Annex 3.1. Data Sources and Country Coverage

Data Sources and Country Coverage

All data sources used in the chapter are listed in Annex Table 3.1.1. The country coverage for the different sections and all figures, except Figure 3.3, is presented in the first column of Annex Table 3.1.2, labeled "Sample Emerging Markets." The selection of the specific set of countries is driven by data availability. The key binding data constraint for inclusion in the core sample of countries is the availability of longer-term (that is, three-year-ahead and longer) forecasts for inflation. The country sample in Figure 3.3 includes 90 countries presented in Annex Table 3.1.2. It includes the 19 sample emerging markets and all other emerging market and developing economies (based on the *World Economic Outlook* classification) for which annual headline inflation data is available, except countries with (1) populations fewer than two million people, or (2) at least one episode of hyperinflation during 1995-2017, defined as annual inflation exceeding 100 percent.

Definitions of Variables

The variable capturing external price pressures is defined as the percent change in the import-weighted producer price index of countries from which country *i* imports, converted to local currency using the nominal effective exchange rate, and relative to the percent change in the GDP deflator:

$$\Delta P^*_{i,t} = \Delta mPPI_{i,t} + \Delta neer_{i,t} - \Delta P_{i,t}, \qquad (3.1)$$

in which $P_{i,t}$ is the natural logarithm of country *i*'s GDP deflator.

The change in the import-weighted foreign producer price index is given by

$$\Delta mPPI_{i,t} = \sum_{j=1}^{J} \omega_{ij,t}\, \Delta PPI_{j,t}, \quad i \neq j,$$

in which $PPI_{j,t}$ is the natural logarithm of country *j*'s producer price index; and $\omega_{ij,t}$ is the share of exports from country *j* to country *i* in country *i*'s total imports as reported in the IMF's Direction of Trade Statistics (lagged one year and measured annually).

The change in the nominal effective exchange rate is constructed as the change in the bilateral exchange rate of each trading partner vis-à-vis the US dollar, weighted by their import shares (Gopinath 2015; Carrière-Swallow and others 2016):

$$\Delta neer_{i,t} = \sum_{j=1}^{J} \omega_{ij,t}\left(\Delta e_{i,t} - \Delta e_{j,t}\right), \quad i \neq j, \quad (3.2)$$

in which $e_{i,t}$ is the natural logarithm of country *i*'s bilateral exchange rate (expressed in local currency per US dollar, so that an increase denotes a depreciation of the domestic currency); and Δ is the first difference operator.

The foreign output gap is defined as

$$Y^{*Gap}_{i,t} = \sum_{j=1}^{J} \omega_{ij,t}\, Y^{Gap}_{j,t}, \quad i \neq j \quad (3.3)$$

in which $Y^{Gap}_{j,t}$ is the Hodrick-Prescott filtered series of real GDP of country *j*.

The measure of inflation persistence is based on country-specific estimates from an unobserved component stochastic volatility model (Stock and Watson 2007, 2010). The approach consists of decomposing consumer price inflation, π_t, into a permanent component, ζ_t, and a transitory component, η_t:

$$\pi_t = \zeta_t + \eta_t, \quad (3.4)$$

$$\zeta_t = \zeta_{t-1} + \varepsilon_t, \quad (3.5)$$

in which η_t and ε_t are independently normally distributed with time-varying variances $\sigma^2_{\eta,t}$ and $\sigma^2_{\varepsilon,t}$, respectively. The measure of inflation persistence underlying the calculations in Figure 3.5 is the estimated standard deviation of the shock to the permanent component of inflation (equation [3.5]).

Annex Table 3.1.1. Data Sources

Indicator	Source
Bilateral Exchange Rate against the US dollar	IMF, International Financial Statistics
Bilateral Exports and Imports	IMF, Direction of Trade Statistics
Central Bank Transparency	Dincer and Eichengreen 2014
Commodity Prices (Food and Energy)	IMF, International Financial Statistics
Core Consumer Price Index	Haver Analytics
Credit Default Swap Spreads	Datastream
EMBIG Spreads	J.P. Morgan
External Prices	IMF staff calculations
Foreign Output Gap	IMF staff calculations
Growth Forecast	Consensus Economics
GVC Participation Index	Aslam, Novta, and Rodrigues-Bastos 2017
Headline Consumer Price Index	Haver Analytics
Inflation Expectations	Consensus Economics; Bureau for Economic Research
Inflation Target	IMF staff calculations based on national authorities
Inflation Targeting Adoption Date	Brito, Carriere-Swallow, and Gruss 2018
Monetary Policy Rate	Haver Analytics
Net Capital Inflows	IMF, Balance of Payments Statistics
Nominal Effective Exchange Rate	IMF staff calculations
Nominal Imports, Exports, and GDP	IMF, World Economic Outlook Database
Producer Price Index	Haver Analytics
Real GDP	IMF, World Economic Outlook Database

Source: IMF staff compilation.

Note: EMBIG = emerging market bond index global; GVC = global value chain.

Annex Table 3.1.2. Country Coverage

Sample Emerging Markets	Other Emerging Markets	Low-Income Developing Countries
Argentina	Albania	Bangladesh
Brazil	Algeria	Benin
Bulgaria	Bolivia	Burkina Faso
Chile	Bosnia and Herzegovina	Burundi
China	Botswana	Cambodia
Colombia	Costa Rica	Cameroon
Hungary	Croatia	Central African Republic
India	Dominican Republic	Chad
Indonesia	Ecuador	Congo, Republic of
Malaysia	Egypt	Côte d'Ivoire
Mexico	El Salvador	Ethiopia
Peru	Gabon	Gambia, The
Philippines	Guatemala	Ghana
Poland	Iran	Guinea
Romania	Jamaica	Haiti
Russia	Jordan	Honduras
South Africa	Kuwait	Kenya
Thailand	Lebanon	Kyrgyz Republic
Turkey	Libya	Lesotho
	Macedonia, FYR	Madagascar
	Mongolia	Malawi
	Morocco	Mali
	Namibia	Mauritania
	Oman	Moldova
	Pakistan	Mozambique
	Panama	Nepal
	Paraguay	Nicaragua
	Qatar	Niger
	Saudi Arabia	Papua New Guinea
	Sri Lanka	Rwanda
	Tunisia	Senegal
	United Arab Emirates	Sierra Leone
	Uruguay	Tanzania
		Togo
		Uganda
		Vietnam
		Yemen
		Zambia

Source: IMF staff compilation.

Annex 3.2. Determinants of Inflation

This annex describes the method for exploring the determinants of inflation dynamics in emerging markets since the middle of the first decade of the 2000s.

Empirical Framework and Baseline Results

The analysis uses a hybrid variant of a standard New Keynesian Phillips curve (Gali and Gertler 1999; Gali, Gertler, and Lopez-Salido 2001, 2003). Drawing from the literature, the specification is augmented with variables that serve as proxies for macro developments abroad (Borio and Filardo 2007; Ihrig and others 2010; Auer, Borio, and Filardo 2017). Formally, the chapter estimates the following equation:

$$\pi_{i,t} = \gamma^{b}\pi_{i,t-1} + \gamma^{f}\pi^{e}_{i,t} + \beta Y^{Gap}_{i,t} + \theta Z^{*}_{i,t} + \eta_{i} + \varepsilon_{i,t}, \quad (3.6)$$

in which π is either core inflation or headline inflation; π^{e} denotes three-year-ahead inflation expectations; Y^{Gap} is the domestic output gap; Z^{*} is a vector of external variables that includes, depending on the specification, the import-weighted foreign output gap, an indicator for external price pressure in the previous period (as defined in Annex 3.1), and the lag of energy and food price inflation; [1] η_{i} denotes country fixed effects; ε is the error term; and i and t are the subindexes for the country and the time period, respectively.[2]

The regression is estimated using data from the first quarter of 2004 to the first quarter of 2018, using median regressions to account for a few extreme observations. Alternatively, the analysis uses robust regressions, which downplay the influence of outliers, and constrained regressions that restrict the sum of the coefficients on past inflation and inflation expectations to be equal to one.[3, 4] The standard errors are corrected for heteroscedasticity and autocorrelation.

