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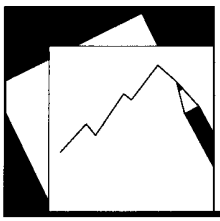

IMF Working Paper

Investment in the Euro Area: Why Has It Been Weak?

Bergljot Barkbu, S. Pelin Berkmen, Pavel Lukyantsau, Sergejs Saksonovs, and Hanni Schoelermann

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Authorized for distribution by Petya Koeva Brooks

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Abstract

Investment across the euro area remains below its pre-crisis level. Its performance has been weaker than in most previous recessions and financial crises. This paper shows that a part of this weakness can be explained by output dynamics, particularly before the European sovereign debt crisis. The rest is explained by a high cost of capital, financial constraints, corporate leverage, and uncertainty. There is a considerable cross country heterogeneity in terms of both investment dymanics and its determinants. Based on the findings of this paper, investment is expected to pick up as the recovery strengthens and uncertainty declines, but persistent financial fragmentation and high corporate leverage in some countries will likely continue to weigh on investment.

JEL Classification Numbers: E22, E51

Keywords: Investment, cost of capital, credit rationing

Authors' E-Mail Addresses: BBarkbu@imf.org; PBerkmen@imf.org; PLukyantsau@imf.org; SSaksonovs@imf.org; HSchoelermann@imf.org.

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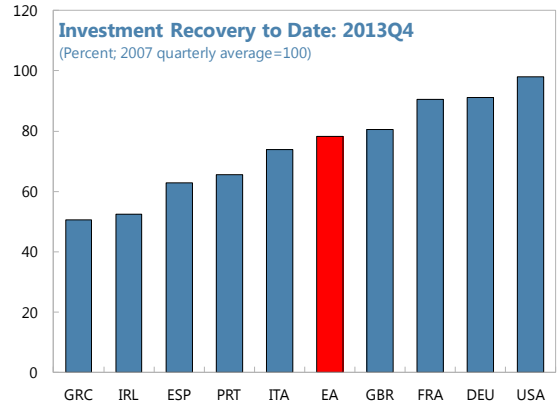
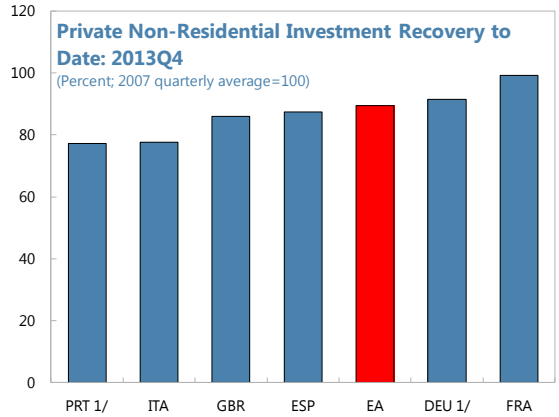
I. INTRODUCTION[1]

Investment in euro area countries has been hit hard since the onset of the crisis and has not yet recovered, including in many of the core economies. Total investment in real terms remains below its pre-crisis level across the euro area. While a part of this decline reflects lower public and housing investment in certain countries,[2] private non-residential investment also remains well below its pre-crisis level particularly in stressed countries (see text charts).[3]



Sources: Eurostat, Haver Analytics; and staff calculations.

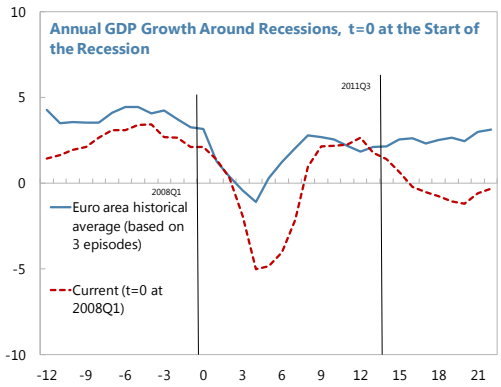


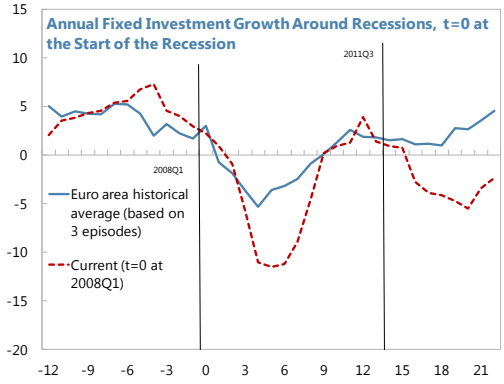
Sources: Eurostat, and staff calculations.
Notes: 1/ Last available data point: DEU = 2012Q4; PRT = 2013Q3.

Overall, the behavior of investment has varied substantially across the euro area and across firm sizes. The decline in investment is larger in stressed economies than in core economies. At the same time, the conditions for SMEs have worsened more than the conditions for larger corporations. This heterogeneity could reflect various interacting factors, such as structural differences between economies and a varying degree of vulnerabilities across countries (such as bank-sovereign links, financial fragmentation, corporate indebtedness, and policy uncertainities).

Weak investment performance in Europe has coincided with large output losses. Real GDP in the euro area remains below its pre-crisis level, the output gap is negative and large, and the recovery is more sluggish than in typical recessions. Given subdued output performance and a weak growth outlook, it is not surprising that investment has also lagged behind the trend observed in most previous recessions (see text charts).

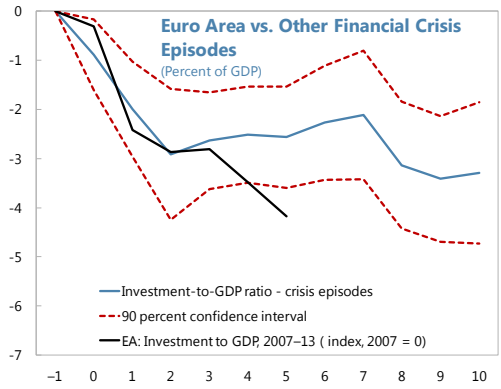
[1] This paper draws on the work that has been done in 2014 Euro Area Policies: Selected Issues (IMF, 2014).
[2] For example, housing investment declined from about 12–13 percent of GDP before the crisis to about 6 percent of GDP in Spain and to about 2–3 percent of GDP in Greece and Ireland after the crisis.
[3] Stressed countries refer to debtor countries who have experienced high funding costs (public and private) and suffered from financial fragmentation during the period covered. For the charts and regressions in this paper, data on private non-residential investment are obtained from Eurostat to ensure consistency and comparability across countries. Looking into other data sources also shows weak investment dynamics. For example, real fixed investment in equipment in Germany and real investment by non-financial corporations in France, equipment and transportation machinery in the euro area are also weaker than their pre-crisis levels.

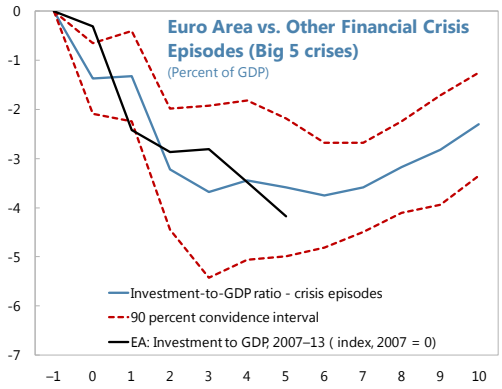




Source: OECD, Eurostat; and staff calculations.
Notes: Quarterly data and year-on-year change. t=0 at 2008 Q1; the second line at 2011 Q3 (t=15) indicates the start of a successive recession in the euro area; historical episodes are based on CEPR-dated recessions: 1974Q3 to 1975Q1, 1980Q1 to 1982Q3, and 1992Q1 to 1993Q3.

Financial crises tend to have durable effects on investment. Evidence from previous financial crises shows that the decline in the investment-to-GDP ratio could be long-lasting, with a peak impact of 3 to 3½ percentage points three years after the crisis (WEO, 2014). In the euro area, the observed decline in the investment-to-GDP ratio since the beginning of the crisis is more severe than the standard financial crisis, but is in line with the decline observed in the most severe of these crises—with the investment ratio standing at 4¼ percentage points below the pre-crisis level (see text charts).



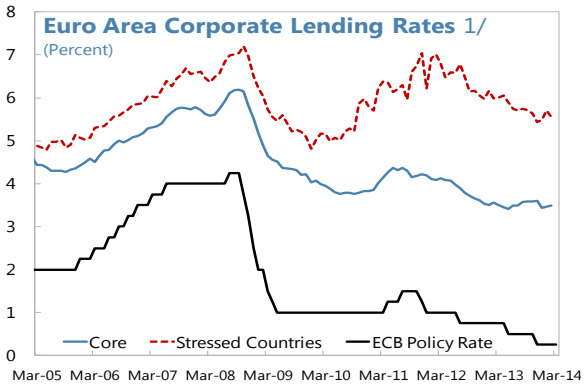


Source: WEO (2014), and staff calculations.
Notes: Gross fixed capital formation in percent of GDP. The entire sample of advanced economy financial crises between 1970 and 2007 identified by Laeven and Valencia (2012). Big 5 financial crises are those in Spain, 1977; Norway, 1987; Finland, 1991; Sweden, 1991; and Japan, 1992. Dashed red lines denote 90 percent confidence bands; and black line denotes the actual evolution of the investment-to-GDP ratio in the euro area from 2007 to 2013. X-axis units are years; t = 0 denotes the year of the financial crisis.

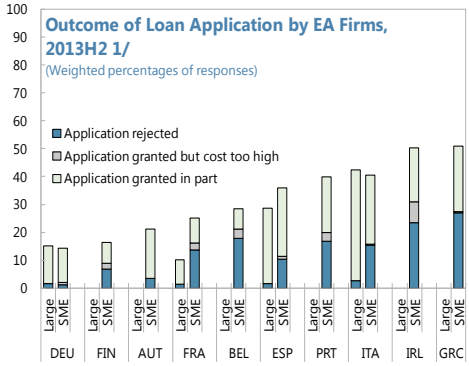
Besides the weak recovery in the aftermath of a financial crisis, other factors that could contribute to weak investment dynamics include elevated financing costs and limited access to finance as a result of financial fragmentation, high corporate leverage, and policy uncertainty.[4]

[4] Investment in many smaller European countries has also been affected by availability of the EU structural funds. For instance, there are indications that investment in Portugal in certain sectors was too high prior to the crisis (see Pina and Abreu, 2012).

The high cost of capital and limited access to funding are likely to have held back investment in certain euro area countries. While the ECB's policy rate is effectively at the lower bound, the lending rates in some countries remain elevated as financial fragmentation persists. Given that debt financing in the euro area is about 90 percent bank-based, higher bank lending rates increase the cost of capital, particularly for smaller firms.[5] In addition, survey evidence suggests that many smaller companies have had difficulty accessing credit. Recent improvements in corporate bond and stock markets are likely to benefit only larger corporations with better access to capital markets (see text charts).



