What anchors for the natural rate of interest?*

Claudio Borio, Piti Disyatat and Phurichai Rungcharoenkitkul†

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Abstract

The paper takes a critical look at the conceptual and empirical underpinnings of prevailing explanations of low real (inflation-adjusted) interest rates over long horizons and finds them incomplete. The role of monetary policy, and its interaction with the financial cycle in particular, deserve greater attention. By linking booms and busts, the financial cycle generates important path dependencies that give rise to intertemporal policy trade-offs. Policy today constrains policy tomorrow. The policy regime is not neutral and can exert a persistent influence on the economy's evolution, including on the real interest rate. This raises serious conceptual and practical questions about the use of the natural interest rate as a monetary policy guidepost. In developing the analysis, the paper also provides a specific critique of the safe asset shortage hypothesis – a hypothesis that has gained considerable popularity in recent years.

JEL classification: E32, E40, E44, E50, E52.

Keywords: Real interest rate, natural interest rate, saving, investment, inflation, monetary policy, safe asset shortage hypothesis.

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† Rungcharoenkitkul (corresponding author), Senior Economist, Bank for International Settlements, Borio: Head of Monetary and Economic Department, Bank for International Settlements, claudio.borio@bis.org; Disyatat: Executive Director, Puey Ungphakorn Institute for Economic Research, Bank of Thailand, pitid@bot.or.th.

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Introduction

The interest rate is of immense importance in today's highly financialised economy. It underpins borrowing and lending and thus acts as a speed regulator for activity. Ensuring that interest rates are at "appropriate" levels – a task largely delegated to central banks – is critical. In making this judgment, the natural or equilibrium interest rate serves as the key benchmark in mainstream monetary policy analysis. This notional rate, a purely theoretical construct, is defined as the real (inflation-adjusted) interest rate that would prevail when actual output equals potential output. The evolution of this rate is seen as driven by changes in underlying saving-investment determinants. Given the presumption that monetary factors are "neutral" in the long-run – ie that they do not influence the path of real variables over that horizon – the secular decline in global real interest rates over much of the past 30 years has generally been seen as reflecting a secular decline in the natural interest rate.

But is this story complete? Is the monetary policy regime just a side-show in the long-run evolution of real interest rates? Our short answers are "no and no". For one, given the great uncertainty surrounding the measurement of the notional natural rate, the presumption that central banks together with market participants can set rates in line with the evolving unobserved natural rate is a heroic one. To be sure, a failure to set rates at their natural level should presumably be reflected in "unsatisfactory" paths for output and inflation. But identifying what is "unsatisfactory" in real time can be quite difficult. Inflation, for example, has been especially insensitive to measures of economic slack and arguably subject to persistent and powerful supply-side forces. Thus, market rates may fail to track the relevant unobserved natural rate for extended periods. More fundamentally, there is a growing recognition that the financial cycle exerts a powerful and potentially long-lasting influence on the economy, not least when it implodes. To the extent that monetary policy, which sets the price of leverage, can influence the financial cycle, it too may have a persistent impact on the economy's long-run path, and hence also on real interest rates. If the definition of equilibrium also precludes the occurrence of boom-bust cycles, as one would reasonably expect, then it may not be possible to define a natural rate independently of the monetary regime.

This perspective differs from the standard narratives put forward to explain the trend decline in real interest rates. Invariably, the presumption is that an excess of *ex ante* saving over investment has driven equilibrium real interest rates down. In this narrative, monetary and financial factors play at most only a cursory role, if any. For instance, Summers' (2015) secular stagnation hypothesis contends that chronically weak aggregate demand together with the zero lower bound have kept desired saving above investment and pushed the natural rate below market rates. And in an open economy context, the global saving glut (Bernanke (2005)) and safe asset shortage (Caballero et al (2017)) hypotheses have postulated that excess saving in emerging market economies (EMEs), as reflected in their current account surpluses, has flowed into advanced economies depressing real rates there.

We develop an alternative perspective, in which monetary factors play a larger role, in a number of steps. Using historical data stretching back to 1870 for 19 countries, we first document that traditional saving-investment fundamentals do a poor job in explaining real interest rate movements consistently. While it is possible to find some relationships consistent with theory in some periods, particularly over the last 30 years, the relationships do not survive over the extended sample. This holds both at the national and global level. By contrast, there is evidence that persistent shifts in real interest rates coincide with changes in monetary regimes. Moreover, from a global perspective, the role of monetary policy in anchor countries is more evident than global saving-investment determinants.

We then illustrate both empirically and theoretically the potential role of monetary policy in influencing real economic developments, and hence the real interest rate, over long horizons through its impact on the financial cycle. The underlying theme is that booms usher in busts. The fragilities that emerge during the bust build up during the preceding boom and cannot be analysed without reference to it. This contrasts with popular approaches that view crises as the result of (exogenous) shocks amplified by financial frictions in the system.

The empirical model decomposes the financial cycle into two sets of variables that in the data are found to have very stable long-run relationships (Juselius and Drehmann (2015)). One is a proxy for private sector debt service burden (interest costs relative to income) – a flow – and the other is a proxy for leverage (real asset prices relative to debt-to-income) – a stock. Deviations of these variables from their long-run relationships interact and, when embedded in a richer empirical system, are found to have a sizeable impact on private sector expenditure and output fluctuations. The system gives rise to endogenous fluctuations in which the financial and real sectors interact leading to a very persistent impact on output. The path-dependence generated by financial cycles highlights the *cumulative* impact of policy. The long-run real interest rate path depends in part on the monetary policy rule in place.

The illustrative theoretical model shows how such path dependence can arise in an environment where loan market frictions give rise to excess risk-taking, which is more severe when interest rates are low. The interest rate the central bank sets is the system's forcing variable that regulates risk-taking period by period. Risk thus accumulates over time and is reflected in the evolution of bank capital. These features introduce an intertemporal policy trade-off. Easier policy today boosts output in the short run but accommodates the build-up of financial imbalances, which generate large output losses in the long run when they implode. Depending on the monetary policy rule, the economy's fragility to boom-bust cycles may be high or low, with significant implications for the long-run evolution of output and real interest rates.

The main takeaway from this analysis is that the natural rate of interest has a couple of limitations as a monetary policy guidepost. First, as traditionally postulated, the definition of the concept neglects the state of the financial cycle and, as such, underestimates the role that monetary policy regimes may play. Put differently, a given real interest rate cannot be an equilibrium one if it generates costly boom-bust cycles, with persistent, if not long-run, effects on output. Second, the fact that the natural rate may be endogenous to monetary policy over the relevant policy horizon compromises its ability to act as a policy anchor. As a result, monetary policy may fail to take into account the collateral damage that comes from an unhinged financial cycle. We propose a more balanced approach that recognises the difficulties monetary policy has in fine-tuning inflation and in which monetary policy responds more systematically to the financial cycle. While retaining price stability-oriented frameworks, implementing such a policy requires adopting greater flexibility than is now often the case.

The paper is organised as follows. The first section questions the empirical relevance of the saving-investment view. Based on historical data for a large cross section of countries, we find that the ability of the saving-investment fundamentals to explain real interest rates is limited, while that of monetary regimes appears more evident. This section also examines critically the safe asset shortage (SAS) hypothesis, given its salience in the debate and as an example of the broader family of saving-investment explanations. The second section explores both empirically and theoretically the monetary factors' potential to exert a persistent impact on the long-run real interest rate path through their impact on the financial cycle. In doing so, the section questions the usefulness of the natural rate of interest as a practical policy guide and argues that, if the concept is used at all, it would be useful to extend it to include a reference to financial equilibrium. The final section discusses the risks that may arise if policy does not take the financial cycle sufficiently into account, including the possibility of a "debt trap". It then considers adjustments to policy frameworks that would allow a more systematic response so as to improve macroeconomic outcomes.

1. Real interest rate determination: saving and investment?

Much attention has been devoted to the trend decline in global real interest rates over the past 30 years and to the exceptionally low levels seen since the Great Financial Crisis (GFC). The predominant explanation rests on the presumption that these developments are driven by changes in underlying saving-investment determinants (eg Bernanke (2005), Caballero et al (2008), Summers (2014) and Broadbent (2014)). In this view, these forces govern variations in some notional "equilibrium" or natural real rate, defined as the real interest rate that would prevail when actual output equals potential output. In turn, market rates gravitate towards this rate. Monetary and financial factors can perturb the real rate only temporarily, without a lasting impact in the medium to long run.

But how well does this standard view hold up to empirical scrutiny? Probably less well than commonly thought. We argue that this is the case generally, including for the popular SAS variant of the standard view.

1.1 A historical perspective

A key limitation of the available evidence is that it relies critically on a number of maintained hypotheses, ie hypotheses assumed to be true as basis for the tests (see also Lubik and Matthes (2015)) But before tuning to these limitations more specifically, it is useful to stand back and consider the distinction between market and natural rates more carefully, as this is often glossed over.

Surely there is – or should be – agreement over how nominal *market* rates are determined *at any given point in time*. This is through the combined actions of central banks and market participants. Central banks set the nominal short-term rate and influence the nominal long-term rate (through signals of future policy rates and asset purchases). Market participants adjust their portfolios based on their expectations of central bank policy, their views about the other factors driving long-term rates, their attitude towards risk and various balance sheet constraints. Given nominal interest rates, actual inflation – which is sticky – determines *ex post* real rates, and expected inflation *ex ante* real rates.

Given the now standard assumption of long-run money (monetary policy) neutrality, it is then appealing to define a *natural* interest rate that is entirely independent of monetary policy. This is the real interest rate that would prevail if the economy was at full employment – the rate that equilibrates desired saving and investment at that point (Wicksell (1898), Woodford (2003)). Of course, since the long run is purely an *analytical* concept – the result of a thought experiment – it needs to be mapped into *calendar* time, which is the only one relevant for policy. In practical terms, "long run" is taken to mean "over sufficiently long horizons" – say a decade – although sometimes even shorter periods.[1] In other words, one tends to assume that market and natural rates will coincide, on average, over such long horizons.[2] This logic does not imply that saving-investment balances influence *market* real rates *directly*, but rather that they affect them *indirectly* through inflation (and expectations thereof) or the setting of nominal rates by central banks and market participants.

This leaves open the question of what are the mechanisms that drive market rates towards the natural rate. We will return to this point later. But the distinction between market and natural rates, as well as the question of how the former gravitate to the latter, is worth keeping in mind when considering the limitations of the two main approaches to establishing empirical evidence for the saving-investment view of real interest rate determination.

The first approach simply *assumes* that, over the relevant sample, the market rate tracks the natural interest rate. It thus abstracts entirely from a discussion of the behaviour of prices and inflation – implicitly assuming monetary neutrality. In its less formal variant, visual inspection of data is the basis for plausible stories (eg, Bean et al (2015)); in its more formal one, the approach relies on more articulated models and parameter calibration to see whether these can produce results roughly consistent with the data (eg, Rachel and Smith (2017), Carvalho et al (2016), Gagnon et al (2016)).[3]

This general strand suffers from three drawbacks. Neither variant provides independent evidence that the market rate has actually tracked the natural rate. Neither really tests the

1 Kocherlakota (2013), for example, argues that policymakers are simply tracking the natural rate in real time. Indeed, standard DSGE models prescribe optimal monetary policy as largely following the natural real rate much of the time.

2 Here and in what follows, it is important to distinguish between the real return on capital and the "financial" real rate. The former reflects the returns from real economic activity, including business investment in real capital, while the latter reflects the yield on a financial instrument deflated by inflation. Typical models subsume all returns into one single interest rate even though in practice the return to capital has been shown to be quite different to the financial real rate (Gomme et al (2015)). Our argument about the importance of monetary policy pertains to the latter. Indeed, in Borio et al (2017a) we examine the link between market interest rates and proxies for the marginal product of capital over a long historical sample and find that it is rather weak (see below).

3 In calibration, the researcher chooses values for both the structural parameters and unobserved shock processes to mimic some key features of the data. These commonly include steady state ratios between variables, second moments of selected variables and so on. Yet the key features typically constitute only a small subset of the model's full implications for the data, and there is less discipline in the remaining directions. This gives the investigator considerable degrees of freedom when fitting the features of interest at the expense of general model fit. Equally problematic is the high reliance on persistent shock processes or unobserved stochastic trends. With a sufficiently high number of such processes, the model can generates a perfect fit without an increase in predictive power – a case of "overfitting".

underlying saving-investment framework of interest rate determination: the first takes it implicitly as the starting point of the analysis; the second does it more explicitly, in the form of a model. And both simply seek to replicate the main stylised features of the data rather than estimating any relationships more tightly based on observable variables.

The second approach seeks to filter out the unobservable natural rates from market rates. Here, the behaviour of inflation provides a key signal (eg, Laubach and Williams (2015), Holston et al (2016), Justiniano and Primiceri (2010), Del Negro et al (2017)). Taking the Phillips curve as the maintained hypothesis, the approach infers that, if inflation rises output must be above potential, and if it falls, output must be below potential. Given that the real interest rate influences aggregate demand, the next step is to infer that whenever inflation rises, the market rate must be below the natural rate, and vice versa when it falls.

The main drawback of this approach, as discussed further below, is that the Phillips curve has proved very elusive for quite some time now, as indicated by the rather weak link between inflation and economic slack (ie, Stock and Watson (2007), Borio (2017a), Forbes et al (2017)). This makes any firm inferences suspect. Moreover, filtering approaches typically relate the unobserved natural rate to other unobservable variables, such as potential growth and preferences, providing many degrees of freedom for the tests. Thus, the maintained hypothesis ends up having a decisive influence on the results. As with calibration, the risk of over-fitting in any given sample is material.

To overcome these drawbacks, in Borio et al (2017a) we examine directly the link between real interest rates and observable saving-investment determinants using long historical data going as far back as 1870 for 19 countries.[4] A long historical perspective is important because it allows analysis of the effects of different factors over successive cycles. This is especially relevant for the financial cycle, which typically has very long duration, in the order of 15-20 years (see below). In contrast, much of the empirical studies outlined above concentrate on the period since the mid-1980s, over which real interest rates have been declining. This makes it harder to distinguish their true drivers from variables that may be temporarily correlated due to similar trends.

Graph 1 shows the time series of global real interest rates, captured by the cross-country median. We see that real rates of both long and short maturities tend to co-move closely, although short-term rates are naturally more volatile. Excluding the World Wars, when real rates drop, sometimes deeply, into negative territory, one can discern four distinct phases. Up to World War I – mostly the classical gold standard – real rates were comparatively high and stable. In the interwar years, after recovering quickly from World War I, they started to fall markedly in the wake of the Great Depression. Real rates then rose much more gradually starting in the early 1950s and, after a new big dip during the Great Inflation, peaked in the early to mid-1980s, reaching levels broadly similar to those seen in the early part of the sample. Finally, they have been declining since then, to historically low levels, wars excepted.

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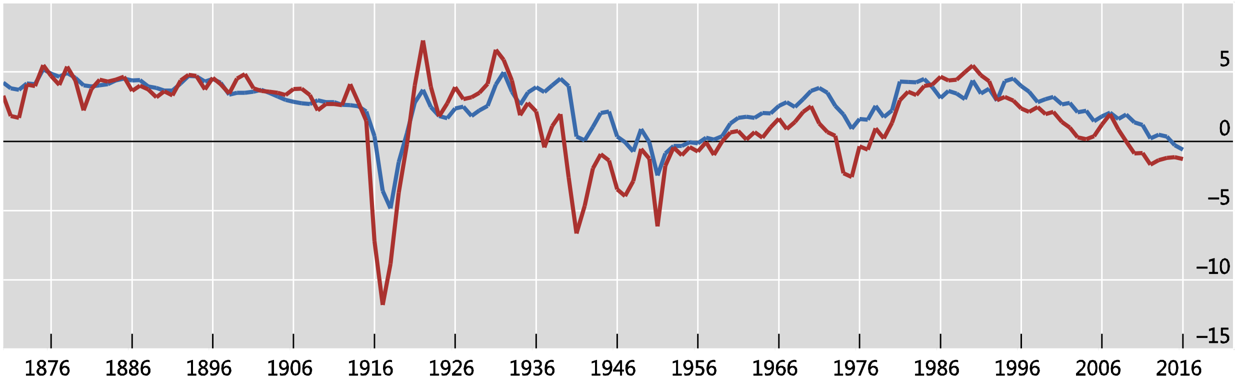
[4] The countries covered include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

Real interest rates

In per cent | Graph 1



Sources: Authors' calculations. The ex ante real interest rate is calculated as a nominal rate minus expected inflation, based on a CPI index. The short rate is based on 3-month government bill while the long rate is the 10-year government bond yields (or their closest proxies). We proxy expected inflation by recursively projecting an autoregressive (AR) model, estimated over a rolling 20-year window, and compute its average over the relevant horizons.

To assess the empirical relevance of the saving-investment perspective, we explore the relationship between real interest rates and the "usual suspects": growth, productivity, demographics, income distribution, the relative price of capital, and the marginal product of capital.[5] We examine long-term rates as well as the standard, Laubach-Williams version of the natural rate. We then compare the role of the usual suspects with that of monetary policy. In particular, we examine whether monetary policy regimes, dated specifically for each country, are able to explain real interest rates. Given our historical data, we are able to cover a number of different monetary regimes.

We come up with two key findings.

