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Cross-country dependence and financial integration in the last 150 years

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Abstract

Over the last two centuries, the international financial system has undergone significant developments, with key historical events shaping financial markets and economies worldwide. We offer a new long-term perspective on international financial market integration using a flexible dynamic panel approach that accommodates heterogeneous slope coefficients while accounting for cross-country dependence. Our analysis uncovers several interesting findings. For real long-term interest rates, we observe a distinct U-shaped pattern. In contrast, the integration of global financial markets for equities has significantly increased in recent years. Additionally, long-term nominal interest rates and bond markets have become considerably more integrated since the Bretton Woods era, exhibiting a J-shaped pattern throughout the period under study.

Keywords Financial integration · Heterogeneous slope coefficients · Cross-country dependence · First era of globalization · Floating exchange rates · U-shaped pattern

JEL Classification F2 · F3 · N1 · N2 · C3

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1 Introduction

Measuring the comovements among international financial markets and quantifying the degree of financial integration are major concerns for academics and policymakers. When international financial markets are closely linked, financial crises and economic downturns can quickly spread across economies. The literature widely acknowledges that financial markets have gradually become highly integrated following the collapse of the Bretton Woods System (see Berben and Jansen 2005, for equity markets, among others). This period is commonly referred to as the modern era of financial globalization. However, from a long-run perspective, some researchers question whether the degree of financial integration in the post-Bretton Woods era is higher compared to the classical Gold Standard period, also known as the first era of financial globalization.

Some studies, such as Quinn (2003), Bordo and Flandreau (2003), and Bordo and Murshid (2006), argue that international financial markets were more integrated prior to World War I (WWI) than they are today. Quinn (2003) utilizes an index of financial openness, while Bordo and Murshid (2006) employ factor analysis to examine shock transmissions and currency crises. Both studies conclude that financial markets were more globalized before 1914 than they are now. Focusing on the Scandinavian case, Øksendal (2007) highlights the importance of the Scandinavian Monetary Union in fostering financial market integration and emphasizes its significance for a more deeply integrated Scandinavian market for short-term credit at the end of the first era of globalization.

On the other end of the spectrum, Bordo et al. (1999b, 2001), Mauro et al. (2002), and Quinn and Voth (2008) argue that financial markets have become more integrated in the modern era of financial globalization. In a similar vein, Volosovych (2011) finds that financial market integration was higher by the end of the twentieth century than in earlier periods and exhibited a J-shaped trend, with a trough in the 1920s. Since the 1970s, advancements in transportation, strengthened contract enforcement, reduced government trade barriers, and the management of information asymmetry have all played significant roles in the globalization and deepening of capital markets (Bordo et al. 1999b). In this line of research, Bordo et al. (2001) conclude that financial crises—specifically banking, currency, and twin crises—are more frequent today due to high capital mobility, particularly in short-term capital, as well as financial safety nets that encourage greater risk-taking. Moreover, Quinn and Voth (2008) adopt a capital account openness approach to explain trends in stock market correlations among developed markets, while Mauro et al. (2002) analyze bond market spread correlations in emerging markets. Both studies advocate for increased financial integration in the post-Bretton Woods period, with the latter study emphasizing the reduced diversification benefits of investing in emerging markets.

Recently, researchers have shown increased interest in the financial integration of Asia with the rest of the world, uncovering new opportunities and challenges that could reshape the economic landscape. Yao et al. (2018) provide evidence on stock markets and analyze the cross-border integration of China's stock market at a global level. The authors demonstrate that Chinese stock markets have become more integrated with global markets, regardless of macroeconomic fluctuations during the period from 2000 to 2015.

Furthermore, by utilizing a country panel data approach to analyze deposit rates and long-term government bond yields, Holmes et al. (2011) advocate for a high degree of financial integration among Asian countries. This conclusion is based on the observed co-movement of interest rates and the capacity of central banks' monetary policies to influence long-term rates both domestically and internationally. Fry-McKibbin et al. (2018), studying East Asia and the Association of Southeast Asian Nations (ASEAN) equity markets, argue for a significant increase in global and regional financial integration from 1997 to 2016. They note, however, that there were reversals in this trend during crisis periods, such as the Asian financial crisis of 1997–98, the Great Recession, and the European debt crisis. Perera and Wickramanayake (2012) examine the level of financial market integration among four major South Asian countries: Bangladesh, India, Pakistan, and Sri Lanka, over a 20-year period from 1990 to 2010. The key findings of the study suggest that both stock and bond returns show co-integration, indicating they follow common long-term trends. Additionally, stock markets in these countries appear to be more strongly integrated compared to bond markets.

Another strand of the literature emphasizes that financial integration in the first era of globalization is actually as high as in the modern era of financial globalization arguing for a U-shaped pattern (Obstfeld and Taylor 2003, 2004 and Goetzmann et al. 2001). Obstfeld and Taylor (2003, 2004) employ a rich dataset comprised of prices and quantities to reach this conclusion, while Goetzmann et al. (2001) confirm the U-shape relationship in a historic stock market correlation framework. In another contribution, Bekaert and Mehl (2019) examine financial globalization in seventeen countries employing a factor model of equity returns to show evidence of high pre-1913, higher post-1990, and low interwar period degree of financial integration (the authors called this pattern "swoosh" shape). To better contextualize the current manuscript within existing strands of literature and clarify its contribution, we summarize all previous works cited in the introduction in Table 1.

This paper contributes to the existing literature in several key ways. First, we utilize the dynamic common correlated effects (DCCE) framework (Chudik and Pesaran 2015; Pesaran 2015), which effectively addresses both parameter heterogeneity and cross-country dependence. Second, our flexible methodology allows for a comprehensive assessment of cross-country dependence across three distinct time periods. Third, we account for unobserved common factors in financial integration, such as technological change and innovation. Ignoring these common factors may lead to biased estimates in panel models that employ traditional estimation techniques (Sarafidis et al. 2009; Sarafidis and Wansbeek 2021, among others).

Our results reveal several interesting findings. Based on long-term nominal interest rates and bond yields, we conclude that financial integration has increased considerably since the Bretton Woods era, following a J-shaped pattern over time. However, when examining real long-term interest rates, we confirm the hypothesis of a U-shaped pattern in financial market integration, as first documented and popularized by Obstfeld and Taylor (2003, 2004). As for equities, our findings align with the conclusions drawn by Bekaert and Mehl (2019). Specifically, they support the argument for increased financial integration in the more recent period, highlighting a significant shift in market dynamics.

Table 1 Literature review

References	Variable	Sample years	Results
Berben and Jansen (2005)	Equity returns	1980–2000	Financial markets became gradually highly integrated following the demise of the Bretton Woods System
Quinn (2003)	Capital account openness	1890–1999	Capital account openness was more extensive between 1890 and 1913 than at any time subsequently. The recent wave of capital account liberalization, by comparison, is less complete and less globally inclusive
Bordo and Murshid (2006)	Long-term bond yield spreads, Exchange market pressure indexes, Short-term interest rate	1880–1914, 1977–2001	International financial markets were even more integrated prior to World War I (WWI) than today
Øksendal (2007)	Financial transfers, Payments for trade	1889–1913	The significance of the monetary union for a more integrated short-term credit market at the end of the first era of globalization
Bordo et al. (1999b)	Capital flows, Trade as % of GDP, Bond	1869–1997	Improvements in transportation, contract enforcement, government trade barriers, and information asymmetry have contributed to the globalization and deepening of capital markets after the 1970s

Table 1 (continued)

