BANK FOR INTERNATIONAL SETTLEMENTS

BIS Working Papers
No 895

Pass-through from short-horizon to long-horizon inflation expectations, and the anchoring of inflation expectations

by James Yetman

Monetary and Economic Department

October 2020

JEL classification: E31, E58.

Keywords: consensus forecasts, inflation expectations anchoring.

This publication is available on the BIS website (www.bis.org).

ISSN 1020-0959 (print)
ISSN 1682-7678 (online)

Pass-through from short-horizon to long-horizon inflation expectations, and the anchoring of inflation expectations

October 2020

James Yetman[1]

Abstract

We investigate pass-through from short-horizon to long-horizon inflation forecasts as a way to assess the anchoring of inflation expectations. We find an overall decline in the pass-through in our sample, with the share of economies having anchored expectations increasing over time. We then investigate what might explain the increase in anchoring. Inflation targeting plays an important role. Low policy rates and persistent deviations of inflation from target are correlated with a decline in expectations' pass-through. This suggests that longer-term expectations remain well anchored, despite recent low inflation out-turns in many economies.

JEL classification: E31, E58.

Keywords: Consensus forecasts, inflation expectations anchoring.

1 james.yetman@bis.org. Bank for International Settlements, Representative Office for Asia and the Pacific, 78th Floor, Two IFC, 8 Finance Street, Central, Hong Kong. The views expressed in this paper are those of the author and do not necessarily reflect those of the Bank for International Settlements. I thank, without implication, Karsten Chipeniuk, Stijn Claessens, Masazumi Hattori, Gunes Kamber, Ricardo Reis, Ilhyock Shim, Pierre Siklos, Christian Upper, Dora Xia and participants at the BSP-BIS conference on "Inflation Dynamics in Asia and the Pacific" and the RBNZ-IMF conference on "Inflation Targeting: Prospects and Challenges" for helpful comments. I also thank Zsuzsa Debreczeni for help in filling gaps in the forecast series and Giulio Cornelli, Zuzana Filková, Amanda Liu and Pamela Pogliani for excellent research assistance.

1. Introduction

Well-anchored long-term inflation expectations play an important role in allowing central banks to pursue an activist monetary policy.[2] In many economies across the globe, longer-horizon inflation expectations appear to have become more stable over time, consistent with greater anchoring. They have remained stable even as inflation outcomes have persistently deviated from central banks' stated inflation objectives in many economies recently. Graph 1 displays six- to 10-year ahead CPI inflation forecasts collected by Consensus Economics for all the economies for which these forecasts are available, for as long as they are available, with the exception of Venezuela.[3] These forecasts, made twice each calendar year, are for an increasing sample of countries over time. What is clear from the graph is that these forecasts are very stable for most economies. Even for those with a history of high inflation, such as Russia and Turkey, they have tended to fall and stabilise over time.

Another way to demonstrate the increased stability of long-term inflation expectations is to compute their standard deviation. Graph 2 shows the standard deviation of long-horizon forecasts, based on five-year (10-observation) rolling samples, once there are five years of data available for each economy. The standard deviation has been approximately flat or declining in nearly all economies.

One explanation for the stability of long-term inflation forecasts is that inflation expectations may be tightly "anchored": economic agents perceive that monetary policy will offset any persistent inflationary effects of shocks, so that inflation reverts to long-term levels after sufficient time, and longer-horizon inflation expectations remain unchanged. But other explanations are possible. For example, the nature of economic shocks could have changed: perhaps they could have become smaller, which has contributed to a decline in intrinsic uncertainty about future inflation.

To separate between these two explanations, the literature has followed several approaches. One is to focus on specific shocks. A second is to use inflation news (that is, the difference between actual inflation and a forecast of inflation) as a summary statistic for the relevant shocks hitting the economy. A third uses changes in short-term inflation expectations to measure shocks, an approach we take here. The underlying idea is to use changes in forecasters' views of short-term inflation as a filter to isolate shocks that are likely to affect inflation. This encompasses shocks of all types, including food prices, administrative prices and wages. We then see how strongly longer-term expectations move over the same time period. The stronger is the relationship between the two, the less well anchored are inflation expectations.

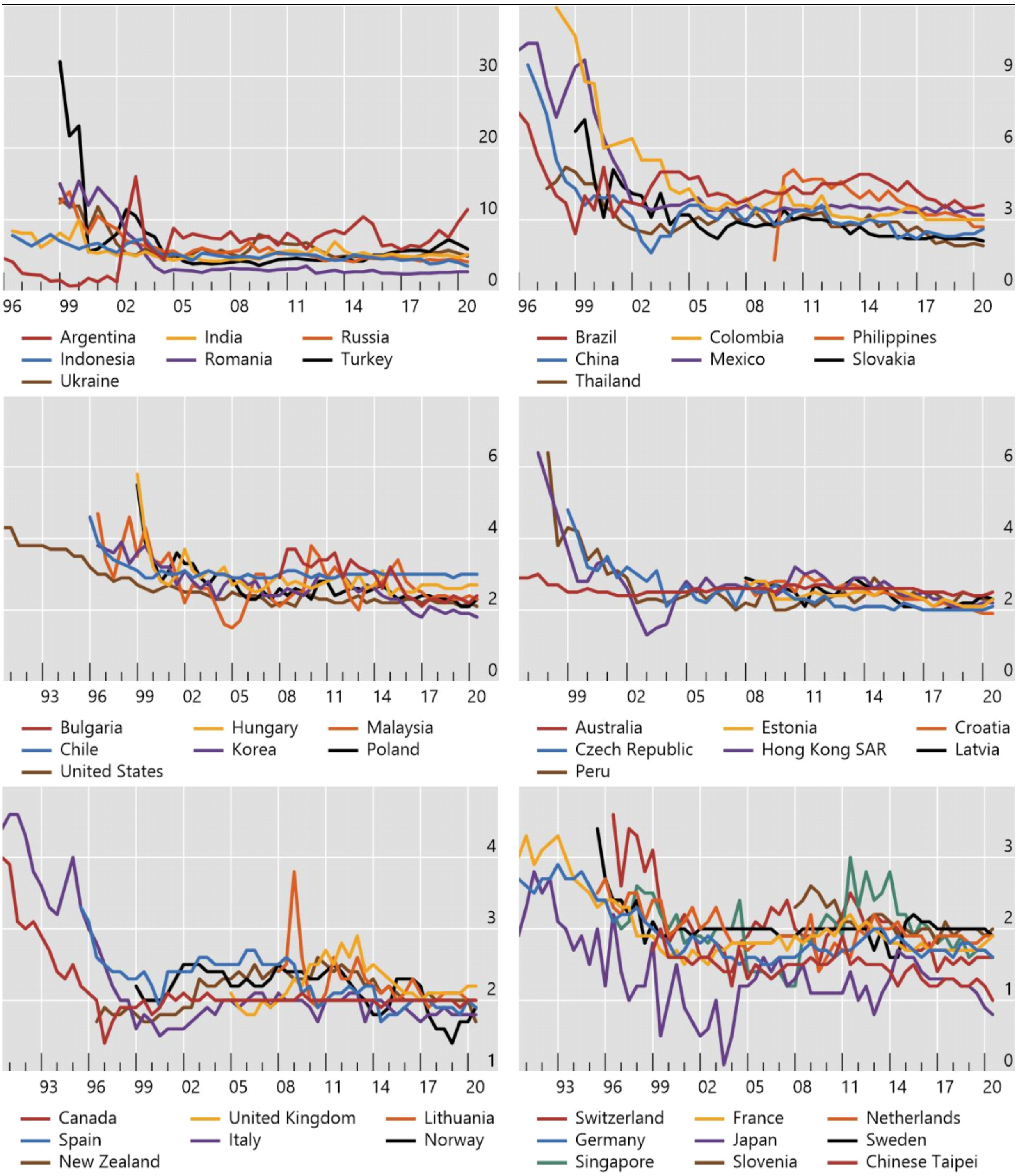
We find an overall decline in the pass-through from short-horizon expectations to long-horizon expectations over time in our sample. Dividing economies into those that are anchored, contained or unmoored in the spirit of Gefang et al (2012), we show that the share of economies with anchored expectations has steadily improved over the last three decades. We then look to see what might explain this improvement, based on second-stage regressions. We find that inflation targeting appears to have played an important role. We also find that low policy rates and gaps between inflation and its target – variables associated with the recent period of low inflation out-turns – are correlated with a decline in expectations' pass-through. This indicates that longer-term inflation expectations remain generally well anchored: perhaps forecasters perceive low inflation outcomes as transitory, and unlikely to persist for as long as the horizon of these long-term forecasts.

[2] See, for example, Eusepi et al (2019) who show that a lack of well-anchored inflation expectations acts as a limit on what monetary policy can accomplish, and serves to constrain the optimal policy response to shocks.

[3] Venezuela is an extreme outlier: inflation and long-term inflation forecasts reached as high as 444,000% and 158%, respectively, during the sample period.