Annex Table 3.2.1 shows the estimation results. The results for core inflation reported in Figure 3.6 are shown in column (1). The findings suggest that price setting has been, to some extent, forward looking, with a coefficient on three-year-ahead inflation expectations ranging between 0.5 and 0.6 in the regressions for core inflation and 0.4 and 0.5 in the regressions for headline inflation. Domestic cyclical conditions, for which the output gap serves as a proxy, also matter. This is in contrast with global cyclical conditions, for which the foreign output gap serves as a proxy, which is not significant even if the external price pressure variable is dropped from the specification. External price developments are an important determinant of inflation, as indicated by the positive and significant coefficient on the lag of external price pressure and food price inflation in the regressions for core and headline inflation. Overall, the explanatory variables account for 52 percent (44 percent) of the variability of core (headline) inflation.

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[1]Differently from Borio and Filardo (2007); Ihrig and others (2010); and Auer, Borio, and Filardo (2017), both the foreign output gap and external price pressure are included in the specification with the aim of capturing both demand and supply shocks. Energy price inflation and food price inflation are not included in the specifications for core inflation.

[2]Despite the relatively high correlation between inflation expectations and past inflation, the variance inflation factor is well below 10 for all explanatory variables, ruling out multicollinearity concerns.

[3]While potential endogeneity is a limitation for the estimation techniques used, the structure of the data (with gaps in the first part of the sample because inflation expectations are available at lower frequency) prevents the use of estimators that rely on lags, such as the generalized method of moments.

[4]The two outstanding outliers refer to Russia in 2015, when inflation increased from about 10 percent to 28 percent in two quarters.

Annex Table 3.2.1. Hybrid Phillips Curve: Estimation Results

	(1)	(2)	(3)	(4)	(5)	(6)
		Core Inflation			Headline Inflation	
	Median Regression	Robust Regression	Constrained Regression	Median Regression	Robust Regression	Constrained Regression
Inflation Expectations Three Years Ahead	0.587***	0.631***	0.566***	0.396***	0.303***	0.564***
	(0.111)	(0.077)	(0.062)	(0.134)	(0.067)	(0.088)
Lag of Core or Headline Inflation	0.494***	0.500***	0.434***	0.422***	0.481***	0.436***
	(0.037)	(0.023)	(0.062)	(0.047)	(0.028)	(0.088)
Output Gap	0.159***	0.168***	0.103	0.188**	0.182***	0.110
	(0.045)	(0.037)	(0.070)	(0.086)	(0.067)	(0.095)
Lag of External Price Pressure	0.018***	0.018***	0.032***	0.005	–0.001	0.020
	(0.004)	(0.003)	(0.011)	(0.008)	(0.007)	(0.014)
Foreign Output Gap	0.021	0.060	0.070	0.117	0.085	0.169
	(0.050)	(0.053)	(0.100)	(0.087)	(0.103)	(0.130)
Lag of Food Price Inflation				0.013***	0.018***	0.025***
				(0.004)	(0.004)	(0.006)
Lag of Energy Price Inflation				0.000	–0.001	–0.001
				(0.002)	(0.002)	(0.003)
Number of Countries	18	18	18	19	19	19
Number of Observations	633	633	633	668	668	668
R^2	0.525			0.445		

Source: IMF staff calculations.

Note: The table presents results for 2004:Q1–2018:Q1. All specifications include country fixed effects. Constrained regressions force the sum of the coefficients on past inflation and expected inflation to be one. Robust regressions report the pseudo R^2. Robust standard errors in parentheses.

* p < .10; ** p < .05; *** p < .01.

Contributions to Inflation Dynamics

The estimated panel coefficients are then used to compute the country-specific contributions from each regressor to inflation in each quarter, considering the persistence of the inflation process (Yellen 2015; Chapter 3 of the October 2016 *World Economic Outlook* [WEO]):

$$C_{i,t}^{x} = C_{i,t-1}^{x} \times \gamma^{b} + \left(\varphi^{f} \times x_{i,t}\right), \quad (3.7)$$

in which $C_{i,t}^{x}$ is the contribution to inflation dynamics in country *i* at period *t* of each explanatory variable x in vector $X = \{\pi^{e}, Y^{Gap}, Z^{*}, \eta_{i}\}$, and φ^{f} is the corresponding coefficient. In other words, a dynamic simulation of the model is run by setting the initial value of each explanatory variable to zero and using the coefficient on lagged inflation to incorporate the effects of inflation persistence that are attributable to previous movements in the explanatory variables. To evaluate which factors contributed to deviations of inflation from the target, the contribution of inflation expectations is recalculated in terms of deviation from either an explicit target or the moving average of 10-year-ahead inflation expectations (see Annex 3.3 for data on inflation targets).[5]

Figure 3.7, panel 1, shows the contribution of each factor to deviations of core inflation from target over four subperiods, which loosely correspond to the precrisis boom (from the first quarter of 2004 to the second quarter of 2008), the global financial crisis (from the third quarter of 2008 to the end of 2009), the postcrisis recovery (the start of 2010 to the second quarter of 2014), and the oil price decline and its aftermath (from the third quarter of 2014 to the first quarter of 2018). The largest contributor to

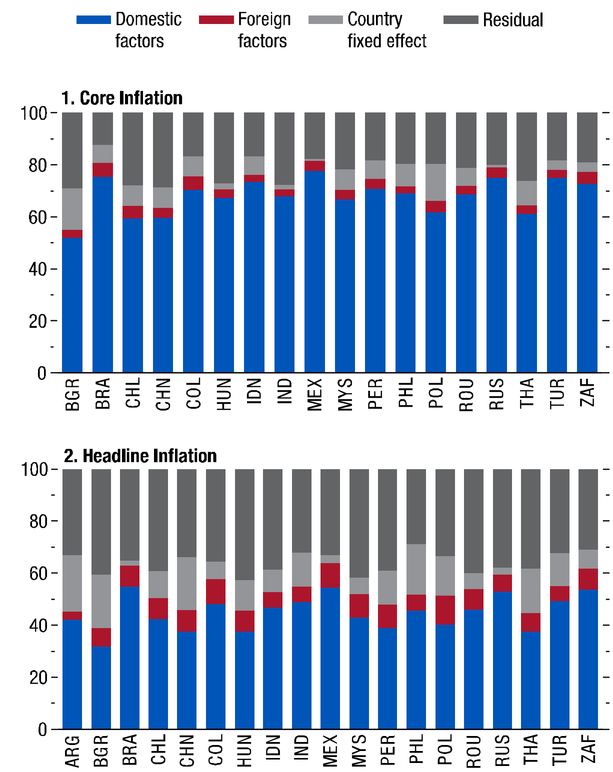
[5]Such decomposition can be performed under the assumption that the coefficients on the lag of inflation and inflation expectations sum to one. Both for median and robust regressions—in which the coefficients are unconstrained—Wald tests cannot reject the hypothesis of the sum of the coefficients being equal to one.

deviations of core inflation from target over the four subperiods was inflation expectations. As expected, inflation was, on average, above target; it had an inflationary effect. Domestic cyclical conditions played a smaller role. Upswings during the boom period led inflation to move above the target, while downturns during the global financial crisis led to lower inflation compared with the target. Among the external factors, the largest contributor is the variable capturing external price pressures, which have been, on average, deflationary during the sample period.[6] The contribution of foreign slack is economically insignificant.

These averages mask substantial cross-country heterogeneity. Figure 3.7, panel 2, shows the contribution from the first quarter of 2004 to the first quarter of 2018 for each country in the sample. Countries such as Chile and Poland, for example, show small contributions of inflation expectations from the target, consistent with the maturity of their monetary frameworks. On the other hand, in Russia and Thailand deviations of inflation expectations from target were sizable.[7]

A low average contribution for a given factor over the entire sample does not mean it does not play an important role in driving inflation dynamics over the short term. For instance, Figure 3.7, panel 3, shows that the share of inflation variability explained by inflation expectations was sizable in Colombia despite the very small average contribution reported in Figure 3.7, panel 2, indicating that the contribution of fluctuations of inflation expectations around the target were relatively large but tended to cancel out along the sample.