First, while the usual suspects appear to work reasonably well in *bivariate* regressions over the often cited, more recent sample, the relationships break down when going back in history. No consistent pattern emerges – a sign that the relationships may be spurious. Even simple visual inspection of the data suggests that this is likely to be the case (Graph 2). The finding is confirmed by more formal testing, when one allows the various real sector determinants to interact. Table 1 shows the results from a panel fixed-effects regression. Statistically significant and correctly signed coefficients, according to the theory, are in green while statistically significant and wrongly signed ones are in red. Not only is there little support for the theory in the full sample, but even for the most recent 30-year window the only variable that significantly retains the expected sign is life expectancy—a variable that in fact has a trend

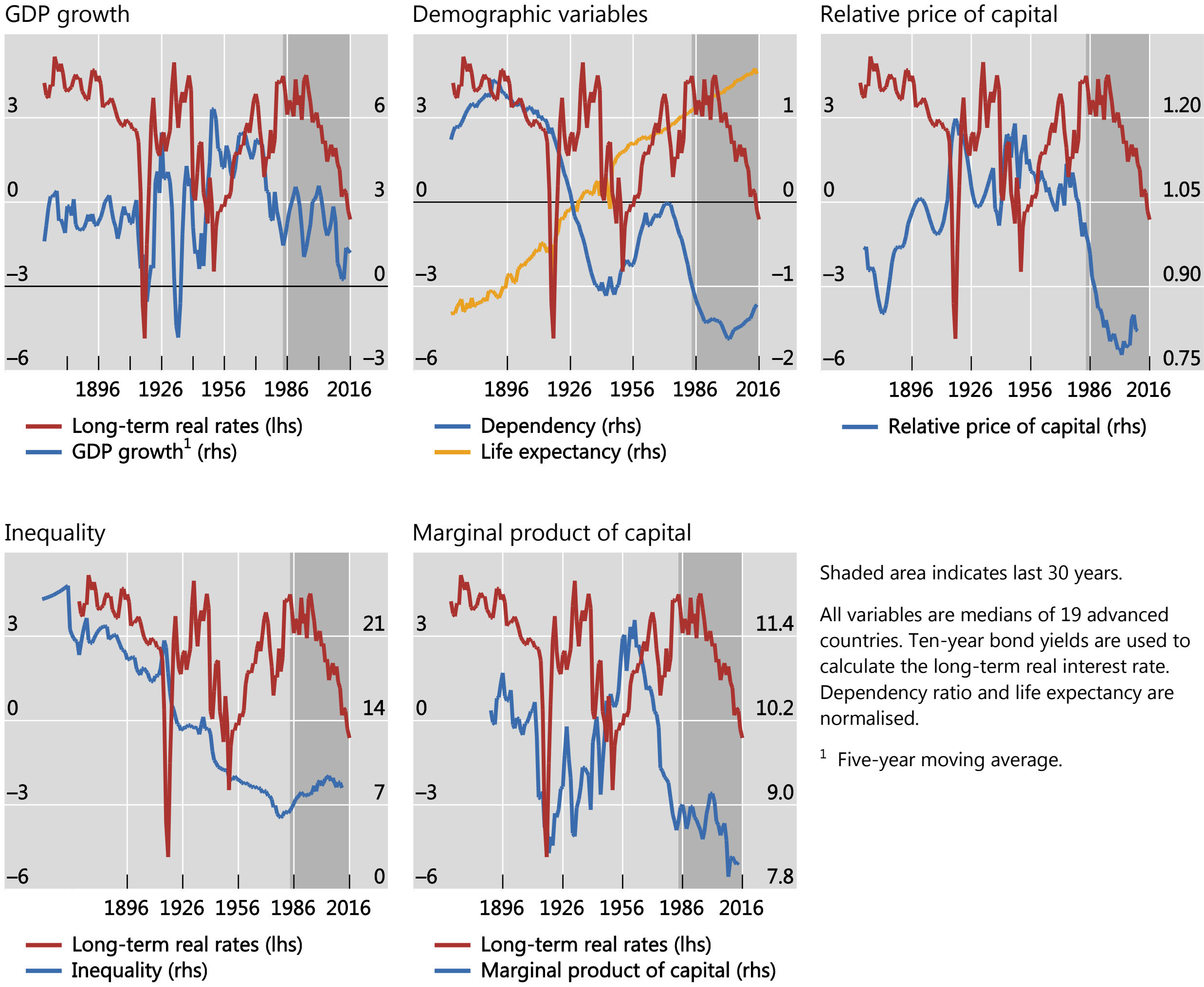
5 For studies following a similar approach, but testing a fewer set of variables and largely on US data, see Hamilton et al (2015) and Lunsford and West (2017). In line with the results reviewed below, they do not find any systematic relationship between the real interest rate and variables such as GDP and productivity growth, which theory takes for granted as the determinants of the natural interest rate.

throughout the long sample. Notably, there is substantial coefficient instability across subsamples in terms of both sign and size.[6]

Real interest rate and saving/investment drivers: spot the correlation

In per cent

Graph 2



Shaded area indicates last 30 years.

All variables are medians of 19 advanced countries. Ten-year bond yields are used to calculate the long-term real interest rate. Dependency ratio and life expectancy are normalised.

[1] Five-year moving average.

Source: Borio et al (2017a).

Second, there are generally economically and statistically significant differences in the level of interest rates across monetary policy regimes; moreover, their trends also differ. This is illustrated, visually, in Graph 3. Formal tests show that monetary regime dummies not only matter but actually perform better than most saving-investment determinants when they are

[6] These findings survive an extensive set of robustness checks. These include: extension to dynamic fixed-effects panel specification; instrumental variables to account for possible endogeneity of the saving-investment factors with respect to interest rates; GMM estimation; inclusion of global counterparts of the saving-investment determinants; and, alternative dependent and independent variables. And it appears robust to the use of different interest rates – long and short; market or traditional estimates of natural rates – as well as measures of inflation expectations.

Real interest rates and the "usual suspects"

Table 1

	(1) Full sample	(2) Gold standard	(3) Interwar	(4) Postwar	(5) Pre-Volcker	(6) Post-Volcker
GDP growth (+)	–0.09**	–0.00	–0.07	0.08	0.07	0.03
	(0.04)	(0.02)	(0.05)	(0.07)	(0.07)	(0.05)
Population growth (+/–)	–0.83*	–0.50	0.25	–0.77**	–0.00	–0.68
	(0.39)	(0.50)	(0.36)	(0.28)	(0.28)	(0.71)
Dependency ratio (+)	0.02	–0.03	–0.04	0.03	0.14***	–0.03
	(0.02)	(0.02)	(0.09)	(0.02)	(0.02)	(0.07)
Life expectancy (–)	0.04	–0.20***	0.41	0.23**	0.47***	–0.32***
	(0.03)	(0.05)	(0.24)	(0.09)	(0.13)	(0.09)
Relative price of capital (+)	0.01	0.11**	–0.06	–0.00	–0.06*	0.01
	(0.02)	(0.03)	(0.05)	(0.01)	(0.03)	(0.03)
Income inequality (–)	0.10*	–0.01	0.00	–0.26***	–0.10	–0.10
	(0.05)	(0.05)	(0.30)	(0.05)	(0.21)	(0.15)
Constant	–1.97	15.33***	–17.90	–14.27*	–42.48***	31.18***
	(2.97)	(2.61)	(21.61)	(7.79)	(11.80)	(7.95)
Adjusted R^2	0.07	0.51	0.22	0.21	0.34	0.26
N	1102	202	205	643	303	340
Country fixed effects	yes	yes	yes	yes	yes	yes

Robust standard errors in parentheses based on country clusters; ***/**/* denotes results significant at the 1/5/10% level.

Full sample, 1870–2016; gold standard, 1870–1913; interwar, 1920–1938; postwar, 1950–2016; pre-Volcker, 1950–1979; post-Volcker, 1980–2016. Dependent variable is the 10-year real interest rate.

Source: Borio et al (2017a).

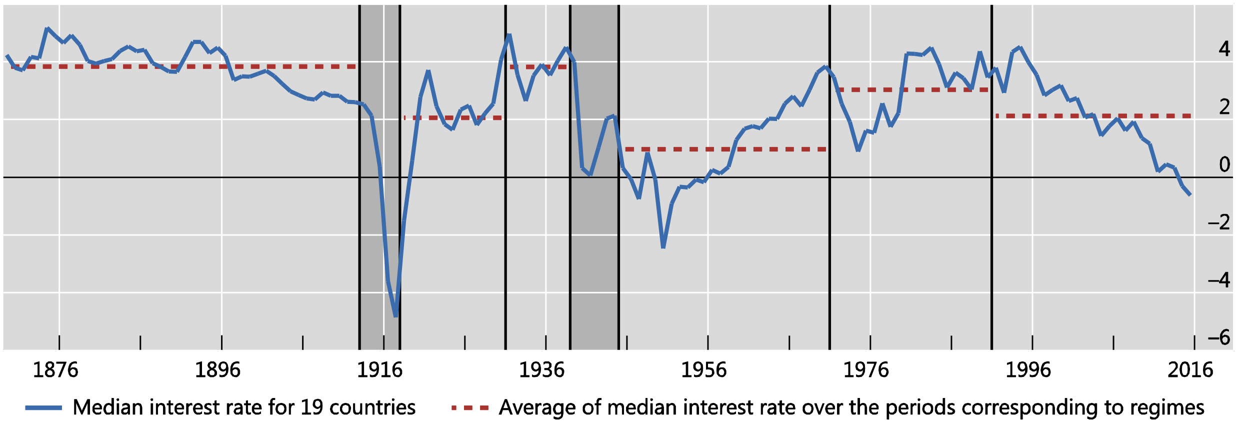
included together. At a global level, we find that the influence of external factors on countries' real interest rates reflects the importance of the financially dominant countries' role as global monetary anchors rather than common variations in global saving-investment determinants.

We explore the global dimension by constructing a global monetary anchor proxy and then including it as an explanatory variable in various regressions.[7] Focusing on a pure global perspective, Table 2 shows the results from regressing the GDP-weighted global real long-term interest rate (excluding the anchor countries) on the global monetary anchor and global saving-investment determinants.

[7] We define the global monetary anchor as the UK policy rate up to World War I and the US counterpart thereafter. To be on the safe side, we regress the US and UK short-term real interest rates on their respective saving-investment determinants – both country-specific and global components. The residuals from these regressions (ie the part of US and UK short-term real rates that cannot be explained by saving-investment determinants) are taken as a "clean" measure of US and UK monetary policy, respectively.

The influence of monetary regimes on real long-term rate[1]

In per cent | Graph 3



[1] Monetary policy regimes, in order: (mainly) classical gold standard; post-WWI gold standard; other interwar years; Bretton Woods; initial post-Bretton Woods (pre-Volcker); post-Volcker tightening and inflation targeting. Shaded areas indicate WWI and WWII (excluded from the empirical analysis).

Source: Borio et al (2017a).

On balance, the results suggest that in a financially integrated world, the role of anchor currencies is important for the dynamics of world interest rates. By contrast, the influence of saving-investment determinants is much less apparent. Specifically, we find that the anchor countries' monetary policy matters for long-term real interest rates in the full sample and all the subsamples with the exception of the classical gold standard.[8] Meanwhile, most of the saving-investment determinants perform poorly, with the exception perhaps of the dependency ratio in the full sample and the post-WWII period. In Borio et al (2017a) we also run panel regressions for the long-term real interest rates, controlling for both country-specific and global saving-investment determinants. There, the dependency ratio turns out to be insignificant in all samples while global monetary policy retains its explanatory power.

The experience of the classical gold standard is especially noteworthy. During this regime, central banks did not vary interest rates systematically with output and inflation as they do now. They simply tended to keep nominal interest rates constant unless the convertibility-into-gold constraint came under threat (eg Flandreau (2008)).[9] Gold acted as a monetary anchor, but only over very long horizons. Still, inflation remained very much range-bound, with the

[8] The lack of statistical significance of monetary policy during the gold standard may at first sight appear puzzling, but it may in fact hide the relevance of the gravitational pull of the anchor country. At the time, a number of peripheral countries, not least the United States, were still benefiting from very gradual interest rate convergence towards rates in the anchor country, the United Kingdom (eg Flandreau and Zumer (2004)). While much slower, this process was analogous to what we saw, say, in the lead-up to the creation of the euro area. Since the interest rates in the anchor country were very steady throughout, this process may help explain the difficulties in finding a visible link with those in the rest of the world.

[9] For illuminating discussions on the gold standard, and the rules of the game as applied in practice, see Bloomfield (1959) and De Cecco (1974).

price level gradually falling or rising over long periods. As a result, nominal and real interest rates were remarkably stable and did not deviate much from each other (Graph 4).

Global monetary policy and global real long-term interest rates

Table 2

	Dependent variable: global real long-term interest rate excl US & UK Linear trend included			
	Full sample	Gold standard	Pre-WWII	Post WWII
Global monetary policy	0.16**	0.08	0.39***	0.31***
	(0.06)	(0.10)	(0.08)	(0.08)
G: GDP growth	0.11**	–0.05	0.04	0.06
	(0.05)	(0.03)	(0.05)	(0.07)
G: pop. growth	–1.53***	3.10***	0.59	0.28
	(0.29)	(0.51)	(0.55)	(0.33)
G: dependency r.	0.16***	–0.06	–0.13	0.15***
	(0.03)	(0.10)	(0.15)	(0.03)
G: life exp.	0.42***	0.09	0.64***	0.69**
	(0.11)	(0.13)	(0.14)	(0.10)
G: capital price	–0.14***	0.07**	–0.17***	–0.20***
	(0.03)	(0.03)	(0.06)	(0.04)
G: inequality	0.14	–0.58***	–0.14	–0.90***
	(0.10)	(0.09)	(0.16)	(0.12)
Constant	–26.21***	23.92*	5.35	–37.27**
	(5.80)	(13.69)	(22.14)	(15.30)
Trend	–0.11***	–0.19***	–0.36***	–0.11
	(0.04)	(0.04)	(0.06)	(0.08)
Number of observations	139	42	66	65
Adjusted R-squared	0.49	0.84	0.67	0.81

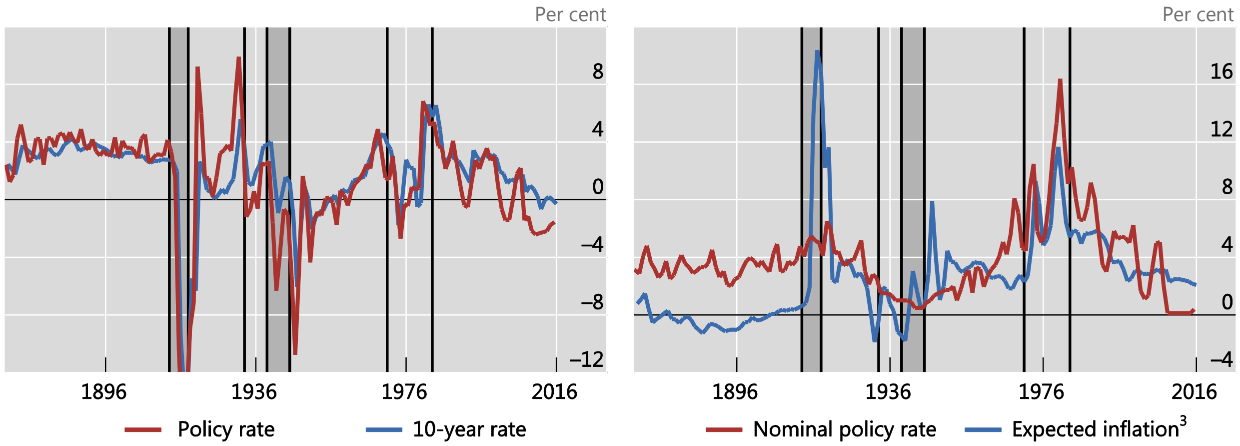
Standard errors in parentheses; * $p<0.1$, ** $p<0.05$, *** $p<0.01$. Horse race between three potential determinants of *global* real long-term interest rate: (i) global monetary policy (set in the centre countries, the United States and United Kingdom); (ii) global aggregates of saving-investment factors (denoted by G); and (iii) country-specific component of the saving-investment factors (denoted by C). Global saving-investments factors calculated as the weighted cross-country averages of each factor based on real GDP at purchasing power parity. The global real long-term interest rate similarly constructed but we exclude the United States and the United Kingdom from the calculation.

Source: Borio et al (2017a)

Given the behaviour of inflation, the standard approach would infer that the market rate tracked the natural rate quite closely. And yet the usual suspects tended to vary just as much as they have in the recent sample (Graph 2). Another possible interpretation is that monetary policy had a persistent impact on the real interest rate without exerting a strong influence on inflation, as the latter was subject to significant non-monetary influences. Indeed, the classical gold standard era coincided with a major globalisation wave, saw rapid technological change and featured a labour force with limited pricing power. The resemblance with the experience since the 1980s–90s is striking (eg Obstfeld and Taylor (2003), Borio (2017a)).

The influence of monetary regimes on real interest rates[1] Graph 4

Interest rates for the monetary anchor countries[2] | Nominal policy rate[2] and expected inflation[2]



[1] Monetary policy regimes, in order: (mainly) classical gold standard; post-WWI gold standard; other interwar years; Bretton Woods; post-Bretton Woods, pre-Volcker; post-Bretton Woods, post-Volcker tightening. Shaded areas indicate WWI and WWII (excluded from the empirical analysis). [2] Data for the United Kingdom up to WWI, and for the United States thereafter. [3] One-year-ahead expected inflation (year-on-year headline CPI).