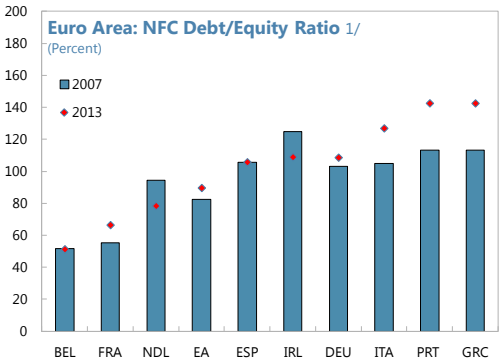
Sources: Haver, ECB, and staff calculations.
1/ Unweighted average; MFI lending to corporations under €1 million, 1–5 years maturity. Core: Germany, France, Belgium, Netherlands. Stressed countries include Greece, Ireland, Italy, Portugal, and Spain. In the sample, Ireland is excluded from May 2011 and Greece from September 2012 due to lack of data.



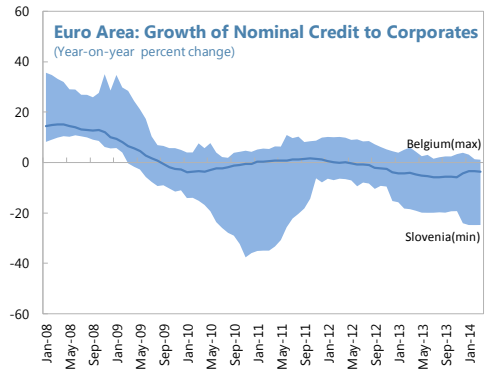
Source: SAFE survey (ECB), and staff calculations.
1/ Among those firms that applied within the last six months.

At the same time the corporate sector remains highly leveraged, particularly in stressed countries. As companies repair their balance sheets and reduce debt, their demand for credit remains low. With high non-performing loans and ongoing deleveraging in both corporate and banking sectors, credit to the private sector continues to shrink (see text charts). Although investment in the euro area could recover without an expansion in credit, such creditless recoveries are typically associated with lower investment and slower GDP growth. Empirically, only about one in five recoveries is creditless (IMF, 2014). A protracted weak recovery with low investment could, in turn, have long-term consequences through lower potential output, reducing expected growth further.

[5] Corporate debt financing is based on data from ECB-Eurostat: Euro Area Accounts, NFC Balance sheet data; financing through loans and corporate bonds; 2013Q4.



Source: ECB.
1/ Debt at euro area level is non-consolidated.



Source: Haver. The decline in the stock of credit for Slovenia at end-2013 is in part due to the transfer of non-performing loans to BAMC.

Against this background, this paper explores the factors explaining non-residential investment across the euro area. Weak recovery, financial fragmentation, high corporate leverage, and policy uncertainty could all hold investment back. To identify the impact of each factor, the paper uses three sets of models: i) an accelerator model (output changes); ii) a neoclassical model (real cost of capital); and iii) an "accelerator +" model (output changes, uncertainty, borrowing costs, leverage, and cash flow).

The paper finds that all of the above-mentioned factors have been important in explaining weak investment, but with considerable differences among countries. The accelerator model which relies only on output changes tracks investment closely, particularly for Spain, but actual post-crisis investment has remained below its model-implied value for most countries. The neoclassical model shows that, as expected, real cost of capital is a significant factor and that financial constraints held back investment in some countries. Nevertheless, the actual post-crisis investment is still below its estimated level for most countries. Finally, the "accelerator +" model helps reduce this difference between actual and estimated investment. Among other factors uncertainty is associated with low investment in most countries. In addition, corporate leverage is negatively associated with investment in Italy, Portugal, and France.

The remainder of the paper is structured as follows. Section II provides a brief overview of the literature on the determinants of investment. Section III then explains the models and discusses the estimation results. Section IV summarizes to what extent the different models help explain the current weakness of investment, and Section V concludes.

II. Literature Survey

There is a vast literature on the determinants of investment. The empirical literature on investment— using aggregate data—has considered a variety of models: the Tobin's Q, the accelerator, neoclassical, and various formulations of Euler equations. Oliner et.al. (1995) provide a good summary of the different models and a comparison of their empirical performance. Simple Euler equations are often found to be poor predictors of investment, while the accelerator model performs relatively well in explaining investment dynamics.

Traditional models focus on output changes, Tobin's Q, and the user cost of capital to explain investment. The Tobin's Q approach models investment using a proxy for the value of a unit of capital in place relative to its current purchase price (Tobin, 1969; and Hayashi, 1982). Both accelerator and neoclassical models essentially model current investment as a function of lagged desired changes in capital stock and depreciation. In the accelerator model, desired changes in capital stock are a function of output growth (Clark, 1917; and Jorgenson, 1971). In the neoclassical model, they are also a function of the user cost of capital (Jorgenson, 1971; and Caballero, 1994).

More recently, other determinants of investment such as uncertainty, leverage, and cash flow have been considered. To capture credit risk, Philippon (2009) uses bond prices instead of equity prices to estimate the value of Tobin's Q. The proposed measure, called "Bond Market's Q", is a function of the real risk-free rate, the spread between bond yields and government bonds, leverage, and uncertainty. He finds that the model fit for the U.S. investment data is better than the Tobin's Q approach. Another strand of literature explores the role of uncertainty, leverage, and cash flow on investment (Baum et. al. 2010; Bloom, 2009; Bloom et al. 2007, 2009; Dixit and Pindyck, 1994). Bloom, Bond, and Van Reenen (2007) focus on the impact of firm-level uncertainty and cash flow on investment. Uncertainty is generally found to be an important determinant of investment, especially for US and UK firms.

Various papers have focused on investment in Europe. Bond et.al (2003) use firm-level data for Belgium, France, Germany, and the UK, covering the period 1978–1989. They find that cash flow and profits are statistically and quantitatively less significant for continental European countries. Mizen and Vermeulen (2005), on the other hand, find that investment in Germany and the UK is sensitive to cash flows, which are driven by creditworthiness (proxied by sales growth and operating profits). More recently, a study by the European Investment Bank (EIB, 2013) shows that uncertainty has been the principal driver of the decline in investment since 2010, while low demand expectations have also played a role. On the other hand, financing constraints were only a serious concern for some countries.

III. Drivers of Investment in the Euro Area

Building on this extensive literature, this paper explores to what extent output dynamics, user cost of capital, uncertainty, financial constraints, and corporate leverage explain private non-residential investment across the euro area. This paper follows an approach similar to Lee and Rabanal (2010). While they focused on forecasting non-residential investment in the US, this paper focuses on explaining past investment dynamics.

Three types of investment models are used to explain the dynamics of private non-residential investment at the aggregate level: i) an accelerator model (changes in output); ii) a neoclassical model (cost of capital); and iii) an "accelerator +" model including uncertainty, leverage, and cash flow variables.

The preferred empirical approach is country-by-country estimation of an aggregate investment equation, given the heterogeneity in the impact of the various determinants on investment. While panel regressions would help exploit cross-country variation in the data, the homogeneity assumption on certain coefficients would be too restrictive, given considerable cross-country differences. Accordingly, time series regressions are run for the euro area, Germany, France, Italy, Spain, Portugal, Ireland and Greece, using quarterly data. Depending on data availability, the regression period runs from the 1990s up to 2012 or 2013, covering post-crisis investment patterns.

Both the accelerator and neoclassical models are nested within the specification that treats investment as a distributed lag function of changes in the desired capital stock (Oliner et.al., 1995). In particular, the investment equation is:

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

where I_t refers to investment and K_t refers to capital stock.

In the case of the accelerator model, changes in the desired capital stock are assumed to be proportional to the changes in output: $\Delta K^*_t = c\Delta Y_t$. The neoclassical model makes an additional assumption that the desired capital stock is set at the level where the real cost of capital (r_t) is equal to its marginal productivity. If the production technology is of Cobb-Douglas form, with output elasticity of capital equal to θ, then the desired capital stock is $K^*_t = \frac{\theta Y_t}{r_t}$.

A. Accelerator Model

The first step is to explore whether changes in output are sufficient to explain investment dynamics in the euro area. The accelerator model is obtained by dividing equation (1) by the lagged capital stock, adding an error term e_t that is assumed to be normally distributed and letting $\beta_i = \omega_i c$:

$$\frac{I_t}{K_{t-1}} = \frac{\alpha}{K_{t-1}} + \sum_{i=1}^{N} \beta_i \frac{\Delta Y_{t-i}}{K_{t-1}} + \delta + e_t, \quad (2)$$

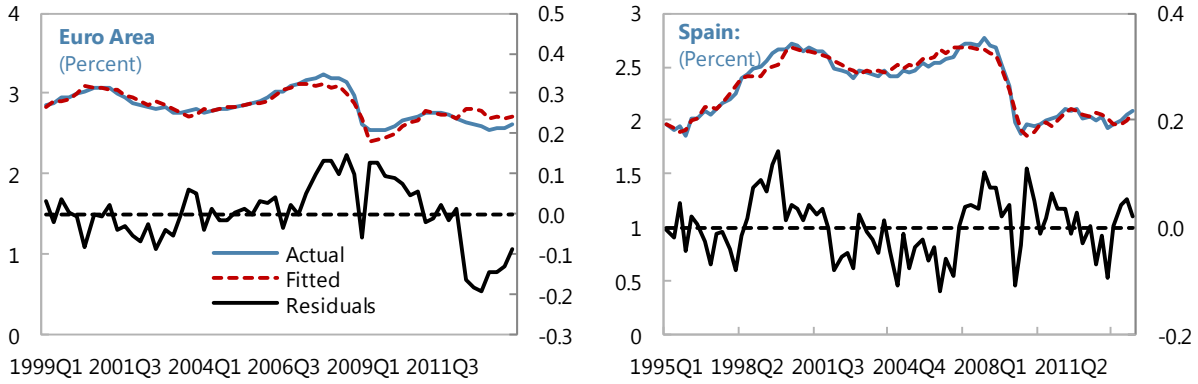
where I is real private non-residential investment, K is the total capital stock, and ΔY is the change in real GDP. [6] The current value of GDP growth is not included in the estimated equation in order to reduce endogeneity concerns. The coefficients of the lags of desired capital stock are expected to be positive, and the constant δ can be interpreted as an indirect estimate of the depreciation rate.

Using the above specification of the accelerator model, the lags of changes in real GDP (up to 12) are correctly signed and significant (Table A2.1). A longer lag selection (at around 30)

[6] Appendix 1 presents data sources and definitions. For Ireland and Greece, total real investment is used.

for the autoregressive distributed lag model would be required to fully eliminate the serial correlation. To control for autocorrelation of the residuals (a common result in the literature), we report Newey-West standard errors with truncation parameter 3.[7]

The accelerator model captures broad trends in investment, but also suggests sizeable underinvestment (a level lower than the predicted value) for the countries considered for the duration of the euro area debt crisis (2010Q2– 2013Q4), with the exception of Spain. The model explains the variation in investment in Spain relatively well (text charts, and Figure A2.1). For most countries, underinvestment becomes smaller towards the end of the sample. However, the model does not seem to adequately explain the behavior of total investment in Greece and Ireland.



Source: IMF staff estimates.

As robustness checks, we use different investment measures and methods to control for serial correlation. We also consider different measures of machinery and equipment investment in Ireland and Germany (with data up to 2013Q4). For both cases, the results are broadly the same. Similarly, the main conclusions remain intact with Prais-Winsten estimates—an alternative approach to address the residual auto-correlation—but the statistical significance of the lagged terms declines for Ireland and Portugal.