Annex Figure 3.2.1. Contribution of Domestic and Global Factors to Inflation Dynamics
(Percent)



Source: IMF staff calculations.
Note: See Annex 3.1 for data sources and country coverage. The bars denote the share of variability in inflation over 2014:Q1–2018:Q1 accounted for by each factor (see Annex 3.2 for details) and represent the average of the absolute values of the country-specific contributions. Domestic factors include inflation expectations and the output gap. Foreign factors include external price pressure and foreign output gap. Data labels use International Organization for Standardization (ISO) country codes.

To establish the relative importance of domestic and foreign factors in determining inflation dynamics, an alternative decomposition—in the spirit of a variance decomposition exercise—is performed:

[6]Breaking up the contribution of the external price pressure variable into its subcomponents reveals that the contribution of the import-weighted nominal effective exchange rate—which in principle could also reflect domestic developments—is small, hovering around zero with the exception of the global financial crisis subperiod, when it reached 0.15 percentage points. The other two subcomponents, the import-weighted foreign PPI inflation and the percent change in the GDP deflator, present larger contributions ranging between 0 and 0.17 percentage points and -0.12 and -0.25 percentage points, respectively.

[7]It should be noted that for several sample countries there are sizable contributions from unexplained factors, as captured by the residual term, that can offset (for example, in case of Thailand) the contribution from deviations of inflation expectations from target.

$$C_i^s = \sum_x^X \frac{\frac{1}{T}\sum_t^T \left|C_{i,t}^x\right|}{\sum_x^S \frac{1}{T}\sum_t^T \left|C_{i,t}^x\right|}, \quad (3.8)$$

in which S denotes two subsets of the X variables—the first subset consists of domestic factors (inflation expectations and the output gap) and the second subset consists of foreign factors (foreign output gap, external price pressure, and commodity price inflation). That is, the expression in equation (3.8) calculates the ratio of the average absolute value of the contribution of each variable to the sum of the same average absolute value of the contributions of all variables; then, it groups contributions into two baskets: domestic and foreign factors.

Domestic contributions to inflation dynamics are much larger than foreign contributions, for both core inflation and headline inflation (Annex Figure 3.2.1). Domestic contributions explain between 52 percent and 77 percent of core inflation dynamics and between 32 percent and 55 percent of headline inflation dynamics. The proportion of inflation dynamics explained by foreign factors is much smaller, ranging between 3 percent and 5 percent for core inflation and 3 percent and 11 percent for headline inflation.

Robustness Exercises and Extensions

Global Factors

The baseline specification (equation [3.6]) includes a vector of external variables, so the changes in inflation expectations should be orthogonal to changes in external factors. Still, one concern is that the evolution of inflation expectations may be capturing global developments that are common across countries. If one were to make the extreme assumption that all the residual is due to uncaptured foreign factors, the average contribution of foreign factors to inflation would be 26 percent for core inflation and 44 percent for headline inflation, still less than or comparable to the average contribution of domestic factors (68 percent for core inflation and 44 percent for headline inflation).

In an alternative specification, the vector of external variables is replaced with time fixed effects as catch-all variables for foreign factors (Annex Table 3.2.2, columns [1] and [2]). In this case, the average contribution of foreign factors to inflation would be 11 percent for both core and headline inflation. Time fixed effects, however, do not capture idiosyncratic movements in external price pressures, given that such pressures can vary by country. Therefore, the external price pressure variable is added back to the specification that includes time fixed effects (Annex Table 3.2.2, columns [3] and [4]).[8] The results confirm that external price pressures remain significant despite the inclusion of time fixed effects, and that the average contribution of foreign factors to inflation dynamics would be 17 percent for core inflation and 14 percent for headline inflation.

[8]The foreign output gap is not included in these specifications because it turns out to be insignificant in the baseline specifications.

Annex Table 3.2.2. Hybrid Phillips Curve: Specification Augmented for External Factors

	(1) Core Inflation	(2) Headline Inflation	(3) Core Inflation	(4) Headline Inflation	(5) Headline Inflation
	Median Regression with Time Fixed Effects	Median Regression with Time Fixed Effects	Median Regression with Time Fixed Effects	Median Regression with Time Fixed Effects	Median Regression with Weighted Commodity Inflation
Inflation Expectations Three Years Ahead	0.832***	0.327***	0.862***	0.353***	0.354***
	(0.111)	(0.082)	(0.104)	(0.080)	(0.102)
Lag of Core or Headline Inflation	0.444***	0.488***	0.435***	0.490***	0.417***
	(0.039)	(0.036)	(0.040)	(0.033)	(0.045)
Output Gap	0.172***	0.230***	0.138***	0.225***	0.167**
	(0.049)	(0.059)	(0.041)	(0.065)	(0.081)
Lag of External Price Pressure			0.016***	0.018***	0.006
			(0.003)	(0.005)	(0.008)
Foreign Output Gap					0.158**
					(0.076)
Lag of Weighted Food Price Inflation					0.045***
					(0.013)
Lag of Weighted Energy Price Inflation					0.016
					(0.018)
Number of Countries	18	19	18	19	19
Number of Observations	634	669	634	669	668
R^2	0.561	0.494	0.568	0.498	0.445

Source: IMF staff calculations.

Note: The table presents results for 2004:Q1–2018:Q1. All specifications include country fixed effects. Robust standard errors in parentheses.

* p < .10; ** p < .05; *** p < .01.

As an additional robustness check, a regression of inflation expectations on foreign price pressure, foreign output gap, and country and time fixed effects is estimated. The coefficients on the external price pressure and the foreign output gap turn out marginally significant in this first stage. In a second stage, the baseline specification (equation [3.6]) is modified to replace inflation expectations with the residual from the first stage, which is orthogonal to all foreign factors (and to domestic effects comoving over time, and fixed across countries). The results are similar to the ones obtained in the baseline regressions, ensuring that inflation expectations are mostly driven by domestic factors. Drawing on Choi and others (2018), in the regression for headline inflation, energy and food price inflation are interacted with the weight of these items in consumer price index (CPI) baskets (Annex Table 3.2.2, column 5). The coefficient for food price inflation remains significant and becomes larger in magnitude, consistent with the large weight of food in the CPI baskets of the 19 sample countries, which averages 32.9 percent. The coefficient for energy inflation, however, is still insignificant, in line with its smaller weight in the CPI basket, which averages 9.6 percent. The results for other variables are virtually unchanged.

Inflation Expectations Horizon

Inflation expectations in the baseline specification correspond to three-year-ahead inflation forecasts, a sufficiently long horizon to capture beliefs about inflation in the long term rather than the effect of transitory shocks and the response of monetary policy. However, to ensure that the results are not dependent on the selection of this specific horizon, a series of robustness tests is performed using inflation expectations of up to seven years ahead (Annex Table 3.2.3). The results for core inflation are robust to the change of the horizon for inflation expectations, with the magnitude of the coefficient decreasing only marginally as the horizon gets longer (the coefficient on expected inflation for horizons three to seven years ahead range from 0.56 to 0.64).[9]

In the case of headline inflation, inflation expectations become insignificant for horizons of six years ahead and beyond, reflecting the higher volatility of headline inflation compared with core inflation.

