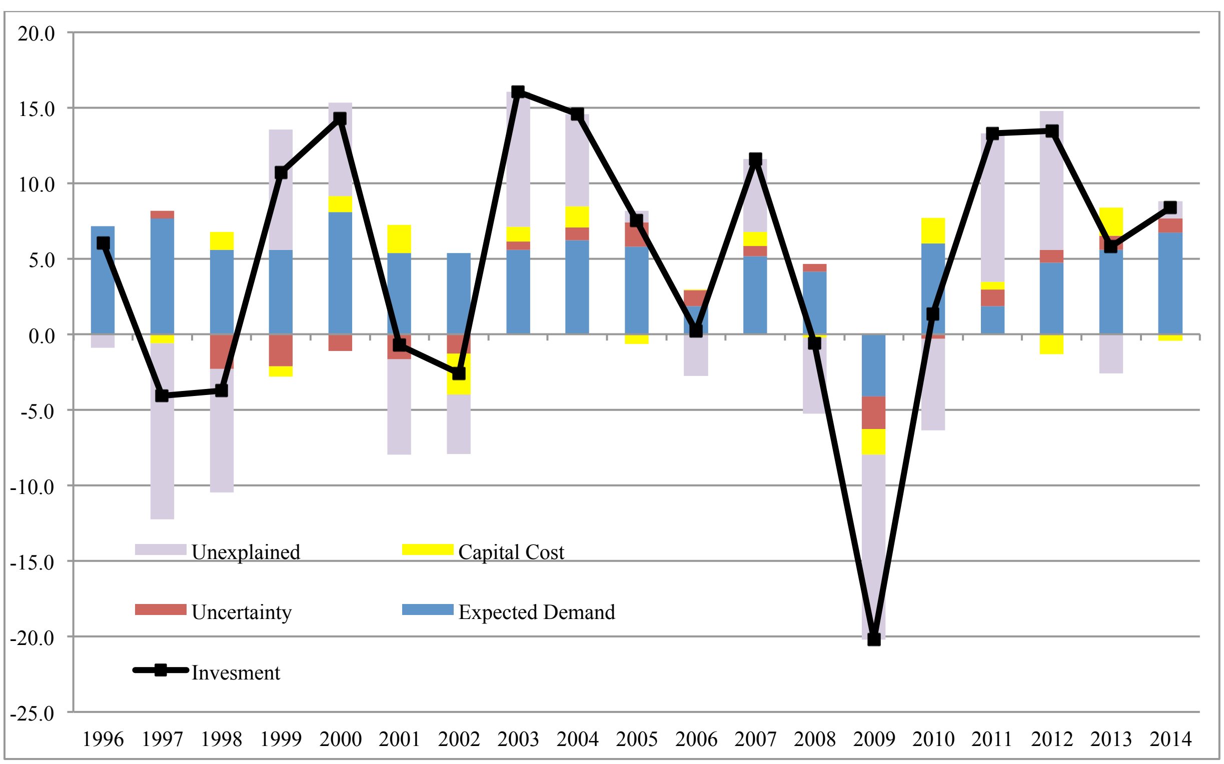
New Zealand