Long-horizon inflation forecasts

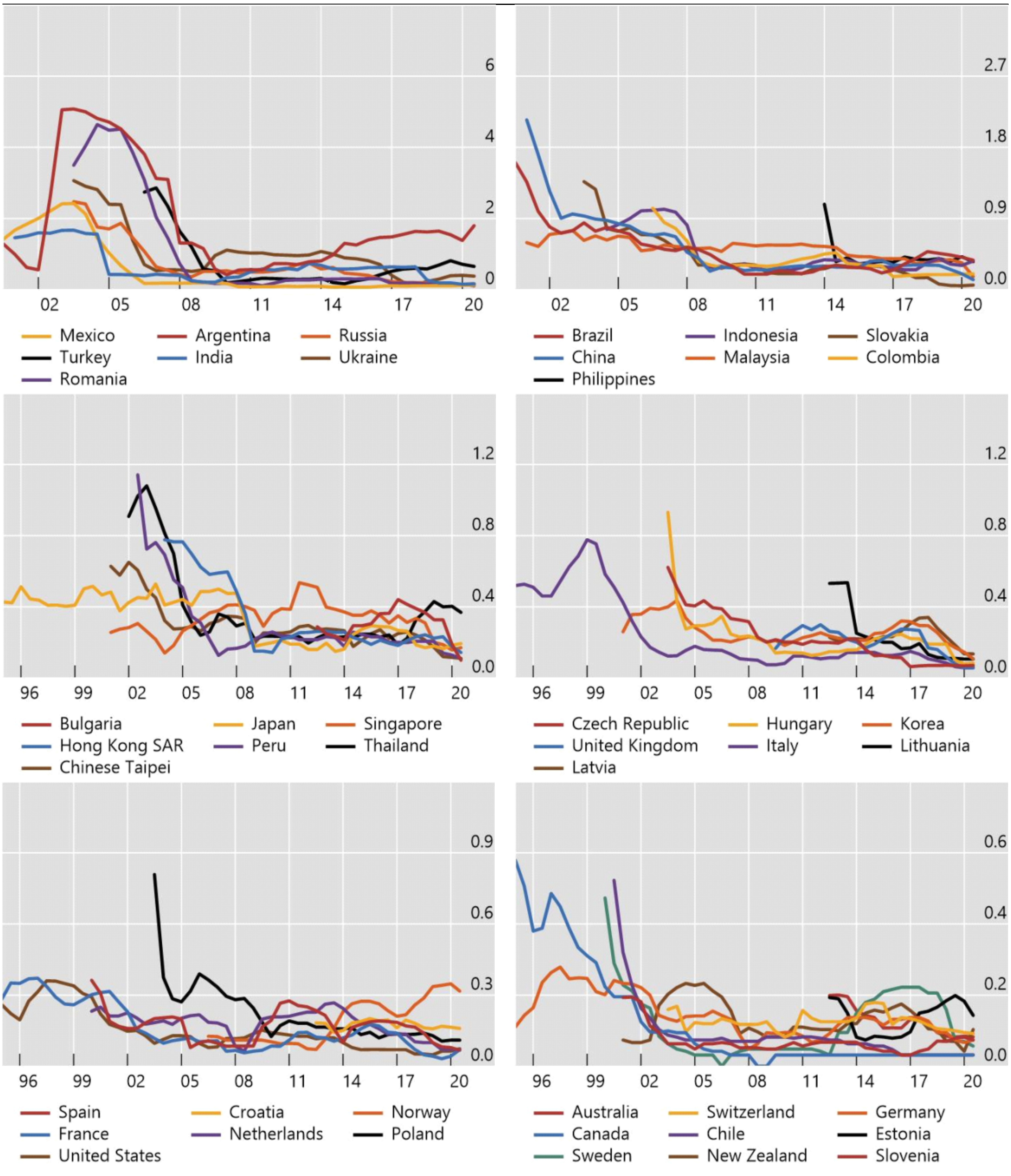
Graph 1



Source: Consensus Economics.

Five-year rolling standard deviation of long-horizon forecasts

Graph 2



Source: Author's calculations.

The next section summarises the literature. Section 3 introduces the data. Section 4 outlines our approach. Section 5 contains the results. Section 6 concludes.

2. Related literature

One paper taking a similar approach to ours is Buono and Formai (2018). They estimate an equation of the form $\pi_{it}^{e,l} = \alpha_{it} + \beta_{it}\pi_{it}^{e,s} + \varepsilon_{it}$ for four economies (the United States, the euro area, Japan and the United Kingdom), allowing for time-varying parameters. The left-hand side variable is a longer-horizon forecast, and the right-hand side variable a short-horizon forecast. They report considerable variability in the degree of anchoring over time, as measured by their estimates of β_{it}, and some de-anchoring in recent years.

Our approach differs from theirs in several important respects. First, in terms of coverage we start with all 45 economies for which Consensus Economics collects long-horizon forecasts, instead of just four. Second, we difference our data, which is arguably necessary in our case since there is evidence of non-stationarity for at least some of our sample. Third, for the long-horizon forecasts we focus on the longest available horizon – six to 10 years ahead – whereas they consider anywhere from two to five years ahead. Fourth, rather than focusing on economy-by-economy estimation, we also consider second-stage regressions in which we use the variation across the economies in our sample to identify what can explain the degree of anchoring and its evolution over time.

Moessner and Takáts (2020) also take a similar approach, mostly focusing on 28 advanced and emerging market economies with inflation targets over 1994–2019. The key difference is that they estimate in levels of forecasts (rather than in first differences), but based on deviations from inflation targets, and include lagged long-horizon inflation expectations as an explanatory variable.[4] They also use panel estimation, instead of estimating one economy at a time.

Another similar paper is Bems et al (2018). One of the four measures of inflation expectations anchoring they construct is based on regressing the change in five-year inflation forecasts on the change in current year forecasts. It is not clear from their paper whether this is an appropriate comparison: as we discuss below, when comparing a "current year" forecast made in October with one made in the following April, they are forecasts of different outcomes, so are not readily comparable. In what follows, we will match the short-term forecasts to ensure that they are of the same outcome.

Other papers substitute expectations of inflation from financial market data for forecast data. For example, Jochmann et al (2010) and Gefang et al (2012) study the relationship between changes in break-even inflation rates for bonds with maturity of two to five years and nine to 10 years. Meanwhile, Strohsal and Winkelamnn (2015) estimate an exponential smooth transition autoregressive (ESTAR) model and assess anchoring in terms of the speed of mean reversion to a long-run anchor, which can be thought of as the market-perceived inflation target. By studying US, euro area, UK and Swedish break-even inflation rate data, they report wide variation in the degree of anchoring across economies and across horizons. The advantage of these two studies is much higher frequency data (daily vs twice yearly) but at the expense that time-varying liquidity and risk premia may contaminate the data, as discussed in Faust and Wright (2013), for example.

Another common approach is to use specific shocks as the right-hand side variable. For example, Kose et al (2018) investigate the sensitivity of five-year forecasts to inflation surprises and find that it has generally declined over time, although it remains higher for emerging and developing economies than for advanced economies. Davis (2014) considers both oil price shocks and inflation surprises, and finds that the sensitivity of inflation expectations to both has declined in inflation targeting economies, but not in others, in a sample of 36 economies.

4 They also estimate an equation more similar to the one we use, of the change in long-term forecasts on the change in short-term forecasts, on a wider panel of 33 economies, and use the results to argue that inflation forecasts are better anchored in advanced economies than in emerging market economies.

Others include different elements of the above approaches. Bundick and Smith's (2018) left-hand side variable is the change in break-even inflation rates from bonds around the time of inflation releases, while their right-hand side variable is the inflation release relative to forecasts shortly beforehand. They find that the relationship between the two variables weakened following the introduction of an inflation target in the United States, but remained statistically significant in Japan. De Pooter et al (2014) examine the sensitivity of both survey and financial market-derived measures of long-term inflation expectations to news for Brazil, Chile and Mexico and find that anchoring has improved over time for all three economies.

Another approach is that taken by Mehrotra and Yetman (2018). They model inflation expectations using a decay function on forecasts with horizons of up to 24 months, where forecasts monotonically diverge from an estimated anchor towards actual inflation as the forecast horizon shortens. They find that this model fits the data well, and indicate that inflation anchors have declined over time for most of the 44 economies in their sample. One limitation of their approach is that a 24-month horizon may be too short to assess the anchoring of long-term inflation expectations.

A key focus of recent research, utilising some of the above methods, is to determine what has happened to the degree of anchoring in the post-Great Financial Crisis (GFC) period. First, on US data, Strohsal et al (2016) regress the deviation in long-term inflation forecasts from target inflation on the following two variables: the deviation in actual inflation from target and the deviation in short-term inflation expectations from target. They derive expectations from bond yields, using a time-varying parameter model. They find partial de-anchoring during the GFC but re-anchoring more recently. Nautz and Strohsal (2015) run news regressions on the daily change in long-term inflation expectations from US financial market data and find that expectations de-anchored during the GFC and had not re-anchored again by the end of their sample in mid-2014.[5]

Focusing on euro area data, Miccoli and Neri (2019) investigate the relationship between the deviations of inflation from analysts' inflation expectations and inflation-linked swap contracts. They find that inflation 'surprises' have significant effects on inflation expectations, although these disappeared after the introduction of the ECB's Asset Purchase Programme. Corsello et al (2019) find that long-horizon inflation expectations have become sensitive to short-horizon inflation forecasts and negative inflation surprises, while Garcia et al (2018) report that during the post-2013 period of low inflation, the euro area has seen lower inflation expectations anchoring in that inflation news has a larger impact on inflation compensation from bonds.

Combining multiple advanced economies, Grishchenko et al (2019) report that there was some de-anchoring of expectations in the euro area in the aftermath of the GFC, while anchoring for the United States actually improved. They define anchoring in terms of the probability of inflation – computed based on surveys of forecasters – lying within target ranges. Galati et al (2011) focus on the euro area, the United Kingdom and the United States and find that the measures of inflation expectations extracted from inflation-indexed bonds and inflation swaps became more volatile after 2007 and more sensitive to news. Natoli and Sigalotti (2017) assess the degree of anchoring for the UK, US and euro area, using a logistic regression to assess the probability that strong negative shocks to short-term inflation expectations are associated with declines in long-term expectations. They find that the risk of de-anchoring spike in 2014, but improved somewhat thereafter. Finally, Moessner and Takáts (2020), discussed above, find no significant change in anchoring around the GFC or when economies are at the zero lower bound, in a wider sample of economies.

Focusing on oil, Sussman and Zohar (2018) report that medium-term break-even inflation rates for France, the United Kingdom and the United States became more sensitive to oil prices following the failure of Lehman Brothers in 2008. Conflitti and Cristadoro (2018) find that oil prices have a statistically significant

[5] Other related papers based on financial market data include Hachula and Nautz (2018) on US data and Nautz et al (2017) on euro area data.

impact on long-run inflation expectations in the euro area since the GFC, but that co-movements with other factors explain this shift.

Some papers have sought to explain what drives the level of anchoring, as we do in this paper. Bems et al (2018) find that the following four factors influence anchoring: (i) whether inflation is systematically above or below an inflation target; (ii) how transparent monetary policy is; (iii) how long a country has had an inflation target; and (iv) how sustainable fiscal policy is. Levin et al (2004), Gürkaynak et al (2010) and Yetman (2015) compare inflation targeting economies with others and report that expectations are better anchored in the former. Dräger and Lamla (2018) find that the sensitivity of US consumers' long-term inflation expectations to short-term inflation expectations is higher for older survey responders who have experienced higher inflation rates. Kumar et al (2015) find that firms in New Zealand display few signs of inflation expectations anchoring, even 25 years after the adoption of inflation targets there. Kose et al (2018) test six possible explanatory variables and find that inflation targeting increases anchoring generally, while greater trade openness, increased central bank transparency and low fiscal debts are associated with increased anchoring for emerging and developing economies but not advanced economies. Meanwhile, financial openness and the exchange rate regime do not appear to affect anchoring in their study.[6]

Low inflation may also affect anchoring. Ehrmann (2015) finds that inflation expectations become more sensitive to lagged outcomes and forecaster disagreement rises when inflation is persistently below target, based on short-horizon forecasts from Consensus Economics for 10 economies.[7] Meanwhile, Banerjee and Mehrotra (2018) report that deflation has a similar effect on anchoring: expectations become more backward looking and forecaster disagreement increases, even when periods where policy rates were close to zero are excluded from their analysis. However, both these studies focus only on short-horizon (next calendar year) forecasts, whereas our focus is on forecasts at longer horizons.

