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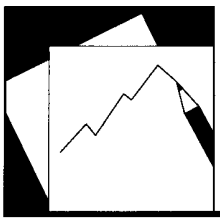

# IMF Working Paper

# The Driving Force behind the Boom and Bust in Construction in Europe

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# The Driving Force behind the Boom and Bust in Construction in Europe

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## Abstract

This paper studies the factors behind pro-cyclical but widely varying construction shares (as a percent of GDP) across countries, with a strong focus on European countries. Using a dataset covering 48 countries (including advanced and emerging economies within and outside Europe) for 1990-2011, we find that country's geography, demographics, and economic conditions are the key determinants of a norm around which actual construction shares revolve in a simple AR(1) and error-correction process. The empirical results show that in many European countries, construction shares overshoot relative to their norms before the recent global crisis, but they have fallen significantly since the crisis. Nevertheless, there is still room for further adjustment in construction shares in some countries which may weigh on economic recovery.

JEL Classification Numbers: E01, E23, E32, L74, N64

Keywords: Construction, Business Cycle, Error-correction, European Growth

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## EXECUTIVE SUMMARY

For many European countries, construction shares (in percent of GDP) have varied greatly before and during the recent economic crisis. Construction shares increased, some to very high levels, during the boom period. For example, during 2000-08 the real estate boom in Ireland, Spain, and Cyprus was synonymous with a construction boom, which boosted growth. In emerging Europe, similar overheating also took place in the Baltic countries, and to a lesser extent, Croatia.

The process has largely reversed itself in these countries since the crisis. For most countries, the deep recession has been accompanied by a collapse in construction activities and a sharp decline in construction shares.

Empirical results established in this paper provide insights on the driving forces behind the changes in construction shares. We show that actual construction shares revolve around a norm that is determined by country-specific fundamentals, in an auto-regressive, error-correcting process. The fundamentals include geography, demographics, and economic conditions such as income level, credit conditions, and stock market performance.

The results offer a compelling narrative on the seemingly volatile and wide varying adjustment process of construction shares experienced in Europe. During the boom, many countries overshoot the norm. After the crisis, the process has reversed and many countries have undershot the norm. But for some countries, the adjustment has fallen short of the model's predictions.

Over the medium-term, constructions shares are likely to recover in many European countries, but some may see further declines ahead. When economic conditions normalize over the medium term, Greece, Iceland, and Ireland in advanced Europe, and Latvia, Lithuania, Hungary, and Ukraine in emerging Europe may see a recovery in their construction shares. But construction shares could decline further in Spain, the United Kingdom, Romania, and the Slovak Republic. The improvement in construction shares, or lack of it, will have serious implications for the speed of recovery in economic activity and for employment.

## I. INTRODUCTION

Construction plays a unique role in economic growth and is often a key barometer of economic conditions. Construction increases a country's physical infrastructure (including housing stocks) which is a critical factor for long-term growth. The performance of the construction sector both affects and is influenced by general economic conditions. Although generally small in size compared to other sectors, its activity has a large impact on output and employment of the whole economy given its close inter-linkages with other sectors.

Before the recent crisis, in many European countries, an increase in construction shares was closely associated with strong growth.[2] Figure 1 shows the correlation between changes in construction (as a percent of GDP) to average GDP growth for both advanced and emerging Europe countries for the period of 1980-2007.[3] For both groups of countries, the very high elasticity between changes in construction share and GDP growth, at around 0.37-0.4, is striking.[4]

Higher construction activity before the crisis was also associated with a lower unemployment rate (Figure 2). For advanced Europe, it appears that on average, a one percentage point increase in the construction share (as a percent to GDP) was associated with about a one percentage point reduction in the unemployment rate. The reduction is somewhat smaller, but still sizable, in Central, Eastern, and Southeastern Europe (CESEE). According to the European Construction Industry Federation (2012), in 2011, construction industry is the biggest industrial employer in Europe, counting for 30.7% of industrial employment (and 7% of Europe's total employment).

In recent years, Europe has had one of the largest variations in construction shares in the world (Figure 3). Variation within Europe is also high compared with other regions. For example, advanced Europe has many positive outliers in terms of construction shares

[2] In this paper, the construction share refers to the value added of contrition industry as a share of GDP. The statistics are generally from national account's data on value-added by industry. The value added of construction industry is not the same as construction spending (on housing or non-housing structures). Construction share in value-added is generally smaller (and generally more stable) than the share of construction spending as a ratio to GDP as construction spending includes imports related to construction. In countries that had experienced a construction boom, increase in imports related to construction also contributed to an increase in the current account deficit. This observation is pointed out to us by Bas Bakker.

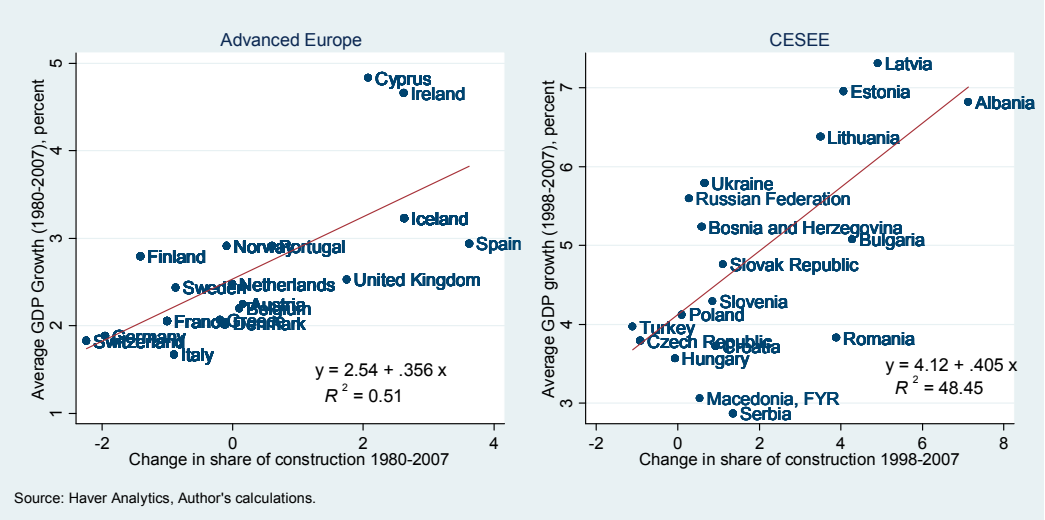
[3] Czech Republic, Slovak Republic, Estonia, and Slovenia which have attained advanced economy status (e.g. in the IMF's WEO classification) are grouped in this paper with the rest of the CESEE countries because for the majority of the period under investigation, they were classified as emerging economies.

[4] The fact that construction ties closely with the performance of general economic activity is not unique to the European experience. Boldrin *et al* (2013) also documents how the interlinkages of construction with other sectors in the U.S. economy propagated the impact of changes in the demand of residential investment, hence amplifying the effect on the overall U.S. economy.

compared with other advanced economies. In fact, among European countries, Spain, Lithuania, and Iceland, had pre-crisis construction shares over 10 percent of GDP (Figure 4 and 5).

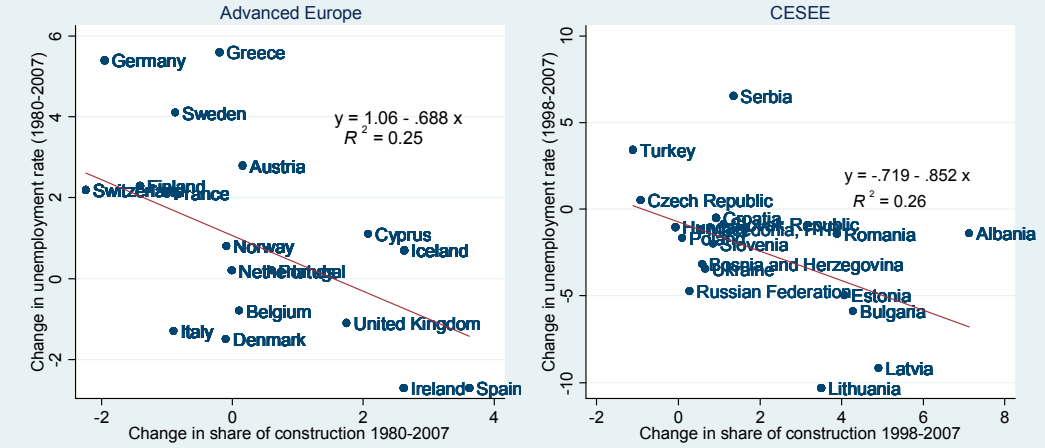
Since the global economic crisis, construction shares have dramatically declined from their peak but the pace of decline varies. Some of the countries, including Ireland, Iceland, and Latvia, saw a decline of around 5 percentage points of GDP from 2007-2011 (Figure 6 and For others, such as Spain and Cyprus, the decline is sizable, but less severe.[5]

Figure 1. Europe: GDP Growth and Construction




Source: Haver Analytics, Author's calculations.

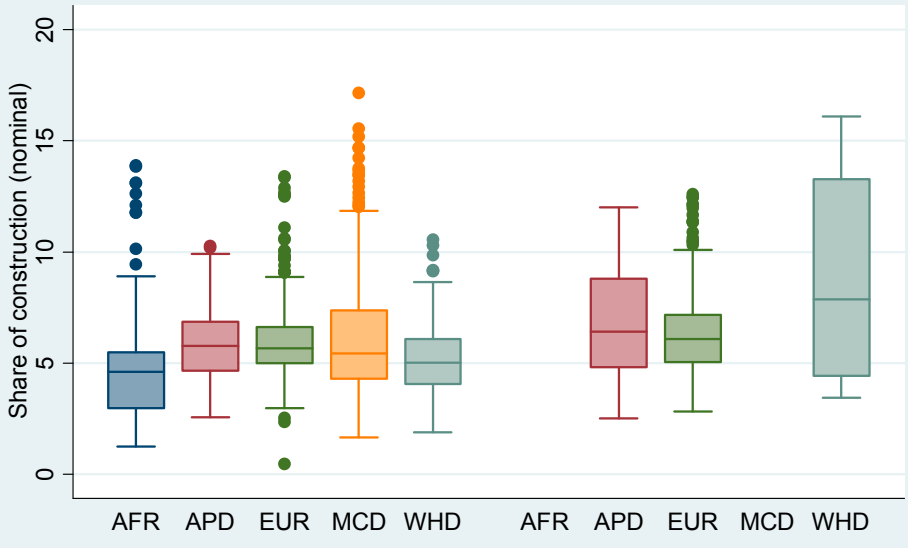
Figure 2. Europe: Unemployment and Construction




Source: Haver Analytics, Author's calculations.