Source: Borio et al (2017a).

Overall, the results indicate that no single saving-investment factor, or combination of such factors, can consistently explain the long-term evolution of real interest rates. This holds at both the domestic and global levels. Thus, the observed correlation between the saving-investment factors and the real interest rate in the latest sample may be largely coincidental, mostly driven by temporary but unrelated trends in the variables. By contrast, monetary regimes appear to be systemically correlated with real interest rate levels and trends.

This naturally raises the question of what might explain the correlation between monetary policy regimes and real interest rates over long horizons. But before addressing this question, it is worth examining more closely one hypothesis that belongs to the broader family of the saving-investment approach: the SAS. This will allow us to make some broader points about the saving-investment approach while addressing a hypothesis that has had considerable influence in the recent academic and policy debates.

1.2 The safe asset shortage hypothesis: a critique

The SAS hypothesis can be easily summarised (eg Caballero et al (2016, 2017)). In its more global variant, the hypothesis states that a growing demand for safe assets from EMEs with less developed financial markets raised global saving pre-crisis, pushing down the equilibrium real rates in safe asset-producing countries. This decline, in turn, drove the build-up of risk that led to the GFC. Post-crisis, a reduction in the safe asset supply caused anaemic growth: investors realised that many asset-backed securities and some sovereign bonds were in fact much less safe than originally thought. This pushed equilibrium rates even lower, well below market rates constrained by the zero lower bound (ZLB). With the risk-free rate being unable to adjust, the adjustments fell fully on output, which contracted much more.

Clearly, the SAS hypothesis is part of the saving-investment family. In fact, just as its savings glut counterpart, the SAS hypothesis sees EMEs' large current account surpluses as a symptom of excess saving, and the corresponding *net* capital flows as the mechanism driving interest rates lower in advanced economies and globally. In addition, the hypothesis highlights a specific mechanism behind the saving-investment balance – the demand for, and supply of, safe assets. As a corollary, it produces at least one additional prediction: all else equal, a reduction in the supply of safe assets relative to demand *drives up the spread between risky and safe assets*. This is true both at and away from the ZLB (see Annex 1 for more details).

Analytically, the SAS arguably suffers from a number of drawbacks. Some are shared with the saving-investment perspective more generally; others are specific to it.

One of the shared drawbacks is the lack of clarity about the distinction between market and natural interest rates, and the possible conflation of the two. In the global context, this manifests itself in the focus on current accounts, and hence *net* capital flows, rather than *gross* capital flows as the more immediate determinants of market interest rates. As argued in more detail in Borio and Disyatat (2011, 2015) this conflates *saving* and *financing*. It is financing – a cash flow concept – and the related portfolio adjustments that influence market rates more directly, quite apart from affecting intermediation patterns, which are more closely linked to financial crises. In turn, this again leaves open the question of what factors ensure that the market rate gravitates towards the natural rate.

One drawback specific to the SAS hypothesis relates to the strong discontinuity that occurs at the ZLB. At that point, for instance, output takes the brunt of the adjustment, despite the possibility for the risk spread to adjust. Arguably, this sharp discontinuity occurs because the decision to hold safe assets does not reflect a marginal portfolio choice. There is a segment of the population that wants to hold only safe assets and would not hold risky ones at any price. It is changes in this population segment's wealth that do all the work. So, when the real interest rate cannot adjust sufficiently to clear the market because of the ZLB, output falls, the wealth of these infinitely risk averse agents drops and the market for safe assets clears. More realistically, one would expect that both away from, and at, the ZLB the adjustment would take place through a widening of the spread between risky and safe assets – a portfolio adjustment that is a typical symptom of a flight to safety.

This relates also to a second drawback of the hypothesis: the idea that a contraction in output would eliminate the excess demand for safe assets. In practice, the opposite is likely to be the case. Safe wealth is destroyed as assets become patently more risky and people may, if anything, become more risk averse as they make losses. These powerful mechanisms are absent from the model. The only way a recession helps in the model is precisely because nothing changes, except the wealth of the infinitely risk averse agents that must be invested in the given supply of safe assets. When that wealth falls, so does the demand for the safe asset.

How does the hypothesis fare empirically? Here, too, the evidence is not very supportive.

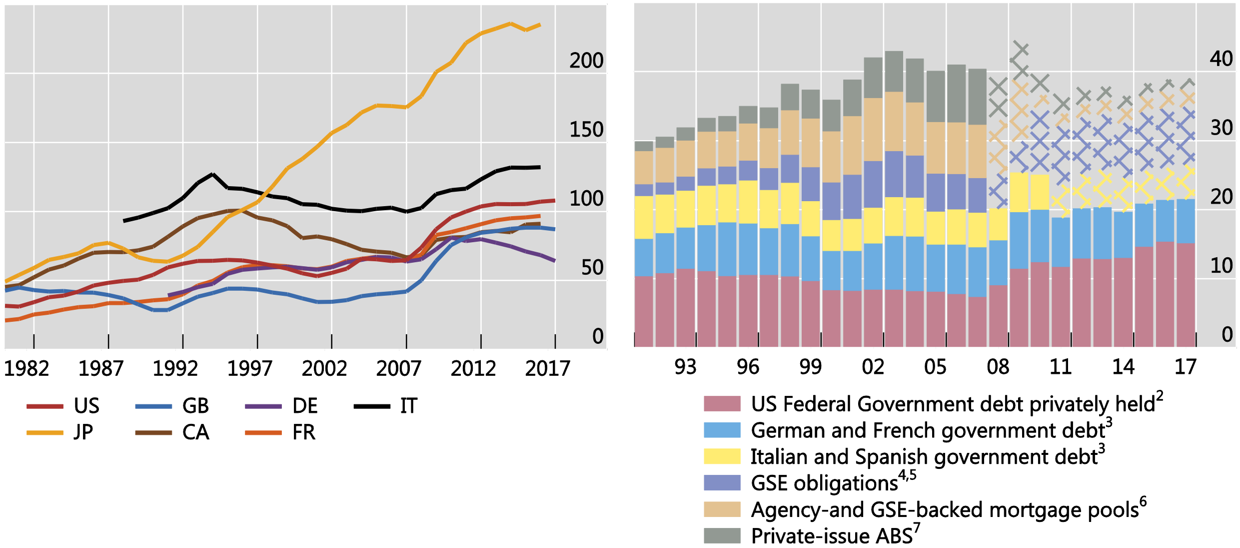
A number of casual observations appear to contradict it. For one, crisis period aside, the behaviour of output appears at odds with the hypothesis. No obvious discontinuity is apparent (eg Cochrane (2016)). And many countries where interest rates are at the ZLB have been experiencing considerable growth, especially when adjusted by the population, and output at or above potential. Japan and Switzerland, just to mention two, are cases in point. But the same could be said of the United States once the country left the crisis behind. Similarly, the strong *gross* capital flows to EMEs since the crisis, coupled with narrowing spreads, hardly indicate a safe asset shortage in those economies.

More generally, it is far from clear that the hypothesis can easily account for the trend decline in real interest rates since the 1980s, or for the behaviour of real interest over longer periods. This seems to be the case both in terms of quantities and prices.

Supply of safe assets

In per cent | Graph 5

General Government Debt to GDP | Safe assets as a share of world GDP[1]



CA=Canada; DE=Germany; FR=France; GB=United Kingdom; IT=Italy; JP=Japan; US=United States; GSE = government-sponsored enterprise; ABS = asset-backed security;

[1] The classification of safe assets follows that of Caballero et al (2017), including those assets deemed by the authors to have lost their "safe haven" status after the financial crisis and are represented by crosses. [2] Federal government marketable and nonmarketable Treasury securities (liability) less Federal government retirement funds holdings and Monetary Authority holdings of Treasury securities. [3] Eurostat's consolidated gross general government debt converted to US dollars and backdated using IMF growth rates. [4] Federal Home Loan Banks, Fannie Mae, Freddie Mac, Farmer Mac, Farm Credit System, the Financing Corporation, and the Resolution Funding Corporation. The Student Loan Marketing Association (Sallie Mae) was included until it was fully privatized in 2004:Q4. Beginning 2010:Q1, almost all Fannie Mae and Freddie Mac mortgage pools are consolidated on Fannie Mae's and Freddie Mac's balance sheets. [5] Debt securities (GSE issues), such issues are classified as agency- and GSE-backed securities. [6] GNMA, Fannie Mae, Freddie Mac, Farmer Mac, and Farmers Home Administration pools. Beginning 2010:Q1, almost all Fannie Mae and Freddie Mac mortgage pools are consolidated on Fannie Mae's and Freddie Mac's balance sheets. Also includes agency- and GSE-backed mortgage pool securities which are used as collateral for agency- and GSE-backed CMOs and privately issued CMOs. Excludes Federal Financing Bank holdings of pool securities, which are included with federal government mortgages and other loans and advances. [7] Includes commercial paper and corporate bonds liabilities net of assets.

Source: Caballero et al (2017), IMF-WEO, Eurostat, US Financial Accounts, TreasuryDirect, BIS calculations

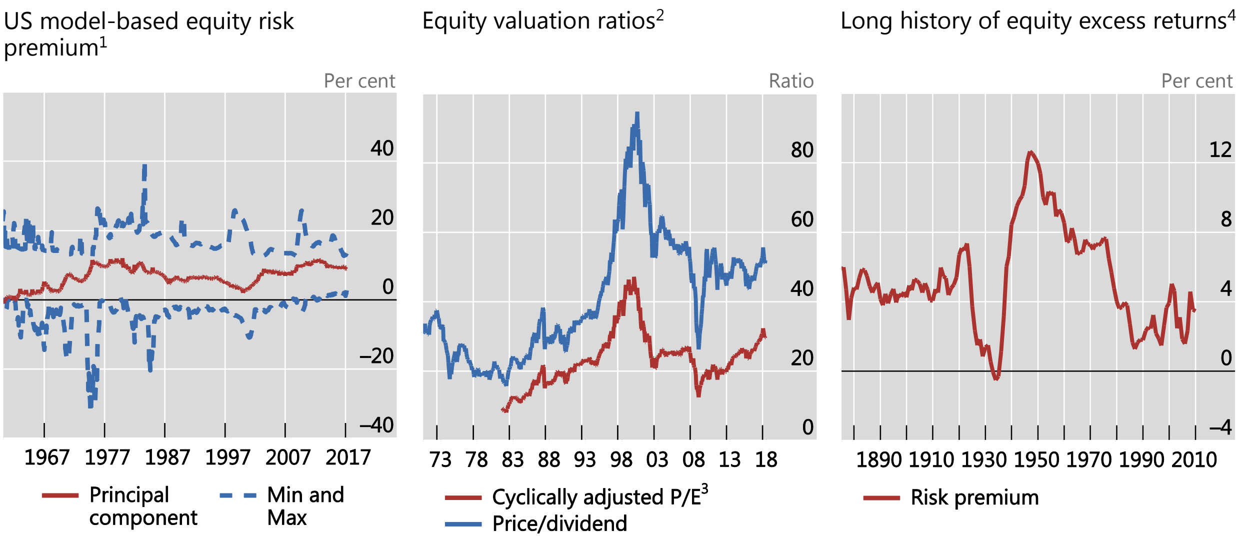
As regards quantities, this conclusion is justified if one just takes the most obvious type of safe asset – advanced economies government debt. Over the last 30 years, the ratio of G7 public debt to GDP has actually risen, not fallen (Graph 5, left panel). Likewise, since 2007, the G7 countries' average ratio of public debt to GDP has increased by 33 percentage points. The United States, for example, has seen its gross federal debt more than double since 2007 to over 100 percent of GDP – the highest level in 60 years. These data hardly suggest a safe asset shortage.

That said, a complication in assessing the hypothesis' validity by looking at the evolution of quantities – and arguably one of the hypothesis drawbacks – is precisely the lack of clarity about the definition of "safe". For instance, Caballero et al (2017) include Italian and Spanish government bonds, as well as private-issued ABS in their measure of safe assets. Others have adopted other alternatives. Safety, it would seem, is in the eye of the beholder, which makes it hard to test the theory. Moreover, in addition to being rather nebulous, supply tells us nothing about demand – the other side of the equation.

Even if one accepts that there has been a substantial reduction in safe asset supply, the link with real interest rates remains elusive. Take, for example, the definition of Caballero et al (2017), which suggests a major fall in the supply between 2007 and 2011 following the two financial crises (Graph 5, right panel). This sharp drop hardly brought about a perceptible structural break in the real interest rate trend, already on its downward trajectory for a couple of decades. It is even more difficult to discern any effects of safe asset supply on real interest rates prior to 2007.

As regards prices, the picture is not very different. In Borio et al (2017a), as part of the robustness checks, we extend the historical analysis to consideration of the risk premium, using the equity risk premium as one measure. As with the saving-investment variables, we find little systematic relationship. More to the point, we also find that over the last 30 years, a higher equity risk premium actually has a positive marginal impact on real rates once one controls for other saving-investment factors. In addition, the premium exhibits no consistent upward trend, first falling to the late-1990s and then rising again. This contrasts with the narrative that emphasises its global rise.

Equity risk premium — Graph 6



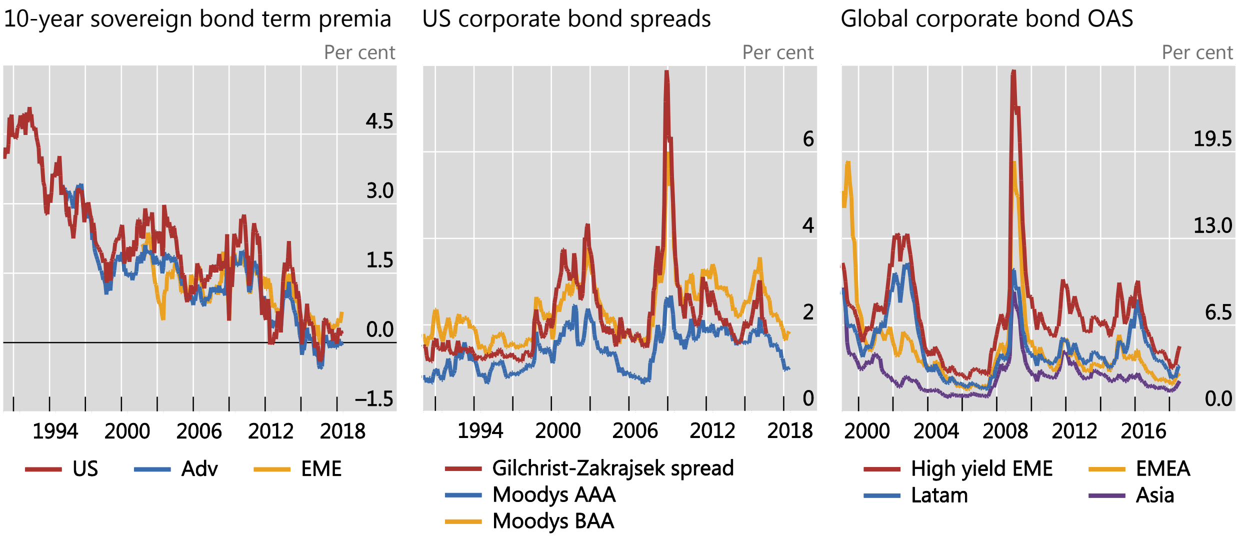
[1] From Duarte and Rosa (2015). [2] For cyclically adjusted price/earnings (CAPE) ratio, 1982–2017. For price/dividend: for US, December 1970–latest; for DE, May 1997–latest; for JP, May 1993–latest; for GB, May 1993–latest. [3] For each country/region, the CAPE ratio is calculated as the inflation-adjusted MSCI equity price index (in local currency) divided by the 10-year moving average of inflation-adjusted reported earnings. [4] From Jordà et al (2017).

Source: Duarte and Rosa (2015); Jordà et al (2017); Barclays; Bloomberg; national data; BIS calculations.

More generally, the proposition that the risk premium has been exceptionally high is not uncontroversial. Estimates of the equity risk premium are notoriously sensitive to the model used, and the range is extremely wide (Graph 6, left-hand panel). Other popular measures of equity valuation often paint a different picture, suggesting that equity is currently rich rather than cheap (ie the risk premium is low rather than high). For instance, the cyclically-adjusted price-to-earnings (CAPE) ratio for the United States is currently at its highest level since the early 2000s (middle panel). Moreover, from a very long-term perspective, equity excess returns bear little relationship with the real interest rate trend (right-hand panel). And equity returns have moved little over the last few decades relative to early on in history, which is at odds with the big move in real interest rates over the same period.

An obvious alternative is to focus on bond spreads and their joint behaviour with risk-free rates. A cursory inspection of the evolution of various risk spreads in fact suggests that the SAS narrative is not that plausible. Spreads between risky and safe assets have not widened in the last couple of decades, when the SAS is supposed to have emerged. In fact, they have compressed significantly in two phases (Graph 7). A more compelling explanation seems to be cyclical swings in risk appetite, linked to monetary and financial factors. For instance, US corporate bond spreads over treasuries have been relatively flat since the mid-1990s and have shown two distinct downward phases punctured by the GFC. Both of these phases coincided with periods of accommodative monetary policy. The Gilchrist-Zakrajsek spread, a more refined measure of the credit risk spread based on micro-level data, shows a similar pattern.