B. Neoclassical Model

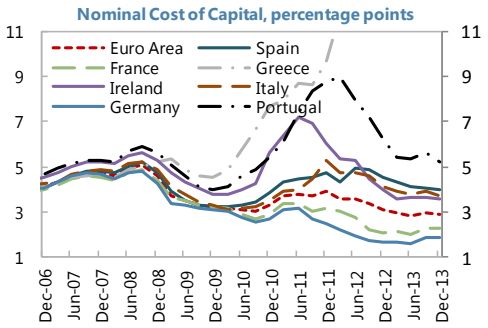
Because output developments cannot fully explain the decline in investment after the crisis, we explore whether changes in the desired capital stock are better proxied by a measure adjusted for the real cost of capital. The neoclassical model can be derived from equation (1), similarly to the accelerator model, letting $\beta_i = \omega_i \theta$. In theory, β_i is expected to be positive. As credit rationing cannot be fully captured by the real cost of capital estimates, the baseline specification is augmented by a proxy for credit rationing (based on a question on financial constraints from the European Commission's consumer and business survey).

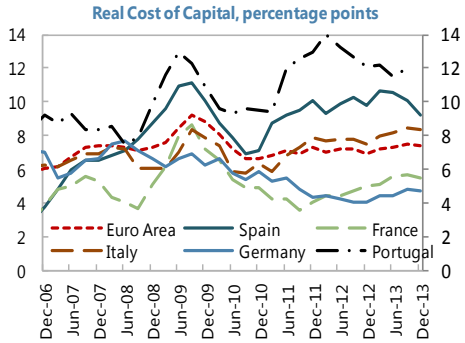
$$\frac{I_t}{K_{t-1}} = \frac{\alpha}{K_{t-1}} + \sum_{i=1}^{N} \beta_i \frac{\Delta\left(\frac{Y_{t-i}}{r_{t-i}}\right)}{K_{t-1}} + \sum_{i=0}^{N} \gamma_i \, fc_{t-i} + \delta + \varepsilon_t$$

[7] Given data availability, we also use lags up to 12 and report Newey-West standard errors. Oliner at. al., 1995 and Lee and Rabanal, 2010 use similar lag lengths.

where I_t refers to investment, K_t refers to capital stock, and fc_t refers to financial constraints.

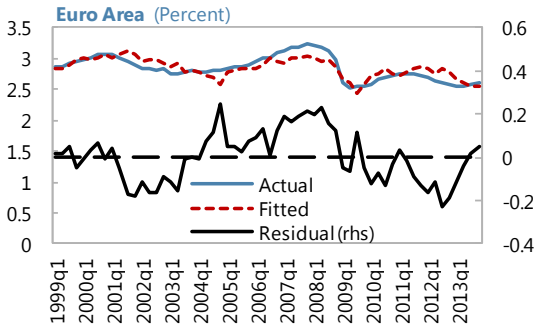
Both nominal and real costs of capital are elevated for the stressed countries (See Appendix 1 for the definition of the cost of capital, and text charts). While reduced policy rates have translated into lower borrowing costs and therefore a lower real cost of capital in the core countries, borrowing costs have remained elevated in the stressed countries—a sign of continued financial fragmentation. Keeping everything else constant, a higher real cost of capital implies a lower level of desired capital stock and therefore a lower level of desired investment.

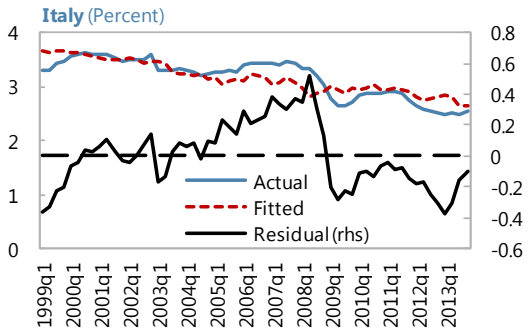




Source: Eurostat; Haver Analytics; and IMF staff calculations.

Similar to the accelerator model, the baseline neoclassical investment model suggests significant underinvestment over the duration of the European debt crisis with the exception of Spain (Table A2.3 and Figure A2.3).[8] However, the coefficients on lagged desired changes in capital stock (proxied by a function of output and real cost of capital) are generally not statistically significant or positive, with the exception of Greece. A similar result has been found by Oliner et.al (1995). In the augmented model, contemporary and lagged financial constraints have significant negative effects on investment in the euro area as a whole, as well as in Germany, Spain and Portugal. The gap between the actual and fitted investment in the euro area and Italy closes towards the end of the estimation period (see text charts).





Source: IMF staff estimates

[8] Similar to the accelerator model, the baseline residuals are serially correlated.

These conclusions are qualitatively robust to alternate lag selection strategies, a measure of the real cost of capital that is focused on debt financing only, and using narrower proxies for non-residential investment for Germany and Ireland.[9] To test whether the crisis has changed the investment dynamics, an intercept and interaction dummies are added to the specification. The intercept terms are generally significant, while the results are mixed for the interaction terms.[10]

C. Accelerator + Model: Exploring Other Determinants of Investment

Beyond output dynamics and the real cost of capital, credit risk (through high corporate leverage and corporate bond spreads), uncertainty, and cash flow may be important in determining investment in line with earlier literature (Philippon 2009; Lee and Rabanal 2010). In this section, we augment the accelerator model with additional variables that can explain euro area investment. Given the dominance of bank-based financing in Europe, to control for differences in bank loan conditions across euro area countries, we use the real lending rate for non-financial corporations (NFCs).[11] To measure uncertainty, the paper uses an economic policy uncertainty index, which is a weighted average of Consensus Economics forecaster dispersion data and an index based on newspaper articles (Baker, Bloom, and Davis 2013)[12]. While this measure captures overall policy uncertainty, it may not reflect firm and sector specific risks and other types of uncertainty.[13] In addition, we control for corporate leverage and firms' cash flow (Lee and Rabanal, 2010; REO APD, 2014). Leverage is expected to be negatively correlated with investment in countries with high corporate leverage and facing financing constraints. [14]Accordingly, the ratio of private non-residential investment to total capital stock is modeled as a function of overall real lending rates to NFCs, corporate bond spreads, uncertainty, corporate leverage, and cash flow. Similar to the neoclassical model, we also control for financial constraints to account for possible credit rationing.[15]

$$\frac{I_t}{K_{t-1}} = \alpha + \beta_1 cbond_{t-1} + \beta_2 rlrate_{t-1} + \beta_3 lnuncer_{t-1} + \beta_4 leverage_{t-1} + \beta_5 cash\ flow_{t-1} + \sum_{i=1}^{N} \gamma_i \frac{\Delta Y_{t-i}}{K_{t-1}} + \beta_6 fc_{t-1} + \varepsilon_t \quad (4)$$

[9] We have experimented with allowing up to 12 lags in every model.

[10] Out-of-sample projections also imply underinvestment. For all countries, one-step-ahead forecasts from 2008Q3 onward produce projected investment levels that are above realized investment levels, particularly during the second phase of the crisis. In the case of Germany, interestingly, during the first phase of the crisis, the decline in projected investment was deeper than the actual decline. This has reversed during the second phase of the crisis. This pattern could reflect the differences in the nature of shocks during the global crisis (2008–2010) and the European sovereign debt crisis (after 2010).

[11] Estimations with the real policy rate produce very similar results.

[12] Starting from April 2014, this index uses only the index based on news items. Our regressions stop at 2013Q4, and therefore do not use this index.

[13] A forthcoming paper focuses on firm specific and overall stock market volatility using firm level data.

[14] If financing is not a problem and leverage is initially low, an increase in leverage could be positively correlated with investment, particularly prior to the crisis.

[15] The number of output change lags included is determined country-by-country on the basis of the Akaike information criterion.

The additional variables (real lending rates, corporate bond spreads, uncertainty, corporate leverage and cash flow) have significant effects on investment. Omitted variable tests show that these factors are jointly significant in modeling investment both at the country and at the euro area level (Table A2.5).[16]

- *High uncertainty* is associated with weak investment, particularly in stressed countries. Uncertainty reduces investment in the majority of the countries in the sample (Spain, Italy, Greece, and Ireland) and in the euro area as a whole. A one standard deviation increase in the uncertainty index reduces investment to capital ratio by 0.03-0.1.

- *Corporate leverage* is negatively correlated with investment in Portugal, Italy, and France. These results are robust to using alternative definitions of firm leverage. In these countries, one percentage point increase in the leverage ratio would reduce investment to capital ratio by about 0.01–0.04 percentage points.

- *Financial constraints* are negatively associated with investment for Italy and Portugal.

- *Cash flow* is found to be statistically significant and with the correct sign for Spain and Germany. For Portugal the coefficient has the reverse sign (with weaker statistical significance). Using a different cash flow-to-sales measure that gives a larger weight to bigger corporations (market-capital weighted average) yields similarly mixed results.

- *Corporate bond spreads* are statistically significant for Ireland, Spain and, to a lesser degree, Germany.

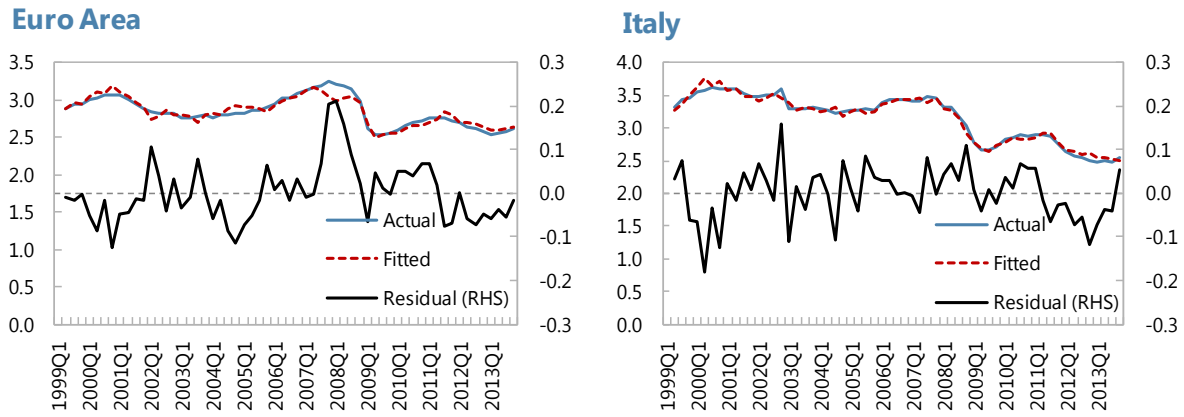
- *Real lending rates* are either insignificant or their coefficients are wrongly signed for most of the sample. The real lending rates significant and have the expected negative correlation only for Italy. While the coefficients for the euro area, Germany and Spain are statistically significant, they have the reverse sign—a common finding in the literature (Caballero, 1999; Sharpe and Suarez, 2014).[17] As this could reflect difficulties in identifying credit demand and supply, we run a separate regression including corporate bond spreads, the real rate and cash flow (representing supply factors) as well as an instrumental variable based on GDP growth, uncertainty,

[16] The omitted variable tests – for the euro area as well as the individual countries – take the restricted model with the investment-to-total capital stock ratio as a function of only output changes and financial constraints as the starting point. They then consider whether augmenting the model by uncertainty and leverage or by all additional factors increases the explanatory power of the model, using F- and likelihood ratio tests of the null hypothesis that the coefficients of the added variables are equal to zero.

