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Financial information and macroeconomic forecasts

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ABSTRACT

We study the forecasting power of financial variables for macroeconomic variables in 62 countries between 1980 and 2013. We find that financial variables such as credit growth, stock prices, and house prices have considerable predictive power for macroeconomic variables at the one- to four-quarter horizons. A forecasting model that includes financial variables outperforms the World Economic Outlook (WEO) forecasts in up to 85% of our sample countries at the four-quarter horizon. We also find that cross-country panel models produce more accurate out-of-sample forecasts than individual country models.

1. Introduction

The crisis of 2007−2009 caused widespread disruptions in the financial market, followed by a global economic downturn. These developments have led to an intense debate on macrofinancial linkages. The present paper contributes to this debate in the context of macroeconomic forecasts. Building our analysis on the extensive body of literature on forecasting, we examine the forecasting power of financial variables for macroeconomic variables in 62 countries between 1980 and 2013. We show that incorporating financial variables such as credit growth, stock prices, house prices, and bond yields in an otherwise simple model improves the accuracy of macroeconomic forecasts significantly.

Our rationale for using financial variables to forecast macroeconomic variables is threefold. First, in the presence of financial market imperfections when the Modigliani-Miller theorem does not hold, changes in credit conditions are likely to result in changes in future macroeconomic conditions. In addition, by affecting the wealth of firms and households, changes in asset prices also affect their investment and consumption decisions. Second, the forward-looking nature of financial variables means that they incorporate information about the future of the economy that is not yet reflected in current macroeconomic outcomes. Finally, contemporaneous financial variables such as stock prices and interest rates can help to nowcast macroeconomic variables in countries where the latter are collected with considerable time lags.[3]

Our methodology is chosen deliberately to be simple, to facilitate easy replication. The model can be estimated either country by country or in a cross-country panel. The simplicity of the model makes it applicable to countries with very limited financial data available. In its simplest specification, the model uses only one financial variable that is available for most countries: private sector credit growth.[4] For countries with more data available, the model can be augmented to include additional financial variables such as stock prices, house prices, corporate and sovereign bond yields, and deposit and borrowing rates.

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[3] However, this argument does not apply to credit growth, which is also collected with time lags.

[4] As of the end of 2015, the IMF's International Financial Statistics (IFS) includes data on private sector credit annually for over 180 economies and quarterly for over 120 economies.

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Our main findings are as follows. Credit growth is associated significantly with GDP growth in the short- to medium-term. The effect is large in the baseline model with only one financial variable (credit growth). In nowcasting, a one-standard-deviation increase in credit growth (i.e., a 24-percentage-point increase in the annualized rate) is associated with a 1.79- percentage-point increase in annualized GDP growth, which corresponds to about one third of a standard deviation of the annualized GDP growth in our sample. A one-standard-deviation increase in credit growth is associated with a 1.15-percentage-point increase in GDP growth at the one-quarter horizon, and a 0.46-percentage-point increase at the four- quarter horizon. In the augmented model with other financial variables, the effect of credit growth remains significant both in nowcasting and at the one-quarter horizon.

Credit growth is also associated significantly with consumption growth, investment growth, and inflation growth in the short- to medium-term. The effect is strongest for investment growth, with a one-standard-deviation increase in credit growth being associated with a 6.9-percentage-point increase in investment growth for nowcasting, a 4.2-percentage-point increase at the one-quarter horizon, and a 2.0-percentage-point increase at the four-quarter horizon.

Stock prices and house prices also predict GDP growth, consumption growth, and investment growth in most of the specifications, conditional on credit growth. Conditional on these variables, deposit and lending rates have little predictive power for macro variables, with one exception: lending rates are associated strongly and positively with future investment growth. Corporate and sovereign bond yields also have some predictive power for macro variables, but their effects are not robust when other financial variables are included.

Our findings are robust across different country groups (i.e., advanced economies, emerging markets, and low-income countries).[5] In particular, credit growth is associated significantly with GDP growth in all country groups, though the coefficients tend to be larger among emerging markets and low-income countries than among advanced economies. The only exception is that credit growth loses statistical significance when sovereign and corporate bond yields are included. Stock prices and house prices also retain predictive power for both advanced economies and emerging markets.[6]

We assess the forecasting performances of our models by comparing their out-of-sample forecasting errors with those from a benchmark model in which the macroeconomic forecasts are based on past macroeconomic outcomes. We also compare the forecasting errors of our model with those implied by publicly-available forecasts from the IMF's World Economic Outlook (WEO). The WEO publishes the IMF's projections on national accounts biannually, along with other indicators for member countries. We find that our financial models have more accurate GDP growth forecasts than the WEO predictions. A simple financial model with credit growth has smaller forecasting errors than the WEO forecasts for 69% of the countries in our sample, while an extended financial model with credit growth, stock prices, and house prices has smaller forecasting errors than WEO forecasts for 85% of the countries.

Given that similar empirical relationships hold across countries, we test whether cross-country information helps to predict individual countries' macro outcomes. We do this by comparing the performance of a model based on individual country regressions to that of a model based on panel regressions. We find that the out-of-sample forecasts based on panel regressions always outperform those based on individual country regressions, even though the individual country regressions always have better in-sample fits.

Our paper relates to several strands of the literature. First, the choice to include credit growth, interest rates, and bond yields in our forecasting model builds on recent literature showing that credit conditions forms an important driver of business cycle fluctuations (Bernanke & Gertler, 1989; Bernanke, Gertler, & Gilchrist, 1996; Gilchrist & Zakrajšek, 2012; Philippon, 2009). The literature on the wealth effects and collateral channel of growth and investment motivates the use of house prices and stock prices (Barro, 1990; Iacoviello, 2012; Kiyotaki & Moore, 1997). Second, our results extend prior empirical evidence that financial variables are leading indicators of business cycles, as was shown by Leamer (2007) for house prices and by Claessens, Kose, and Terrones (2008) and Estrella and Mishkin (1998) for other financial variables. The previous empirical research on macrofinancial forecasts has mostly explored the procyclical nature of financial variables in a small set of advanced economies. In particular, most studies have focused on forecasting macroeconomic activities using asset prices, broadly defined to include interest rates, interest spreads, returns, and the values of financial and tangible assets, such as bonds, stocks, and housing (Stock & Watson, 2003). Asset prices data have the advantage of being available in real time with small measurement errors; however, they are available only for a limited set of countries. Our paper contributes to this literature by broadening our understanding of these relationships using a model and data that are applicable to a large number of countries.

Third, from a methodological perspective, this paper relates to the discussion of the pros and cons of using pooled international data in forecast models (Garcia-Ferrer, Highfield, Palm, & Zellner, 1987; Hoogstrate, Palm, & Pfann, 2000).

The rest of the paper is organized as follows. Section 2 introduces our forecasting model and data. Section 3 presents our results. Section 4 concludes.

[5] Our definition of advanced economies follows the WEO classification. We define low-income countries as all countries that are eligible to obtain concessional financing (i.e., Poverty Reduction and Growth Trust) from the IMF (IMF, 2016). The remaining countries form the emerging market group. One exception is Bolivia, which graduated from PRGT-eligibility on October 16, 2015, but is still included in our low-income countries regression. See Appendix Table A.2 for details.

[6] We do not have data on either stock prices or house prices for low-income countries.

