Global financial cycles and risk premiums*

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Abstract

This paper studies the synchronization of financial cycles across 17 advanced economies over the past 150 years. We show that the comovement of credit, equity and house prices has increased above and beyond growing real sector integration. The sharp increase in the comovement of global equity markets in the past three decades is particularly notable. We demonstrate that fluctuations in risk premiums, and not risk-free rates and dividends, account for most of the observed equity price synchronization post-1980. We also show that U.S. monetary policy has come to play an important role as a source of fluctuations in risk appetite across global equity markets. These fluctuations are transmitted across both fixed and floating exchange rate regimes, but the effects are muted in floating rate regimes.

Keywords: financial cycles, asset prices, equity return premium, policy spillovers, financial centers

JEL Codes: E50, F33, F42, F44, G12, N10, N20.

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1. Introduction

The Global Financial Crisis highlighted the need for an evolution in macroeconomic thinking. In the past 40 years, the advanced world has become exponentially more leveraged. This "financial hockey stick" had profound implications for the business cycle. Jordà *et al.* (2016) showed that business cycle correlations are far from universal cosmological constants. Rather, their evolution appears to be tightly linked with the growth of credit relative to GDP. Added to the urgency to integrate finance into the basic architecture of business cycle models, one could add that there is a more fundamental need to understand the financial cycle and its interplay with the business cycle.

The first goal of this paper is to fill some of these gaps by analyzing global financial cycles over the past 150 years across a sample of 17 advanced economies. While the comovement of real variables has been extensively studied in the literature, financial cycles have received less attention. This is partly due to the fact that long-run data for credit growth, house prices and equity prices have only recently become available (Jordà *et al.*, 2016, 2017b).

Our analysis reveals that synchronization of financial cycles across countries has become increasingly prevalent. We can now speak of a global financial cycle whose effects are felt widely and more vividly over the past few decades than ever before. For the most part, financial synchronization has increased hand in hand with international synchronization of real variables, such as GDP, consumption and investment. Equity price synchronization follows a different pattern, however. We find a much more rapid increase in global synchronicity since the 1990s. Moreover, we find that this rise in equity price synchronicity exceeds that of dividends, whose international comovement is more in line with the comovement of cycles in real variables. The explanation for this divergence is the striking rise in the volatility and global covariation of equity return premiums, or risk premiums. Our analysis thus lends support to accounts that put asset prices and risk premiums at center stage in explaining the synchronization of the global economy (Dedola and Lombardo, 2012; Devereux and Yetman, 2010; Dumas *et al.*, 2003; Fostel and Geanakoplos, 2008; Ward, 2017).[1]

The second goal of this paper is to analyze the role that monetary policy plays in explaining the increased synchronization of global risk appetite. In particular, we find that

[1] Dumas *et al.* (2003) explain the excessive correlation of equity prices over fundamentals through the excessive volatility of a common stochastic discount factor.

U.S. monetary policy is a powerful driver of global risk appetite and thus binds together global equity prices. Moreover, we show that this synchronization of international risk taking is a new phenomenon. In the first era of globalization, before 1914, we do not find evidence linking risk appetite internationally. Possible explanations include current monetary practice and a more prominent role of leveraged financial intermediaries in the world economy today.

Links between our findings and the existing literature are numerous. First, we add a longer-run cross-country perspective to the existing financial cycle literature, such as Claessens *et al.* (2011), Drehmann *et al.* (2012) as well as Aikman *et al.* (2014) and Schüler *et al.* (2015). Second, we confirm recent research regarding the increase in global financial synchronization over the past two decades (e.g. Bruno and Shin, 2013; Cerutti *et al.*, 2014; Obstfeld, 2014). Our data provide evidence in support of this trend towards increased financial synchronization. Third, we extend the literature that studies the relation between financial– and real–cycle comovements (see Metiu and Meller, 2015). Fourth, our work builds on an emerging literature that investigates the nexus between monetary policy and risk taking, asset prices, and global financial synchronization (Miranda-Agrippino and Rey, 2015).

The remainder of this paper is organized as follows. Section 2 briefly introduces our data and documents common long-run trend towards higher real and financial cycle synchronization. Section 3 digs deeper into the source of synchronization in equity markets and shows that the sharp increase in the comovement of the global equity return premium explains most of the comovement in international stock returns. Section 4 contains the core empirical part of the paper. It addresses the question of whether financial center monetary policy is a common driver of global equity return premiums. More specifically, we study how global equity markets react to changes in U.S. interest rates since WW2, and compare the results to previous periods. In Section 5 we evaluate the robustness of our results by using instrumental variable methods on the unexpected component of rate changes, as proxied by Gertler and Karadi (2015) high frequency shocks.

A natural international transmission channel is via exchange rates and hence we evaluate whether our findings on synchronicity are stronger for countries with fixed exchange regimes relative to countries that allow their exchange rate to float freely. We find some evidence that the transmission effects are stronger for fixed exchange rate regimes, but they are still sizable for floaters. This finding adds an important new dimension to the debate about the degree to which international financial integration undermines monetary policy autonomy. In the case of equity markets, there is suggestive evidence that monetary policy in the center country triggers swings in risk appetite that appear to be independent of domestic monetary conditions.

The paper concludes by first providing an extensive discussion of our results in the context of recent literature in Section 6, followed by the conclusion. Numerous other robustness checks are included in an extensive appendix.

2. Financial and real cycle synchronization, 1870-2013

2.1. Data

The data that we use in this paper come from a number of sources. Real variables come from the latest vintage of the Jordà *et al.* (2016) Macrohistory Database (available at `www.macrohistory.net/data`). The dataset comprises annual data from 1870 to 2013, for 17 countries: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, U.K. and the U.S.. Combined, these 17 countries make up more than 50% of world GDP throughout the period we are looking at.

Financial cycles are associated with the synchronized ebb and flow in credit aggregates, house prices and equity prices across countries (see Aikman *et al.*, 2014; Claessens *et al.*, 2011; Drehmann *et al.*, 2012). The credit series cover loans of all monetary financial institutions—including savings banks, postal banks, credit unions, mortgage associations and building associations—to the non-financial private sector.

To study equity- and house-price comovements we rely on the newly collected dividend yields and rental yield series introduced by Jordà *et al.* (2017b). The equity premium is defined as the excess total return of equity over long-term government bonds. Detailed explanation on how these data were constructed are available in that paper.

2.2. Methods

In order to analyze the international comovement of real and financial cycles we calculate 15-year rolling-window Spearman rank correlation coefficients. One reason to use this measure of correlation instead of the more traditional Pearson correlation is to capture monotone but not necessarily linear relationships. The appendix reports results based on rolling-window Pearson correlation coefficients, which turn our to be qualitatively similar. The 15-year rolling-windows that we use are backward-looking, that is, the correlation coefficient reported for 2000 is based on data from 1986 to 2000. Hence, we denote the Spearman correlation coefficient between countries i and j calculated over the 15-year window ending at time t as $s_t^{i,j}$ for $i, j = 1, \ldots n$, n being the cross-sectional sample size. A global measure of association can then be constructed as the average of these bilateral correlations as follows:

$$\bar{s}_t = \frac{\sum_i \sum_{j<i} s_t^{i,j}}{N}; \qquad N = \frac{(n-1)n}{2}. \tag{1}$$

In terms of notation, t is the rolling-window time index defined earlier, $\bar{s}_t$ is the average bilateral correlation coefficient at t and $s_t^{i,j}$ is the bilateral correlation coefficient for country-pair i, j. The number of distinct correlations excluding the correlation of one country with itself is given by the usual formula $n(n-1)/2$ where n is the total number of countries in the sample. In order to account for the cross-sectional and temporal dependencies, all confidence intervals are constructed using a cross-sectional block-bootstrap procedure (see Kapetanios, 2008).

As a robustness check, we also construct a GDP-weighted average version of expression (1). In particular, we use the relative purchasing power-adjusted real GDP of the bilateral country pair i, j, that is:

$$\bar{s}_t^{\omega} = \sum_i \sum_{j<i} \omega_{i,j,t}\, s_t^{i,j} \qquad \text{with} \tag{2}$$

$$\omega_{i,j,t} = \frac{(GDP_{i,t} + GDP_{j,t})}{\sum_i \sum_{j<i}(GDP_{i,t} + GDP_{j,t})};$$

where $GDP_{i,t}$ denotes country i's GDP at time t. Results based on this GDP-weighted measure are generally very similar to those based on the unweighted measure described in expression (1) and are therefore reported in the appendix.

Next, we note that to isolate the cyclical component in the financial series of our database we rely on the Baxter-King band-pass filter. Financial cycles are typically characterized by relatively low frequency movements, with one cycle lasting between 8 to 16 years according to Drehmann *et al.* (2012), while Schüler *et al.* (2015) find important variation in credit cycles well above the 20 year periodicity. Results by Cagliarini and Price (2017) in contrast suggest that financial cycles are not necessarily longer than business cycles. Also, equity prices, which we are also of interest here, exhibit important short-term variation. As a way to accommodate these divergent views, we take a conservative approach and therefore focus on a broad cycle-band ranging from 2 to 32 years.

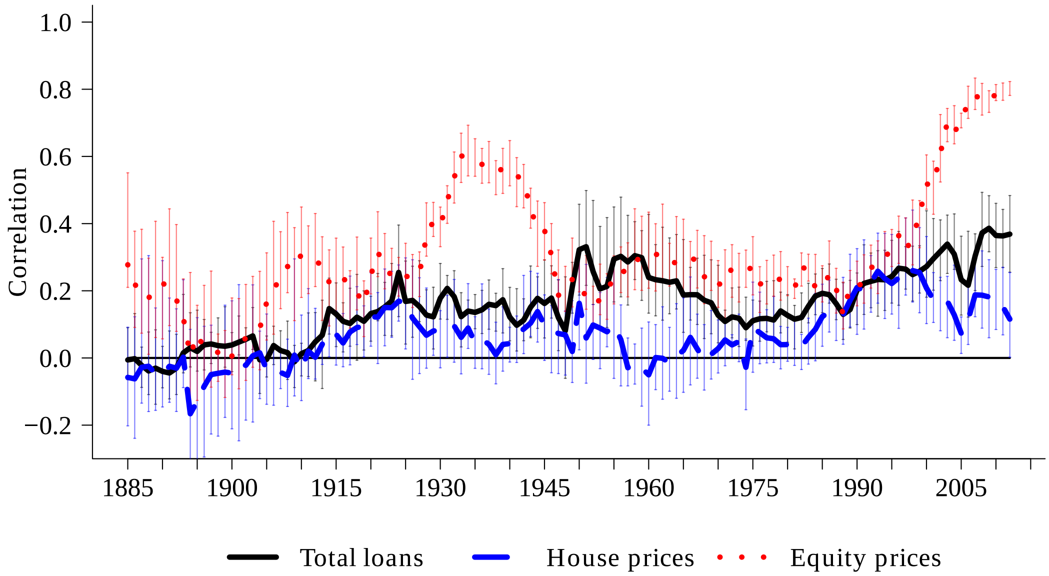
As a robustness check, we also report results based on an alternative nonparametric detrending method recently suggested by Hamilton (2016). This approach relies on the observation that, unlike short-lived cyclical fluctuations, trend components are the only feature of the data that can be forecasted at longer horizons. Yet another approach is to put more weight on high-frequency annual changes. This has the advantage of not having to rely on a pre-processing filtering step. Hence, we study annual growth rates (total loans, house prices, credit prices, GDP, consumption, investment, dividends) and first differences (real short-term rates, equity return premiums). Finally, we calculate concordance indices as proposed by Harding and Pagan (2002) in order to address concerns about heteroskedasticity bias in correlation coefficients (see Forbes and Rigobon, 2002). Importantly, the core findings of the paper do not depend on the filtering method used. The appendix contains results using these alternative approaches for completeness.

2.3. Financial and real synchronization

Figure 1 displays the average bilateral correlation of three financial variables – real credit, real house prices and real equity prices—for the 17 country sample. Comovement in credit- and equity price-cycles has risen substantially over time. In particular, the comovement of credit and equity markets is at a historical peak today, with Spearman correlation coefficients of about 0.4 and 0.8 respectively. Abstracting from the bouts of house price comovement associated with WW1 and WW2 housing busts, international house prices are also more correlated today than before, but the divergence in global house prices since the financial crisis has dampened synchronization in recent years. The rise in equity price correlation to near unity since the 1990s is particularly striking as it exceeds even the correlation in asset prices during the declines associated with the Great Depression. The comovement in credit, house prices and equity prices is higher in the past few decades than in previous periods. But how does this compare to the long-run synchronization of real cycles in GDP, consumption and investment?

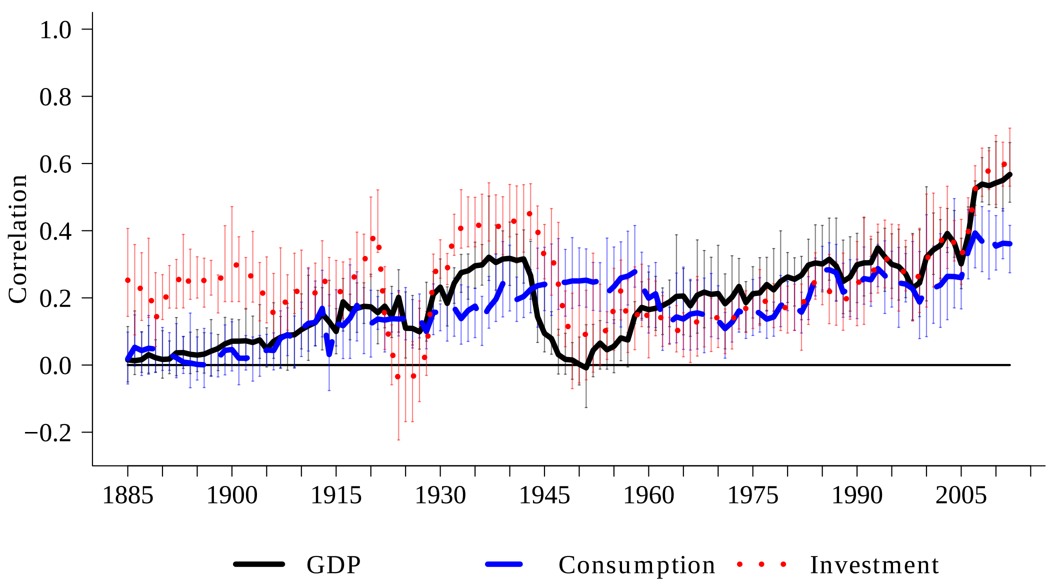
Figure 2 shows that the comovement of cycles in real variables also exhibits an upward trend since the start of the sample. The cyclical behavior GDP across countries is a good example—even accounting for the blip up due to the Great Depression (see Bordo and Helbling, 2003). GDP today exhibits an average bilateral correlation of somewhat above

Figure 1: *Average bilateral financial cycle correlation*



Notes: Spearman rank correlation coefficients based on 15-year rolling windows. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure 2: *Average bilateral real economy correlation*



Notes: Spearman rank correlation coefficients based on 15-year rolling windows. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

0.5, its highest value since 1870. Similarly consumption correlation has trended upward nearly on a par with GDP, although today it is slightly lower than the correlation for GDP (see Backus *et al.*, 1992). The international comovement of investment had already been relatively high in the late 19th and early 20th centuries, but by the 2000s the comovement in investment reached a new peak.

International synchronization of the financial and real sectors of economies have increased in tandem. At some level this is to be expected. Globalization forces would tend to increase integration in the real economy and with it, the financial sector. However, as Figures 1 and 2 illustrate, it looks as if comovement in financial variables has increased much more rapidly than expected.

One way to investigate this question is to analyze the residuals of regressions of the cyclical component of financial variables on the cyclical component of GDP, investment and consumption. As a result, we will use the term "excess financial comovement" to designate any comovement of financial variables that cannot be explained by real sector variables. In particular, consider the following expression:

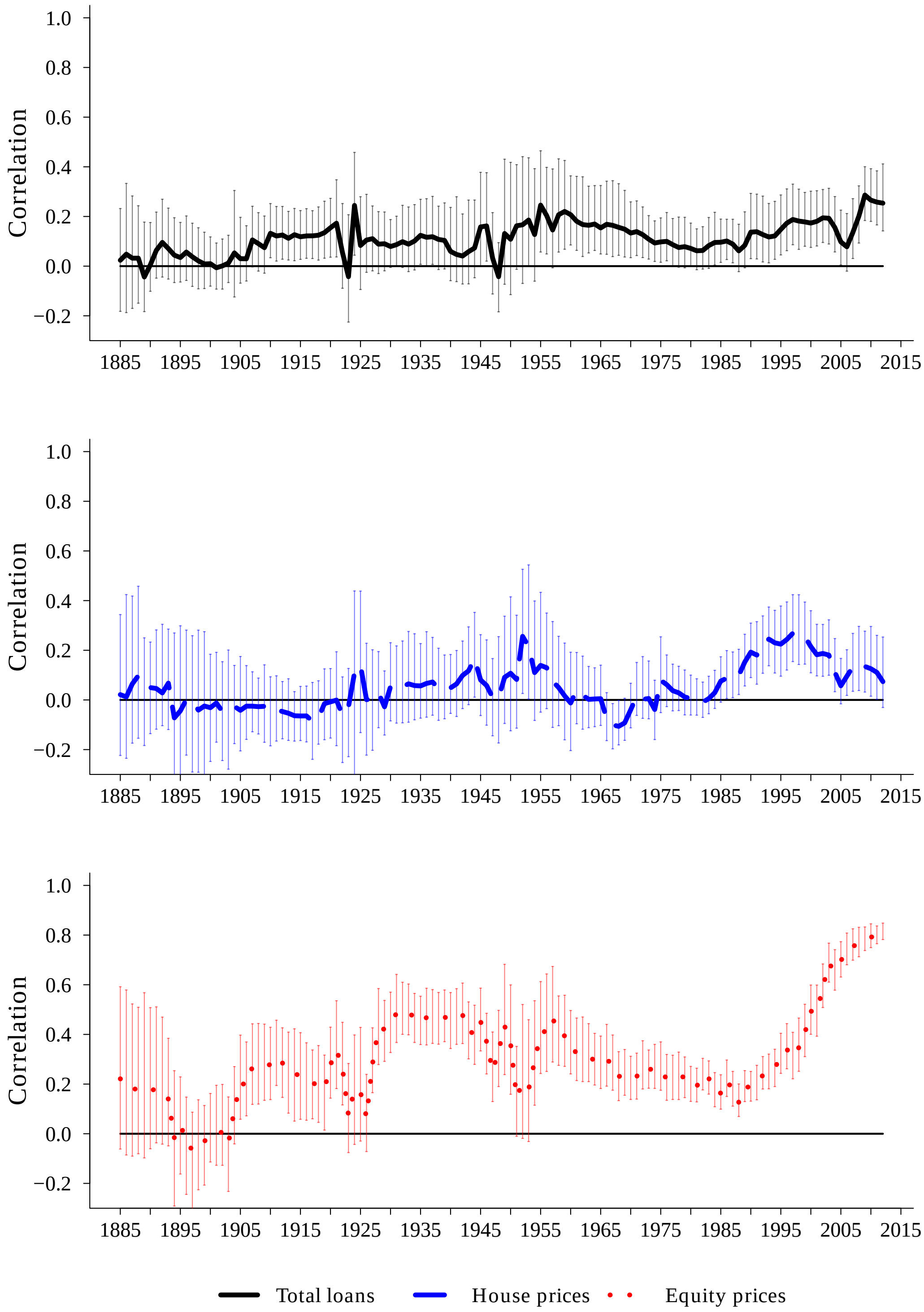
$$y_{i,t} = \beta_0 + \beta_1 GDP_{i,t} + \beta_2 C_{i,t} + \beta_3 I_{i,t} + \epsilon_{i,t}, \quad (3)$$

where y denotes either credit, house prices, or equity prices. With the residuals from this regression, $\widehat{\epsilon}_{i,t}$, we repeated the correlation analysis in Figures 1 and 2. Any remaining correlation in the residuals can be interpreted as excess comovement of international financial indicators over and above that of international real indicators (for related residual-based approaches to identify excess comovement in financial series see Kalemli-Ozcan *et al.*, 2013; Kallberg *et al.*, 2014).

Figure 3 displays the results. We find some increase in excess comovement for total loans and house prices. Until the 1990s, the entire increase in bilateral correlation of loans and house prices was accounted for by higher comovement of real variables This changed in the past 25 years. In the 1990s, excess correlation became significantly different from 0, but at 0.2 remained relatively low. By contrast, the excess correlation for equity prices is extremely high today.