[5] The latest 2012 data show that construction shares fell further to 8.3 percent of GDP in Spain and 5.7 percent of GDP in Cyprus.

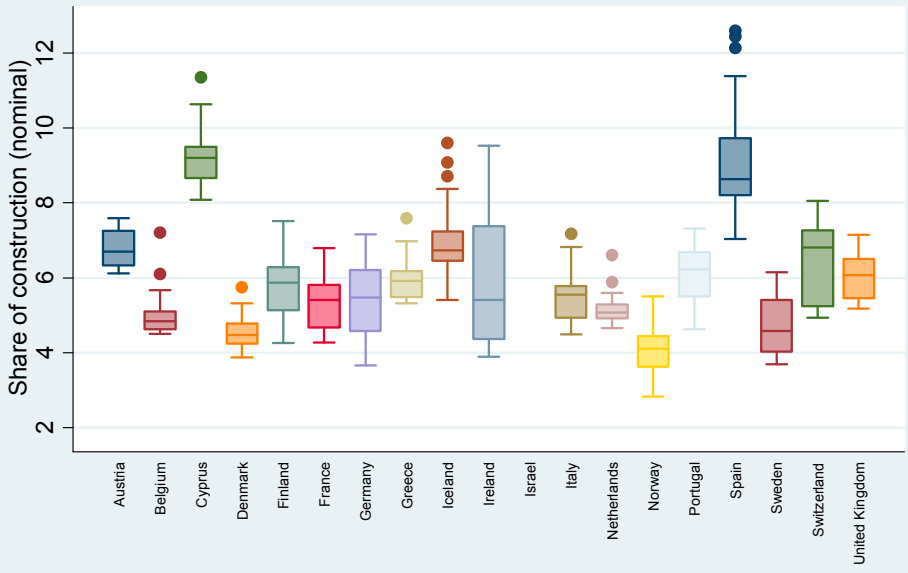
Figure 3. Share of Construction in GDP, 1980-2011
(in percent of GDP)




Note: The upper (lower) adjacent value is the number that is closest to the point which is 1.5 inter-quartilerange (IQR) --i.e. 1.5*(q[75]-q[25]) from the 75 (25) percent quartile.

Source: Haver Analytics, and Author's calculation.

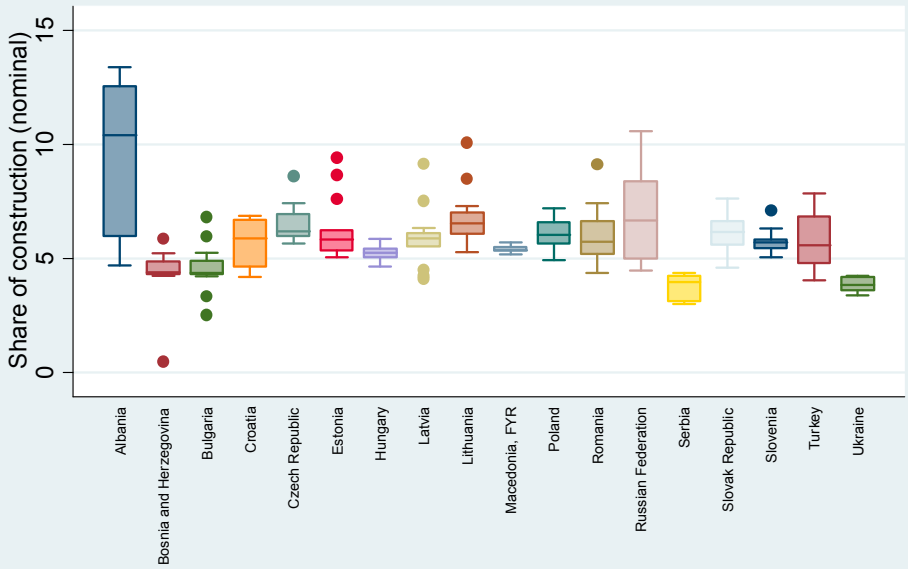
Figure 4. Advanced Europe: Share of Construction in GDP, 1980-2011
(in percent of GDP)




Note: The upper (lower) adjacent value is the number that is closest to the point which is 1.5 inter-quartilerange (IQR) --i.e. 1.5*(q[75]-q[25]) from the 75 (25) percent quartile.

Source: Haver Analytics, and Author's calculation.

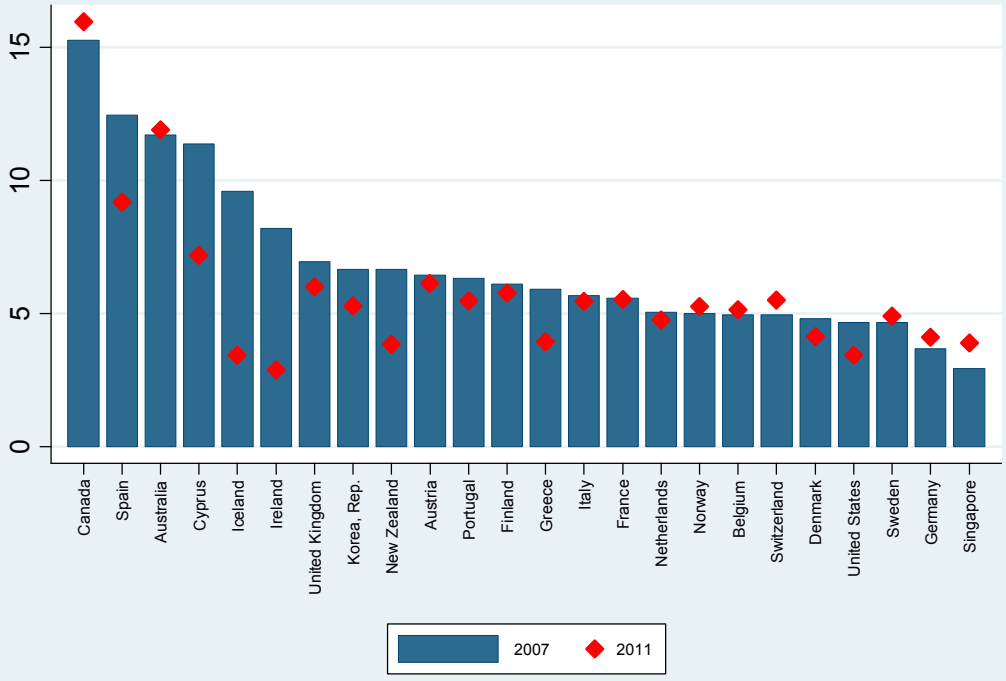
Figure 5. CESEE: Share of Construction in GDP, 1980-2011
(in percent of GDP)




Note: The upper (lower) adjacent value is the number that is closest to the point which is 1.5 inter-quartilerange (IQR) --i.e. 1.5*(q[75]-q[25]) from the 75 (25) percent quartile.

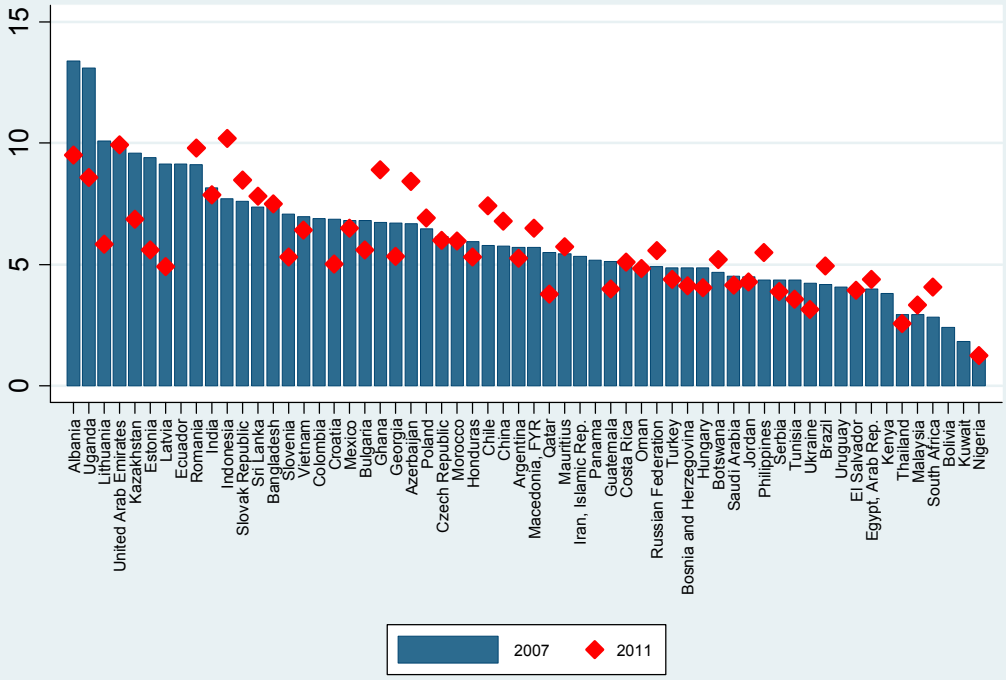
Source: Haver Analytics, and IMF staff calculation.

Figure 6: Advanced Economies: Construction Share
(in percent of GDP)




Source: Haver Analytics.

Figure 7. Emerging Economies: Construction Share
(in percent of GDP)




Source: Haver Analytics.