[17] The results remain basically unchanged when substituting with other lending rate variables such as the change in the real lending rate, adding the real rate to the model as a separate variable, or interacting the real lending rate variable with a crisis dummy to distinguish between boom and bust episodes.

leverage and real lending rates to proxy demand factors. However, real rates are still positively correlated with investment, suggesting that the regression is still picking up the response of the policy rate to economic cycle.

Overall, the model seems to work better for stressed countries, in particular for Italy and Spain, and to a lesser extent for Portugal and the euro area as a whole (Table A2.4 and Figure A2.4).[18] It performs comparatively poorly for Germany and France.[19] Particularly for countries with good fit, this model reduces the underinvestment observed in earlier models for the post-crisis period substantially (see text charts).



Source: IMF staff estimates

Using the estimated coefficients from the Accelerator + model, we can separate the contributions of output changes and all remaining factors to the evolution of investment (Figure A2.5). For the euro area, output explains a large share of the weak investment from 2008 onwards, but the combined effect of uncertainty, corporate leverage and other remaining factors also explain a share. For Spain, weak output explains almost all the decline in investment during the crisis, but for Italy and Ireland, the additional factors were the main drag on investment.

Additional robustness checks do not alter our findings. For example, using alternative investment series for machinery and equipment investment in Ireland and Germany (with data up to 2013Q4) produces broadly similar results. The results are also robust to using alternative estimation techniques to correct for residual autocorrelation. Employing a Cochrane-Orcutt estimation method instead of the Newey-West estimator, the signs of the coefficients remain the same, though their size and significance level differ slightly from the results reported above.

The paper also explored the Tobin's Q model, but the model did not perform well in explaining investment, possibly reflecting data measurement issues at the aggregate level.

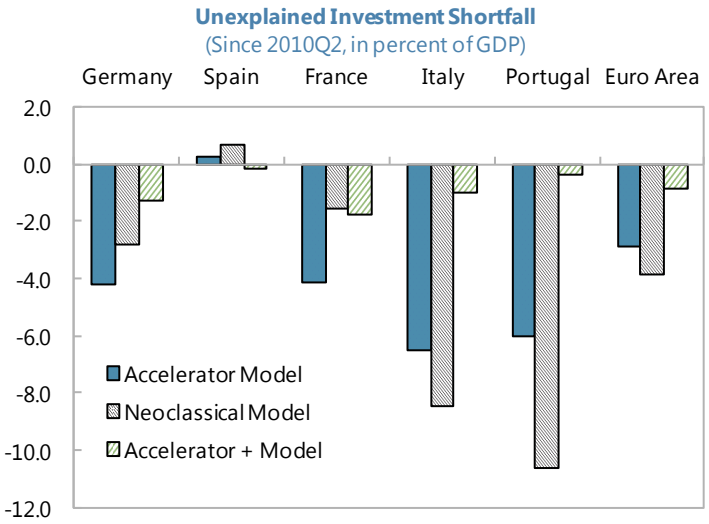
[18] For Portugal, after controlling for other factors some output coefficients turn negative. This could potentially reflect omitted variable bias, stemming from the EU structural funds, which have played an important role in investment in Portugal.

[19] Pérez Ruiz (2014) uses a broader set of determinants to explain the level of business investment in France. The model provides a good fit for France.

Several definitions of Tobin's Q (for NFCs) were considered: i) quarterly series that are interpolated from annual Tobin's Q (Woldscope, Corporate Vulnerability Unit); ii) price-to-book ratio; iii) stock prices deflated by GDP deflator. In addition, the model controls for firm leverage (debt-to-asset ratio) and cash-flow. Among the Tobin's Q proxies used, only price-to-book ratio appears to be significant in a few specifications for Germany, France, and Portugal. Controlling for endogeneity (by two-stage least squares) and running the regressions for the pre-crisis period, the significance of the results increases somewhat: price-to-book ratio and leverage are significant and correctly signed for Germany, Greece, Portugal, and the euro area. Overall, however, model performance remains weak. This could reflect measurement issues with aggregate data, lack of quarterly series, and the dominance of unlisted companies (mainly SMEs) in some countries. These results are available upon request.

IV. The Magnitude of Missing Investment

The residuals from the models presented in the previous section provide an estimate of how much investment is "missing" in euro area countries. We term "unexplained investment shortfall" the cumulative sum of residuals from the beginning of the euro area debt crisis in 2010Q2 (inclusive) until the end of the sample, i.e. the difference between the predicted and the actual level of investment. The comparison of different models allows us to better understand what the drivers of this shortfall are.



Source: IMF staff estimation.
Notes: DEU ends in 2012 Q4 and PRT in 2013 Q3

During the euro area debt crisis, investment has been systematically lower than the model-predicted level, except in Spain. Overall, controlling only for output, the cumulative unexplained shortfall in investment is about 3–6 percent of GDP (excluding Spain). The shortfall is highest for Italy and Portugal. These are two countries in our sample that have a high level of corporate leverage, financial fragmentation, and policy uncertainty, and not surprisingly these are the factors that turn out be significant in explaining investment.

Once we control for these other determinants, the cumulative shortfall declines substantially to about ½–2 percent (see text chart). Focusing on Italy and Portugal, the shortfall declines from about 6 percent of GDP to less than 1 percent of GDP. For Spain, the overall model fit (across the models) is better than for other countries, and most of the variation in investment

is explained with all the models. As a result, the missing investment for Spain is around zero across the models.

V. CONCLUSION

Weak investment across the euro area has been driven by a combination of factors. Empirical evidence suggests that output dynamics can explain the broad trends in investment, including a part of its collapse after the financial crisis. In particular, output can explain almost all of the movement in investment in Spain. In other countries, however, private non-residential investment has been lower than implied by output developments since the onset of the European debt crisis.

In addition to output dynamics, financial constraints affect investment, particularly for Italy, Portugal, and Spain. The neoclassical model that seeks to proxy desired capital stock with a measure based on the real cost of capital generally does not produce significant results, except for Greece. Nevertheless, investment continues to remain below its model implied value for most of the countries.

High uncertainty and corporate sector leverage are additional impediments to investment, particularly for some of the stressed countries. These factors explain a big portion of the decline in investment that was not explained by output changes and real cost of capital.

Based on these results, investment is expected to pick up as the recovery strengthens and uncertainty declines. The recovery in the euro area is ultimately grounded in complementary policy actions at both at the national and euro area levels. Demand support, balance sheet repair, completion of the banking union, and structural reforms are needed to further strengthen the euro area economy and reduce uncertainty (Euro Area Policies: 2014 Article Consultation Staff Report, IMF, 2014b). Corporate debt-to-equity remains elevated in some stressed countries, and the deleveraging process is still at an early stage. At the same time, firms' access to capital needs to improve in stressed countries to support investment. A sustained recovery in investment will require dealing with both the corporate debt overhang and financial fragmentation.

Building on the evidence from aggregate data, future work will focus on firm-level investment, particularly for SMEs. Firm-level analysis will supplement macro-level regressions and differentiate better investment patterns of large and small corporations. It will also better capture the impact of other firm-specific variables, such as cash flow, leverage, and Tobin's Q.

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APPENDIX 1. DATA DEFINITIONS AND SOURCES

Real investment. Investment data are taken from the Eurostat with the exception of Greece and Ireland, where World Economic Outlook (WEO) data for total investment is used. Private non-residential investment is the sum of investment in transport and other machinery and equipment, cultivated assets, and intangible fixed assets. Left panel of the first text figure uses the following sources:
Greece: Gross capital formation, (NSA, millions of chained 2005 euro); source – ELSTAT; Haver code - N174NCC@G10. Ireland: Gross fixed capital formation (SA, millions of chained 2011 euro); source – CSOI; Haver code - S178NFC@G10. Spain: Gross capital formation (SA/WDA, millions of chained 2008 euro); source – INE; Haver code - S184NFBC@G10. Portugal: Gross capital formation (SA, millions of chained 2006 euro); source – INE; Haver code - S182NFBC@G10. Italy: Gross fixed investment (SA/WDA, millions of chained 2005 euro); source – ISTAT; Haver code - S136NFC@G10. Euro Area: Gross capital formation (SA/WDA, millions of chained 2005 euro); source – Eurostat; Haver code - S025NFBC@G10. United Kingdom: Gross fixed capital formation (SA, millions of chained 2010 pounds); source – ONS; Haver code - S112NFC@G10. France: Gross fixed capital formation (SWDA, millions of Chained 2010 euro); source – INSEE; Haver code - FRSNFIC@FRANCE. United States: gross capital formation (SA, billions of chained 2009 dollars); source – BEA; Haver code - S111NFBC@G10. Germany: Gross capital formation (SA/WDA, billions of chained 2005 euro); source – Bundesbank; Haver code - S134NFBC@G10.

Capital stock series are from AMECO database—the annual series were linearly interpolated so that the stock of capital in the last quarter would match the corresponding annual figure. Alternative measures of capital stock were also calculated using perpetual inventory method. The initial capital stock values from the AMECO capital stock were scaled by applying appropriate investment subcomponent ratios. Depreciation rates are assumed constant and equal to average rates implied by the AMECO series.

Real GDP on quarterly basis was obtained from the WEO database.

Real cost of capital. The correct measure of the cost of capital depends on the structure of financing of the firm. The flow of funds data suggests that liabilities of non-financial corporations consist primarily of loans and equity with the share of bond financing being less than 10 percent in most periods and countries. The following formula is used for the real cost of capital:

$$r_{i,t} = \left[\left(\frac{D_{i,t}}{D_{i,t}+B_{i,t}+E_{i,t}}\right) l_{i,t} + \left(\frac{B_{i,t}}{D_{i,t}+B_{i,t}+E_{i,.t}}\right) i_t + \left(\frac{E_{i,t}}{D_{i,t}+B_{i,t}+E_{i,t}}\right) c_{i,t} - \pi_{i,t} + \delta_i\right] \times \frac{P^I_{i,t}}{P_{i,t}},$$

where $D_{i,t}$, $B_{i,t}$ and $E_{i,t}$, are the amounts of bank loans, bonds (securities other than shares), and equity in the liabilities of non-financial corporations. For the nominal costs of different kind of capital we use MFI lending rates in a given country for new business at all maturities, $l_{i,t}$, for bank loan liabilities; yield on the euro area wide corporate bond index, i_t, for bond liabilities; and the yield on 10 year government bond $c_{i,t}$ to price equity liabilities.[20]

[20] We have experimented with alternative approaches to price equity capital – such as variations on the dividend growth model; however, they tend to produce counterintuitive implications for the ranking of the cost of capital across different countries. Using a 10-year government bond establishes a sensible lower bound for the cost of equity and, assuming that the

(continued…)

In line with the literature, from the nominal rate, we subtract the year-on-year change in investment deflator $\pi_{i,t}$, add the estimated depreciation rate (implied rates based on AMECO series), which is assumed to be constant but different across countries δ_i and multiply the result by the relative price of investment goods (investment deflator) to output, $P^I_{i,t}/P_{i,t}$. In addition, we also use a measure of real cost of capital for debt financing, composed of bond and bank lending. In most countries the real cost of capital has been declining throughout the 2000s, however, after the crisis Southern European countries diverged from France and Germany. Figure A1.1 shows the nominal and real cost of capital for the countries considered. As of the latest available data, the lowest real cost of capital is in Germany (5 percent), while Portugal has the highest cost (12.0 percent). The volatility of real cost of capital in Greece (for which only a shorter sample is available) is driven by the volatility of the investment deflator. ***Financial constraints:*** This variable is from 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.