The effect of recent low inflation periods can also be investigated using quantile regressions. Taking this approach, Banerjee et al (2020) examine how inflation risks have changed over time. They report a general decline in upside inflation risks over time, reflecting successful disinflationary processes and the adoption of inflation targeting regimes. They also show that the zero lower bound represents a prominent source of downside inflation risk, especially in advanced economies.

3. Data

Our data are from Consensus Economics. Each month, Consensus Economics surveys panels of forecasters representing a large number of economies on their forecasts of around 8–10 economic variables for each of the current and next calendar years. In addition, twice per year, they also collect longer-term forecasts of a smaller set of variables for two, three, four, five and six–10 years ahead. One variable that is nearly always included in these surveys is the percent change in consumer prices (or average annual percent change in the case of six- to 10-year forecasts). The availability of these long-horizon inflation forecasts is summarised in Table 1.

For most economies, the shorter-term forecasts are available at the forecaster level, but only averages for the long-term forecasts. We use median short-term forecasts where possible in our study, and the averages published by consensus where not.

6 See, also, an earlier literature summarised in Svensson (2010).

7 Relatedly, Fukuda and Soma (2019) find that the introduction of an inflation target in Japan raised long-horizon expectations from negative of positive territory, but that expectations fell again once it became clear that the 2% target would not be met.

Long-term inflation forecast availability[1]

Table 1

Economy	Economy code	Start date	Classification
Argentina	AR	October 1995	EM
Australia	AU	April 1996	AE
Brazil	BR	October 1995	EM
Bulgaria[2]	BG	September 2007	EM
Canada	CA	April 1990	AE
Chile	CL	October 1995	EM
China	CN	April 1996	EM
Colombia	CO	October 1997	EM
Croatia[2]	HR	September 2007	EM
Czech Republic[2]	CZ	September 1998	EM
Estonia[2]	EE	September 2007	EM
France	FR	April 1990	AE
Germany	DE	April 1990	AE
Hong Kong SAR	HK	April 1997	AE
Hungary[2]	HU	September 1998	EM
India[3,4]	IN	April 1996	EM
Indonesia	ID	April 1996	EM
Italy	IT	April 1990	AE
Japan	JP	April 1990	AE
Korea	KR	April 1996	AE
Latvia[2]	LV	September 2007	EM
Lithuania[2]	LT	September 2007	EM
Malaysia	MY	April 1996	EM
Mexico	MX	October 1995	EM
Netherlands	NL	April 1995	AE
New Zealand	NZ	April 1996	AE
Norway	NO	October 1998	AE
Peru	PE	October 1997	EM
Philippines	PH	April 2009	EM
Poland[2]	PL	September 1998	EM
Romania[2]	RO	September 1998	EM
Russia[2]	RU	September 1998	EM
Singapore	SG	April 1996	AE
Slovakia[2]	SK	September 1998	EM
Slovenia[2]	SI	September 2007	EM
Spain	ES	April 1995	AE
Sweden	SE	April 1995	AE
Switzerland	CH	October 1998	AE
Chinese Taipei	TW	April 1996	EM
Thailand	TH	April 1997	EM
Turkey[2]	TR	September 1998	EM
Ukraine[2]	UA	September 1998	EM
United Kingdom[3]	GB	October 2004	AE
United States	US	April 1990	AE

[1] The sample end date is April 2020 for all economies. Long-horizon forecasts are for six- to 10-years ahead and, unless otherwise stated, are collected every April and October. The sample includes all economies for which long-horizon CPI inflation forecasts are available before 2018 with the exception of Venezuela (an extreme outlier), and the euro area (we instead include the constituent national economies where available). The final column indicates whether an economy is classified as an advanced economy (AE) or an emerging market (EM) in later estimation. [2] For indicated economies, forecasts were collected in March and September up until March 2014, and April and October beginning in October 2014. [3] For India and the United Kingdom, there are also long-term for forecasts for the WPI and RPIX respectively, which we do not use. [4] Forecasts for India are for fiscal years; all others are for calendar years.

Source: Consensus Economics.

We first assess the stationarity of the forecasts using the Phillips and Perron (1998) unit root test. For this test, we match the long-term forecasts with short-term forecasts for each of the current and next year made at the same time, so that the samples are the same length and consist of two observations each year. The relevant version of the test for our purposes is without a trend. We list the *p*-values for each economy in our sample in Appendix Table A1. While we can reject a null hypothesis of non-stationarity at the 10% level in 64% of the cases examined, there are other cases where there is little evidence to reject. In 7% of cases, the *p*-value is greater than 0.5. In some cases, we cannot reject non-stationarity for advanced economies with the longest available sample period (France and Germany, for example). Given the lack of convincing evidence that all our forecast data is non-stationary, we will proceed by differencing the forecast data (as described in the next section), and assess the pass-through from changes in short-term forecasts to changes in long-term forecasts.

4. Estimation approach

Our estimated relationship takes the general form:

$$\Delta\pi_{it}^{e,l} = \beta_i \Delta\pi_{it}^{e,s} + \varepsilon_{it}. \tag{1}$$

We match the long-term forecasts, $\pi_{it}^{e,l}$, with the median short-term forecasts, $\pi_{it}^{e,s}$, collected at the same time by Consensus Economics for the same economy. The change in the long-term forecast is straightforward to compute. Given that these forecasts are of average inflation six–10 years ahead of the forecast date, and the forecast dates are only six months apart, the forecast periods overlap considerably (90%). We simply use the change in the long-term forecasts from one forecast date to the next as our dependent variable.

The overlap in short-term forecasts is much less, so we take a different approach. For each month, there are forecasts for each of the current and next calendar years. Between October of one year and April of the following year, we compute the change in the forecast from October's forecast of the next year to April's forecast of the current year, which are forecasts of the same outcome, but with horizons of 15 months and 9 months, respectively, relative to the completion of the year being forecast.

Between April and October, since these are in the same year, and there are forecasts for both the current and next year at each date, we have two possible short-term forecast measures available. The difference between the forecasts of next year's inflation compares horizons of 21 and 15 months, while the difference between the forecasts of this year's inflation compares horizons of nine and three months.

Neither of these choices is ideal: first, they do not match the gap in horizons between October and April; and second, at very short horizons such as three months, given that the forecasts are typically on annual average inflation, they are not much of a forecast since most of the actual monthly data underlying inflation is already known. We therefore take a third option: the average of the change in the two annual inflation forecasts available between April and October. This has the attractive property of matching on average the horizons of the short-term forecasts used to construct the change between October and April.

For some economies and for some of the sample, the long-term forecasts collected are those made in March and September instead of April and October (Table 1). In this case, we use the corresponding shorter-horizon forecasts (also made in March and September), which means that the forecast horizons differ by one month from most of the sample. We expect that any effect of this on the results will be minor.

For India, inflation forecasts correspond to fiscal years (ending March 31) instead of calendar years. Nonetheless, from October to April still crosses a (fiscal) year while April to October does not. We can thus use the same approach, but now the (average) horizon change between the short term forecasts is from 18 months to 12 months (instead of from 15 months to nine months, as for all other economies).

5. Results

5.1 Evidence of anchoring

We first estimate equation (1) by panel OLS with robust standard errors and report the results in Table 2. The model fits well, with an R-squared of 0.23, and the coefficients vary widely from low negative numbers to 0.42 for India and 0.60 for Turkey. The standard errors of the estimates also vary widely, between 0.014 (Chile) and 0.27 (Turkey).[8]

For the four economies where our results can be compared with Buono and Formai (2018), the level of our estimates of pass-through are uniformly lower, by around 0.3 to 0.6. There are two likely explanations for this. First, we estimate our equation in differences, and hence any trend that is present in the inflation data that influences the long- and short-term expectations similarly does not inflate our estimates. Second, our left-hand side variable is for a longer horizon than theirs, and hence less correlated with short-horizon forecasts if forecasters believe that inflation will display mean reversion.

Clearly, well-anchored expectations would be expected to result in a low estimate of β_i. But, in addition, we would expect the standard error of the estimate to be small: one can interpret a high standard error as reflecting the fact that there is an uneven relationship between short- and long-term expectations, such that sometimes pass-through is higher than others. Graph 3 displays a scatter plot of the coefficients and their standard error for each economy. There is a positive relationship between the two (ρ = 0.37).

[8] As mentioned earlier, we exclude Venezuela as an extreme outlier. For example, when imposing the same coefficient on all 44 economies and dropping one country at a time, there is very little effect on the estimated coefficient. But if we add Venezuela to the sample, the overall coefficient changes from 0.11 to 0.00 and the R-squared falls from 0.11 to 0.0015.

Regressions results

Table 2

Number of observations:	1928		
R-squared:	0.233	F(44, 1840):	5.74
Root MSE:	0.680	Prob > F:	0.0000

