

Annex 1.9. Methodologies Underlying Assessment of Bubble Risks¹

This annex outlines the methodologies underlying the assessment of asset valuation summarized in Table 1.8 in Section A and Box 1.4 in Section B. It also discusses additional findings in greater detail emerging from the econometric work that seeks to explain the determinants of local government yields.

Section A

Table 1.8 summarizes the assessment of asset valuation. In Table 1.8, latest actual observations are expressed in terms of the deviation from either the period average or model value (when econometrics approaches are used). The deviations are further converted into a distribution of zero mean and unit standard deviation, or a z-score (i.e., dividing by the standard deviation of the deviations).²

Equity

Backward looking valuation numbers are calculated using both the dividend-yield and price-to-book ratios. Each ratio is converted into a z-score separately, before being combined into one index by taking an unweighted average. Forward looking valuations are calculated for both a shorter horizon and a longer horizon. The former relies on the 12-month forward price-to-earnings ratio. The latter is estimated using a dividend discount model, which bases valuation assessment on analysts' forecasts of, for instance, inflation, nominal long-term yields, and nominal earnings growth over a long horizon. The model uses monthly observations that go back to January 1988, from DataStream, Bloomberg, and IBES.

What are the potential consequences if investors are too sanguine about growth or interest rates? Our sensitivity analysis in Table 1.19 indicates that equity valuations could come under significant pressure if growth disappoints or interest rates rise more than expected, pointing to the risk of a sudden correction.³ Local government yields could be pressured upwards if policy rates and liquidity conditions rise sharply or fiscal sustainability worsens. Such negative scenarios could also translate into a fast and significant reversal of recent portfolio flow trends.

¹ This annex was prepared by Will Kerry, Ken Miyajima, Shanaka J. Peiris, and Marta Sanchez Sache.

² The variables underlying the z scores displayed in Table 1.8 are either in percent or basis points. Therefore, the deviations from either the period average or model value are calculated as a difference, without further scaling by either the period average or model value.

³ To illustrate this point, we measured the sensitivity of the results from the dividend discount model to a change in two main inputs, long-term real yields and earnings growth. The size of shocks to long-term yields was selected guided by our econometric analysis that relates government yields to domestic and external determinants. As for earnings growth expectations, we relied on historical deviations of analyst expectations from outturns to determine the size of possible shocks. The results indicate that unexpected shocks of reasonably realistic sizes could make valuations appear overly stretched. Data limitations prevented a broader extension of this analysis to emerging market and other advanced economies.

Table 1.19. Sensitivity of Equity Valuations Using Dividend Discount Model to Shocks to Discount Rate and Earnings Growth

(z score, February 2010 data)

	Baseline	Alternative valuations when							
		discount rate is shocked by ... (basis points)				earnings growth is shocked by ... (percentage points)			
		+50	+100	+200	+300	-1	-3	-5	-10
Australia	-2.1	-1.5	-1.0	0.0	0.7	-1.6	-0.6	0.4	2.9
Austria	-0.1	0.2	0.4	0.7	1.0	0.1	0.4	0.8	1.6
Belgium	-0.3	0.2	0.4	0.7	0.9	0.0	0.3	0.6	1.2
Canada	0.4	1.0	1.5	2.4	3.0	0.9	1.8	2.7	4.9
France	-1.1	-0.5	0.1	0.9	1.6	-0.7	0.3	1.2	3.5
Germany	-1.3	-0.9	-0.5	0.2	0.7	-0.9	-0.2	0.6	2.5
Ireland	0.9	0.9	1.0	1.0	1.1	0.9	1.0	1.1	1.4
Italy	-0.6	-0.3	-0.1	0.3	0.6	-0.4	0.1	0.5	1.6
Japan	-2.6	-2.3	-2.1	-1.7	-1.4	-2.5	-2.2	-1.9	-1.3
Netherlands	-1.0	-0.6	-0.2	0.5	1.0	-0.7	-0.1	0.5	2.0
Spain	0.2	0.7	1.1	1.7	2.2	0.5	1.3	2.1	3.9
Sweden	0.2	0.6	1.0	1.7	2.2	0.6	1.4	2.2	4.1
Switzerland	0.9	1.3	1.7	2.3	2.7	1.1	1.7	2.3	3.6
United Kingdom	-0.9	-0.5	0.0	0.6	1.2	-0.6	0.1	0.9	2.7
United States	-0.1	0.6	1.2	2.1	2.8	0.4	1.4	2.4	4.7

Sources: Bloomberg, L.P.; Consensus Economics; Datastream; IBES; and IMF staff estimates.