Summing up, we document a substantial increase in the comovement of financial variables that can only be partly explained by increasing real sector linkages. Like Jordà *et al.* (2017b), we find that before WW2, real returns on housing and equities followed remarkably similar trajectories. After WW2 this was no longer the case. In particular, the

Figure 3: *Excess financial comovement*



Notes: Spearman rank correlation coefficients based on 15-year rolling windows. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

cyclical synchronization of international stock markets decoupled from underlying real sector correlations. In the following sections, we will take a closer look at the drivers of "excess comovement" in international equity markets.

3. Understanding equity market comovements

Understanding the sources behind the recent and dramatic increase in the comovement of international equity markets requires that we study the components of pricing determination separately. In particular we look at the international comovement of dividends, risk-free rates and equity return premiums to back out the contribution from each source. Consider the standard asset pricing equation:

$$Q_t = E_t\left\{\sum_{k=1}^{\infty} m_{t+k} D_{t+k}\right\} = Q_t^{RN}\rho_t. \tag{4}$$

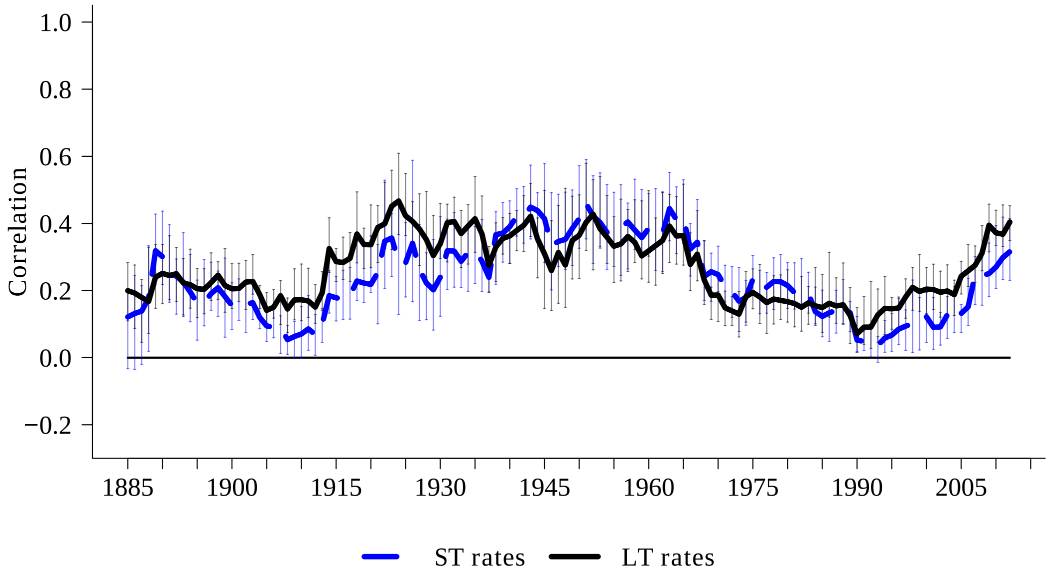
D denote dividends and m stands for the economy's stochastic discount factor (SDF), that is, a function of the investor's rate of time preference and attitudes toward risk encapsulated by the convexity of the utility function. Q^{RN} denotes asset prices as counterfactually valued by a risk-neutral investor who prices an asset according to the present value of future dividends discounted by risk-free rates $R = 1 + r$:

$$Q_t^{RN} = E_t\left\{\sum_{k=1}^{\infty}\left(\prod_{j=1}^{k-1} R_{t+j}^{-1}\right) D_{t+k}\right\}. \tag{5}$$

ρ is a time-varying scalar that captures variation in an economy's stochastic discount factor m in excess of the variation in risk-free rates and dividend streams that define Q^{RN}. In the following analysis, we will call the term ρ "risk appetite" since ρ reflects investor sentiment via its dependence on the stochastic discount factor and hence the investor's attitudes toward risk. The exposition, however, is consistent with different asset pricing theories that give different explanations for fluctuations in risk aversion. The term ρ_t can, in addition, reflect consumption habits, intermediary portfolio constraints as well as "irrational" animal spirits.[2]

[2]Our measure for *risk appetite* (ρ) is the equity return premium. To better understand the relationship between ERP and ρ consider the following non-arbitrage condition $E_t\{m_{t+1}R_{t+1}\} = E_t\{m_{t+1}\frac{Q_{t+1}+D_{t+1}}{Q_t}\}$, which through the ERP definition and the variance formula can be rearranged to yield $0 = cov_t(m_{t+1}, ERP_{t+1}) + E_t(m_{t+1})E_t(ERP_{t+1})$. As the product of the expected values of m and ERP is generally positive the covariance term is negative, implying that whenever time variation in ρ moves m,

Figure 4: *Average bilateral interest rate correlations*



Notes: Spearman rank correlation coefficients based on 15-year rolling windows. Bars – 95% cross-sectionally block-bootstrapped confidence bands. *ST* refers to short-term and *LT* to long-term rates respectively.

Note that the asset pricing equations 4 and 5 are formulated in expectations, while in our empirical comovement analysis we rely on ex post realized values for dividends, risk-free rates and the equity return premium ($ERP_t \equiv \frac{Q_t+D_t}{Q_{t-1}} - R_t$) – our indicator for risk appetite. The ex post realized values cease to be good indicators of their ex ante expected counterparts whenever expectation errors become important.

Using this basic asset pricing machinery, we can then ask: Which of the three equity price components —dividends, risk-free rates, or risk appetite—drives the high international comovement of equity markets? Figures 4 and 5 provide the answer. These figures show, first in Figure 4, the short-term and long-term risk-free rates, R. Figure 5 instead displays the average bilateral correlation between dividends, D, and the equity return premium, ERP.

Figure 4 shows that the average bilateral correlation in short- and long-term interest rates follow a similar time path. Interest rate correlations start to rise at the same time when the excess equity price correlation goes up (displayed in Figure 5), around 1990,

this movement should be offset by an inverse movement in the expected ERP. According to equations 4 and 5 the SDF (m) is also a function of risk-free rates (R), $m = f(ERP, R)$, which thus similarly affect m. Thus the difference in the international comovement of R and the international comovement of ERP can convey an idea of the role of *risk appetite* in internationally synchronizing SDFs and thus equity prices.

after having fallen in the previous 30 years. Importantly, short-term rate correlations are still below their historical peak during the heyday of the Bretton Woods system in the middle of the 20th century.

Figure 5 shows that the increases in equity price comovement in the 1920s and the 2000s were accompanied by a significant increase in the comovement of dividends and equity return premia. Since 1990 however the international correlation of equity return premia has risen from around 0.2 to 0.8, twice as much as that of dividends.

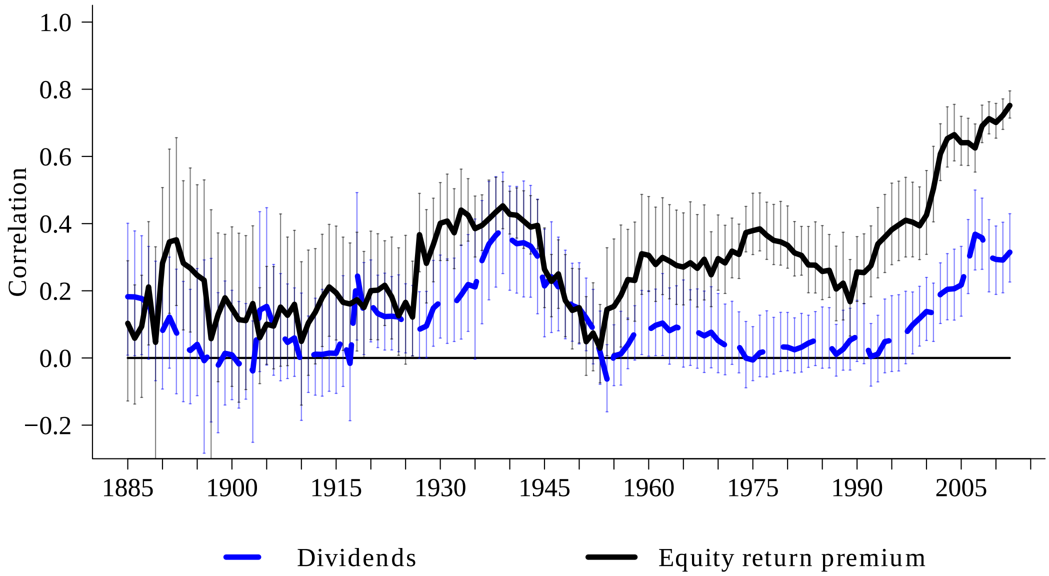
In other words, the rising comovement of equity return premiums, *ERP*—our indirect measure of risk appetite— holds the key to understanding today's excess equity price synchronization. We are not the first to document that international equity price comovement in the late 20th century has become increasingly dominated by factors other than dividends and risk-free rates. Ammer and Mei (1996) and Engsted and Tanggaard (2004) report related findings for the U.S. and U.K. stock markets and Jordà *et al.* (2017b) report similar results for the economies in our sample. More recently, Miranda-Agrippino and Rey (2015) have shown that a substantial part of global asset returns since the 1990s can be explained by one global factor that is closely and inversely related to measures of market volatility and risk aversion. With this paper, we are the first to show that this is a novel development in the history of international financial integration that was not present in the first era of global finance.

4. Monetary policy and synchronization of risk taking

What might explain that risk appetite in global equity markets is increasingly synchronized? A popular view, often embraced by practitioners in financial markets, is that monetary policy in global financial centers, in particular the Federal Reserve, plays an important role in explaining risk-taking in international financial markets.

Such effects can occur through different channels as existing studies argue (Bekaert *et al.*, 2013; Miranda-Agrippino and Rey, 2015). Fed policy may internationally synchronize the balance sheet capacity of financial intermediaries through its effect on asset prices (Ward, 2017). U.S. monetary policy may also directly act as a focal point that synchronizes risk perceptions of international investors (see Bacchetta and van Wincoop, 2013). The U.S. dollar is also an important vehicle currency that underpins today's global financial system (Shin, 2012). U.S. monetary policy decisions may thus have global reach (Canova, 2005; Kim, 2001). Ehrmann *et al.* (2011) show that about 30% of the fluctuations

Figure 5: *Average bilateral dividend yield and equity return premium correlations*



Notes: Spearman rank correlation coefficients based on 15-year rolling windows. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

in euro area financial markets can be attributed to U.S. financial market fluctuations. Theoretically, Bruno and Shin (2013) propose a model in which global banks, with access to the financial center's wholesale money markets, transmit the financial center's financing conditions to regional banks around the world. Cetorelli and Goldberg (2012) present related econometric evidence on how global banks contribute to the international transmission of liquidity shocks through the lending conducted by their foreign affiliates.

4.1. Methods

To investigate whether monetary policy in financial centers is a driver of risk appetite, we estimate a set of cumulative impulse response functions using local projections (Jorda, 2005). We begin with the following specification:

$$\Delta_h y_{i,t+h} = \alpha_i^h + \sum_{k=1}^{5} \beta_k^h \Delta y_{i,t-k} + \sum_{k=0}^{5} \gamma_k^h \Delta R_{t-k}^c + \sum_{k=0}^{5} \delta_k^h X_{i,t-k} + u_{i,t+h}, \quad h = 1, ..., H \tag{6}$$

where α_i are country-fixed effects, $\Delta_h y_{i,t+h} = y_{i,t+h} - y_{i,t-1}$ is, by our convention, the h-year cumulative growth rate of y, ΔR^c is the first difference in the center country's short-term rate, X_i is vector of control variables and $u_{i,t+h}$ are error terms. The parameters $\{\gamma_0^h\}_{h=1,\ldots,H}$ in expression (6) allow us to sketch out the behavior of equity prices, dividends and risk-free rates over the H years following a center country interest rate change ΔR_t^c. Note that this specification allows for a contemporaneous effect of the controls and center rate changes on the outcome variable.

Our impulse variable is the change in policy in the financial center, R^c. Later, we will corroborate the results with monetary policy "shock" measures, thus capturing the unanticipated part of policy changes in recent decades. The idea is to account for potential cross-country endogeneity contamination.

The U.S. was not always the world's financial center country. In the 19th century the U.K.'s financial system and currency played a similarly central role. The measure R^c is therefore the U.K. short-term rate prior to 1914 and the U.S. short-term rate after 1947. During the interwar years, the U.S. became the world's most important financial center according to some metrics, while the U.K. retained this title until WW2 according to others (see Chiţu *et al.*, 2014). Hence, we construct R^c as the average of U.S. and U.K. short-term rates for the interwar years.

The control variables are five lags of the log differences of GDP, CPI, equity prices, house prices, total loans, as well as housing return premiums, equity return premiums and short-term rates. We additionally control for five lags of the center country's growth rates in per capita GDP and inflation. Finally, we also include the center country's equity prices into the vector of controls as Rigobon and Sack (2004) document that the Fed is more likely to raise rates when the stock market has gone up and vice versa (also see Bjørnland and Leitemo, 2009; Castelnuovo and Nisticò, 2010; Chadha *et al.*, 2004; Furlanetto, 2011).

Moreover, in order to test whether financial center monetary policy explains the increase in the comovement of equity return premiums and risk appetite we separate the equity price impulse responses into two parts. Log-linearizing equation (5) around a balanced growth path yields an expression that can be used to calculate that part of the equity price response which is justified by the dividend and real rate responses, Q^{RN}, according to

$$q_t^{RN} = \sum_{k=1}^{\infty} \left(\frac{\overline{D}}{\overline{\overline{R}}}\right)^k \left[\left(1 - \frac{\overline{D}}{\overline{\overline{R}}}\right) E_t\{d_{t+k-1}\} - E_t\{r_{t+k}\}\right] + k, \tag{7}$$

where small letters denote the logarithms of the original variables, $\overline{D}$ is the gross dividend growth rate along the balanced growth path, $\overline{R}$ is the respective interest rate, $\overline{D}/\overline{R} := C < 1$ and k denotes a linearization constant (see Cochrane, 2009, p.395). In the following we set C to 0.96. On the basis of expression (7) we can calculate the equity price (cumulative) response that is implied by any given dividend and interest rate response as:

$$\sum_{k=0}^{\infty} \frac{\partial q_{t+k}^{RN}}{\partial R_t^c} \Delta R_t^c = \sum_{j=1}^{\infty} C^k \left[(1-C) \sum_{k=0}^{\infty} \frac{\partial d_{t+k+j-1}}{\partial R_t^c} \Delta R_t^c - \sum_{k=0}^{\infty} \frac{\partial r_{t+k+j}}{\partial R_t^c} \Delta R_t^c \right]. \tag{8}$$

The difference between the cumulative response in actual equity prices Q and the cumulative response implied by dividends and risk-free rates Q^{RN} reflects the excess response of equity prices due to time-varying risk appetite ρ. For the practical calculation of the cumulative risk-neutral price response the infinite sums for the dividend and risk-free rate responses have to be replaced by a finite sum. We opted for seven-year cumulative responses because the dividend and risk-free rate responses are statistically indistinguishable from zero at higher time horizons.

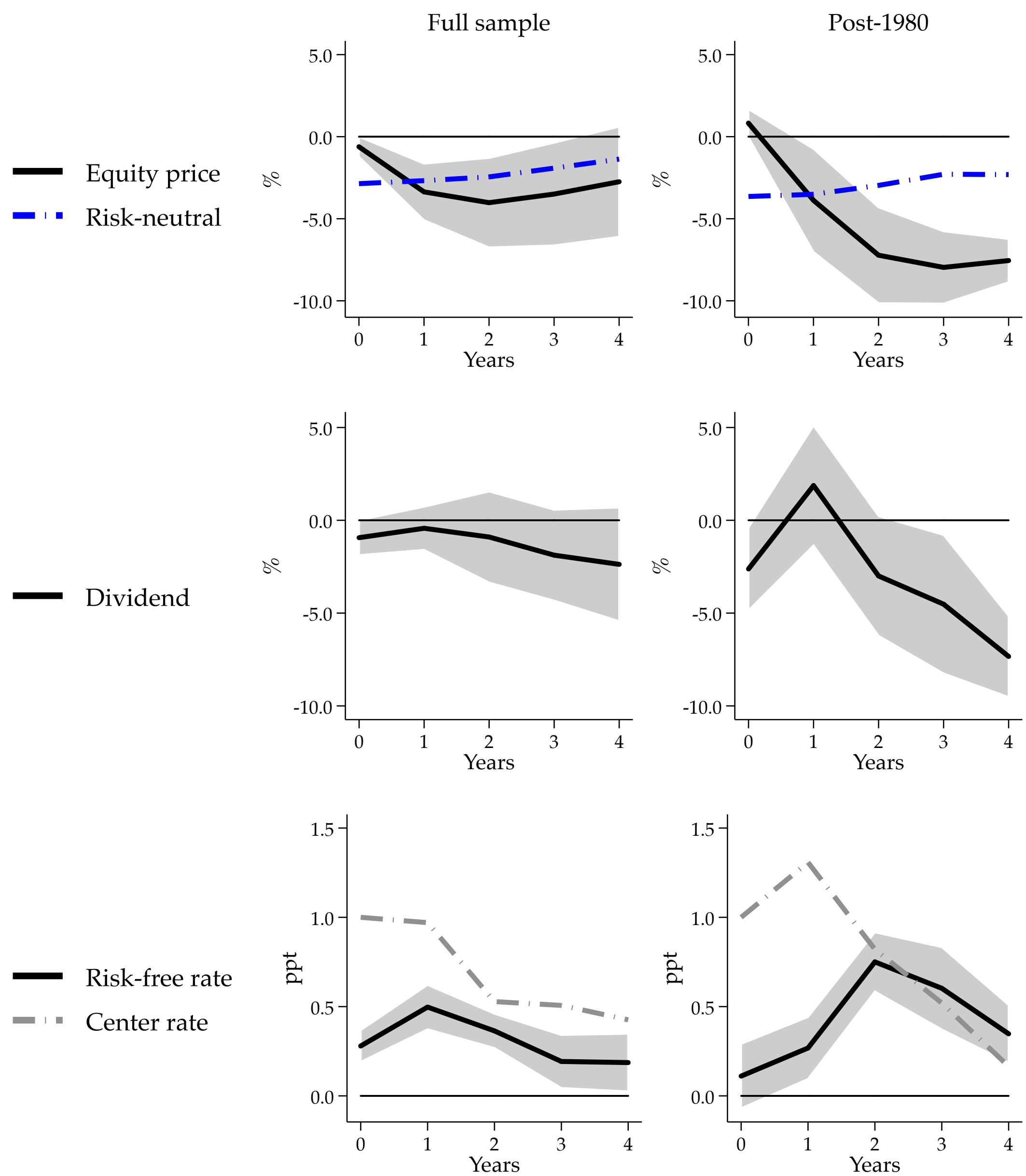
4.2. The response of global equity markets

Figure 6 shows the response of equity prices (Q) and risk-neutral equity prices (Q^{RN}), as well as the dividend- (D) and interest rate (R) responses from which the Q^{RN}-response was derived from. The risk-neutral response is the response that shows how a risk-neutral investor would value equity on the basis of future dividends that are discounted with the risk-free rate. The risk-neutral price response is labelled 'Risk-neutral' in the figure. The left column in Figure 6 shows the full sample results, while the right column focuses on the post 1980 subsample in order to focus on the period of rising comovement in global risk appetite.

Our first key result is that the response of equity prices has become stronger over time. The international response to a $+1$ ppt center interest rate hike has almost doubled from the full sample average of about -4% to the post-1980 trough of -8%. Furthermore, the negative response has grown more persistent.