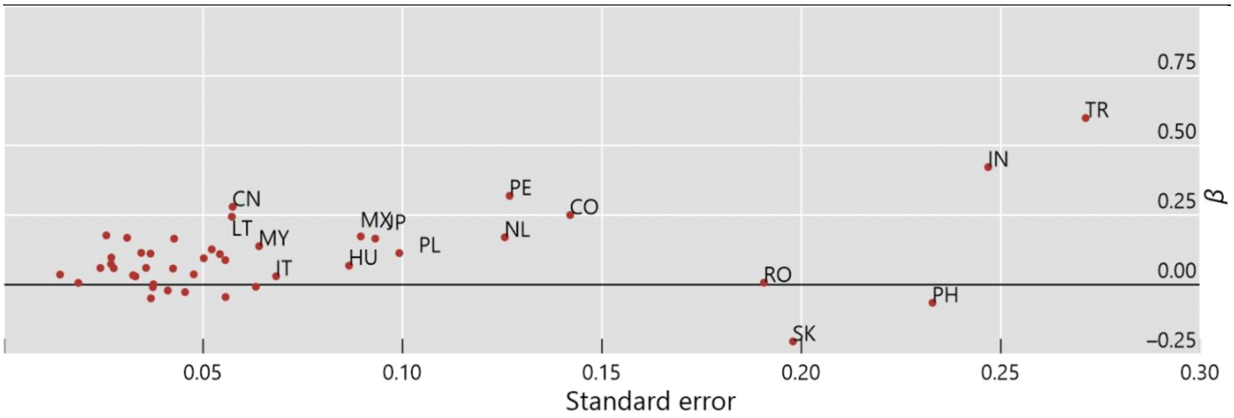
Economy	β_i	se	*t*-stat	*p*-value	95% lower bound	95% upper bound	Classification[1]
AR	0.168	0.031	5.43	0.000	0.11	0.23	C
AU	0.030	0.033	0.90	0.370	-0.04	0.09	A
BG	0.109	0.054	2.02	0.044	0.00	0.22	C
BR	0.177	0.026	6.87	0.000	0.13	0.23	C
CA	0.033	0.033	1.02	0.307	-0.03	0.10	A
CH	-0.009	0.037	-0.25	0.803	-0.08	0.06	A
CL	0.036	0.014	2.55	0.011	0.01	0.06	C
CN	0.280	0.057	4.87	0.000	0.17	0.39	C
CO	0.250	0.142	1.76	0.079	-0.03	0.53	C
CZ	0.127	0.052	2.43	0.015	0.02	0.23	C
DE	0.074	0.027	2.74	0.006	0.02	0.13	C
EE	0.059	0.028	2.13	0.033	0.00	0.11	C
ES	0.114	0.034	3.30	0.001	0.05	0.18	C
FR	0.094	0.050	1.88	0.060	0.00	0.19	A
GB	0.037	0.048	0.77	0.440	-0.06	0.13	A
HK	0.165	0.043	3.86	0.000	0.08	0.25	C
HR	-0.045	0.056	-0.80	0.422	-0.15	0.06	A
HU	0.068	0.087	0.79	0.432	-0.10	0.24	C
ID	-0.008	0.063	-0.12	0.901	-0.13	0.12	A
IN	0.422	0.247	1.71	0.087	-0.06	0.91	C
IT	0.030	0.068	0.44	0.661	-0.10	0.16	A
JP	0.165	0.093	1.77	0.076	-0.02	0.35	C
KR	-0.049	0.037	-1.34	0.181	-0.12	0.02	A
LT	0.244	0.057	4.26	0.000	0.13	0.36	C
LV	0.006	0.019	0.33	0.741	-0.03	0.04	A
MX	0.173	0.090	1.93	0.053	0.00	0.35	C
MY	0.138	0.064	2.15	0.031	0.01	0.26	C
NL	0.170	0.126	1.35	0.176	-0.08	0.42	C
NO	-0.021	0.041	-0.52	0.605	-0.10	0.06	A
NZ	0.034	0.032	1.03	0.302	-0.03	0.10	A
PE	0.319	0.127	2.51	0.012	0.07	0.57	C
PH	-0.065	0.233	-0.28	0.779	-0.52	0.39	C
PL	0.113	0.099	1.14	0.254	-0.08	0.31	C
RO	0.007	0.191	0.04	0.972	-0.37	0.38	C
RU	0.001	0.038	0.03	0.978	-0.07	0.07	A
SE	0.058	0.042	1.36	0.174	-0.03	0.14	A
SG	0.088	0.056	1.58	0.113	-0.02	0.20	A
SI	0.060	0.024	2.46	0.014	0.01	0.11	C
SK	-0.204	0.198	-1.03	0.302	-0.59	0.18	A
TH	0.097	0.027	3.59	0.000	0.04	0.15	C
TR	0.598	0.271	2.21	0.027	0.07	1.13	U
TW	0.111	0.037	3.02	0.003	0.04	0.18	C
UA	0.060	0.036	1.68	0.093	-0.01	0.13	A
US	-0.027	0.045	-0.60	0.552	-0.12	0.06	A

[1] A stands for anchored, C for contained and U for unmoored.

Source: author's calculations.

Estimates

Graph 3



Source: author's calculations

We next characterise each economy, in the spirit of Gefang et al (2012), into one of three categories. Anchored (A) economies are those where the estimated pass-through is low and precisely estimated (which we define as having a 95% confidence interval that includes 0.0 and an upper bound below 0.2). Contained (C) are those that are not anchored but have pass-through significantly below one (that is, the 95% confidence band excludes 1.0). Finally, unmoored (U) economies are those where pass-through is not significantly different from one. All the economies in our sample fit into one of these categories. We include these classifications in the right-most column of Table 2. Of the 44 economies, 18 are anchored, 25 contained and one (Turkey) unmoored.

One possibility is that the level of pass-through merely reflects inflation outcomes: where inflation is higher and either more volatile or persistent, pass-through from short-term inflation expectations to longer-term expectations is higher. While there is a relationship between these variables, they are not particularly strong: the correlation between β_i or its estimated standard error and the average inflation ($\overline{\pi}_{it}$), the standard deviation of inflation ($sd(\pi_{it})$), or the persistence of inflation ($\rho(\pi_{it})$), based on 10-year rolling samples, are all less than 0.3 (see Table 3).[9]

Correlations

Table 3

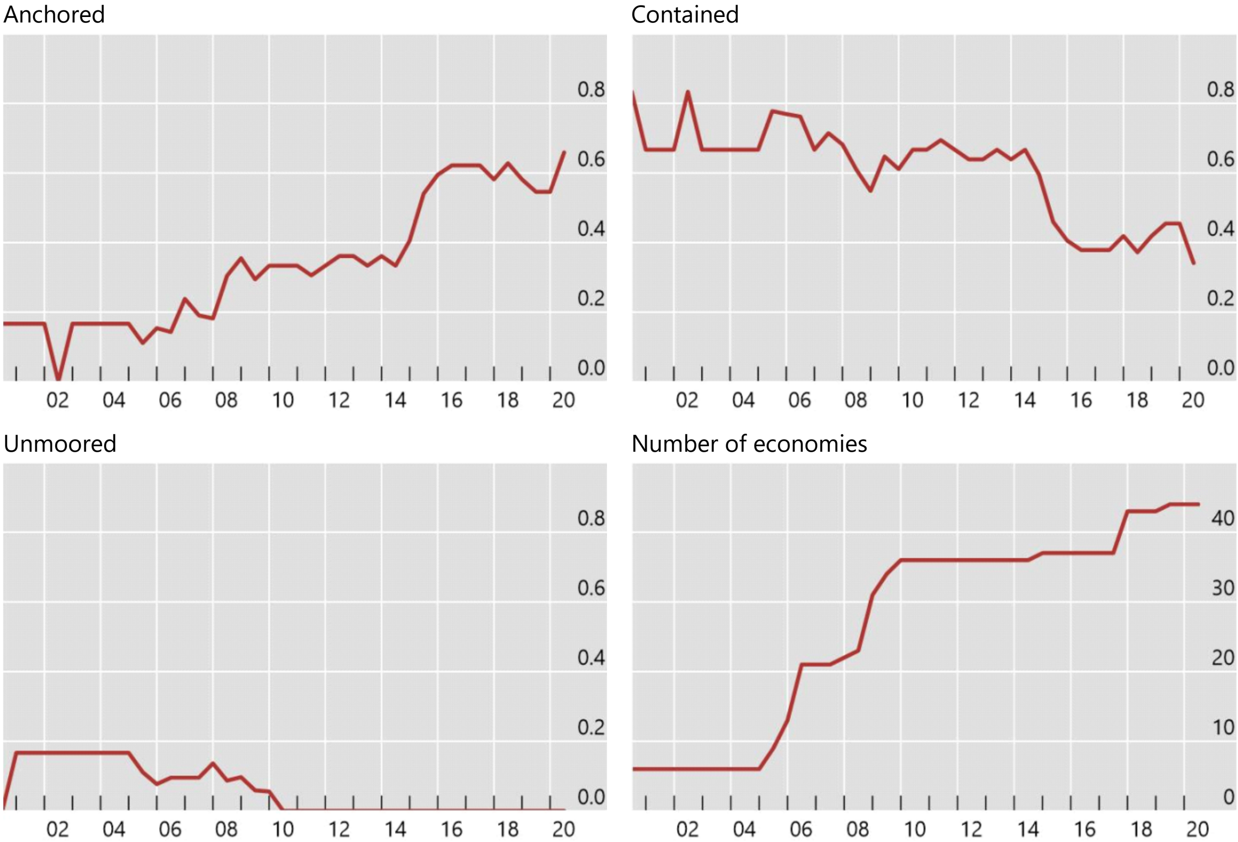
	β_i	$se(\beta_i)$	$\overline{\pi}_{it}$	$sd(\pi_{it})$	$\rho(\pi_{it})$
β_i	1.000				
$se(\beta_i)$	0.651	1.000			
$\overline{\pi}_{it}$	0.136	0.071	1.000		
$sd(\pi_{it})$	0.163	0.012	0.834	1.000	
$\rho(\pi_{it})$	0.176	0.226	0.226	0.243	1.000

Source: author's calculations.

[9] Our measure of persistence here is the coefficient on lagged inflation in a regression of 12-month inflation on itself lagged by 12 months and an intercept, based on rolling 120-month samples. If we instead use 60-month – ie five-year – rolling samples, the correlations are all less than 0.1 and some are negative.

Another question we can address is whether anchoring has increased or not over time. We estimate 10-year rolling samples, economy-by-economy, once there are 10 years of data.[10] We then count up, for each sample, the share of economies that are anchored, contained or unmoored, and display the shares and the sample size (ie the number of economies) in Graph 4.

Share of economies by degree of anchoring Graph 4



Note: based on 10-year rolling sample; x-axis displays the end date, while the y-axis contains the share of economies by economies, except for the bottom-right quadrant which displays the total number of economies in the sample. For the underlying estimates and their confidence bands, see Appendix Graph A1.

Source: author's calculations.

The results suggest a gradual improvement in anchoring over time. Early in the sample, around two-thirds of those included had contained expectations, with the remainder split evenly between anchored and unmoored. But, over time, the share of anchored economies has increased to around 60% and contained has fallen to around 40%, while there have been no unmoored economy in any of the rolling samples ending in the most recent 10 years. This improvement in anchoring would be even greater without the growth of the sample over time: if we only focus on the six economies in the original sample, for example, the average share of economies with anchored expectations over the last five years would have been around 13% higher (and that of contained expectations 13% lower).

[10] The estimates and their 95% confidence bands are displayed in Appendix Graph A1.

5.2 Understanding inflation expectations pass-through

We next look to see what factors might explain inflation expectations pass-through over time. To do this, we regress the $\hat{\beta}_i$'s estimated on 10-year rolling samples discussed above on a number of explanatory variables extracted from the same 10-year period. We group the explanatory variables into two categories: those related to inflation outcomes, and institutional factors. The first group includes:

- Mean π: rolling average inflation rate over 10-year period. Pass-through may be higher when inflation is higher.
- Low π: low inflation dummy, defined as 12-month average inflation below 1%. We take the average value of this dummy over 10 years. Pass-through could be higher when inflation is very low and conventional monetary policy efficacy is impaired. Alternatively, if forecasters view the low inflation period as a temporary phenomenon, pass-through could be lower: with monetary policy expected to regain its potency, near-term expectations would have little implication for longer-term expectations.[11]
- Persistent π: persistent inflation, where persistence is measured using the coefficient on lagged inflation in a regression of 12-month inflation on itself lagged by 12 months and an intercept, based on rolling 120-month (ie 10-year) samples. More persistence is likely to lead mechanically to higher pass-through from short-horizon to long-horizon expectations.