References	Variable	Sample years	Results
Bordo et al. (2001)	Gross Domestic Product (GDP)	1880–1997	Financial crises (banking, currency, and twin crises) are more frequent today because of high capital mobility (especially short-term capital)
Mauro et al. (2002)	Sovereign bond yields	1870–1913, 1992–2000	Comovement of economic fundamentals seems to be higher today than in the past
Quinn and Voth (2008)	Capital account openness	1893–2005	Financial markets became more integrated in the modern era of financial globalization
Volosovych (2011)	Sovereign bond markets	1875–2009	Financial market integration by the end of the twentieth century was higher than in earlier periods and exhibited a J-shaped trend with a trough in the 1920s
Yao et al. (2018)	Prices	2000–2015	Chinese stock markets have become more integrated with the world markets irrespective of any macroeconomic fluctuations over the period 2000–2015
Holmes et al. (2011)	Three-month deposit rates, Long-term government bond yields	1995–2008	The high degree of financial integration among Asian countries is based on the co-movement of interest rates and the ability of central banks' monetary policy to affect long rates within and beyond borders

Table 1 (continued)

References	Variable	Sample years	Results
Fry-McKibbin et al. (2018)	Stock returns	1997–2006	Improvements in financial integration over time with deviations from the trend occurring during periods of financial crises in Asia in 1997–98, the U.S. in 2007–10 and the European debt crisis
Obstfeld and Taylor (2003, 2004)	Long-term real interest rate, Bond and Equity returns, Stocks of foreign capital	1860–2000	Financial integration in the first era of globalization is actually as high as in the modern era of financial globalization arguing for a U-shaped pattern
Goetzmann et al. (2001)	Equity markets	1850–2000	The time-series of average correlations show a pattern consistent with the "U" shaped hypothesis about the globalization at the two ends of the twentieth century
Bekaert and Mehl (2019)	Equity returns	1885–2014	High pre-1913, higher post-1990, and low interwar period degree of financial integration (the authors called this pattern "swoosh" shape)

The remainder of the paper is structured as follows. Section 2 presents the econometric methodology we use to measure international financial market integration over the long run. Section 3 describes the data and provides a theoretical framework for explaining the variations in the employed data in relation to financial integration. Section 4 presents historical information on international monetary regimes. In Sect. 5, we present the baseline results and robustness checks. Finally, Sect. 6 provides our concluding remarks.

2 Econometric methodology

2.1 Dynamic common correlated effects

To measure global financial integration the current paper adopts insights from a dynamic common correlated effects (DCCE) panel regression as in Chudik and Pesaran (2015) and Pesaran (2015). This framework is consistent under both parameter heterogeneity and cross-country dependence. We assume that the financial variable under study (e.g., interest rates, equities, bonds), y_{it}, the regressors, x_{it}, and the covariates, g_{it}, are generated according to the following linear covariance stationary dynamic panel data model with heterogeneous slope coefficients and a factor structure dependence,

$$y_{it} = c_{yi} + \phi_i y_{i,t-1} + \beta_{0i}{}' x_{i,t} + \beta_{1i}{}' x_{i,t-1} + u_{it} \tag{1}$$

$$u_{it} = \gamma_i{}' f_t + \varepsilon_{it} \tag{2}$$

and

$$\omega_{it} = \begin{pmatrix} x_{i,t} \\ g_{it} \end{pmatrix} = c_{\omega i} + a_i y_{i,t-1} + \Gamma_i{}' f_t + v_{it} \tag{3}$$

for $i = 1, 2, \ldots, N$ and $t = 1, 2, \ldots, T$, where c_{yi} and $c_{\omega i}$ are individual fixed effects for country i, x_{it} is $k_x \times 1$ vector of regressors specific to cross-sectional country i at time t, g_{it} is $k_g \times 1$ vector of covariates specific to country i, $k_g \geq 0$, $k_x + k_g = k$, f_t is an $m \times 1$ vector of unobserved common factors, ε_{it} represents the idiosyncratic errors, Γ_i is an $m \times k$ matrix of factor loadings, a_i is a $k \times 1$ vector of unknown coefficients, and v_{it} is assumed to follow a general linear covariance stationary process distributed independently of the idiosyncratic errors, ε_{it}.

The process for the exogenous variables in Eq. (3), can also be written equivalently as an autoregressive distributed lagged (ARDL) panel model in ω_{it}. But we have chosen to work with this particular specification as it allows us to distinguish between cases of strictly and weakly exogenous regressors in terms of the feed-back coefficients, a_i. The case of strictly exogenous regressors, covered in Pesaran (2006), refers to the special case when $a_i = 0_{k\times 1}$. As in the earlier literature, the above specification also allows the regressors to be correlated with the unobserved common factors. Lags of x_{it} and g_{it} are not included in (3), but they could be readily included. In order to keep the notations and exposition simple, we also abstract from observed common effects, additional lags of the dependent variable, and other deterministic terms in (1) and (3). Such additional regressors can be readily accommodated at the cost of further notational complexity.

In a dynamic panel such as Eq. (1), where the idiosyncratic errors u_{it} are cross-sectionally weakly dependent and $E(\phi_i) = \phi$, the lagged dependent variable is no longer strictly exogenous. Therefore, the resulting estimator is inconsistent. Chudik and Pesaran (2015) demonstrate that the estimator achieves consistency when the floor

of $\sqrt[3]{T}$ lags of the cross-sectional averages is included for both the dependent variables and the strictly exogenous variables. Specifically, the equation to be estimated is:

$$y_{it} = c_{yi} + \phi_i y_{i,t-1} + \beta_i' x_{i,t} + \sum_{l=0}^{p_T} \delta_{il}' \overline{z}_{t-l} + e_{yit} \tag{4}$$

where $\overline{z}_t = \left(\overline{y}_{t-1}, \overline{x}_t\right)$ and $p_T = \left[\sqrt[3]{T}\right]$ denotes the number of lags. Consider ϕ_i and β_i as stacked into $\pi_i = (\phi_i, \beta_i)$, then the MG estimates are given by:

$$\hat{\pi}_{MG} = \frac{1}{N} \sum_{i=1}^{N} \hat{\pi}_i \tag{5}$$

For more details on the econometric theory, we refer to Chudik and Pesaran (2015).

2.2 Cross-country dependence

To pin down the degree of global financial integration, we calculate Pesaran's (2015, 2021) test for the null hypothesis of weak against strong cross-sectional dependence over the three periods mentioned in the previous section. The test statistic follows the standard normal distribution and is given by:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \right) \tag{6}$$

$$\hat{\rho}_{ij} = \hat{\rho}_{ji} = \frac{\sum_{t=1}^{T} \hat{u}_{it} \hat{u}_{jt}}{\left(\sum_{t=1}^{T} \hat{u}_{it}^2\right)^{1/2} \left(\sum_{t=1}^{T} \hat{u}_{jt}^2\right)^{1/2}} \tag{7}$$

where $\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}$ is the average correlation coefficient across countries with $\hat{\rho}_{ij}$ being the correlation coefficient between country i and country j.

We also consider bias-corrected versions of the Pesaran's (2015; 2021) test proposed by Juodis and Reese (2021), Fan et al. (2015), Pesaran and Xie (2021). All test results are reported in the tables.

It is important to note that ignored heterogeneous slope coefficients and cross-sectional dependence is likely to lead to biased estimation of the parameters (for the case of cross-sectional dependence, we refer to Sarafidis et al. 2009, among others).