Note: This table indicates the sensitivity of present equity valuations to higher discount rates and lower earnings expectations, based on a dividend discount model. The numbers in the table represent z-scores (the differences between actual equity prices and estimated equilibrium levels divided by the standard deviation of the differences) to account for country-specific data characteristics. For instance, a value of two signifies actual values are above equilibrium by two standard deviations, potentially becoming stretched. Green signifies one standard deviation or less, orange between one and two standard deviations, and red two standard deviations or greater. The table uses long-term consensus forecasts of long-term government yields for discount rates and IBES forecasts of long-term earnings growth.

Residential real estate

Residential house prices are scaled by rental rates and income to estimate price-to-rent and price-to-income ratios. Data are mostly quarterly, going back to the first quarter of 1970. They are obtained from the OECD and other internal sources.

Local sovereign yield

The econometric model extends the approach of Baldacci and Kumar (2009) outlined in the October 2009 GFSR from annual to quarterly frequency, while using a wider set of global factors. Local government bond yields were related to a set of domestic and global factors in a fixed-effect panel approach for two sets of countries separately. Data for a group of 12 large advanced economies span 1980Q1-2009Q3, while those for 23 emerging and other advanced economies cover 1995Q1-2009Q3. Similar, but different sets of domestic and global factors were used for the two sets of regressions.

Group 1

Group 1 consists of larger advanced economies, often equipped with regional core financial markets. The baseline specification relates the local 10-year government yield to the policy rate, the deficit-to-GDP ratio, real GDP growth, and global liquidity (Table 1.20, model 3). Higher policy rates, fiscal deficits, and economic growth, as well as tighter global liquidity lead to higher local government yields. Inflation is statistically significant, but highly correlated with policy rates given the countries under consideration tend to target inflation. Therefore, the variable is not included in the baseline model to avoid multicollinearity. The coefficient on risk aversion represented by the VIX index is statistically significant and negative, suggesting local government debt was perceived as safe assets on average over the sample period. However, sovereign concerns have emerged recently for some euro area countries, making it somewhat difficult to disentangle the impact of VIX on yields. Larger gross capital flows to the local debt

Table 1.20. Group 1: Impact of Domestic and External Factors on Local Government Yields

Dependent variable: 10-year government bond yields

Period: 1980Q1-2009Q3

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Policy rate (%)	0.700 *** (0.037)	0.594 *** (0.465)	0.652 *** (0.402)	0.686 *** (0.037)	0.684 *** (0.037)	0.651 *** (0.041)	0.640 *** (0.042)	0.669 *** (0.038)
Deficit (% of GDP)	-0.150 ** (0.044)	-0.161 ** (0.477)	-0.129 ** (0.332)	-0.148 ** (0.042)	-0.142 * (0.046)	-0.129 ** (0.033)	-0.118 ** (0.033)	-0.140 ** (0.043)
Real GDP growth (yoy, %)	0.061 * (0.022)	0.069 * (0.256)	0.065 ** (0.173)	0.052 * (0.019)	0.069 * (0.023)	0.063 ** (0.017)	0.069 ** (0.018)	0.060 * (0.020)
Inflation (yoy, %)		0.192 * (0.063)						
Global excess liquidity growth (yoy, %)			-0.301 *** (0.404)			-0.290 *** (0.045)	-0.284 *** (0.043)	
VIX (%)				-0.026 *** (0.004)		-0.006 (0.005)		-0.026 *** (0.005)
Foreign debt inflow (% of GDP)					-0.064 * (0.021)		-0.057 * (0.020)	-0.068 * (0.022)
Constant	2.256 *** (0.273)	2.114 *** (0.257)	2.728 *** (0.300)	2.870 *** (0.298)	2.445 *** (0.282)	2.846 *** (0.334)	2.888 *** (0.315)	3.062 *** (0.337)
R-squared								
within	0.833	0.848	0.854	0.837	0.837	0.855	0.856	0.841
between	0.931	0.920	0.953	0.936	0.918	0.953	0.939	0.922
overall	0.861	0.873	0.879	0.865	0.861	0.880	0.878	0.865