We also consider a number of other inflation-related variables, including variations on the above (eg the average of a dummy based on inflation below 0%), various thresholds for high inflation and the rolling standard deviation of inflation over the preceding 10 years. These were highly correlated with the above measures and/or offered only trivial explanatory power, so were subsequently dropped. We do, however, consider those economies where mean inflation was under 10% as a robustness check, given the long upper tail of inflationary experience in our sample.[12]

Our second group of explanatory variables includes:

- Low i: a policy rate (or discount rate) at or near the zero bound, defined as below or equal to 0.3%. Pass-through could be higher when forecasters believe that the efficacy of conventional monetary policy tools is constrained, or lower when this is perceived to be a transitory state.[13]
- IT: inflation targeting dummy, averaged over the 10-year sample. This variable is based on Hammond (2011) and updated using the monetary policy framework designations as listed in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). The precise inflation targeting starting points is determined based on individual central bank publications: see Appendix Table A2 for details. Pass-through may be lower when the central bank has a clearly articulated numerical goal for inflation that it seeks to achieve at a specific horizon that may serve as a focal point for anchoring expectations.
- FX stable: a measure of exchange rate stability. We define a dummy variable based on the annual standard deviation of the domestic currency against either the US dollar or euro (or Deutsche Mark in the pre-euro period) of less than 1% at daily frequency, similar to Carvalho Filho (2010). The average of this dummy over 10-year rolling samples is included in our regressions. On the one hand, stable exchange rates tend to result from policy frameworks focused on their stability, potentially at the expense of stabilising inflation. Then they could imply increased pass-through. On the other hand, mechanisms independent of monetary policy such as purchasing power parity

[11] Twenty-five per cent of post-2007 inflation observations satisfy our definition of low inflation, compared to 7% earlier.

[12] "Mean π" has a mean value of 39%, but a median of only 3.4% and a maximum of 1293%, indicating a highly skewed distribution. 83% of all inflation observations are less than 10%.

[13] Twenty per cent of post-2007 policy rates satisfy this criterion, versus 0.5% earlier.

could play a role in anchoring long-term expectations even if short-term inflation volatility increases, provided that the base currency has anchored inflation expectations (see, for example, Rogoff (1996)). In that case, economies with stable exchange rates may not display a strong connection between short-term and long-term inflation expectations.

We present the correlations between these explanatory variables in Table 5.

Correlations between explanatory variables, full sample

Table 5

	Mean π	Low π	Persistent π	Low i	IT	FX stable
Mean π	1.00					
Low π	−0.28	1.00				
Persistent π	0.22	−0.05	1.00			
Low i	−0.30	0.23	0.07	1.00		
IT	0.06	−0.21	−0.02	−0.31	1.00	
FX stable	−0.28	−0.10	0.04	0.33	−0.65	1.00

In all our regressions, we also add annual time fixed effects or fixed effects for each jurisdiction or both. These are robustness checks, but also provide insights into what dimension of variation in the data is important for driving our results.

The main results are displayed in Table 6. Starting with the strongest results, we first find that persistent inflation is associated with higher pass-through from short-horizon to longer-horizon inflation expectations in all model specifications, something that we would expect to see as a mechanical consequence of any well-designed forecasting methodology. Second, following an inflation target is always associated with lower levels of pass-through. The improvement in anchoring is apparent even with year and economy dummies, indicating that it is not simply a result of an increasing number of inflation targeting central banks: the effect persists after we allow for a trend change in the level of anchoring and comparing the behaviour of the same economies before and after the adoption of inflation targets. Third, low policy rates are always associated with lower pass-through, although this is statistically insignificant when both economy and year fixed effects are included. Consistent with some of the studies discussed in Section 2, low policy rates in recent years have not been associated with de-anchoring of inflation expectations, even as conventional monetary policy instruments have run out of runway.

The results for the effects of exchange rate stability are more mixed. When economy fixed effects are not included, a stable exchange rate is associated with lower levels of pass-through. By contrast, when economy fixed effects are included, the sign switches and the results remain highly significant. In practical terms, this suggests that economies with stable exchange rates against either the US dollar or euro generally experience lower levels of expectations pass-through. However, once we control for this average effect, periods when the exchange rate is relatively stable are those when an individual economy experiences relatively high levels of pass-through.

Finally, there is no strong relationship between expectations pass-through and either the level of inflation or a dummy variable indicating that inflation is very low. If we exclude high-inflation periods, we do obtain significantly positive coefficients for both these variables provided that there are no economy fixed effects. This indicates that, for most economies, both relatively high or low inflation can be associated with increased inflation expectations pass-through. However, there is insufficient variation at the level of individual economies to identify any effect once economy fixed effects are included.

Regression results

Dependent variable: $\hat{\beta}_i$

Table 6

	All				Mean inflation < 10%			
Mean π	0.0013	0.0028	-0.0085	-0.0028	0.0077	0.0094	-0.00027	0.0021
	(0.0021)	*(0.0020)*	*(0.0039)*	*(0.0040)*	*(0.0021)*	*(0.0019)*	*(0.00722)*	*(0.0071)*
			**		***	***		
Low π	0.040	0.019	-0.0043	-0.023	0.050	0.041	0.0037	-0.018
	(0.020)	*(0.019)*	*(0.0139)*	*(0.014)*	*(0.019)*	*(0.017)*	*(0.0145)*	*(0.015)*
	**				***	**		
Persistent π	0.073	0.064	0.095	0.056	0.077	0.063	0.11	0.049
	(0.016)	*(0.018)*	*(0.013)*	*(0.017)*	*(0.016)*	*(0.018)*	*(0.01)*	*(0.019)*
	***	***	***	***	***	***	***	***
Low *i*	-0.14	-0.051	-0.16	-0.0070	-0.13	-0.055	-0.15	-0.0015
	(0.02)	*(0.023)*	*(0.02)*	*(0.028)*	*(0.02)*	*(0.022)*	*(0.02)*	*(0.0281)*
	***	**	***		****	**	***	
IT	-0.11	-0.089	-0.52	-0.32	-0.13	-0.10	-0.50	-0.31
	(0.01)	*(0.012)*	*(0.05)*	*(0.05)*	*(0.01)*	*(0.01)*	*(0.06)*	*(0.05)*
	***	***	***	***	***	***	***	***
FX stable	-0.062	-0.053	0.089	0.14	-0.063	-0.055	0.10	0.16
	(0.017)	*(0.016)*	*(0.028)*	*(0.03)*	*(0.016)*	*(0.012)*	*(0.02)*	*(0.03)*
	***	***	***	***	***	***	***	***
Year FE	N	Y	N	Y	N	Y	N	Y
Economy FE	N	N	Y	Y	N	N	Y	Y
No of observations	*1083*	*1083*	*1083*	*1083*	*1033*	*1033*	*1033*	*1033*
Adjusted *R*-squared	0.16	0.23	0.54	0.59	0.19	0.25	0.56	0.61

Robust standard errors are in brackets. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

We next split the sample between advanced and emerging market economies and repeat the estimation on the two sub-samples, as reported in Table 7. One key result that continues to hold is that inflation targeting is associated with a statistically significant decline in expectations pass-through in all specifications. However, the persistence of inflation is not significant for the emerging market economy sample, and low policy rates are also less significant, although this may be partly due to the small number of such observations for this sub-sample, constituting 3% of the sample (versus 9% for advanced economies).

We also separately examine the inflation targeting economies in our sample, focusing on those samples for which there was an inflation target for the full 10-year rolling samples, and consider additional measures that specifically apply to them:

- IT length: the number of consecutive years for which a central bank has had an inflation target. Pass-through may be lower if an inflation targeting regime has been in place for longer.
- Mean $\left|\pi - \pi^*\right|$: the average absolute gap between inflation and the target. Perhaps pass-through increases with deviations of inflation from the specified target.

Regression results

Dependent variable: $\hat{\beta}_i$

Table 7

	Advanced economies				Emerging market economies			
Mean π	-0.018	-0.018	-0.0054	-0.019	0.0077	0.0046	-0.0021	-0.0023
	(0.009)	*(0.010)*	*(0.0097)*	*(0.010)*	*(0.0021)*	*(0.0026)*	*(0.0046)*	*(0.0049)*
	*	*		*	***	*		
Low π	0.027	0.030	-0.0057	-0.039	0.050	-0.057	0.017	-0.034
	(0.022)	*(0.022)*	*(0.0220)*	*(0.023)*	*(0.019)*	*(0.031)*	*(0.018)*	*(0.017)*
				*	***	*		**
Persistent π	0.13	0.14	0.12	0.053	0.077	-0.036	0.020	0.029
	(0.02)	*(0.02)*	*(0.02)*	*(0.022)*	*(0.016)*	*(0.024)*	*(0.025)*	*(0.028)*
	***	***	***	***	***			
Low *i*	-0.15	-0.10	-0.14	-0.062	-0.13	-0.044	-0.28	-0.043
	(0.02)	*(0.03)*	*(0.02)*	*(0.034)*	*(0.02)*	*(0.034)*	*(0.05)*	*(0.046)*
	***	***	***	*	****		***	
IT	-0.12	-0.093	-0.49	-0.30	-0.13	-0.035	-0.52	-0.30
	(0.02)	*(0.015)*	*(0.11)*	*(0.10)*	*(0.01)*	*(0.016)*	*(0.06)*	*(0.06)*
	***	***	***	***	***	**	***	***
FX stable	-0.061	-0.043	0.040	0.13	-0.063	0.026	0.27	0.14
	(0.018)	*(0.015)*	*(0.037)*	*(0.04)*	*(0.016)*	*(0.031)*	*(0.04)*	*(0.06)*
	***	***		***	***		***	**
Year FE	N	Y	N	Y	N	Y	N	Y
Economy FE	N	N	Y	Y	N	N	Y	Y
No of observations	*536*	*536*	*536*	*536*	*547*	*547*	*547*	*547*
Adjusted *R*-squared	0.30	0.33	0.57	0.61	0.10	0.33	0.53	0.60

Robust standard errors are in brackets. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

We also considered the average gap between inflation and the target, Mean $(\pi - \pi^*)$, but this is highly correlated with the level of inflation (ρ = 0.89). The correlations between all the explanatory variables considered for the inflation targeting sample are given in Table 8.