Bond premium — Graph 7



Source: Gilchrist and Zakrajsek (2012), Bank of America Merrill Lynch, Bloomberg, FRED, BIS calculations.

Is the effect of the SAS visible further out the risk spectrum, perhaps in emerging market bonds? Again, this is not the case. Corporate bond spreads in emerging market and advanced economies have tended to co-move, rather than the gap widening, as the SAS hypothesis would suggest (Graph 7, middle and right panels). A similarly high global correlation prevails in sovereign bond markets. Term premia in advanced and EMEs track each other very closely, both pre- and post-crisis (left panel). In some EMEs, the yield has actually been *lower* than the corresponding one in advanced economies. All this points to a global factor driving a synchronised swings in risk appetite and flight to quality among global investors. US monetary policy has been identified as a prime candidate (eg. Miranda-Agrippino and Rey (2018))

More formal analysis developed in Annex 1 confirms the broad conclusion that emerges from this cursory look at the data. There we employ a VAR with sign restrictions in order to trace the shocks driving the evolution of four variables: the credit spread, the 5-year 5-year forward real rate (a rough proxy for the natural rate), the term premium on safe bonds and the VIX. We consider four shocks: a safe asset shock; a shock to the natural rate unrelated to the safe asset shock; a flight-to-safety shock; and a global risk-appetite shock. We identify find a safe asset shock as one that lowers the 5-year 5-year rate, increases credit spreads, and lowers the term premium. We find that this shock explains only a small part of the evolution of the system variables. In particular, it explains less than 10 basis points of the decline in the natural interest rate since 2011, while the three other shocks together explain as much as 1.20 percentage points.

Can the data be explained in a more convincing way? The narrative we find more plausible is that central banks' low interest rate policy led to a search for yield by investors globally (see also next section). The large demand for securitised instruments and bonds of fiscally weak countries simply reflected the fact that they offered marginally higher returns than safe and secure US treasuries. Even a naïve investor would presumably have known that an asset yielding a higher return is inherently more risky.[10] Post-GFC, after the acute risk aversion face ended, the same search-for-yield behaviour emerged again.[11]

2. Real interest rate determination: financial and monetary factors?

2.1 Setting the stage: compasses and monetary policy non-neutrality

The preceding analysis casts doubt on the completeness of explanations that anchor real interest rates to the evolution of some notional equilibrium rate driven by saving-investment fundamentals. The presumption that over time market rates gravitate towards the natural rate is neither trivial nor innocuous. What compass guides central banks and market participants in the journey? And what is the final destination?

[10] It goes without saying that while the relative supplies of safe assets may change, there is never a "shortage" in the practical sense that one is unable to acquire them. Given the very liquid market for US treasuries, one can always purchase safe asset so long as one is willing to pay the market price. Investors willingly bought "alternative" safe assets presumably given the risk-return trade-off.

[11] Our concern with the SAS hypothesis goes beyond just the analytical and empirical relevance but extends to its policy implications. These can be quite counterproductive, especially at the current juncture. The focus on current account imbalances and on the key role (and indeterminacy) of exchange rates at the ZLB could fuel protectionist pressures and raise the risk of currency wars. The need to increase the supply of safe assets could encourage fiscal imprudence at a time when public debt-to-GDP ratios are at a peacetime high. And the idea that large-scale central bank government debt purchases are contractionary fails to recognise their stabilising role during the crisis and support for the subsequent recovery, negative side-effects notwithstanding (Borio and Zabai (2018)).

The answer to both questions is the same: it depends on the model that defines the natural (equilibrium) rate. The concept's specific incarnation is fundamentally model-dependent. As already noted, in the standard framework the natural interest rate is the rate that equates actual output with potential output period by period and inflation is the corresponding compass. This raises two possible problems.

Empirically, the weak and elusive link between measures of economic slack, including the output gap, and inflation undermines the usefulness of the compass. But inflation need not be the only gauge of deviations of the market from the natural rate. Another one could be the build-up, and subsequent unwinding, of financial imbalances, which generate major costs for the economy. This is indeed what happened around the GFC. Repeating a familiar pattern in history, the decade leading up to the GFC saw a major credit (and asset price) boom *even as* inflation remained quiescent while interest rates remained quite low. This was then followed by a virulent bust. What we saw was an outsize "financial cycle" (eg Drehmann et al (2012)).[12] Moreover, the link between low interest rates and the build-up of financial imbalances, and financial vulnerabilities more generally, partly by encouraging risk-taking, has become increasingly recognised, in both academia (see references below) and policymaking. And it has been recognised even by proponents of the saving-investment view of interest rate determination (eg Summers (2015)).

Conceptually, the link raises questions about the usefulness of the standard definition of the natural rate. It is odd to argue in the same breath that the natural or equilibrium interest rate is very low, even negative, and that this very rate will generate financial instability further down the road, given the serious output costs that instability generates. More plausibly, a reasonable notion of equilibrium interest rate should encompass the absence of macroeconomic instability. Arguably, the apparent tension between equilibrium and macroeconomic stability reflects the incompleteness of the analytical framework used to define the rate itself – a framework that does not incorporate financial instability and financial booms and busts more generally. Put differently, defining the equilibrium interest rate ignoring the intertemporal trade-off arising from the financial sector is a serious omission. This is somewhat ironic: after all, the interest rate is the quintessential intertemporal price. And it is set in the financial sector.

This suggests that it would be logical to broaden the definition of the natural interest rate to encompass some notion of *financial* equilibrium. This would rule out the development of financial imbalances and take account of their serious macroeconomic costs. It would ensure that the corresponding growth is *sustainable* over time.

Analytically, a growing literature is indeed moving in that direction, in the sense of recognising that the natural rate definition should incorporate financial factors ("frictions"). But the vast majority of this work is firmly in the tradition of overlaying those frictions on an otherwise standard real business-cycle framework. In that framework, in the absence of

12 A number of papers have documented the fact that credit booms can often occur in the absence of inflationary pressure, particularly when they are driven by positive supply shocks (Mendoza and Terrones (2008), Christiano et al (2008)).

persistent shocks the economy rapidly returns to steady state. This is true regardless of whether the frictions are primarily on the borrower side (eg Bernanke et al (1999)) or on the lender side (Gertler and Kiyotaki (2011), Cúrdia, and Woodford (2016)) and of whether non-linearities and feedback mechanisms are present (Gertler et al (2017), Brunnermeier and Sannikov (2014)).[13] In all of these cases, financial factors simply increase the persistence of the effects of the shocks, rather than generating endogenous boom/bust cycles. This greatly reduces the relevance of the additional information provided by the financial factors and of intertemporal trade-offs.

Empirically, there is growing evidence that financial cycles matter. Many studies have found that strong credit and/or asset prices increases, beyond historical norms, are useful leading indicators of subsequent busts and financial crises (eg Borio and Lowe (2002), Borio and Drehmann (2009), Aldasoro et al (2018), Reinhart and Rogoff (2009), Schularick and Taylor (2012), Jordà et al (2016)). For similar reasons, strong credit growth and/or financial conditions also carry information about subsequent economic slowdowns (Mian and Sufi (2014), Mian et al (2017), Claessens et al (2012), Jordà et al (2016), Drehmann et al (2017)), large negative output gaps or deeper recessions (Borio and Lowe (2004), Krishnamurthy and Muir (2016)) or downside risks to output (Adrian et al (2017)).[14] Moreover, and speaking even more directly to the identification of the right compass, recent research has found that information about the state of the financial cycle outperforms inflation in a straight horse race to identify potential output and output gaps in real time (Borio et al (2017b)).[15]

The importance of the financial cycle is underlined by the evidence indicating that busts associated with crises tend to generate *long-lasting, if not permanent*, output costs (eg BCBS (2010), Cerra and Saxena (2008), Blanchard et al (2015)). The full set of mechanisms at work is still unclear. Some may be the familiar hysteresis channels operating through the impact of slumps on labour and capital markets (eg Reifschneider et al (2015)). But, more interestingly, others may include the much less recognised impact of financial booms and subsequent busts on resource misallocations. Cecchetti and Kharroubi (2015) document that credit booms undermine productivity growth. Going further and drawing on a sample of over 20 countries spanning 30 years, Borio et al (2016) find that credit booms misallocate resources towards lower-productivity growth sectors, notably construction, and that the impact of the misallocations that occur *during the boom* is twice as large in the wake of a subsequent banking crisis, even controlling for the effect of the crisis itself.[16] The impact can be sizeable, equivalent cumulatively to several percentage points of GDP over a number of years. Debt and capital stock overhangs, combined with difficulties in reallocating resources when balance

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[13] Gertler and Gilchrist (2018) and Brunnermeier et al (2013)) provide a literature review.

[14] In particular, Adrian et al (2017) find that the unconditional distribution of output is highly skewed to the left as a function of financial conditions. Specifically, financial conditions boost growth in the near term but sap it longer term. The corresponding indicator is called "GDP at risk".

[15] These findings have been confirmed by subsequent research, eg Arseneau and Kiley (2114), Krustev (2018). In a similar vein, Kiley (2015), Cukierman (2016) and Taylor and Wieland (2016) have argued that the omission of factors that are likely to influence output fluctuations – such as credit – may result in misspecification and affect inference concerning the natural interest rate.

[16] In closely related work, Gopinath et al (2015) find that capital flows into Spain, triggered by low interest rates in the wake of European monetary unification, disproportionately benefited firms that had not been finance-constrained hitherto and generated resource misallocations.

sheets are impaired, are likely to play a key role. All this echoes the "specificity" issues Caballero (2007) has raised. Slumps, and the financial crises that sometimes accompany them, are largely a symptom of underlying stock problems and, in turn, tend to exacerbate them.

The relevance of financial factors in defining the natural rate opens the door for one form of monetary non-neutrality. This will arise whenever monetary policy has an impact on the relevant financial factors. Non-neutrality can arise even in frameworks that eschew the financial cycle itself (eg, De Fiore and Tristani (2011), Benigno et al (2014), Curdia and Woodford (2016), Vines and Wills (2018)). [17] These authors highlight the impact that policy has on the natural rate itself. But, more relevant for our analysis, it can arise through the impact of monetary policy on the financial cycle, including through resource misallocations.[18] Such an impact is quite intuitive, since monetary policy affects economic activity partly by influencing credit conditions, asset prices and, as growing evidence indicates, risk-taking itself – the so-called "risk-taking channel".[19] All this is consistent with the broader literature indicating that monetary policy can increase financial instability risks by encouraging the build-up of financial vulnerabilities that in turn increase future downside risks to the real economy (see Adrian and Liang (2016) for a review).

We next explore the implications of financial cycles for monetary non-neutralities and monetary policy in more detail. We do so based on two illustrative exercise, one empirical and one theoretical. A key feature of both is a tight link between financial busts and the booms that precede them. Booms sow the seeds of the subsequent busts as a result of the vulnerabilities that build up over time. Key to that link is allowing debt overhangs (disequilibrium excess stocks) to influence the economy's evolution. While we do not capture them explicitly, we believe that capital stock overhangs, interacting with heterogeneous labour pools, are also operating in the background.

2.2 Monetary policy and the financial cycle: an empirical model

A key feature of financial cycles is their large amplitude and length compared to business cycles, as traditionally measured. This is so at least when one is concerned with those cycles

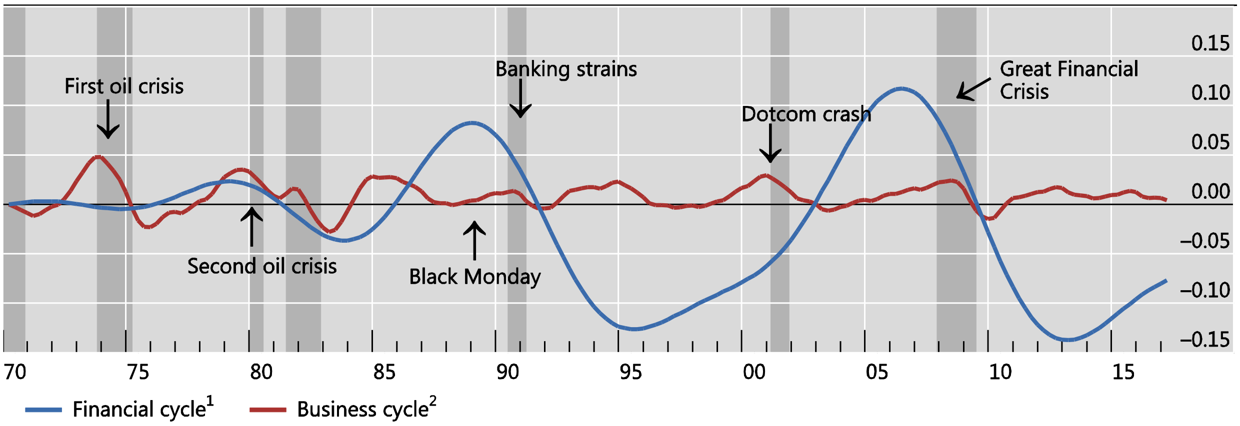
[17] Hoeberichts and Van den End (2018) provide some suggestive empirical evidence from seven OECD countries indicating that a prolonged period of low real interest can reduce the natural rate.

[18] In related literature, Barnett et al (2014) and Cette et al (2016) provide corroborative evidence on the link between low interest rates and resource misallocation for the United Kingdom and southern European countries, respectively. This could reflect in part the fact that low interest rates can reduce the incentive to repair impaired balance sheets. For evidence on the latter, see eg Caballero et al (2008) for Japan, Acharya et al (2016) for Europe, and Albertazzi and Marchetti (2010) and Schivardi et al (2017) for Italy. For a cross-country analysis on the link between low rates and "zombie" firms, see Banerjee and Hofmann (2018).

[19] Borio and Zhu (2012), who coined the term, describe various possible mechanisms at work. Maddaloni and Peydró (2011), Altunbas et al (2014)) find that banks tend to make riskier loans and lower their lending standards when rates are lower (see Dell'Ariccia and Marquez (2013) and Adrian and Liang (2016) for a literature review). The effects are not confined to within countries. Using security-level data on portfolio investment into the United States, Ammer et al (2018) find that declining home-country interest rates lead investors to shift their portfolios toward riskier US corporate bonds, consistent with a search for yield. Bruno and Shin (2015) discuss the channel in the context of foreign currency lending and find empirical evidence for it.

that has the largest macroeconomic costs (Drehmann et al (2012), Borio (2014)).[20] While there are many possible ways of capturing the financial cycle quantitatively, a parsimonious one is in terms of credit and property prices. Graph 8 illustrates the financial cycle for the United States using a simple statistical filter. We see that the amplitude and length of the fluctuations has been increasing since around the early 1980s, that the length is considerably longer than that of the traditional business cycle (blue versus red line) and that banking crises, or serious banking strains, tend to occur close to the financial cycle peak. This pattern holds across many countries (eg Drehmann et al (2012), Claessens et al (2011), Borio (2014)). Another key feature, as already noted, is that the bust tends to generate deeper recessions and may coincide with banking crises, causing very long-lasting, if not permanent, damage to the economy. That is, output may regain its pre-crisis long-term growth trend but evolve along a lower path. In some cases, growth itself may also be seriously damaged for a long time.

Financial and business cycles in the United States — Graph 8



[1] The financial cycle as measured by frequency-based (bandpass) filters capturing medium-term cycles in real credit, the credit-to-GDP ratio and real house prices. [2] The business cycle as measured by a frequency-based (bandpass) filter capturing fluctuations in real GDP over a period of one to eight years.

Source: Drehmann et al (2012), updated.

To capture the salient features of the financial cycle and its interaction with the policy and the real economy, in Juselius et al (2017) we construct a more articulated empirical model. The model has two key features. First, it makes clear that output and financial cycles should not be thought of, and measured, separately. Once separate filters are dropped, given the intricate nexus between financial factors and economic activity, output and financial cycles are best characterised *jointly*. One cannot have a view about the output cycle without implicitly having a view about the financial cycle and its link with the real economy. Second, and related, both output and financial cycles are *endogenous* to policy. And this endogeneity goes beyond just cyclical fluctuations: policy may have very persistent impact on the trend itself. As a result, the now standard separation of trend from cycle becomes problematic. Blanchard et al (2015), Martin et al (2015), and Reifschneider et al (2015) provide a discussion of this issue.

[20] It is possible to find financial cycles at higher frequencies, depending on the specific components and filters used. The one above is the most relevant if one is interested in serious slumps and financial crises. See also Claessens and Kose (2018) for a broader review of the related literature.

The starting point is a characterisation of the financial cycle based on two stable long-run (co-integrating) relationships.

The first relationship relates to *stocks*. It links credit-to-GDP to real asset prices. This could be seen, for instance, as a proxy for the role of collateral constraints. We refer to deviations of this relationship from its long-run value as the *leverage gap*, $\widetilde{lev}_t$, expressed as

$$\widetilde{lev}_t = (cr_t - y_t) - (p_{A,t} - p_t) - \overline{lev} \tag{1}$$

where cr_t is credit to the non-financial private sector, y_t is output, $p_{A,t}$ is an asset price index, p_t is the consumer price level and $\overline{lev}$ is a steady state constant. We construct the asset price index based on residential property prices, commercial property prices and equity prices (see Juselius and Drehmann (2015) for details).