3 Data description and financial integration

We consider the nominal and real long-term interest rates, bond returns, and equity returns as the dependent variables. For real long-term interest rates (r_t), we use an ex-post measure based on the difference, ($r_t = lti_t - \pi_t$), between the long-term

nominal interest rates (lti_t) and inflation (π_t). For control variables, we utilize key macroeconomic variables, including inflation ($\pi_t = 100 \cdot (\ln(p_t) - \ln(p_{t-1}))$), where p_t is the consumer price index (CPI)); the first difference of the logarithm of the debt-to-GDP ratio ($100 \cdot (\ln(debtGDP_t) - \ln(debtGDP_{t-1}))$); and the logarithm of the equity dividend yield ($\ln(D_t) - \ln(E_t)$), where D_t is dividend per share and E_t is the price per share (specifically for equities). Inflation serves as a key indicator of economic stability and is often used to assess the effectiveness of monetary policy (Cochrane 2022). Low and stable inflation is typically associated with higher and more stable economic growth, increased investment and savings, and enhanced financial stability. Many central banks, including the Federal Reserve, have adopted inflation targeting as a framework for sound monetary policy. This approach aims to anchor inflation expectations and promote price stability while allowing for some discretion in addressing short-term economic fluctuations (see Bernanke and Mishkin (1997), Stock and Watson (2003), and references therein). The debt-to-GDP ratio is a key indicator used to assess a country's fiscal sustainability. This indicator helps evaluate a government's ability to meet its financial obligations and maintain economic stability over time (see, for example, Feldstein 1982; Giavazzi et al. 2000, among others). The relationship between stock prices, dividends, and stock returns is well established in the discounted cash flow model. The equity dividend yield is an important predictor of stock market returns and valuation, as documented by seminal studies such as Fama and French (1988) and Campbell and Shiller (1988a). These works have established a significant relationship between dividend yields and future stock returns, particularly over longer horizons.

To examine the dynamic panel model, we obtain panels of annual frequency from the *Macrohistory Database* (10,422 observations in total). Specifically, we use annual data for the following countries: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the UK, and the USA. These countries account for an increasingly large share of global capital movements (see, for example, Table 3 in Schularick 2006). Detailed data definitions and sources are found in Table 2.

The three variables mentioned earlier are by no means the only important indicators for macroeconomic analysis. Exchange rates and economic institutions also play significant roles. Below, we carry out the analysis by focusing on three different periods that correspond to three different exchange rate regimes. Still, we maintain the parsimony of our proposed models by having the main monetary and fiscal policy indicators as the primary regressors.

The degree of financial integration has fluctuated over time due to various economic, political, and institutional factors. A theoretical framework for explaining these variations can be constructed around several key variables, including macroeconomic conditions, as evidenced by the behaviour of real long-term interest rates, nominal long-term interest rates, bond returns, and equity returns. These variables are key indicators of the changing economic landscape and investor sentiment. They influence the incentives and barriers to cross-border capital mobility. For instance, real long-term interest rates can be viewed as a barometer of the broader macroeconomic environment. Periods of lower real rates often coincide with more accommodative

Table 2 Definitions and sources of variables

Variables	Definition	Sources
Dependent variables		
Real long-term interest rate	Long-term nominal interest rate minus inflation	Òscar Jordà, Moritz Schularick, and Alan M. Taylor. 2017. Macrofinancial History and the New Business Cycle Facts. NBER Macroeconomics Annual 2016, volume 31
Long-term nominal interest rate	Long-term nominal interest rate	Òscar Jordà, Moritz Schularick, and Alan M. Taylor. 2017. Macrofinancial History and the New Business Cycle Facts. NBER Macroeconomics Annual 2016, volume 31
Bond total return	Government bond total return is equal to bond price at time t plus coupon payment at time t (minus one), divided by bond price at time $t-1$	Òscar Jordà, Moritz Schularick, and Alan M. Taylor. 2017. Macrofinancial History and the New Business Cycle Facts. NBER Macroeconomics Annual 2016, volume 31
Equtiy total return	Equity total return is equal to equity price at time t plus equity dividend at time t (minus one), divided by equity price at time $t-1$	Òscar Jordà, Moritz Schularick, and Alan M. Taylor. 2017. Macrofinancial History and the New Business Cycle Facts. NBER Macroeconomics Annual 2016, volume 31
Control variables		
Inflation	Difference in the natural logarithm of consumer prices at time t and $t-1$	Òscar Jordà, Moritz Schularick, and Alan M. Taylor. 2017. Macrofinancial History and the New Business Cycle Facts. NBER Macroeconomics Annual 2016, volume 31
Debt/GDP	Public debt-to-GDP ratio	Òscar Jordà, Moritz Schularick, and Alan M. Taylor. 2017. Macrofinancial History and the New Business Cycle Facts. NBER Macroeconomics Annual 2016, volume 31
Equity dividend yield	Equity dividend yield is equal to equity dividend, divided by equity price	Òscar Jordà, Moritz Schularick, and Alan M. Taylor. 2017. Macrofinancial History and the New Business Cycle Facts. NBER Macroeconomics Annual 2016, volume 31

monetary policies, stronger economic growth, and lower inflation, creating an environment conducive to increased international investment and financial integration. Conversely, higher real rates may signal a more restrictive policy stance, dampening the appetite for cross-border capital flows and contributing to a reduction in the degree of financial integration.

Similarly, the dynamics of nominal long-term interest rates can provide insights into the relative attractiveness of fixed-income investments across different markets. When nominal yields converge across countries, it can create arbitrage opportunities

and encourage greater cross-border portfolio flows, thereby enhancing financial integration. Conversely, divergences in nominal rates may create barriers to investment, leading to a retraction of international capital and a decline in financial integration.

Additionally, the performance of bond and equity markets plays a crucial role in shaping the incentives and risk perceptions of global investors. Periods of strong and synchronized returns across various asset classes and markets tend to foster an environment of increased risk tolerance, prompting investors to pursue greater international diversification and contributing to higher levels of financial integration. Contrarily, episodes of volatile or divergent asset returns can lead to a flight to safety, resulting in a retrenchment of cross-border investments and a reduction in the degree of financial integration.

Importantly, these macroeconomic and financial variables do not operate in isolation; they are influenced by a complex interplay of economic, political, and institutional factors. Changes in monetary and fiscal policies, regulatory frameworks, technological advancements, and geopolitical dynamics can all profoundly impact the incentives and constraints faced by investors, ultimately shaping the ebb and flow of global financial integration over time. Most relevant to our analysis, the aforementioned factors are typically unobserved country-specific factors and/or unobserved common factors that influence all countries.

By examining fluctuations in key variables, researchers can better understand the drivers behind financial integration. This analysis lays a strong theoretical foundation for interpreting empirical findings. It also informs policy discussions about the factors that affect global financial interconnectedness.

4 International monetary regimes: historical background

In our study, we focus on three different periods that correspond to three different monetary regimes: the First Era of Globalisation (1871–1913), the Bretton Woods Monetary System (1950–1973), and the Floating Exchange Rates period (1974–2016). To avoid noisy data from non-market periods, the wartime years (1914–1918, 1939–1945) have been omitted, partly due to missing data. The German hyperinflation period (1919–23) has also been excluded. During the two world wars, the global economy was severely disrupted. The post-World War I years led to the German hyperinflation period, which is a critical episode in economic history. This event, together with the Great Depression, had a profound and far-reaching impact on the global financial system.

4.1 Sample period 1871–1913

Our first period (1871–1913) is often referred to as the First Era of Globalization due to the unprecedented expansion of technological growth, trade liberalization, and financial interconnectedness that characterized this time. Specifically, the late nineteenth and early twentieth centuries witnessed remarkable technological advancements, particularly in the fields of transportation and communication. The construction

of railroads and the introduction of steamships significantly reduced the costs and time associated with long-distance travel and shipping. Moreover, the invention of the telegraph enabled rapid communication across continents, leading to more efficient global business operations. Moreover, the invention of the telegraph enabled rapid communication across continents, leading to more efficient global business operations.

Many countries, particularly in Europe and North America, began to embrace free trade policies during this period. Additionally, the post-1870 era witnessed the growth of international financial markets and the widespread adoption of the Gold Standard, which facilitated exchange rate stability and made international financial transactions more predictable. From the 1870s onward, the Gold Standard became the predominant monetary system globally, with major economic powers such as Germany and the United States joining other European nations in its adoption.