Corporate bond prices. We use the average spread of corporate over government bonds with 1 to 5 years maturity for the euro area as a whole for all countries in the sample, to proxy corporate bond market conditions. This measure inherently gives more weight to large euro area economies and applies to larger firms. (Merill-Lynch indices, Bloomberg). The variable is measured in basis points.

Real lending rates. Nominal rates, for all loan sizes and maturities, are from the ECB and, in the case of Greece, the IFS. The series has been deflated by the annualized same-quarter change in the GDP deflator.

Uncertainty index**:** Bloom (2009); Baker, Bloom, Davis (2013). Natural log of uncertainty index*100. The index for Italy is used as a proxy for Spain, Portugal, Ireland and Greece, due to lack of data for these countries. Database is downloadable from the following website: http://www.policyuncertainty.com/europe_monthly.html.

Corporate sector leverage: Debt-to-equity ratio from the ECB, defined as the ratio of outstanding debt of nonfinancial corporations to outstanding stock of shares (in percent).

Cash flow-to-sales: Worldscope. IMF's Corporate vulnerability (percent, median estimate).

Crisis dummy: crisis =1 from 2008Q3 (used only for robustness checks).

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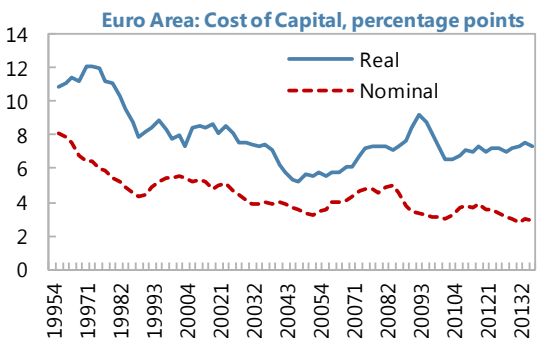
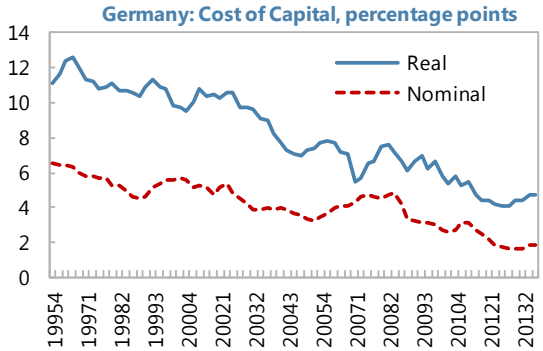
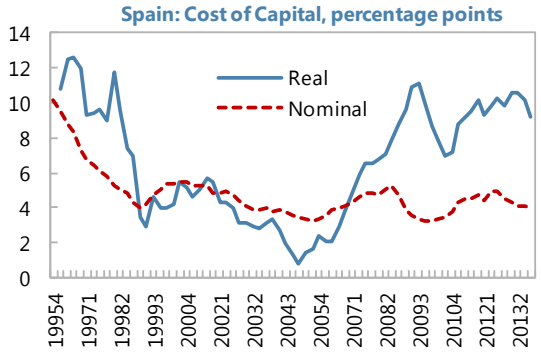
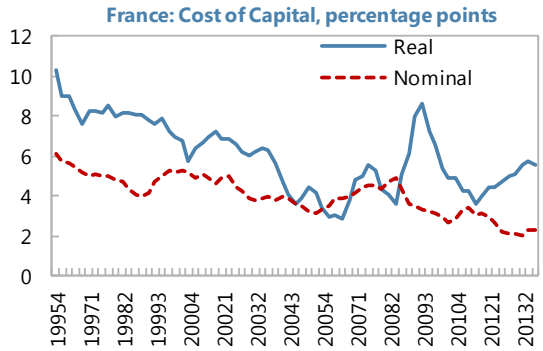
risk premium is constant, is not expected to affect the results. For the euro area, we use the simple average of the 10-year bond yields in France, Germany, Spain, and Italy.

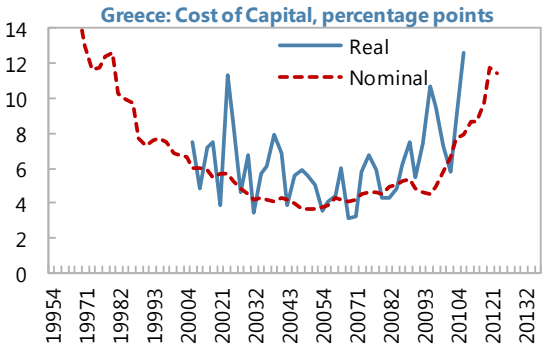
Figure A1.1. Cost of Capital Calculations

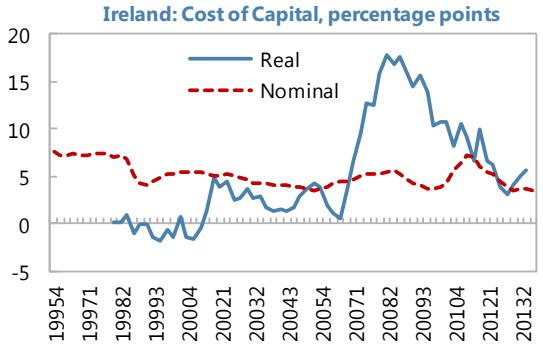


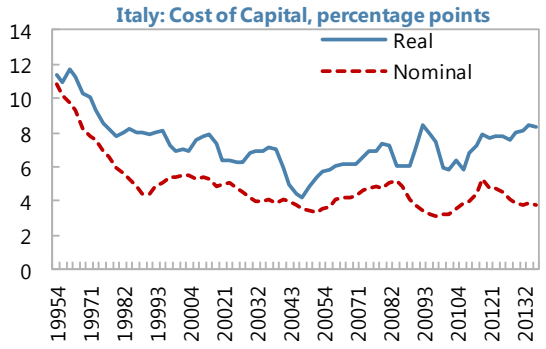


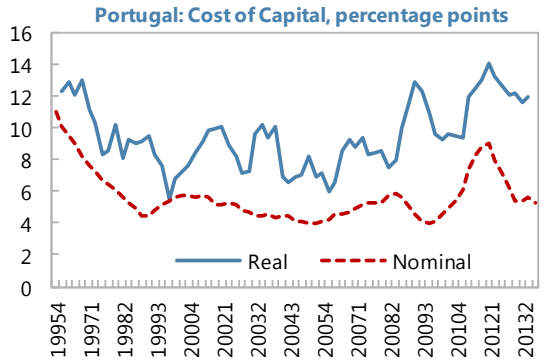












Source: Haver Analytics; and IMF staff estimates.

APPENDIX 2. RESULTS

RESULTS OF THE ACCELERATOR MODEL[21]

$$\frac{I_t}{K_{t-1}} = \frac{\alpha}{K_{t-1}} + \sum_{i=1}^{N} \beta_i \frac{\Delta Y_{t-i}}{K_{t-1}} + \delta + e_t$$

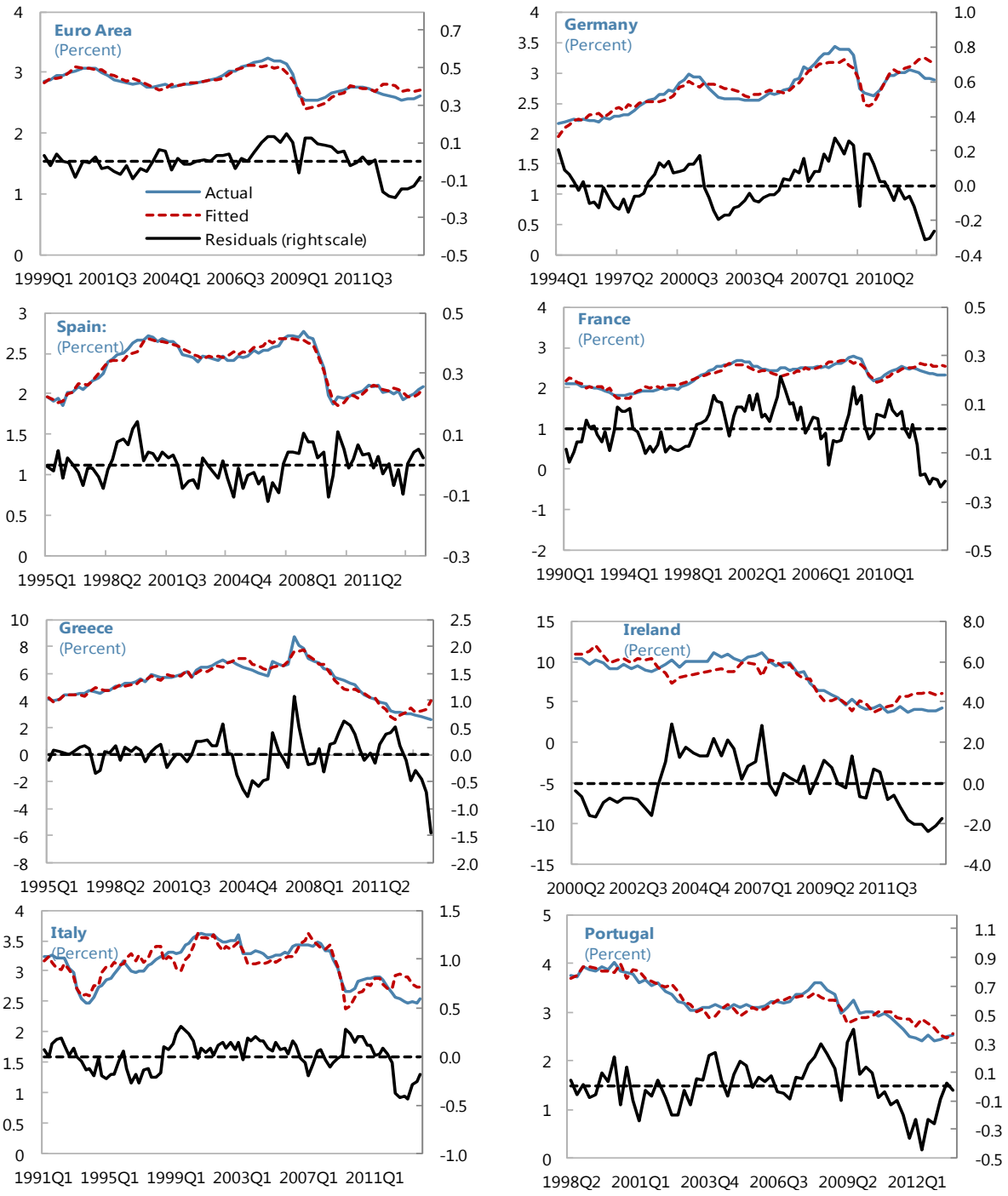
Table A2.1 Accelerator Model - Total Investments (Newey-West HAC standard error estimates)