The second relationship relates to *flows*. It links the credit-to-GDP ratio to the lending rate on outstanding debt. It captures the impact of the cash flow constraints that households and companies face in relation to interest payments (eg. Hughson et al (2016)). We refer to deviations of this relationship from its long-term value as the debt service gap, $\widetilde{dsr}_t$, expressed as

$$\widetilde{dsr}_t = (cr_t - y_t) + \beta_{dsr} i_{L,t} - \overline{dsr} \tag{2}$$

where $i_{L,t}$ is the nominal average lending rate on the stock of credit, and $\overline{dsr}$ is a steady-state constant.

Together, relationships (1) and (2) pin down the long-run (sustainable) level of the credit-to-GDP ratio, consistent with real asset prices (via the leverage gap) and the nominal lending rate (via the debt service gap). In effect, when *both* leverage and debt service gaps are closed, the credit-to-GDP ratio, real asset prices and the lending rate take values that are consistent with their long-run levels. This can be thought of as a measure of *financial equilibrium*.

The evolution of these gaps has a sizeable impact on private sector expenditure and output fluctuations. This is intuitive. Heavier debt service burdens depress spending, not least as they squeeze cash flows. And higher asset prices in relation to credit can boost both spending and credit growth. There are many stories and simple models that capture these mechanisms, although none that as yet fully captures their interaction.

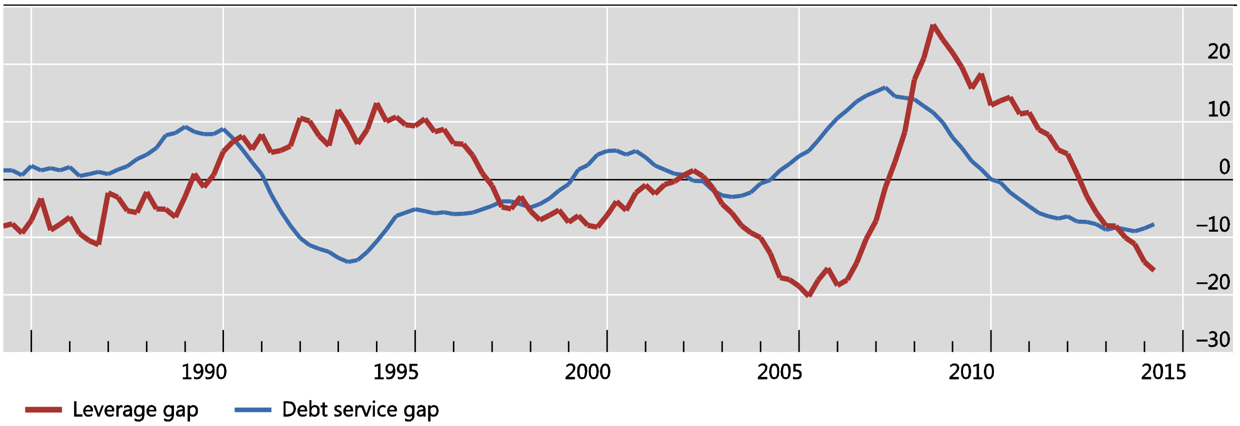
Critically, in this set-up the two financial gaps interact so as to produce endogenous economic cycles. For example, a negative leverage gaps implies high credit growth and hence higher asset prices, which supports output. But it also boosts debt service burdens, which acts as a drag on growth. The latter effect, in particular, is very persistent and generates the link between financial busts and permanent output losses. It also implies that the current state of the financial cycle predicts subsequent output paths rather well. Indeed, Juselius and Drehmann (2015) find that knowledge of where the leverage and debt-service gaps were prior to the GFC is sufficient to trace much of the subsequent movement in output, although not quite the depth of the recession, *out of sample*.

Graph 9 depicts the estimated leverage and debt service gaps for the United States from 1985 Q1 to 2015 Q1. The debt service gap was large and positive before and during the three recessions in our sample, in particular in the most recent one. By contrast, the leverage gap was very low during the commercial real estate and leveraged buy-out boom in the late 1980s and the housing boom in the mid-2000s. This simply reflects the fact that asset prices tend to run ahead of the credit-to-GDP ratio during booms, even as this ratio increases beyond historical trends. This makes borrowers look deceptively solid during the boom.

We then add the two financial gaps to a standard filtering system that includes key macroeconomic relationships such as those in the Laubach and Williams (2015) set-up. This allows us to estimate potential output and the natural rate of interest. In other words, our augmented system *nests* theirs. The key difference is that both trend estimates now incorporate also the additional requirement that the financial gaps are closed in equilibrium – our specific definition of "financial equilibrium". We refer to the corresponding estimates as "finance-neutral potential output" and "finance-neutral natural rate", respectively. The latter is the real interest rate consistent with output at potential, inflation on target, *and* both financial gaps closed. Note that in this system we *allow* inflation and the financial-cycle proxies to *compete* freely in providing information about the output gaps and natural interest rates: the data are allowed to speak, and tell us which one is superior, in the same spirit as Borio et al (2017b).

Leverage and debt service gaps for the United States

Per cent Graph 9



Source: Juselius et al (2017).

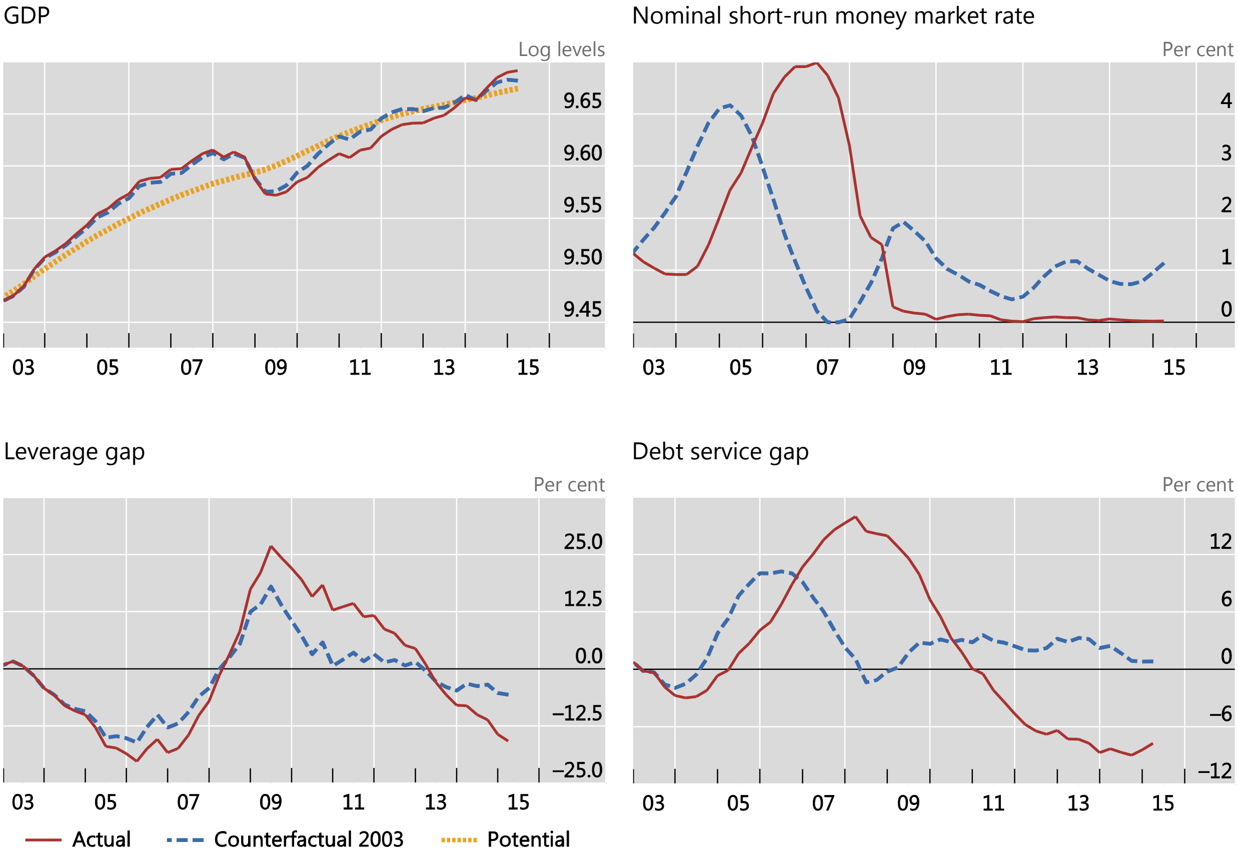
Within this set-up, we can also study the effects of different monetary policy rules. In particular, we conduct counterfactual simulations of a rule in which policy reacts systematically to financial cycles proxies *in addition to* output and inflation with one that does not.[21] Graph 10 illustrates the results of a counterfactual experiment, with the policy implemented starting in 2003. The results would be even starker if implementation started earlier.

A number of findings emerge. First, responding systematically to the financial cycle proxies can result in significant output gains. The counterfactual output path is considerably higher after 2008 and only slightly lower before then (top left hand panel). By the end of the simulation, the cumulative output gains exceeds 12 percent. This comes at little cost in terms

[21] The specific rule adds the debt service gap to the Taylor rule.

of inflation. In fact, on average, inflation is effectively unchanged (not shown).[22] Second, leaning early is key, and this can gain considerable room for manoeuvre in the bust. In the counterfactual, the policy rate is some 1 percentage point higher until mid-2005; it can then afford to decline earlier, starting roughly when the debt-service gap peaks, and is normalised more quickly after the recession, as output recovers faster (top right-hand panel). Finally, the source of the gains is that the policy helps smooth out the financial cycle (bottom panels). Hence the much smaller amplitude in the cycle in asset prices, real credit and the credit-to-GDP ratio (Graph 11).

Monetary policy smooths the financial cycle[1] Graph 10

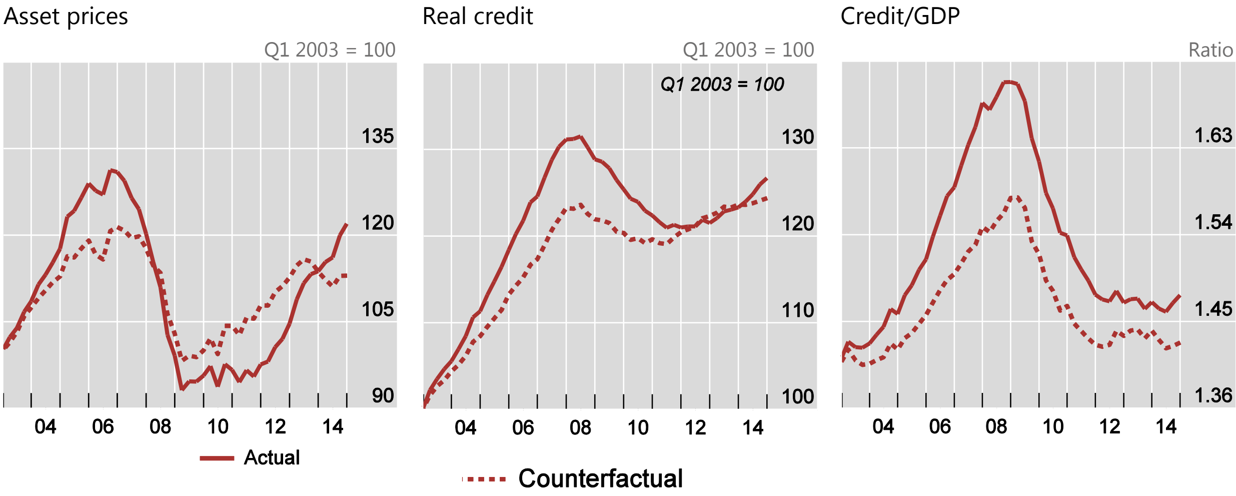


[1] In the counterfactual experiment, we set policy in line with an augmented Taylor rule that takes account of the finance-neutral natural rate, the finance-neutral output gap and the debt service gap in line with equation (11). Results are based on the filter (3)-(10). We retain the historical errors to derive the evolution of the variables in the counterfactual. The counterfactual policy starts in 2003 Q1.

Source: Juselius et al (2017); based on US data.

[22] This reflects the flatness of the Phillips curve and the overall improvement in output performance.

Monetary policy smooths the financial cycle Graph 11



Source: Juselius et al (2017); based on US data.

The results also shed light on the definition of the natural rate of interest. Graph 12 shows that simply taking financial factors into account in estimating the natural rate yields a "finance-neutral" natural rate (red line) that is generally higher, and that declines by less in recent years, than the Laubach-Williams estimate (blue line). Not surprisingly, in the counterfactual (dashed line) the finance-neutral natural rate declines by even less. This highlights its endogeneity with respect to policy.

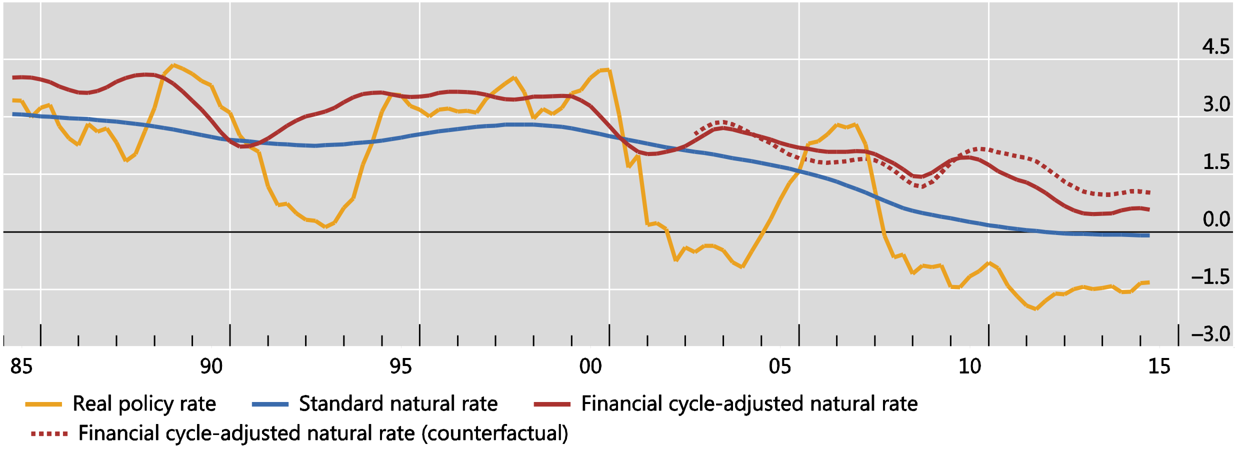
The results illustrate the path-dependence of policy when a reaction function is embedded in a framework where financial cycles interact with the real economy. In this setting, what matters is the policy's cumulative role. Responding systematically also to the financial cycle ("leaning against the wind") should not be seen as taking action only when signs of instability are apparent – within, say, the framework of an early-warning system. That would be too late. Rather, policy should strive to maintain the economy close to financial equilibrium both in good and bad times.[23]

Importantly, it is the financial cycle, not the shocks, that generates persistence. And the output effects occur *regardless* of whether a crisis takes place. With respect to the GFC, for example, much of the contraction in output was already baked-in before 2008: financial imbalances had grown to such a point that the subsequent drag on output was inevitable. The crisis only exacerbated the severity of the downturn. Thinking of crises as shocks is inadequate when busts in fact derive from preceding booms.

[23] Filardo and Rungcharoenkitkul (2016) reach similar conclusions using optimal control techniques based on the more stylised version of the financial cycle illustrated in Graph 11.

Comparing interest rates: standard and financial cycle-adjusted

In per cent Graph 12



Source: Juselius et al (2017); based on US data.

There are, of course, obvious limitations to this type of analysis. It is always hazardous to make counterfactual evaluations based on historical correlations. The exercise is quite stylised, and does not address explicitly the complications that arise in small open economies, notably the exchange rate and capital flows. Moreover, it does not fully characterise the uncertainty that plagues policymaking. Even so, we would argue that the exercise is instructive. In particular, the Lucas critique can be overdone.[24] Indeed, the public becoming aware of the central bank's reaction function could even *enhance* the policy's effectiveness, just as anti-inflation credibility reduces the likelihood of second-round effects in wages and prices.

2.3 Monetary policy and the financial cycle: a theoretical model

We now turn to a theoretical model to illustrate explicitly how monetary policy can have a potentially significant and persistent impact on economic activity by influencing the financial cycle (Rungcharoenkitkul et al (forthcoming)). A key theme is that the economy may admit a multiplicity of outcomes and monetary policy acts to pin down a particular path. Policy is inherently non-neutral and the system's vulnerability to financial boom-busts depends on the central bank's reaction function. Short-term-oriented monetary policy may inadvertently encourage risk-taking during the boom, making the economy more fragile down the road. This path-dependence creates an important intertemporal policy trade-off.[25] In the following,

[24] Studies have found that the Lucas critique may be of limited relevance in practice. For instance, a common finding is that the parameters of empirical vector autoregressions (VARs) are remarkably stable despite changes in estimated policy equations in the sample (eg Favero and Hendry (1992), Leeper and Zha (2003), Rudebusch (2005)). In the present context, the main parameters of the VAR are stable over both pre- and post-crisis samples. This suggests, for instance, that adopting unconventional monetary policy tools post-crisis has not generated sizeable changes to the system's dynamics. To the extent that the adoption of these tools constitutes shifts in the monetary policy function, this provides indirect evidence against a strong Lucas critique effect in our sample.

[25] This is consistent with a recent theoretical contribution by Adrian and Duarte (2017), who formalise the non-neutrality of money through its impact on risk premia. In their setting, optimal policy involves responding to financial vulnerabilities because of the potential impact on future output.

we outline the intuition of how the model works (Annex 2 provides a more detailed description).