The shift to the Gold Standard in the late nineteenth century sparked debate among economists regarding its impact on global finance. One school of thought, exemplified by Eichengreen (2019), argues that the Gold Standard enhanced international investment by eliminating currency fluctuation risks. Another perspective suggests that adopting the Gold Standard signaled a country's commitment to responsible economic management, thereby attracting foreign capital (Bordo and Kydland 1995; Bordo and Rockoff 1996).

However, some economists propose that both the adoption of the Gold Standard and the increase in cross-border investments were actually outcomes of deeper economic and political forces (Eichengreen 1992; Obstfeld and Taylor 1998). This perspective emphasizes that the Gold Standard was a historically specific institution, shaped by the political and economic conditions of its time. Indeed, many capital movements were not related to the Gold Standard, regardless of whether countries maintained a fixed exchange rate.

For example, British capital heading abroad, especially that invested in private enterprises, sought the most profitable opportunities—chasing natural resources, educated populations, migrants, and young demographics. Moreover, flows toward private sector investment opportunities abroad were encouraged by previous investments in government-financed projects (Clemens and Williamson 2000).

Another example is French investment in Russia's railway development. During the late nineteenth and early twentieth centuries, France invested heavily in Russia, particularly in its railway system. This investment was not primarily driven by Russia's adherence to the Gold Standard (which Russia only fully adopted in 1897) but rather by a combination of political alliances and economic opportunities (Collins 1973).

4.2 Sample period 1950–1973

The Bretton Woods era (1944–1971) was characterized by a concerted effort to reconstruct the global economy. During this time, international trade experienced remarkable expansion, and worldwide economic growth entered one of its most rapid phases in history. The concerns that emerged during the interwar period regarding the management of global capital persisted throughout the Bretton Woods era. In the initial stages, most advanced economies maintained capital controls as a strategy to

avert currency crises and prevent bank runs. This approach provided governments with increased authority in implementing proactive monetary policies.

These capital restrictions were gradually lifted in the 1970s, following the collapse of the Bretton Woods system. Although capital markets eventually rebounded, their recovery was slow. By the late 1960s, global capital flows could no longer be effectively constrained, and the mechanisms supporting the fixed exchange rate system began to erode.

4.3 Sample period 1974–2016

In the third period, spanning from 1974 to 2016, floating exchange rates emerged after the Bretton Woods era, revealing a distinct trend. Although fixed exchange rate systems were eventually abandoned, the period between the 1970s and the 1990s was characterized by a notable increase in capital mobility. Governments of industrialized countries no longer required capital controls to maintain fixed exchange rates, as the fixed peg had been abandoned. The flexibility of floating exchange rates allowed them to adapt to market dynamics, enabling the gradual lifting of capital controls and encouraging the flow of capital across borders. In peripheral nations, economic reforms were implemented to reduce transaction costs and risks associated with foreign investments, resulting in increased capital inflows. However, this trend was disrupted by the financial crises of the late 1990s, including the Asian and Russian financial crises. These crises highlighted the vulnerabilities inherent in fixed exchange rate systems, especially in developing regions. During the 1990s, the term "globalization" gained prominence to describe the phenomenon of a world economy becoming increasingly integrated and interdependent. This era was characterized by the seemingly free movement of goods, services, and capital, although labor mobility faced significant limitations.

5 Empirical analysis

5.1 Baseline results

Table 3 presents the summary statistics, including the mean, standard deviation, and the minimum and maximum values for the dependent variables, as well as the control variables used in the analysis. As anticipated, equity returns are higher than bond returns, albeit with a higher standard deviation. We also examined Sharpe Ratios; however, due to the low data frequency, the conditional variance/standard deviation of annual equity returns remains relatively constant. Therefore, we have opted to use raw returns, as described in Table 2. Inflation during the period from 1871 to 1913 is significantly lower than in the other two periods, which is expected given the dominance of gold standard arrangements. Additionally, the Debt-to-GDP ratio is lower during the Bretton Woods period, reflecting the high growth rates experienced by the global economy during that time.

Our findings, summarized in Tables 4, 5, 6, 7, reveal that during the First Era of Globalization, cross-country dependence was estimated at approximately 30% for real

Table 3 Descriptive statistics

Estimation period: 1871–1913							
	Real long-term interest rate	Long-term nominal interest rate	Bond total return	Equity total return	Inflation	Debt/GDP	Equity dividend yield
Mean	4.113	4.543	0.04	0.061	0.361	0.489	− 3.119
St. Dev	5.139	2.528	0.05	0.081	4.609	0.316	0.22
Maximum	37.781	23.715	0.314	0.435	28.748	1.525	− 2.569
Minimum	− 22.344	1.96	− 0.206	− 0.288	− 31.342	0.03	− 4.207
Number of obs	645	602	363	363	645	645	363
Estimation period: 1950–1973							
	Real long-term interest rate	Long-term nominal interest rate	Bond total return	Equity total return	Inflation	Debt/GDP	Equity dividend yield
Mean	1.818	5.907	0.042	0.119	4.088	0.389	− 3.336
St. Dev	3.734	2.307	0.065	0.213	3.405	0.313	0.413
Maximum	19.109	20.9	0.509	1.177	18.098	2.169	− 2.598
Minimum	− 14.568	2.39	− 0.125	− 0.28	− 7.113	0.044	− 6.63
Number of obs	384	384	384	264	384	384	264
Estimation period: 1974–2016							
	Real long-term interest rate	Long-term nominal interest rate	Bond total return	Equity total return	Inflation	Debt/GDP	Equity dividend yield
Mean	2.782	7.272	0.09	0.137	4.49	0.596	− 3.507
St. Dev	3.351	4.129	0.107	0.275	4.614	0.362	0.511
Maximum	10.744	21.503	0.811	1.496	32.122	2.39	− 2.146

Table 3 (continued)

Estimation period: 1871–1913

	Real long-term interest rate	Long-term nominal interest rate	Bond total return	Equity total return	Inflation	Debt/GDP	Equity dividend yield
Minimum	− 24.623	− 0.066	− 0.313	− 0.561	− 1.36	0.043	− 7.579
Number of obs	688	688	672	462	688	688	462

This table presents descriptive statistics for the variables used in the analysis. Dependent variables are the real long-term interest rate, which is equal to long-term nominal interest rate minus inflation, the long-term nominal interest rate, the government bond total return, and the equity total return. As control variables, we use inflation, debt-to-GDP ratio, and equity dividend yield

Table 4 Real long-term interest rate

	Estimation period 1871–1913	Estimation period 1950–1973	Estimation period 1974–2016
	Dynamic CCE	Dynamic CCE	Dynamic CCE
Dependent variable			
Real long-term interest rate			
Control variables			
Real long-term interest rate lag(1)	1.514***	0.926	0.465***
	(0.005)	(0.432)	(0.000)
Inflation lag(1)	1.663***	0.821	0.245**
	(0.001)	(0.468)	(0.012)
Debt/GDP lag(1)	− 0.013	0.051	0.016
	(0.707)	(0.319)	(0.402)
Number of cross-country lags	3	2	3
Number of obs	545	328	619
Cross-country dependence			
(average correlation) applies to u_{it}(CD)	0.291	0.084	0.225
Cross-country dependence (CD-tests):			
CD	21.75***	4.46***	20.03***
	(0.000)	(0.000)	(0.000)
CDw	− 1.34	− 0.23	− 1.01
	(0.181)	(0.817)	(0.31)
CDw+	223.12***	184.64***	347.2***
	(0.000)	(0.000)	(0.000)
CDˆ	− 1.11	− 2.52**	3.88***
	(0.268)	(0.012)	(0.000)

The table displays results examining heterogeneous-coefficient panel models. Estimation methods are the dynamic common correlated effects (DCCE, Chudik and Pesaran 2015). Dependent variable is the real long-term interest rate (long-term nominal interest rate minus inflation). Control variables are the lagged values of real long-term interest rate, inflation and debt-to-GDP ratio. CD, CDw, CDw+ and CDˆ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021; Juodis and Reese, 2021; Fan et al. 2015; Pesaran and Xie 2021, respectively). (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively

long-term interest rates, 24% for equities, 16% for long-term nominal interest rates, and 10% for bonds. With the exception of the bond market, these values are notably substantial and statistically significant, as confirmed by the cross-sectional dependence test proposed by Pesaran (2015).