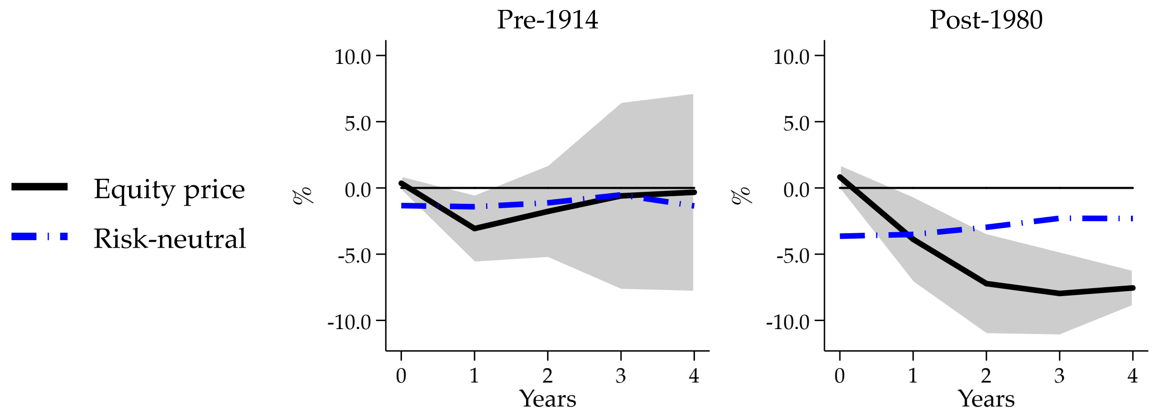
Partly this is due to international dividends and real short-term rates having become more sensitive to changes in U.S. monetary policy. In the full sample dividends fell on average by about 2.5% and interest rates peaked at 0.5 ppt. Since 1980 the respective numbers have gone up to 5% and 0.75 ppt respectively. Stronger global dividend and real rate reactions to U.S. monetary policy, however, are insufficient to explain the stronger

Figure 6: *Decomposing the global equity market response*



Notes: Cumulative impulse response functions to +1ppt increase in financial center interest rates. Risk-neutral – risk neutral price (Q^{RN}). Center rate – financial center (U.K. and/or U.S.) short-term risk-free rate own response. Confidence bands calculated on the basis of Driscoll-Kray standard errors. Risk neutral price (Q^{RN}) calculated according to equation (8).

Figure 7: *Pre-1914 vs. Post-1980 equity price responses*



Notes: Cumulative impulse response functions to +1ppt increase in financial center interest rates. Risk-neutral – risk neutral price (Q^{RN}). Center rate – financial center (U.K. and/or U.S.) short-term risk-free rate own response. Confidence bands calculated on the basis of Driscoll-Kray standard errors. Risk neutral price (Q^{RN}) calculated according to equation (8).

equity price responses.

The implied risk-neutral equity price Q^{RN}, calculated according to equation (8) from the dividend and interest rate responses alone, suggests that dividend and safe rate responses explain only about 25% of the post-1980 equity price response over 4 years. Fluctuations in risk appetite are by far the most important driver, accounting for three quarters of the response.

Moreover, Figure 7 shows how much stronger the response has become from one globalization era to the next. Before 1914, equity markets reacted to rate changes much as would be expected from a risk-neutral investor. Equity prices declined in response to 100 bps increase of the policy rate of the Bank of England, but there is no major impact above and beyond the risk neutral path. In the post-1980 globalization, this effect is magnified by the effect on risk aversion.

4.3. Expected equity return premium responses

So far we have looked at the reaction of global risk appetite to center-country policy shocks only indirectly, by separating the fundamental component Q^{RN} from the actually realized equity price response Q. The resulting difference between the two responses indicates changes in risk appetite. Alternatively, we can look at the direct response of the equity return premium, ERP. The difficulty here is that we are interested in the ex-ante expected equity return premium as a measure of global risk appetite. However, we only observe the ex-post realized equity return premium.

In order to get a sense of the response of the *ex-ante* expected equity return premium to center-country monetary policy changes we propose a strategy that allows us to derive a lower bound estimate of the response of *ex-ante* expected equity return premiums from their *ex-post* realized counterparts. Specifically, the expected equity return premium $E_t(ERP_{t+1})$ can be decomposed into the ex-post realized equity return premium ERP_{t+1} and an expectation error η_t:

$$\underbrace{E_t(ERP_{t+1})}_{\text{ex-ante expected ERP}} = \underbrace{ERP_{t+1}}_{\text{ex-post realized ERP}} - \eta_t. \tag{9}$$

Recall the *ex-post* realized equity return premium $ERP_{t+1} = \frac{Q_{t+1}+D_{t+1}}{Q_t} - R_{t+1}$. In order to determine how the ex-ante expected equity return premium reacts to center-country monetary policy changes, we need to know how the expectation error η reacts itself.

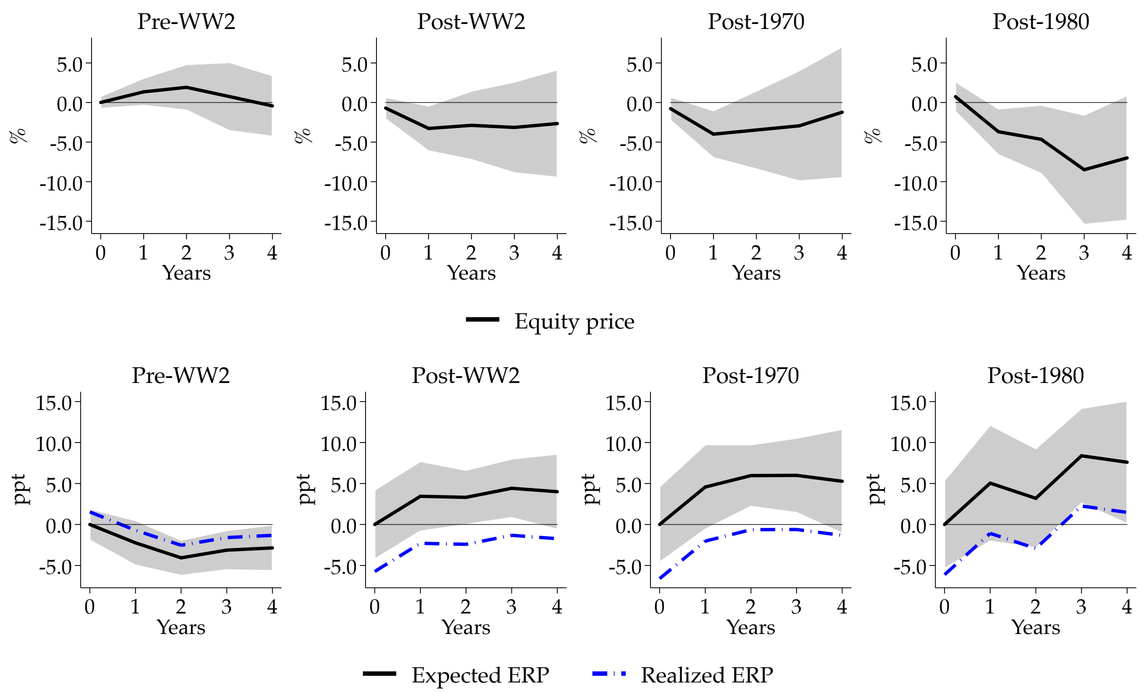
Assuming rational expectations, the expectation error η_t would be fully explained by exogenous innovations to the shock process and is restricted to the period in which the shock occurs—the contemporaneous period. Assuming additionally that the $h = 0$ response of the ex-ante expected rate is 0, this implies that, when estimating impulse response functions, the contemporaneous response of a variable to a shock constitutes an estimate of the expectation error η_0 for that variable.[3] Note that this is a conservative estimate given that empirical studies suggest that 12 months after a contractionary monetary policy shock risk appetite is somewhat depressed (see Bekaert *et al.*, 2013; Bruno and Shin, 2015). In this sense the proposed responses of ex-ante realized ERP likely constitute a lower-bound estimate. In the case of the ex-ante expected equity return premium, the estimate for the $h = 0$ expectation error accordingly is:

$$\eta_0 = \frac{\partial ERP_1}{\partial R_0^c} \Delta R_0^c \tag{10}$$

As the expectation error is restricted to the contemporaneous period, the cumulative response of the expected equity return premium can simply be calculated as the cumulative response of the realized equity return premium shifted by the expectation error in

[3]This is assuming that innovations to center-country rates are not correlated with other shocks. For correlated shocks the contemporaneous response reflects expectation errors related to different shocks.

Figure 8: *Equity prices and equity return premiums*



Notes: Cumulative impulse response functions to +1ppt increase in financial center interest rates. Risk-neutral – risk neutral price (Q^{RN}). Confidence bands calculated on the basis of Driscoll-Kray standard errors. Risk neutral price (Q^{RN}) calculated according to equation 8.

$h = 0$:

$$\underbrace{\sum_{h=0}^{\infty} \frac{\partial E_{t+k}(ERP_{t+1+h})}{\partial R_t^c} \Delta R_t^c}_{\text{expected ERP response}} = \underbrace{\sum_{h=0}^{\infty} \frac{\partial ERP_{t+1+h}}{\partial R_t^c} \Delta R_t^c}_{\text{realized ERP response}} - \eta_0 \tag{11}$$

Figure 8 depicts the resulting international response of the *ex-ante* expected equity return premium, together with the ex-post realization (dashed line) as well as equity prices for various subsamples. The figure shows that the global impact of financial center-country monetary policy on global equity prices is mostly a post-WW2, and in particular a post-1980 phenomenon. Within the post-WW2 sample, the global response of the *ERP* grows stronger over time, with equity prices decreasing by about 10% from trend value after a 1ppt FED rate hike. The expected equity return premium that investors require to hold equity increases by 5 to 10 ppts. In light of these results, U.S. monetary policy is indeed a powerful driver of global risk appetite in equity markets. This 5 to 10 pps risk appetite effect compares to a peak-response in the risk-free rate of 0.5 ppt and a -5% effect in dividends. Changes in risk appetite are of first order importance for the transmission of center country monetary policy across international equity markets.

4.4. Exchange rate regimes

Risk-appetite spillovers of US monetary policy are substantial. Do floating exchange rates help countries avoid such spillovers? Floating exchange rates are thought to insulate domestic interest rates from foreign interest rates. But it is unclear whether this insulation generalizes to risk premiums and risk appetite more generally. It is natural to ask the extent to which floating exchange rates effectively decouple domestic financial conditions from substantial comovements in risk appetite. To address this question we condition our previous analysis on a country's exchange rate regime.

The classification of the exchange rate regime has occupied international economists for a long time (Klein and Shambaugh, 2015). Before WW2 our peg dummy follows Obstfeld *et al.* (2004) and Obstfeld *et al.* (2005); thereafter we rely on the exchange rate regime classification scheme of Ilzetzki *et al.* (2008) for 1940-1959, and the Shambaugh exchange rate classification dataset for 1960-2014 (Klein and Shambaugh, 2008; Obstfeld *et al.*, 2010; Shambaugh, 2004).

Our peg dummy takes the value of 1 if a country was on the gold standard before 1940. From 1940 onwards, it takes the value of 1 for economies whose exchange rate stays within a +/- 2% band, and 0 otherwise. We follow Obstfeld *et al.* (2005) in not considering one-off realignements as breaks in the peg regime. Similarly, single-year pegs are recoded as floats, as they quite likely simply reflect a lack of variation in the exchange rate.

Using this exchange rate indicator, we estimate local projections according to the following specification:

$$\begin{aligned}\Delta_h y_{i,t+h} = \alpha_i^h &+ \sum_{k=1}^{L} \beta_k^h \Delta y_{i,t-k} + \sum_{k=0}^{L} \gamma_k^h \Delta R_{t-k}^c \\ &+ \sum_{k=0}^{L} \delta^h \Delta R_{t-k}^c \times float_{i,t} + \sum_{k=0}^{L} \eta_k^h X_{i,t-k} + u_{i,t-1+h}, \quad h = 1, ..., H \end{aligned} \tag{12}$$

where α_i are country-fixed effects, $\Delta_h y_{i,t+h}$ are h-year changes the dependent variable and $u_{i,t+h}$ are error terms. The $\{\gamma_0^h\}_{h=1,...,H}$ in expression (12) allows us to sketch out the average behavior of international risky and safe interest rates over the H years following a center-country policy rate shock ΔR^c. The $\{\delta_0^h\}_{h=1,...,H}$ allow us to investigate the difference in the response between pegs and floaters. $float_{i,t}$ is a dummy variable that is 1 in periods when the exchange rate with respect to the center-country floats, has been floating for the previous 3 years, and will be floating for the following 4 years (i.e. the entire projection horizon). Analogously the dummy is 0 in years when the exchange rate is fixed in the current year, was fixed throughout the previous 3 years and continuous to be fixed in the 4 years to come. This definition ensures that estimated impulse response functions clearly distinguish between pegs and floats. In all cases we make use of the bilateral peg dummy describing the exchange rate regime status between any country and the center-country. In addition to the control variables used previously (see equation (6)) X now also includes a binary indicator for the existence of capital controls. The capital control dummy is described in detail in Jordà *et al.* (2015).

Figures 9 and 11 show the international responses of equity prices and ERP for the full sample. The equity price- and ERP responses tend to be stronger for countries whose exchange rate is pegged to the USD. Over the full sample, equity prices are down by 3% in year 1, while there is no significant response among floats. On average pegs' risk appetite still tends to be more affected than floaters' risk appetite although the effects are weak. Tables 1 and 3 show the impulse responses for pegs and floats and the p-value for a Wald-test for equality of the impulse responses. The tests confirm that historically the response to center-country monetary policy changes has been significantly more pronounced for pegs.

We now turn to the post-WW2 subsample, as our previous results show that this is the period when risk premium spillovers were strongest. Figures 10 and 12 show the differential equity price- and ERP responses of pegs and floats to a +1ppt change in the U.S. rate. We find that for the post-WW2 sample the peg-float dichotomy is somewhat less clear. Floaters' equity prices and ERP now also show a pronounced response to center-country interest rate changes. Pegs on average still exhibit a stronger response. However, tables 2 and 4 show that Wald-test for equality of responses can no longer reject the null of equality at conventional confidence levels.

Figure 9: *Exchange rate regime and equity price responses, full sample*

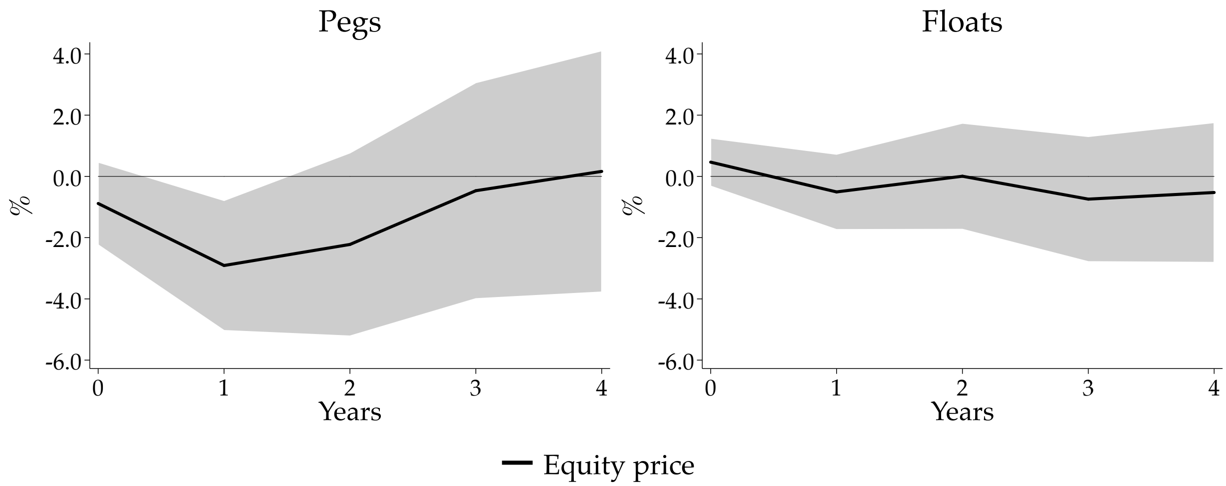


Table 1: *Exchange rate regime and equity price responses, full sample*

	(1) Year 0	(2) Year 1	(3) Year 2	(4) Year 3	(5) Year 4
Pegs	-0.88	-2.91***	-2.22	-0.46	0.16
	(0.69)	(1.08)	(1.52)	(1.80)	(2.01)
Floats	0.46	-0.50	0.00	-0.74	-0.52
	(0.40)	(0.62)	(0.88)	(1.04)	(1.16)
Peg=Float (p-value)	0.05*	0.02**	0.14	0.87	0.73
Observations	810	810	810	810	810
R^2	0.57	0.57	0.44	0.37	0.31

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Wald test for equality of peg and float responses.

Figure 10: *Exchange rate regime and equity price responses, post-1945*

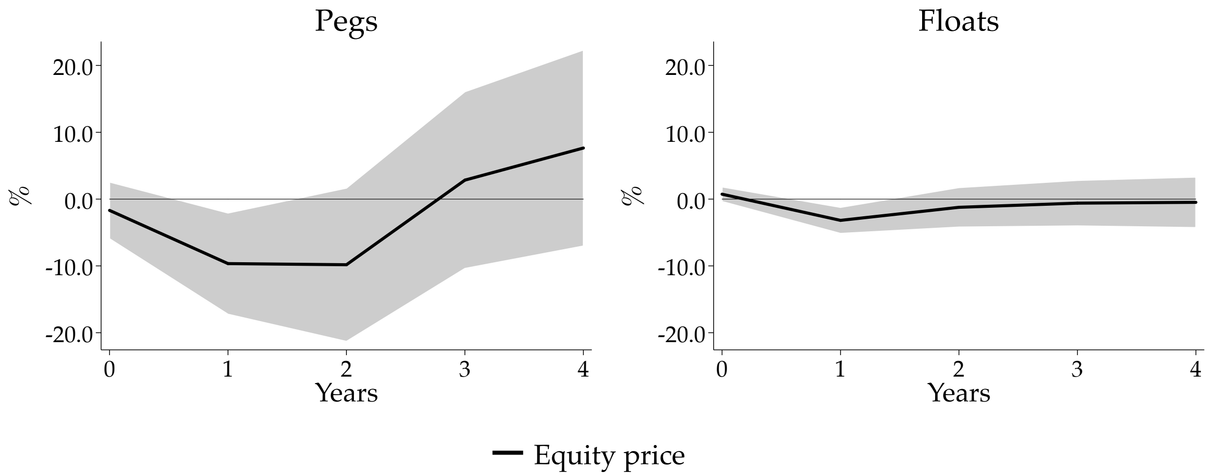


Table 2: *Exchange rate regime and equity price responses, post-1945*

	(1) Year 0	(2) Year 1	(3) Year 2	(4) Year 3	(5) Year 4
Pegs	-1.46	-8.36**	-6.94	3.05	6.63
	(2.23)	(3.79)	(5.55)	(6.46)	(7.17)
Floats	0.94*	-3.10***	-1.17	0.12	-0.06
	(0.57)	(0.97)	(1.43)	(1.66)	(1.85)
Peg=Float (p-value)	0.27	0.15	0.29	0.64	0.34
Observations	577	577	577	577	577
R^2	0.74	0.70	0.55	0.52	0.48

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Wald test for equality of peg and float responses.

Figure 11: *Exchange rate regime and equity return premium responses, full sample*

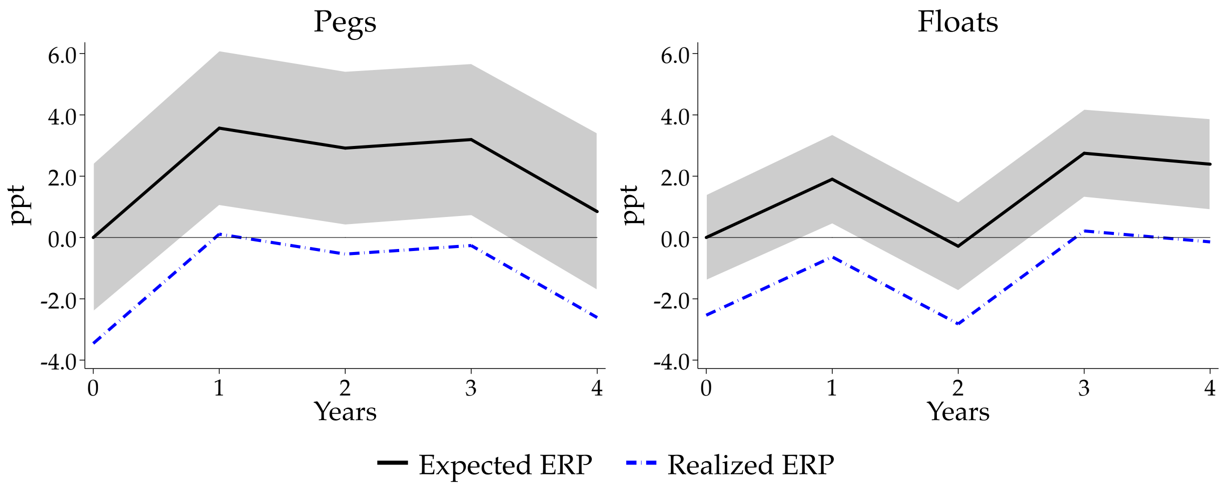


Table 3: *Exchange rate regime and equity return premium responses, full sample*

	(1) Year 0	(2) Year 1	(3) Year 2	(4) Year 3	(5) Year 4
Pegs	0.00	3.56***	2.91**	3.19**	0.84
	(1.23)	(1.28)	(1.28)	(1.26)	(1.31)
Floats	0.00	1.90**	-0.28	2.74***	2.39***
	(0.71)	(0.74)	(0.74)	(0.73)	(0.75)
Peg=Float (p-value)	1.00	0.56	0.07*	0.71	0.06
Observations	810	810	810	810	810
R^2	0.43	0.46	0.45	0.48	0.43

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Wald test for equality of peg and float responses (based on realized ERP).