* p<0.05, ** p<0.01, *** p<0.001

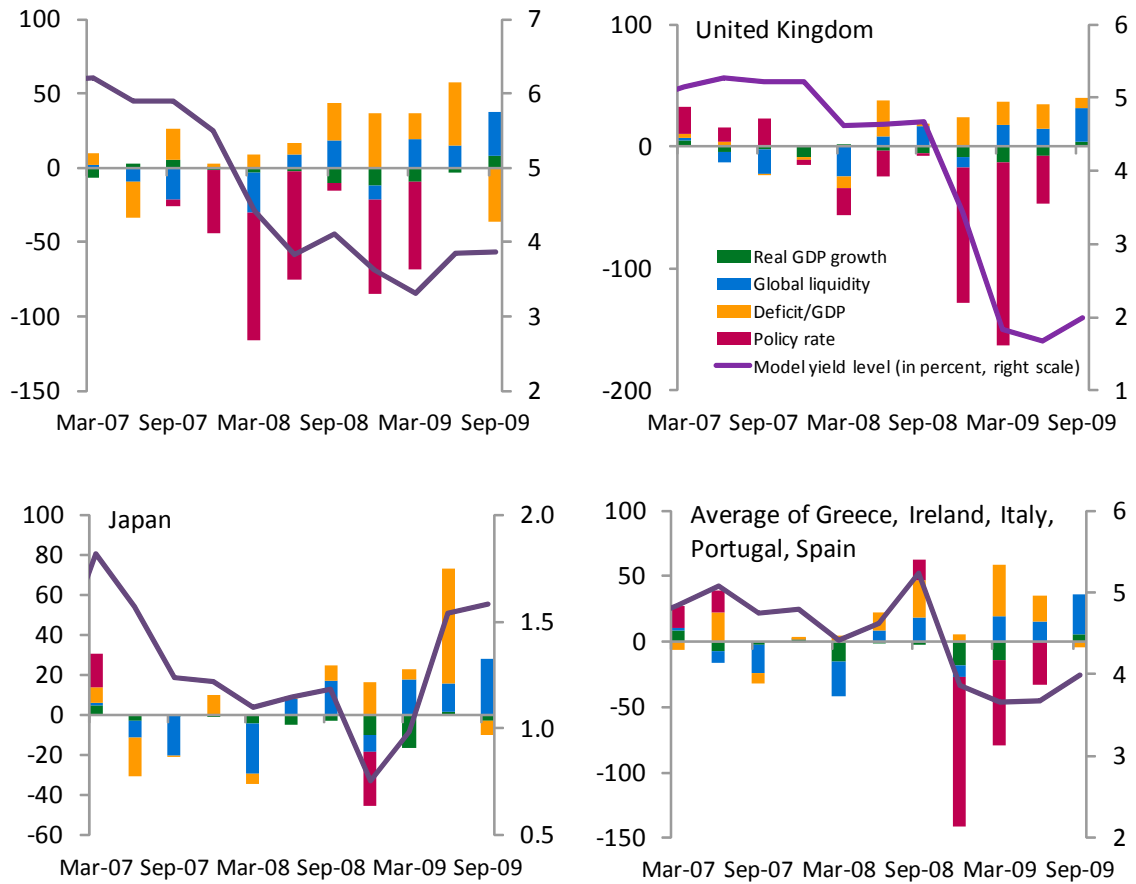
Source: IMF staff estimates.

Note: Included countries: Australia, Canada, France, Germany, Greece, Ireland, Italy, Japan, Portugal, Spain, United Kingdom, and United States.