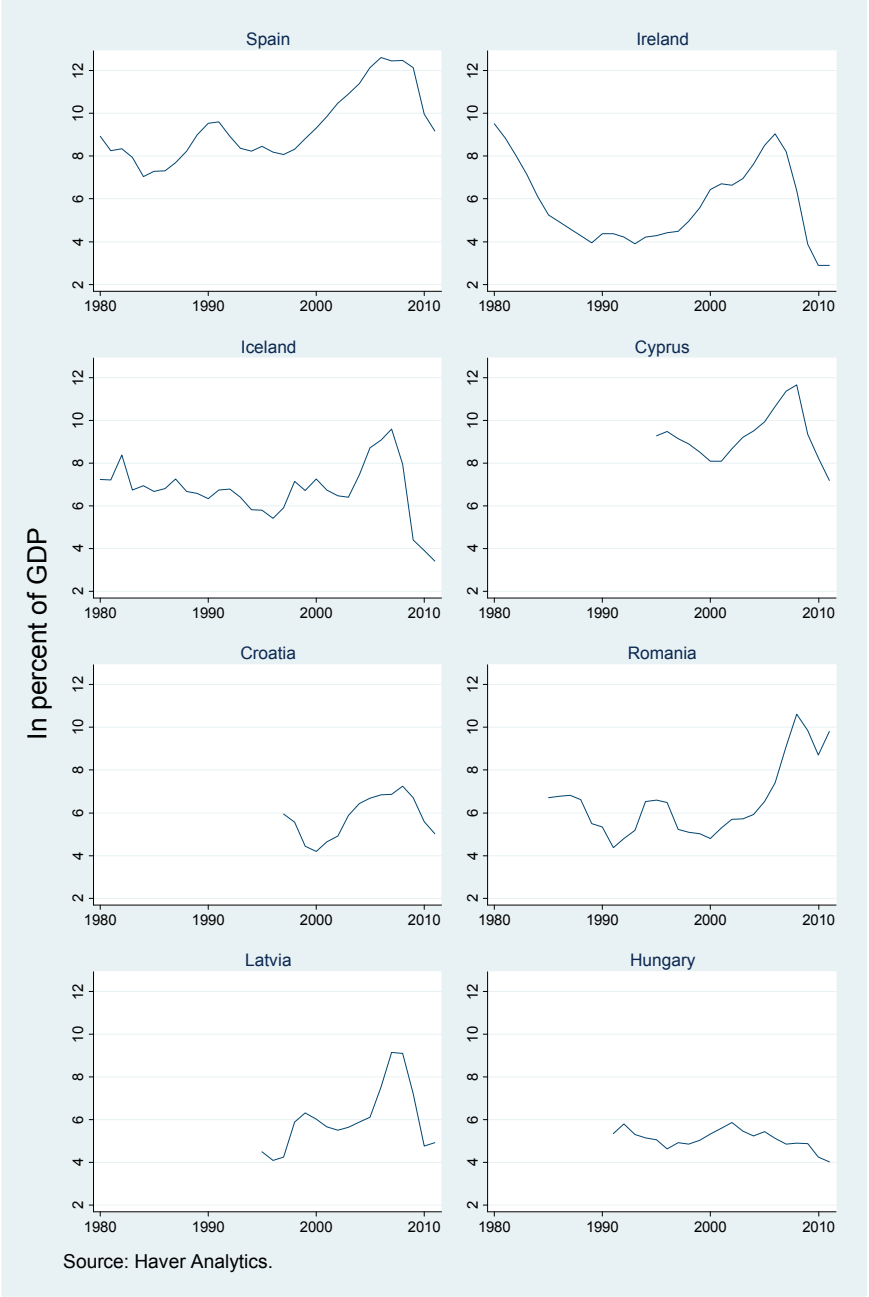
With these stylized facts as a background, this paper first explores the link between construction shares and country-specific fundamentals. We determine what the "normal" level of construction share is for a given set of fundamentals; and explain the high construction shares in Europe during the boom and their decline since the crisis. Using a dataset of both European and non-European countries, we find the most important fundamentals driving the "norm" are demographics, geography, and economic conditions such as per capita income, credit conditions, and stock market performance.

We then identify the adjustment dynamics of construction share around its norm. We find that the pace of adjustment of actual construction shares around the norm are driven by the size of the deviation from the norm, and the previous period's change in construction shares themselves. This auto-regressive, error-correcting process explains the distinctly high and low growth periods of construction shares. The gradual auto-regressive adjustment process also explains the pro-cyclicality of construction shares.[6]

[6] The change in construction share suggests that construction is highly pro-cyclical. A rising construction share during the boom time means construction grows faster than GDP, and a sharp decline during the recession reverses the process.

Predictions for medium term adjustment in construction shares based on the empirical results are encouraging, but raise concerns too. Many European countries' construction shares are now below their medium-term norms. This suggests that as economic conditions normalize, construction shares are likely to recover. However, a few countries such as Spain, Romania, which had experienced a strong boom in construction before the crisis, have not yet fully adjusted after the crisis (Figure 8). This forebodes a painful adjustment yet to come which will likely weigh on the already weak economic situation of these countries.

Figure 8. Construction Share in Selected European Countries
(In percent of GDP)




Source: Haver Analytics.

The remainder of the paper is organized as follows. Section II provides a brief review of the related literature. Section III describes the dataset and the main methodology. Section IV presents the empirical results, and Section V concludes.

## II. LITERATURE REVIEW

Most of the cyclical patterns in construction are similar to the business-cycle characteristics of investment in the macro-economic literature. For example, in a comprehensive study of 71 post-war US macro-economic time series, Stock and Watson (1999) found that investment in structure, especially residential structure is highly volatile and pro-cyclical. They also noted that employment in contract and construction is more than twice as volatile as the cyclical component of real GDP.[7]

These similarities are not a coincidence since construction activity is a type of investment. Construction, as recorded in national accounts, includes housing construction, construction of business structure, and infrastructure related construction.

Investment (including in business structure) is typically driven by factors such as general economic conditions, stock market performance, and credit conditions. With intuition traced back to Keynes's General Theory, Brainard and Tobin (1968) proposed that the ratio—famously known as Tobin's *q*—of market valuation of capital assets to their replacement cost is a superior reliable indicator for investment decisions than the rate of interest.[8] Blanchard, Rhee, and Summers (1998), however, found that empirically, firm fundamentals such as profit, dividend are a better gauge that market valuation to explain firm level investment. Credit conditions also matter because firms generally face liquidity constraint.

Housing construction is driven by demographic trends, household income, housing prices or rent, and credit conditions. Demand for residential housing is influenced by the housing services provided from residential housing, and the process is similar to the demand of other consumer durables (as described in Chow (1957)). In addition to factors like housing price and rent which affect demand, demographic characteristics such as population growth, household formation, and household income are also key deterministic factors.

Geography also plays a role. It affects the cost of construction. For example, countries with high population densities would require more high- rise buildings, whose construction costs

[7] Basu and Taylor (1999) and Bergman, Bordo, and Jonung (1998) presented similar results with a longer time period and a wider set of countries. Agresti and Mojon (2001) focused on business cycle in the Euro area countries and found that investment was also procyclical.

[8] The first formulation where *q* appeared is in Tobin (1969).

are steeper than low-rise buildings (Tan, 1999, Gat, 1995). Also countries endowed with popular tourism destinations will require more tourism infrastructure to accommodate tourism demand and therefore higher construction needs.

Different approaches have been developed to explain the time series behavior of investment—in particular the distributed lag feature of investment. Jorgensen (1969) suggested delivery lag as the reason for pro-cyclicality of aggregate investment. This approach is generalized into the adjustment cost approach, where the level of investment is constrained by adjustment costs associated with investment, as formulated e.g. in Mussa (1977) and also Hayashi (1982). Kydland and Prescott (1982) used a time to build technology to generate co-moments of investment with output.

Researchers have documented a distinct relationship between stages of economic growth and demand for construction. As noted in Bon (1992), and also supported in Ruddock and Lopes (2006), the so called "Bon curve" claims that construction demand is low in less developed economies. During their expansion phase, the growth in construction outstrips the rest of the economy and therefore increases as a share of GDP. As the economy approaches maturity, the rate of increase in construction slows and as a result the construction share (as a percent to GDP) declines.

## III. Data Set and Main Methodology

We incorporate three elements of the literature summarized above to analyze the cross-country and time-varying differences in construction shares, particularly in Europe. First, the compiled dataset includes potential explanatory variables related to geography, demographics, and economic conditions. Second, the modeling and estimation attempts to capture the pro-cyclicality through a distributive lag and an error-correction process (similar to the adjustment cost approach). Finally, advanced economies and emerging economies are treated separately given the long-term shifts in construction shares as economies develop.

The dataset includes annual data for over 23 advanced economies and 25 emerging economies, spanning a period from the middle of 1990 to 2011. The full list of countries is in the appendix table A1. The data span varies across countries because of missing
The countries are separated into two groups (advanced and emerging economies) with estimation performed separately following different specifications for each type of economy.[9]

Following the literature, we identify—and collect data on—three sets of country specific variables. They are related to geography, demographics, and economic conditions.

[9] The hypothesis of structural homogeneity across economies (advanced and emerging) was tested and rejected (see table A3).

Geographic variables include population density, and whether the country contains popular tourist destinations. For the latter, we use tourism expenditure (in percent of GDP) as a Demographic variables include population growth, dependency ratio, and share of urban population. Variables related to economic conditions include level of per capita income, excess rent inflation (above CPI inflation), unemployment rate, credit conditions (interest rate or private sector credit growth), and stock market performance (return and volatility of main stock market index). Since national accounts data do not distinguish private and public related construction activities, we also include government capital expenditure (in percent of GDP) as a control variable.[10] Because public capital expenditure may react differently to some of factors listed earlier—particularly economic conditions, including the government capital expenditure variable will help mitigate the potential missing variable bias.

The variables applied in the analysis are limited by data availability. For example, we would like to use housing price as an explanatory variable, but there are no consistent and reliable housing price data available for a large enough set of countries. As a remedy, we use data on excess rent inflation (which is the difference between rent inflation and headline inflation). Details on data and their sources are provided in appendix Table A2. Data on the stock of business or housing structures would have permitted a stock-and-flow approach to modeling, but they are not easily available.

We model the construction share as following an autoregressive (AR), error-correction process. For country *i* and time *t*, its construction share $y_{it}$ is governed by the following relationships.

First, there is construction share norm which is related to *k* country-specific fundamental variables of $\boldsymbol{x} = (x_1, x_2, \dots, x_k)$, where

$$y_{it}^{norm} = a + a_1 x_{1it} + \cdots + a_k x_{kit} + \varepsilon_{it} \quad (1)$$

The short-run dynamics of actual $y_{it}$ then follows an error correction process:

$$\Delta\, y_{it} = \; b_1 \Delta y_{it-1} + b_2\, \Delta y_{it-2} + \cdots + \; \gamma_1 EC_{it-1} + \cdots \; + \; \theta_{it} \quad (2)$$

where $EC_{it} = y_{it} - y_{it}^{norm} = y_{it} - (a + a_1 x_{1it} + \cdots + a_k x_{kit})$, is the deviation from the norm.