Figure 12: *Exchange rate regime and equity return premium responses, post-1945*

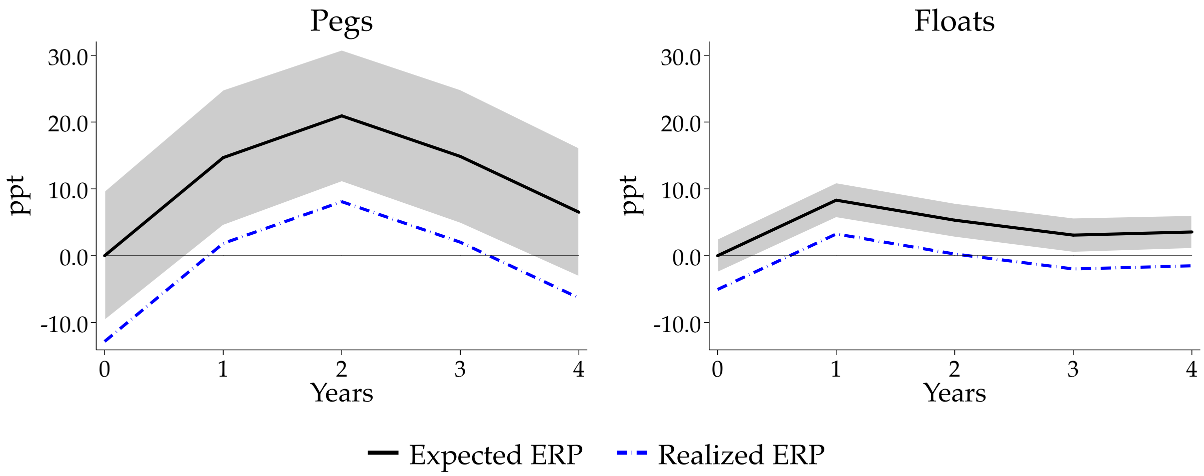


Table 4: *Exchange rate regime and equity return premium responses, post-1945*

	(1) Year 0	(2) Year 1	(3) Year 2	(4) Year 3	(5) Year 4
Pegs	0.00	12.73**	19.38***	12.85**	4.84
	(4.96)	(5.03)	(5.06)	(4.93)	(4.87)
Floats	0.00	7.64***	4.83***	3.36***	3.29***
	(1.28)	(1.30)	(1.30)	(1.27)	(1.25)
Peg=Float (p-value)	1.00	0.72	0.12	0.58	0.26
Observations	577	577	577	577	577
R^2	0.52	0.56	0.54	0.59	0.59

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Wald test for equality of peg and float responses (based on realized ERP).

5. Monetary policy shocks

Although arguably exogenous from the perspective of a small economy, policy changes in the financial center might not be unanticipated. In order to address such anticipation concerns, this section corroborates the previously reported results using an instrument for monetary policy changes from Gertler and Karadi (2015) in a local projection instrumental variable (LPIV) framework (see Jordà *et al.*, 2017a). The Gertler-Karadi shock measure captures changes in futures markets in a short time window around FOMC rate decisions and thereby measures the "surprise" component of rate changes.

The local projection instrumental variable approach to estimating impulse responses using high frequency monetary policy instruments can be laid out as follows:

$$\Delta_h y_{i,t+h} = \alpha_i^h + \sum_{k=1}^{5} \beta_k^h \Delta y_{i,t-k} + \sum_{k=0}^{5} \gamma_k^h \Delta \hat{R}^c_{i,t-k} + \sum_{k=0}^{5} \delta_k^h X_{i,t-k} + u_{i,t+h}, \quad h = 1, ..., H, \quad (13)$$

where $\hat{R}^c_t$ is the prediction from a first stage regression of the effective federal funds rate R^c on the high frequency instruments (HFI)

$$R^c_t = \zeta + \theta FF1_t + \omega FF3_t + \tau ED6_t + \nu ED9 + \chi ED12 + \epsilon_t \quad (14)$$

where $FF1, FF3, ED6, ED9$ and $ED12$ are the unexpected changes in the Federal Funds futures of the current month, the 3-month ahead monthly Fed Funds futures and the 6-, 9- and 12-month ahead futures on 3-month Eurodollar deposits respectively. We aggregate the monthly first stage predictions up to the annual level by taking the total sum of the predicted values over the 12 months within each year. Due to the shorter time span for which the HFIs are available this setup only allows us to compare the post-1990 impulse response functions.

The first stage results are displayed in table 5. The HFIs are clearly relevant with R^2's ranging from 0.176 to 0.38, depending on which instruments are included. The following results are based on the specification including all HFIs (depicted in column 5).

The impulse responses we obtain for our baseline approach and the HFI approach are reassuringly similar in direction and magnitude, indicating that center-country interest rate changes can indeed be treated as largely exogenous for the rest of the world. Also note that the post-1990 responses are stronger than the post-1980 ones, indicating that the impact of U.S. monetary policy on the rest of the world has grown over time—similar to

Table 5: *First stage regression results*

	(1)	(2)	(3)	(4)	(5)
FF1	1.88***		1.22***		1.46***
	(0.15)		(0.26)		(0.28)
FF3		2.13***	0.93***		1.08***
		(0.19)	(0.32)		(0.38)
ED6				1.41*	-1.75*
				(0.80)	(0.89)
ED9				1.92	0.90
				(1.38)	(1.26)
ED12				-1.84**	0.52
				(0.91)	(0.78)
R^2	0.35	0.31	0.36	0.17	0.38
Observations	284	270	270	342	270

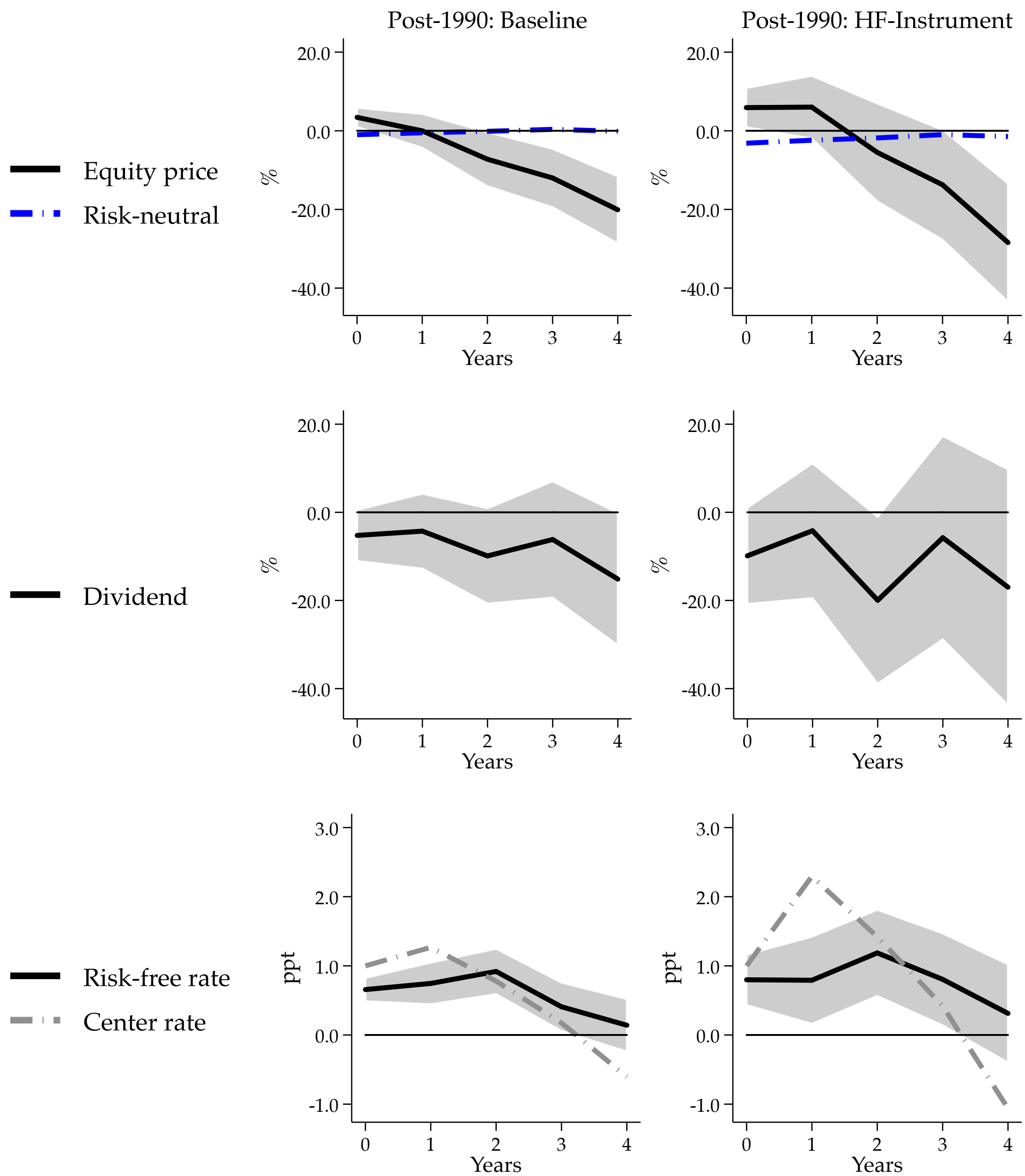
Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Dependent variable: federal funds target rate change in ppts.
All variables in ppts changes; monthly observations.

the results we presented above.

6. Discussion

What explains the late 20th century rise in international risk premium synchronization? The post-Bretton Woods synchronization of risk-premiums coincides with a rollback of capital controls and financial liberalization. These changes may lead to an increase in the international synchronization of risk premiums via the balance sheets of financial intermediaries (Ueda, 2012). Cross-country market integration of safe and risky assets should, by arbitrage, lead to an international equalization of the return on assets within the same risk-class, and hence an international equalization of risk premiums (Dedola and Lombardo, 2012). Kollmann *et al.* (2011) and Alpanda and Aysun (2014) present theoretical accounts where the equalization of global returns springs from the optimization problem of a global bank that aims to equalize its returns across regions. The observation that the post-Bretton Woods synchronization of risk premiums coincides with a period of capital account liberalization is consistent with such models. However, explanations based on

Figure 13: *Decomposing the global equity price response (high frequency instruments)*



Notes: Cumulative impulse response functions to +1ppt increase in financial center interest rates. Risk-neutral – risk neutral price (Q^{RN}). Center rate – U.S. short-term risk-free rate own response. Confidence bands calculated on the basis of Driscoll-Kray standard errors. Risk neutral price (Q^{RN}) calculated according to equation 8.

financial openness beg the question of why extensive risk premium comovement did not occur already during the first era of financial globalization before 1914 (Quinn and Voth, 2008).[4]

Behavioral theories of financial market behavior also offer explanations for investor overreaction. Behavioral theories attribute excess variation in asset prices to systematic mis-judgements in human psychology (Akerlof and Shiller, 2010; Kahneman and Tversky, 1979; Shiller, 2000) and to collective manias and panics (Kindleberger, 1978). The wedge that such "animal spirits" drive between fundamentals and asset valuations can help understand observed asset pricing puzzles (Bordalo *et al.*, 2012; Gennaioli and Shleifer, 2010). If globally synchronized, behavioral forces could explain the excess international comovement of equity prices that we observe. For example, in a globalized world economy with global news flows, investors' sentiment can be synchronized by their exposure to a similar set of information.

Our empirical investigation does not provide conclusive evidence, but we note that the temporal pattern of international risk premium comovement again begs the question why behavioral forces did not induce excessive comovement in risk appetite in earlier periods of financial globalization when international investors presumably were subject to the same cognitive constraints and similar information flows.

A key difference between late 19th and late 20th century financial globalization concerns the international monetary system. Prior to 1914, global money aggregates were linked to global gold supply, which was fixed in the short run. As a consequence, global liquidity supply was inelastic in the short-run. On a regional level, this meant that gold inflows and credit expansions in one region tended to be offset by gold outflows and credit contractions in other regions, as David Hume famously analyzed (Hume, 1752). The pre-1914 gold standard thus introduced a desynchronizing force into global finance that may have impeded the emergence of globally synchronized risk premiums. In contrast, in the post-Bretton Woods period, global finance is built on a fiat money system that allows for a more elastic supply of liquidity. By and large, such a system is more likely to accommodate a globally synchronized expansion of liquidity supply

[4] The extent of international financial market integration in the late 19th and late 20th centuries differs in several respects. While (net) cross-border capital flows and (net) foreign asset positions are comparable across both globalizations (Obstfeld and Taylor, 2004), financial globalization in the late 20th century encompassed a wider range of financial assets than did its late 19th century precursor (Bordo *et al.*, 1998). In particular late 19th century financial globalization was focused in industries with high tangible capital that were less plagued by information asymetries, such as railways, public bonds, mining and public utilities. Put differently, measured risk premiums might not be comparable across time.

and comovement in risk premiums. Such different elasticities of global liquidity in the pre-1914 and post-1970 financial globalizations could help to explain the temporal pattern of risk premium comovement we observe.

Another strain of the theoretical literature on global financial spillovers that could account for the observed temporal pattern of risk premium comovement relates to the form of international financial intermediation. What is new in the late 20th century financial globalization is that international banks play a central role (Cassis *et al.*, 2016, ch.11). The earlier financial globalization was not dominated by leveraged financial intermediaries. Instead, wealthy private individuals and mutual funds were the main vehicles for international capital flows (see Feis, 1964; Michie, 1986).

If banks hold foreign assets on their balance sheets and mark them to market, price changes can synchronize the risk appetite and the trading behavior of banks around the world (Adrian and Shin, 2009; Bruno and Shin, 2015; Miranda-Agrippino and Rey, 2015; Ward, 2017). For instance, if Federal Reserve policy affects U.S. equity prices, falling asset prices in the U.S. decrease (risk-weighted)-asset-capital ratios of U.S. as well as *international* banks which start to cut down their risk-taking in sync with U.S. banks. If no large risk-neutral player steps in to compensate for the lower risk taking of the leverage-constrained intermediaries, risk-spreads will increase.[5]

Schularick and Taylor (2012) show that late 20th century banking is characterized by an explosion in bank credit and total bank assets, giving rise to a ”financial hockey stick” pattern in the global credit-to-GDP ratio, that is reminiscient of the temporal pattern in international risk premium correlations. That this ‘‘financial hockey stick” pattern is closely related to important international business cycle moments has already been established by Jordà *et al.* (2016). For instance, investment and credit growth comovement increases in the bank credit-to-GDP ratio. The broad picture here is consistent with an important role of intermediary balance sheets for the amplification of international financial spillovers (Alpanda and Aysun, 2014; Dedola and Lombardo, 2012; Devereux and Yetman, 2010; Kollmann *et al.*, 2011).

[5]For open economy models where international spillovers become stronger in the level of intermediary leverage see Devereux and Yetman (2010) and Ueda (2012).

7. Conclusions

This paper documents the international synchronization of risk taking in recent decades. Our findings have important implications for economic policymaking around the world. The emergence of a U.S. led global financial cycle indicates that for policymakers in other countries, the world economy has become a considerably more demanding environment to operate in. Risk appetite spillovers, largely decoupled from domestic inflation, output or unemployment drive a wedge between conventional targets of monetary policy and financial stability targets. The divergence of real and financial policy targets may worsen the trade-offs involved in the application of existing policy instruments.

On a global level, the synchronization of financial conditions also raises the question about the scope for international economic policy coordination. The case for global policy cooperation rests on the existence of an inefficiency that cooperation could improve upon. The documented global synchronization of risk appetite, driven by U.S. monetary policy certainly warrants further investigations as to the possibilities of improving policy responses.

Small open economies that find themselves at the mercy of the ebb and flow of global risk appetite may consider broadening their range of policy tools in order to regain control of domestic policy targets. A broader range of national policy instruments enables national policymakers to counter inefficient spillovers even in the absence of international policy cooperation (see Korinek, 2016). What international or national economic institutions are best situated for monitoring and, if warranted, intervening into the international spillovers of risk appetite, is an important question.

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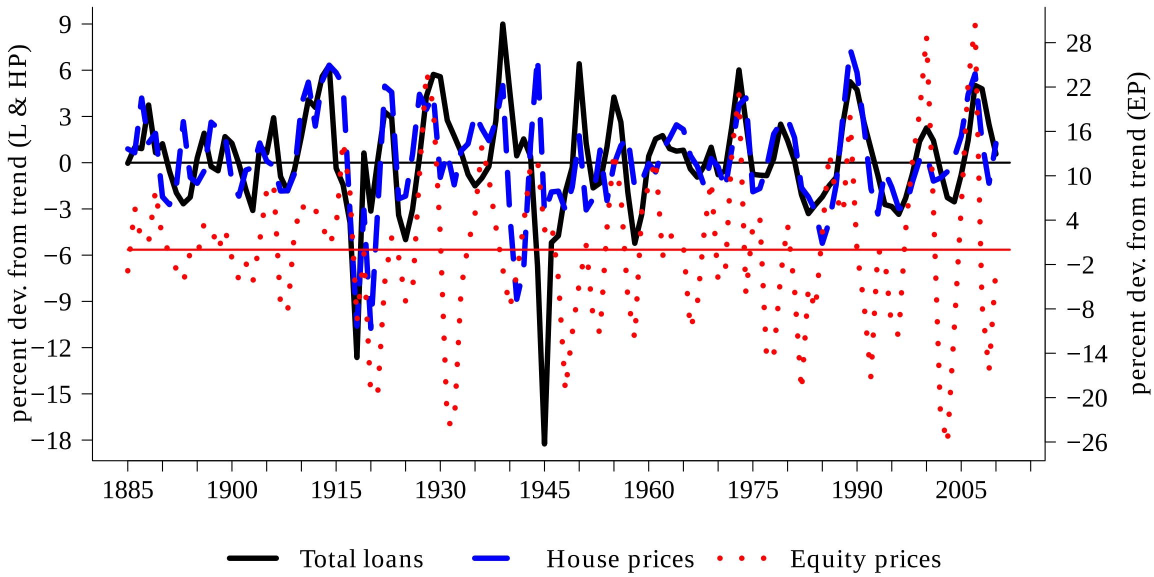
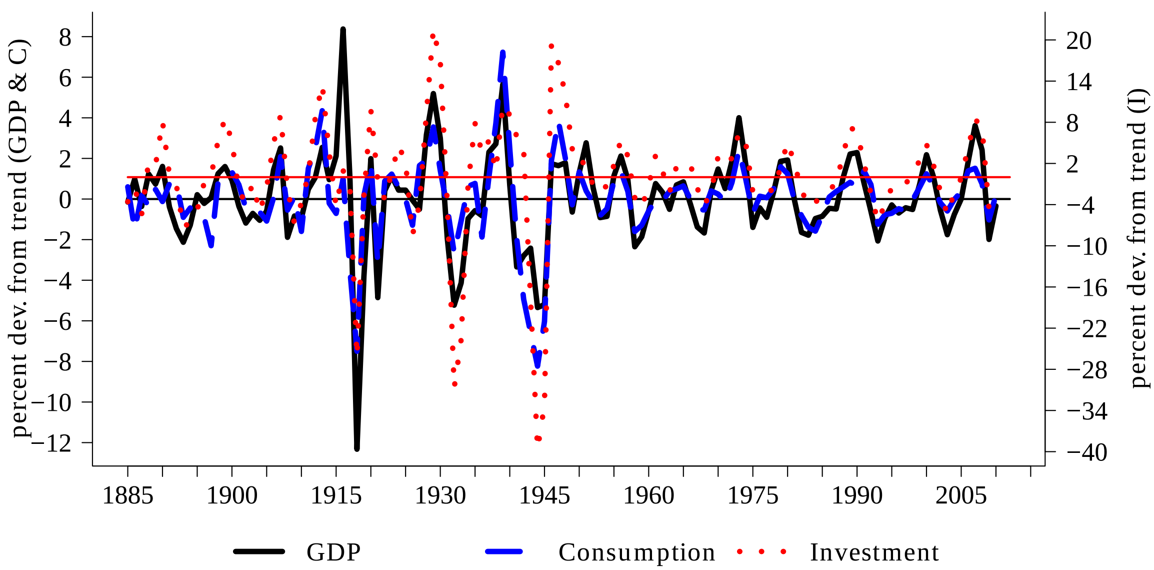
Appendix A: Global averages

Figure A.1: *Financial cycles, global average (2-32 year cycles)*



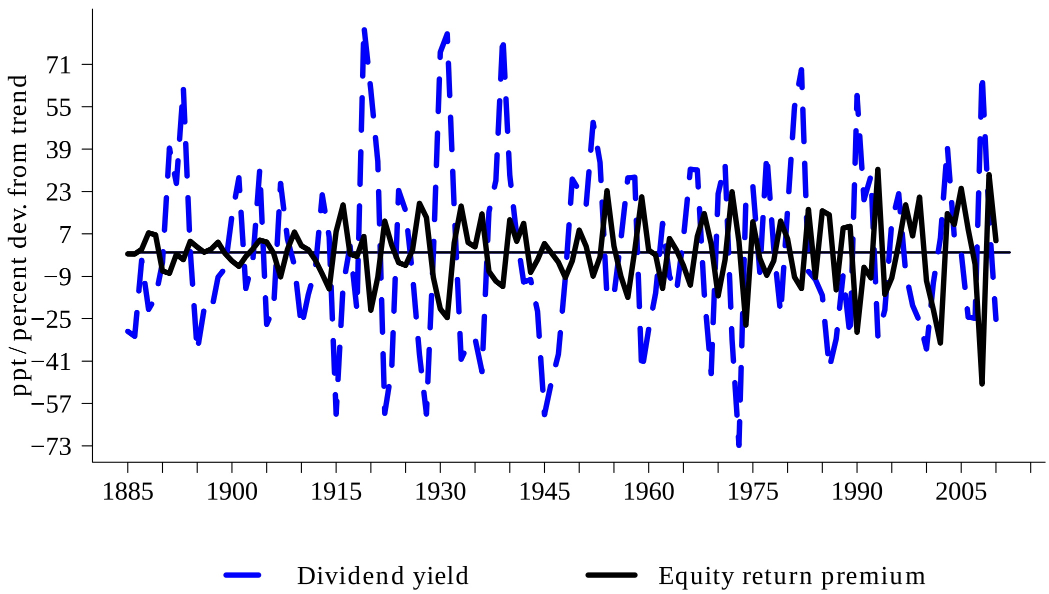
Notes: Global means. All series were detrended with a Baxter-King filter isolating cycles in the 2 to 32-year period range. Outliers have been dropped from the graph in order to simplify the graphical exposition.