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2. Empirical model and data

We assess the predictive ability of financial variables for macroeconomic activity by estimating the following forecasting model:

$$\nabla^h Y_{c,t+h} = \alpha + \sum_{i=1}^{p} \beta_i \nabla Y_{c,t-i} + \gamma X_{ct} + \mu_c + \varepsilon_{c,t+h}, \quad (1)$$

where Y_{ct} is a quarterly macroeconomic indicator (specified below) for country c in quarter t; $\nabla^h Y_{c,t+h} \equiv z/(h+1)\ln(Y_{t+h}/Y_{t-1})$ measures the annualized growth rate, where $h \geq 0$ is the forecast horizon; $z = 400$ is a scaling constant; X_{ct} is a vector of predictors; and μ_c is the country fixed effects. We include the lagged value $\nabla Y_{c,t-i}$ as predictors because the left-hand-side variable is likely to be serially correlated. Thus, the coefficient γ captures the marginal information content of the predictors X_{ct} beyond that contained in $\nabla Y_{c,t-i}$. We determine the lag length p in each specification using the Akaike information criterion (AIC), and use Newey–West standard errors to correct for the autocorrelation and heteroskedasticity of the moving-average error term $\varepsilon_{c,t+h}$ that results from overlapping observations.[7] The timing adopted by this framework allows for "nowcasting" (i.e., $h = 0$), in which contemporaneous financial variables are used to forecast macroeconomic activities. This is most useful when macroeconomic indicators are observed with lags but contemporaneous financial variables are available readily.

We consider the following key measures of macroeconomic activity on the left-hand-side: GDP growth, private consumption growth, private investment growth, and consumer price index (CPI) inflation. We use a vector of financial variables as predictors, including private sector credit growth, stock prices, house prices, the bank prime loan rate, and the deposit rate. In addition, for a subsample of advanced economies for which data are available, we also estimate an extended model that includes data on sovereign bond yields and corporate bond yields. The main sources for house price data are the OECD and the Bank of International Settlements (BIS). The main sources for data on stock prices and bond yields are Bloomberg and Datastream. We use two policy controls: government consumption as a proxy for fiscal policy and the short-term interest rate as a proxy for monetary policy. GDP, consumption, investment, and all financial variables are converted into real terms using country-specific GDP deflators. For all variables that are not seasonally adjusted in the raw data, we perform seasonal adjustment using the X-12-ARIMA method proposed by the U.S. Census Bureau. Table A.1 in the Appendix summarizes the data source(s) for each variable.

There are considerable variations in the availability of quarterly data over the period 1980−2013, even in the sample of advanced economies. Although some countries, such as France, the US and Japan, have a quasi-exhaustive data coverage for the baseline model, others, such as Sweden, Germany and the Netherlands, exhibit significant data gaps. Using data on corporate bond yields reduces the sample coverage significantly for advanced economies. Furthermore, the number of quarterly observations is larger for advanced than for emerging countries. Although there are an average of 87 quarterly observations per country for advanced economies, there are only 41 quarterly observations per country on average for emerging economies. We present summary statistics in Appendix Table B.1.

[7] In another specification (not shown), we also include up to two lags of financial variables. Our main results are not affected.

3. Empirical results

Because the data coverage is very unbalanced across countries, we estimate the model for the sample of all countries and for four different subsamples of countries: two for advanced economies, one for emerging markets, and one for low-income countries. For advanced economies, we first present the results for all countries using the baseline specification. We then present the results for the extended model with sovereign bond yields and corporate bond yields for the subsample of countries for which such data are available. Finally, we compare the forecasting errors of the panel models with both those of the individual country models and those implied by the IMF's WEO forecasts, on both an in-sample and an out-of-sample basis.

3.1. Panel estimation results

Table 1 presents the results on the sample of all countries with data available. Panels A and B present the results for GDP growth and consumption growth, while Panels C and D present the results for investment growth and inflation. In each panel, columns 1 to 3 present the nowcasting results; columns 4 to 6 present forecasting results at the one-quarter horizon; and columns 7 to 9 present forecasting results at the four-quarter horizon.

We present three specifications: a baseline specification with credit growth and the policy controls (government consumption and policy rate), and two augmented specifications: one that adds stock prices and house prices and another that also adds deposit and lending rates. Using the most comprehensive set of variables leads to a reduction in the number of observations by about one half relative to the baseline specification. In order to be able to compare the relative importance of predictor variables, we report standardized coefficients for all financial variables and policy controls.

Credit growth is associated significantly with GDP growth in most specifications. The effect in our baseline specifications is large. In nowcasting, a one-standard-deviation increase in credit growth (i.e., a 24 percentage point increase in annualized rate) is associated with a 1.79 percentage point increase in annualized GDP growth, which corresponds to about one-third of a standard deviation of the annualized GDP growth in our sample. A one-standard-deviation increase in credit growth is associated with a 1.15 percentage point increase in GDP growth at the one-quarter horizon, and a 0.46 percentage point increase at the four-quarter horizon. In the augmented specifications, the effect remains significant for nowcasting and at the one-quarter horizon with a slightly smaller effect (0.87 and 0.96 percentage points respectively for nowcasting; and 0.65 and 0.43 percentage

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Table 1
Panel regression results: All countries.

	Nowcasting			1-quarter-ahead forecasting			4-quarter-ahead forecasting		
Panel A: GDP growth									
Credit growth	1.787***	0.873*	0.959**	1.151***	0.653***	0.432**	0.468***	0.190	0.016
	[0.529]	[0.461]	[0.469]	[0.312]	[0.230]	[0.187]	[0.175]	[0.138]	[0.116]
Stock prices		0.617***	0.591***		1.137***	0.949***		0.861***	0.733***
		[0.200]	[0.187]		[0.109]	[0.155]		[0.079]	[0.105]
House prices		1.263***	1.013***		1.194***	0.946***		1.008***	0.849***
		[0.234]	[0.268]		[0.198]	[0.237]		[0.162]	[0.198]
Deposit rate			1.503			0.623			1.087
			[3.218]			[3.047]			[2.584]
Lending rate			8.077			8.054			6.132
			[5.692]			[5.054]			[4.605]
Government	0.734***	1.232***	0.984**	0.512**	0.693***	0.486***	0.244***	0.299***	0.146
consumption growth	[0.281]	[0.389]	[0.470]	[0.205]	[0.187]	[0.174]	[0.091]	[0.113]	[0.092]
Policy rate	−0.431**	−0.343	−2.425***	−0.483**	−0.255	−2.159***	−0.324	−0.060	−1.804***
	[0.217]	[0.212]	[0.543]	[0.242]	[0.190]	[0.481]	[0.238]	[0.198]	[0.493]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3487	2261	1547	3478	2254	1544	3381	2205	1520
Adjusted R^2	0.107	0.112	0.086	0.151	0.224	0.165	0.248	0.290	0.265
Panel B: Consumption growth									
Credit growth	2.977***	1.118**	0.580*	1.480***	0.639**	0.321	0.707***	0.359**	0.183
	[0.778]	[0.466]	[0.333]	[0.399]	[0.309]	[0.253]	[0.247]	[0.157]	[0.127]
Stock prices		0.560**	0.121		0.679***	0.351***		0.587***	0.395***
		[0.220]	[0.162]		[0.140]	[0.118]		[0.079]	[0.090]
House prices		1.739***	1.498***		1.463***	1.300***		0.991***	0.795***
		[0.220]	[0.252]		[0.201]	[0.207]		[0.128]	[0.138]
Deposit rate			2.398			1.287			−0.294
			[2.587]			[2.321]			[1.933]
Lending rate			1.199			3.555			5.764
			[4.924]			[4.631]			[3.795]
Government	0.153	0.249	0.254	0.749*	0.363*	0.183	0.552**	0.132	−0.021
consumption growth	[0.626]	[0.324]	[0.405]	[0.389]	[0.208]	[0.202]	[0.268]	[0.114]	[0.094]
Policy rate	−1.478**	−0.008	−1.282**	−1.507**	−0.103	−1.343**	−1.141**	0.006	−1.208***
	[0.632]	[0.213]	[0.648]	[0.610]	[0.191]	[0.611]	[0.462]	[0.173]	[0.462]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4274	2647	1906	4237	2636	1899	4125	2591	1868
Adjusted R^2	0.143	0.222	0.214	0.191	0.352	0.357	0.293	0.508	0.552
Panel C: Investment growth									
Credit growth	6.925***	3.134**	1.834	4.161***	2.244	0.631	2.046***	0.791	0.155
	[1.706]	[1.526]	[1.204]	[1.344]	[1.493]	[0.714]	[0.656]	[0.495]	[0.359]
Stock prices		1.375***	0.333		2.698***	1.342***		0.364	1.666***
		[0.518]	[0.482]		[0.748]	[0.352]		[0.244]	[0.282]
House prices		4.576***	4.047***		4.222***	3.663***		−2.345***	3.031***
		[0.802]	[0.744]		[0.592]	[0.683]		[0.570]	[0.533]
Deposit rate			2.824			2.525			−1.887
			[9.197]			[8.046]			[6.895]
Lending rate			27.216*			28.851**			29.254***
			[14.620]			[12.407]			[9.405]
Government	0.761	0.665	0.449	0.857*	0.742**	0.493	0.660**	0.364	0.230
consumption growth	[0.884]	[0.575]	[0.631]	[0.486]	[0.360]	[0.402]	[0.293]	[0.244]	[0.219]
Policy rate	−3.291***	−2.407***	−8.760***	−2.932***	−2.542***	−8.852***	−2.656***	−2.345***	−7.841***
	[0.939]	[0.725]	[2.202]	[0.792]	[0.653]	[1.907]	[0.684]	[0.570]	[1.511]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4186	2573	1832	4153	2565	1828	4050	2526	1803
Adjusted R^2	0.083	0.089	0.083	0.083	0.184	0.164	0.115	0.257	0.274