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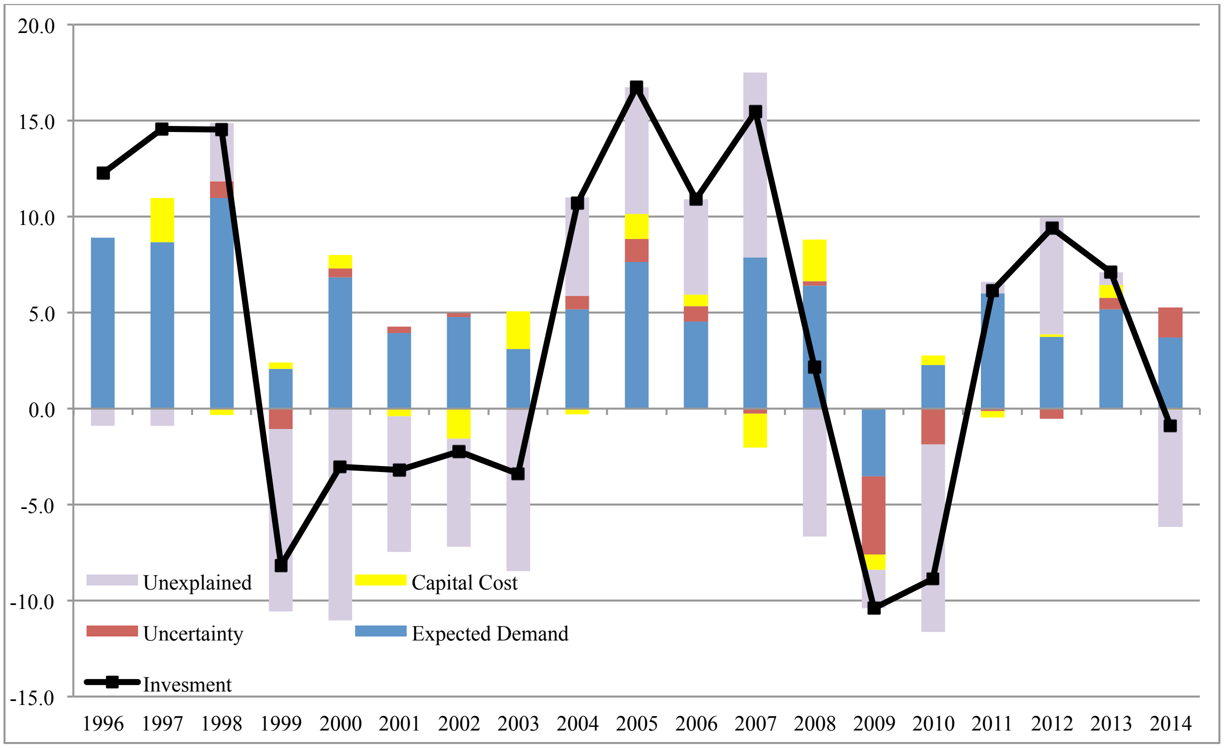
Norway