Correlations between explanatory variables, inflation targeting sample

Table 8

	Mean π	Low π	Persistent π	Low *i*	FX stable	IT length	Mean $\lvert\pi - \pi^*\rvert$
Mean π	1.00						
Low π	-0.15	1.00					
Persistent π	0.10	0.01	1.00				
Low *i*	-0.32	0.30	0.00	1.00			
FX stable	-0.22	-0.02	0.20	0.27	1.00		
IT length	-0.46	0.08	0.05	0.39	-0.13	1.00	
Mean $\lvert\pi - \pi^*\rvert$	0.66	-0.01	0.24	-0.11	0.13	-0.40	1.00

The regression results are presented in Table 9. For the inflation targeting economies, results tend to be more uniform across the different specifications: when we add fixed effects, statistical significance tends to decline but the signs of the estimates remain generally unchanged. Perhaps this reflects greater homogeneity of the sample compared with the full sample estimated above.

Regression results for inflation targeters

Dependent variable: $\hat{\beta}_i$

Table 9

Mean π	0.010	0.010	0.019	0.022
	(0.003)	*(0.003)*	*(0.008)*	*(0.007)*
	***	***	**	***
Low π	0.059	0.040	0.049	0.016
	(0.012)	*(0.012)*	*(0.012)*	*(0.010)*
	***	***	***	
Persistent π	0.0069	0.0085	0.015	0.0057
	(0.0105)	*(0.0117)*	*(0.013)*	*(0.0159)*
Low i	-0.13	-0.13	-0.16	-0.15
	(0.03)	*(0.02)*	*(0.03)*	*(0.02)*
	***	***	***	***
FX stable	0.14	0.14	0.12	0.044
	(0.04)	*(0.04)*	*(0.04)*	*(0.042)*
	***	***	***	
IT length	-2.1E-04	-1.8E-04	-1.3E-04	1.1E-04
	(6.4E-05)	*(1.0E-04)*	*(6.5E-05)*	*(6.1E-04)*
	***	*	**	
Mean $\left\|\pi - \pi^*\right\|$	-0.021	-0.018	-0.0042	-0.0028
	(0.008)	*(0.008)*	*(0.0131)*	*(0.0140)*
	***	**		
Year FE	N	Y	N	Y
Economy FE	N	N	Y	Y
No of observations	*401*	*401*	*401*	*401*
Adjusted *R*-squared	0.16	0.19	0.69	0.74

Robust standard errors are in brackets. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

The results indicate that, for inflation targeting economies, both higher average inflation and very low levels of inflation are associated with higher pass-through, as is a stable exchange rate. As with the full sample, low policy rates are associated with reduced pass-through. In addition, having an inflation target for a longer period is associated with a reduction in pass-through. Somewhat surprisingly, a larger gap (in absolute terms) between inflation outcomes and the target is generally associated with a decline in pass-through, suggesting that past policy misses have not been associated with a deterioration in anchoring. In contrast, inflation persistence appears with a positive sign throughout, as expected, although it is no longer statistically significant.

6. Conclusions

In this paper, we investigate pass-through between short-horizon and long-horizon inflation forecasts as a way to assess the anchoring of inflation expectations. We find an overall decline in the pass-through from short-term to long-term expectations over time in our sample. When we divide our sample into economies with anchored, contained or unmoored expectations, the share of economies with anchored expectations has steadily improved over the last three decades.

We then look to see what might explain this improvement, based on second-stage regressions. We find that inflation targeting has played a significant role and, among inflation targeters, this effect is stronger the longer an economy has had an inflation target. Low inflation is generally associated with higher expectations pass-through for inflation targeters. However, other variables associated with the recent period of low inflation out-turns – low policy rates and persistent deviations of inflation from target (for inflation targeters) – are surprisingly correlated with a decline in expectations' pass-through. This suggests that longer-term expectations remain well anchored: perhaps forecasters perceive low inflation outcomes as transitory, and unlikely to persist for as long as the horizon on the long-term forecasts. Alternatively, as Malmendier and Nagel (2015) and Diamond et al (2015) suggest, long-term inflation expectations could be influenced by average inflation outcomes over an extended period of history. However, it remains to be seen if this relatively good news that long-term expectations have remained anchored even in the face of very low inflation will persist if inflation were to continue at current low levels.

One important caveat is that this study focuses on the expectations of professional forecasters. If agents were less forgiving in their assessment of short-term deviations from target when they set prices and wages, which ultimately drive the inflation process, the effects on anchoring would be felt more quickly.

References

Banerjee, Ryan and Aaron N Mehrotra (2018): "Deflation expectations", *BIS Working Papers*, no 699.

Banerjee, Ryan, Juan Contreras, Aaron Mehrotra and Fabrizio Zampolli (2020): "Inflation at risk in advanced and emerging market economies", *BIS Working Papers*, no 883.

Bems, Rudolfs, Francesca Caselli, Francesco Grigoli, Bertrand Gruss and Weichen Lian (2018): "Expectations' anchoring and inflation persistence", *International Monetary Fund Working Paper*, no 18/280.

Bundick, Brent and A Lee Smith (2018): "Does communicating a numerical inflation target anchor inflation expectations? Evidence & bond market implications", *Federal Reserve Bank of Kansas City Research Working Paper*, no 18-01.

Buono, Ines and Sara Formai (2018): "New evidence on the evolution of the anchoring of inflation expectations", *Journal of Macroeconomics*, vol 57, pp 39–54.

Carvalho Filho, Irineu E (2010): "Inflation targeting and the crisis: an empirical assessment", *IMF Working Paper*, no 10/45.

Conflitti, Cristina and Riccardo Cristadoro (2018): "Oil prices and inflation expectations", *Bank of Italy Occasional Papers*, no 423.

Corsello, Francesco, Stefano Neri and Alex Tagliabracci (2019): "Anchored or de-anchored? That is the question", *Banca D'Italia Occasional Papers*, no 516.

Davis, J Scott (2014): "Inflation targeting and the anchoring of inflation expectations: cross-country evidence from Consensus Forecasts", *Federal Reserve Bank of Dallas Globalization and Monetary Policy Institute Working Paper*, no 174.

De Pooter, Michiel, Patrice Robitaille, Ian Walker and Michael Zdinak (2014): "Are inflation expectations well anchored in Brazil, Chile and Mexico?" *International Journal of Central Banking*, vol 10(2), pp 337–400.

Dräger, Lena and Michael J Lamla (2018): "Is the anchoring of consumers' inflation expectations shaped by inflation experience?", *CESifo Working Paper*, no 7042.

Ehrmann, Michael (2015): "Targeting inflation from below: how do inflation expectations behave?", *International Journal of Central Banking*, vol 11(S1), pp 213–49.

Eusepi, Stefano, Marc Giannoni and Bruce Preston (2019): "On the limits of monetary policy", unpublished manuscript.

Faust, Jon and Jonathan Wright (2013): "Forecasting inflation", *Handbook of Economic Forecasting 2A*, pp 2–56, G Elliott and A Timmermann (eds), Elsevier, Amsterdam.

Fukuda, Shin-ichi and Naoto Soma (2019): "Inflation target and anchor of inflation forecasts in Japan", *Journal of the Japanese and International Economies*, vol 52, pp 154–170.

Galati, Gabriele, Steven Poelhekke and Chen Zhou (2011): "Did the crisis affect inflation expectations?", *International Journal of Central Banking*, vol 7(1), pp 167–207.

Garcia, Juan Angel and Sebastian Werner (2018): "Inflation news and euro area inflation expectations", *IMF Working Paper*, no 18/167.

Gefang, Deborah, Gary Koop and Simon M Potter (2012): "The dynamics of UK and US inflation expectations", *Computational Statistics & Data Analysis*, vol 56(11), pp 3120–3133.

Grishchenko, Olesya, Sarah Mouabbi and Jean-Paul Renne (2019): "Measuring inflation anchoring and uncertainty: a US and euro area comparison", *Journal of Money, Credit and Banking*, vol 51(5), pp 1053-1096.

Gürkaynak, Refet S, Andrew Levin and Eric Swanson (2010): "Does inflation targeting anchor long-run inflation expectations? Evidence from the US, UK, and Sweden", *Journal of the European Economic Association*, vol 8(6), pp 1208–1242.

Hachula, Michael and Dieter Nautz (2018): "The dynamic impact of macroeconomic news on long-term inflation expectations", *Economics Letters*, vol 165, pp 39–43.

Hammond, Gill (2011): "State of the art of inflation targeting", *CCBS Handbook no 29*, London: Bank of England.

Hattori, Masazumi, and James Yetman (2017): "The evolution of inflation expectations in Japan", *Journal of the Japanese and International Economies*, vol 46, pp 53–68.

Jochmann, Markus, Gary Koop and Simon M Potter (2010): "Modeling the dynamics of inflation compensation", *Journal of Empirical Finance*, vol 17, pp 157–167.

Kose, Ayhan, Hideaki Matsuoka, Ugo G Panizza and Dana Lauren Vorisek (2018): "Inflation expectations: review and evidence", *World Bank Policy Research Working Paper*, no 8785.

Kumar, Saten, Olivier Coibion, Hassan Afrouzi and Yuriy Gorodnichenko (2015): "Inflation targeting does not anchor inflation expectations: evidence from firms in New Zealand", *Brookings Papers on Economic Activity*, Fall, pp 151–208.

Levin, Andrew T, Fabio M Natalucci and Jeremy M Piger (2004): "The macroeconomic effects of inflation targeting", *Review-Federal Reserve Bank of Saint Louis*, vol 86(4), pp 51–58.

Malmendier, Ulrike and Stefan Nagel (2015): "Learning from inflation experiences", *The Quarterly Journal of Economics*, vol 131(1), pp 53–87.

Mehrotra, Aaron and James Yetman (2018): "Decaying expectations: what inflation forecasts tell us about the anchoring of inflation expectations", *International Journal of Central Banking*, vol 14(5), pp 55–101.

Miccoli, Marcello and Stefano Neri (2019): "Inflation surprises and inflation expectations in the Euro area", *Applied Economics*, vol 51(6), pp 651–662.

Moessner, Richhild and Elod Takáts (2020): "How well-anchored are long-term inflation expectations?" *BIS Working Papers*, no 869.

Natoli, Filippo and Laura Sigalotti (2017): "An indicator of inflation expectations anchoring", *Bank of Italy Working Papers*, no 1103.

Nautz, Dieter, Laura Pagenhardt and Till Strohsal (2017): "The (de-)anchoring of inflation expectations: new evidence from the euro area", *North American Journal of Economics and Finance*, vol 40, pp 103–115.

Nautz, Dieter and Till Strohsal (2015): "Are US inflation expectations re-anchoring?" *Economics Letters*, vol 127, pp 6–9.

Phillips, Peter C B and Pierre Perron (1988): "Testing for a unit root in time series regression", *Biometrika*, vol 75(2), pp 335–346.

Rogoff, Kenneth (1996): "The purchasing power parity puzzle", *Journal of Economic literature*, vol 34(2), pp 647–668.

Strohsal, Till, Rafi Melnick and Dieter Nautz (2016): "The time-varying degree of inflation expectations anchoring", *Journal of Macroeconomics*, vol 48, pp 62–71.