(*continued on next page*)

points respectively at the one-quarter horizon). However, the effect at the four-quarter horizon is not statistically significant.

Similarly, credit growth has forecasting power for consumption growth and investment growth; however, the effect on investment growth is not significant in the augmented specifications. Credit growth is associated negatively with inflation growth, but the effect tends to vanish in augmented specifications and at the four-quarter horizon. Note that the linear framework proposed here cannot disentangle the dual effects of credit growth in predicting growth in tranquil times and predicting crises (Schularick & Taylor, 2012), though Loayza and Ranciere (2006) and Ranciere, Tornell, and Westermann (2006) do propose such a framework. However, this literature has shown that the growth-enhancing effect of credit development

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Table 1 (*continued*).

	Nowcasting			1-quarter-ahead forecasting			4-quarter-ahead forecasting		
Panel D: Inflation									
Credit growth	−3.669**	−0.650***	−0.586***	−1.790*	−0.229**	−0.062	−0.717	0.064	0.209
	[1.833]	[0.184]	[0.203]	[0.940]	[0.107]	[0.114]	[0.461]	[0.101]	[0.146]
Stock prices		0.097	0.095		0.065	0.083		0.025	0.036
		[0.083]	[0.105]		[0.068]	[0.083]		[0.075]	[0.073]
House prices		−0.496**	−0.585**		−0.300	−0.392		0.055	0.050
		[0.209]	[0.283]		[0.217]	[0.290]		[0.143]	[0.175]
Deposit rate			−1.312			−1.272			−0.750
			[1.899]			[2.049]			[1.903]
Lending rate			−6.009			−5.013			−2.368
			[3.837]			[3.859]			[3.004]
Government	1.672	0.150	0.166	1.019	0.174	0.227	0.302	0.143**	0.167*
consumption growth	[1.258]	[0.123]	[0.152]	[0.780]	[0.110]	[0.145]	[0.293]	[0.067]	[0.085]
Policy rate	3.543***	1.889***	3.037***	3.941***	1.791***	2.897***	4.430***	1.634***	2.410***
	[1.187]	[0.357]	[0.933]	[1.372]	[0.424]	[1.052]	[1.488]	[0.462]	[0.900]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4544	2746	1988	4510	2738	1986	4402	2698	1959
Adjusted R^2	0.506	0.540	0.551	0.536	0.551	0.559	0.548	0.587	0.586

Notes: The table reports the results of an ordinary least squares (OLS) fixed effects (FE) estimate. The sample period is 1980 Q1 to 2013 Q4. The dependent variable is annualized GDP, consumption, investment growth, or inflation. The right-hand-side includes the lagged left-hand-side variable. We use the Akaike information criterion (AIC) to determine the lag length in each specification. Newey–West standard errors are given in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

dominates the crisis effect on average, which is consistent with our findings.

Stock prices and house prices are associated positively with GDP growth in all specifications. The effects are significant at the 1% confidence level and tend to be substantial. At the one-quarter horizon, a one-standard-deviation increase in either the house price index or the stock price index leads to an increase in GDP growth of 0.95 percentage points. The effect remains strong at the four-quarter horizon: 0.73 percentage points for the stock price index and 0.85 percentage points for the house price index. The effect for nowcasting is slightly smaller for the stock price index (0.59 percentage points), but larger for the house price index (1.01 percentage points). Stock and house prices also predict consumption growth. An increase in house prices has a stronger impact on consumption growth than an increase in stock prices. This result is not surprising, given that housing wealth represents 50% or more of total household wealth (ECB, 2004; Iacoviello, 2012). Stock and house prices also have large and significant impacts on investment growth in most specifications. Neither stock nor house prices predict inflation significantly.

Conditional on other financial variables and policy controls, the deposit and lending rates do not predict GDP growth significantly, with one exception: the lending rates are associated strongly and positively with future investment growth. Table 2 presents similar results for advanced economies, broadly confirming the results obtained for the full sample. The same is true for the sample of advanced economies with information on sovereign bond yields (Appendix Table B.2), although the effect of credit growth is weaker in that sample. A one-standard-deviation increase in the corporate bond yield leads to percentage reductions in the GDP growth of 0.7 and 0.75 percentage points at the one- and four-quarter horizons respectively, in the baseline specification. This negative effect is smaller (0.48 percentage points) in the most comprehensive specification and at the four-quarter horizon. An increase in the corporate bond yield has an even stronger negative effect on investment growth, but the results are not robust beyond the baseline specification. The results for corporate bond yields are consistent with the findings of Gilchrist and Zakrajšek (2012) for the U.S. economy.[8]

Table 3 presents the results for emerging markets. The effect of credit growth on GDP growth is much stronger for emerging markets than for advanced economies, but its forecasting ability is significant only at the one-quarter horizon. Another notable difference is that house price growth is correlated negatively with investment growth, and that an increase in the lending rate has a strong negative impact on consumption. The first fact is consistent with a house price boom crowding out investment, and the second with the presence of severe short-run borrowing constraints, thus tying consumption to lending conditions in emerging markets.

Table 4 presents results for low-income countries, which also show credit growth to have substantial power to forecast GDP and consumption growth at the one- and four-quarter horizons. However, we note that these results may not be representative of this group of countries because our sample consists of only three countries, due to limited data availability.

Comparing the in-sample goodness-of-fit values across specifications suggests that the best specification includes credit growth, house prices, stock prices, policy controls and the optimal number of lags of the dependent variable. The adjusted R^2 values at the four-quarter horizon for all countries are in the range of 0.25 to 0.3 for investment and GDP growth, and in the range of 0.5 to 0.6 for

[8] Interestingly, both the coefficient of the sovereign bond yield in the prediction of GDP and investment and the coefficient of the corporate bond yield in the prediction of investment switch signs when different predictors are added to the model, probably because the sovereign and corporate bond yields covary with other predictors.