Figure A.2: *Real cycles, global average (2-32 year cycles)*



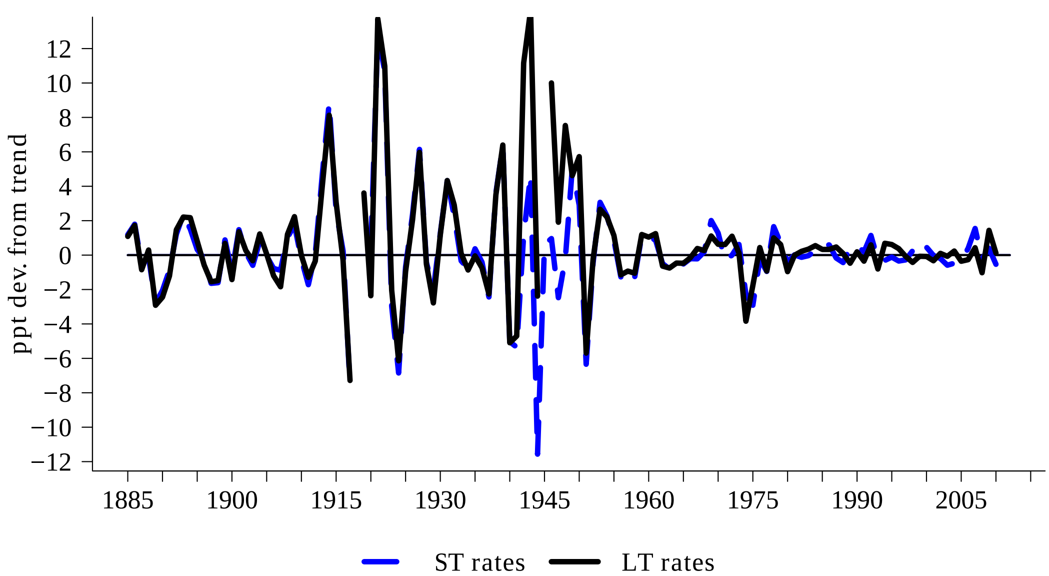
Notes: Global means. All series were detrended with a Baxter-King filter isolating cycles in the 2 to 32-year period range. Outliers have been dropped from the graph in order to simplify the graphical exposition.

Figure A.3: *Dividend yield and equity return premium, global average (2-32 year cycles)*



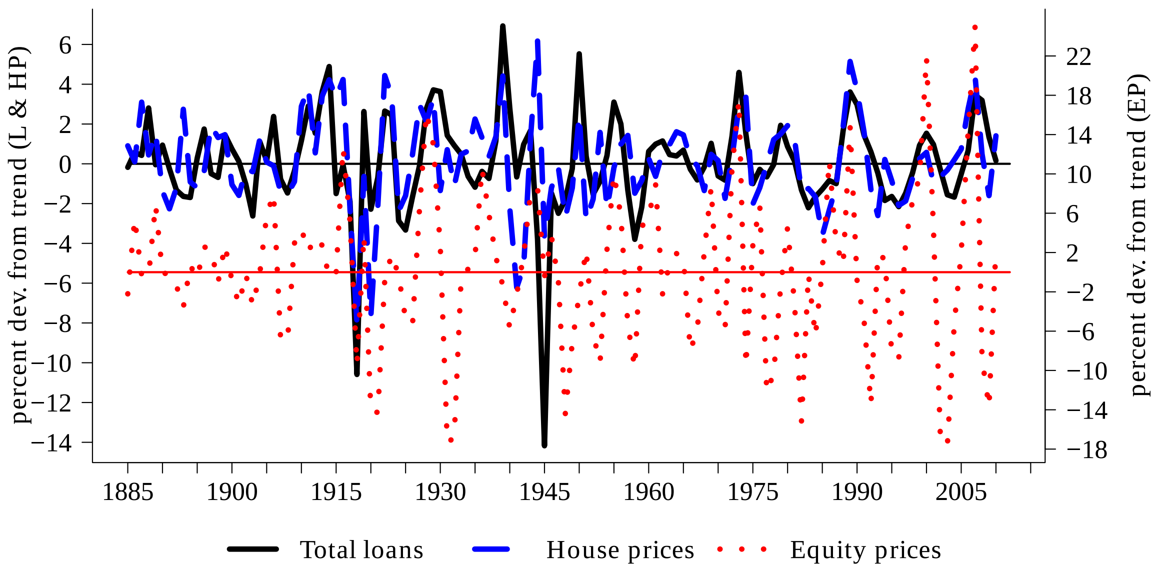
Notes: Global means. All series were detrended with a Baxter-King filter isolating cycles in the 2 to 32-year period range. Outliers have been dropped from the graph in order to simplify the graphical exposition.

Figure A.4: *Interest rates, global average (2-32 year cycles)*



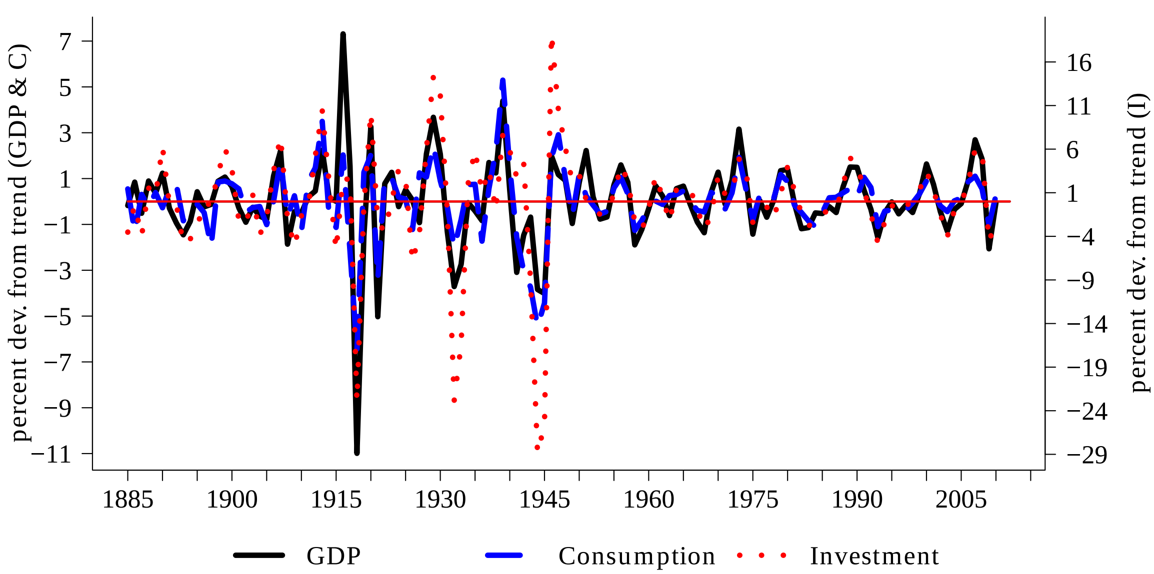
Notes: Global means. All series were detrended with a Baxter-King filter isolating cycles in the 2 to 32-year period range. Outliers have been dropped from the graph in order to simplify the graphical exposition.

Figure A.5: *Financial cycles, global average (2-8 year cycles)*



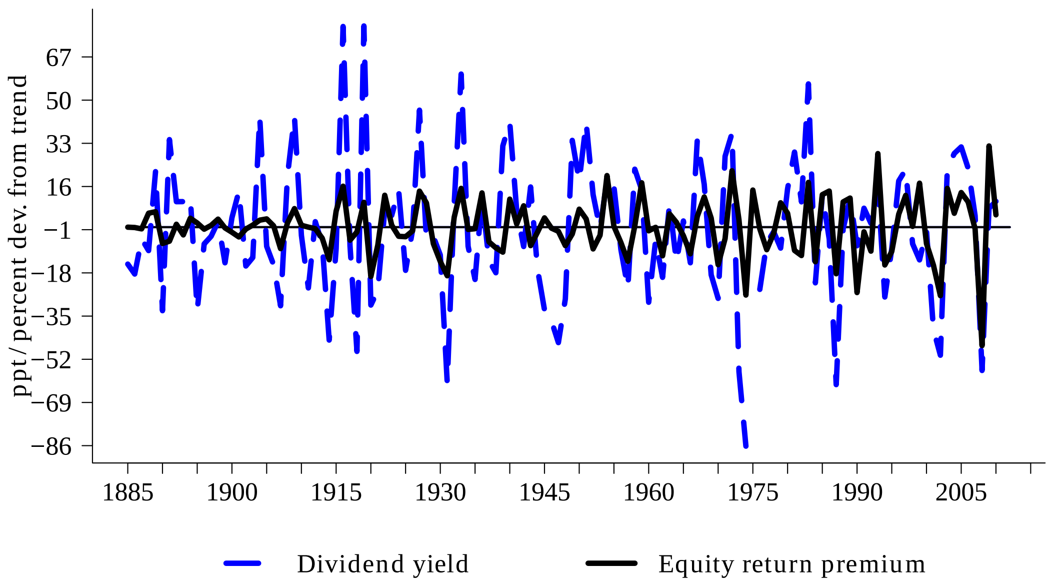
Notes: Global means. All series were detrended with a Baxter-King filter isolating cycles in the 2 to 8-year period range. Outliers have been dropped from the graph in order to simplify the graphical exposition.

Figure A.6: *Real cycles, global average (2-8 year cycles)*



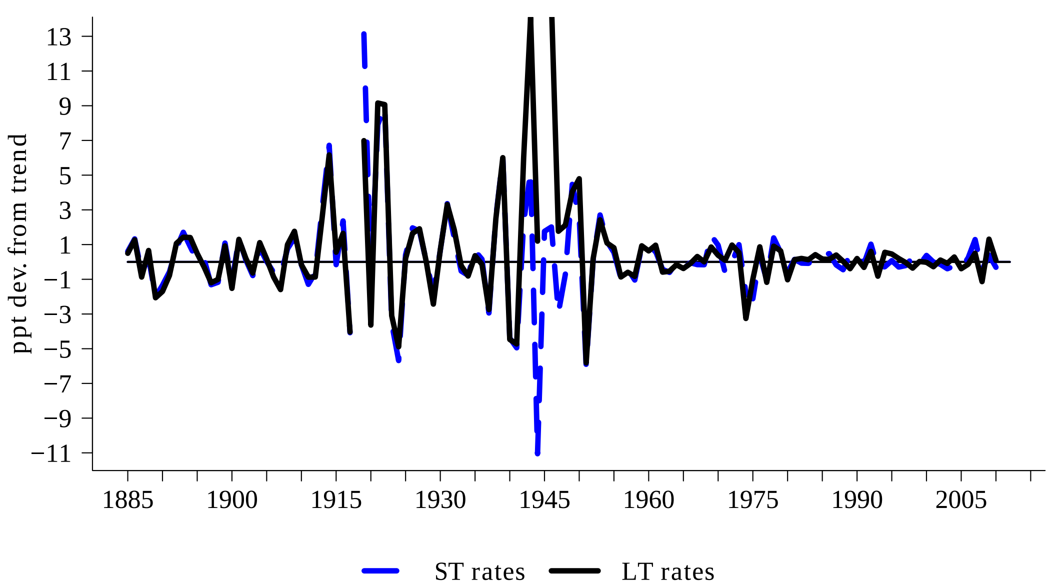
Notes: Global means. All series were detrended with a Baxter-King filter isolating cycles in the 2 to 8-year period range. Outliers have been dropped from the graph in order to simplify the graphical exposition.

Figure A.7: *Dividend yield and equity return premium, global average (2-8 year cycles)*



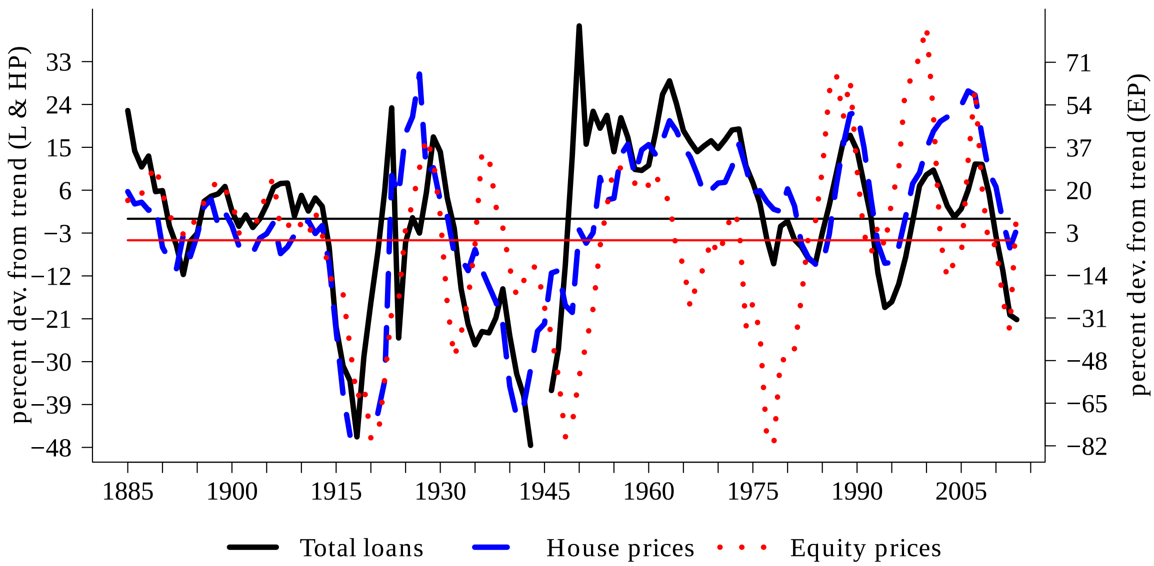
Notes: Global means. All series were detrended with a Baxter-King filter isolating cycles in the 2 to 8-year period range. Outliers have been dropped from the graph in order to simplify the graphical exposition.

Figure A.8: *Interest rates, global average (2-8 year cycles)*



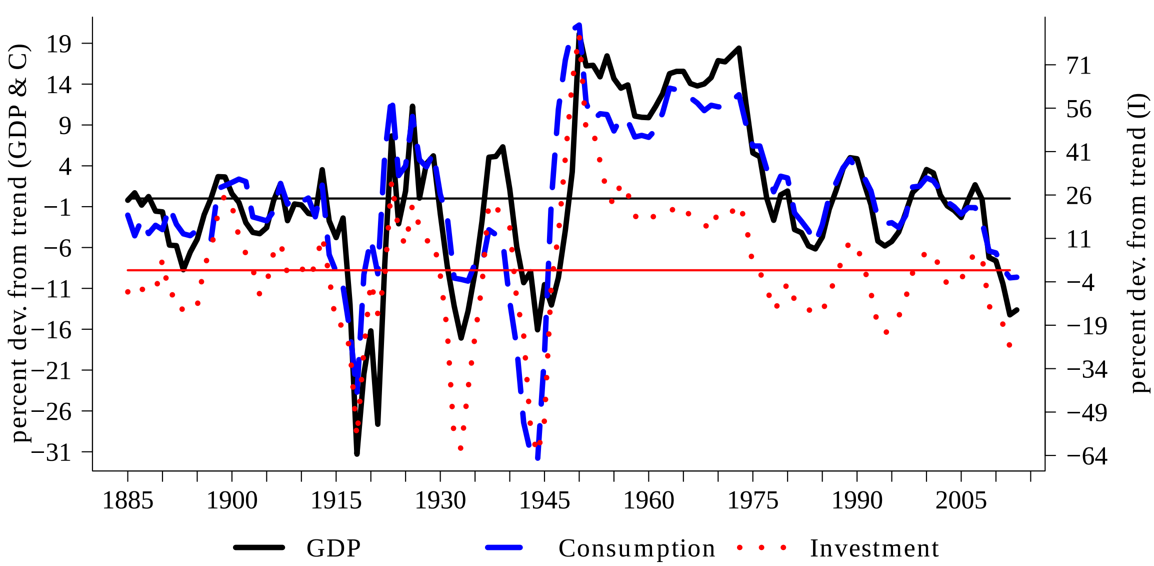
Notes: Global means. All series were detrended with a Baxter-King filter isolating cycles in the 2 to 8-year period range. Outliers have been dropped from the graph in order to simplify the graphical exposition.

Figure A.9: *Financial cycles, global average (Hamilton filter)*



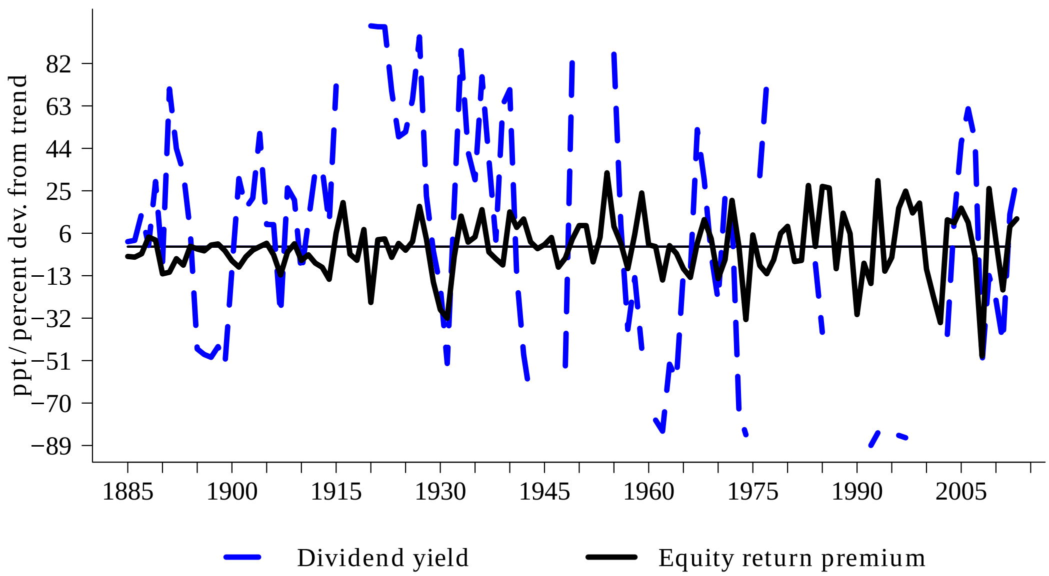
Notes: Global means. All series were detrended with the Hamilton filter, using lags five to eight. Outliers have been dropped from the graph in order to simplify the graphical exposition.