In reality, $y_{it}^{norm}$ is unobserved. So it has to be estimated indirectly. Rather than specify it as some smoothed version of $y_{it}$, we instead apply the two-step procedure proposed by Engel

[10] This variable is based on construction spending so its coverage does not accord strictly with that of the value-add construction share.

and Granger (1987), and estimate the equation (1) using $y_{it}$ directly. The estimates from this equation generate an error correction component (*EC*)—also called deviation from the norm. The *EC* term acts as a lever in the second equation on the short-run dynamics. Equation (2) models the change in construction share as a function of its own past dynamics, as well as the deviation from the norm in the previous period ($EC_{t-1}$). This set up, as noted by Engel and Granger (1987), is equivalent to modeling $y_{it}$ as an AR process, when $y_{it}$ is stationary.

The estimation of equation (1) is done using a panel based generalized least square (GLS) method to control for cross country heterogeneity. Given the wide variation across countries, the issue of cross-section heterogeneity is a serious concern, and its existence are confirmed by the test results of cross-section heterogeneity (see Appendix table A3).

Estimation results show that, as expected, demographics, geography, and economic conditions are the main factors determining construction shares. The results of different specifications of eq. (1) are shown in Table 1-2 for advanced and emerging economies separately. For both types of economies, a core set of variables appear to have significant explanatory power. The signs of the coefficients are in line with what theory would predict and the coefficients are stable across different specifications, although there are differences between the two types of economies.[11]

Here are the results discussed in more detail:

- Higher **population density** generally raises the construction share for both types of economies. This is likely because of the higher cost of building high-density structure as noted earlier.

- Countries having attractive **tourism** destinations would understandably require more infrastructure for tourist accommodation, and have higher construction shares. This is evident for both types of economies.[12]

- For advanced economies, the **dependency ratio** negatively affects the construction share. Dependency ratio affects construction through a few different and possibly competing channels. For example, a population with a high dependency ratio will have higher number of families. This will tend to increase demand for residential

[11] The norm equation is also estimated using fixed effects and random effects to check for robustness (appendix Table A3-4). They show that fixed and random effects estimation results are not satisfactory which are expected given the presence of cross-section heterogeneity.

[12] It should be pointed out that tourism expenditure is not a perfect proxy and it would be better to use the stock of tourism infrastructure. High tourism expenditure does not necessarily mean permanently higher construction shares since after an initial period of construction, the stock of tourism infrastructure would be adequate to meet demand.

housing. On the other hand, high dependency ratio reduces household earning and thus housing affordability, depressing demand for housing. Our results suggest that overall, a higher dependency ratio may reduce housing affordability enough that demand for construction is reduced.

- For emerging economies, **population growth** is a significant explanatory variable, and is also significant for advanced economies in some specifications.[13]

- On economic conditions, higher **per capita income**, **excess rent inflation**, more favorable **credit conditions**, a booming **stock market**, and less volatile stock market performance generally contributes to higher construction shares. These variables are significant for both advanced and emerging economies. As discussed earlier, these variables affect the investment demand in business and residential structures through different channels. Higher per capita income (and lower **unemployment rate** for advanced economies) directly boosts household income. Easier credit conditions such as lower **interest rate** (or higher **credit growth** as proxied for emerging economies) reduce the liquidity and financing constraints for business and households. A booming and less volatile, stock market stimulates investment by increasing Tobin's *q* for firms, and by increasing household wealth and investment demand. Rapidly rising rent—in excess of general inflation—would boost investment for residential housing since it makes house ownership more attractive, and also increases the return on residential investment for commercial developers.

- As a control variable, **government capital expenditure** is significant, reflecting the large portion of government capital investment in infrastructure. Other control variables such as global real GDP growth, or a country's own GDP growth are not significant.

To illustrate the results of the norm equation, we show in Figures 9 and 10, a decomposition of the estimated construction share norm for a few selected European countries. The results are presented as differences relative to a reference country (Germany for advanced Europe and Czech Republic for CESEE countries.), and they demonstrate the major components for construction share norm (in relative importance).[14] In Cyprus, for example, the main factors behind its high construction share norm (relative to Germany) were tourism expenditure, government capital expenditure, and lower pre-crisis unemployment. In Ireland, before the crisis, a few factors including high tourism expenditure, low unemployment and high excess

[13] Other demographic variables such as ratio of urban population, share of population age 25-49 are also significant for advanced economies in certain specifications.

[14] For advanced European countries, differences in the contribution of interest rate and stock market variables are very minor (less than 0.1 percentage point of GDP) and are not shown.

rent inflation, high dependency ratio, as well as government capital expenditure contributed to a relatively high construction share norm. Since the crisis, the construction share norm has fallen significantly, in line with high unemployment, decline in per capita income, and a fall in rent inflation. For Spain, the fundamentals suggested a relatively small difference in the construction share norm (of less than 2 percent) with that of Germany (before the crisis), as the positive affect of high tourism expenditure and high government capital expenditure are offset by higher unemployment rate, lower per capital income, and higher population density, even though the actual construction shares were much higher than Germany's. Nevertheless, the large gap between actual and the norm for Spain suggests that Spain is somewhat an outlier in this group.

Having estimated the construction share norm equation, the error-correction dynamic equation (2) is estimated, and the results are shown in Table 3–4. The chosen specification of the construction share norm equation is the first specification in Table 1–2 for the two types of economies respectively.

Results of the dynamic equation (2) show that changes in construction share can be well captured by a relatively simple AR(1), error-correction process. For both types of economies, the estimation is done using the dynamic panel estimation method proposed in Arellano and Bond (1991). The second lag of construction share and error-correction term are not significant, and the Arellano-Bond test statistics for autocorrelation in first differences are well behaved, suggesting no further correlation in the differenced residuals. The coefficients of the error-correction terms for both types of economies are remarkably similar at 0.3. This suggests that for each period, about a third of the previous period's gap between the construction share norm and actual level of construction share are corrected in the current period. On the other hand, the AR(1) coefficients are positive, and are 0.46 and 0.3 respectively for the two type of economies.

## IV. What Do the Results Reveal?

### A. Advanced Europe

At the peak of the boom, construction shares in several European countries appear to be above the norm based on country specific fundamentals and economic conditions (Figure The actual construction share significantly exceeded its norm in Spain, Finland, Cyprus, and United Kingdom; a few others like Netherland, Switzerland were below the norm.[15] Most striking is Spain, where the actual share exceeded the norm by close to six percentage points of GDP. On the other hand, Ireland's construction share peaked in 2006 (exceeding the norm

[15] Vermeulen and Rouwendal (2007) found that government regulation of land use was the main factor restricting housing supply (and high housing price) in the Netherlands, which may explain the persistently lower actual construction share relative to the construction share norm in the Netherlands.

by about 1.7 percentage points of GDP) but fell sharply in 2007 as its economy succumbed to crisis.

The decline in construction share since the global crisis appears to be mostly in line with model predictions. In Figure 12, we present the cumulative adjustment in construction share since 2008 predicted by equation (2), using actual data for explanatory variables except for the construction share itself. Some of the model predictions are quite close to the actual change observed since 2008. For Austria, Norway, Sweden, Belgium, Italy, France, UK, Iceland, and France, the difference is less than 2 percentage points of GDP.

For Spain, Ireland, the Netherlands, Cyprus, Switzerland, and Greece, there is a large gap between the predicted adjustment and actual adjustment. Spain stands out as the actual decline in its construction share has been more benign than predicted by the model. On the other hand, in Ireland and Cyprus, the actual decline has been much larger than the decline predicted by the model. For the Netherlands and Switzerland, while the model predicted an increase in construction share, the actual change is either very small (Switzerland) or close to zero (the Netherlands). For Greece, the actual decline is also larger and sharper than model predictions. For Portugal, Denmark, Germany, Austria, Norway, Sweden, Belgium, France, and the United Kingdom, the small changes in construction shares are very close to that predicted by the model.

By 2011, we have seen a divergence between the actual construction share and the potential level of medium-term norm in a couple of countries (Figure 13). The medium-term norms are calculated for each country assuming all explanatory variables revert to the average of 2000–2011 level or to the 2017 level using IMF's 2013 Spring WEO projections, and they are compared with actual construction shares of 2011.[16] The figure shows that for Finland, Spain, and the United Kingdom, the actual construction share was above the predicted medium-term norm. This would signal that construction shares are likely to adjust downwards over the medium-term. On the other hand, it appears that for Ireland, Greece, the Netherlands, and Germany, the 2011 level of construction shares may be below the medium-term norm, and there is room for it to increase over the medium-term.[17] For Portugal, Sweden, Italy, and Norway, the 2011 level of construction shares is close to their medium-term norms.

### B. Central, Eastern, and Southeastern Europe

For CESEE countries, the results suggest a similar pre-crisis boom in construction, resulting in overshooting of the construction share norm in a few countries. Before the crisis, Croatia,

[16] Projections for Cyprus are based on the European Commission's Winter 2012 forecasts.

[17] The recent crisis in Cyprus could result in a much lower medium-term norm than presented here as Cyprus faces a drastic change in its growth model and a reduction in long-term growth potential after the recent crisis.

Bulgaria, the three Baltic countries (Estonia, Latvia, and Lithuania), and Slovak Republic had a strong boom in construction that exceeded the norm determined by their country specific fundamentals. At the peak of boom (2007), the difference is over 1 percentage point of GDP for these countries, and close to 3 percent for Croatia. On the other end of the spectrum, Hungary and Romania appeared to be below the norm in 2007.[18]

The pace of adjustment since the 2008 crisis has varied in the CESEE as in advanced Europe. For countries like Lithuania and Latvia, the actual decline has been more severe than projected by the model. For Ukraine, Hungary, and Serbia, and to a less extent, Slovenia, Czech Republic, and Turkey, the actual decline is not severe, but was the opposite of the increase predicted by the model. For Estonia, Poland, and Bulgaria, the adjustment in construction shares is close to what is predicted by the model. On the other hand, in Croatia, Romania, and Slovak Republic, the actual decline or increase in construction share is either smaller than or opposite of model predictions.

Looking forward, construction shares could further change over the medium-term for a few of the CESEE countries. For example, in Ukraine, Serbia, Latvia, Lithuania, and Hungary, the 2011 level of construction share is below the medium-term norm, which suggests room for increase over the medium-term. On the other hand, for Slovak Republic and Romania, and to a lesser extent, Croatia, Bulgaria, and Estonia, the 2011 level is above the medium-term norm. This overshooting indicates that there is a very real possibility that construction share may adjust downward in these countries over the medium-term.

## V. CONCLUSION

We have shown that changes in construction shares revolve around a norm that is determined by country specific characteristics. These characteristics, or fundamentals, include a country's geography, demographics, and economic conditions. The pro-cyclical nature of construction shares can be captured by a simple AR(1) error-correction process.[19]

Based on these empirical results, there is clear evidence of overshooting during the 2000–07 construction booms in Europe. Many countries such as Spain, Ireland, the Baltic countries, Croatia, and Romania experienced strong construction booms. In these countries, construction shares exceeded their norms for a sustained period.