Annex Table 3.2.3. Hybrid Phillips Curve: Alternative Forecast Horizon

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Core Inflation				Headline Inflation			
	Median Regression, Four Year Ahead Infl. Exp.	Median Regression, Five Year Ahead Infl. Exp.	Median Regression, Six Year Ahead Infl. Exp.	Median Regression, Seven Year Ahead Infl. Exp.	Median Regression, Four Year Ahead Infl. Exp.	Median Regression, Five Year Ahead Infl. Exp.	Median Regression, Six Year Ahead Infl. Exp.	Median Regression, Seven Year Ahead Infl. Exp.
Inflation Expectations n Years Ahead	0.637***	0.614***	0.585***	0.560***	0.397**	0.448*	0.256	–0.066
	(0.125)	(0.130)	(0.131)	(0.155)	(0.158)	(0.245)	(0.262)	(0.247)
Lag of Core or Headline Inflation	0.502***	0.524***	0.548***	0.549***	0.459***	0.461***	0.502***	0.537***
	(0.037)	(0.037)	(0.037)	(0.036)	(0.047)	(0.044)	(0.048)	(0.040)
Output Gap	0.138***	0.136***	0.144***	0.168***	0.164*	0.152**	0.179**	0.172**
	(0.036)	(0.040)	(0.038)	(0.041)	(0.088)	(0.077)	(0.081)	(0.081)
Lag of External Price Pressure	0.021***	0.018***	0.020***	0.020***	0.008	0.004	0.008	0.003
	(0.003)	(0.003)	(0.004)	(0.003)	(0.009)	(0.008)	(0.009)	(0.008)
Foreign Output Gap	0.050	0.042	0.057	0.002	0.080	0.119	0.034	0.051
	(0.047)	(0.051)	(0.048)	(0.050)	(0.098)	(0.077)	(0.088)	(0.101)
Lag of Food Price Inflation					0.013***	0.013***	0.013***	0.013***
					(0.004)	(0.004)	(0.005)	(0.005)
Lag of Energy Price Inflation					0.000	0.000	–0.000	–0.000
					(0.002)	(0.002)	(0.002)	(0.002)
Number of Countries	18	18	18	18	19	19	19	19
Number of Observations	577	603	576	576	612	638	611	610
R^2	0.514	0.519	0.513	0.511	0.446	0.439	0.442	0.443

Source: IMF staff calculations.
Note: Infl. Exp. = inflation expectations. The table presents results for 2004:Q1–2018:Q1. All specifications include country fixed effects. Robust regressions report the pseudo R-squared. Robust standard errors in parentheses.
* p < .10; ** p < .05; *** p < .01.

Extensions

The past few decades have witnessed a trade integration process that has led many emerging markets to participate more in global value chains (GVCs). Deeper integration should be reflected in stronger competition from abroad, possibly affecting inflation dynamics. To assess the role of stronger trade integration, the baseline specification is extended to include conventional measures of trade openness and participation in GVCs, as well as their interactions with external variables:[10]

$$\pi_{i,t} = \gamma^b \pi_{i,t-1} + \gamma^f \pi^e_{i,t} + \beta Y^{Gap}_{i,t} + \theta Z^*_{i,t} + \varphi T_{i,t} Z^*_{i,t} + \psi T_{i,t} + \eta_i + \varepsilon_{i,t}, \quad (3.9)$$

[9]One potential concern with the Phillips curve specification is reverse causality from current inflation to inflation expectations, especially at shorter horizons. The decrease in estimated coefficients as the horizon lengthens in Annex Table 3.2.3 is consistent with this concern. But the small magnitude of the differences suggests that the effect is limited in economic terms.

[10]Trade openness is calculated as the sum of real imports and real exports divided by real GDP. The GVC participation index is calculated as the sum of backward participation (imported intermediate inputs used to generate output for export) and forward participation (that is, exports of intermediate goods used as inputs for the production of exports of other countries) as a ratio of gross exports (see Aslam, Novta, and Rodrigues-Bastos 2017 and Chapter 3 of the April 2017 WEO for more details about the global value chain participation measure).

in which $T_{i,t}$ is a measure of trade openness or participation in GVCs. The results suggest that there is no significant evidence that deeper trade integration has a significant effect on domestic inflation (Annex Table 3.2.4). If anything, the coefficients on trade openness and GVC participation are positive when they are significant, but they are relatively small, and the results are not consistent across inflation measures (Annex Table 3.2.4, columns (1) and [3]). The interaction term between trade openness and foreign output gap in the specification for headline inflation is significant (Annex Table 3.2.4, column [2]), suggesting that movements in foreign cyclical conditions have an impact on inflation when the economy is more open, although the magnitude of the effect is small.

Since 2001, when China joined the World Trade Organization, the country has quickly increased its share in global trade owing to relatively lower export prices and has become an important trading partner for many economies in the sample, possibly affecting inflation dynamics. The analysis explores the role of price pressure from China by decomposing the external price pressure variable into its Chinese and non-Chinese components. The results indicate that external price pressure from China does not have any significant impact on core or headline inflation dynamics, while non-Chinese external price pressures remain a significant determinant in the specification for core inflation, consistent with the results of the baseline specification.

Annex Table 3.2.4. Hybrid Phillips Curve: Extensions

	(1) Core Inflation	(2) Headline Inflation	(3) Core Inflation	(4) Headline Inflation	(5) Core Inflation	(6) Headline Inflation
	Interaction: Trade Openness	Interaction: Trade Openness	Interaction: GVC Participation	Interaction: GVC Participation	China External Price Pressure	China External Price Pressure
Inflation Expectations Three Years Ahead	0.643***	0.406***	0.632***	0.378***	0.551***	0.399***
	(0.100)	(0.107)	(0.096)	(0.121)	(0.096)	(0.104)
Lag of Core or Headline Inflation	0.479***	0.422***	0.479***	0.427***	0.502***	0.426***
	(0.031)	(0.047)	(0.032)	(0.049)	(0.030)	(0.046)
Output Gap	0.154***	0.223***	0.173***	0.194**	0.163***	0.206***
	(0.044)	(0.073)	(0.040)	(0.085)	(0.037)	(0.079)
Lag of External Price Pressure	0.009	0.011	–0.001	0.029		
	(0.008)	(0.016)	(0.014)	(0.036)		
Foreign Output Gap	–0.047	–0.195	0.038	–0.141	0.019	0.082
	(0.106)	(0.139)	(0.160)	(0.290)	(0.040)	(0.095)
Lag of Food Price Inflation		0.014		0.020		0.012***
		(0.009)		(0.017)		(0.004)
Lag of Energy Price Inflation		–0.002		–0.008		0.000
		(0.004)		(0.008)		(0.002)
Trade Openness	0.015*	0.026				
	(0.008)	(0.020)				
Trade Openness x Lag of External Price Pressure	0.000	–0.000				
	(0.000)	(0.001)				
Trade Openness x Foreign Output Gap	0.002	0.007**				
	(0.003)	(0.003)				
Trade Openness x Lag of Food Price Inflation		–0.000				
		(0.000)				
Trade Openness x Lag of Energy Price Inflation		0.000				
		(0.000)				
GVC Participation			0.060**	–0.033		
			(0.030)	(0.065)		
GVC Participation x Lag of External Price Pressure			0.000	–0.000		
			(0.000)	(0.001)		
GVC Participation x Foreign Output Gap			–0.001	0.004		
			(0.003)	(0.006)		
GVC Participation x Lag of Food Price Inflation				–0.000		
				(0.000)		
GVC Participation x Lag of Energy Price Inflation				0.000		
				(0.000)		
External Price Pressure excluding China					0.018***	0.007
					(0.003)	(0.007)
External Price Pressure from China					–0.004	–0.002
					(0.004)	(0.009)
Number of Countries	18	19	18	19	18	19
Number of Observations	624	659	633	668	627	662
R^2	0.524	0.453	0.526	0.446	0.523	0.446

Source: IMF staff calculations.
Note: The table presents results for 2004:Q1–2018:Q1. All specifications include country fixed effects. Robust standard errors in parentheses. GVC = global value chain.
* $p < .10$; ** $p < .05$; *** $p < .01$.

Annex 3.3. Anchoring of Inflation Expectations

This annex provides additional details about the metrics constructed to assess the extent of anchoring of inflation expectations in emerging markets.

Data

Inflation Expectations

Inflation expectations are captured by survey-based inflation forecasts from professional forecasters reported by Consensus Economics for horizons between three and seven years ahead.[1] Focusing on forecasts for three years ahead and beyond ensures that beliefs about inflation in the long term are captured rather than the effect of transitory shocks and the response of monetary policy. Long-term inflation surveys are available at biannual frequency up to 2013 and quarterly thereafter.

Inflation Target

For economies that adopted inflation-targeting regimes, the inflation targets at each point in time for the current year and subsequent seven years are retrieved from published inflation reports.[2] When a single target is announced, it is assumed that the announcement is for the year of the report and all subsequent years. When a target is announced for the long term without an explicit path of targets for intermediate years, the assumption is that the long-term target corresponds to the inflation target three years after the last explicit short-term target.