Figure A.10: *Real cycles, global average (Hamilton filter)*



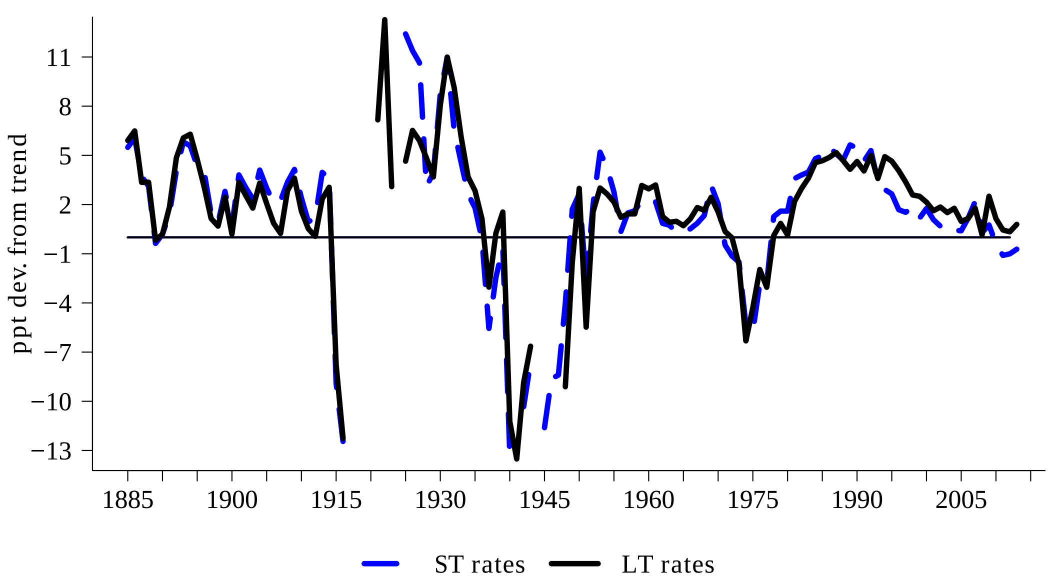
Notes: Global means. All series were detrended with the Hamilton filter, using lags five to eight. Outliers have been dropped from the graph in order to simplify the graphical exposition.

Figure A.11: *Dividend yield and equity return premium, global average (Hamilton filter)*



Notes: Global means. All series were detrended with the Hamilton filter, using lags five to eight. Outliers have been dropped from the graph in order to simplify the graphical exposition.

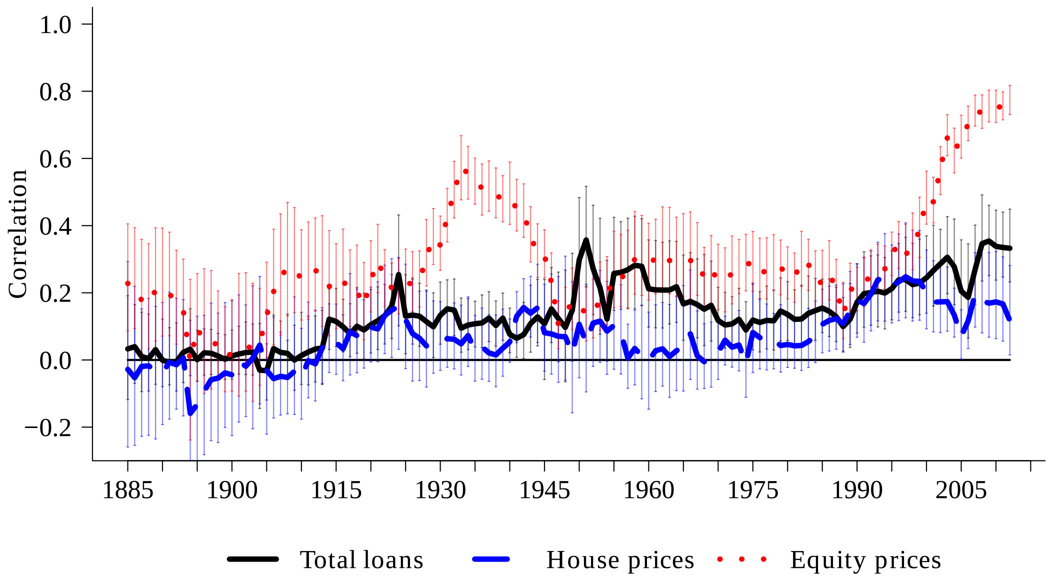
Figure A.12: *Interest rates, global average (Hamilton filter)*



Notes: Global means. All series were detrended with the Hamilton filter, using lags five to eight. Outliers have been dropped from the graph in order to simplify the graphical exposition.

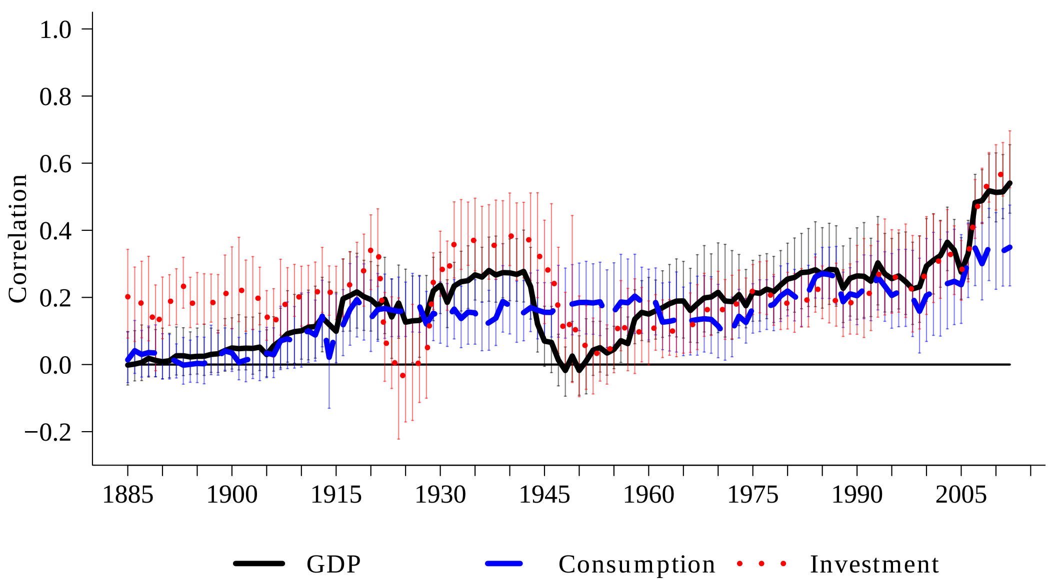
Appendix B: Average bilateral correlations

Figure A.13: *Average bilateral financial cycle correlation (2-8 year cycles)*



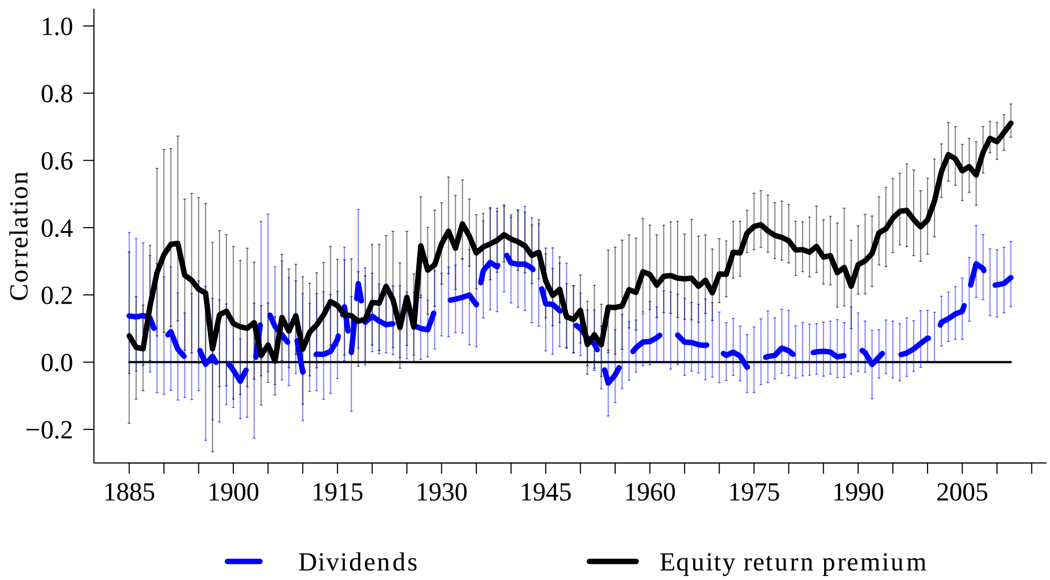
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. 2 to 8-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.14: *Average bilateral real economy correlation (2-8 year cycles)*



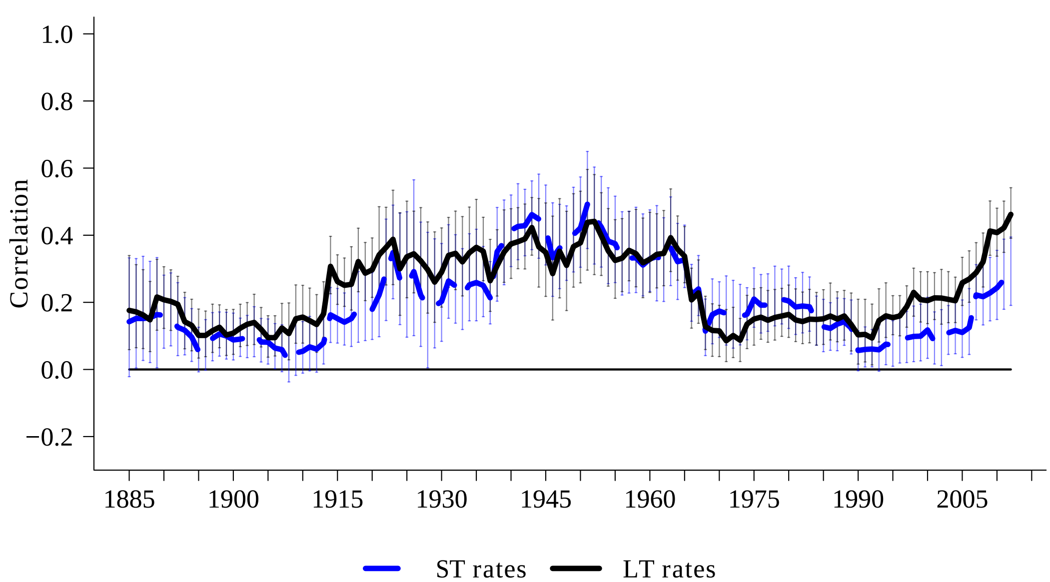
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. 2 to 8-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.15: *Average bilateral dividend yield and equity premium correlation (2-8 year cycles)*



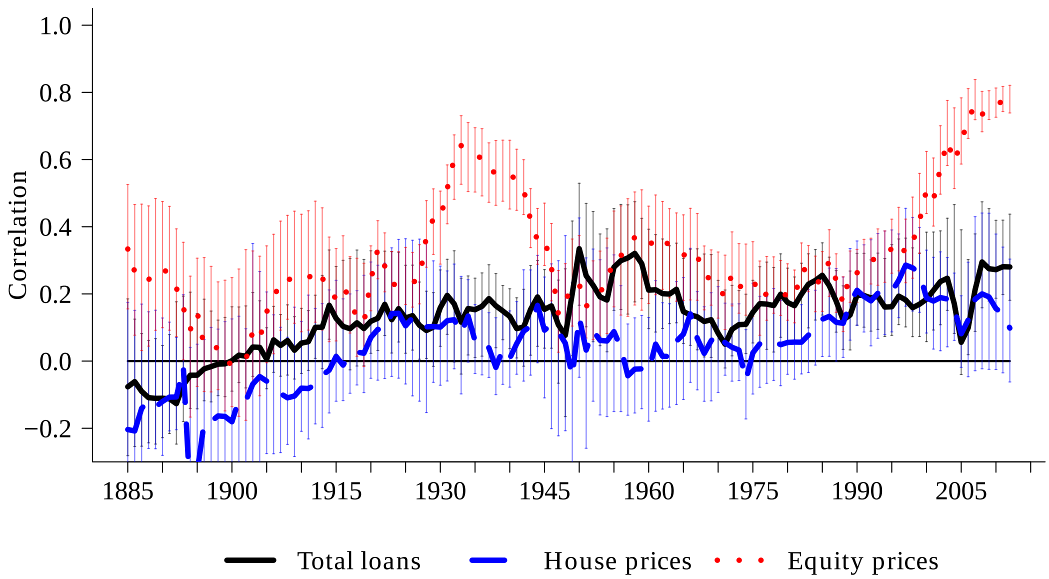
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. 2 to 8-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.16: *Average bilateral interest rate correlation (2-8 year cycles)*



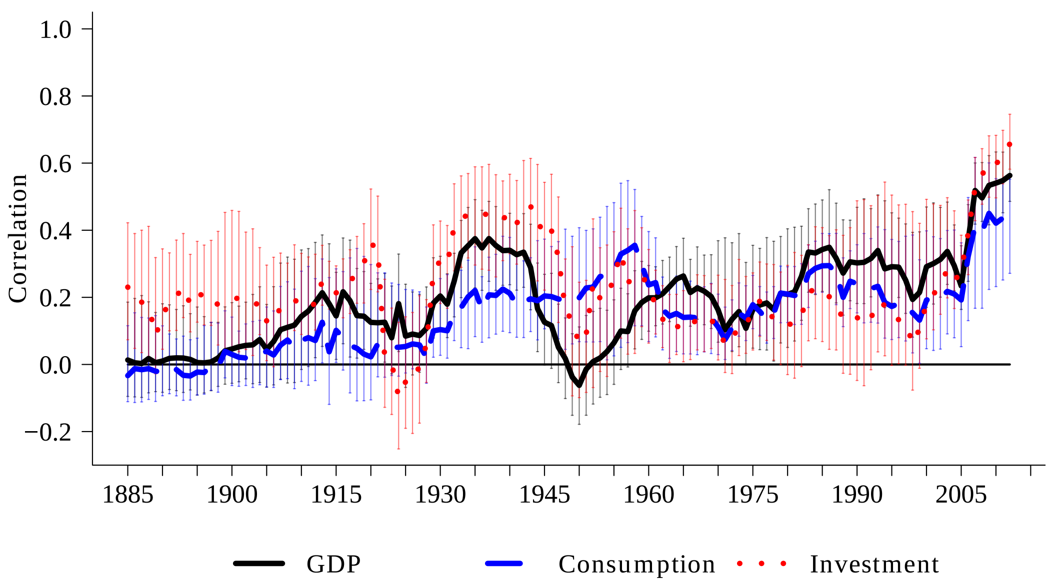
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. 2 to 8-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.17: *GDP-weighted average bilateral financial cycle correlation (2-32 year cycles)*



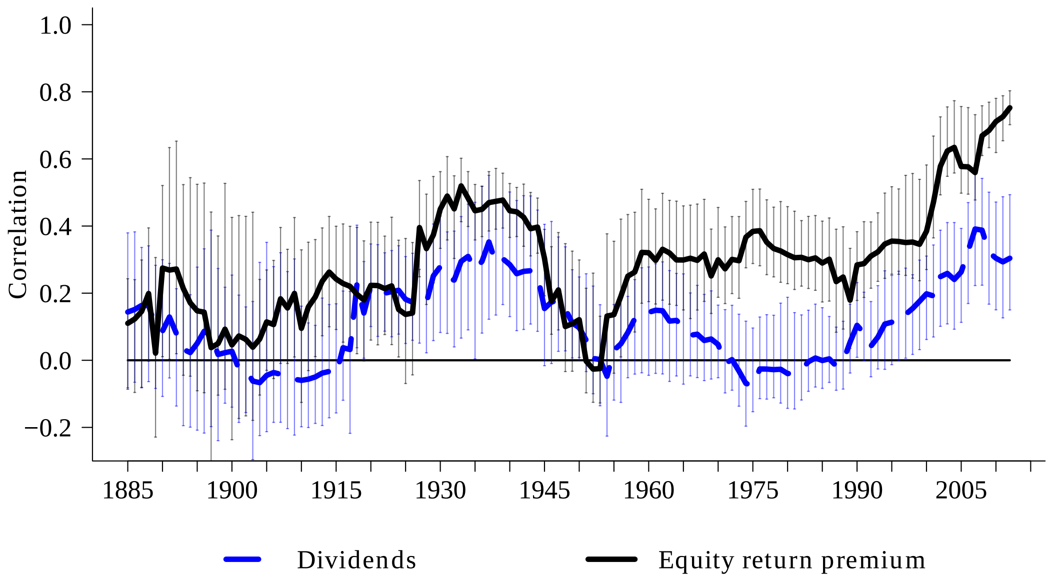
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. 2 to 32-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.18: *GDP-weighted average bilateral real economy correlation (2-32 year cycles)*



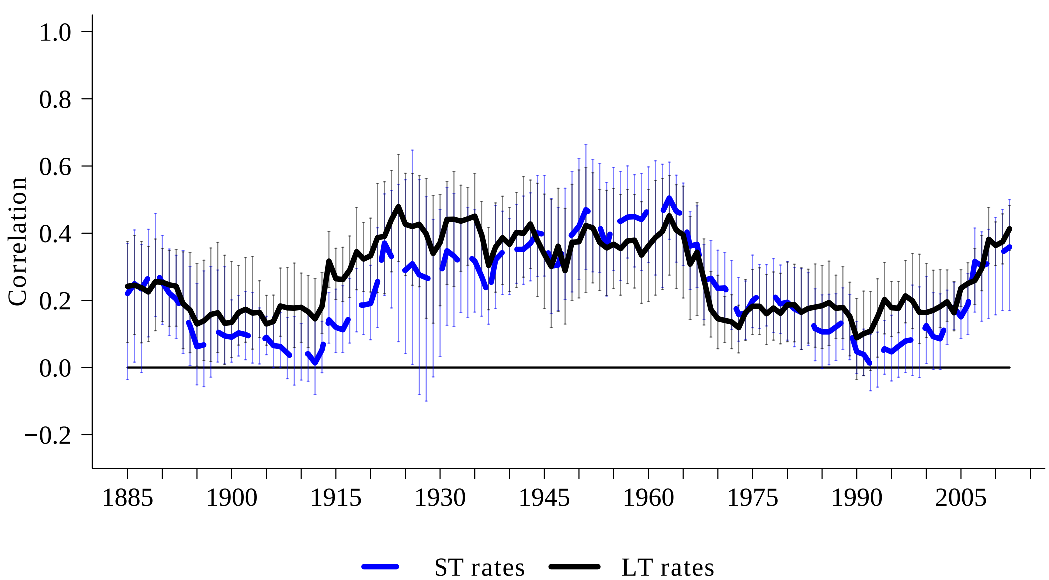
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. 2 to 32-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.19: *GDP-weighted average bilateral dividend yield and equity premium correlation (2-32 year cycles)*



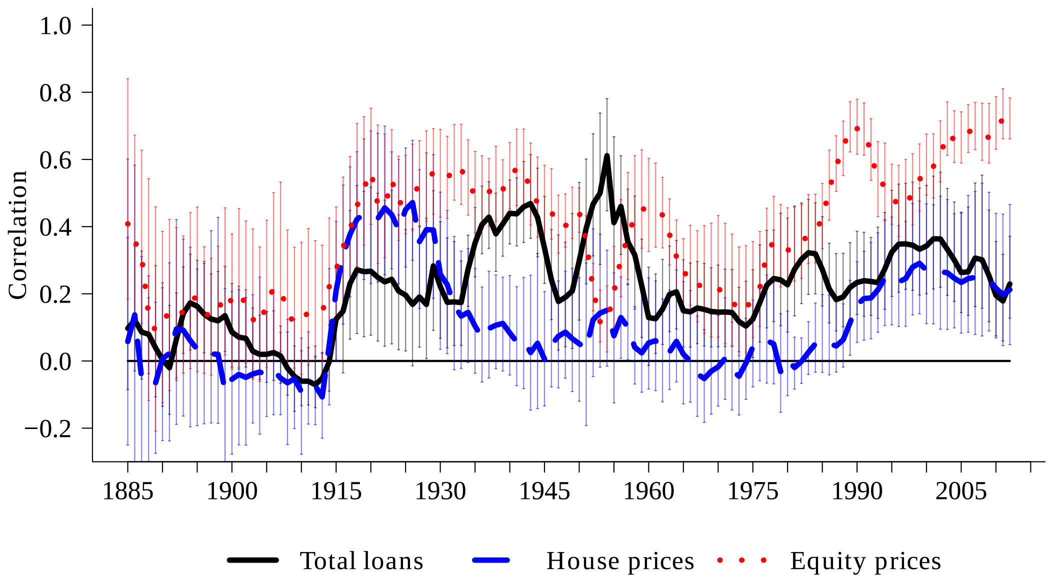
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. 2 to 32-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.20: *GDP-weighted average bilateral interest rate correlation (2-32 year cycles)*