Model 3 is the baseline. Showing fixed-effect panel regression results with robust standard errors.

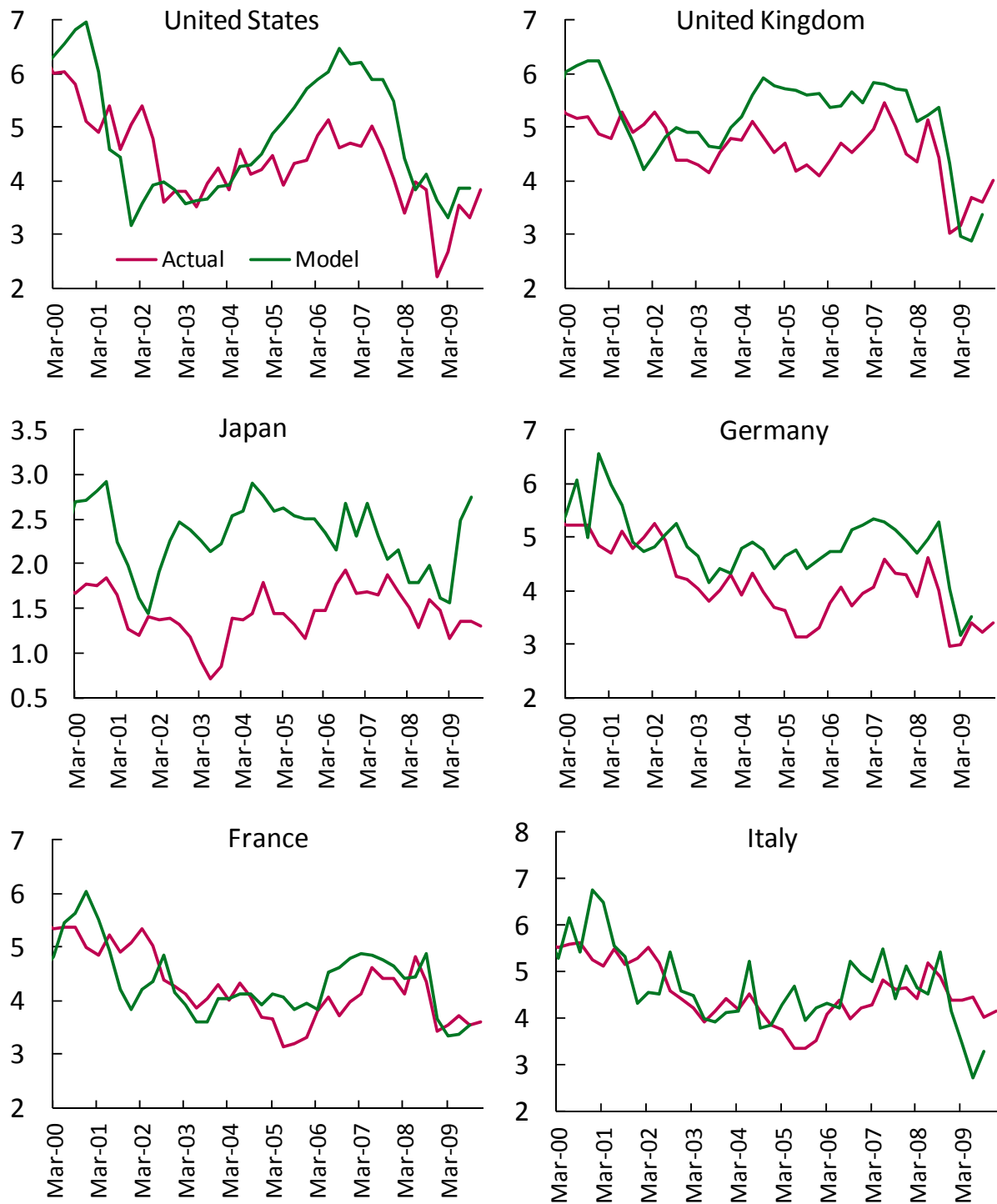
market increase demand and reduce yields, and the impact is significant even when included in the model along with global liquidity. However the variable lacks the latest data points. A decomposition of the model's dynamics indicates monetary easing in response to the global financial crisis has contributed to the sharp reduction in local government yields, often counterbalancing the impact of fiscal deterioration and reduced excess in global liquidity. Yields bottomed out in 2009 after monetary policy easing halted (Figures 1.50 and 1.51).