	Euro Area	Germany	Spain	France	Greece	Ireland	Italy	Portugal
α	-200700 **	-222248 ***	-22311 ***	-90732 ***	-37403 ***	-15327	-57655 ***	-3756
	(97242.82)	(23056.6)	(1592.14)	(7255.75)	(2735.32)	(13273.16)	(11991.01)	(2851.86)
β1	0.32 ***	0.21 ***	0.41 ***	0.26 ***	0.38 **	0.75 **	0.47 ***	0.29 ***
	(0.06)	(0.06)	(0.09)	(0.06)	(0.17)	(0.28)	(0.08)	(0.08)
β2	0.21 **	0.23 ***	0.49 ***	0.23 ***	0.70 ***	0.99 **	0.39 ***	0.26 **
	(0.1)	(0.07)	(0.06)	(0.05)	(0.15)	(0.42)	(0.09)	(0.1)
β3	0.25 ***	0.25 ***	0.23 ***	0.23 ***	1.10 ***	0.92 **	0.37 ***	0.26 ***
	(0.06)	(0.06)	(0.07)	(0.05)	(0.1)	(0.38)	(0.07)	(0.06)
β4	0.22 ***	0.18 ***	-0.05	0.20 ***	0.71 ***	0.76 **	0.19 **	0.24 ***
	(0.07)	(0.04)	(0.08)	(0.05)	(0.12)	(0.29)	(0.08)	(0.07)
β5	0.13 *	0.13 ***	0.12 *	0.20 ***	1.04 ***	0.37	0.27 ***	0.21 **
	(0.07)	(0.04)	(0.07)	(0.05)	(0.12)	(0.35)	(0.09)	(0.08)
β6	0.16 ***	0.10 **	0.39 ***	0.17 ***	1.12 ***	0.30	0.18 ***	0.19 **
	(0.05)	(0.04)	(0.06)	(0.06)	(0.16)	(0.39)	(0.07)	(0.08)
β7	0.17 **	0.07	0.09	0.09 *	0.82 ***	0.28	0.28 ***	0.22 ***
	(0.07)	(0.05)	(0.06)	(0.06)	(0.18)	(0.33)	(0.07)	(0.07)
β8	0.06	0.09 *	0.00	0.12 **		0.57 **	0.24 ***	0.10
	(0.04)	(0.05)	(0.05)	(0.05)		(0.25)	(0.07)	(0.07)
β9	0.10 **	0.12 **	0.05	0.11 **		0.55	0.09	0.16 **
	(0.05)	(0.06)	(0.04)	(0.05)		(0.34)	(0.07)	(0.08)
β10	0.09 *	0.07	0.15 ***	0.10 **		0.71 *	0.18 ***	0.16 *
	(0.05)	(0.05)	(0.03)	(0.05)		(0.39)	(0.06)	(0.09)
β11	0.05	0.10 *	0.06 *	0.08		1.04 ***	0.26 ***	0.17 *
	(0.04)	(0.05)	(0.03)	(0.05)		(0.35)	(0.07)	(0.09)
β12	0.18 ***			0.20 ***		0.75 **	0.38 ***	0.16 *
	(0.05)			(0.06)		(0.3)	(0.08)	(0.08)
δ	3.43 ***	5.99 ***	2.76 ***	3.98 ***	10.65 ***	8.92 ***	4.29 ***	3.81 ***
	(0.38)	(0.35)	(0.05)	(0.16)	(0.48)	(2.75)	(0.3)	(0.66)
N	60	76	76	96	76	54	92	62
Adjusted R-squared	0.79	0.82	0.95	0.86	0.92	0.66	0.75	0.82
D-W Statistic	0.50	0.38	0.99	0.33	0.69	0.50	0.35	0.80
S.E. of regression	0.09	0.14	0.06	0.10	0.39	1.52	0.18	0.18

Notes: * - significant at 10 percent; ** - significant at 5 percent; *** - significant at 1 percent. EA sample includes 1991Q1 - 2013Q4; Germany: 1994Q1-2012Q4; Spain and Greece: 1995Q1 - 2013Q4; France: 1990Q1 - 2013Q4; Ireland: 2000Q2 - 2013Q3; Italy: 1991Q1 - 2013Q4; Portugal: 1998Q2 - 2013Q3.
Standard errors in parenthesis.

[21] Results are in percent terms.

Figure A2.1. Accelerator Model: Private Non-residential Investment/Capital Ratio



Sources: Eurostat; IMF. World Economic Outlook database; OECD, Analytical database; European Commission, AMICO database; and IMF staff calculations.

Note: Total investment for Greece and Ireland.

RESULTS OF THE NEOCLASSICAL MODEL

$$\frac{I_t}{K_{t-1}} = \frac{\alpha}{K_{t-1}} + \sum_{i=1}^{N} \beta_i \frac{\Delta\left(\frac{Y_{t-i}}{r_{t-i}}\right)}{K_{t-1}} + \delta + \varepsilon_t$$

Table A2.2: Neoclassical Model: Estimates with Newey West Standard Errors
Estimation Period: 1995Q1 - 2013Q4 for most countries /1

	Euro Area	Germany	Spain	France	Greece	Ireland	Italy	Portugal
α	241,396**	-205,726***	34,672***	22,430	-51,155***	92,896***	166,796***	12,617***
	(95,654)	(49,825)	(7,454)	(13,375)	(10,192)	(17,731)	(45,868)	(1,816)
β1	-0.142	-0.0623	-0.00878	0.0226	0.244***	-0.0401	-0.000238	0.00587
	(0.101)	(0.135)	(0.0109)	(0.0203)	(0.0637)	(0.0417)	(0.0825)	(0.0386)
β2	-0.0927	-0.0766	-0.00998	0.00837	0.202**	-0.0452	-0.0122	0.0201
	(0.0942)	(0.132)	(0.0118)	(0.0215)	(0.0807)	(0.0524)	(0.0694)	(0.0412)
β3	-0.00225	-0.0339	-0.00900	0.00535	0.467***	-0.0451	0.0176	-0.0156
	(0.0772)	(0.122)	(0.0120)	(0.0193)	(0.0610)	(0.0497)	(0.0788)	(0.0492)
β4	-0.0560	0.00871	-0.00996	-0.00782	0.600***	-0.0619	-0.0197	-0.0154
	(0.0916)	(0.0836)	(0.0132)	(0.0208)	(0.0692)	(0.0408)	(0.0888)	(0.0472)
β5	-0.0952		-0.0102	0.00393	0.757***	-0.0814***	0.00507	0.00611
	(0.0937)		(0.0133)	(0.0267)	(0.0788)	(0.0256)	(0.110)	(0.0470)
β6	0.0392		-0.00869	0.00895	0.909***	-0.0613***	0.0202	-0.0262
	(0.0837)		(0.0121)	(0.0222)	(0.104)	(0.0209)	(0.113)	(0.0567)
β7	0.0710		-0.00514	0.00957	0.976***	-0.0426***	0.0167	0.00711
	(0.0707)		(0.0108)	(0.0195)	(0.124)	(0.0147)	(0.132)	(0.0620)
β8	0.0184		-0.00168	0.0236	0.829***	-0.0319***	0.0575	0.00266
	(0.0921)		(0.0112)	(0.0180)	(0.114)	(0.00932)	(0.140)	(0.0599)
β9	0.0756		0.00284	0.0169	0.704***	-0.0195**	0.0151	
	(0.0973)		(0.0123)	(0.0173)	(0.0946)	(0.00939)	(0.119)	
β10	0.157			0.0277	0.511***	-0.0180*	0.00667	
	(0.124)			(0.0224)	(0.0876)	(0.00972)	(0.127)	
β11				0.0240	0.270***	-0.0129*	0.0365	
				(0.0230)	(0.0613)	(0.00740)	(0.128)	
β12				0.0309	0.154**	-0.00697	0.107	
				(0.0309)	(0.0611)	(0.00585)	(0.159)	
δ	1.855***	5.937***	1.224***	2.040***	13.24***	-12.42***	-0.696	0.135
	(0.394)	(0.792)	(0.268)	(0.267)	(1.505)	(3.869)	(1.044)	(0.480)
N	61	64	62	60	29	50	60	62
R-squared	0.310	0.397	0.511	0.312	0.907	0.690	0.624	0.633
Adjusted R-squared	0.155	0.345	0.415	0.118	0.827	0.578	0.517	0.570
S.E. of regression	0.177	0.231	0.211	0.119	0.485	1.709	0.251	0.283
D-W Statistic	0.234	0.184	0.182	0.231	0.862	0.281	0.156	0.150

1/ Sample for Germany ends in 2012Q4. Ireland and Portugal 2013Q3. Greek real cost of capital is available from 2001 onwards and Irish real cost of capital is available from 1999 onwards.

Note: Standard errors in parenthesis.

$$\frac{I_t}{K_{t-1}} = \frac{\alpha}{K_{t-1}} + \sum_{i=1}^{N} \beta_i \frac{\Delta\left(\frac{Y_{t-i}}{r_{t-i}}\right)}{K_{t-1}} + \sum_{i=0}^{N} \gamma_i \, fc_{t-i} + \delta + \varepsilon_t$$

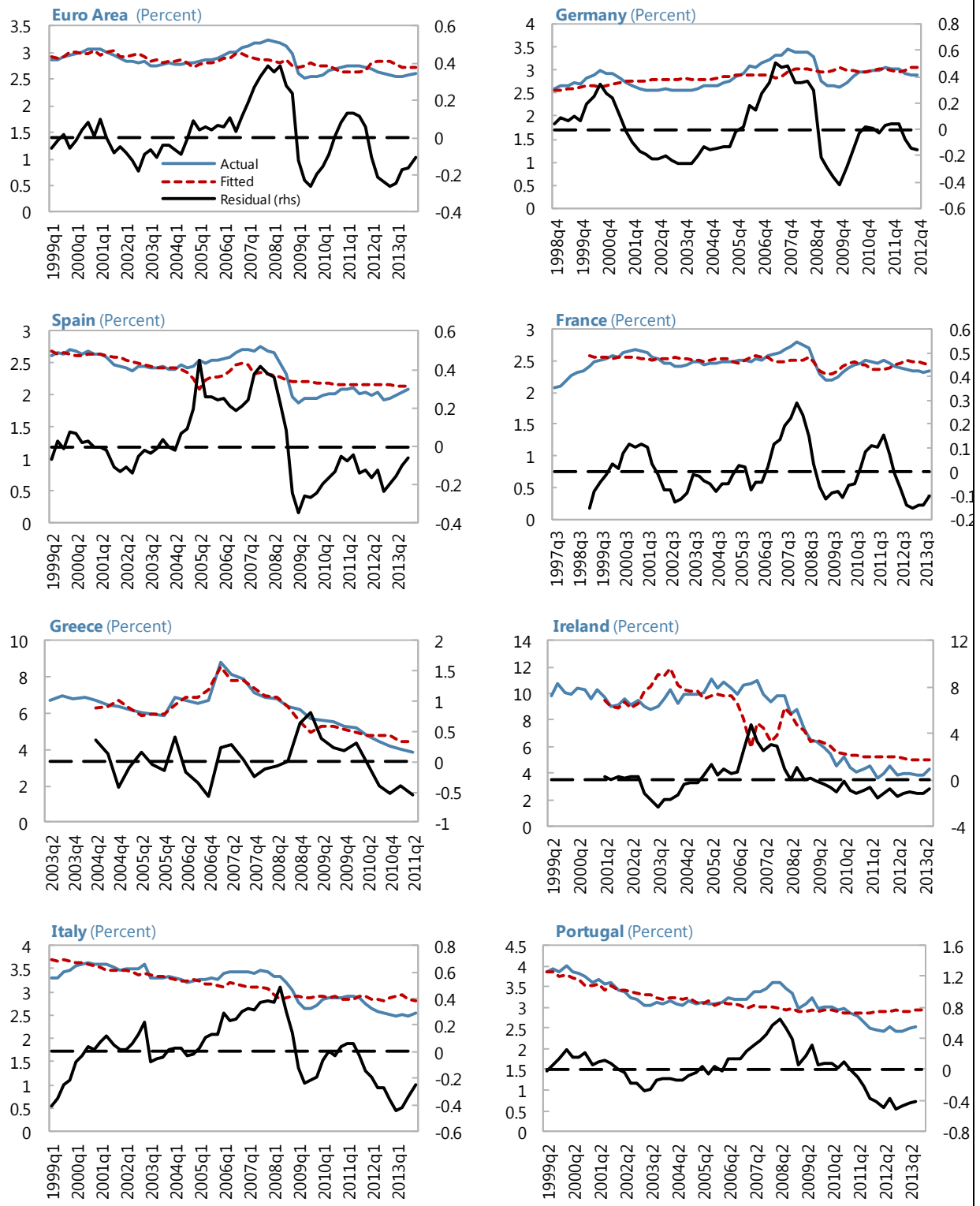
Table A2.3: Neoclassical Model Augmented with Financial Constraints: Estimates with Newey West Standard Errors
Estimation Period: 1995Q1 - 2013Q4 for most countries /1