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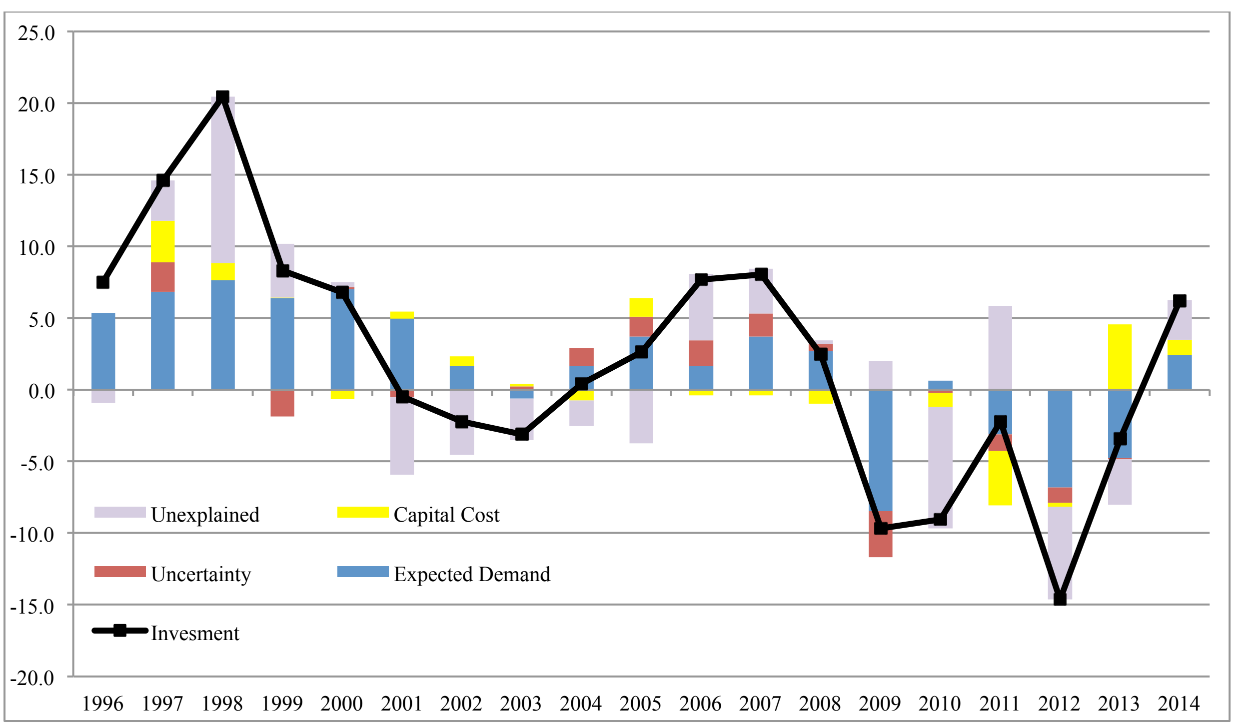
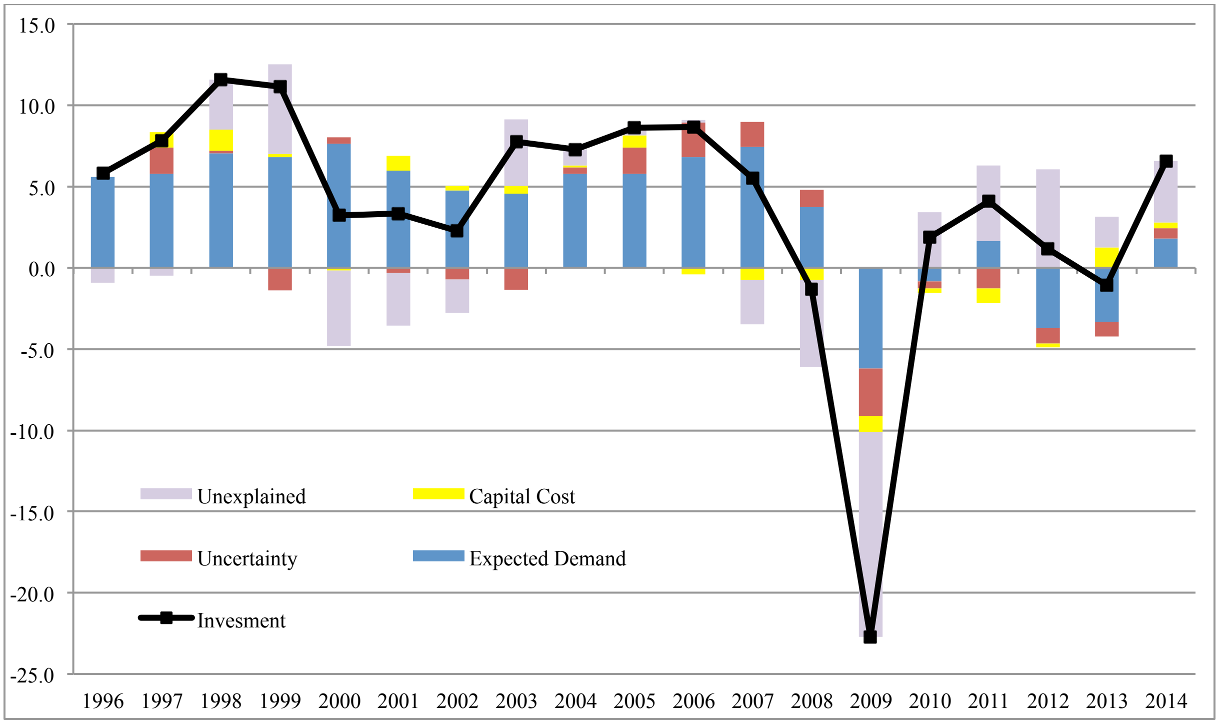
Portugal