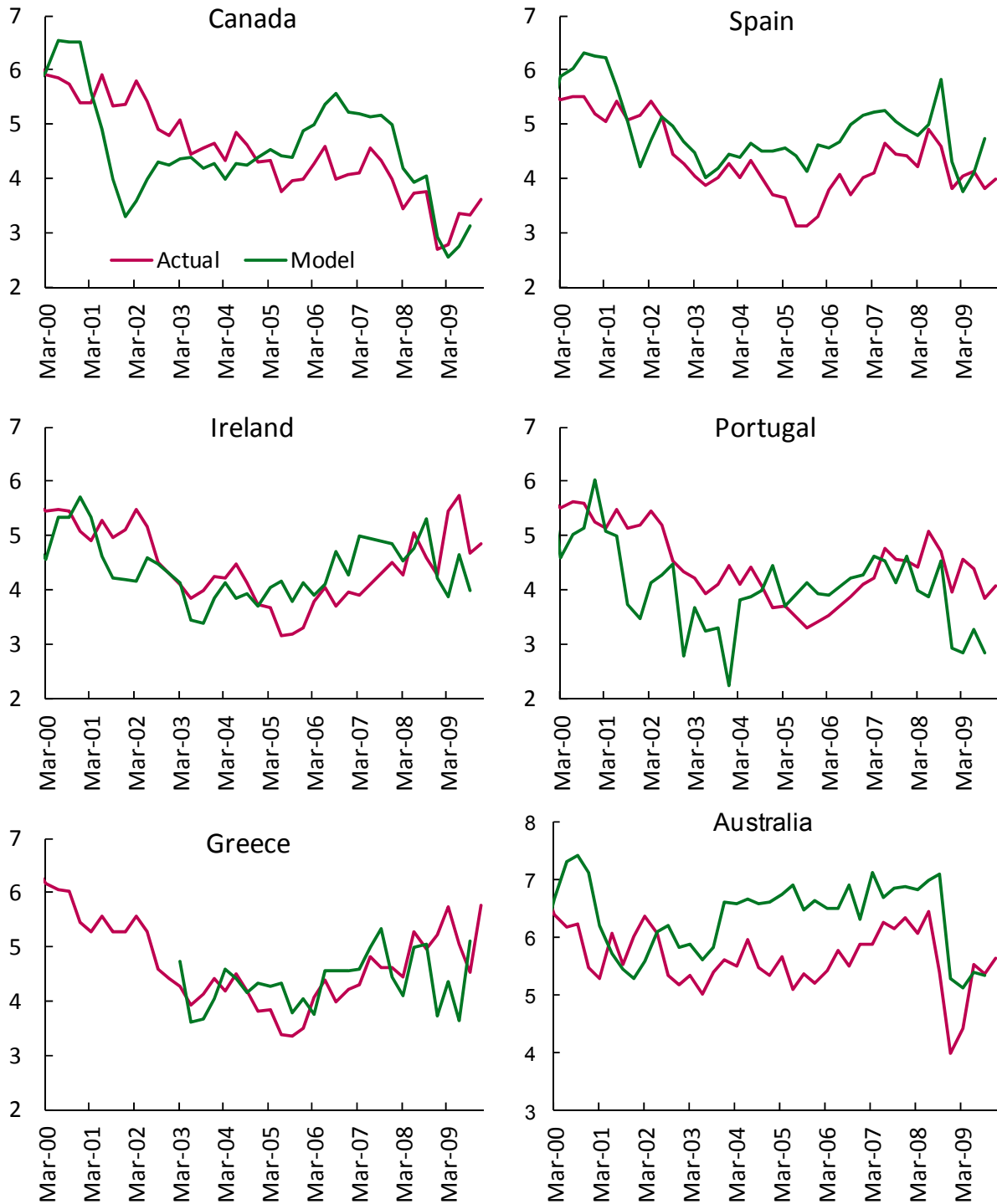
Figure 1.50. Contributions to Change in Local Government Yields
(In basis points)



Source: IMF staff estimates.