	Euro Area	Germany	Spain	France	Greece	Ireland	Italy	Portugal
α	-507,279***	-450,609***	9,752	6,546	-44,545**	92,896***	100,171*	24,477***
	(186,844)	(65,147)	(6,595)	(18,503)	(17,547)	(17,731)	(55,275)	(5,235)
β1	-0.0960	-0.104	-0.00578	0.0222	0.270***	-0.0401	0.0314	-0.141**
	(0.0750)	(0.0889)	(0.00419)	(0.0179)	(0.0846)	(0.0417)	(0.0894)	(0.0516)
β2	-0.0820	-0.0665	-0.00884*	0.00497	0.244*	-0.0452	-0.0220	-0.205***
	(0.0780)	(0.0998)	(0.00466)	(0.0203)	(0.125)	(0.0524)	(0.0836)	(0.0724)
β3	0.0197	-0.00688	-0.00616	0.00221	0.482***	-0.0451	0.0284	-0.250**
	(0.0503)	(0.0809)	(0.00468)	(0.0174)	(0.0934)	(0.0497)	(0.0862)	(0.0913)
β4	0.00570	-0.0400	-0.00671	-0.00585	0.591***	-0.0619	0.00272	-0.109
	(0.0583)	(0.0712)	(0.00523)	(0.0215)	(0.104)	(0.0408)	(0.101)	(0.0873)
β5	-0.0628		-0.00780	0.00159	0.729***	-0.0814***	0.0256	-0.0608
	(0.0772)		(0.00566)	(0.0271)	(0.105)	(0.0256)	(0.106)	(0.0449)
β6	0.0191		-0.00728	0.00753	0.820***	-0.0613***	0.0352	-0.127**
	(0.0684)		(0.00473)	(0.0222)	(0.125)	(0.0209)	(0.117)	(0.0582)
β7	0.0610		-0.00419	0.00722	0.866***	-0.0426***	0.0458	-0.0978*
	(0.0636)		(0.00399)	(0.0186)	(0.169)	(0.0147)	(0.130)	(0.0553)
β8	-0.0186		-0.00121	0.0235	0.714***	-0.0319***	0.0889	0.0551
	(0.0844)		(0.00472)	(0.0169)	(0.125)	(0.00932)	(0.141)	(0.0922)
β9	0.0613		0.00213	0.0171	0.598***	-0.0195**	0.0224	
	(0.0807)		(0.00589)	(0.0169)	(0.120)	(0.00939)	(0.105)	
β10	0.121			0.0235	0.441***	-0.0180*	0.0471	
	(0.0982)			(0.0232)	(0.102)	(0.00972)	(0.124)	
β11				0.0209	0.235***	-0.0129*	0.0579	
				(0.0211)	(0.0681)	(0.00740)	(0.120)	
β12				0.0306	0.139*	-0.00697	0.129	
				(0.0296)	(0.0685)	(0.00585)	(0.152)	
γ0	-0.141***	-0.0807***	-0.0681***	-0.00961	-0.0579		-0.0593	-0.0889***
	(0.0363)	(0.0237)	(0.0161)	(0.00917)	(0.0411)		(0.0363)	(0.0133)
γ1		-0.0532**			-0.0465			-0.0936***
		(0.0264)			(0.0638)			(0.0228)
δ	5.394***	9.977***	2.273***	2.395***	12.94***	-12.42***	0.979	-0.343
	(0.900)	(1.073)	(0.265)	(0.400)	(2.215)	(3.869)	(1.304)	(1.123)
N	61	64	62	60	29	50	60	42
R-squared	0.628	0.702	0.787	0.330	0.921	0.690	0.659	0.747
Adjusted R-squared	0.535	0.665	0.740	0.122	0.829	0.578	0.553	0.654
S.E. of regression	0.131	0.165	0.141	0.119	0.481	1.709	0.242	0.193
D-W Statistic	0.380	0.376	0.488	0.180	1.017	0.112	0.602	0.767

1/ Sample for Germany ends in 2012Q4. Ireland and Portugal 2013Q3. Greek real cost of capital is available from 2001 onwards and Irish real cost of capital is available from 1999 onwards.

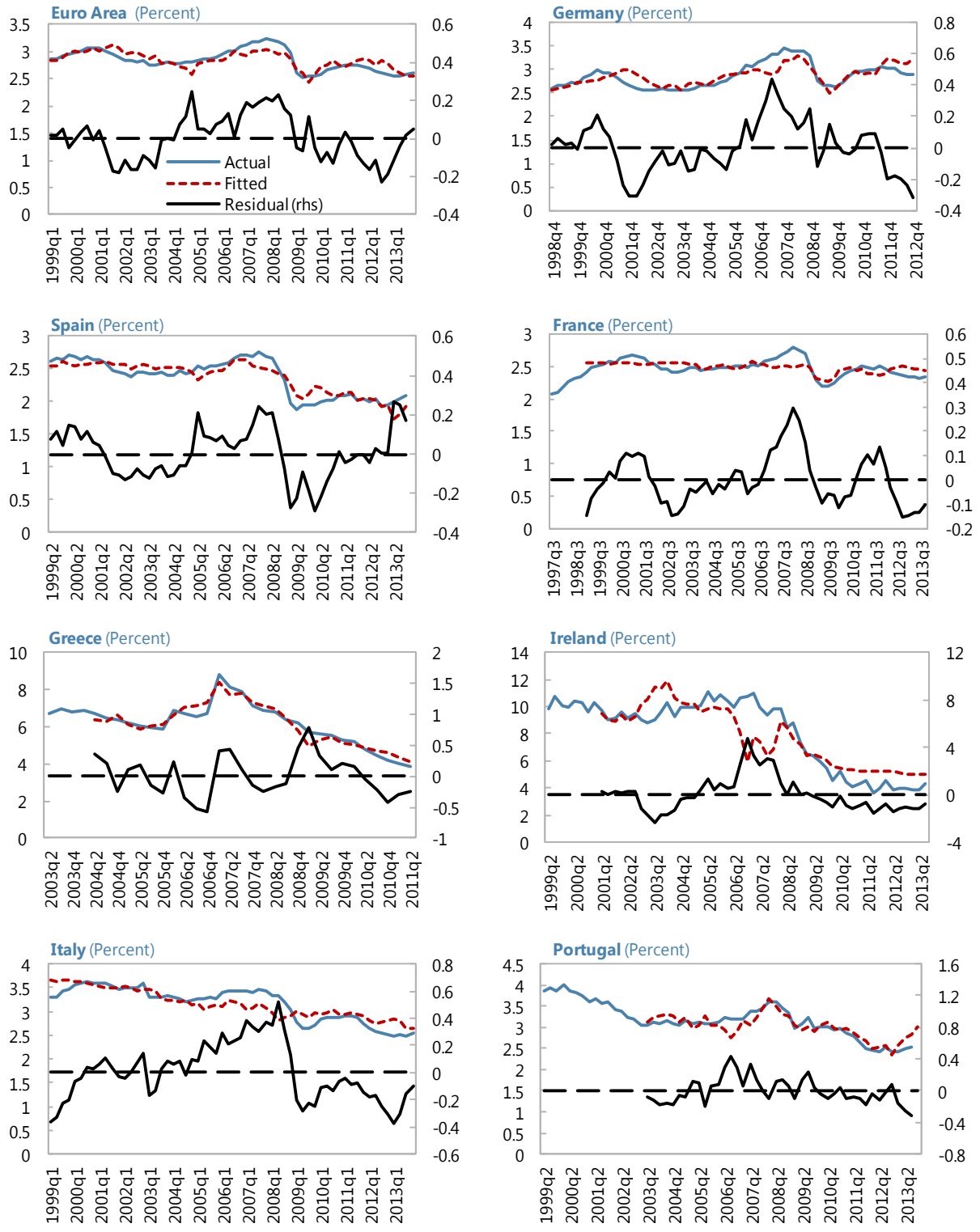
Note: Standard errors in parenthesis.

Figure A2.2. Neoclassical Model Without Financial Constraints: Private Non-residential Investment to Capital Ratio



Source: Haver Analytics; Eurostat and IMF Staff Calculations.

Figure A2.3. Neoclassical Model with Financial Constraints: Private Non-residential Investment to Capital Ratio



Sources: Haver Analytics; Eurostat; and IMF staff calculations.