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Table 2
Panel regression results: Advanced economies.

	Nowcasting			1-quarter-ahead forecasting			4-quarter-ahead forecasting		
Panel A: GDP growth									
Credit growth	1.000**	0.517	0.543	0.728***	0.477**	0.236*	0.369**	0.156	−0.025
	[0.404]	[0.363]	[0.336]	[0.279]	[0.194]	[0.124]	[0.178]	[0.135]	[0.106]
Stock prices		0.470**	0.390**		0.950***	0.645***		0.721***	0.556***
		[0.185]	[0.155]		[0.099]	[0.124]		[0.071]	[0.093]
House prices		1.336***	1.180***		1.380***	1.206***		1.160***	1.063***
		[0.258]	[0.314]		[0.217]	[0.260]		[0.177]	[0.204]
Deposit rate			−4.772			−4.904			−1.684
			[3.563]			[3.136]			[2.499]
Lending rate			7.451			6.784			1.916
			[6.394]			[5.436]			[4.605]
Government	0.461	1.012***	0.710	0.355*	0.563***	0.280*	0.153*	0.226**	0.050
consumption growth	[0.295]	[0.383]	[0.464]	[0.212]	[0.172]	[0.153]	[0.087]	[0.100]	[0.084]
Policy rate	0.064	0.043	−0.799	0.035	0.096	−0.542	0.137	0.234	−0.391
	[0.215]	[0.200]	[0.732]	[0.194]	[0.173]	[0.595]	[0.191]	[0.174]	[0.456]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2335	1793	1103	2334	1790	1104	2299	1764	1101
Adjusted R^2	0.136	0.132	0.098	0.219	0.256	0.160	0.313	0.287	0.231
Panel B: Consumption growth									
Credit growth	1.525***	1.118**	0.620*	0.809***	0.534*	0.243	0.517***	0.275*	0.118
	[0.490]	[0.492]	[0.336]	[0.309]	[0.310]	[0.249]	[0.184]	[0.143]	[0.110]
Stock prices		0.590***	0.109		0.622***	0.229***		0.532***	0.303***
		[0.228]	[0.134]		[0.147]	[0.088]		[0.080]	[0.075]
House prices		1.754***	1.575***		1.436***	1.297***		1.031***	0.876***
		[0.212]	[0.232]		[0.196]	[0.167]		[0.139]	[0.130]
Deposit rate			−4.694**			−4.298**			−3.343*
			[2.317]			[2.187]			[1.919]
Lending rate			4.515			4.942			5.122
			[4.534]			[4.339]			[3.735]
Government	0.045	0.190	0.292	0.117	0.316	0.172	−0.011	0.045	−0.093
consumption growth	[0.563]	[0.309]	[0.382]	[0.250]	[0.219]	[0.211]	[0.105]	[0.109]	[0.095]
Policy rate	0.135	0.299*	−0.003	0.094	0.169	−0.144	0.208	0.227	−0.313
	[0.243]	[0.169]	[0.577]	[0.194]	[0.153]	[0.549]	[0.180]	[0.153]	[0.474]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2598	2008	1292	2588	2002	1289	2559	1980	1280
Adjusted R^2	0.190	0.332	0.384	0.304	0.487	0.572	0.451	0.620	0.742
Panel C: Investment growth									
Credit growth	3.562**	2.351	0.803	2.693	1.676	−0.130	1.663**	0.726	0.015
	[1.555]	[1.523]	[1.011]	[1.640]	[1.552]	[0.518]	[0.734]	[0.534]	[0.326]
Stock prices		1.250**	−0.017		2.542***	0.858***		1.956***	1.200***
		[0.608]	[0.414]		[0.884]	[0.272]		[0.264]	[0.231]
House prices		4.529***	3.616***		4.419***	3.503***		3.822***	3.135***
		[0.914]	[0.703]		[0.529]	[0.508]		[0.471]	[0.468]
Deposit rate			−20.843**			−17.237**			−15.053**
			[9.469]			[7.554]			[6.875]
Lending rate			15.230			15.666			15.535*
			[12.985]			[10.678]			[8.954]
Government	0.489	0.705	0.599	0.569	0.633*	0.458	0.219	0.094	0.025
consumption growth	[0.895]	[0.546]	[0.548]	[0.450]	[0.348]	[0.381]	[0.250]	[0.230]	[0.216]
Policy rate	−0.365	−0.712	−1.265	−0.306	−0.903**	−1.858	−0.489	−0.946**	−2.181*
	[0.713]	[0.499]	[1.980]	[0.566]	[0.435]	[1.566]	[0.511]	[0.411]	[1.298]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2546	1934	1218	2539	1931	1218	2516	1915	1215
Adjusted R^2	0.079	0.118	0.110	0.077	0.233	0.190	0.103	0.307	0.304

(*continued on next page*)

consumption and inflation. The regression results indicate comparable levels of goodness-of-fit for GDP growth in advanced and emerging economies, but a much better fit for consumption growth in the group of advanced economies than in the emerging markets group (0.62 vs. 0.18). The goodness-of-fit is of a similar order of magnitude across the two groups for investment growth and inflation.

Overall, our results across samples display a large array of similarities, as well as a few differences. Credit growth is a strong predictor of GDP, consumption, and investment growth in both the advanced and emerging market samples. Its predictive power is weakened only by the introduction of stock and house prices at the four-quarter horizon. Stock prices are also a leading indicator

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Table 2 (*continued*).

	Nowcasting			1-quarter-ahead forecasting			4-quarter-ahead forecasting		
Panel D: Inflation									
Credit growth	−0.622***	−0.456***	−0.375**	−0.261***	−0.229***	−0.103	−0.017	−0.059	−0.006
	[0.146]	[0.150]	[0.160]	[0.078]	[0.088]	[0.074]	[0.043]	[0.051]	[0.054]
Stock prices		0.058	−0.021		0.052	−0.009		0.069	−0.004
		[0.084]	[0.081]		[0.066]	[0.063]		[0.051]	[0.045]
House prices		−0.084	−0.006		0.098	0.174*		0.319***	0.407***
		[0.089]	[0.108]		[0.075]	[0.097]		[0.076]	[0.089]
Deposit rate			1.799			1.978			1.749
			[1.354]			[1.303]			[1.250]
Lending rate			−2.886			−2.176			−1.624
			[2.093]			[2.031]			[1.782]
Government	0.210**	0.115	0.062	0.178**	0.117	0.103	0.171***	0.118**	0.088
consumption growth	[0.097]	[0.111]	[0.125]	[0.072]	[0.097]	[0.110]	[0.057]	[0.060]	[0.065]
Policy rate	1.347***	1.093***	1.110***	1.129***	0.900***	0.812**	1.084***	0.792***	0.715**
	[0.171]	[0.159]	[0.417]	[0.160]	[0.150]	[0.389]	[0.159]	[0.143]	[0.312]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2725	2084	1360	2717	2080	1359	2692	2062	1353
Adjusted R^2	0.594	0.534	0.561	0.669	0.581	0.645	0.712	0.661	0.734

Notes: See the notes to Table 1.

of GDP growth in both samples and remain highly significant even at the four-quarter horizon. House prices predict consumption growth and investment growth in both samples; however, house prices predict GDP growth in the advanced economies sample but not in the emerging markets sample, possibly because of a negative correlation between house prices and net exports. This is consistent with an episode of real exchange rate appreciation, a house price boom, and a loss of export competitiveness (Kalantzis, 2015; Schneider & Tornell, 2004). Another important difference regards the policy rate, which is not significant in the sample of advanced economies but is strongly and negatively significant in the sample of emerging markets. This result is consistent with the evidence of a stronger bank lending channel of monetary policy in emerging markets than in advanced economies (Dave, Dressler, & Zhang, 2013).