Figure 1.51. Group 1. Local Government Actual and Model Yields
(In percent)

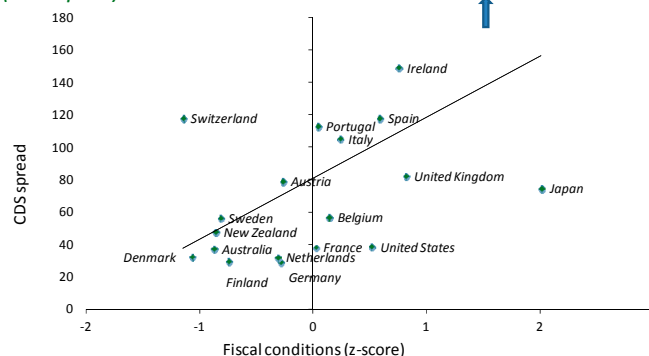




Source: IMF staff estimates.

Local government yields appear to be broadly consistent with fundamentals, given the loose monetary and fiscal conditions. Actual yields had been lower than model predictions (i.e., actual bond prices had been higher than model predictions) in most of the 12 included countries during 2004-08, but most notably in the United States, Germany, Canada, and Australia, echoing former Federal Reserve Chairman Greenspan's "conundrum" as to why global government yields remained at levels considered unusually low (Figure 1.51). In Q3 2009, actual yields and model predictions were broadly comparable excepting several instances. Japanese yields were below model predictions (i.e., actual bond prices were higher than model predictions), and factors not included in the model, such as Japan's high saving rates and institutions, may explain this result (IMF 2009c). In some euro area countries, actual yields were moderately above model predictions (i.e., actual bond prices were below model predictions) in Italy, Ireland, and Portugal. This may reflect greater fiscal uncertainty that is not captured in our model, but which is highlighted by higher CDS spreads (Figure 1.52). In Greece, model predictions were above actual yields (i.e., actual bond prices were higher than model predictions) in Q3 2009, reflecting a sharp increase in the deficit-to-GDP ratio. Actual yields, however, rose sharply in Q4.

Figure 1.52. Fiscal Conditions
(In basis points)



Sources: Bloomberg L.P.; IMF, *World Economic Outlook* database; and IMF staff estimates.
Note: Fiscal conditions represent a simple average of 2010 debt and fiscal balance in percent of GDP in terms of z-score relative to cross-country average. CDS spreads are the average of daily data during February 2010.

Long-term yields may rise substantially if monetary and liquidity conditions were to normalize. For instance, a 200 basis point increase in the policy rate and a 5 percentage point deceleration in growth of global excess liquidity could raise local government yields by nearly 300 basis points. Deterioration in the fiscal balance by five percentage points of GDP on a quarter-to-quarter basis could raise local government yields by another 65 basis points.

Group 2

The determinants of local government yields are broadly similar to those for countries in Group 1. The baseline model includes the policy rate, the debt-to-GDP ratio, and the VIX index (Table 1.21, model 8). Policy rates remain a key driver of local government yields, but the debt-to-GDP ratio, rather than fiscal deficits, has a statistically significant impact on yields. Higher global risk aversion (VIX) leads to higher local yields, likely reflecting flight to assets denominated in reserve currencies. Real GDP growth has a statistically significant impact in some specifications, and the sign was negative.⁴

⁴ Higher GDP growth tends to lower yields (as opposed to increasing yields for countries in Group 1), probably because many economies in Group 2 may have "excess" capacity and not exhibit classic business cycles. Hence, higher income growth eases economy-wide liquidity constraints. Our valuation assessment is broadly robust to the including of the variable.