[18] During the period of 1980-2007, the average deviation from estimated norm was high in Croatia, Estonia, Bulgaria, and Romania, but low in Hungary.

[19] The definition of construction may not be the same across countries, and it may have also changed over time for some countries. But these caveats should have relatively small impact on the results of the paper since the panel estimation adjusts for cross county heterogeneity.

Since the crisis, this process has been largely reversed but the pace has not been uniform. The decline in construction shares took place in most of the European countries accompanying the economic recession. In some economies, such as Ireland, Cyprus, Latvia, and Lithuania, the decline has been steeper than predicted by the model. In some other countries like Ukraine and Hungary, there was a decline instead of the increase predicted by the model. In many countries, including Austria, Sweden, Belgium, Italy, France, the U.K., Poland, and Bulgaria, the adjustment is closely in line with model projections. In Spain and Cyprus, the actual changes are smaller than expected, and construction shares actually increased in Slovak Republic and Romania in contrast to the predicted declines.

Further adjustment may be in store for some economies before they reach their projected medium-term norms. While many countries could expect construction shares to recover as economy conditions normalize, this would not be the case for all. Construction shares in Spain, Finland, and Romania may need to decline further before being fully aligned with their medium-term norms. For Spain in particular, the large gap indicates that such a decline in construction activity would weigh heavily on its economic activity and employment.

Table 1. Advanced Economies: Norm Equation Estimation Results

| VARIABLES | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| **Demographics and geography** | | | | | | |
| Dependency Ratio (pct) | -0.0980*** | -0.0988*** | -0.0812*** | -0.163*** | -0.103*** | -0.0716*** |
| | (0.00944) | (0.00936) | (0.00969) | (0.0218) | (0.00964) | (0.0138) |
| Density (Population over area, in logs) | 0.503*** | 0.503*** | 0.621*** | -0.214*** | 0.487*** | 0.202*** |
| | (0.0256) | (0.0257) | (0.0279) | (0.0258) | (0.0232) | (0.0410) |
| Tourism expenditure (share of GDP) | 0.295*** | 0.295*** | 0.306*** | 0.392*** | 0.263*** | 0.351*** |
| | (0.0151) | (0.0151) | (0.0149) | (0.0221) | (0.0163) | (0.0158) |
| **Economic conditions** | | | | | | |
| Income per capita | 0.00643*** | 0.00676*** | 0.00710*** | -0.0138*** | 0.00778*** | -0.00368 |
| | (0.00151) | (0.00144) | (0.00117) | (0.00250) | (0.00152) | (0.00275) |
| Excess rent inflation (relative to CPI) | 0.0617*** | 0.0566*** | 0.0749*** | 0.000357 | 0.0441*** | 0.0241 |
| | (0.0176) | (0.0178) | (0.0151) | (0.0204) | (0.0170) | (0.0178) |
| Unemployment rate (pct) | -0.168*** | -0.166*** | -0.153*** | -0.0314** | -0.148*** | -0.152*** |
| | (0.0115) | (0.0116) | (0.0108) | (0.0160) | (0.0126) | (0.0142) |
| Interest rate (pct) | -0.0342*** | -0.0349*** | -0.0496*** | 0.00673 | -0.0330*** | |
| | (0.00991) | (0.00990) | (0.00949) | (0.0145) | (0.00913) | |
| Stock market index, avg daily return annualized (pct) | -0.00145*** | -0.00157*** | -0.000537 | -2.26e-05 | -0.000930** | -0.000187 |
| | (0.000512) | (0.000504) | (0.000342) | (0.000710) | (0.000467) | (0.000689) |
| Stock market volatility (mean adjusted) | -0.883** | -1.279*** | -0.554** | 0.776** | -0.915*** | -0.289 |
| | (0.353) | (0.456) | (0.219) | (0.364) | (0.326) | (0.390) |
| **Control variable** | | | | | | |
| Government capital expenditure (pct of GDP) | 0.440*** | 0.442*** | 0.480*** | 0.0629* | 0.399*** | 0.252*** |
| | (0.0224) | (0.0227) | (0.0226) | (0.0330) | (0.0248) | (0.0315) |
| Global GDP at market exchange rate (% change) | | -0.0178 | | | | |
| | | (0.0144) | | | | |
| **Alternative variables or specifications** | | | | | | |
| Population growth (log difference) | | | 0.434*** | | | |
| | | | (0.0772) | | | |
| Ratio of population age 25-49 | | | | -24.50*** | | |
| | | | | (2.568) | | |
| Share of urban population (pct) | | | | | -0.0108*** | |
| | | | | | (0.00261) | |
| Real credit growth (log difference) | | | | | | 0.00355 |
| | | | | | | (0.00476) |
| Constant | 14.05*** | 14.15*** | 13.85*** | 19.62*** | 14.93*** | 10.20*** |
| | (0.471) | (0.472) | (0.443) | (1.884) | (0.455) | (0.657) |
| Observations | 273 | 273 | 273 | 238 | 253 | 253 |
| Number of countries | 23 | 23 | 23 | 22 | 23 | 23 |
| $R^2$ | 0.193 | 0.193 | 0.188 | 0.510 | 0.176 | 0.299 |

Standard errors in parentheses. * denotes significance level. Estimations using generalized least square (GLS) with no country dummies.
*** p<0.01, ** p<0.05, * p<0.1

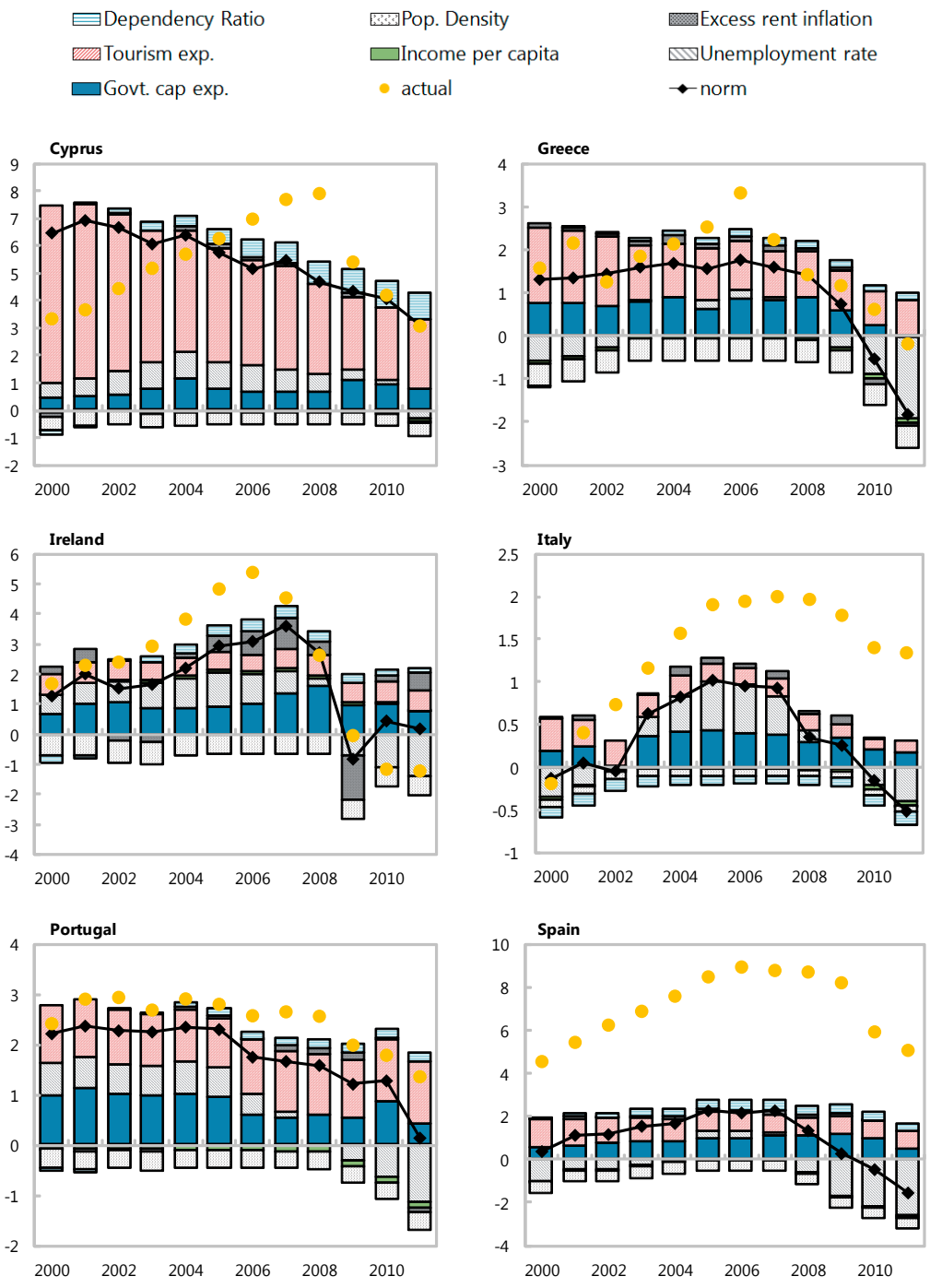
Table 2. Emerging and Developing Economies: Norm Equation Estimation Results

| VARIABLES | (1) | (2) | (3) |
|---|---|---|---|
| **Demographics and geography** | | | |
| Density (Population over area, in logs) | -0.171*** | -0.171*** | -0.174*** |
| | (0.0624) | (0.0626) | (0.0625) |
| Population growth (log difference) | -1.250*** | -1.250*** | -1.245*** |
| | (0.0554) | (0.0566) | (0.0571) |
| Tourism expenditure (share of GDP) | -0.216*** | -0.216*** | -0.215*** |
| | (0.0279) | (0.0286) | (0.0286) |
| **Economic conditions** | | | |
| Income per capita | 0.101*** | 0.101*** | 0.101*** |
| | (0.00872) | (0.00899) | (0.00904) |
| Excess rent inflation (relative to CPI) | 0.0691*** | 0.0691*** | 0.0693*** |
| | (0.00352) | (0.00355) | (0.00345) |
| Real credit growth (log difference) | 0.00575*** | 0.00563* | 0.00564* |
| | (0.00196) | (0.00331) | (0.00335) |
| Stock market index, avg daily return annualized (pct) | -0.00179*** | -0.00178*** | -0.00176*** |
| | (0.000273) | (0.000291) | (0.000287) |
| **Control variable** | | | |
| Government capital expenditure (pct of GDP) | 0.0722*** | 0.0722*** | 0.0736*** |
| | (0.00785) | (0.00794) | (0.00847) |
| **Alternative variables or specifications** | | | |
| GDP growth (log difference) | | 0.000299 | -0.00210 |
| | | (0.00717) | (0.00916) |
| Stock market volatility (mean adjusted) | | | -0.239 |
| | | | (0.461) |
| Constant | 3.714*** | 3.715*** | 3.712*** |
| | (0.713) | (0.713) | (0.708) |
| Observations | 215 | 215 | 215 |
| Number of countries | 25 | 25 | 25 |
| $R^2$ | 0.451 | 0.451 | 0.451 |

Standard errors in parentheses. * denotes significance level. Estimations using generalized least square (GLS) with no country dummies.