The framework has two key features.

First, it makes a clear distinction between saving (or endowments) and financing. Financing, a cash flow concept, is essential because firms need to pay for the production costs before generating output. They can only do so by borrowing from banks whose funding costs are set by the central bank. Monetary policy thus acts as the system's forcing variable, ultimately driving its evolution. In effect, interest rates anchor the real economy as opposed to the other way around.

Second, the banking system is inherently prone to instability, exhibiting episodes of excessive risk-taking punctuated by periods of risk aversion. The financial cycle arises due to frictions on both the lending and borrowing sides. On the borrowing side, firms enjoy limited liability and imperfect screening, so even those with negative-value projects apply for loans. On the lending side, short-lived bank managers focus on immediate profits rather than banks' long-term solvency. Banks compete to lend, and an individual bank can undercut its competitors by offering a lower interest rate. The incentive to poach is assumed to be stronger when all other banks are also lending more aggressively, due to search externalities.[26] As a result, banks play a co-ordination game when competing, where both aggressive and conservative lending can emerge in equilibrium.

There is no steady state in the credit market, and the economy alternates between booms and busts. The lending rate is not uniquely pinned down by fundamentals, but fluctuates endogenously with the financial cycle. In a boom, active bank competition prevails and banks set low interest rates. Easy credit conditions boost output and consumption. However, the low interest rate also expands the set of bad firms in the total loan pool, and gradually weakens the banking sector by sapping its profits. As bank capital runs low, competition becomes increasingly untenable. Eventually the bankruptcy threat forces all banks to switch to the conservative lending equilibrium, triggering a bust. Banks then set high interest rates, which help curb aggregate bad loans and enable banks to slowly repair their balance sheets. During this 'balance sheet recession', output and welfare suffer owing to tighter financial conditions.

As a result, a trade-off between short-term and longer-term output arises – a key constraint for the central bank. A higher policy rate today raises the cost of funds for the banks, pushing up the equilibrium lending rate, which restrains the boom. This naturally comes at the cost of more subdued economic activity in the short run. At the same time, this 'leaning' policy promotes a more robust financial sector, enabling banks to provide financing to the real economy more sustainably. The central bank must strike a balance between these two competing considerations.

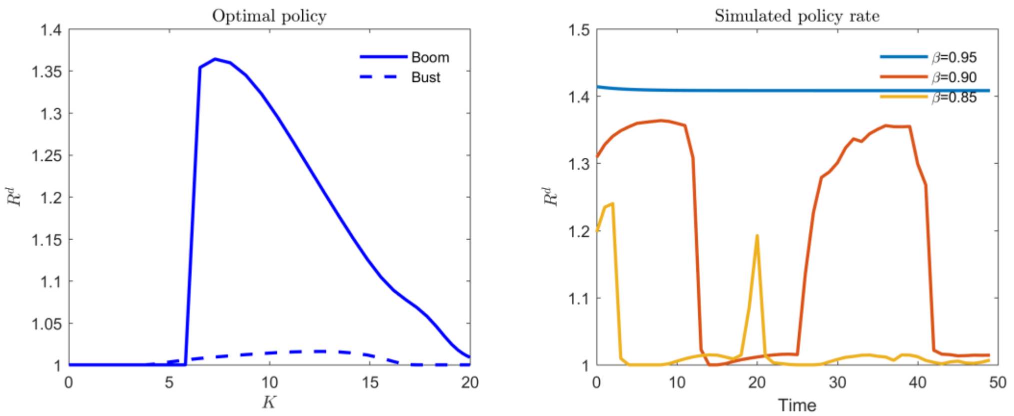
Optimal monetary policy generally prescribes some leaning during a boom. The extent varies over time. In particular, it depends on the state of the banking sector as captured by the level of bank capital. Graph 13 (left hand panel) shows the optimal policy interest rate as a function of bank capital, K. When the economy is in a boom and banks are very well capitalised

[26] When banks compete aggressively, more credit is supplied. In this environment, we assume that bad firms spend less effort to search for cheaper credit, which can already be obtained at low cost. As a result, the matching function between firms and banks is subject to externalities, creating strategic complementarity.

(K is high), the central bank sets the interest rate relatively low. As the boom continues, excessive competition erodes K and prompts a progressively higher policy rate, as the central bank steps up its effort to rein in the boom. Leaning is beneficial because it helps delay the onset of a bust, even if it does not prevent it (doing so may be too costly). Once the level of bank capital drops to a critically low level, a bust becomes so imminent that the marginal benefit of leaning no longer makes up for the short-term cost to the central bank. At this point, the central bank switches to implement a low interest rate in anticipation of a bust. Thus, optimal policy traces an inverted U-shaped function of bank capital. In a bust, the central bank simply sets a low interest rate to maximise the short-term payoff – the best it can do in the circumstances.

Optimal policy and simulations

Graph 13



Source: Rungcharoenkitkul et al (forthcoming).

Naturally, the degree of leaning depends on the central bank's preferences. A myopic policymaker, who places a smaller weight on future outcomes, is less willing to sacrifice current output for greater financial stability (and hence higher future output).[27] As a result, it leans relatively less throughout the boom. The myopic central bank suffers from a form of time inconsistency. It would like to keep output high today, but in doing so, it weakens the financial sector and narrows its policy choices tomorrow. In other words, a lower interest rate today raises the likelihood of a future bust, whose materialisation justifies even lower interest rates: in this sense, low rates beget lower rates. The right-hand panel of Graph 13 shows simulated interest rate paths (median from 500 simulations) for central banks with a varying degree of myopia. More myopic central banks (lower values of β) choose lower rates initially, and subsequently tend to plunge into a bust earlier and more often. This in turn forces them to cut rates further. Meanwhile, the most forward-looking central bank avoids the bust for the first 50 periods, and manages to keep interest rate high throughout in the median simulation.

27 The model assumes overlapping generations, so the central bank's discount factor weighs different cohorts'' welfare. The discount factor may be better interpreted as the degree of the policymaker's myopia than as reflecting a representative agent's time preference.

The model highlights the role of the monetary policy reaction function in determining the average level of (real) interest rates. A policy rule that takes too little account of financial stability not only prescribes a lower interest rate in normal times, but also leads to a higher incidence of crises, which in turn calls for even lower interest rates. From this perspective, the stubbornly low post-GFC global interest rates could be viewed as the result of a financial boom-bust cycle. The same insights may also help explain the trend decline in real interest rates in recent decades. Successive boom-bust cycles may have left a more permanent mark on the financial sector, exposing the economy to more virulent recessions over time. The trend decline in interest rates may reflect the need for monetary policy to come to the rescue in those situations (eg, early 1990s and during the GFC; Drehmann et al (2012).

3. Policy implications

3.1 How useful is the natural interest rate as a policy benchmark?

The preceding analysis argues that prevailing economic models may underestimate the influence that monetary policy has on persistent movements in real interest rates. This raises questions about the exogeneity of the natural rate of interest and its ability to act as policy anchor. If monetary policy, through its influence on the financial cycle, can affect real output and real interest rates persistently over time, then it is not possible to define a natural rate independently of the monetary policy rule. The ability of a variable to act as policy benchmark is undermined if the variable is itself endogenous to the policy it is supposed to guide. Indeed, some of the studies mentioned above explicitly recognise this possibility, even though they do not incorporate a financial cycle (eg, De Fiore and Tristani (2011)).

Once the natural rate becomes endogenous to policy, the very concept of equilibrium becomes less useful. Instead of a unique exogenous equilibrium path to which the economy gravitates over time, there is a multiplicity of equilibrium paths for output and the real interest rate that depend on policy. Interestingly, this harks back to Keynes' rejection of the natural rate in his General Theory, where he argues that there is no single natural rate of interest that balances the economy at full employment.[28] In his liquidity preference theory, the long-term interest rate is the outcome of central bank and market participant decisions. Depending on market participants' expectations and willingness to take on risk, the interest rate could persist at some arbitrary level for a long time. In sharp contrast to the current standard New Keynesian frameworks, the friction underlying deviations of market from natural interest rates is a *capital market failure* rather than *price* (and possibly wage) *stickiness*.[29]

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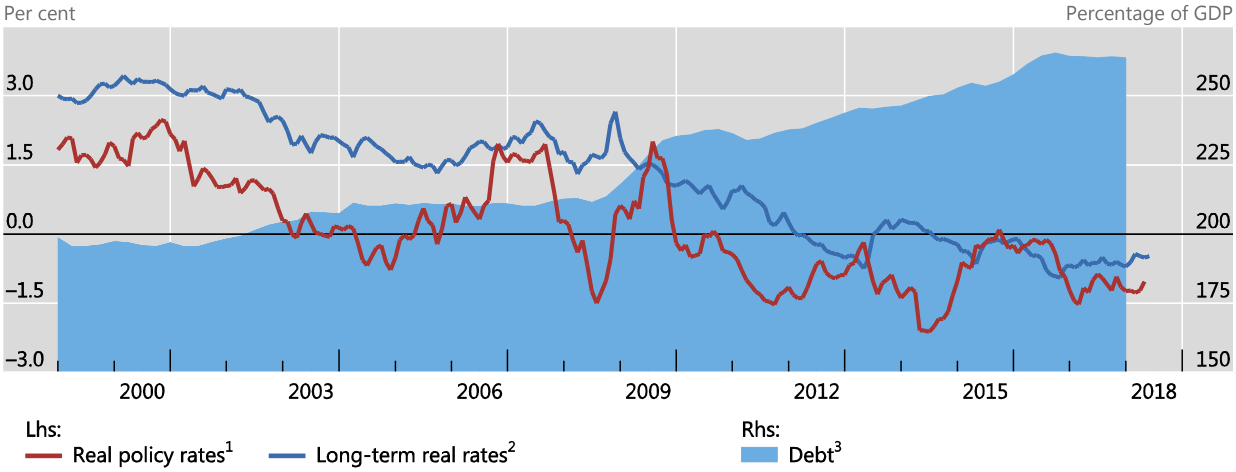
[28] Keynes rejected the notion that the rate of interest equilibrated the demand and supply for loanable funds because, in his view, the generation of income and expenditure are causal and the rate of interest merely an effect: "[the] novelty [of my theory] lies in my maintaining that it is not the rate of interest, but the level of incomes which ensures equality between savings and investment." (Keynes (1937), p 241). For an in-depth discussion, see Leijonhufvud (1981) and for a more recent sceptical view of the natural rate, see Laidler (2011) and his review.

[29] "It is only [...] with sticky prices that one is able to introduce the crucial Wicksellian distinction between the actual and the natural rate of interest, as the discrepancy between the two arises only as a consequence of a failure of prices to adjust sufficiently rapidly" (Woodford (2003), p 238). Interestingly, the notion of a market failure is also at the core of Wicksell's (1898) story. He regarded the divergence between the market and natural rates as a

The possibility of various paths that depend on the sequence of monetary policy actions even raises the prospect of the economy evolving along unsustainable paths. In the language of our model, monetary policy can act like a forcing variable that sustains the system at some arbitrary level for an extended duration. Given path dependence, actions today condition outcomes tomorrow that, in turn, constrain choices taken at that point. And they can do so in ways that increasingly narrow the room for maneouvre and worsen economic outcomes.

Into a debt trap? Graph 14



[1] Nominal rate less headline consumer price inflation. Simple average of Germany, Japan and the United States. [2] Simple average of index-linked 10-year government bond yields of France, Japan and the United States. [3] Total credit to non-financial sectors. Weighted average of the G7 economies plus China based on GDP and PPP exchange rates.

Sources: Bloomberg; Datastream; national data; BIS calculations.

Responding asymmetrically to the financial cycle is a case in point. With low and stable inflation, if central banks do not lean against the build-up of financial imbalances but ease aggressively and persistently after the bust, they may impart a downward bias to nominal and real interest rates. If, as a result, debt continues to rise in relation to GDP or does not adjust sufficiently, a "debt trap" might emerge: it would become harder to raise interest rates without causing damage to the economy owing to the large debt overhang (Borio and Disyatat (2014)). The important role debt service burdens play in influencing expenditures underlines this possibility. As a result, low rates beget lower rates.[30] This is a form of "time inconsistency" that can be more insidious than the familiar one in the context of inflation (Borio (2014)). As Graph 14 suggests, the data indicate that this possibility should not be dismissed out of hand.

disequilibrium phenomenon. In the case of a purely credit economy, he saw no forces driving market rates towards equilibrium.

[30] From this perspective, references to "passive" monetary policy as just an innocent bystander to a falling equilibrium real rate are misleading (eg Kocherlakota (2013)). There is, in fact, a certain tension within the prevailing views of monetary policy. On the one hand, monetary policy is seen as "passive", simply tracking an exogenous natural rate and having little influence on real outcomes in the medium run. On the other hand, monetary policy has been seen as critical in arresting the GFC, thereby preventing a much worse outcome, and as being "the only game in town", paving the way for a lasting recovery through its strong influence on global financial conditions in the face of powerful headwinds.

Consider how such a scenario can give rise to fundamentally contrasting interpretations.[31] Seen through the lens of the standard approach, the contraction in aggregate demand in a debt trap would be interpreted as a sign that the natural rate has fallen, driven exclusively by some deep underlying real factors. Seen through the lens of an approach that attaches importance to monetary policy, the financial cycle and indebtedness, it would be seen as a sign that the economy has been following an unsustainable path. And what policymakers would take as given (exogenous) at any point would be, at least in part, the result of a sequence of past policy decisions. Asymmetric policies during boom and bust phases may end up diminishing policy ammunition over successive financial and business cycles.[32]

All this suggests that there is a prima facie case for monetary policy to pay closer attention to the financial cycle than in the past. We may have been underestimating the influence of benign disinflationary forces, notably linked to globalisation and technology, and overestimating the ability of monetary policy to fine-tune inflation, especially to push it up towards targets in the face of powerful headwinds. If so, we may also have been underestimating the collateral damage that such strategies may generate in terms of financial and macroeconomic stability over longer horizons, especially by amplifying the financial cycle.

3.3 Adjusting policy frameworks

If monetary policy plays an important role in the build-up and unwinding of the financial cycle, would it be prudent to adjust overall policy frameworks but not those for monetary policy? We would suggest that the answer is "no". It is not possible to do justice to this argument within the confines of this paper, but we can make some general considerations (see Borio et al (2018) and references therein).

An obvious possibility would be to reinforce prudential frameworks and have them bear the whole burden. And indeed, a lot has been done post-crisis to strengthen regulation and supervision, at both the level of individual institutions ("micro-prudential") and of the system as a whole ("macroprudential"). Moreover, the macroprudential dimension is explicitly designed to address the financial cycle and the financial system's procyclicality ((eg Borio (2011, 2018), Caruana (2010), BCBS (2010b) and FSB-IMF-BIS (2011)).

But it would arguably be unwise to expect prudential policy to do the whole job on its own. A more balanced approach would also envisage a role for monetary policy (Borio (2018)). Our analysis suggests that its role is too significant to be ignored. It is monetary policy that underpins the term structure of *market* interest rates. And it is market interest rates that underpin credit creation and the availability of external financing in general. In other words, monetary policy ultimately sets the *price of leverage*. The central bank's reaction function, describing how market interest rates are set in response to economic developments, is the

31 See also Borio (2017b), for a detailed comparison of the secular stagnation hypothesis and one that highlights the role of the financial cycle –the financial cycle drag hypothesis – in interpreting the evolution of the economy over the past 20 years or so.

32 Of course, persistent effects of monetary policy on real interest rates are also possible if monetary policy remains passive as inflation takes off, leading to deviations of the market from the natural interest rate. This is one way to characterise the experience the Great Inflation of the 1970s. Lubik and Matthes (2016), for example, estimated a model of learning and argued that misperceptions about the state of the economy on the part of the Federal Reserve led to sustained deviations from equilibrium real rates.

financial system's ultimate anchor. And financial expansions and contractions can cause serious damage to the economy even short of banking crises.

How can central banks gain the necessary room for manoeuvre to respond more systematically to the financial cycle?

The smallest adjustment would be to lengthen the horizon over which to achieve a given inflation objective. In fact, to varying degrees, this is already how flexible inflation targeting is implemented. It has been widely recognised that the optimum horizon over which to guide inflation back to target depends on the nature of the "shocks". Indeed, some central banks that take account of financial stability/financial cycle considerations have done precisely this (eg the Central Bank of Norway and the Reserve Bank of Australia, to mention just two). One issue with this approach is the extent to which inflation deviations from target will be tolerated before central bank credibility comes into question. This is likely to be country-specific and depend on history and institutional arrangements. Moreover, given the history of inflation targeting, inflation shortfalls arguably raise less reputational concerns than inflation above target. For instance, in a country like Switzerland, persistent deviations in the form of actually falling prices have been tolerated quite easily: the central bank has progressively de-emphasised the target while never officially renouncing it.

More radically, central bank mandates could be amended to, say, include financial stability as a separate consideration. The advantage of this approach is that it would definitely give the central bank ample room for manoeuvre. The disadvantage is that it would explicitly introduce the notion of a trade-off that need not be there over a sufficiently long horizon. Moreover, the mandates enshrined in the central bank law are typically written in very general terms and provide plenty of scope for interpretation.[33] For example, the Reserve Bank of Australia's actually refers also to the "welfare of the Australian people", which is clearly quite broad in scope. In order to attach greater weight to financial stability considerations, the central bank has modified its agreement with the government and used the mandate in its communication to avoid further easing in a context of very high and rising household debt and rich property prices.[34] By contrast, the recently established independent commission in Norway has recommended explicitly adding financial stability to the central bank's mandate and setting up a joint policy committee for monetary and macroprudential policies. The objective is to strengthen the foundation for policies the Central Bank of Norway has already been following since 2012.