A decomposition of model yields suggest that deterioration in fiscal conditions (rising debt-to-GDP ratios) and risk appetite pushed yields higher following Lehman Brother's bankruptcy, while monetary easing counterbalanced these pressures in early 2009 (Figure 1.53). Policy rates continue to decline in Q3 2009 the most in Europe, Middle East and Africa (EMEA), as economic activity remained depressed in the region.

Table 1.21. Group 2: Impact of Domestic and External Factors on Local Government Yields

Dependent variable: medium-term government bond yields

Period: 1995Q1-2009Q3

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Policy rate (%)	0.778 *** (0.122)	0.774 *** (0.119)	0.750 *** (0.115)	0.780 *** (0.124)	0.755 *** (0.118)	0.776 *** (0.120)	0.750 *** (.116)	0.737 *** (0.156)
Debt (% of GDP)	0.103 ** (0.301)	0.108 * (0.039)	0.124 ** (0.035)	0.104 ** (0.031)	0.116 ** (0.039)	0.108 * (0.039)	0.126 ** (.036)	0.138 *** (0.036)
Real GDP growth (yoy, %)	-0.134 * (0.056)	-0.131 * (0.057)	-0.083 (0.063)	-0.141 * (0.058)	-0.079 (0.063)	-0.139 * (0.059)	-0.088 (.064)	
Global excess liquidity growth (yoy, %)		0.067 (0.141)			-0.164 (0.142)	0.062 (0.145)		
VIX (%)			0.046 (0.027)		0.054 (0.029)		0.051 (.028)	0.069 * (0.025)
Foreign debt inflow (% of GDP)				0.142 (1.552)		0.290 (1.501)	1.779 (1.454)	
Constant	-0.802 (1.364)	-1.064 (1.8347)	-2.547 (2.170)	-0.795 (1.396)	-2.226 (2.209)	-1.040 (1.883)	-2.711 (2.239)	-3.804 (1.928)
R-squared								
within	0.546	0.549	0.564	0.553	0.565	0.553	0.570	0.555
between	0.686	0.676	0.643	0.689	0.661	0.679	0.643	0.611
overall	0.653	0.647	0.632	0.656	0.644	0.650	0.634	0.612

* p<0.05, ** p<0.01, *** p<0.001

Source: IMF staff estimates.

Note: Included countries: Argentina, Brazil, Chile, Colombia, Croatia, Czech Republic, Estonia, Hungary, India, Indonesia, Kazakhstan, Korea, Latvia, Lithuania, Malaysia, Peru, Philippines, Poland, Russia, South Africa, Thailand, and Turkey.

Note: Model 8 is the baseline. Showing fixed-effect panel regression results with robust standard errors.

Actual yields in 2009Q3 were somewhat lower than model predictions (i.e., bond prices were higher than model predictions) in a handful of countries, but not meaningfully so. Going forward, local yields may be vulnerable to policy rate “normalization” and renewed retrenchment in risk appetite.