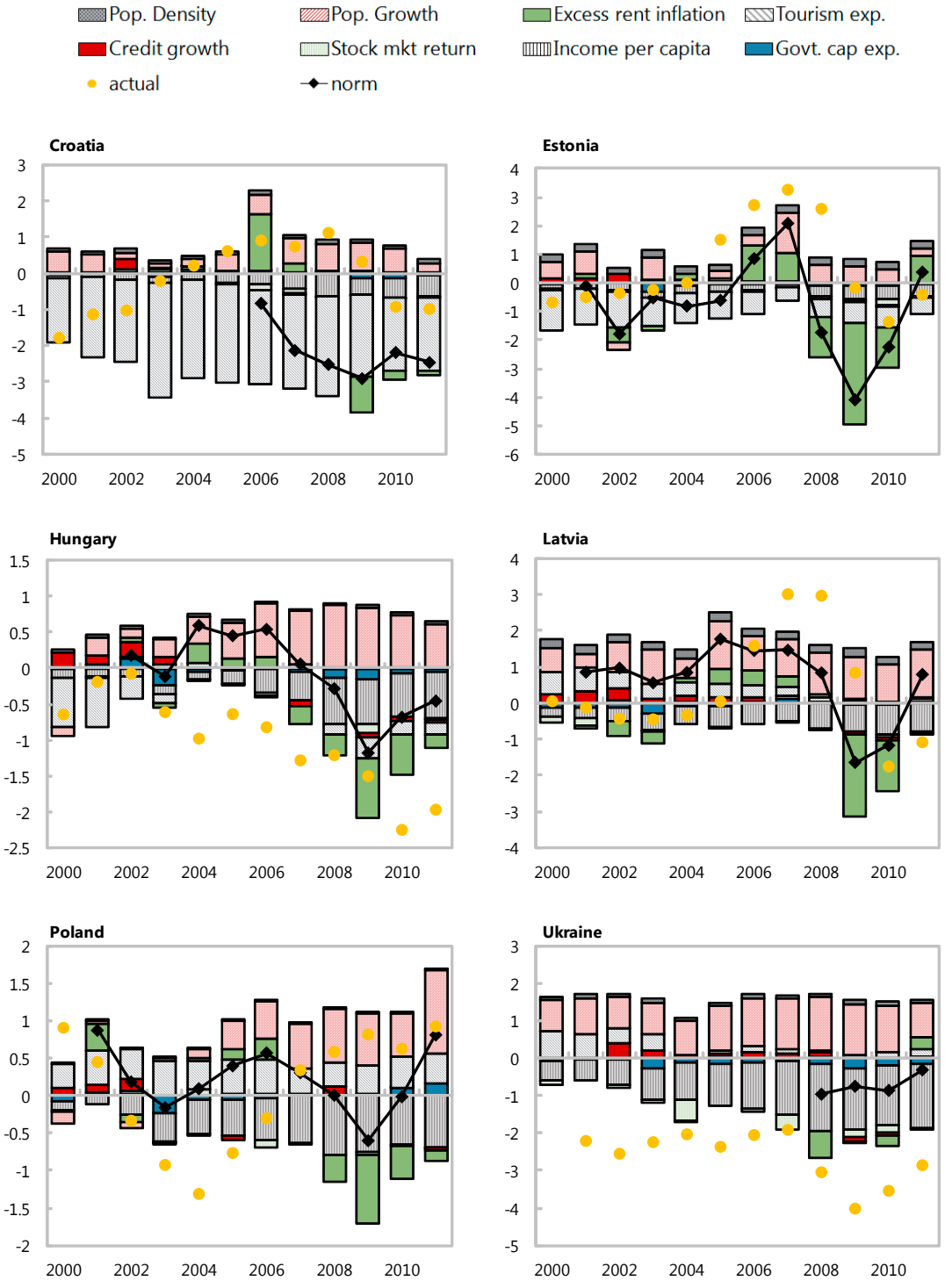
*** p<0.01, ** p<0.05, * p<0.1

Figure 9. Selected Advanced European Countries: Construction Share
(Actual, norm, and components of the norm)



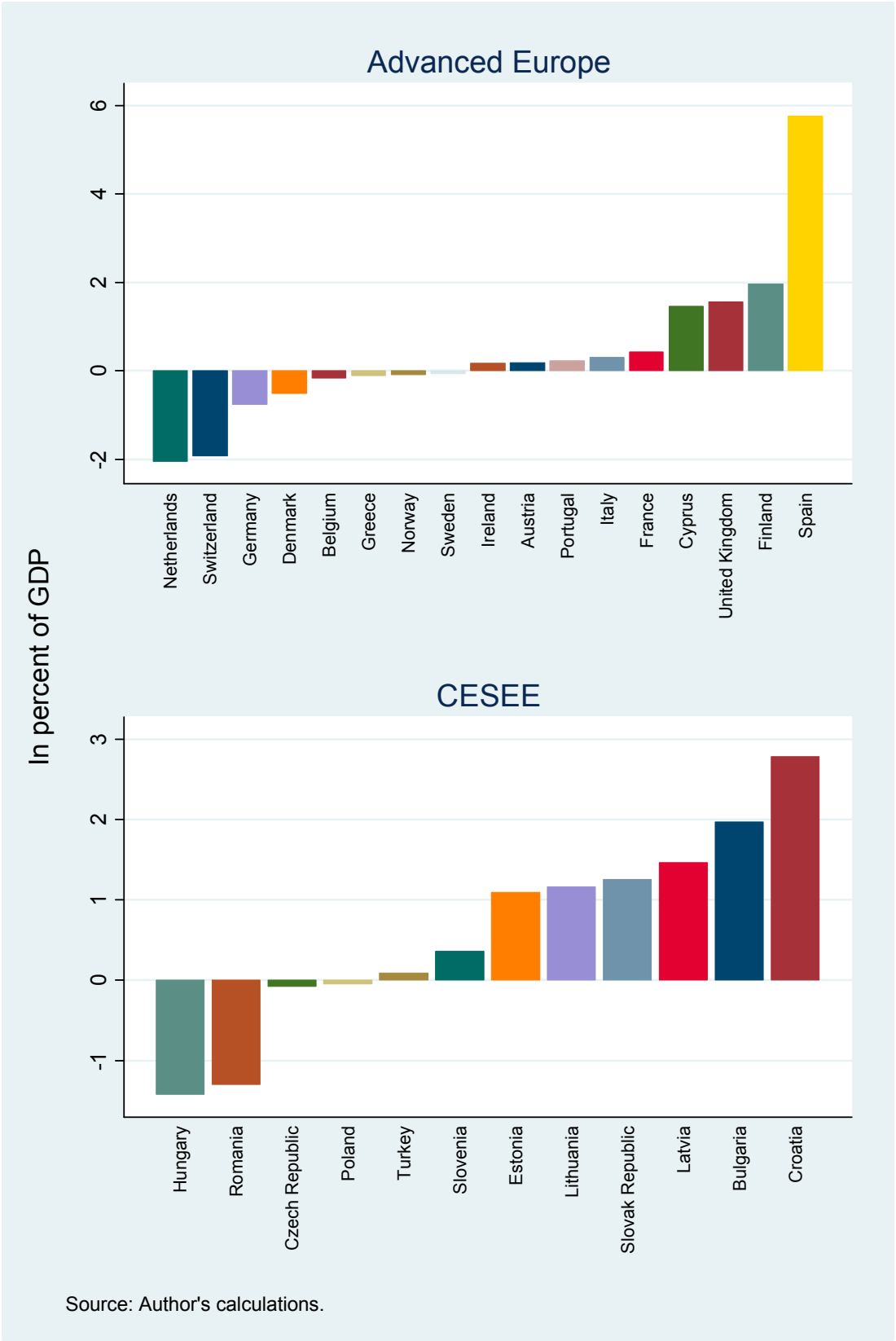

Source: Author's calculaton.
Note. All variables shown are relative to Germany (used as a reference country), based on estimation. For example, the norm shown is the difference of the norm vis-a-vis the norm of Germany. Contributions from interest rate and stock market variables are less than 0.1 percent of GDP and are not shown.

Figure 10. Selected CESEE European Countries: Construction Share
(Actual, norm, and components of the norm)




Source: Author's calculaton.
Note. All variables shown are relative to Czech Republic (used as a reference country), based on estimation. For example, the norm shown is the difference of the norm vis-a-vis the norm of Czech Republic.

Figure 11. Europe: Construction Share, Deviation from Norm in 2007




Source: Author's calculations.