At the end of the day, mandates matter less than the analytical framework used to implement them. Many of the current arrangements already provide significant room for

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[33] For instance, Section 2a of the Federal Reserve Act states: "The Board of Governors of the Federal Reserve System and the Federal Open Market Committee shall maintain long run growth of the monetary and credit aggregates commensurate with the economy's long run potential to increase production, so as to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates." Given the reference to monetary and credit aggregates as well as moderate interest rates, this leaves considerable room for interpretation.

[34] The agreement signed in September 2016 modifies the previous one from October 2013. It clarifies that the medium-term 2–3% inflation objective, on average, is to be pursued "over time", rather than more precisely "over the cycle". In addition, it now states explicitly that "the medium-term focus provides the flexibility for the Reserve Bank to set its policy so as best to achieve its broad objectives, *including financial stability*" (emphasis added).

manoeuvre, as evidenced by the varying degree to which inflation targeting central banks take financial stability concerns into account. Admittedly, including financial stability in central banks' mandates could help the institution resist political pressure when taking decisions that put long-term gains above short-term ones. That said, the unpredictability of the political process means that changes in mandates should be treated with great caution.

Conclusion

Drawing on both empirical and theoretical work, we have argued that monetary policy may play a more important role in long-run real economic outcomes, including real interest rates, than commonly thought. This, in turn, raises questions about the notion of a natural rate that is independent of policy – especially a rate that does not even include financial factors in its definition. As a result, current approaches may overestimate the concept's usefulness as a policy benchmark.

In particular, we have argued that monetary policy plays a significant role in anchoring the financial cycle, in ways that are not incorporated in prevailing macroeconomic analytical frameworks. The central banks' reaction function influences the financial cycle, not least by influencing risk-taking. The cumulative impact of policy may end up constraining policy choices once the future becomes today. In technical terms, the interaction between monetary policy and the financial cycle generates path-dependence. In practical terms, the issue is not so much whether monetary policy should lean against the wind, monetary policy *is* the wind – for better or worse, the policy regime is a determinant of long-run outcomes.

Will low interest rates persist into the future? If our conjecture is correct, that will depend in part on the extent to which monetary regimes could address more successfully the financial cycle. But this would need to be just one element of a broader macro-financial stability framework that included, not just monetary policy, but also prudential, fiscal and even structural policies. Ensuring lasting financial and macroeconomic stability, alongside stable prices, is obviously a task that goes way beyond monetary policy. But it is one to which, with some refinements, monetary policy frameworks could arguably contribute more than they currently do.

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Annex 1: An empirical analysis of the safe asset shortage hypothesis

In order to guide our empirical analysis, it is worth laying out the SAS framework a bit more precisely. In principle, a safe asset shortage shock works no differently from other saving-investment factors. In its stripped down form, the key idea has been formalised using an IS-LM-like framework, eg as in Caballero et al (2016). Their model consists of an IS condition, a Taylor rule and a safe asset market equilibrium condition:

$$y - \bar{y} = -\delta(r - \bar{r}) - \delta_s(r^s - \bar{r}^s)$$
$$r^s = \bar{r}^s + \phi(y - \bar{y})$$
$$s = \psi_y y + \psi_s r^s$$

where y, r and r^s are real output, the risky real interest rate, and safe real interest rate, respectively. Upper bars denote equilibrium values (ie potential output and natural interest rates). In turn, s denotes the exogenous supply of safe assets. All coefficients are non-negative.

The model yields two key predictions.

First, a decline in the safe asset supply s leads to a lower output y and a lower risk-free real interest rate r^s (last two equations). Thus, a SAS boosts desired saving, just as IS curve shifts to the left in the standard model. Furthermore, a safe asset supply shift can be interpreted as a shock to the natural rate (at $y = \bar{y}$, $\bar{r}^s = (s - \psi_y \bar{y})/\psi_s$).

Second, the risky real rate r increases with the SAS. This follows from the first prediction and the first equation, as long as the effects of interest rates on output are non-degenerate ($\delta_s > 0$ and $\delta < \infty$). Therefore, the risk spread $r - r^s$ unambiguously increases as safe assets become scarcer. When the effective lower bound on the safe interest rate becomes binding, the first prediction needs to be modified – after a safe asset supply shrinkage, the adjustment falls on output rather than the safe interest rate, exacerbating a recession. Meanwhile, the risk spread still rises.

Our focus in assessing the SAS hypothesis is on the behaviour of the yield spread between safe and risky assets.[35] The implication that risk spreads increase as the interest rate on safe assets declines sets the SAS hypothesis apart from other saving-based explanations. It is natural to expect that relative supply and demand, mediated by risk preferences, should influence the risk spread. The empirical question is whether it has done so in a way consistent with the SAS hypothesis. Specifically, can the SAS explain the *trend decline* in the *level* of interest rates? In exploring this hypothesis, the joint behavior of risk-free rates and risk spreads is important.

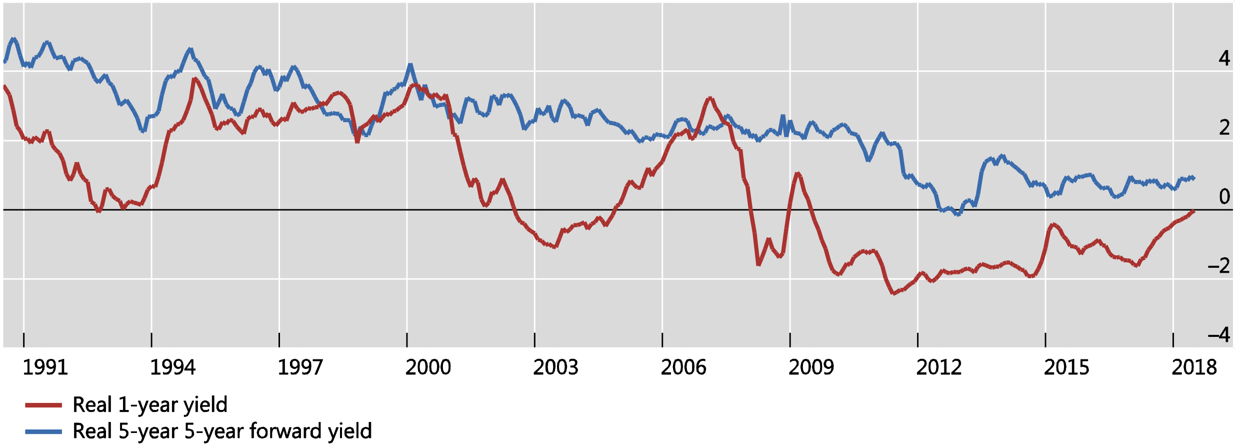
To test the SAS hypothesis more formally, we start by flexibly modelling the joint dynamics of the real interest rate and various risk premia via a VAR based on monthly data. We include the following variables: (1) the term premium of US 10-year government bond (rp); (2) 5-year

[35] Our goal here is to assess how well the SAS hypothesis helps explain the recent fall in real interest rates. The broader implications of safe asset supply, for example on market liquidity and financial stability, lie beyond the scope of our analysis.

5-year forward real interest rate calculated from the US inflation-adjusted government bond's yield curve ($5y5y$); (3) option-adjusted spreads of high-yield EME US-dollar denominated corporate bonds (hy); and (4) the VIX (vix).[36]

Real interest rates

In per cent | Graph A1



Source: Consensus Economics, FRED, BIS calculations.

The 5-year 5-year forward real rate captures what the "market" expects the real yield on a 5-year bond to prevail in five years' time. It is a natural proxy for the natural rate, which should be free from the influence of transient perturbations to real interest rates, particularly due to monetary policy. In the case of the United States, both short-term and 5-year 5-year forward real rates have declined in recent decades, with the monetary policy influence on the short-term rate clearly being substantial (Graph A1). By focusing on the forward real rate, we can zoom in on the secular determinants of real interest rates as posited by SAS hypothesis.[37]

Our strategy is to identify safe-asset and other competing shocks through sign restrictions, and then to examine the relative importance of such shocks in explaining the evolution of yields through a historical-decomposition exercise. A SAS shock is assumed to: i) lower the natural rate, proxied here by the $5y5y$; ii) raise the risk spread, hy; and iii) lower the tern premium of safe bonds, rp. We leave unrestricted its effect on the VIX.

The sign restrictions for the other three shocks are as follows. A *natural rate or "r*" shock* unrelated to a SAS is restricted to affect $5y5y$, and is otherwise unrestricted. It may be logical

[36] The sample coverage is December 1998 to May 2018. The term premium is estimated using the linear regression ACM method (Adrian et al (2015)). The 5-year 5-year forward rate is computed using the Treasury inflation-protected securities' (TIPs) yield curve. Before 2003, when the TIPs data commenced, we use the forward rate from the nominal yield curve minus the long-term inflation expectations using Consensus Economics survey. Option-adjusted spreads are from Bank of America.

[37] Advocates of the SAS view sometimes refer to short-term interest rates in motivating their discussion. Caballero et al (2017), for example, use the decline in 1-year treasury yield to motivate the rise in demand for safe asset. But such a short tenure, the predominant factor moving rates is monetary policy. We focus on long-term bonds, which we think are more relevant for the story.

Sign restriction assumptions Table A1

	Shocks			
Variables	Natural rate	Safe asset	Flight to safety	Risk appetite
rp_10		-1	-1	
5y5y	1	-1		
hy		1	1	1
vix			1	1
Periods (months)	6	6	1	1

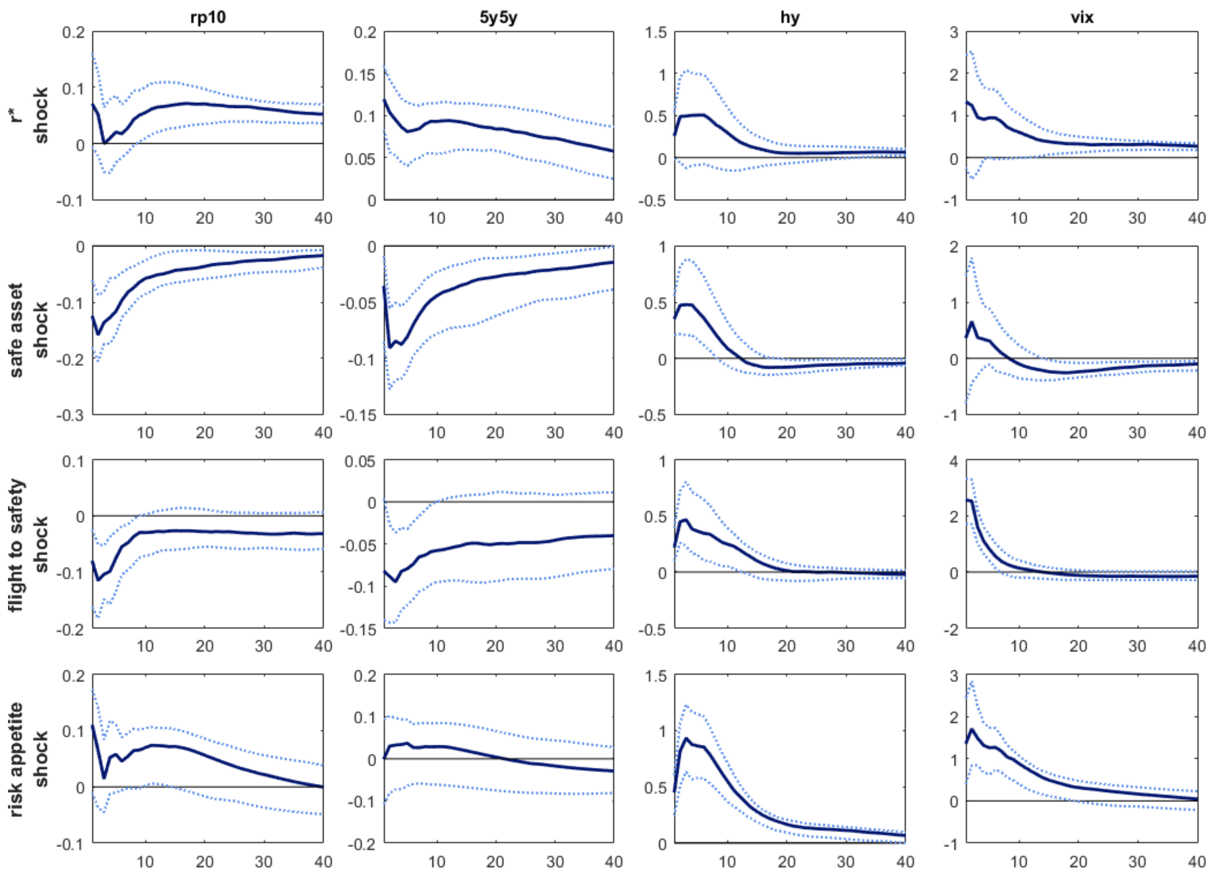
to interpret this shock as representing the influence of saving-investment factors, but it also encompasses all other possible determinants of the $5y5y$. Next, *a "flight-to-safety" shock* is assumed to lower the term premium (rp) and raise both the risk spread (hy) and the VIX. The shock represents a short-term increase in the demand for safe sovereign securities driven by general concerns (a fear factor) in global financial markets. Finally, a global *"risk appetite" shock* is assumed to drive up both the risk spread (hy) and the VIX, but is not required to affect the long-term real rate or the term premium in any specific direction. For the safe asset and natural rate shocks, which in theory should have more persistent effects, we impose the sign restrictions for 6 months after the occurrence of the shocks. For the flight to safety and risk appetite shocks, the restrictions are enforced only on impact. Table A1 summarises the sign restrictions used to identify the four shocks.

The identified model produces impulse responses that accord reasonably well with the intended interpretation of each shock. Graphs A2 shows the impulse response functions of the four shocks, together with a one standard error band. A positive r* shock leaves a very persistent effect on r*, well beyond 40 months, and has generally ambiguous effects on the other variables as may be expected. For a safe asset shock, the effect on 5y5y is persistent, but noticeably less so compared with the r* shock. The effect on spreads of a safe asset shock is even more short-lived, lasting no more than 10 months. Note that under the SAS, there is no reason why the impact on spreads should be any less persistent than that on the real interest rate.[38] Next, a flight to safety shock has a relatively short-lived effect on the three variables subject to sign restrictions – as may be expected. The shock also lowers 5y5y in the short term, probably reflecting its impact on risk premium component of the forward rate. Finally, the global risk appetite shock does not materially affect the US term premium and 5y5y, validating the interpretation of the shock.

[38] In this sense, our identification strategy is conservative and favours the SAS hypothesis. A different approach would be to evaluate whether the sign restrictions as well as the high degree of persistence predicted by the SAS hypothesis are compatible with the data. See Kilian and Lütkepohl (2017) for a discussion of why verifying sign restrictions in such a manner is challenging. Instead, we take these identified shocks as given, and examine how important they are in a historical-decomposition exercise.

Impulse response functions

Graph A2



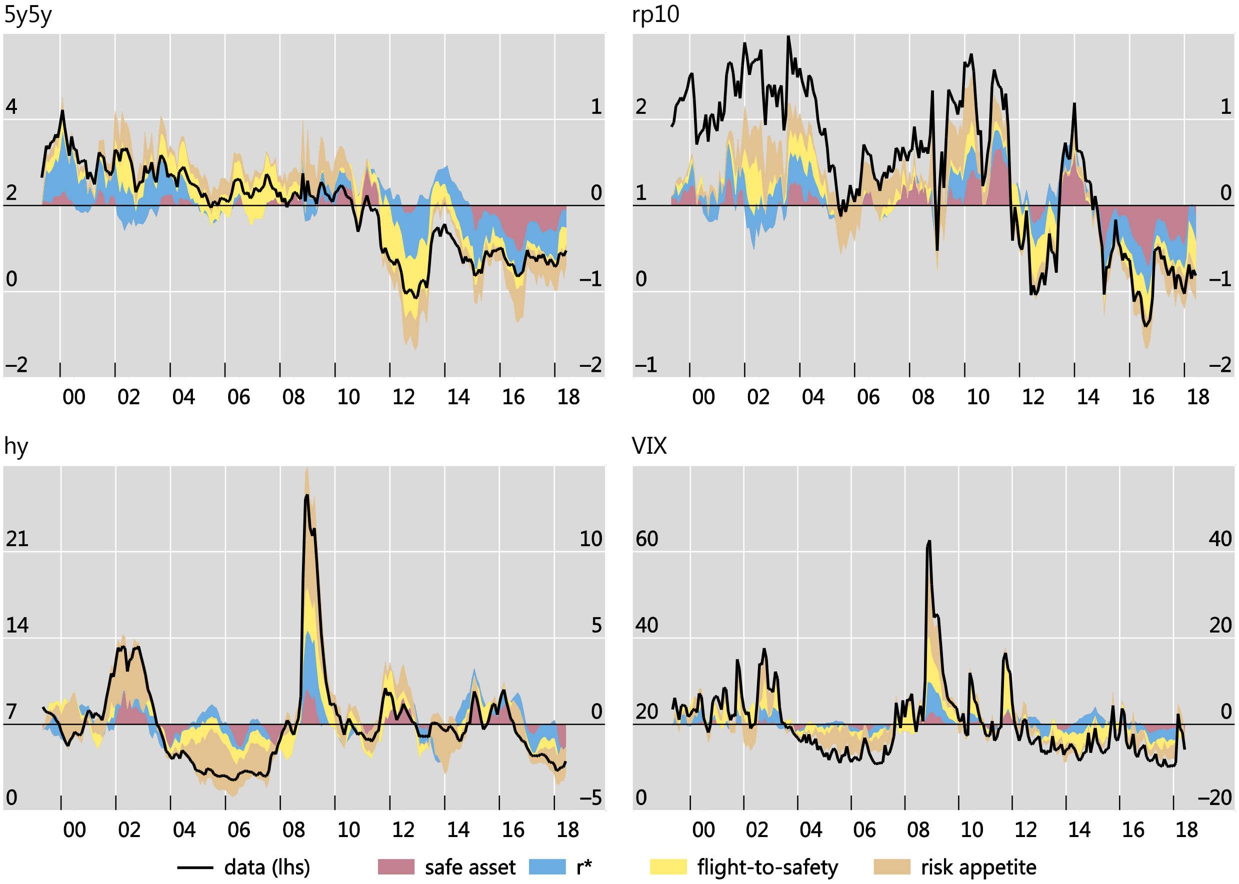
Responses of endogenous variables (columns) to shocks identified via sign restrictions (rows). Dotted lines represent one standard deviation bounds.