3.2. Panel versus country-specific forecasts: in- and out-of-sample results

This section compares the forecast performance of a panel model estimated using pooled international data to that of an individual country model estimated with country-specific data. Of particular interest is the extent to which the use of pooled international data can improve the forecasting performance.

We compute root mean squared errors (RMSE) for each model and subsample. For each subsample of countries, we report two sets of results: the full sample fit and the out-of-sample forecast on quarterly GDP growth. For the full-sample fit, we use data for the period 1980–2013. For our out-of-sample forecast, we first use data for the period 1980–1999 to fit our models, then use these fitted models to compute the four-quarter forecasts for the period 2000–2007. We limit the forecast years to prior to 2007 so as to exclude the period of the global financial crisis and the subsequent Great Recession, in order to focus our attention on normal times instead of tail events. The relationship between financial and real variables may be very different in periods of financial crisis, but we leave this question for future research. We also minimize the influence of extreme events by dropping from the sample any observations in which the annualized GDP growth rate is greater than 30% or less than −30%.

We assess the performances of three models. The first is an AR model with the optimal number of lags chosen by the AIC for up to seven lags. The second is a financial model that augments an AR model with credit growth and two policy controls (the policy rate and government consumption). The third is a financial model that augments an AR model with credit growth, house price growth, stock price growth, and two policy controls.

We compare the RMSEs of the panel model and the individual country models. Table B.3 presents the in-sample results for advanced economies and shows that the forecasts based on individual country regressions outperform the panel forecasts for all but one country. However, the result is reversed when one considers out-of-sample forecasts (Table 5, Panel A). In that case, the panel forecasts display lower RMSEs for all but four advanced countries in the model with credit growth as the only financial variable. In some countries, such as Belgium and Japan, the RMSEs are reduced by a factor of three.

Emerging markets show similar results. Although the forecasts based on individual country regressions always outperform the panel forecasts in-sample (Appendix Table B.4), the opposite is true for out-of-sample forecasts (Table 5, Panel B). All nine emerging economies for which the data allow us to perform out-of-sample forecasting display smaller panel forecast errors than individual forecast errors. The reduction in RMSE can be very substantial. The RMSE is reduced by half for Turkey and Brazil and by three-quarters for Colombia and Peru.

One possible reason why the panel model outperforms the individual country models is that it incorporates more observations into its estimation, thus reducing the variance. Including more observations may also reduce the bias enough that it reduces the small-sample bias; however, using cross-country data may increase the bias because of potential heterogeneity across countries, in

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Table 3
Panel regression results: emerging markets.

	Nowcasting			1-quarter-ahead forecasting			4-quarter-ahead forecasting		
Panel A: GDP growth									
Credit growth	4.539***	5.390***	5.073***	2.398***	3.568***	3.224***	0.552	0.815	1.022
	[0.634]	[0.936]	[0.994]	[0.538]	[0.792]	[0.805]	[0.417]	[0.663]	[0.674]
Stock prices		1.767***	1.638***		2.142***	2.122***		1.192***	1.171***
		[0.538]	[0.561]		[0.450]	[0.475]		[0.324]	[0.326]
House prices		0.532	0.023		−4.173***	−1.652		−5.360***	1.411
		[0.561]	[0.459]		[1.316]	[3.833]		[1.512]	[4.626]
Deposit rate			−254.799**			−0.156			0.051
			[125.273]			[0.352]			[0.348]
Lending rate			26.840			−190.540			−49.181
			[26.495]			[133.586]			[160.038]
Government	1.945***	1.948*	2.816***	1.354***	0.634	1.632**	0.388	0.259	0.633
consumption growth	[0.583]	[1.122]	[1.043]	[0.481]	[0.955]	[0.732]	[0.325]	[0.444]	[0.393]
Policy rate	−1.725***	−2.809***	−0.917	−2.085***	−2.930***	−1.555	−1.919***	−2.761***	−4.186**
	[0.496]	[0.578]	[1.275]	[0.626]	[0.567]	[1.109]	[0.621]	[0.616]	[1.804]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1043	468	444	1032	464	440	973	441	419
Adjusted R^2	0.107	0.143	0.153	0.103	0.218	0.234	0.155	0.277	0.292
Panel B: Consumption growth									
Credit growth	5.788***	0.354	0.107	2.875***	0.939	0.942	1.034*	0.573	0.684*
	[1.522]	[1.519]	[1.544]	[0.791]	[0.852]	[0.738]	[0.575]	[0.457]	[0.388]
Stock prices		−0.026	0.171		0.653*	0.810**		0.608**	0.640**
		[0.543]	[0.528]		[0.385]	[0.387]		[0.283]	[0.304]
House prices		1.367**	1.379**		1.102**	1.246***		0.448	0.484
		[0.530]	[0.574]		[0.438]	[0.477]		[0.278]	[0.302]
Deposit rate			67.860			180.565			127.158
			[130.166]			[113.188]			[91.924]
Lending rate			−78.655*			−72.865**			−34.282*
			[40.073]			[36.535]			[19.574]
Government	−0.068	1.584	1.398	2.529**	0.640	0.528	2.271**	0.567	0.616
consumption growth	[1.736]	[1.746]	[1.973]	[1.202]	[0.706]	[0.806]	[0.885]	[0.348]	[0.387]
Policy rate	−4.128***	−2.223***	0.300	−4.288***	−1.862**	−1.123	−3.543***	−1.551***	−1.820
	[1.398]	[0.670]	[2.104]	[1.419]	[0.753]	[1.447]	[1.027]	[0.590]	[1.365]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1527	639	614	1502	634	610	1425	611	588
Adjusted R^2	0.184	0.071	0.075	0.214	0.113	0.123	0.287	0.182	0.189
Panel C: Investment growth									
Credit growth	13.229***	7.069***	5.338*	6.575***	4.484**	3.114	2.584**	0.590	−0.356
	[1.878]	[2.424]	[2.920]	[1.375]	[1.995]	[2.068]	[1.099]	[1.556]	[1.710]
Stock prices		2.394*	2.438*		2.957***	3.109***		2.343***	2.440***
		[1.363]	[1.392]		[1.005]	[1.080]		[0.718]	[0.716]
House prices		2.984**	2.642*		2.095*	2.087		1.239	1.296
		[1.338]	[1.452]		[1.192]	[1.280]		[0.849]	[0.891]
Deposit rate			−1,019.597***			−668.876**			−616.427**
			[296.588]			[291.995]			[262.830]
Lending rate			44.151			46.204			99.554*
			[68.932]			[63.868]			[56.346]
Government	3.970*	−1.812	−0.755	2.696**	−0.573	0.201	2.415***	1.282	1.969*
consumption growth	[2.040]	[3.032]	[3.513]	[1.281]	[1.504]	[1.672]	[0.920]	[0.967]	[1.013]
Policy rate	−7.568***	−11.091***	0.511	−7.097***	−11.730***	−4.832	−6.417***	−11.138***	−7.149**
	[1.769]	[2.328]	[4.740]	[1.574]	[2.129]	[5.419]	[1.422]	[2.014]	[2.874]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1491	639	614	1467	634	610	1393	611	588
Adjusted R^2	0.126	0.111	0.123	0.123	0.219	0.230	0.177	0.341	0.362

(*continued on next page*)

which case choosing between the panel and individual forecasts involves a bias–variance tradeoff.