Table 3. Advanced Economies: Dynamic Equation Estimation Results

| VARIABLES | (1) | (2) |
|---|---|---|
| $\Delta y_{t-1}$ | 0.342* | 0.456*** |
| | (0.179) | (0.121) |
| $\Delta y_{t-2}$ | -0.0283 | |
| | (0.103) | |
| $EC_{t-1}$ | -0.147 | -0.308*** |
| | (0.111) | (0.0684) |
| $EC_{t-2}$ | -0.216 | |
| | (0.132) | |
| Constant | 0.256 | 0.231 |
| | (0.210) | (0.181) |
| Observations | 206 | 229 |
| Number of countries | 23 | 23 |
| Arellano-Bond test for AR(1) | 0.00618 | 0.00559 |
| Arellano-Bond test for AR(2) | 0.731 | 0.883 |

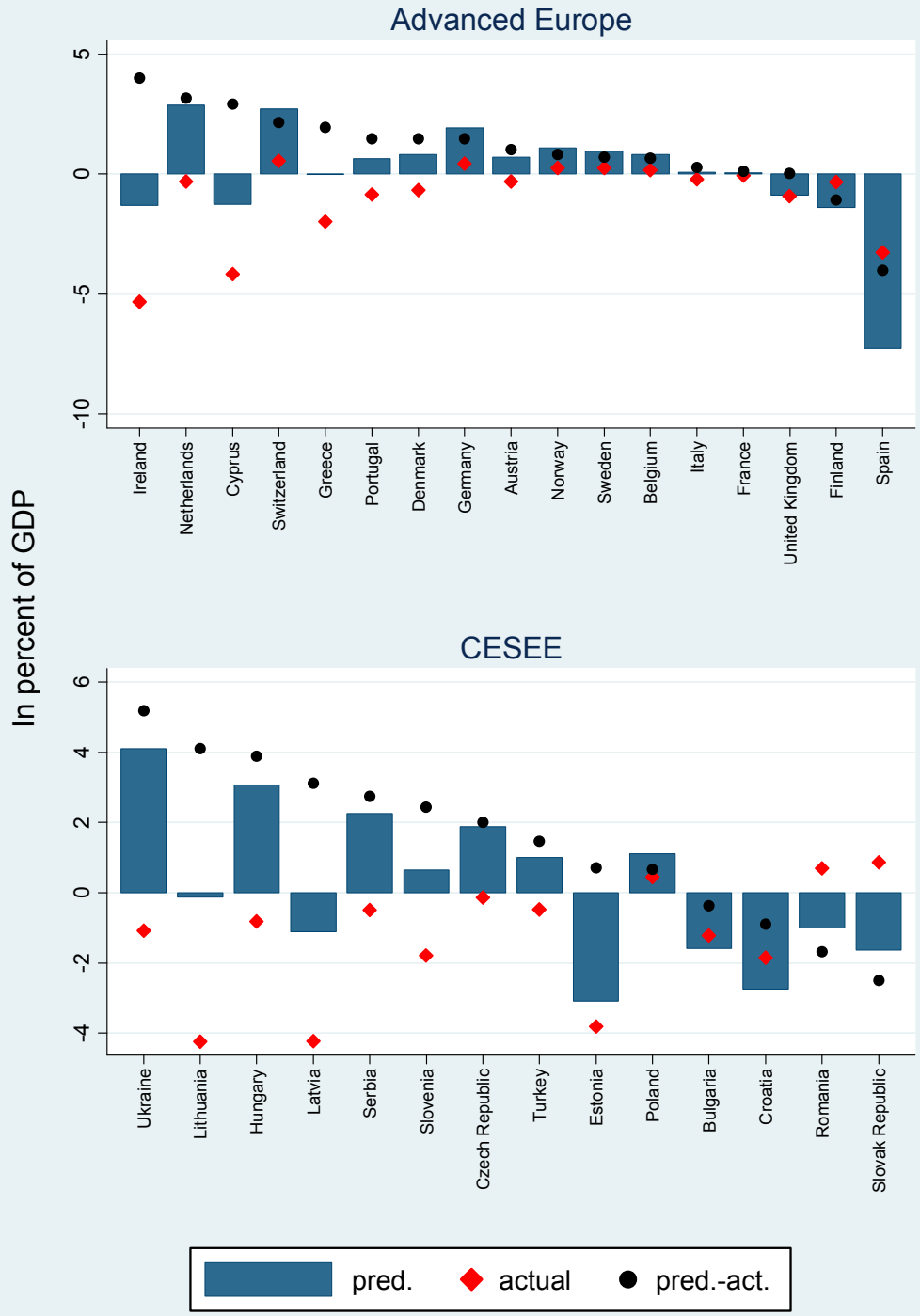
Standard errors in parentheses. * denotes significance level.
*** p<0.01, ** p<0.05, * p<0.1
Note. Error correction term (EC) is based on GLS estimation of specification (1) in Table 2.

Table 4. Emerging and Developing Economies: Dynamic Equation Estimation Results

| VARIABLES | (1) | (2) |
|---|---|---|
| $\Delta y_{t-1}$ | 0.415*** | 0.292*** |
| | (0.100) | (0.0681) |
| $\Delta y_{t-2}$ | -0.184 | |
| | (0.139) | |
| $EC_{t-1}$ | -0.378*** | -0.309*** |
| | (0.0725) | (0.0577) |
| $EC_{t-2}$ | 0.109 | |
| | (0.0878) | |
| Constant | 0.241*** | 0.246*** |
| | (0.0850) | (0.0880) |
| Observations | 143 | 166 |
| Number of countries | 22 | 23 |
| Arellano-Bond test for AR(1) | 0.0260 | 0.0609 |
| Arellano-Bond test for AR(2) | 0.197 | 0.964 |

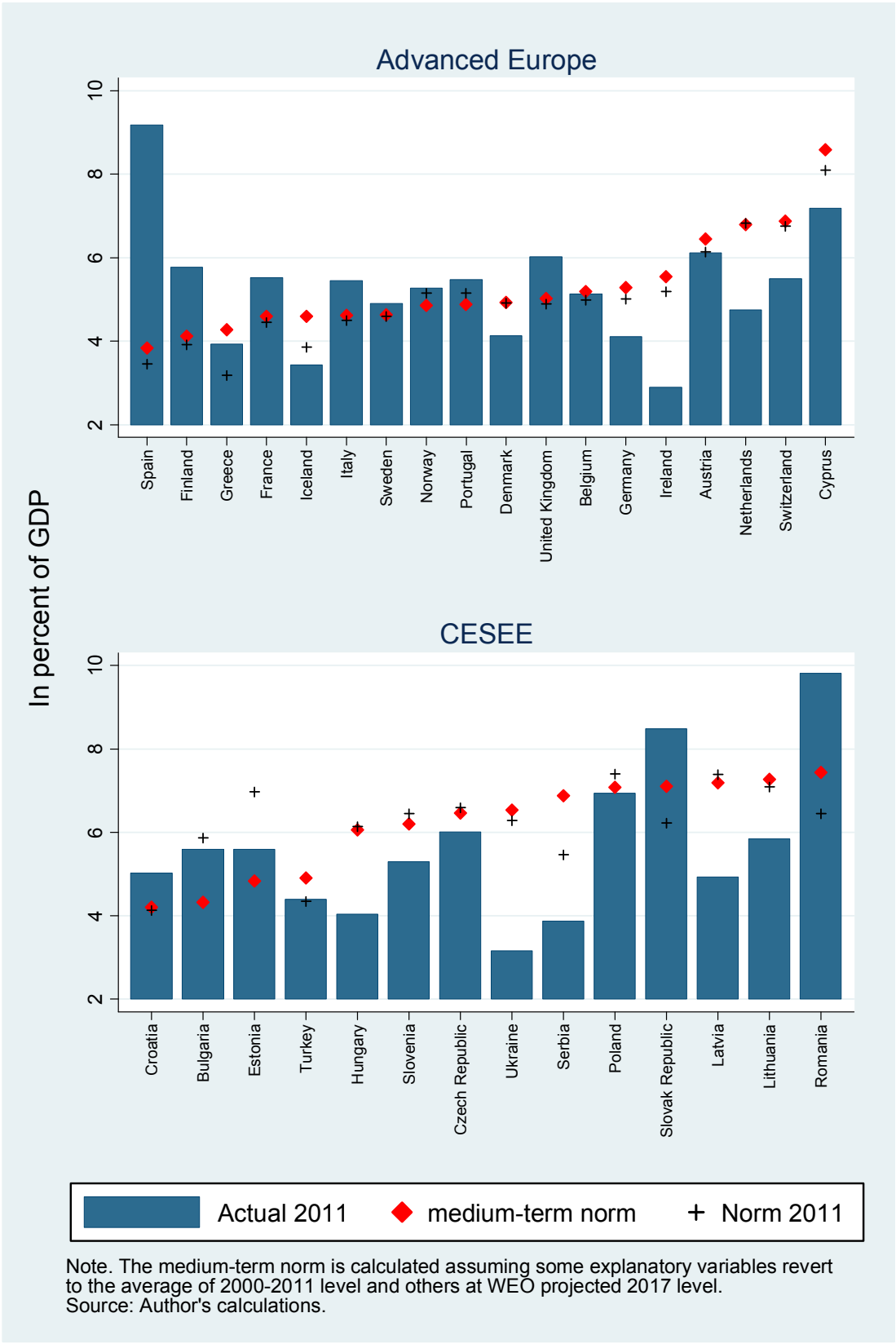
Standard errors in parentheses. * denotes significance level.
*** p<0.01, ** p<0.05, * p<0.1
Note. Error correction term (EC) is based on GLS estimation of specification (1) in Table 2.

Figure 12. Europe: Cumulative Adjustment in Construction Share
(Relative to projection from 2008)




Note. Projected adjustment based on estiamted error correction model and actual observations.
of independent variables in 2008-2011.
Source: Author's calculations.

Figure 13. Europe: Deviation from Medium-Term Fundamental in Construction Shares




Note. The medium-term norm is calculated assuming some explanatory variables revert to the average of 2000-2011 level and others at WEO projected 2017 level.
Source: Author's calculations.

## Appendix Tables

Table A1. List of Countries Included in the Sample

| Advanced economies | Emerging Economies |
|---|---|
| Australia | Argentina |
| Austria | Bulgaria |
| Belgium | Chile |
| Canada | China |
| Cyprus | Colombia |
| Denmark | Croatia |
| Finland | Czech Republic* |
| France | Estonia* |
| Germany | Hungary |
| Greece | Indonesia |
| Iceland | Kazakhstan |
| Ireland | Latvia |
| Italy | Lithuania |
| Japan | Mexico |
| Korea, Rep. | Philippines |
| Netherlands | Poland |
| Norway | Romania |
| Portugal | Saudi Arabia |
| Spain | Serbia |
| Sweden | Slovak Republic* |
| Switzerland | Slovenia* |
| United Kingdom | South Africa |
| United States | Thailand |
| | Turkey |
| | Ukraine |

* Czech Republic, Slovak Republic, Estonia, and Slovenia which have attained advanced economy status (e.g. in the IMF's WEO classification) are classified in this paper with the rest of the CESEE countries because for the majority of the period of the investigation, they are classified as emerging economies.