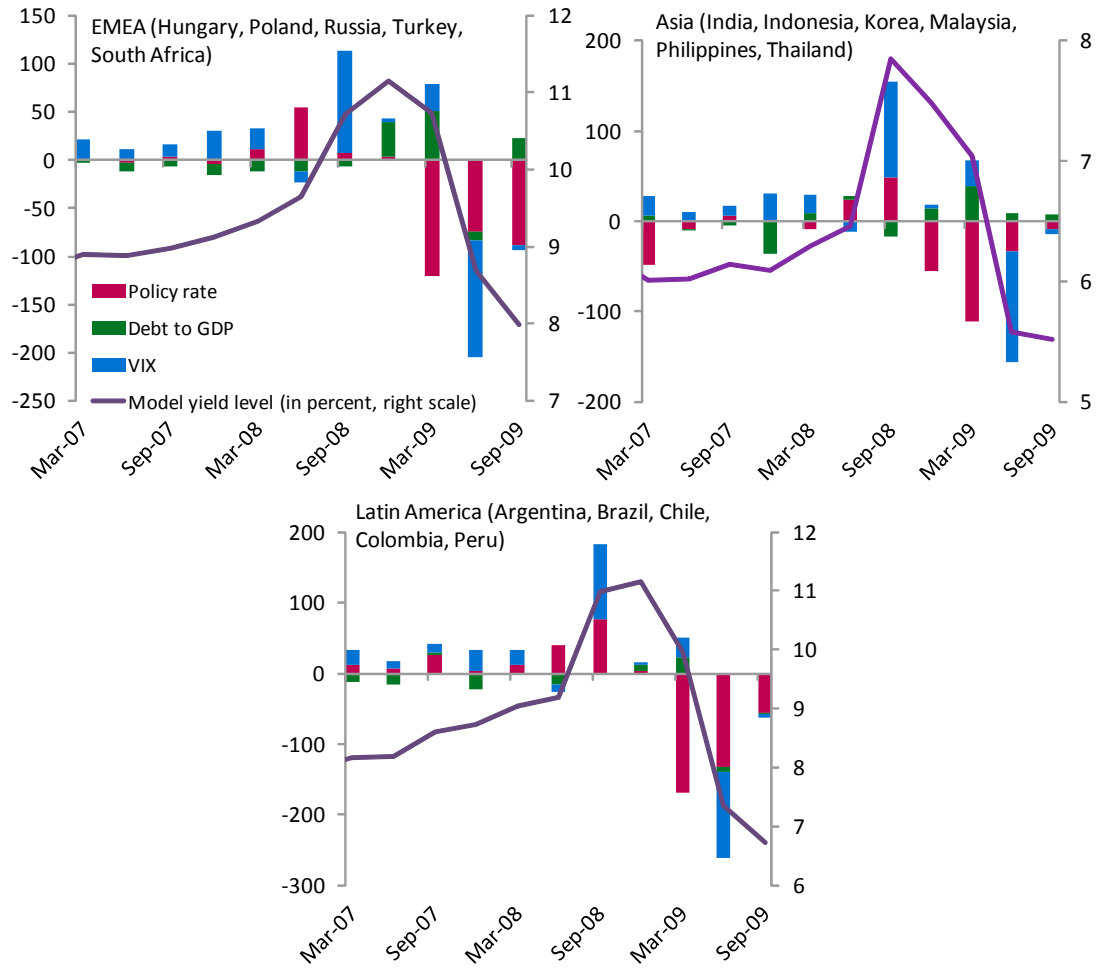
Local corporate credit

The model extends that featured in Box 1.5 of the April 2009 GFSR (IMF, 2009a), which seeks to explain U.S. investment-grade corporate bond spreads based on a combination of business cycle variables, volatility, and financial strains in various sectors. The specification used for this GFSR excludes variables representing capital inflow into the asset class.

External sovereign credit

The model explores the determinants of emerging market sovereign external bond spreads, by relating JPMorgan's EMBIG composite index spread to variables representing economic, political, and financial risks, as well as a range of external factors. For more detail on the methodology, see Box 1.5 of the April 2006 GFSR (IMF, 2006).

Figure 1.53. Group 2 - Contributions to Change in Local Government Yield
(In basis points)



Source: IMF staff estimates.

Section B

Box 1.4 looks at the conditions in emerging markets that could potentially lead to the formation of asset price bubbles. The method used to create the figures follows that in Borio and Lowe (2002). The charts show quarterly real domestic credit, real cumulative portfolio inflows and real asset prices. Real asset prices are the simple average of real equity prices and real house prices, where available. Each data series is shown relative to its trend, calculated using a Hodrick-Prescott filter with a high smoothing parameter, an approach widely accepted in the academic literature. The de-trended series is then converted to a z-score using the average and standard deviation calculated over the period 1991 to 2005.

The first figure shows the average of the three time series in past episodes of financial stress, specifically: (i) data for the euro area, Japan, United Kingdom and United States in the early 1990s; (ii) information for the same countries but for the recent Global Credit Crisis; and (iii) figures for the south-east Asian countries (excluding Japan) during the 1997 crisis. The chart plots a smoothed, four-quarter moving average. The second figure shows a z-score of the median de-trended series for Brazil, China, India, and Russia. The z-score is based on the same period as above.