For economies that do not follow inflation-targeting regimes, the inflation target is set to the mean inflation forecast for the longest-term horizon (that is, after 10 years).

Measuring Inflation Expectations Anchoring

Following earlier contributions in the literature, the analysis considers four complementary metrics aimed at capturing the degree of anchoring of inflation expectations:

- *Root-mean-square deviation of mean inflation forecasts from target:* If inflation expectations are well anchored, beliefs about future inflation should be, on average, close to the inflation target pursued by the monetary authority (Demertzis, Marcellino, and Viegi 2012; Kumar and others 2015*)*. The root-mean-square deviation of the mean inflation forecast at horizon *h* from the inflation target over period ω is given by

$$\sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(\pi_t^{e,h}-\pi^*\right)^2}, \text{ with } h=3,\dots,7;\ t\in\ \omega, \quad (3.10)$$

  in which π^* is the central bank's inflation target for inflation-targeting economies or the one-year moving average of 10-year-ahead inflation forecasts ($\pi_t^{e,10}$) otherwise.

- *Standard deviation of mean inflation forecasts:* If inflation expectations are well anchored, revisions of agents' long-term forecasts should be small, and thus the average forecast relatively stable over time (Kumar and others 2015). The standard deviation of the mean inflation forecast at horizon *h* over period ω is given by

[1]In the case of South Africa, the source is the Bureau for Economic Research, and inflation forecasts are available for horizons of three years ahead and over the next five years. In all cases inflation expectations are based on CPI inflation forecasts, but it should be noted that the CPI definition may have changed over time. For example, in India the CPI for industrial workers was replaced by a national CPI in 2011.

[2]The timing of the adoption of inflation targeting is based on Brito, Carrière-Swallow, and Gruss (2018).

$$\sqrt{\frac{1}{T-1}\sum_{t=1}^{T}\left(\pi_t^{e,h}-\overline{\pi^{e,h}}\right)^2}, \text{ with } h = 3, \ldots, 7;\ t \in \omega, \quad (3.11)$$

in which $\overline{\pi^{e,h}}$ is the average of mean inflation forecasts over period ω.

- *Dispersion of inflation forecasts:* Individual beliefs about long-term inflation should be close to each other if expectations are well-anchored—and would coincide if they are perfectly anchored (Capistrán and Ramos-Francia 2010; Dovern, Fritsche, and Slacalek 2012; Ehrmann 2015; Kumar and others 2015). The dispersion of forecasts is captured by the standard deviation of *h*-year-ahead inflation forecasts of individual forecasters at each period *t*, averaged over period ω:

$$\frac{1}{T}\sum_{t=1}^{T}\left(\sqrt{\frac{1}{J-1}\sum_{j=1}^{J}\left(\pi_{j,t}^{e,h}-\pi_t^{e,h}\right)^2}\right), \text{ with } h = 3, \ldots, 7;\ t \in \omega, \quad (3.12)$$

in which $\pi_{j,t}^{e,h}$ denotes the inflation forecast of agent *j* at time *t* for horizon *h* and $\pi_t^{e,h}$ is the average across forecasters.

- *Sensitivity to inflation surprises:* Under well-anchored expectations, there should be little comovement between long-term inflation expectations and short-term inflation expectations, which would capture inflation surprises (Ehrmann 2015; Kumar and others 2015). The sensitivity of *h*-year-ahead inflation forecasts to short-term forecasts, β^h, is obtained by estimating the following country-specific regressions over period ω:

$$\Delta\pi_t^{e,h} = \alpha + \beta^h \Delta\pi_t^{e,1} + \varepsilon_t, \quad \text{with } h = 3, \ldots, 7;\ t \in \omega, \quad (3.13)$$

in which $\Delta\pi_t^{e,1}$ and $\Delta\pi_t^{e,h}$ denote the change in mean inflation forecasts for the short term (that is, for the current year) and for h years ahead, respectively, between surveys at $t-1$ and t.

A lower value denotes better-anchored expectations in all metrics. These measures are computed using three-, five-, and seven-year-ahead inflation forecasts. Then, for each metric, the highest value (that is, the lowest degree of anchoring) across horizons is taken. Although the four metrics capture distinctive characteristics of the behavior of inflation expectations, the results are consistent across metrics. The correlation between the relative ranking of countries across any two of the anchoring measures ranges from 0.56 to 0.87 (Annex Table 3.3.1).

Annex Table 3.3.1. Correlation of Relative Ranking across Anchoring Metrics, 2004–18

	Deviation of Long-Term Forecasts from Target	Standard Deviation of Long-Term Forecasts	Dispersion of Long-Term Forecasts	Sensitivity of Long-Term to Short-Term Forecasts
Deviation of Long-Term Forecasts from Target	1.00			
Standard Deviation of Long-Term Forecasts	0.85	1.00		
Dispersion of Long-Term Forecasts	0.77	0.87	1.00	
Sensitivity of Long-Term to Short-Term Forecasts	0.56	0.67	0.74	1.00

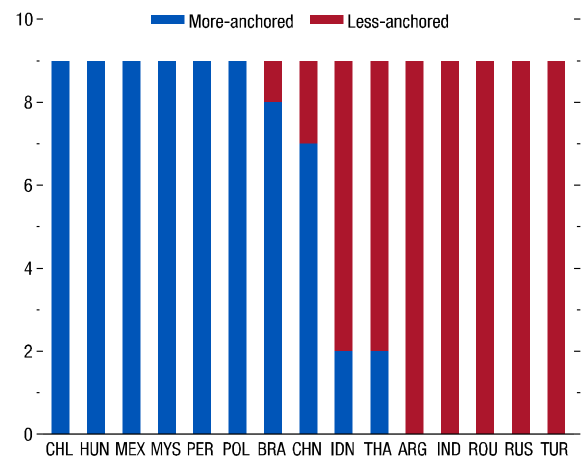
Source: IMF staff calculations.

Country Groups

The simple average of each country's ranking across all four measures is then used to classify countries into two groups based on the degree of inflation expectations anchoring.[3]

In each period, the more-anchored (less-anchored) group comprises countries with average ranking below (above) the median. The degree of anchoring is slow moving, as evidenced by the fact that the split of countries across groups is largely unchanged across periods (Annex Figure 3.3.1).

Annex Figure 3.3.1. Degree of Anchoring, Rolling Windows
(Number of rolling windows)



Source: IMF staff calculations.
Note: See Annex 3.1 for data sources and country coverage. The figure shows the number of six-year rolling windows starting in 2000 in which each country is classified in the more- and less-anchored group based on its average ranking across all four anchoring metrics. Only countries with data for all anchoring metrics in all rolling windows are included. Data labels use International Organization for Standardization (ISO) country codes.

[3]An alternative criterion is used in robustness exercises. The set of more-anchored countries according to the alternative criterion are those that rank better than the median country in all four anchoring measures.

Annex 3.4. Anchoring of Inflation Expectations and Monetary Policy: Model-Based Guidance

A small semistructural model with an explicit role for monetary policy credibility (Al-Mashat and others 2018a) is used to illustrate how adverse external shocks can have different impacts on inflation dynamics and monetary policy depending on the degree of anchoring of inflation expectations. The model simulations are reported in Figure 3.12. This annex presents the details of the model and the exercise undertaken.

The inflation process is modeled using a semistructural New Keynesian Phillips curve for an open economy:

$$\pi_t = \beta_1 \pi_t^e + (1 - \beta_1)\pi_{t-1} + \beta_2 y_t + \beta_{41} z_t + \beta_{42}(z_t - z_{t-1}) + \varepsilon_t^{\pi}, \quad (3.14)$$

in which headline inflation (π_t, quarter over quarter and annualized) is a function of demand pressures in the economy, represented by the output gap (y_t), and exchange rate dynamics (z_t is the real exchange rate gap). The specification of the inflation process aims to reflect both first-round and second-round exchange rate pass-through effects.