Table A2. List of Data and Its Sources

| Variable | Source |
|---|---|
| Population | IFS |
| Share of urban population | OECD |
| Ratio of age 25-49 | OECD |
| Dependency ratio | World Development Index |
| Area | CIA World Fact Book |
| GDP | WEO |
| Construction (Value added) | Have Analytics, OECD, Eurostat |
| Interest rate | IFS (lending rate, various definitions), World Development Index |
| Private Sector Credit (Nominal) | IFS and Haver Analytics (various definitions) |
| Unemployment rate | WEO, Haver Analytics |
| Global GDP growth | WEO |
| CPI: Rent for housing | Haver Analytics |
| CPI | Haver Analytics |
| Tourism expenditure | World Development Index, World Bank |
| Income per capita (in US dollars) | WEO |
| Government capital expenditure | AMECO (Europeans Commission), World Development Index |
| Stock market index | Bloomberg, World Development Index |
| Stock market index volatility (mean adjusted) | Calculated (based on daily stock market index data) |

Table A3. Heterogeneity test results

| | Advanced Economies | Emerging and Developing Economies |
|---|---|---|
| | Specification (1) in Table 1 | Specification (1) in Table 2 |
| Null hypthoesis | No heterogeneity in panel | No heterogeneity in panel |
| Likelihood-ratio (LR) | $\chi^2(22)$ | $\chi^2(24)$ |
| LR statistic | 462.33 | 162.71 |
| Prob > $\chi^2$ | 0 | 0 |

Table A4. Advanced Economies: Alternative Estimation for Construction Norm Equation

| VARIABLES | (1) GLS | (2) Fixed effect | (3) Random Effect |
|---|---|---|---|
| Dependency ratio (pct) | -0.0980*** | -0.118 | -0.134** |
| | (0.00944) | (0.0717) | (0.0558) |
| Density (Population over area, in logs) | 0.503*** | -0.880 | -0.640 |
| | (0.0256) | (6.461) | (0.427) |
| Excess rent inflation (relative to CPI) | 0.0617*** | 0.0411*** | 0.0418*** |
| | (0.0176) | (0.00757) | (0.00862) |
| Tourism expenditure (share of GDP) | 0.295*** | 0.0349 | 0.0884 |
| | (0.0151) | (0.220) | (0.169) |
| Income per capita | 0.00643*** | 0.0332** | 0.0299*** |
| | (0.00151) | (0.0151) | (0.00927) |
| Unemployment rate (pct) | -0.168*** | -0.268*** | -0.261*** |
| | (0.0115) | (0.0343) | (0.0492) |
| Interest rate (pct) | -0.0342*** | 0.0141 | 0.00501 |
| | (0.00991) | (0.0586) | (0.0377) |
| Stock market index, avg daily return annualized (pct) | -0.00145*** | 0.00343*** | 0.00310*** |
| | (0.000512) | (0.00106) | (0.00112) |
| Stock market volatility (mean adjusted) | -0.883** | 0.00659 | 0.135 |
| | (0.353) | (0.333) | (0.313) |
| Government capital expenditure (pct of GDP) | 0.440*** | 0.342 | 0.345* |
| | (0.0224) | (0.210) | (0.188) |
| Constant | 14.05*** | 3.221 | 6.098 |
| | (0.471) | (58.12) | (3.730) |
| Observations | 273 | 273 | 273 |
| Number of countries | 23 | 23 | 23 |

Standard errors in parentheses. * denotes significance level. Estimations using generalized least square (GLS) with no country dummies.

*** p<0.01, ** p<0.05, * p<0.1

Data source: Haver Analytics.

Table A5. Emerging Economies: Alternative Estimation for Construction Norm Equation

| VARIABLES | (1) GLS | (2) Fixed effect | (3) Random Effect |
|---|---|---|---|
| Density (Population over area, in logs) | -0.171*** | 1.004 | -0.0193 |
| | (0.0624) | (8.906) | (0.361) |
| Population growth (log difference) | -1.250*** | -0.0668 | -0.235 |
| | (0.0554) | (0.498) | (0.274) |
| Excess rent inflation (relative to CPI) | 0.0691*** | 0.0336** | 0.0338** |
| | (0.00352) | (0.0133) | (0.0136) |
| Tourism expenditure (share of GDP) | -0.216*** | -0.0987 | -0.109 |
| | (0.0279) | (0.131) | (0.0920) |
| Real credit growth (log difference) | 0.00575*** | 0.00999 | 0.0109* |
| | (0.00196) | (0.00725) | (0.00622) |
| Stock market index, avg daily return annualized (pct) | -0.00179*** | -0.00163* | -0.00173** |
| | (0.000273) | (0.000811) | (0.000849) |
| Income per capita | 0.101*** | 0.127*** | 0.129*** |
| | (0.00872) | (0.0376) | (0.0328) |
| Government capital expenditure (pct of GDP) | 0.0722*** | 0.147 | 0.106 |
| | (0.00785) | (0.115) | (0.0761) |
| Constant | 3.714*** | 14.14 | 4.465 |
| | (0.713) | (85.67) | (3.877) |
| Observations | 215 | 215 | 215 |
| Number of countries | 25 | 25 | 25 |

Standard errors in parentheses. * denotes significance level. Estimations using generalized least square (GLS) with no country dummies.
*** p<0.01, ** p<0.05, * p<0.1

Table A6a. Structural Difference Test Results (Including Real Credit)

| VARIABLES | (1) | (2) |
|---|---|---|
| Density (Population over area, in logs) | -0.118*** | -0.0495 |
| | (0.0277) | (0.0968) |
| Population growth (log difference) | -0.162** | -0.790*** |
| | (0.0717) | (0.113) |
| Excess rent inflation (relative to CPI) | 0.0327*** | 0.0419*** |
| | (0.00775) | (0.0105) |
| Tourism expenditure (share of GDP) | 0.207*** | -0.200*** |
| | (0.0133) | (0.0332) |
| Real credit growth (log difference) | -0.00343 | 0.00225 |
| | (0.00298) | (0.00520) |
| Stock market index (in logs) | 0.342*** | -0.0605 |
| | (0.0183) | (0.0424) |
| Per capita Income | -0.0108*** | 0.0475*** |
| | (0.00176) | (0.0145) |
| Government capital expenditure (% of GDP) | 0.0389*** | -0.0226** |
| | (0.0129) | (0.0112) |
| Unemployment rate (pct) | -0.157*** | -0.109*** |
| | (0.00801) | (0.0142) |
| Stock market volatility (mean adjusted) | 1.242*** | -0.602 |
| | (0.384) | (0.817) |
| Dummy*Density (Population over area, in logs) | | 0.0139 |
| | | (0.121) |
| Dummy*Population growth (log difference) | | 1.537*** |
| | | (0.217) |
| Dummy*Excess rent inflation (relative to CPI) | | -0.00579 |
| | | (0.0389) |
| Dummy*Tourism expenditure (share of GDP) | | 0.465*** |
| | | (0.0456) |
| Dummy*Real credit growth (log difference) | | 0.0116 |
| | | (0.0108) |
| Dummy*Stock market index (in logs) | | 0.606*** |
| | | (0.0732) |
| Dummy*Per capita Income | | -0.0540*** |
| | | (0.0152) |
| Dummy*Government capital expenditure (% of GDP) | | 0.460*** |
| | | (0.0625) |
| Dummy*Unemployment rate (pct) | | 0.00323 |
| | | (0.0301) |
| Dummy*Stock market volatility (mean adjusted) | | 2.819** |
| | | (1.262) |
| Type of Economy Dummy | | -8.389*** |
| | | (1.407) |
| Constant | 2.422*** | 7.737*** |
| | (0.269) | (1.054) |
| Observations | 474 | 474 |
| Number of countries | 48 | 48 |
| Chi-test | | 294.3 |
| Prob>Chi2 | | 0 |

Standard errors in parentheses. * denotes significance level. Estimations using generalized least square (GLS) with no country dummies.

*** p<0.01, ** p<0.05, * p<0.1

Note. Includes credit as explanatory variable. The Chi-test tests whether parameters are constant across countries of different types of economy (advanced or developing, emerging).

Table A6b. Structural Difference Test Results (Including Interest Rate)

| VARIABLES | (1) | (2) |
|---|---|---|
| Density (Population over area, in logs) | -0.413*** | -0.215** |
| | (0.0416) | (0.101) |
| Population growth (log difference) | -0.299*** | -0.914*** |
| | (0.0975) | (0.106) |
| Excess rent inflation (relative to CPI) | 0.0458*** | 0.0431*** |
| | (0.0106) | (0.00997) |
| Tourism expenditure (share of GDP) | 0.0731*** | -0.186*** |
| | (0.0189) | (0.0296) |
| Interest rate (pct) | -0.0297*** | 0.0635*** |
| | (0.0108) | (0.0157) |
| Stock market index (in logs) | 0.244*** | -0.0128 |
| | (0.0285) | (0.0408) |
| Per capita Income | -0.0162*** | 0.0753*** |
| | (0.00302) | (0.0160) |
| Government capital expenditure (% of GDP) | 0.00118 | 0.00678 |
| | (0.0117) | (0.0133) |
| Unemployment rate (pct) | -0.121*** | -0.112*** |
| | (0.0131) | (0.0124) |
| Stock market volatility (mean adjusted) | 1.217** | -0.686 |
| | (0.592) | (0.891) |
| Dummy*Density (Population over area, in logs) | | 0.168 |
| | | (0.125) |
| Dummy*Population growth (log difference) | | 1.465*** |
| | | (0.213) |
| Dummy*Excess rent inflation (relative to CPI) | | -0.00350 |
| | | (0.0349) |
| Dummy*Tourism expenditure (share of GDP) | | 0.512*** |
| | | (0.0416) |
| Dummy*Interest rate (pct) | | -0.0920*** |
| | | (0.0285) |
| Dummy*Stock market index (in logs) | | 0.595*** |
| | | (0.0722) |
| Dummy*Per capita Income | | -0.0779*** |
| | | (0.0167) |
| Dummy*Government capital expenditure (% of GDP) | | 0.452*** |
| | | (0.0491) |
| Dummy*Unemployment rate (pct) | | -0.0313 |
| | | (0.0282) |
| Dummy*Stock market volatility (mean adjusted) | | 2.800** |
| | | (1.260) |
| Type of Economy Dummy | | -5.741*** |
| | | (1.499) |
| Constant | 1.321*** | 4.880*** |
| | (0.472) | (1.166) |
| Observations | 508 | 508 |
| Number of countries | 48 | 48 |
| Chi-test | | 370.0 |
| Prob>Chi2 | | 0 |

Standard errors in parentheses. * denotes significance level. Estimations using generalized least square (GLS) with no country dummies.

*** p<0.01, ** p<0.05, * p<0.1

Note. Includes credit as explanatory variable. The Chi-test tests whether parameters are constant across countries of different types of economy (advanced or developing, emerging).

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