Strohsal, Till and Lars Winkelmann (2015): "Assessing the anchoring of inflation expectations", *Journal of International Money and Finance*, vol 50, pp 33–48.

Sussman, Nathan and Osnat Zohar (2018): "Has inflation targeting become less credible?" *BIS Working Papers*, no 729.

Svensson, Lars E O (2010): "Inflation targeting", *Handbook of Monetary Economics* 3, pp 1237–1302, Elsevier, Amsterdam.

Yetman, James (2015): "The evolution of inflation expectations in Canada and the US", *Canadian Journal of Economics*, vol 50(3), pp 711–737.

Phillips-Perron unit root tests on forecasts p-values

Table A1

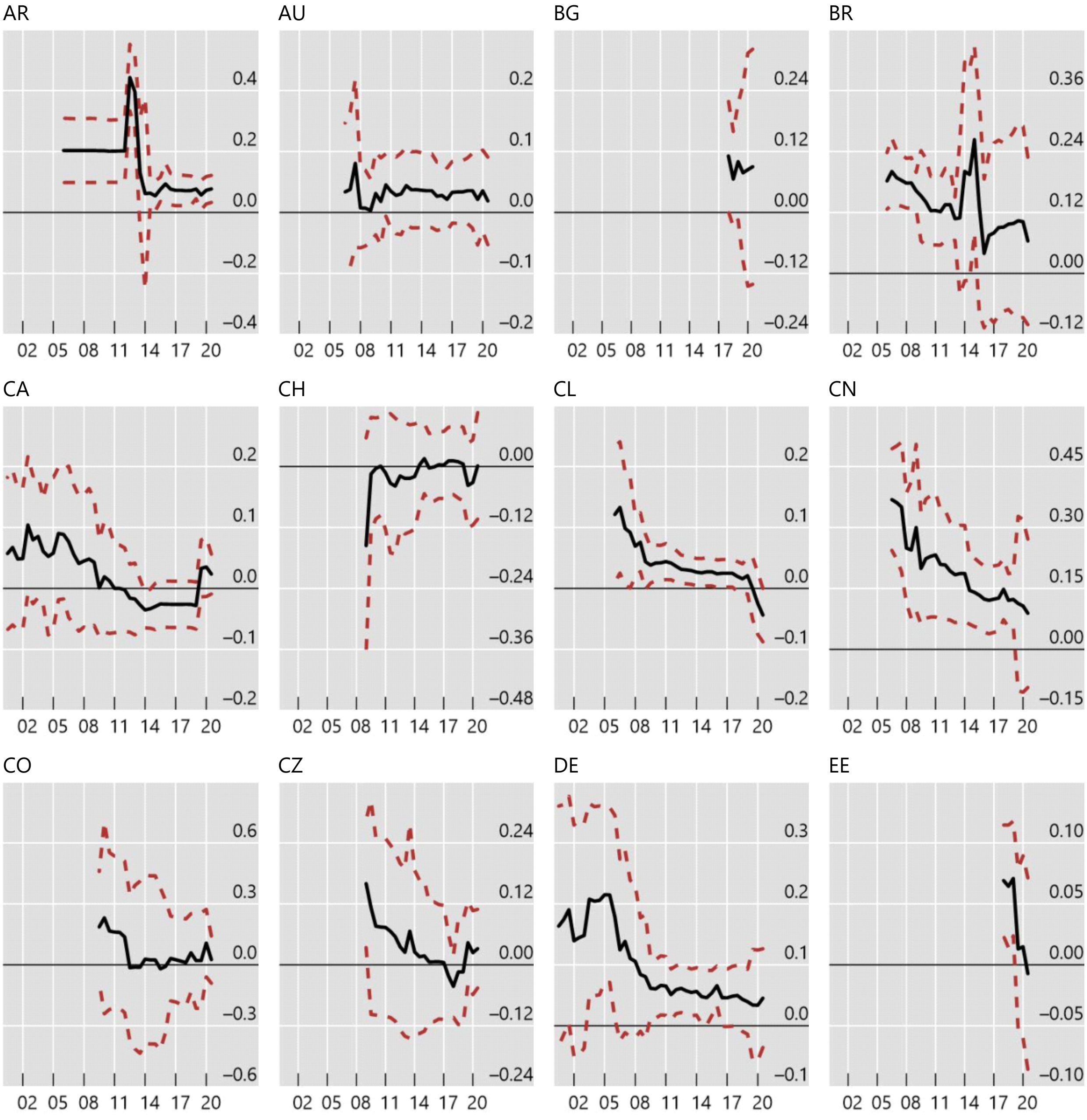
Economy	Long-term	Current year	Next year
AR	0.151	0.101	0.381
AU	0.023	0.003	0.000
BG	0.647	0.289	0.277
BR	0.000	0.000	0.000
CA	0.000	0.003	0.000
CH	0.138	0.028	0.100
CL	0.000	0.000	0.000
CN	0.000	0.000	0.000
CO	0.000	0.001	0.000
CZ	0.000	0.000	0.000
DE	0.373	0.125	0.185
EE	0.249	0.088	0.000
ES	0.017	0.111	0.116
FR	0.240	0.065	0.169
GB	0.445	0.094	0.001
HK	0.098	0.256	0.238
HR	0.817	0.364	0.593
HU	0.000	0.007	0.000
ID	0.218	0.999	1.000
IN	0.013	0.108	0.284
IT	0.055	0.400	0.321
JP	0.020	0.044	0.067
KR	0.511	0.036	0.694
LT	0.028	0.181	0.080
LV	0.246	0.139	0.037
MX	0.080	0.000	0.000
MY	0.004	0.010	0.150
NL	0.007	0.043	0.041
NO	0.393	0.000	0.000
NZ	0.486	0.031	0.011
PE	0.000	0.003	0.000
PH	0.002	0.105	0.589
PL	0.000	0.003	0.000
RO	0.042	0.000	0.199
RU	0.004	0.000	0.000
SE	0.000	0.002	0.000
SG	0.034	0.022	0.121
SI	0.396	0.210	0.344
SK	0.001	0.436	0.358
TH	0.583	0.081	0.356
TR	0.000	0.000	0.000
TW	0.007	0.000	0.005
UA	0.006	0.041	0.000
US	0.005	0.004	0.039

Notes: *p*-values from a Phillips-Perron test for a null hypothesis of non-stationarity. Colours indicate rejection of non-stationary at the 10% (grey), 5% (orange) and 1% (red) level, respectively.