Inflation expectations (π_t^e, annualized) represent the key deviation from standard semistructural New Keynesian models. Inflation expectations have both a forward-looking and a backward-looking component, and the credibility of monetary policy determines their relative weights:

$$\pi_t^e = c \times \pi 4_{t+4} + (1 - c)\pi 4_{t-1}. \quad (3.15)$$

In the case of perfect credibility ($c = 1$), inflation expectations are fully forward looking. As monetary policy credibility deteriorates ($c < 1$), more households and firms rely on past inflation developments as a guide to form their expectations. If expectations are driven only by past developments ($c = 0$), current and future monetary policy responses to economic shocks are neglected. Consequently, more aggressive monetary policy actions are required to stabilize inflation and real activity in a context of low credibility.

The rest of the model closely follows standard semistructural gap models. The output gap is linked to the evolution of the real effective interest rate, the real exchange rate gap, and foreign demand (y_t^f):

$$y_t = \alpha_1 y_{t+1} + \alpha_2 y_{t-1} - \alpha_3 r_t^m + \alpha_4 z_t + \alpha_5 y_t^f + \varepsilon_t^y, \quad (3.16)$$

in which r_t^m is the real effective interest rate gap, given by $r_t^m = (i_t^m - \pi_t^e) - \bar{r}_t^m$ (in which i_t^m is the nominal effective cost of borrowing and $\bar{r}_t^m$ is the trend real effective interest rate). Firms rely on both domestic and foreign financing, so the nominal effective cost of borrowing (i_t^m) is a combination of the domestic interest rate (i_t) and the foreign interest rate (i_t^f), including the country risk premium (rp_t) and after adjusting for exchange rate (S_t) dynamics:

$$i_t^m = \omega i_t + (1 - \omega)[i_t^f + rp_t + \Delta S_{t+1}]. \quad (3.17)$$

The country risk premium is assumed to follow a stationary autoregressive process with its persistence given by parameter ρ_{rp}. Exchange rate dynamics are driven by a modified uncovered interest parity condition:

$$(S_t^e - S_t) \times 4 = \delta_2\left[i_t - \left(i_t^f + rp_t\right)\right] + (1 - \delta_2)\left[\Delta \bar{Z}_t \times 4 + \left(\pi 4_{t-1} - \pi 4_{t-1}^f\right)\right] + \varepsilon_t^S, \quad (3.18)$$

in which S_t^e is the expected log level of the nominal exchange rate, $\Delta \bar{Z}_t$ is the trend real exchange rate depreciation (quarter over quarter, annualized), and $\pi 4_t$ is year-over-year headline inflation. This specification allows for imperfect pass-through of the interest rate differential to the exchange rate and reflects the expected nominal trend depreciation.

Consistent with the uncovered interest parity specification, the expected nominal exchange rate is a combination of purely model-consistent expectations and the extrapolation of the past nominal exchange rate trend depreciation ($\pi 4_t^f$ is foreign year-over-year inflation):

$$S_t^e = \delta_1 S_{t+1} + (1 - \delta_1)\left[S_{t-1} + 2\left(\Delta \bar{Z}_t + (\pi 4_{t-1} - \pi 4_{t-1}^f)/4\right) + \delta_3 z_t\right]. \quad (3.19)$$

Monetary policy operates under a flexible inflation-forecast-targeting regime and is described by a standard policy rule that includes both the expected deviation of inflation from the target ($\overline{\pi}$) over the policy-relevant horizon and the cyclical position of the economy ($\bar{\iota}_t$ is the neutral nominal policy rate):

$$i_t = \gamma_1 i_{t-1} + (1 - \gamma_1)\left[\bar{\iota}_t + \gamma_2\left(\pi 4_{t+4} - \overline{\pi}\right) + \gamma_3 y_t\right] + \varepsilon_t^i. \quad (3.20)$$

The model is calibrated to two illustrative open emerging markets. The two economies only differ in the extent to which monetary policy is credible, as determined by parameter c—which is set to 0.6 in the "high-credibility" case and to 0.2 in the "low-credibility" case. The other parameters take the same values in both economies.

Annex 3.5. The Event Study Methodology for the Taper Tantrum

This annex provides additional details on the empirical approach to studying how domestic exchange rates, inflation, output growth, and monetary policy in emerging markets responded to the May 2013 taper tantrum event.

Background

In May 2013, Federal Reserve officials began talking about the option to taper their quantitative easing program. Against the backdrop of a stronger US recovery, on May 22, 2013, Chairman Bernanke mentioned in his testimony to Congress the possibility of tapering the pace of Treasury and agency bond purchases later in the year (Sahay and others 2014). Both long-term US bond yields and the foreign exchange value of the dollar relative to other major currencies increased significantly at the time of the press conference (Neely 2014). This announcement had a strong negative financial and economic impact on emerging markets, which generally experienced a reversal in capital flows.

Empirical Framework

The approach to assessing the response of domestic variables to the Federal Reserve's announcements in May 2013 is similar to that of Jordà, Schularick, and Taylor (2013). More precisely, the analysis studies the conditional cumulative response of a set of macro variables using a local projection framework. The following specification is estimated:

$$y_{i,t+h} = \alpha_{ih} + \sum_{k=1}^{3} \phi_h^k y_{i,t-k} + \beta_h taper_t + \gamma_h less\_anchored_i \times taper_t + \varepsilon_{i,t+h}, \quad (3.21)$$

in which $taper_t$ is a dummy variable equal to one in May 2013 and zero otherwise; and $less\_anchored_i$ is a dummy variable equal to one for countries with less-anchored inflation expectations over 2004–17, as defined in Annex 3.3, and zero otherwise. The estimation includes three lags of the annualized change in the dependent variable. It also includes country fixed effects that capture any time-invariant country-specific characteristics (they absorb, for instance, the dummy for the extent of anchoring that is country specific and time invariant, and therefore is not included separately in the estimation). Standard errors are corrected for serial correlation, heteroscedasticity, and cross-sectional dependence using the Driscoll-Kraay (1998) procedure.

The dependent variable is defined as the cumulative response between t and $t+h$ of the exchange rate, consumer prices, output growth, and monetary policy rates. Given that output is not available at monthly frequency, the analysis uses the mean output growth forecast from Consensus Economics.[1]

The coefficient β_h captures the conditional post–taper tantrum path of the dependent variable for more-anchored countries, while the effect for less-anchored countries is given by $\beta_h + \gamma_h$. The significance of the γ_h coefficient provides a direct measure of whether the effect is significantly different between the two groups.

Robustness Exercises

One concern with the anchoring classification is that it is computed over 2004–17 and thus could be endogenous to developments during the taper tantrum event. As a robustness exercise, the analysis is

[1]The dependent variable is defined as $y_{i,t+h} = \frac{Y_{i,t+h} - Y_{i,t}}{Y_{i,t}} \times 100$ in the case of the exchange rate and consumer prices; and as $y_{i,t+h} = Y_{i,t+h} - Y_{i,t}$ in the case of output growth forecasts and the monetary policy rate. The GDP forecast for the current and following year are combined to obtain a synthetic 12-months-ahead fixed horizon forecast at monthly frequency. It is constructed as the weighted average of the forecasts for the current and the next calendar year, with weights that vary according to the date the forecast was produced.

repeated using a classification computed with data up to March 2013. The results, shown in Annex Figure 3.5.1, are robust to this alternative classification.

An additional robustness exercise uses an alternative criterion to classify countries according to the degree of anchoring of inflation expectations. The more-anchored group comprises countries that score better than the median in all four anchoring measures described in Annex 3.3. The results are broadly unchanged (Annex Figure 3.5.2).