We shed some light on this bias–variance tradeoff by calculating the bias and variance of our estimates for the panel and individual country models.[9] The results are presented in Appendix Table B.5 and B.6, and show that the panel model forecasts have smaller in-sample and out-of-sample variances than those of the individual country models in most countries: about 90% for advanced economies and 100% for emerging markets. While

[9] The mean square error (MSE) of an estimator can be decomposed exactly into the sum of the squared bias and the variance. For empirical estimates, the decomposition is not exact because the covariance term may be non-zero.

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Table 3 (*continued*).

	Nowcasting			1-quarter-ahead forecasting			4-quarter-ahead forecasting		
Panel D: Inflation									
Credit growth	−10.123**	−2.411***	−2.288***	−4.665**	−0.284	−0.034	−1.527	1.208***	1.515***
	[4.668]	[0.527]	[0.544]	[2.239]	[0.538]	[0.576]	[1.116]	[0.382]	[0.482]
Stock prices		−0.081	−0.036		0.103	0.088		0.116	0.092
		[0.267]	[0.289]		[0.234]	[0.241]		[0.246]	[0.262]
House prices		−1.334**	−1.288*		−1.259*	−1.251*		−0.661	−0.570
		[0.650]	[0.708]		[0.701]	[0.729]		[0.406]	[0.379]
Deposit rate			95.768			209.292			306.391
			[125.152]			[160.210]			[247.152]
Lending rate			−36.362			−39.737			−24.131
			[24.489]			[29.972]			[32.522]
Government	7.865	0.142	0.376	5.279	0.565	0.760	1.888	0.262	0.446
consumption growth	[5.621]	[0.528]	[0.608]	[3.738]	[0.606]	[0.720]	[1.469]	[0.243]	[0.290]
Policy rate	6.532***	4.234***	4.661*	7.874***	4.357***	3.689	9.361***	3.920**	1.627
	[1.843]	[1.320]	[2.522]	[2.442]	[1.487]	[2.325]	[2.815]	[1.517]	[1.554]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1662	662	628	1638	658	627	1561	636	606
Adjusted R^2	0.583	0.572	0.578	0.568	0.516	0.528	0.571	0.480	0.500

Notes: See the notes to Table 1.

Table 4
Panel regression results: low-income countries.

	Nowcasting	1-quarter-ahead forecasting	4-quarter-ahead forecasting	Nowcasting	1-quarter-ahead forecasting	4-quarter-ahead forecasting
	Panel A: GDP growth			Panel C: Investment growth		
Credit growth	6.745**	6.921***	2.143**	34.041***	9.447	6.636
	[3.070]	[1.813]	[0.845]	[11.249]	[6.949]	[5.725]
Government	1.303	0.020	0.571*	−10.776*	0.026	−1.314
consumption growth	[1.112]	[0.536]	[0.324]	[6.405]	[2.958]	[1.575]
Policy rate	−5.414**	−6.052**	−3.135*	−8.176*	−3.202	−5.550
	[2.148]	[2.331]	[1.654]	[4.519]	[2.982]	[3.746]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	109	112	109	149	147	141
R^2	0.067	0.213	0.125	0.182	0.369	0.058
	Panel B: Consumption growth			Panel D: Inflation		
Credit growth	9.386***	4.335*	2.630**	−4.213**	−0.891	1.163
	[3.490]	[2.340]	[1.075]	[1.852]	[1.360]	[1.412]
Government	1.036	0.144	−0.090	0.995	0.644	0.470
consumption growth	[2.699]	[1.329]	[0.277]	[0.671]	[0.507]	[0.413]
Policy rate	0.229	−0.783	−1.223	1.236	0.938	−0.592
	[2.881]	[1.415]	[1.024]	[0.762]	[0.736]	[0.406]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	149	147	141	157	155	149
R^2	0.196	0.338	0.463	0.299	0.181	0.142

Notes: See the notes to Table 1.

the panel model generally has larger biases for in-sample forecasts, it has smaller biases for out-of-sample forecasts in most countries. In summary, the better performance of the panel model for out-of-sample forecasts comes from a reduction in both the bias and the variance; for in-sample forecasts, the panel model reduces the variance at the cost of a large bias.

This comparison of the panel and individual forecasts is an important result of this paper. Although allowing the regression coefficient to be country-specific improves the in-sample fit, imposing common coefficients in a panel regression gives a stronger out-of-sample forecasting power. In other words, the cross-country information obtained from the panel regression helps to improve the individual country forecasts.

3.3. Comparison with the WEO forecasts

This section compares the forecast performances derived from our financial models with the publicly available forecasts included in the World Economic Outlook (WEO) of the IMF. We are interested in examining whether and when our models result in forecasts that are more accurate than the WEO forecasts.

The WEO publishes the IMF's projections on national accounts and other indicators for member countries. The publication is released in April and September/October each year. For about 50 of the largest countries, which account for about 90% of world output, the forecasts are updated for each WEO exercise. At times the WEO revises previous forecasts, so we focus our attention on the forecasting errors of the initial forecast, which we obtain by compiling WEO publications of various vintages.

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Table 5
Comparing panel and individual country model performances (out-of-sample).

Panel A: Advanced economies						
Country	Model 1 (AR)			Model 2 (AR and Credit)		
	Individual RMSE	Panel RMSE	1 if Panel outperforms Individual	Individual RMSE	Panel RMSE	1 if Panel outperforms Individual
United States	2.849	2.711	1	3.515	2.683	1
United Kingdom	2.982	3.021	0	2.762	2.879	0
Austria	3.848	3.452	1	3.562	3.337	1
Belgium	3.802	3.331	1	9.411	3.407	1
Denmark	4.235	4.308	0	4.639	8.059	0
France	1.934	2.021	0	2.435	2.180	1
Germany	3.000	3.171	0	3.244	3.052	1
Italy	3.247	2.349	1	3.902	2.657	1
Netherlands	3.164	2.440	1	3.480	2.449	1
Norway	10.317	9.990	1	9.194	9.817	0
Switzerland	2.914	3.041	0	2.790	2.784	1
Canada	3.243	3.661	0	6.057	4.711	1
Japan	3.763	3.599	1	14.569	4.456	1
Finland	4.790	4.985	0	7.052	5.019	1
Malta	9.040	5.303	1	23.071	5.397	1
Portugal	4.030	3.658	1	5.169	3.873	1
Spain	3.003	3.491	0	4.075	3.562	1
New Zealand	4.590	4.306	1	5.480	4.340	1
Cyprus	6.093	6.088	1	5.964	6.706	0
Israel	8.338	7.555	1	9.365	7.827	1
Korea	8.746	6.601	1	10.559	6.335	1
Slovak Republic	12.142	8.449	1	103.860	6.755	1
Latvia	16.049	8.904	1	258.976	7.547	1
Panel model outperforms (%)			65			83***
Panel B: Emerging market						
Country	Model 1 (AR)			Model 2 (AR and Credit)		
	Individual RMSE	Panel RMSE	1 if Panel outperforms	Individual RMSE	Panel RMSE	1 if Panel outperforms
Turkey	14.752	10.411	1	22.197	9.432	1
Brazil	8.879	5.863	1	8.879	5.099	1
Colombia	16.349	6.715	1	19.428	5.636	1
Peru	19.225	9.181	1	43.486	8.766	1
Indonesia	13.260	6.984	1	14.539	6.318	1
Malaysia	14.515	10.304	1	13.002	9.465	1
Philippines	5.529	5.379	1	6.442	5.082	1
Thailand	8.760	5.465	1	38.981	4.965	1
Hungary	11.239	8.648	1	20.567	8.826	1
Panel model outperforms (%)			100***			100***

Notes: The table shows the out-of-sample forecasting errors (RMSE) of 4-quarter-ahead GDP growth from both an individual country model and a panel model. Model 1 is an AR model with lags chosen by the AIC. Model 2 adds credit growth and policy variables to the AR model. The bottom row is the percentage of cases in which the panel model outperforms the individual country model. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

We assess the performances of our models in real time by computing out-of-sample four-quarter forecast errors on the quarterly GDP growth for each country from 2004 Q1 to 2013 Q1 (i.e., 19 quarters). The forecasts are based on a fitted model estimated with pooled international data in a rolling window of 20 years prior to each forecasting period.[10]

We examine the performances of two financial models. A simple financial model is one that augments an AR model with credit growth and two policy controls (policy rate and government consumption), while an expanded financial model is a model that augments an AR model with credit growth, stock prices, house prices, and two policy controls.