Source: authors' calculations.

Quantitatively, the safe asset shocks play a very small role in explaining the past secular decline in 5y5y real interest rate. Graph A3 describes the results of the historical decomposition, showing the contributions of the four shocks in driving the endogenous variables. Note in particular the top left panel, which shows a historical decomposition of the 5-year 5-year forward rate, our proxy for the natural interest rate. Most of the decline in this variable can be explained by the r* and flight-to-safety shocks, with the safe asset shock contributing little. Even during the euro crisis in 2011, when the concern about safe assets arguably reached its height, the contribution of the r* and flight-to-safety shocks was much larger than that of the safe asset shock. In fact, the contributions from safe asset shocks only turned negative in the last few years, contrary to the usual narrative.[39]

Historical decomposition

Graph A3



Areas in each panel represent the cumulative contributions from various shocks to the respective endogenous variable. Any discrepancy between the sum of areas and the data reflects the constant term in the vector autoregression, and the fact that shocks prior to the estimation sample cannot be observed.

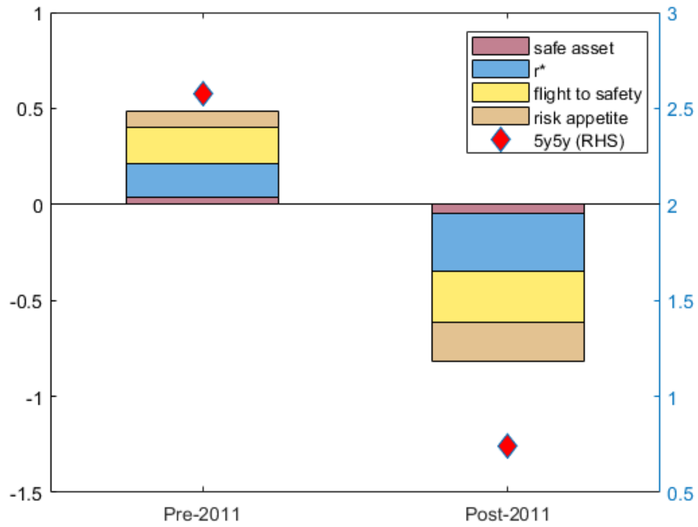
Source: authors' calculations

The limited role of safe asset shocks emerges also when comparing the average contributions from the various shocks across sub-periods (Graph A4). Since 2011, the 5y5y real rate averages about 0.75 per cent, a drop of more than 1.75 percentage points from the pre-2011 average. Safe asset shocks contribute very little to this drop, explaining less than 10 basis points. Each of the three other shocks explains between 30-50 basis points of the 5y5y decline, and together they account for 1.20 percentage points.

[39] On the other hand, the results appear generally consistent with the standard risk-on risk-off narrative. Risk appetite shocks explain well the widening of risk spreads and the VIX during the dot-com and GFC episodes, as well as the spread and term premium compression during the conundrum years 2005-2007.

Average historical decompositions of real 5y5y rate

Graph A4



Sample averages of the historical decomposition, taken over June 1998 to June 2011 (pre-2011) and July 2011-May 2018 (post-2011) periods respectively.

Source: authors' calculations

Annex 2: A model of monetary policy and the financial cycle

The economy consists of overlapping generations of households, firms and bank managers. They all live for two periods. Households choose labour supply and allocate consumption over their two-period lives. Firms require labour input to start production, which takes one period to complete, and need to pay wages upfront. The production lag gives rise to a financing need. Banks provide this financing by creating bank deposits through loan extension. Deposits are the economy's means of payment. Banks are infinitely-lived institutions that retain all profits and losses through their capital, though they are managed by short-lived managers who focus only on next-period profits. Every period, new loans and deposits are created to enable new production, while old ones are extinguished (settled).

There are two types of firms that differ in the riskiness of their production technology. To make things stark, we assume that productive firms succeed for sure and can always pay back their loans; by contrast, unproductive ones fail almost surely but will nonetheless seek loans due to limited liability. Banks cannot distinguish between firm types. In addition, they operate in an imperfectly competitive market, so that they can poach customers by lowering the interest rate they set on loans. But in doing so, they attract both types of firm according to a matching function that depends on the average interest rate level. When loan interest rates are high, we assume that unproductive firms search harder for cheaper credit. This makes poaching more expensive because offering a lower interest rate is likely to attract a larger proportion of unproductive firms. Banks do not take into account the impact of their lending rate on the overall interest rate, hence the matching function is subject to an externality, which leads to strategic complementarity and multiple equilibria. When all banks set high lending rates, it is costly for an individual bank to deviate and undercut others, as it would attract relatively more unproductive firms. Similarly, when lending rates are low, each bank finds it desirable to keep its lending rate low, given that poaching is less likely to attract bad firms.

Three functions succinctly capture the model's reduced form. The first is the household labour (L_t) supply

$$L_t = L^s(W_t, R_t^d)$$

which is increasing in both real wage W_t (substitution effect) and the real deposit interest rate R_t^d (income effect). The second is firms' labour demand

$$L_t = L^d(R_t W_t)$$

which is decreasing in the marginal cost of production – a product of the wage bill and the interest rate on loans, R_t. Finally, bank managers' optimisation gives rise to a loan pricing function

$$R_t = R(L_t W_t, R_t^d, \theta_t)$$

where $\theta_t \epsilon \{\theta_L, \theta_H\}$ captures the intensity of unproductive firms' credit search, which is low (θ_L) when interest rates are low and high (θ_H) when interest rates are high. The model is closed by a central bank that sets the deposit interest rate, R_t^d, in a manner further elaborated below.

The regime-dependent loan-pricing equation reflects the existence of multiple equilibria in the loan market. A "boom" phase of low loan rates and ample credit, and a "bust" one of high loan rates and scarce credit. The regime switches stochastically depending on the level of bank capital K_t

$$P(boom|bust) = \varphi(K_t - a)$$

$$P(bust|boom) = \varphi(K_t - b)$$

where $\varphi(.)$ is a logistic function, and thresholds a and b centre the probability distribution of regime switches around specific bank capital levels. We assume $a > b$ so that the economy needs to replenish the bank capital lost over time before it can recover. The assumption implies that both regimes are persistent The evolution of bank capital is given by

$$K_{t+1} = K_t + \Pi_{t+1}$$

where bank profit, Π_{t+1}, depends on the interest rate margin, the volume of loans to productive firms, and loan loss from lending to non-productive firms.

Under quite general calibrations and depending on the monetary policy rule, the framework is able to produce recurring financial boom-bust cycles. During booms, banks over-compete by setting low loan rates, which allows more unproductive firms to join the borrower pool and generates systematic losses. As bank capital runs low, there is a growing probability of a bust. Once a bust happens, all banks switch to coordinate on the other equilibrium of conservative lending and higher loan rates. They thereby gradually repair their balance sheets. As bank capital recovers, the probability of a return to a boom phase increases.[40]

We solve for the equilibrium numerically for a given set of parameter calibration. All private agents take the current monetary policy stance as given when making decisions. As they live only for two periods, future policy actions, regimes and bank capital do not feature in their decisions.[41] This allows the equilibrium to be computed period by period for a given policy interest rate R_t^d. To illustrate the mechanics of the model, Graph A5 plots equilibrium values for selected variables as a function of the policy interest rate in both the boom and bust regimes. The period payoff is defined simply as the sum of the utility of all economic agents.

Consider first the boom regime (solid lines). The lending rate generally increases with the policy rate, transmitting the effect of monetary policy (top left panel of Graph A5). A higher lending rate raises financing costs, and curtails output and consumption (top right panel). As a result, the period payoff declines with the policy rate (bottom left panel). In this economy, the short-run payoff is maximised when the policy rate is relatively low ($R_t^d \approx 1$) because this leads to low financing costs for firms and maximal period output. But at such a low interest rate, aggressive competition among banks leads to a large number of unproductive firms entering the borrower pool, resulting in loan losses. Bank profits are therefore negative for interest rates below a certain range (bottom right panel). A persistently low policy interest rate gradually erodes the level of bank capital, eventually plunging the economy into a bust.

In a bust, banks coordinate on the conservative lending equilibrium, pushing the lending rate sharply higher, and output and period payoff much lower (dashed lines in Graph A5). Monetary policy remains effective at the margin, but it can no longer sustain the output level and period payoff attained during the boom. The regime switch is a legacy from past actions that cannot be undone in the short run. At the same time, restrained lending competition implies positive bank profits for any level of the policy interest rate, as banks repair their balance sheets. Over time, this raises bank capital and the economy eventually returns to a boom regime.

The central bank is assumed to maximise the infinite discounted sum of period payoffs with a discounting parameter β. Given the overlapping generations structure, the discount factor effectively serves as the weight attached to the welfare of different generations. We numerically solve this dynamic programming problem and obtain the optimal choice of R_t^d as a function of bank capital and the regime (left panel of Graph 13 in the main text.)

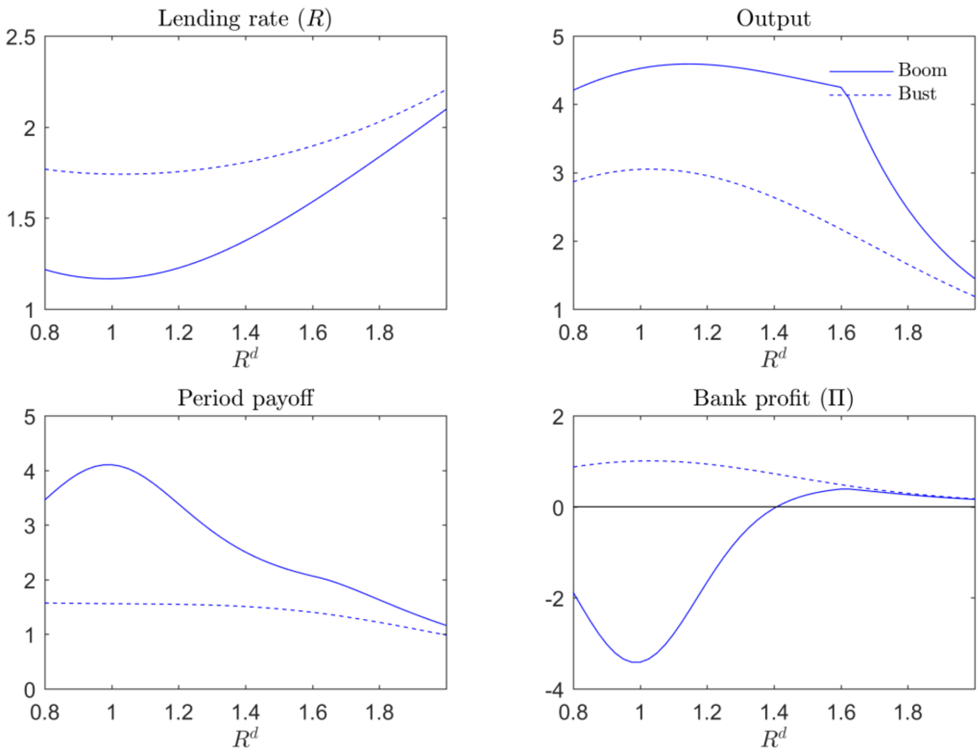
In a boom, the central bank faces an intertemporal trade-off. Setting a low interest rate raises the immediate payoff but at the expense of deteriorating bank capital and hence a higher chance of entering into a disruptive bust in the future. Optimal policy in fact requires interest rates somewhat higher than the period-payoff-maximising level ($R_t^d \approx 1$ as outlined above) in order to internalise the effect of bank competition and "lean against" the financial

[40] The model's feature that banks lose money during booms is a shorthand for a build-up of fragility, which makes the banking system more vulnerable to shocks. In reality, banks usually report strong earnings during booms, and the system's fragility remains hidden. Our model simply assumes that bank capital can be observed accurately (profits correctly measured), but booms are nonetheless persistent for reasons other than informational frictions.

[41] In our model, agents are perfectly informed and utilise all available information. Nonetheless, the finite life assumption resonates with the literature that appeals to finite horizons and bounded rationality as the source of excessive risk-taking and the boom-bust phenomenon.

boom. The optimal interest rate depends on the level of bank capital. When banks are very well capitalised, a bust is only a remote possibility and the optimal policy rate is low. As capital declines, the trade-off between short-run and longer-run payoff becomes more stringent, and optimal policy prescribes progressively more forceful leaning. Leaning continues until bank capital drops to a very low level, rendering a bust almost certain. At this point, it is optimal to set the rate low to maximise the period payoff, and simply brace for the impending bust. This is consistent with the counterfactual simulation of the empirical model above, where policy rates are lowered ahead of the downturn.

Period equilibrium as a function of policy rate Graph A5



Source: Rungcharoenkitkul et al (forthcoming).

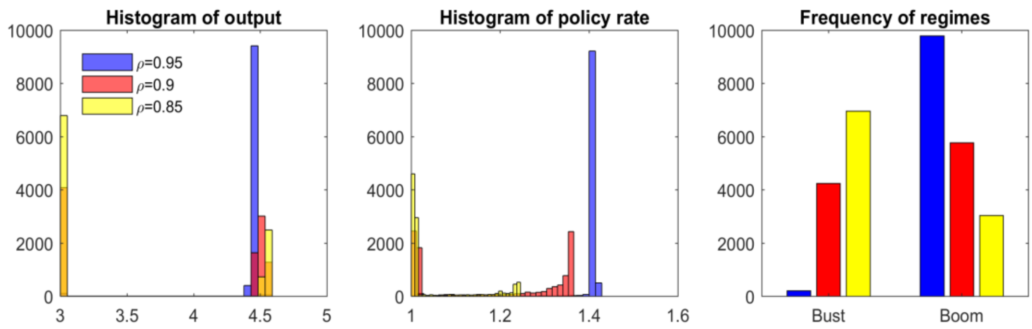
In the bust phase, banks enter balance sheet-repair mode and a low interest rate no longer undermines banks' stability. Optimal monetary policy can focus on mitigating the effect of higher spreads induced by heightened risk aversion, and shore up short-run output and period-payoff (dashed line, Graph 13 left panel). Interest rates are thus uniformly low regardless of the value of bank capital.

The optimal degree of leaning also depends on central banks' preferences, namely their discount factor. The more weight the central bank places on future generations' welfare relative to the present one, the stronger is the incentive to lean. To illustrate how outcomes depend on central bank preferences, we simulate the model 500 times each for three different monetary policy regimes, from one that is relatively myopic ($\beta = 0.85$) to those that are progressively more forward-looking ($\beta = 0.9$ and 0.95). We initialise all simulations with a boom state and a moderately robust banking sector (bank capital equals 10). The right-hand panel of Graph 13 in the main text shows the median interest rate paths corresponding to the three central banks.

The more forward-looking central bank (higher β) starts off implementing a higher interest rate than others. In doing so, it has a firmer control on the financial cycle. As shown in the graph, in the median outcome the economy never enters into a crisis for the first 50 periods (there is only a small number of simulations where a bust occurs due to bad luck). Meanwhile, a more myopic central bank that chooses a lower interest rate to begin with benefits from higher short-term output and payoff, but enters a bust phase earlier. When that occurs, it has to implement a minimal interest rate to support activity. More myopic central banks also spend more time in busts. For the most myopic central bank shown in the graph, the median path interest rate path hardly deviates from the minimum level.

One can also appreciate the role of monetary policy regimes by examining long-run outcomes. In Graph A6 below, we plot the histograms of selected variables corresponding to the three central banks. We generate the histograms from simulations (they are approximations to the ergodic distributions). When the central bank is forward-looking and leans more, the economy tolerates a slightly lower output and consumption during booms (blue bars). The upside is that the economy spends less time in a bust, and the rate need not be cut substantially as often. In the long run, a central bank that values future outcomes relatively more would produce higher interest rates, more stable output and a lower incidence of busts, on average. The distribution of interest rates depends on the policy reaction function rather than being anchored to some exogenous fundamentals.

Long-run distribution of equilibrium Graph A6



Source: Rungcharoenkitkul et al (forthcoming).