Source: author's calculations

Spain



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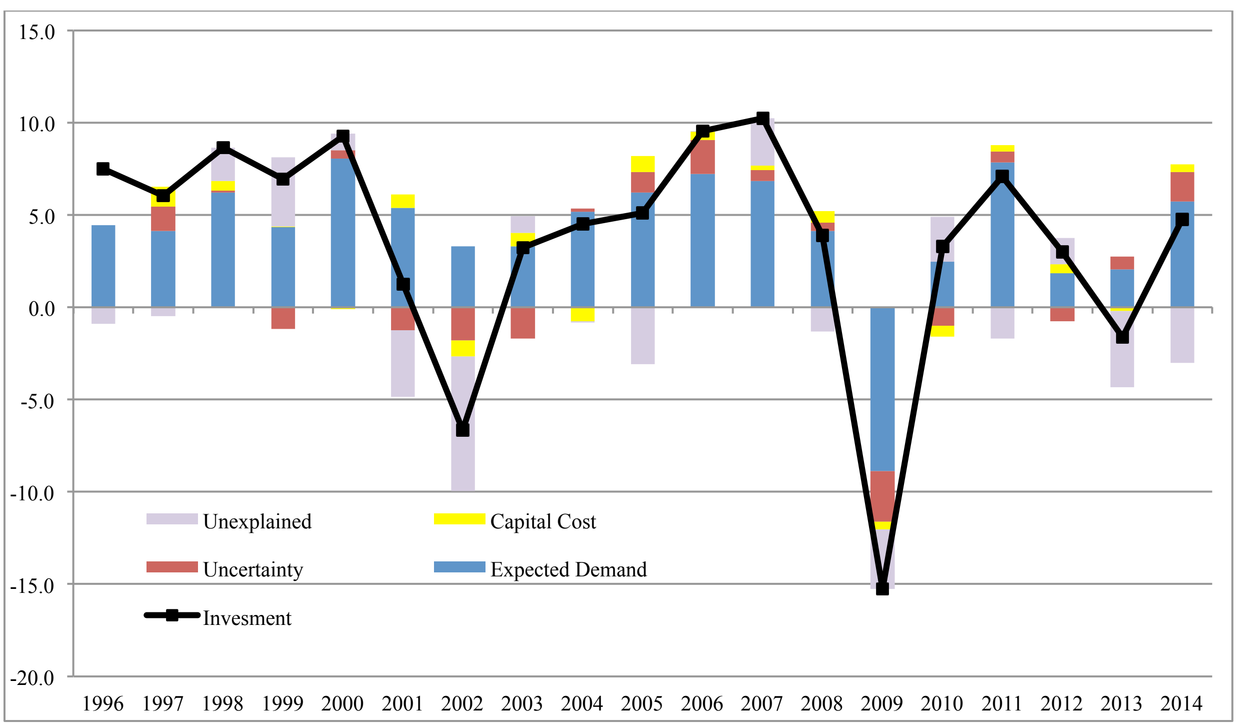
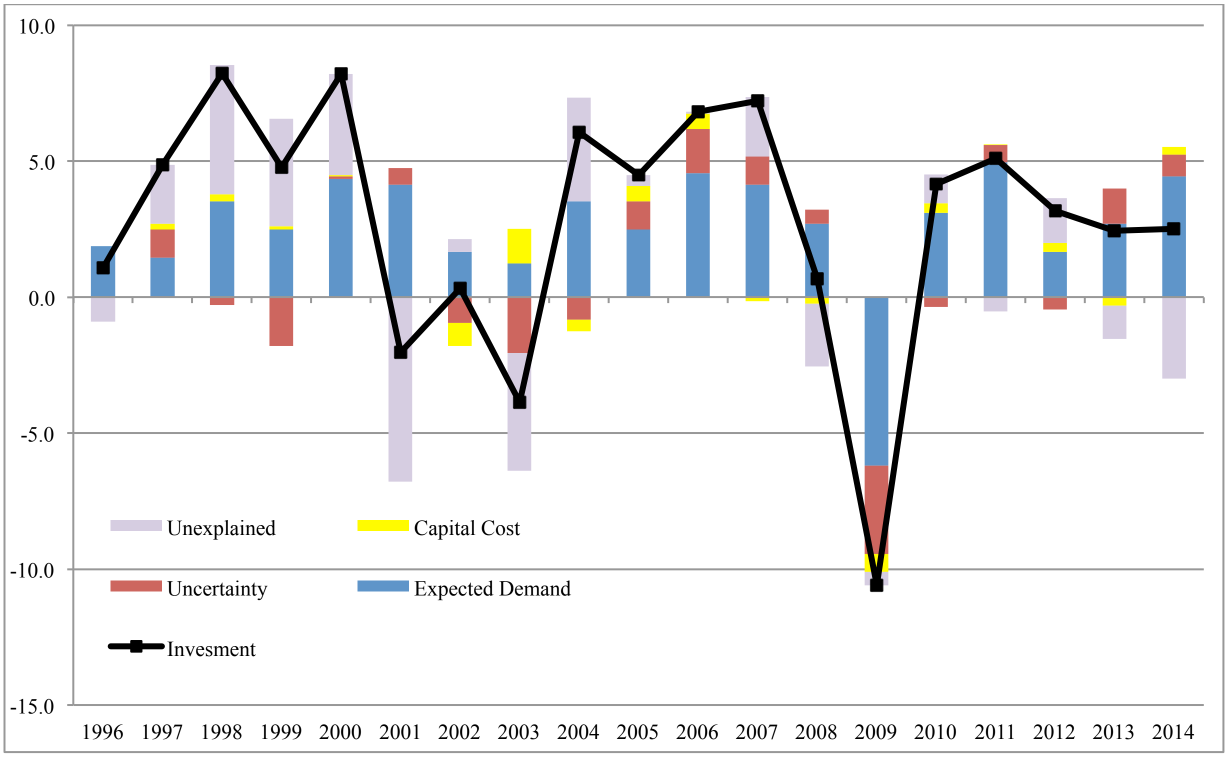
Sweden