Tables 6 and 7 compare the RMSEs of the two models to those implied by the WEO forecasts. The forecasts based on the simple financial model outperform the WEO forecasts in 69% of the countries in our sample. When the financial model is augmented to include stock and house prices as well, its RMSE is reduced even further. The out-of-sample forecasts of the expanded financial model are more accurate than the WEO forecasts in 85% of the countries in our sample. Our results suggest that incorporating financial information and pooled international

[10] Our models do not make predictions if one or more predictors are missing. As a result, the RMSEs for some countries are based on fewer than 19 forecasts. The RMSEs of the WEO forecasts are based on fewer than 19 forecasts for some countries because of data availability limitations.

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Table 6
Comparing WEO forecasts with a simple financial model.

Country	WEO forecasts		Model 2 (AR + Credit)		1 if Model 2 outperforms WEO
	RMSE	No. of obs.	RMSE	No. of obs.	
United States	3.127	12	2.321	19	1
United Kingdom	4.076	18	3.269	19	1
Austria	3.332	18	2.858	18	1
Belgium	3.592	18	3.015	15	1
France	2.544	18	2.312	19	1
Germany	3.111	18	3.308	18	0
Italy	3.985	18	3.743	18	1
Sweden	4.020	12	3.294	11	1
Switzerland	2.412	14	2.147	19	1
Canada	2.856	16	3.765	10	0
Japan	3.511	16	3.651	19	0
Finland	4.128	18	4.392	18	0
Greece	6.180	18	5.353	18	1
Iceland	1.954	1	6.519	13	0
Portugal	3.234	17	3.247	18	0
Spain	3.300	16	2.732	18	1
Turkey	9.021	5	5.017	19	1
New Zealand	4.846	5	3.065	15	1
Brazil	4.973	2	3.631	19	1
Mexico	1.576	3	5.454	11	0
Peru	2.024	3	4.977	19	0
Cyprus	3.218	5	2.839	8	1
Israel	4.415	12	3.292	8	1
India	12.193	4	4.135	13	1
Korea	5.514	14	3.646	19	1
Malaysia	4.161	2	6.982	18	0
Philippines	6.095	5	2.711	19	1
Thailand	7.678	5	3.716	16	1
Russia	7.166	5	4.258	5	1
Croatia	7.486	5	3.973	19	1
Slovenia	7.675	12	4.078	18	1
Romania	4.419	3	7.029	16	0
Model 2 outperforms WEO (%)					69**

Notes: The table shows out-of-sample forecasting errors (RMSE) of 4-quarter-ahead GDP growth. Model 2 adds credit growth and policy variables to an AR model with lags chosen by the AIC. The bottom row shows the percentage of cases in which model 2 outperforms the WEO forecasts. Statistical significance is shown for a two-tailed binomial test. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

data can potentially improve the accuracy of macroeconomic forecasts in the medium term for a large number of countries.

We compare the accuracy of our forecasts with that of the WEO forecasts further by using the test of Diebold and Mariano (1995). The results are presented in Appendix Table B.7 and B.8. They show that our simple financial model outperforms the WEO forecasts (at a 10% confidence level) in 17 of the 32 sample countries, and underperforms the WEO forecasts in only one country. Our expanded financial model outperforms the WEO forecasts in 20 of the 28 sample countries, and underperforms the WEO forecasts in only two countries.

4. Factor model

Here, we propose an alternative estimation based on a factor model using either country-specific or global factors. The advantage of factor models is that they are parsimonious, capturing common movements in financial variables within a country or globally. In the literature, Stock and Watson (2006) and Engel, Mark, and West (2014) show that factor models perform well for forecasting basic macro variables and exchange rates. Rey (2013) also points out the importance of global factors in cross-country macroeconomic dynamics.

For the country-specific factor model, we first estimate a set of factors and factor loadings from country-specific financial variables using principal components. We then use the estimated factors to forecast the macro variables. For the global financial factor model, we first estimate the factors and factor loadings using financial variables from all countries in the sample where available. We then use the estimated global factors to forecast the macro variables. We use credit, house prices and stock prices as the underlying variables for factor estimation. We do not include other financial variables because they have limited forecasting power, as is shown in our baseline results. In addition, doing so reduces our sample size.

The results based on country-specific factors are presented in Tables 8 and 9. Note the first two factors represent 70%–92% of the total variance in our sample. The correlations between factors and variables show that the first factor is explained mainly by house prices and credit growth (60% and 58% respectively), whereas the second factor is explained mainly by stock prices (52%).

The results presented in Table 8 for advanced economies show that both factors have very strong predictive

Table 7
Comparing WEO forecasts with the expanded financial model.

Country	WEO forecasts		Model 3 (AR + Credit + Equity + Housing)		Model 3 outperforms WEO
	RMSE	No. of obs.	RMSE	No. of obs.	
United States	3.127	12	1.774	9	1
United Kingdom	4.076	18	2.882	9	1
Austria	3.332	18	2.341	9	1
Belgium	3.592	18	2.521	4	1
France	2.544	18	1.918	9	1
France	2.544	18	1.918	9	1
Germany	3.111	18	2.702	9	1
Italy	3.985	18	3.285	9	1
Sweden	4.020	12	2.620	7	1
Canada	2.856	16	3.262	7	0
Japan	3.511	16	3.384	9	1
Finland	4.128	18	3.488	9	1
Finland	4.128	18	3.488	9	1
Greece	6.180	18	5.072	7	1
Iceland	1.954	1	5.170	9	0
Portugal	3.234	17	3.027	9	1
Spain	3.300	16	2.143	9	1
New Zealand	4.846	5	2.490	8	1
Brazil	4.973	2	3.432	7	1
Peru	2.024	3	5.070	9	0
Israel	4.415	12	3.559	8	1
Malaysia	4.161	2	6.812	7	0
Philippines	6.095	5	2.870	5	1
Thailand	7.678	5	3.329	3	1
Russia	7.166	5	6.111	9	1
Romania	4.419	3	2.320	5	1
Model 3 outperforms WEO (%)					85**

Notes: The table shows out-of-sample forecasting errors (RMSE) of 4-quarter-ahead GDP growth. Model 3 adds credit, stock price, and house price growth and policy variables to an AR model with lags chosen by the AIC. The bottom row shows the percentage of cases in which model 3 outperforms the WEO forecasts. Statistical significance is shown for a two-tailed binomial test. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

power for GDP, consumption, and investment growth. In all but two cases, the factor variables are significant at the 1% confidence level. Including the factor variables increases the goodness-of-fit slightly. For the GDP growth, the adjusted R^2 values increase from 13%, 26%, and 29% in the baseline model (Table 2) to 17%, 29%, and 31% in the factor model for nowcasting and one- and four-quarter-ahead forecasting respectively. Table 9 shows similar—although slightly weaker—findings for emerging economies. In contrast to the growth of GDP and its components, the factor model does a mediocre job of predicting inflation.