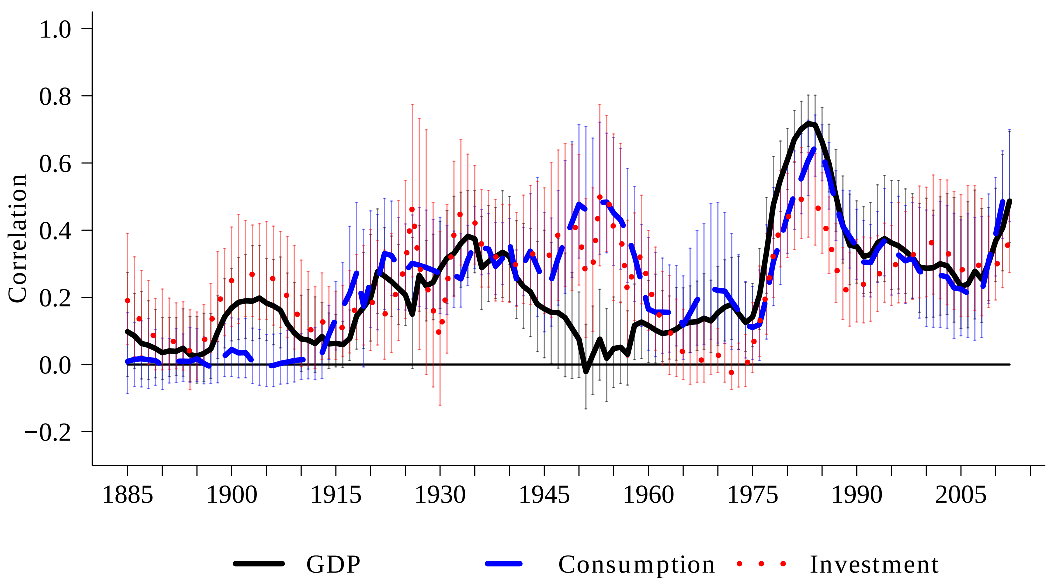
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. 2 to 32-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.21: *Average bilateral financial cycle correlation (Hamilton filter)*



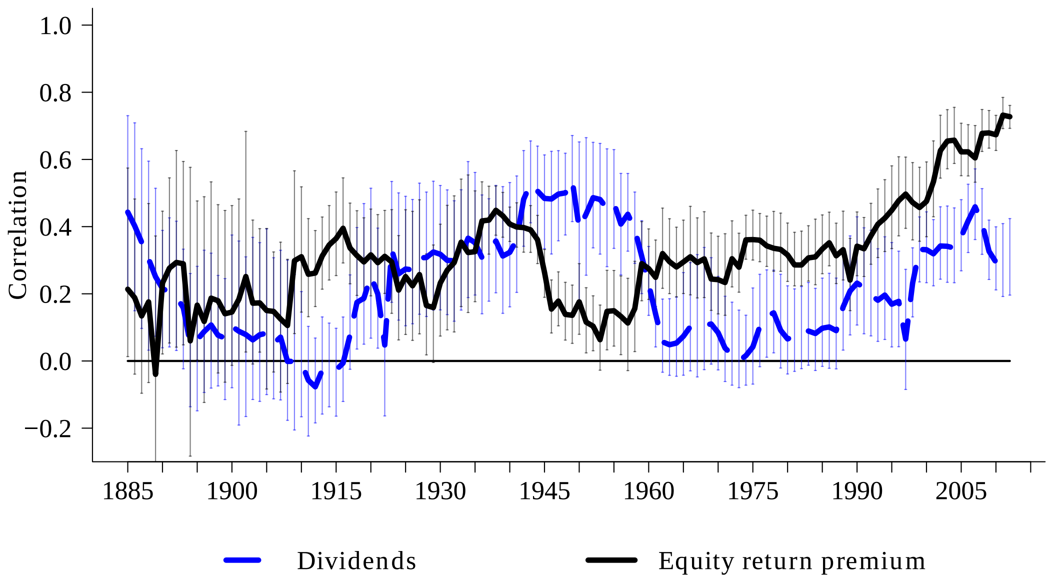
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. Hamilton filter detrended seiries (using lags five to eight). Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.22: *Average bilateral real economy correlation (Hamilton filter)*



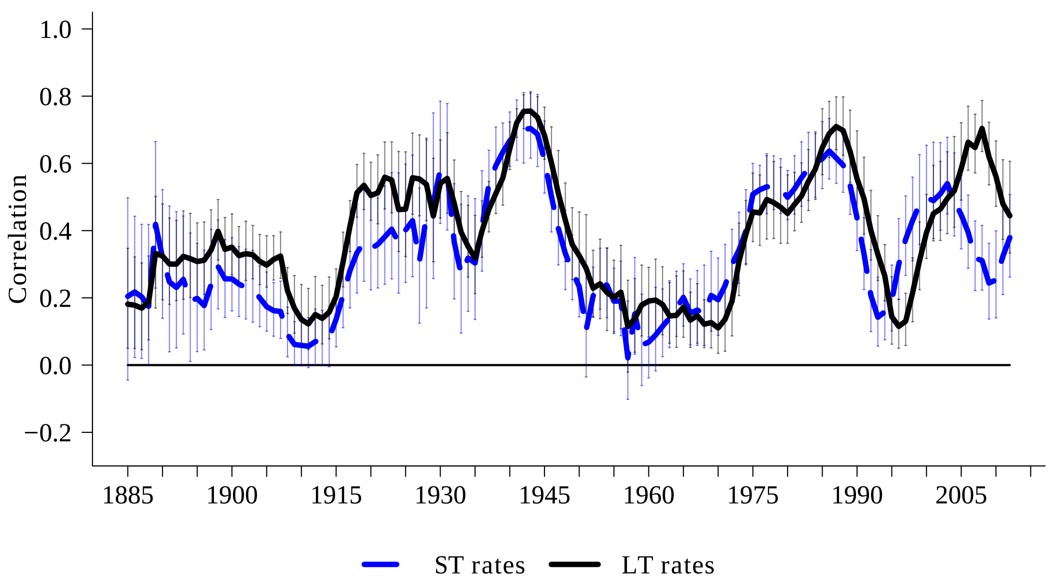
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. Hamilton filter detrended seiries (using lags five to eight). Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.23: *Average bilateral dividend yield and equity premium correlation (Hamilton filter)*



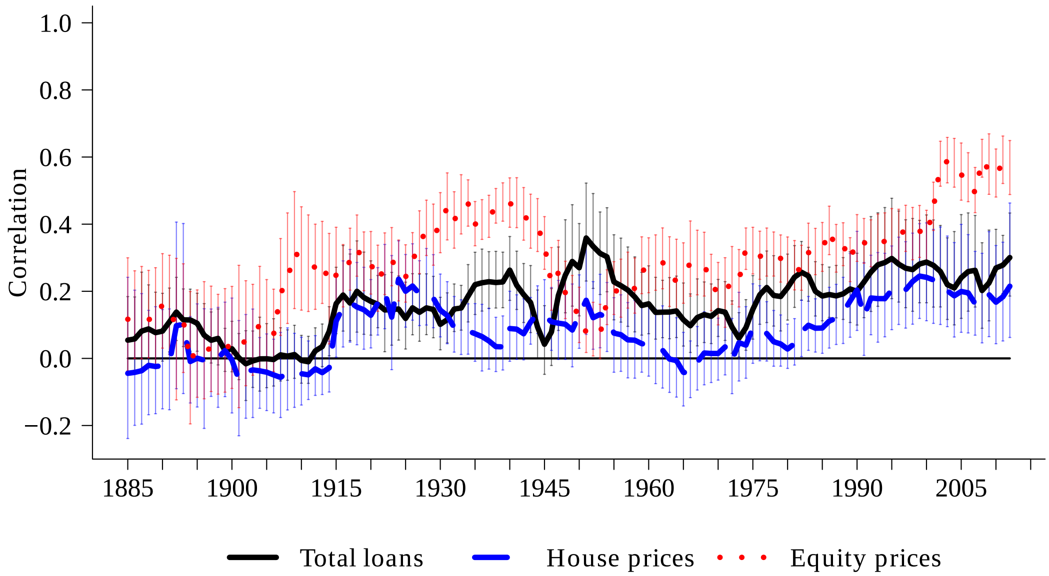
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. Hamilton filter detrended series (using lags five to eight). Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.24: *Average bilateral interest rate correlation (Hamilton filter)*



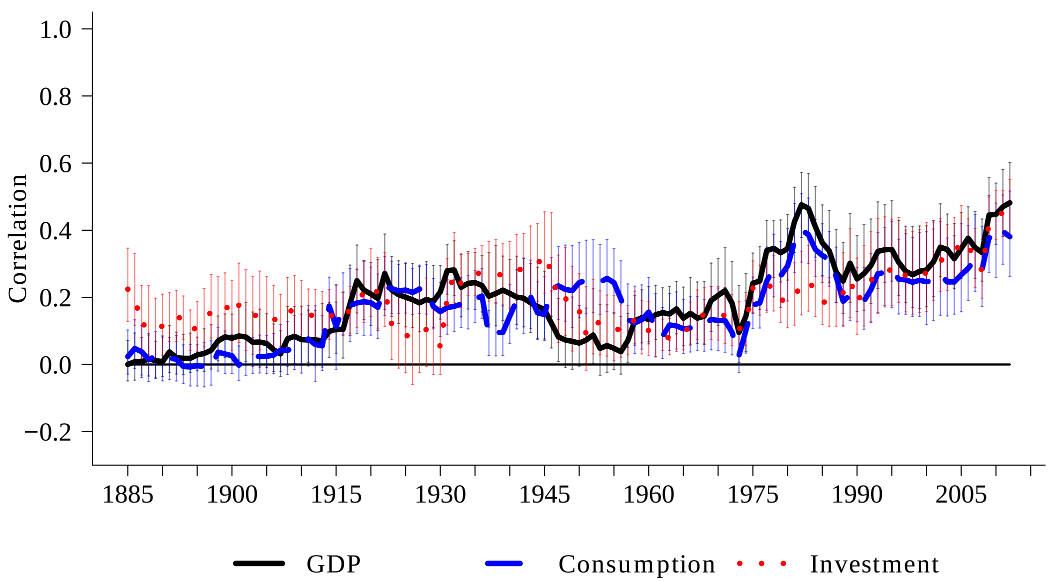
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. Hamilton filter detrended series (using lags five to eight). Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.25: *Average bilateral financial cycle correlation (annual growth rates)*



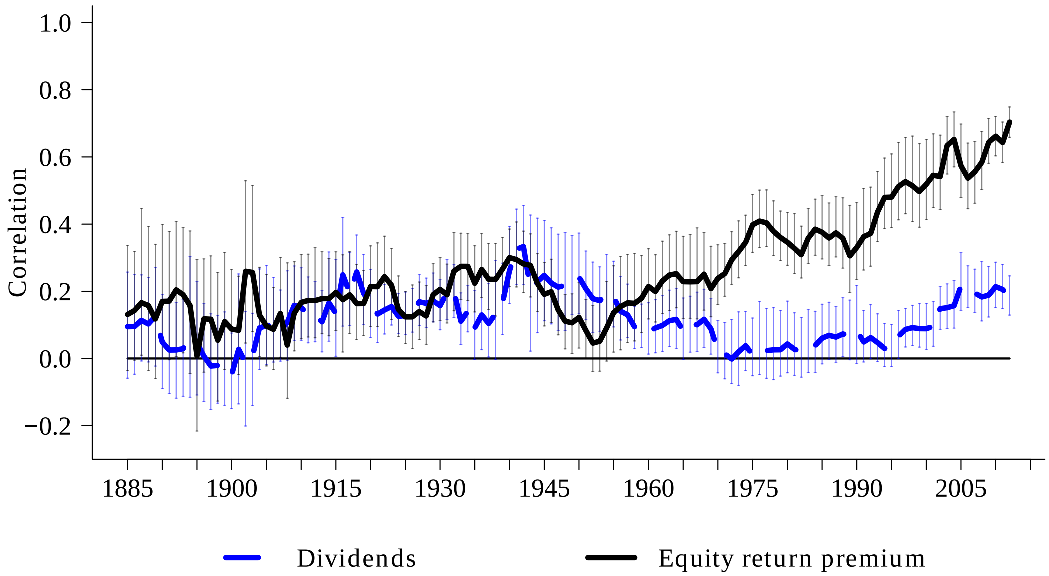
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. First differences (for rates) and growth rates for all other variables. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.26: *Average bilateral real economy correlation (annual growth rates)*



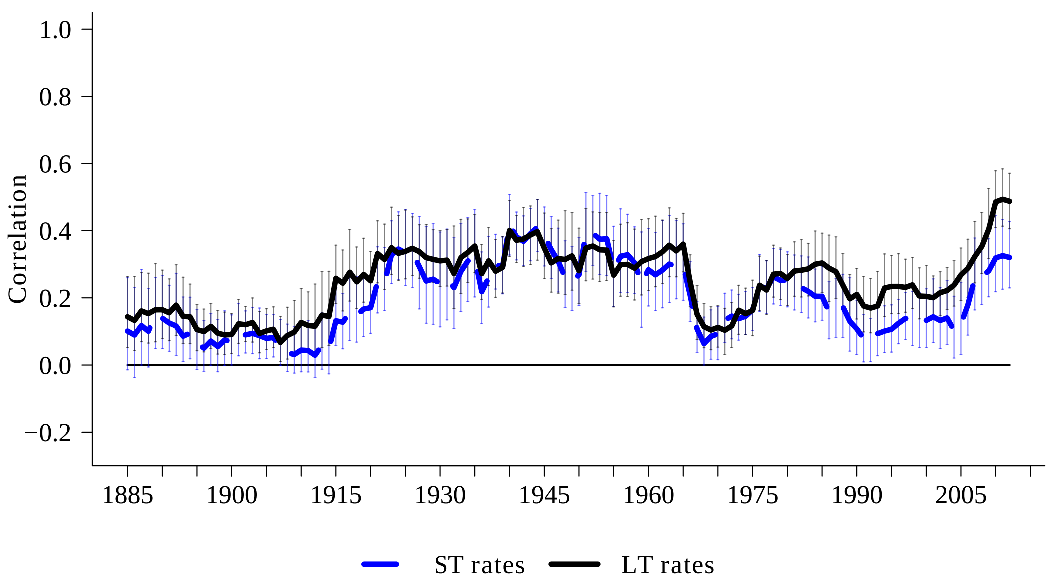
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. First differences (for rates) and growth rates for all other variables. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.27: *Average bilateral dividend yield and equity premium correlation (first differences)*



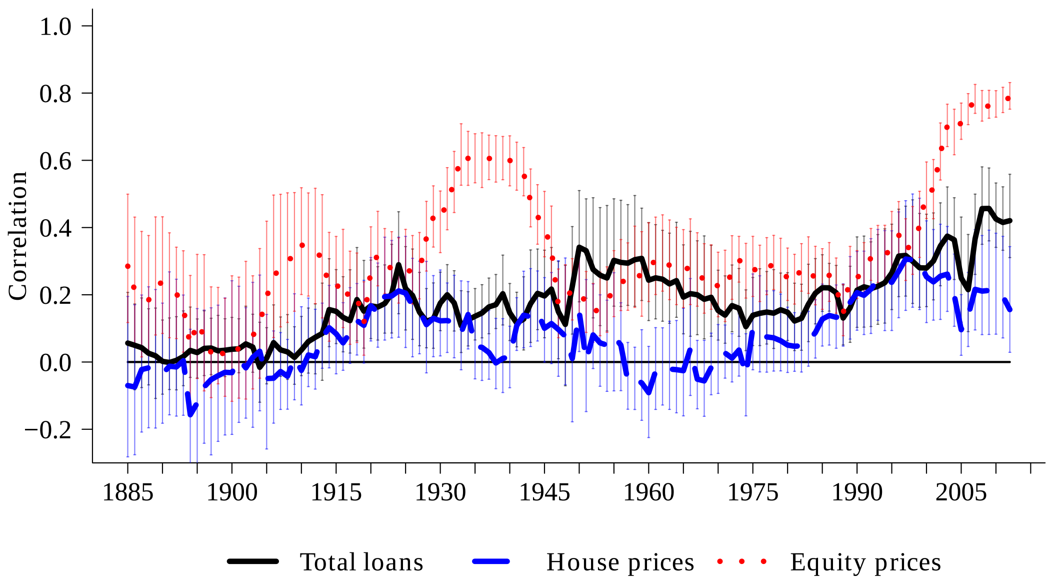
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. First differences (for rates) and growth rates for all other variables. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.28: *Average bilateral interest rate correlations (first differences)*



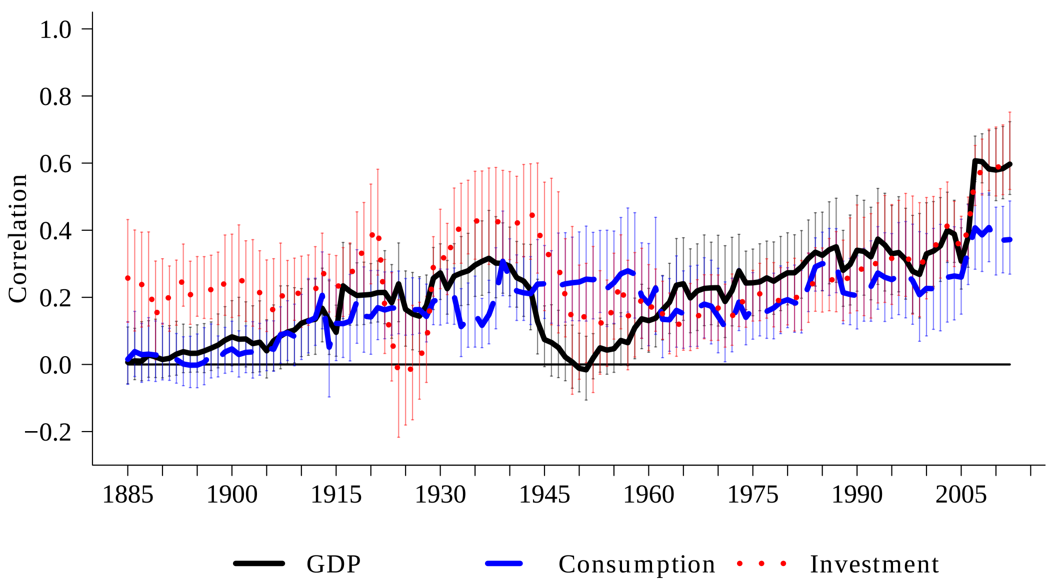
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. First differences (for rates) and growth rates for all other variables. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.29: *Average bilateral financial cycle correlation (Pearson correlation coefficient)*