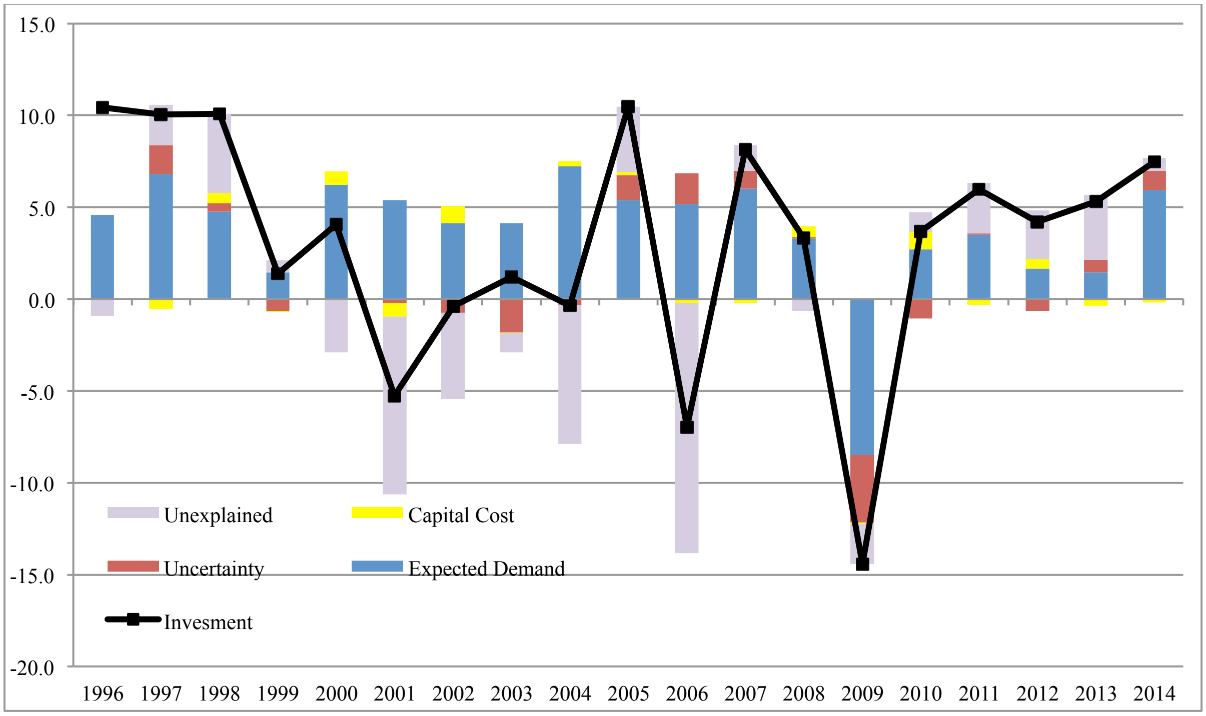
Source: author's calculations

Switzerland



Source: author's calculations

UK



Source: author's calculations