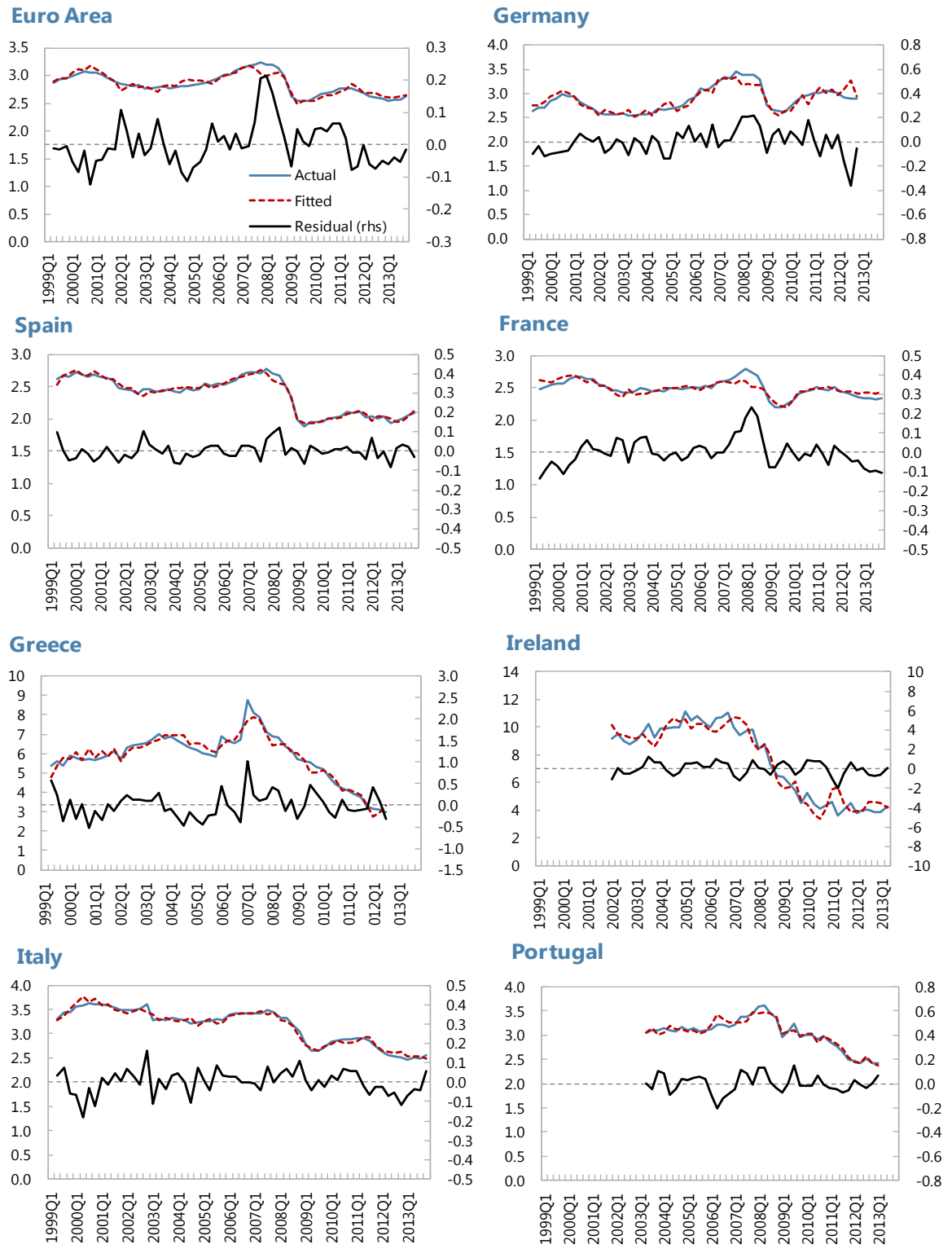
RESULTS OF THE ACCELERATOR + MODEL

$$\frac{I_t}{K_{t-1}} = \alpha + \beta_1 cbond_{t-1} + \beta_2 rlrate_{t-1} + \beta_3 lnuncer_{t-1} + \beta_4 leverage_{t-1} + \beta_5 cash\ flow_{t-1} + \sum_{i=1}^{N} \gamma_i \frac{\Delta Y_{t-i}}{K_{t-1}} + \beta_6 fc_{t-1} + \varepsilon_t$$

Table A2.4. Accelerator + Model (Controlling for Output Changes and Financial Constraints)

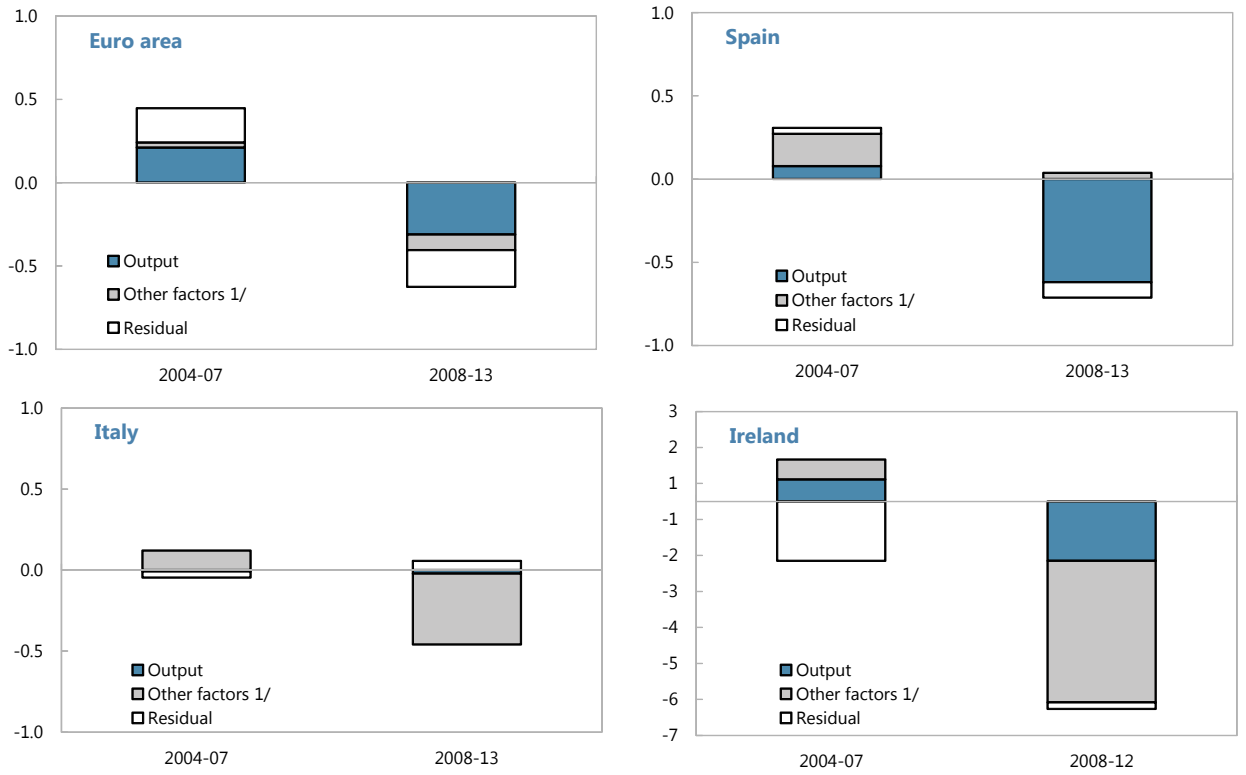
	Euro Area	Germany	Spain	France	Greece	Ireland	Italy	Portugal
α	3.554***	2.014***	1.956***	2.674***	10.102***	15.715***	4.692***	7.379***
	(0.577)	(0.578)	(0.226)	(0.443)	(1.205)	(3.069)	(0.382)	(0.732)
β_1	-0.0004	-0.001*	-0.002***	-0.0004	0.0002	-0.008***	0.0003	-0.001
	(0.0005)	(0.0004)	(0.0003)	(0.0005)	(0.001)	(0.003)	(0.0004)	(0.001)
β_2	0.089**	0.067**	0.038***	0.013	-0.012	0.094	-0.07***	0.06
	(0.036)	(0.025)	(0.013)	(0.032)	(0.031)	(0.056)	(0.015)	(0.036)
β_3	-0.003***	-0.0003	-0.001*	0.0004	-0.012***	-0.027***	-0.003***	0.0001
	(0.001)	(0.001)	(0.0004)	(0.0004)	(0.002)	(0.005)	(0.0005)	(0.001)
β_4	0.005	-0.003	0.006***	-0.007**	0.01***	0.033***	-0.005*	-0.043***
	(0.004)	(0.002)	(0.002)	(0.003)	(0.003)	(0.006)	(0.003)	(0.013)
β_5	-0.019	0.077**	0.01***	-0.01	-0.065	-0.15	0.018	-0.047*
	(0.03)	(0.036)	(0.003)	(0.06)	(0.053)	(0.189)	(0.018)	(0.025)
γ_1	0.203***	0.109**	0.293***	-0.115	0.72***	0.008	0.333***	-0.215*
	(0.065)	(0.045)	(0.094)	(0.092)	(0.216)	(0.198)	(0.065)	(0.117)
γ_2	0.091**	0.165**	0.308**	-0.008	0.814***	0.362	0.194***	-0.277*
	(0.043)	(0.073)	(0.115)	(0.071)	(0.209)	(0.225)	(0.065)	(0.159)
γ_3	0.182***	0.385***	0.209***	0.205***	1.012***	0.502**	0.26***	-0.237
	(0.064)	(0.076)	(0.076)	(0.063)	(0.206)	(0.231)	(0.073)	(0.139)
γ_4	0.203***	0.302***	-0.044	0.205**	0.751***	0.871***	0.137**	-0.145
	(0.058)	(0.063)	(0.076)	(0.082)	(0.152)	(0.228)	(0.058)	(0.092)
γ_5	0.118*	0.184***	0.327***		1.171***	0.608*	0.138**	-0.09
	(0.061)	(0.054)	(0.096)		(0.142)	(0.327)	(0.054)	(0.074)
γ_6	0.047	0.148	0.345***		0.965***	0.445	0.116*	-0.147
	(0.071)	(0.091)	(0.102)		(0.225)	(0.32)	(0.059)	(0.104)
γ_7	0.041	0.115	0.093		0.549***	0.446	0.132**	-0.206*
	(0.051)	(0.09)	(0.065)		(0.168)	(0.315)	(0.063)	(0.116)
γ_8	0.047	0.199**	-0.048			0.493*	0.105	-0.186*
	(0.073)	(0.077)	(0.064)			(0.263)	(0.075)	(0.102)
γ_9	0.165***	0.215**	0.153*			0.185	0.107*	0.099
	(0.056)	(0.1)	(0.087)			(0.182)	(0.058)	(0.088)
γ_{10}		0.218***	0.176***			0.34	0.092	0.184**
		(0.07)	(0.057)			(0.389)	(0.06)	(0.065)
γ_{11}		0.112				0.408	0.107	0.214***
		(0.08)				(0.339)	(0.067)	(0.065)
γ_{12}							0.1*	0.131**
							(0.058)	(0.06)
β_6	0.029	0.137***	-0.011	-0.005	-0.005		-0.034***	-0.07***
	(0.017)	(0.024)	(0.012)	(0.005)	(0.022)		(0.007)	(0.015)
N	59	55	59	59	54	46	59	40
R-squared	0.88	0.84	0.98	0.68	0.94	0.93	0.97	0.94
Adjusted R-sq	0.84	0.76	0.97	0.62	0.92	0.9	0.96	0.89
S.E. of regression	0.08	0.13	0.05	0.08	0.35	0.86	0.07	0.10
DW statistic	0.71	1.26	1.55	0.5	1.57	1.09	1.71	1.19

Figure A2.4. Accelerator + Model (Controlling for Output Changes and Financial Constraints)



Sources: AMECO database; Haver Analytics; Eurostat; and IMF staff estimates.

Figure A2.5. Contributions to Change in Investment-to-Capital Ratio (Accelerator + Model, cumulative)



1/ Corporate bond spreads, real lending rates, uncertainty, leverage, cash flow, and financial constraints.

Table A2.5 Significance of Accelerator + Model

	Full model		Uncertainty and leverage	
	F	LR	F	LR
Euro Area	8.21***	39.56***	9.95***	21.22***
Germany	6.51***	34.7***	7.66***	17.84***
Spain	21.78***	75.45***	19.26***	36.48***
France	2.98**	15.97***	7.27***	14.79***
Greece	18.13***	63.91***	41.74***	58.26***
Ireland	15.44***	59.71***	30.01***	48.58***
Italy	20.21***	74.35***	23.8***	43.97***
Portugal	9.81***	48.19***	20.13***	39.39***

F = F=statistic; LR = Likelihood ratio. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Source: IMF staff estimations