Exchange Rate Pass-Through Estimates

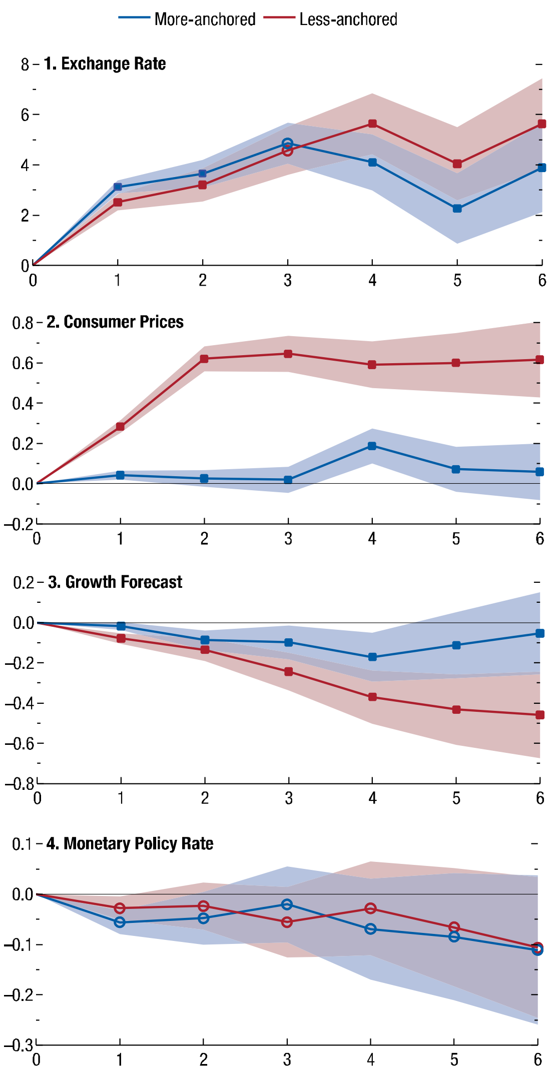
A local projection framework is used to estimate the cumulative response of headline consumer prices to a change in the nominal exchange rate:

$$\frac{CPI_{i,t+h} - CPI_{i,t}}{CPI_{i,t}} = \alpha_{ih} + \Gamma_y + \sum_{j=0}^{3} \phi_h^j \frac{CPI_{i,t-j} - CPI_{i,t-j-12}}{CPI_{i,t-j-12}} + \lambda_h X_{i,t} + \beta_h \Delta er_{i,t}$$

$$+\gamma_h less\_anchored_i * \Delta er_{i,t} + \varepsilon_{i,t+h}, \quad (3.22)$$

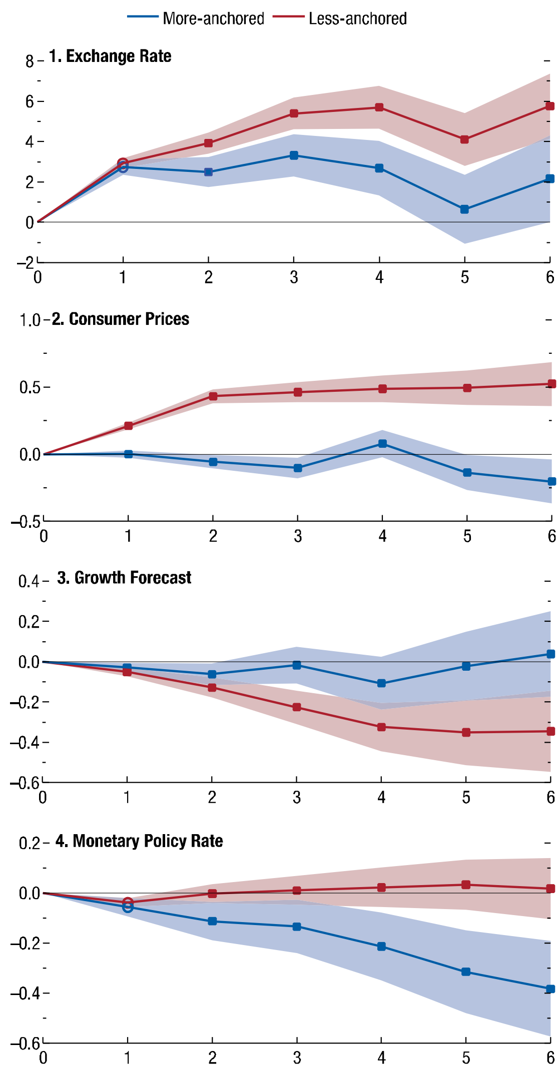
in which Γ_y denotes year fixed effects, $\Delta er_{i,t}$ is the change in the bilateral exchange rate against the US dollar, and $X_{i,t}$ includes external prices and the output gap. Figure 3.14 shows the exchange rate pass-through estimate for more-anchored countries (β_h) and less-anchored countries ($\beta_h + \gamma_h$) for each horizon between 0 and 12.

Annex Figure 3.5.1. Effect of May 2013 "Taper Tantrum"—Alternative Classification Based on Pre-2013 Data
(Percentage points)



Source: IMF staff calculations.
Note: See Annex 3.1 for data sources and country coverage. The figures show the cumulative impulse response to the taper tantrum episode (see Annex 3.5 for details). An increase in the exchange rate denotes a depreciation. *X*-axis denotes time in months, with the taper tantrum episode at 0. The shaded areas correspond to 90 percent confidence intervals computed with Driscoll-Kraay standard errors. Solid squares (unfilled circles) for responses denote that the difference between the two responses is statistically significant (not statistically significant) at a 90 percent confidence level. The criterion used to classify countries as more- and less-anchored is defined in Annex 3.3 and is based on anchoring measures up to March 2013.

Annex Figure 3.5.2. Effect of May 2013 "Taper Tantrum"—Alternative Classification Based on Median Measures
(Percentage points)



Source: IMF staff calculations.
Note: See Annex 3.1 for data sources and country coverage. The figures show the cumulative impulse response to the taper tantrum episode (see Annex 3.5 for details). An increase in the exchange rate denotes a depreciation. *X*-axis denotes time in months, with the taper tantrum episode at 0. The shaded areas correspond to 90 percent confidence intervals computed with Driscoll-Kraay standard errors. Solid squares (unfilled circles) for responses denote that the difference between the two responses is statistically significant (not statistically significant) at a 90 percent confidence level. The criterion used to classify countries as more- and less-anchored labels countries that score better than the median in all four anchoring measures as the more-anchored countries.

Annex 3.6. Monetary Policy Reaction Function

This annex describes the approach used to estimate monetary policy reaction functions and to assess the countercyclicality of monetary policy. The analysis builds on a vast literature originated in the seminal work of Taylor (1993). The monetary policy reaction function estimated is similar to the one in Coibion and Gorodnichenko (2012):

$$R_{i,t} = \alpha_i + \rho R_{i,t-1} + \gamma \pi_{i,t} + \beta Y_{i,t}^{Gap} + \phi \Delta neer_{i,t} + \varepsilon_{i,t}^{R}, \quad (3.23)$$

in which $R_{i,t}$ denotes the monetary policy rate, $R_{i,t-1}$ captures the inertia of monetary policy,[1] $\pi_{i,t}$ is the quarter-over-quarter change in headline consumer prices, $Y_{i,t}^{Gap}$ is the real-time output gap,[2] $\Delta neer_{i,t}$ is the change in the nominal effective exchange rate (as defined in Annex 3.1), and $\varepsilon_{i,t}^{R}$ captures other factors that may influence monetary policy in emerging markets.

To assess whether the degree of anchoring of inflation expectations affects the ability of monetary authorities to conduct countercyclical policy, the analysis explores whether the coefficient of the output gap (β) varies across countries with more- and less-anchored inflation expectations. The specification in equation (3.23) is modified to include an interaction term between the output gap and a dummy variable ($less\_anchored_i$), indicating whether country i belongs to the less-anchored group as defined in Annex 3.3:

$$\begin{aligned} R_{i,t} = \alpha_i &+ (\rho_1 + \rho_2 less\_anchored_i) R_{i,t-1} + (\gamma_1 + \gamma_2 less\_anchored_i) \pi_{i,t} \\ &+ (\beta_1 + \beta_2 less\_anchored_i) Y_{i,t}^{Gap} + (\phi_1 + \phi_2 less\_anchored_i) \Delta neer_{i,t} \\ &+ \varepsilon_{i,t}^{R}. \end{aligned} \quad (3.24)$$

The negative estimate of β_2 in Table 3.6.1, column (1), confirms that monetary policy is more countercyclical in countries with more-anchored inflation expectations.