Table 5 Long-term nominal interest rate

	Estimation period 1871–1913	Estimation period 1950–1973	Estimation period 1974–2016
	Dynamic CCE	Dynamic CCE	Dynamic CCE
Dependent variable			
Long-term nominal interest rate			
Control variables			
Long-term nominal interest rate lag(1)	0.661***	0.488***	0.361***
	(0.000)	(0.000)	(0.000)
Inflation lag(1)	0.005*	0.012	0.151**
	(0.097)	(0.853)	(0.024)
Debt/GDP lag(1)	0.362	3.201	− 1.199
	(0.745)	(0.247)	(0.403)
Number of cross-country lags	3	2	3
Number of obs	505	328	615
Cross-country dependence			
(average correlation) applies to u_{it}(CD)	0.161	0.127	0.544
Cross-country dependence (CD-tests):			
CD	8.61***	7.33***	40.34***
	(0.000)	(0.000)	(0.000)
CDw	− 0.57	0.92	3.87***
	(0.566)	(0.358)	(0.000)
CDw+	160.09***	232.81***	458.42***
	(0.000)	(0.000)	(0.000)
CD^	8.81***	10.35***	11.88***
	(0.000)	(0.000)	(0.000)

The table displays results examining heterogeneous-coefficient panel models. Estimation method is the dynamic common correlated effects DCCE, Chudik and Pesaran 2015). Dependent variable is the long-term nominal interest rate. Control variables are the lagged values of long-term nominal interest rate, inflation and debt-to-GDP ratio. CD, CDw, CDw+ and CD^ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021; Juodis and Reese, 2021; Fan et al. 2015; Pesaran and Xie 2021, respectively). (∗∗∗), (∗∗), and (∗) indicate 1%, 5% and 10% significance levels, respectively

Under the Bretton Woods arrangements, capital controls were a central feature of the system, enabling countries to maintain fixed exchange rates while preserving the autonomy to conduct independent monetary policies. This is reflected in our results, which show a significant decline in cross-country dependence, particularly for real long-term interest rates and equities. In contrast, the decline in dependence for long-term nominal interest rates was relatively small, while the figures for bonds across

Table 6 Bond total return

	Estimation period 1881–1913	Estimation period 1950–1973	Estimation period 1974–2015
	Dynamic CCE	Dynamic CCE	Dynamic CCE
Dependent variable			
Bond			
Control variables			
Bond lag(1)	0.168	− 0.347	− 0.244**
	(0.103)	(0.138)	(0.014)
Inflation lag(1)	0.001	− 0.002	0.012**
	(0.687)	(0.766)	(0.023)
Debt/GDP lag(1)	0.001	− 0.003	0.001
	(0.322)	(0.176)	(0.604)
Number of cross-country lags	3	2	3
Number of obs	319	328	603
Cross-country dependence			
(average correlation) applies to u_{it}(CD)	0.100	0.103	0.350
Cross-country dependence (CD-tests):			
CD	4.25***	6.18***	28.36***
	(0.000)	(0.000)	(0.000)
CDw	− 0.67	0.87	− 2.66***
	(0.503)	(0.382)	(0.008)
CDw+	65.17***	142.53***	322.47***
	(0.000)	(0.000)	(0.000)
CD^	2.95***	1.49	2.17**
	(0.003)	(0.137)	(0.030)

The table displays results examining heterogeneous-coefficient panel models. Estimation method is the dynamic common correlated effects (DCCE, Chudik and Pesaran 2015). Dependent variable is the government bond total return. Control variables are the lagged values of bond return, inflation and debt-to-GDP ratio. CD, CDw, CDw+ and CD^ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021; Juodis and Reese, 2021; Fan et al. 2015; Pesaran and Xie 2021, respectively). (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively

the two periods remained essentially similar. This outcome can primarily be attributed to the fact that, after World War I, international financial markets remained largely disintegrated, with the recovery of confidence in the benefits of financial and, more generally, economic integration taking time to materialize. Furthermore, the new international monetary system established after World War II was predicated on limited cross-border capital mobility and active economic policies.

Following the collapse of the Bretton Woods System and the onset of the floating rate era, international financial markets experienced substantial growth, characterized

Table 7 Equity total return

	Estimation period 1881–1913	Estimation period 1950–1973	Estimation period 1974–2015
	Dynamic CCE	Dynamic CCE	Dynamic CCE
Dependent variable			
Equity			
Control variables			
Equity lag(1)	0.048	0.205	0.056
	(0.678)	(0.209)	(0.666)
Inflation lag(1)	0.002	− 0.003	0.040**
	(0.514)	(0.751)	(0.026)
Equity dividend lag(1)	0.004	0.540***	0.179*
	(0.937)	(0.005)	(0.1)
Number of cross-country lags	3	2	3
Number of obs	319	231	395
Cross-country dependence			
(average correlation) applies to u_{it}(CD)	0.241	0.104	0.326
Cross-country dependence (CD-tests):			
CD	10.28***	3.77***	10.28***
	(0.000)	(0.000)	(0.000)
CDw	0.66	− 1.85	0.43
	(0.508)	(0.064)	(0.669)
CDw+	83.69***	48.89***	100.25***
	(0.000)	(0.000)	(0.000)
CD^	− 0.17	1.42	− 2.14**
	(0.869)	(0.155)	(0.033)

The table displays results examining heterogeneous-coefficient panel models. Estimation method is the dynamic common correlated effects (DCCE, Chudik and Pesaran 2015). Dependent variable is the equity total return. Control variables are the lagged values of equity total return, inflation, and the log of the equity dividend yield. CD, CDw, CDw+ and CD^ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021, Juodis and Reese, 2021, Fan et al. 2015; Pesaran and Xie 2021, respectively). (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively

by reduced financial regulation and, later, the widespread elimination of restrictions on international capital mobility. Notably, these policy choices are mirrored in our measure of cross-country dependence, which shows a marked increase during this period, surpassing even the levels recorded during the First Era of Globalization. For instance, average cross-country dependence rises to approximately 54% for long-term nominal interest rates, 35% for bonds, 32% for equities, and 22% for real long-term interest rates. Collectively, these results point to a significant rise in financial integration across global markets.

Regarding the control variables, we observe that during periods of flexible exchange rates, inflation plays a significant role in shaping financial variables. Specifically, inflation has a strong positive effect on both real and nominal long-term interest rates.

However, the relationship between inflation and nominal interest rates is more nuanced and can vary across countries. While the Fisher hypothesis suggests a one-to-one relationship between inflation and nominal interest rates, empirical evidence indicates that this relationship is neither consistent nor uniform across contexts (see, for example, Clemente, Gadea, Montañés, and Reyes, 2017, among others).

In contrast, the impact of inflation on equities and bonds is less pronounced, although it remains statistically significant. This finding is consistent with Viceira (2012), who emphasizes the continued importance of inflation as a determinant for both asset classes.

Another noteworthy result from the tables above is the role of the dividend yield ratio in explaining equity behaviour. As expected, it shows a positive relationship with equity returns, consistent with the existing financial literature (Campbell et al. 1997; Hodrick 1992; Nelson and Kim 1993, among others).

Additionally, in line with the findings of Fama and Schwert (1977), we observe a negative relationship between inflation and equity returns during the Bretton Woods period; however, this result is not statistically significant.