Appendix Table B.9 and B.10 present results with two global factors. Note that the first two factors represent around 22% of the total variance in our sample. Each of the higher-order factors represents 5% or less of the total variance. The correlations among factors and variables show that the first factor is explained mainly by global stock prices, whereas the second factor is explained mainly by house prices and credit growth in various countries.[11] Overall, the global factor model underperforms relative to the country-specific model. However, one exception is inflation, for which the second factor does a good job of predicting for both advanced economies and emerging markets.

[11] Appendix Table B.11 shows the top financial series that explain the global factors.

5. Conclusion

The results of this paper provide ample support for the hypothesis that financial variables contain information that can be used to forecast macroeconomic variables up to the four-quarter horizon. Such information comes from the aggregate quantity (e.g. credit growth) or price (e.g. stock and house prices) of the economy. Such forecasting power of financial variables is present in advanced economies, emerging markets, and low-income countries.

This paper sheds light on the relative merits of country-specific and panel models for macroeconomic forecasting. Although country-specific models provide better in-sample fits, panel models provide more accurate out-of-sample forecasts. A more systematic exploration of why this is the case would be an interesting avenue for future research.

Running a horse race between our models' forecasts and the WEO forecasts reveals that incorporating financial information and pooled international data can improve on the accuracy of the WEO forecasts for up to 85% of the countries in our sample. Comparing our forecasts to other benchmarks would be a natural extension of this paper.

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Table 8
Financial factor model (advanced economies).

	Nowcasting	1-quarter-ahead forecasting	4-quarter-ahead forecasting
Panel A: GDP growth			
Financial factor 1	2.261***	2.552***	1.888***
	[0.605]	[0.431]	[0.284]
Financial factor 2	2.667***	3.603***	3.491***
	[1.032]	[0.712]	[0.608]
Government consumption growth	0.557	0.466**	0.186*
	[0.385]	[0.196]	[0.111]
Policy rate	0.234	0.260	0.396*
	[0.227]	[0.203]	[0.207]
Observations	1075	1074	1055
Adjusted R^2	0.164	0.285	0.310
Adjusted R^2 (with credit, house prices, and stock prices)	0.132	0.256	0.287
Panel B: Consumption growth			
Financial factor 1	3.306***	2.383***	1.800***
	[0.819]	[0.519]	[0.339]
Financial factor 2	1.927	2.360***	2.240***
	[1.177]	[0.880]	[0.568]
Government consumption growth	−0.014	0.263	0.023
	[0.409]	[0.280]	[0.130]
Policy rate	0.527**	0.409**	0.478**
	[0.208]	[0.190]	[0.200]
Observations	1159	1155	1139
Adjusted R^2	0.405	0.561	0.677
Adjusted R^2 (with credit, house prices, and stock prices)	0.332	0.487	0.620
Panel C: Investment growth			
Financial factor 1	8.371***	8.958***	6.193***
	[2.460]	[3.196]	[1.110]
Financial factor 2	5.444**	6.210***	7.929***
	[2.513]	[2.119]	[1.472]
Government consumption growth	0.152	0.276	−0.010
	[0.607]	[0.459]	[0.278]
Policy rate	−0.465	−0.678	−0.786*
	[0.525]	[0.496]	[0.474]
Observations	1213	1211	1198
Adjusted R^2	0.127	0.227	0.283
Adjusted R^2 (with credit, house prices, and stock prices)	0.118	0.233	0.307
Panel D: Inflation			
Financial factor 1	−0.430	−0.052	0.352*
	[0.284]	[0.222]	[0.181]
Financial factor 2	−0.214	−0.085	0.171
	[0.667]	[0.550]	[0.375]
Government consumption growth	0.078	0.097	0.098
	[0.136]	[0.120]	[0.075]
Policy rate	1.023***	0.804***	0.743***
	[0.205]	[0.196]	[0.195]
Observations	1221	1219	1207
Adjusted R^2	0.540	0.557	0.625
Adjusted R^2 (with credit, house prices, and stock prices)	0.534	0.581	0.661

Notes: The table reports the results of an ordinary least squares (OLS) fixed effects (FE) estimate. The right-hand-side includes the lagged left-hand-side variable, (country-specific) financial factors, and policy controls. We use Akaike information criterion (AIC) to determine the lag length in each specification. Newey-West standard errors are given in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

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Table 9
Financial factor model (emerging economies).

	Nowcasting	1-quarter-ahead forecasting	4-quarter-ahead forecasting
Panel A: GDP growth			
Financial factor 1	2.180**	1.308**	−0.054
	[0.870]	[0.619]	[0.472]
Financial factor 2	4.653***	5.774***	3.937***
	[1.567]	[1.689]	[1.248]
Government consumption growth	0.638	−0.048	−0.599
	[1.386]	[1.116]	[1.283]
Policy rate	−2.742***	−2.792***	−5.201*
	[0.668]	[0.672]	[2.663]
Observations	311	307	288
Adjusted R^2	0.112	0.194	0.268
Adjusted R^2 (with credit, house prices, and stock prices)	0.143	0.218	0.277
Panel B: Consumption growth			
Financial factor 1	0.796	0.688	0.068
	[0.918]	[0.610]	[0.516]
Financial factor 2	2.889	3.059**	2.169*
	[2.184]	[1.386]	[1.271]
Government consumption growth	1.302	0.431	−0.660
	[2.604]	[0.964]	[1.528]
Policy rate	−1.438	−1.125	−3.425
	[1.138]	[1.134]	[2.139]
Observations	352	349	332
Adjusted R^2	0.053	0.085	0.168
Adjusted R^2 (with credit, house prices, and stock prices)	0.071	0.113	0.182
Panel C: Investment growth			
Financial factor 1	4.180*	3.906**	0.917
	[2.443]	[1.984]	[0.912]
Financial factor 2	6.681**	9.829***	6.924***
	[3.015]	[2.709]	[2.298]
Government consumption growth	−5.841*	−2.762*	−4.557
	[3.141]	[1.465]	[3.913]
Policy rate	−14.549***	−13.761***	−16.482***
	[3.222]	[2.529]	[4.381]
Observations	352	349	332
Adjusted R^2	0.154	0.316	0.462
Adjusted R^2 (with credit, house prices, and stock prices)	0.111	0.219	0.341
Panel D: Inflation			
Financial factor 1	−0.826	−0.738*	−0.268
	[0.523]	[0.434]	[0.332]
Financial factor 2	−7.688**	−6.023**	−2.271
	[3.269]	[2.739]	[1.410]
Government consumption growth	0.226	0.571	3.459***
	[0.560]	[0.749]	[1.269]
Policy rate	6.709***	7.662***	3.140**
	[1.319]	[1.722]	[1.421]
Observations	366	364	348
Adjusted R^2	0.642	0.620	0.560
Adjusted R^2 (with credit, house prices, and stock prices)	0.572	0.516	0.480

Notes: The table reports the results of an ordinary least squares (OLS) fixed effects (FE) estimate. The right-hand-side includes the lagged left-hand-side variable, (country-specific) financial factors, and policy controls. We use the Akaike information criterion (AIC) to determine the lag length in each specification. Newey-West standard errors are given in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

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Appendix A. Supplementary data

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