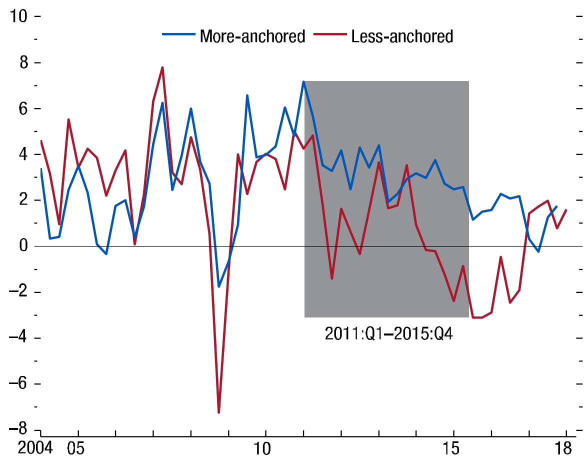
These reduced-form estimations of countercyclicality are based on the reaction of monetary policy to the average constellation of shocks hitting the economy. But policy action depends on the nature of the shock. If a shock causes inflation and the output gap to move in the same direction, stabilizing inflation and closing the output gap both imply that monetary policy should be countercyclical. However, a shock that moves inflation and the output gap in opposite directions would pose a dilemma for the monetary authority. For instance, an external shock that is expected to depress domestic activity (for example, a deterioration in the terms of trade) and leads to a depreciation of the exchange rate will push actual inflation up. If inflation expectations are not anchored, the central bank may have to tighten monetary policy to control inflation despite expecting weaker activity.

[1]Monetary policy inertia can be optimal given uncertainty about the quantitative impacts of policy changes, the expectations channel of interest rates, and the dependence of financial sector stability on the predictability of interest rates; it can also reflect the central bank's need to build credibility and to form the majority voting blocs to support the policy change (Brainard 1967; Woodford 2003; Goodhart 2005; Coibion and Gorodnichenko 2012).

[2]The real-time output gap is obtained from different vintages of the World Economic Outlook (WEO) database. When output gap estimates are not available, the real-time output gap is estimated by applying a Hodrick-Prescott filter to real output series of each vintage and using output forecasts to avoid the endpoint problem.

Two strategies are pursued to explore whether better-anchored inflation expectations enhance the ability to conduct countercyclical monetary policy in the face of shocks that cause inflation and the output gap to move in opposite directions. The first strategy focuses on the monetary policy reaction function from the first quarter of 2011 to the fourth quarter of 2015, when emerging markets experienced a significant slowdown in net capital inflows (see Annex Figure 3.6.1 and the discussion in Chapter 2 of the April 2016 WEO). The specification in equation (3.24) is extended by interacting its right-hand side variables with a dummy variable indicating whether the observation is from the period of capital flow slowdown:

Annex Figure 3.6.1. Net Capital Inflows to Emerging Markets, 2004–18
(Percent of GDP)



Sources: IMF Balance of Payments Statistics; and IMF staff calculations.
Note: See Annex 3.1 for data sources and country coverage. Balanced sample of 19 emerging economies divided into more-/less-anchored groups. See Annex 3.1 for the complete list of sample countries. All variables are GDP weighted.

$$
\begin{aligned}
R_{i,t} = {} & (\rho_1 + \rho_2 less\_anchored_i + \rho_3\tau_t + \rho_4 less\_anchored_i\tau_t)R_{i,t-1} \\
& +(\gamma_1 + \gamma_2 less\_anchored_i + \gamma_3\tau_t + \gamma_4 less\_anchored_i\tau_t)\pi_{i,t} \\
& +(\beta_1 + \beta_2 less\_anchored_i + \beta_3\tau_t + \beta_4 less\_anchored_i\tau_t)Y_{i,t}^{Gap} \\
& +(\phi_1 + \phi_2 less\_anchored_i + \phi_3\tau_t + \phi_4 less\_anchored_i\tau_t)\Delta neer_{i,t} \\
& +\alpha_i + \varepsilon_{i,t}^{R}, \qquad (3.25)
\end{aligned}
$$

where τ_t is dummy variable equal to one for observations from the first quarter of 2011 to the fourth quarter of 2015, and zero otherwise. The estimate of $\beta_2 + \beta_4$ in column (2) of Annex Table 3.6.1 captures the impact of inflation expectations anchoring on the countercyclicality of monetary policy during the capital flow slowdown episode.

The second strategy is to instrument the output gap with an external variable, the Chicago Board Options Exchange Volatility Index (VIX), given that it is plausible to assume that the risk appetite of global investors, for which the VIX is a proxy, affects monetary policy in emerging markets mainly through the output gap, inflation, and exchange rate movements. The specification is the same as in equation (3.24) but $Y_{i,t}^{Gap}$ and $Y_{i,t}^{Gap} \times less\_anchored_i$ are instrumented by the VIX and the interaction between the VIX and the anchoring dummy.[3] The instrumental variables approach yields the "local average treatment effect"—that is, the average effect for the part of the sample that is influenced by the instrumental variable (Imbens and Angrist 1994). In the current context, the term "local" refers to the output gap fluctuation affected by the VIX. The negative and significant estimate of β_2 in column (3) of Annex Table 3.6.1 suggests that countries with better-anchored inflation expectations are more able to support activity in the face of negative shocks to global risk appetite that depress domestic output than are countries with less-anchored inflation expectations.

[3]The VIX passes the first-stage F-test for weak instruments. The F-statistics for the output gap and the interaction of the output gap with the anchoring dummy are 19.5 and 19.3, respectively, as reported in column (3) of Annex Table 3.6.1.

Annex Table 3.6.1. Estimation of Monetary Policy Rules

		(1) 2004–18, OLS	(2) 2011–15, OLS	(3) 2004–18, IV
Lagged Policy Rate	$\rho1$	0.902***	0.896***	0.802***
		(0.0223)	(0.0303)	(0.0391)
Output Gap	$\beta1$	0.0543***	0.0498**	0.653***
		(0.0185)	(0.0179)	(0.167)
Inflation	$\gamma1$	0.101***	0.113***	0.0693***
		(0.0253)	(0.0306)	(0.0242)
Nominal Effective Exchange Rate	$\phi1$	0.00192	0.00313	–0.00506
		(0.00238)	(0.00348)	(0.00393)
Lagged Policy Rate × Less–Anchored	$\rho2$	0.0197	0.0191	0.101**
		(0.0315)	(0.0346)	(0.0428)
Output Gap × Less–Anchored	$\beta2$	–0.0382*	–0.0294	–0.329*
		(0.0211)	(0.0222)	(0.189)
Inflation × Less–Anchored	$\gamma2$	–0.0562*	–0.0554	–0.0555*
		(0.0294)	(0.0338)	(0.0288)
Nominal Effective Exchange Rate × Less–Anchored	$\phi2$	0.0142***	0.0135*	0.0265***
		(0.00438)	(0.00771)	(0.00565)
Output Gap × Less–Anchored × τ_t	$\beta4$		–0.0323	
			(0.0549)	
Nominal Effective Exchange Rate × Less–Anchored × τ_t	$\phi4$		0.00308	
			(0.0162)	
Output Gap × Less–Anchored + Output Gap × Less–Anchored × τ_t	$\beta2 + \beta4$		–0.0618	
			(0.0522)	
Nominal Effective Exchange Rate × Less–Anchored + Nominal Effective Exchange Rate × Less–Anchored × τ_t	$\phi2 + \phi4$		0.0167	
			(0.0106)	
Number of Observations		1,064	1,064	1,064
R^2		0.935	0.936	0.904
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Source: IMF staff calculations.

Note: IV = instrumental variables; OLS = ordinary least squares. Robust standard errors in parentheses. All specifications include country fixed effects. Remaining interaction terms in equation (3.25) are included but not reported in column (2). In column (3), Output Gap and Output Gap × Less–Anchored are instrumented by the Chicago Board Options Exchange Volatility Index (VIX) and the interaction between VIX and the anchor dummy.

* $p < .10$; ** $p < .05$; *** $p < .01$.

References

See main chapter for the list of references.