Finally, with regard to persistence, the first lag appears to be significant, particularly for long-term nominal interest rates. This result is consistent with key contributions in the literature, such as Campbell and Yogo (2006).

Focusing on the cross-country measure of dependence, we relate our main findings within the broader context of the long-term evolution of financial market integration. Specifically, our results resonate with the U-shaped pattern proposed by Obstfeld and Taylor (2003, 2004), the J-shaped trajectory identified by Volosovych (2011), and the "swoosh"-shaped dynamic described by Bekaert and Mehl (2019). Figure 1 provides an illustrative overview of our analysis, presenting cross-country dependence estimates across the key historical periods under examination.

The results for real long-term interest rates provide clear evidence of a U-shaped pattern, lending strong support to the hypothesis advanced by Obstfeld and Taylor (2003). In contrast, the trajectory of equity market integration follows more of a "swoosh"-shaped pattern, aligning with the findings of Bekaert and Mehl (2019).

Furthermore, we find that in the aftermath of the Bretton Woods collapse, integration in long-term nominal interest rates and bond markets increased markedly, with average cross-country dependence surpassing levels observed in the pre-1914 period. This leads us to identify a J-shaped pattern of financial integration over time for these two asset classes, a result that closely echoes the conclusions of Volosovych (2011), who also focuses on sovereign bond markets.

Notably, Bekaert and Mehl (2019), in their study of equity markets, reject the presence of alternative patterns proposed in earlier literature such as the U-shaped and J-shaped trajectories identified by Obstfeld and Taylor (2003) and Volosovych (2011), respectively, and instead argue for a steadily increasing level of financial integration in recent decades, captured by the "swoosh" pattern.

In contrast, our findings point to the coexistence of all three patterns across different asset classes. Specifically, we find that during the First Era of Globalization, equity

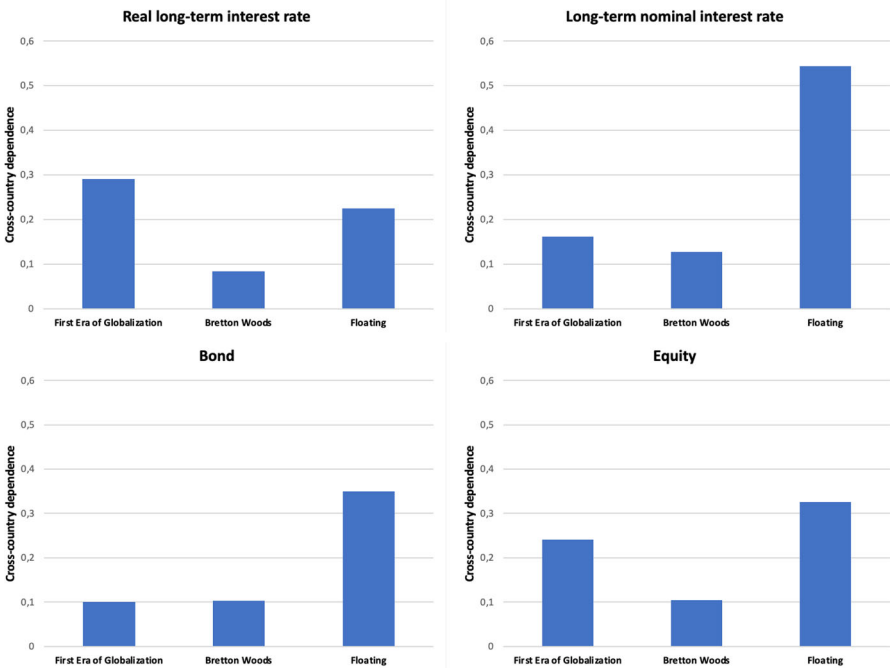

Fig. 1 The figure displays the results of cross-country dependence for the *heterogeneous* coefficient DCCE model in three different sub-periods: The First Era of Globalisation (1871–1913), the Bretton Woods Monetary System (1950–1973), and Floating Exchange Rates (1974–2016)

markets were more globally integrated than bond markets—a result that stands in opposition to the conclusions of Bordo (2003).

5.2 Robustness checks

In this section, we carry out a number of robustness checks to evaluate our baseline results.

5.2.1 Homogeneous coefficient DCCE model

We developed a version of our model that uses homogeneous parameters and summarizes the cross-country dependence estimates shown in Fig. 2. Our analysis demonstrates that restricted models with identical coefficients across countries (homogeneous coefficients) result in greater cross-country dependence than models with heterogeneous coefficients. This finding holds across all four variables we examined, but it is particularly pronounced during the second and third time periods.

However, we should emphasize that the heterogeneous parameter model demonstrates robustness, providing consistent estimates under both the null hypothesis (parameter homogeneity) and the alternative hypothesis (parameter heterogeneity).

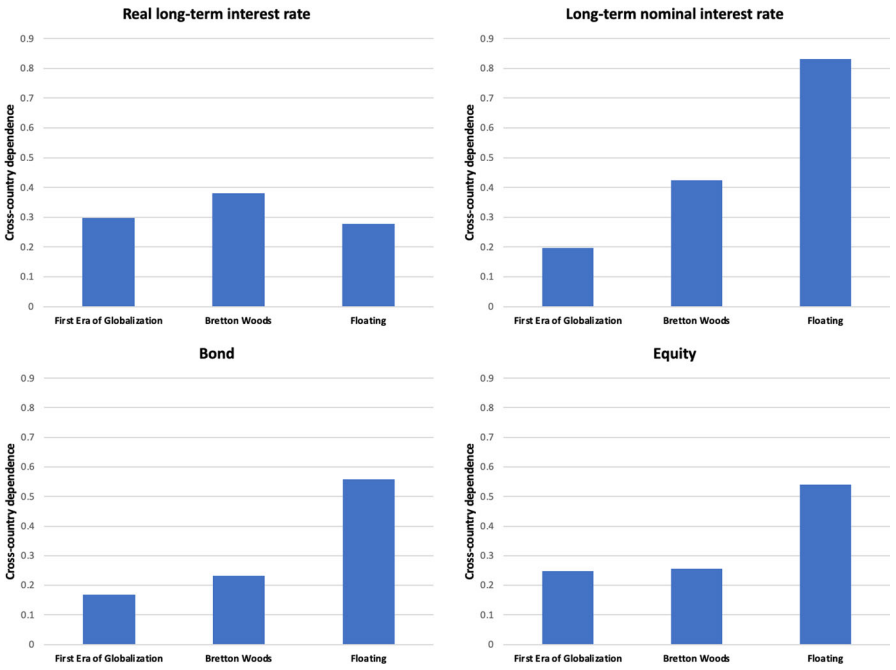

Fig. 2 The figure displays the results of cross-country dependence for the *homogeneous* coefficient DCCE model in three different sub-periods: The First Era of Globalisation (1871–1913), the Bretton Woods Monetary System (1950–1973), and Floating Exchange Rates (1974–2016)

In contrast, the homogeneous parameter model remains consistent solely under the null hypothesis while being more efficient than its heterogeneous counterpart. However, under the alternative hypothesis of parameter heterogeneity, the homogeneous model becomes inconsistent.

Overall, our research indicates the importance of considering parameter heterogeneity. Ignoring this factor might lead to overestimation and biased results when relying on a restricted homogeneous parameter model.

5.2.2 Rank condition of heterogeneous coefficient DCCE model

We also present test results to confirm that the rank condition is satisfied for the heterogeneous coefficient DCCE estimator in our samples. The rank condition is met when the number of estimated factors, m, is less than or equal to the rank of the matrix formed by the cross-sectional averages of the data, ϱ (for details, see De Vos et al. 2024). The results are reported in Table 8 and indicate that the rank condition is satisfied for all sub-samples except for one: bonds issued during the period from 1871 to 1913.