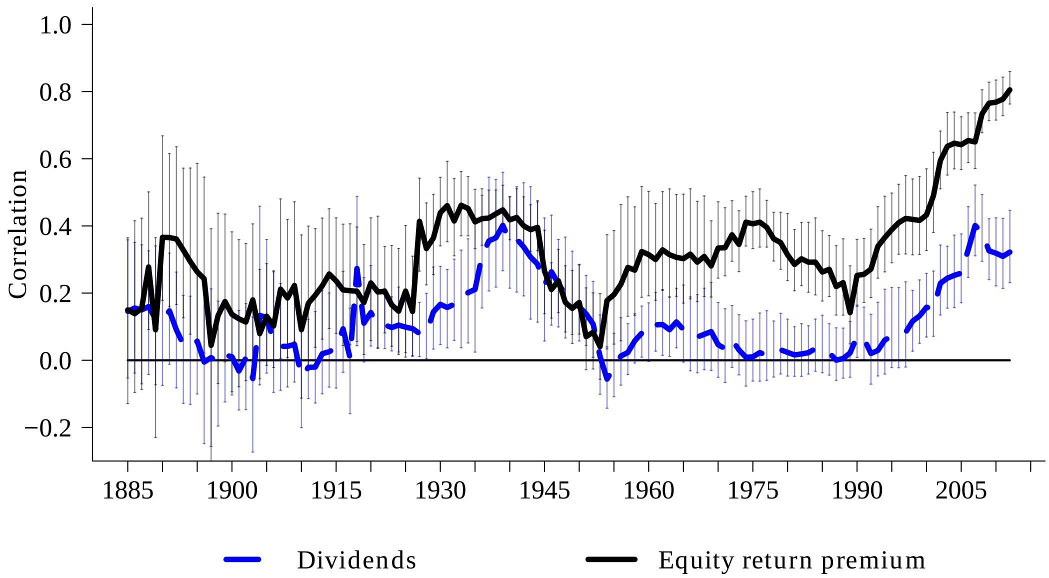
Notes: Pearson correlation coefficients based on 15-year rolling windows. 2 to 32-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.30: *Average bilateral real economy correlation (Pearson correlation coefficient)*



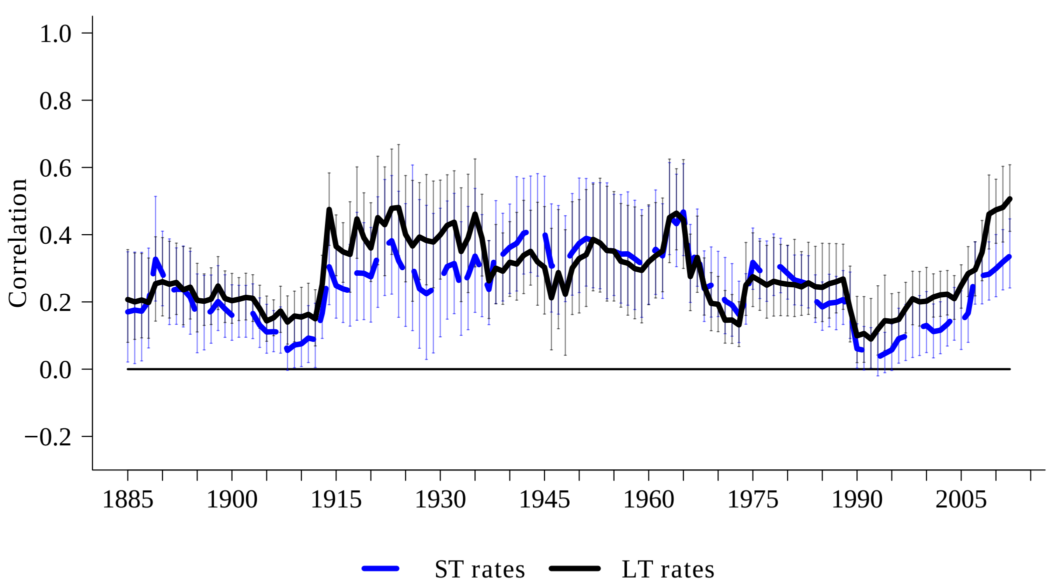
Notes: Pearson correlation coefficients based on 15-year rolling windows. 2 to 32-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.31: *Average bilateral dividend yield and equity return premium correlations (Pearson correlation coefficient)*



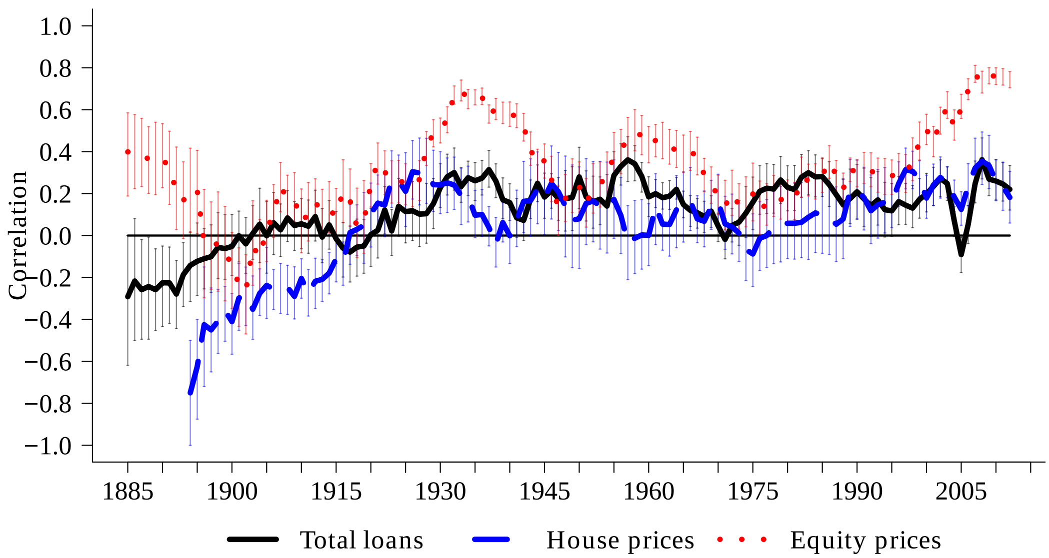
Notes: Pearson correlation coefficients based on 15-year rolling windows. 2 to 32-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.32: *Average bilateral interest rate correlations (Pearson correlation coefficient)*



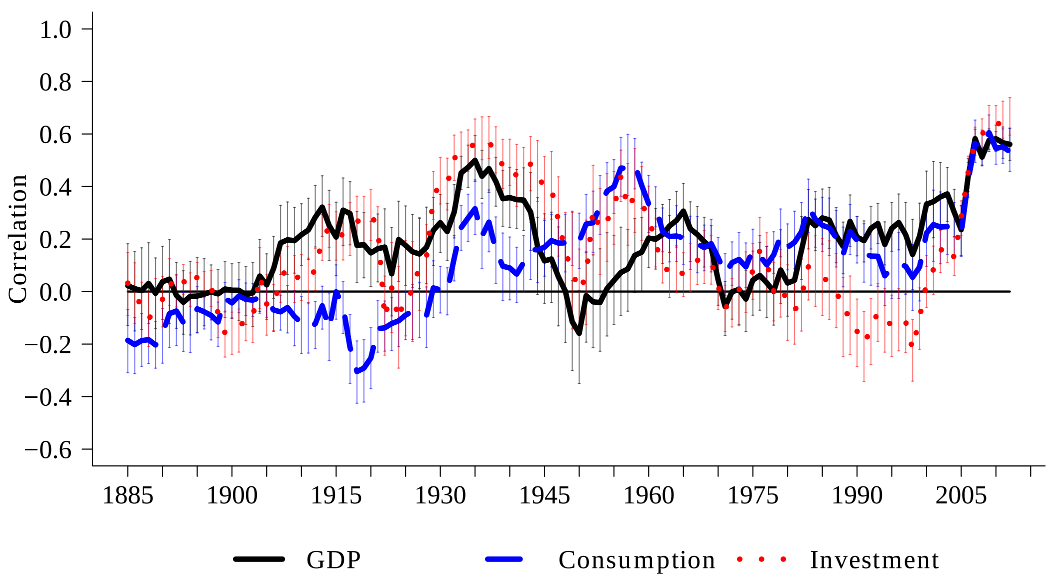
Notes: Pearson correlation coefficients based on 15-year rolling windows. 2 to 32-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.33: *Average bilateral financial cycle correlation (USA)*



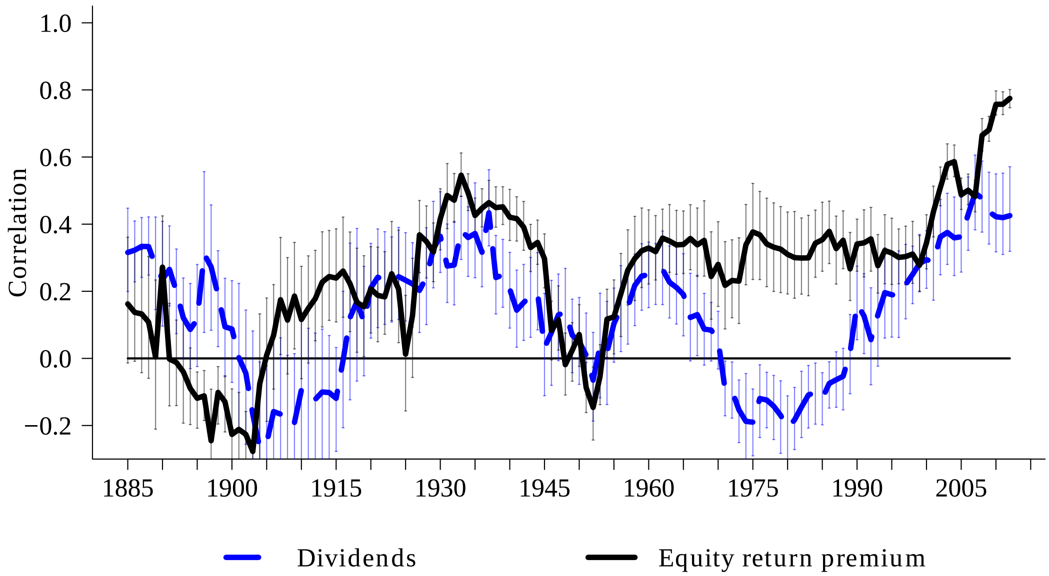
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. 2 to 32-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.34: *Average bilateral real economy correlation (USA)*



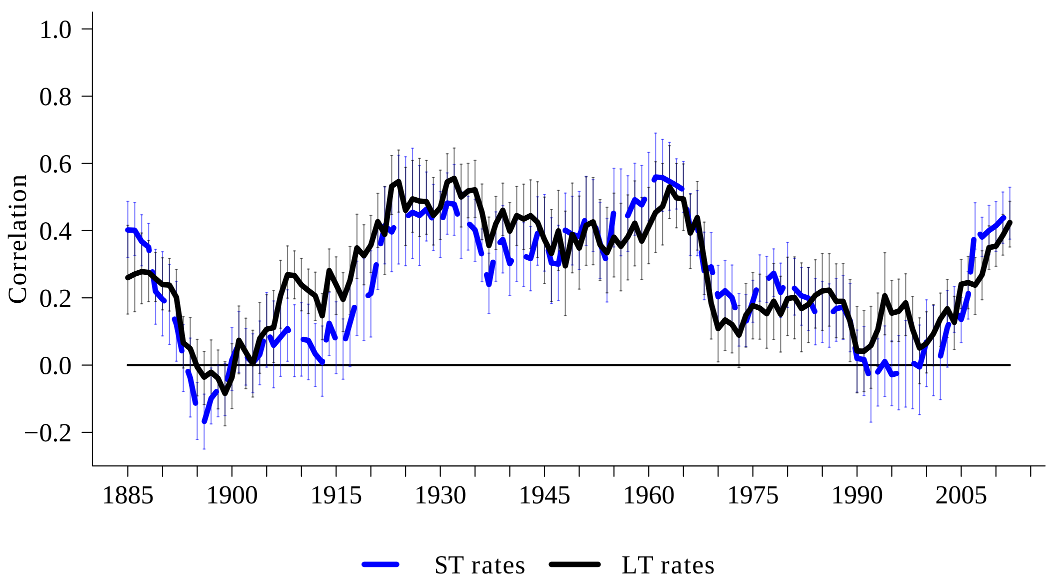
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. 2 to 32-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.35: *Average bilateral dividend yield and equity return premium correlations (USA)*



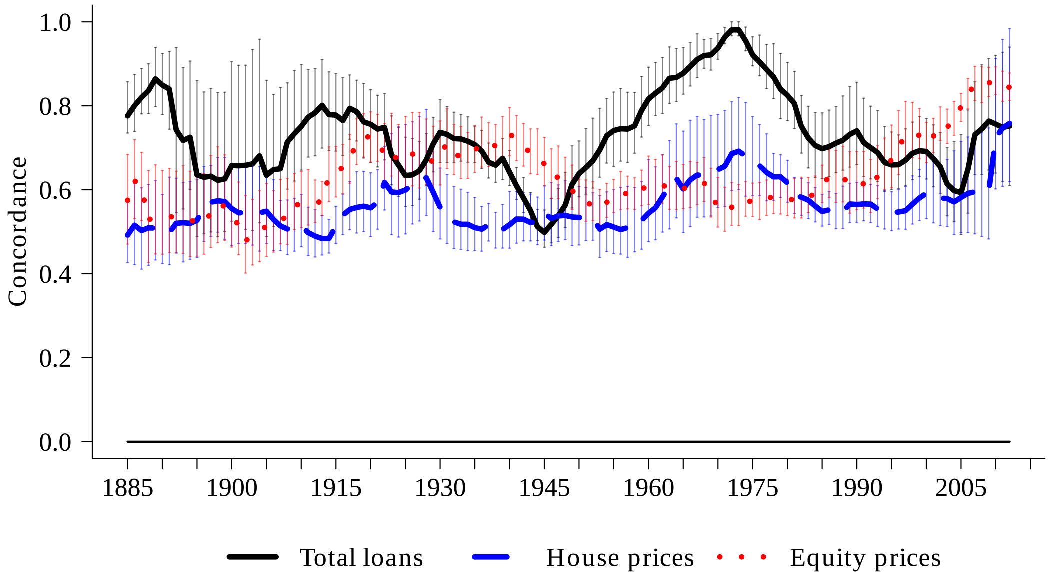
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. 2 to 32-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.36: *Average bilateral interest rate correlations (USA)*



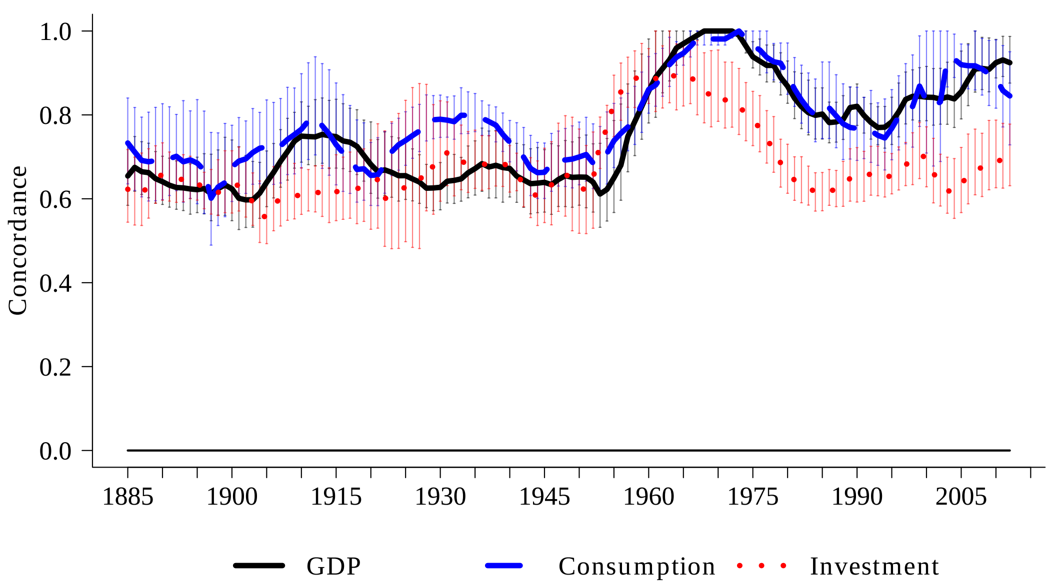
Notes: Spearman rank correlation coefficients based on 15-year rolling windows. 2 to 32-year period Baxter-King detrended series. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.37: *Average bilateral financial cycle concordance*



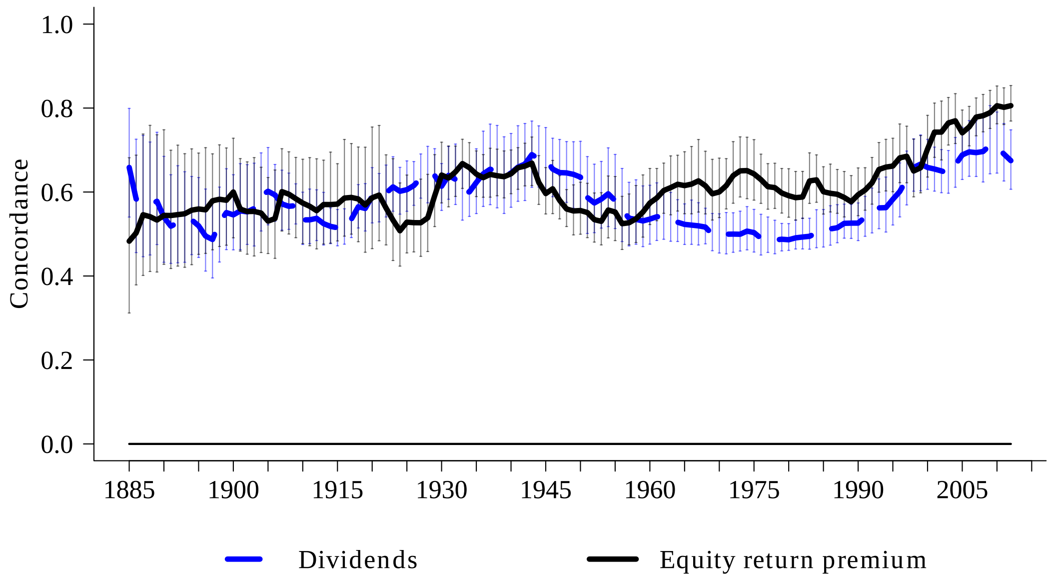
Notes: Concordance based on 15-year rolling windows. Peaks defined as highest values in +/-2 year window. Minimum phase length 2 years. Minimum cycle length 4 years. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.38: *Average bilateral real economy concordance*



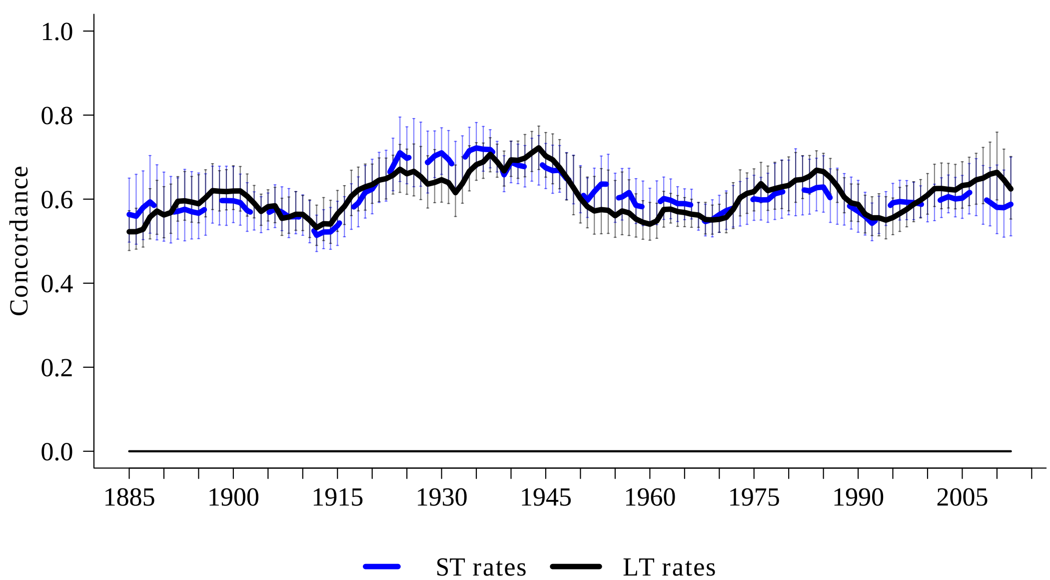
Notes: Concordance based on 15-year rolling windows. Peaks defined as highest values in +/-2 year window. Minimum phase length 2 years. Minimum cycle length 4 years. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.39: *Average bilateral dividend yield and equity return premium concordance*



Notes: Concordance based on 15-year rolling windows. Peaks defined as highest values in +/-2 year window. Minimum phase length 2 years. Minimum cycle length 4 years. Bars – 95% cross-sectionally block-bootstrapped confidence bands.

Figure A.40: *Average bilateral interest rate concordance*



Notes: Concordance based on 15-year rolling windows. Peaks defined as highest values in +/-2 year window. Minimum phase length 2 years. Minimum cycle length 4 years. Bars – 95% cross-sectionally block-bootstrapped confidence bands.