Expectations pass-through: estimated coefficients and 95% confidence bands

Ten-year rolling samples

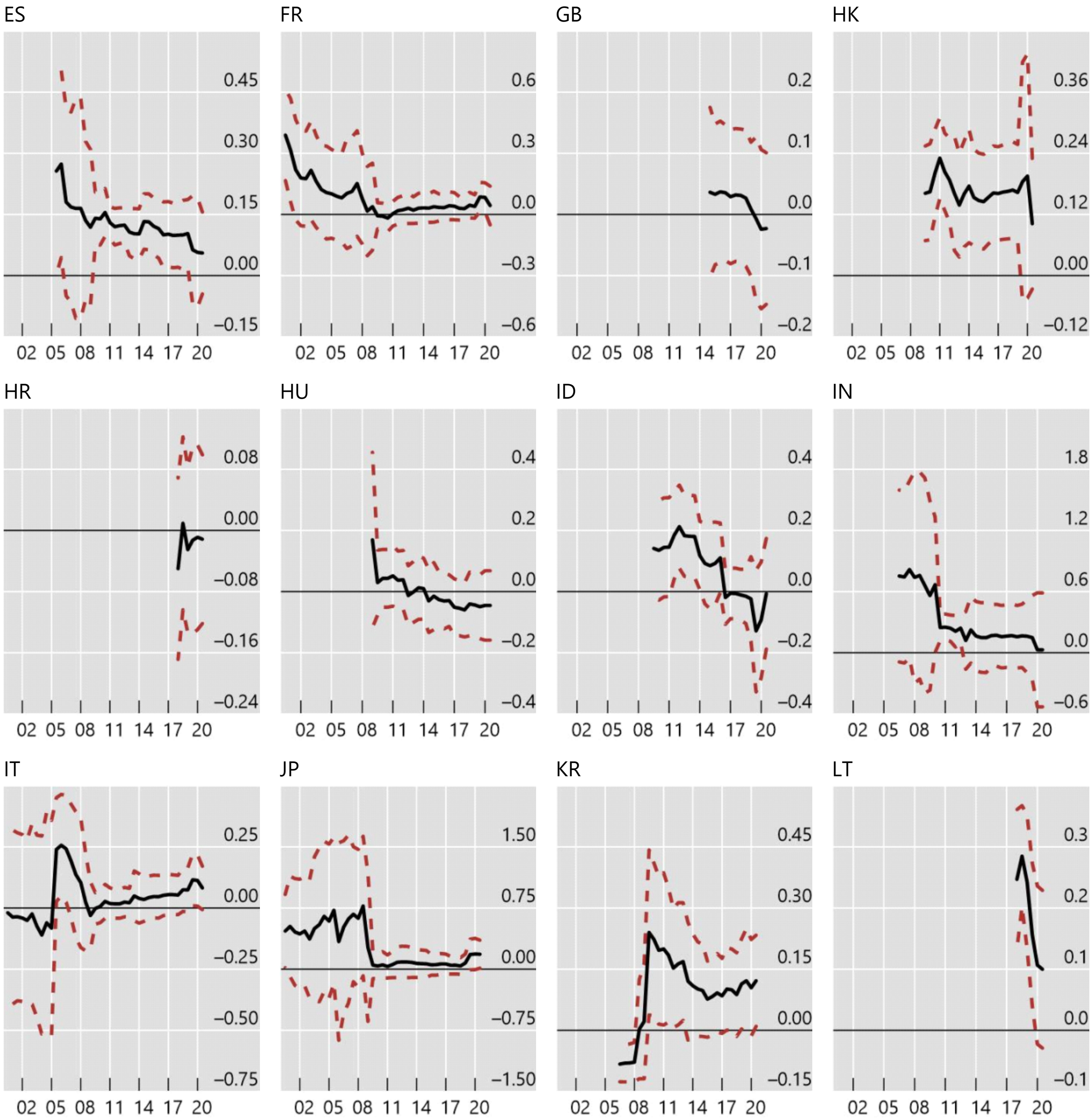
Graph A1



Source: author's calculations

Expectations pass-through: estimated coefficients and 95% confidence bands

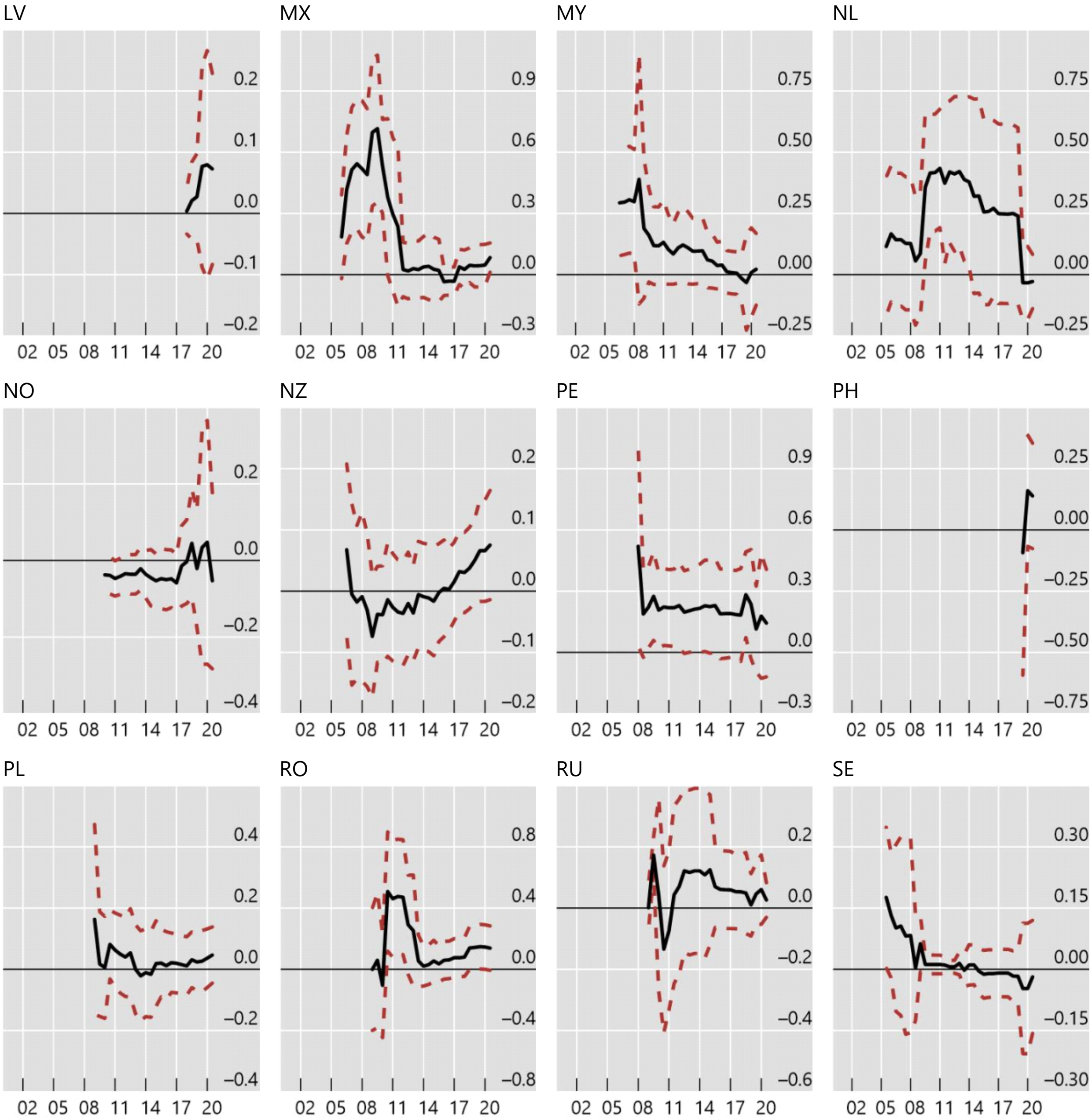
Ten-year rolling samples | Graph A1 (cont.)



Source: author's calculations

Expectations pass-through: estimated coefficients and 95% confidence bands

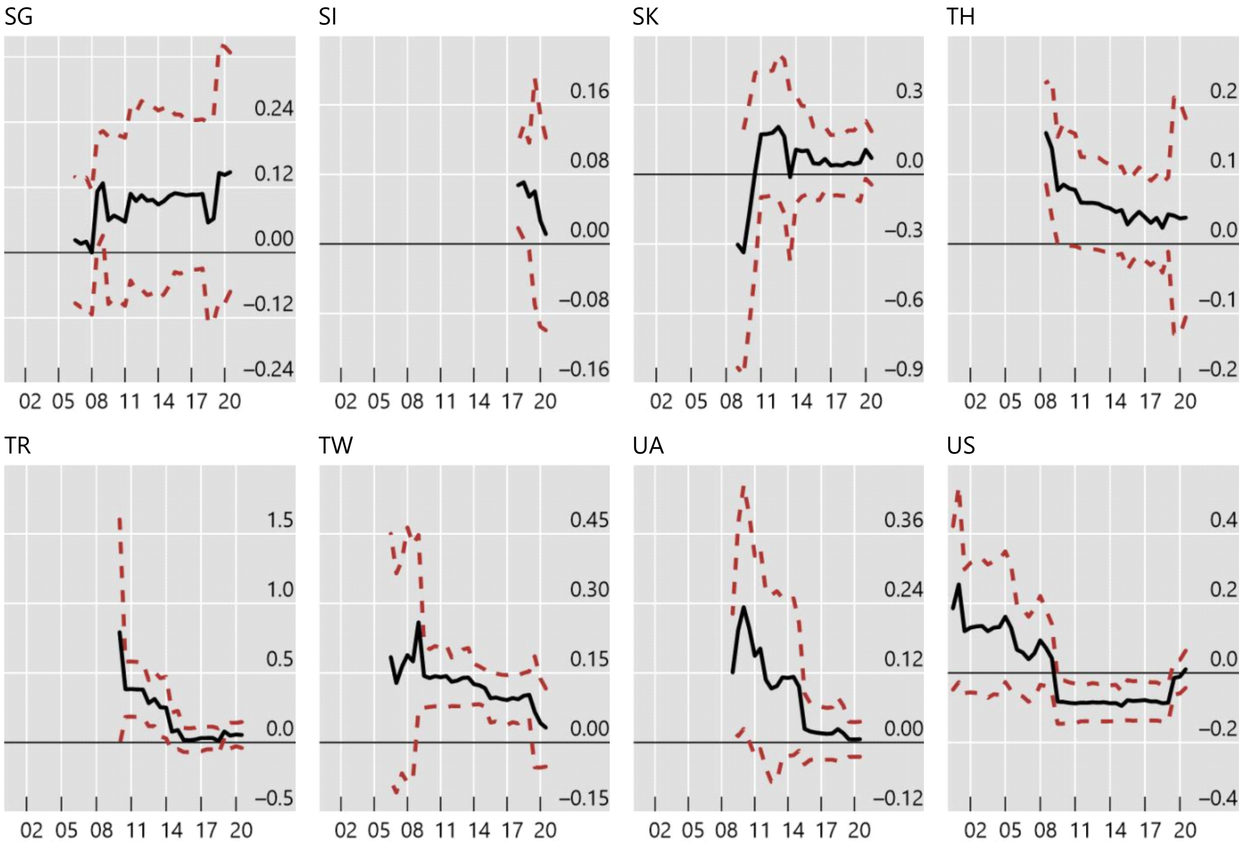
Ten-year rolling samples Graph A1 (cont.)



Source: author's calculations

Expectations pass-through: estimated coefficients and 95% confidence bands

Ten-year rolling samples Graph A1 (cont.)



Source: author's calculations

Inflation targeters

Table A2

Economy	IT adoption	First observation post adoption
AU	06.1993	04.1996
BR	06.1999	10.1999
CA	02.1991	04.1991
CL	09.1999	10.1999
CO	10.1999	04.2000
CZ	12.1997	09.1998
GB	10.1992	10.2004
HU	06.2001	09.2001
ID	07.2005	10.2005
IN	02.2015	04.2015
JP	04.2013	10.2013
KR	04.1998	10.1998
MX	01.2001	04.2001
NO	03.2001	04.2001
NZ	12.1989	04.1996
PE	01.2002	04.2002
PH	01.2002	04.2009
PL	09.1998	03.1999
RO	08.2005	09.2005
RU	11.2014	04.2015
SE	01.1993	04.1995
TH	05.2000	10.2000
TR	01.2006	03.2006
UA	03.2016	04.2016

Notes: IT adoption dates are based on Hammond (2011), and updated using IMF AREAER classifications. Where no month is specified, this is narrowed down based on central bank publications. For example, for Japan, April 2013 was the first time the Bank of Japan spoke of a specific time horizon to achieve the 2% target. For details, see Hattori and Yetman (2017). The right-hand column indicates the earliest long-term inflation forecast in our sample following the introduction of inflation targeting.

Previous volumes in this series

894 October 2020	Effects of eligibility for central bank purchases on corporate bond spreads	T Mäkinen, F Li, A Mercatanti and A Silvestrini
893 October 2020	Assessing the fiscal implications of banking crises	Claudio Borio, Juan Contreras and Fabrizio Zampolli
892 October 2020	Banking across borders: Are Chinese banks different?	Eugenio Cerutti, Catherine Koch and Swapan-Kumar Pradhan
891 October 2020	At the crossroads in the transition away from LIBOR: from overnight to term rates	Basil Guggenheim and Andreas Schrimpf
890 October 2020	How does international capital flow?	Michael Kumhof, Phurichai Rungcharoenkitkul and Andrej Sokol
889 September 2020	Foreign Exchange Intervention and Financial Stability	Pierre-Richard Agénor, Timothy P Jackson and Luiz Pereira da Silva
888 September 2020	Competitive effects of IPOs: Evidence from Chinese listing suspensions	Frank Packer and Mark M Spiegel
887 September 2020	Fintech and big tech credit: a new database	Giulio Cornelli, Jon Frost, Leonardo Gambacorta, Raghavendra Rau, Robert Wardrop and Tania Ziegler
886 September 2020	Price search, consumption inequality, and expenditure inequality over the life-cycle	Yavuz Arslan, Bulent Guler and Temel Taskin
885 September 2020	Credit supply driven boom-bust cycles	Yavuz Arslan, Bulent Guler and Burhan Kuruscu
884 September 2020	Retailer markup and exchange rate pass-through: Evidence from the Mexican CPI micro data	Fernando Pérez-Cervantes
883 September 2020	Inflation at risk in advanced and emerging market economies	Ryan Banerjee, Juan Contreras, Aaron Mehrotra and Fabrizio Zampolli
882 September 2020	Corporate zombies: Anatomy and life cycle	Ryan Banerjee and Boris Hofmann
881 September 2020	Data vs collateral	Leonardo Gambacorta, Yiping Huang, Zhenhua Li, Han Qiu and Shu Chen

All volumes are available on our website www.bis.org.