Table 8 Rank Condition of heterogeneous coefficient DCCE estmator

	Estimation period 1871–1913	Estimation period 1950–1973	Estimation period 1974–2016
Real long-term interest rate			
RC	1	1	1
ϱ	3	2	3
m	1	1	2
Long-term nominal interest rate			
RC	1	1	1
ϱ	3	3	3
m	1	2	2
Bond total return			
RC	0	1	1
ϱ	1	2	3
m	2	2	2
Equity total return			
RC	1	1	1
ϱ	1	3	2
m	1	1	1

RC = 1 is a binary classifier indicating whether the rank condition holds. ϱ is the rank of the unobserved matrix of average factor loadings (estimated by the matrix of cross-sectional averages of the data), m is number of (estimated) factors in the data

5.2.3 Mean-group instrumental variable model

In this subsection, we implement the Mean-Group Instrumental Variable (MGIV) estimator proposed by Norkute et al. (2021) and Cui et al. (2022). The advantage of this estimator is that it does not require the rank condition, as the factors are estimated using Principal Component Analysis (PCA) rather than cross-sectional averages. The resulting average cross-country dependence figures are illustrated in Fig. 3. Although the trend over time is similar across the two models (DCCE and MGIV), cross-country dependence is generally higher in the MGIV model. This increased cross-country dependence in the MGIV model, compared to the DCCE model, can be attributed to its more flexible modeling of common factors and advanced estimation techniques. In contrast, there is a noticeable difference in the real long-term interest rate: in the MGIV model, cross-country dependence during the second period is as high as in the third period when compared to the DCCE model. Similarly, for equities, we now observe a J-shaped pattern in the MGIV model, rather than a 'swoosh' pattern.

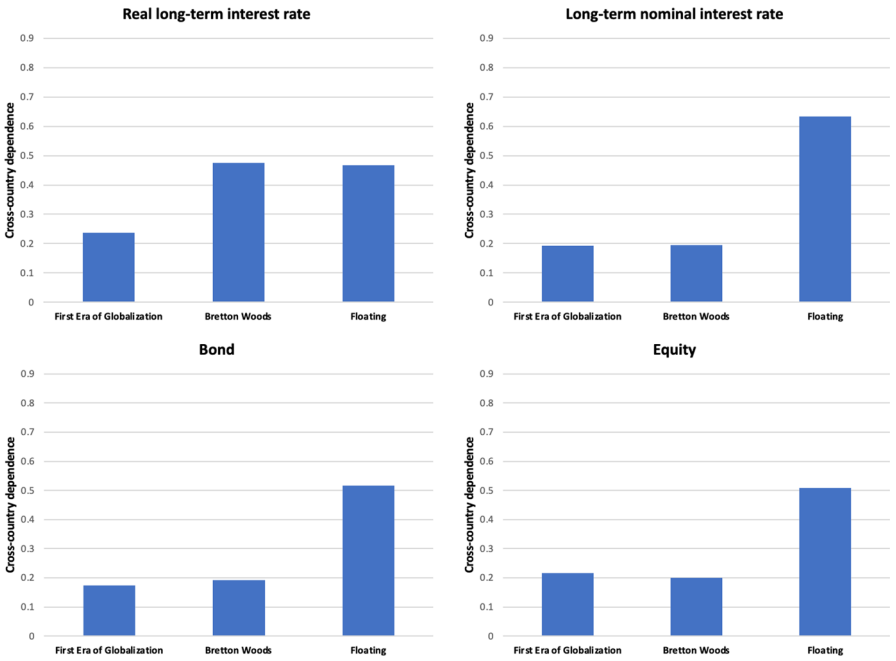

Fig. 3 The figure displays the results of cross-country dependence for the *Mean-Group Instrumental Variable* model in three different sub-periods: The First Era of Globalisation (1871–1913), the Bretton Woods Monetary System (1950–1973), and Floating Exchange Rates (1974–2016)

5.2.4 Heterogeneous coefficient DCCE model (excluding Spain)

During the First Era of Globalization (1871–1914), most major economies adopted the Gold Standard; however, there were notable exceptions. Spain is a significant example of a country that did not adopt the Gold Standard during this period. The Spanish peseta remained on a flexible exchange rate regime throughout the era. Furthermore, during the Bretton Woods era (1944–1971), Spain was under the dictatorship of Franco, which distinguished it from many other Western countries at the time. To account for this potential issue, we re-ran our models excluding Spain. The results, presented in Tables 9, 10, 11, 12, are generally robust and lend credibility to our main findings.[1] Overall, we conclude that despite not adopting the gold standard, Spain still experienced convergence in interest rates, bonds, and equities with other countries during this period of financial globalization. Similarly, although the Bretton Woods system was widespread, it was not the sole driver of financial globalization during this time.

Sabaté et al. (2019) highlight differing monetary patterns between the peripheral Southern countries and their Northern counterparts during the period 1870–1938. Following their argument, we conduct a robustness check by excluding the Southern

[1] For equities, there is no data available for Spain; therefore, our main results remain unchanged.

Table 9 Real long-term interest rate

	Estimation period 1871–1913	Estimation period 1950–1973	Estimation period 1974–2016
	Dynamic CCE	Dynamic CCE	Dynamic CCE
Dependent variable			
Real long-term interest rate			
Control variables			
Real long-term interest rate lag(1)	1.396***	2.524	0.437***
	(0.003)	(0.390)	(0.000)
Inflation lag(1)	1.515***	2.811	0.208**
	(0.001)	(0.392)	(0.031)
Debt/GDP lag(1)	− 0.008	0.111	0.021
	(0.820)	(0.342)	(0.281)
Number of cross-country lags	3	2	3
Number of obs	515	307	580
Cross-country dependence			
(average correlation) applies to u_{it}(CD)	0.294	0.051	0.265
Cross-country dependence (CD-tests):			
CD	20.8***	3.34***	21.71***
	(0.000)	(0.001)	(0.000)
CDw	− 0.82	2.98***	0.23
	(0.414)	(0.003)	(0.818)
CDw+	199.69***	215.68***	320.41***
	(0.000)	(0.000)	(0.000)
CD^	− 0.91	1.15	0.72
	(0.362)	(0.249)	(0.474)

The table displays results examining heterogeneous-coefficient panel models. Estimation methods are the dynamic common correlated effects (DCCE, Chudik and Pesaran 2015). Dependent variable is the real long-term interest rate (long-term nominal interest rate minus inflation). Control variables are the lagged values of real long-term interest rate, inflation and debt-to-GDP ratio. CD, CDw, CDw+ and CD^ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021; Juodis and Reese, 2021; Fan et al. 2015; Pesaran and Xie 2021, respectively). (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively

peripheral countries, specifically Italy, Portugal, and Spain. The main results remain qualitatively unchanged, as reported in the Appendix (Tables 18, 19, 20, 21).

Table 10 Long-term nominal interest rate

	Estimation period 1871–1913	Estimation period 1950–1973	Estimation period 1974–2016
	Dynamic CCE	Dynamic CCE	Dynamic CCE
Dependent variable			
Long-term nominal interest rate			
Control variables			
Long-term nominal interest rate lag(1)	0.616***	0.544***	0.404***
	(0.000)	(0.000)	(0.000)
Inflation lag(1)	− 0.001	0.022	0.104
	(0.964)	(0.724)	(0.138)
Debt/GDP lag(1)	0.213	1.014	− 1.079
	(0.736)	(0.613)	(0.486)
Number of cross-country lags	3	2	3
Number of obs	475	307	576
Cross-country dependence			
(average correlation) applies to u_{it}(CD)	0.292	0.113	0.548
Cross-country dependence (CD-tests):			
CD	15.97***	4.82***	36.41***
	(0.000)	(0.000)	(0.000)
CDw	− 1.13	2.99***	− 3.56***
	(0.258)	(0.003)	(0.000)
CDw+	195.7***	215.1***	385.5****
	(0.000)	(0.000)	(0.000)
CD^	− 0.96	12.34***	6.48***
	(0.339)	(0.000)	(0.000)

The table displays results examining heterogeneous-coefficient panel models. Estimation method is the dynamic common correlated effects (DCCE, Chudik and Pesaran 2015). Dependent variable is the long-term nominal interest rate. Control variables are the lagged values of long-term nominal interest rate, inflation and debt-to-GDP ratio. CD, CDw, CDw+ and CD^ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021; Juodis and Reese, 2021; Fan et al. 2015; Pesaran and Xie 2021, respectively). (∗∗∗), (∗∗), and (∗) indicate 1%, 5% and 10% significance levels, respectively

Table 11 Bond total return

	Estimation period 1881–1913	Estimation period 1950–1973	Estimation period 1974–2015
	Dynamic CCE	Dynamic CCE	Dynamic CCE
Dependent variable			
Bond			
Control variables			
Bond lag(1)	0.168	− 0.297	− 0.228**
	(0.103)	(0.219)	(0.025)
Inflation lag(1)	0.001	− 0.025	0.012**
	(0.687)	(0.411)	(0.025)
Debt/GDP lag(1)	0.001	− 0.007	0.001
	(0.322)	(0.231)	(0.301)
Number of cross-country lags	3	2	3
Number of obs	319	307	565
Cross-country dependence			
(average correlation) applies to u_{it}(CD)	0.100	0.080	0.360
Cross-country dependence (CD-tests):			
CD	4.25***	4.08***	27.39***
	(0.000)	(0.000)	(0.000)
CDw	1.2	1.03	− 2.13**
	(0.231)	(0.304)	(0.033)
CDw+	67.04***	116.26***	290.06***
	(0.000)	(0.000)	(0.000)
CD^	2.95***	3.45***	5.11***
	(0.003)	(0.001)	(0.000)

The table displays results examining heterogeneous-coefficient panel models. Estimation method is the dynamic common correlated effects (DCCE, Chudik and Pesaran 2015). Dependent variable is the government bond total return. Control variables are the lagged values of bond return, inflation and debt-to-GDP ratio. CD, CDw, CDw+ and CD^ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021; Juodis and Reese, 2021; Fan et al. 2015; Pesaran and Xie 2021, respectively). (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively

Table 12 Equity total return

	Estimation period 1881–1913	Estimation period 1950–1973	Estimation period 1974–2015
	Dynamic CCE	Dynamic CCE	Dynamic CCE
Dependent variable			
Equity			
Control variables			
Equity lag(1)	0.048	0.205	0.056
	(0.678)	(0.209)	(0.666)
Inflation lag(1)	0.002	− 0.003	0.040**
	(0.514)	(0.751)	(0.026)
Equity dividend lag(1)	0.004	0.540***	0.179*
	(0.937)	(0.005)	(0.1)
Number of cross-country lags	3	2	3
Number of obs	319	231	395
Cross-country dependence			
(average correlation) applies to u_{it}(CD)	0.241	0.104	0.326
Cross-country dependence (CD-tests):			
CD	10.28***	3.77***	10.28***
	(0.000)	(0.000)	(0.000)
CDw	0.66	− 1.85*	0.43
	(0.508)	(0.064)	(0.669)
CDw+	83.69***	48.89***	100.25***
	(0.000)	(0.000)	(0.000)
CD^	− 0.17	1.42	− 2.14**
	(0.869)	(0.155)	(0.033)

The table displays results examining heterogeneous-coefficient panel models. Estimation method is the dynamic common correlated effects (DCCE, Chudik and Pesaran 2015). Dependent variable is the equity total return. Control variables are the lagged values of equity total return, inflation, and the log of the equity dividend yield. CD, CDw, CDw+ and CD^ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021; Juodis and Reese, 2021; Fan et al. 2015; Pesaran and Xie 2021, respectively). (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively

5.2.5 Heterogeneous coefficient DCCE model (excluding the great recession)

In the most recent period studied, many countries, particularly in Europe, experienced the effects of the Great Recession. To address this, we focused our analysis on a specific timeframe from 1974 to 2006. The results of this analysis are presented in Table 13. As observed, our baseline results are primarily influenced by both real and nominal long-term interest rates. Notably, these rates exhibit lower cross-country dependence.

Table 13 Estimation period 1974–2006

	Dynamic CCE
Dependent variable Real long-term interest rate	
Control variables	
Real long-term interest rate lag(1)	0.261*
	(0.097)
Inflation lag(1)	0.101
	(0.565)
Debt/GDP lag(1)	− 0.001
	(0.951)
Number of cross-country lags	3
Number of obs	459
Cross-country dependence	
(average correlation) applies to u_{it}(CD)	0.156
Cross-country dependence (CD-tests):	
CD	14.51***
	(0.000)
CDw	1.15
	(0.249)
CDw+	313.72***
	(0.000)
CD^	− 0.55
	(0.582)
Dependent variable	
Long-term nominal interest rate	
Control variables	
Long-term nominal interest rate lag(1)	0.409***
	(0.000)
Inflation lag(1)	0.206*
	(0.055)
Debt/GDP lag(1)	− 2.249
	(0.199)
Number of cross-country lags	3
Number of obs	455
Cross-country dependence	
(average correlation) applies to u_{it}(CD)	0.301
Cross-country dependence (CD-tests):	

Table 13 (continued)

	Dynamic CCE
CD	20.58***
	(0.000)
CDw	− 1.2
	(0.229)
CDw+	335.45***
	(0.000)
CD^	4.18***
	(0.000)
Dependent variable	
Bond total return	
Control variables	
Bond lag(1)	− 0.255
	(0.120)
Inflation lag(1)	0.009*
	(0.069)
Debt/GDP lag(1)	− 0.001
	(0.829)
Number of cross-country lags	3
Number of obs	459
Cross-country dependence	
(average correlation) applies to u_{it}(CD)	0.287
Cross-country dependence (CD-tests):	
CD	21.59***
	(0.000)
CDw	− 3.14***
	(0.002)
CDw+	263.05***
	(0.000)
CD^	1.46
	(0.145)
Dependent variable	
Equity total return	
Control variables	
Equity lag(1)	− 0.028
	(0.724)
Inflation lag(1)	0.029*
	(0.081)

Table 13 (continued)

	Dynamic CCE
Equity dividend lag(1)	0.268**
	(0.014)
Number of cross-country lags	3
Number of obs	290
Cross-country dependence	
(average) applies to the u_{it}(CD)	0.279
Cross-country dependence (CD-tests):	
CD	11.91***
	(0.000)
CDw	− 1.17
	(0.243)
CDw+	141.50***
	(0.000)
CD^	0.68
	(0.494)

The table displays results examining heterogeneous-coefficient panel models. Estimation method is the dynamic common correlated effects (DCCE, Chudik and Pesaran 2015). CD, CDw, CDw+ and CD^ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021; Juodis and Reese, 2021; Fan et al. 2015; Pesaran and Xie 2021, respectively). (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively

This finding is not surprising, especially in light of the significant decline in interest rates worldwide after 2007.

6 Summing up

In this paper, we reconsider the issue of international financial market integration from the late nineteenth century to the present era. To this end, we adopt a flexible econometric framework to explicitly measure cross-country dependence in several financial variables and to determine the degree of financial integration among major economies. Our main hypothesis is to test whether there was an increase in financial integration in global markets after the Bretton Woods era compared to the earlier periods of the heyday of financial integration (1871–1913) and the Bretton Woods system.

Our overall assessment of financial market integration over time is, at best, mixed. In some cases, the financial integration of the pre-1913 era remains unsurpassed; however, in other instances, today's financial markets are more closely integrated than those of the past. Specifically, our analysis reveals a significant increase in financial integration after Bretton Woods, as evidenced by long-term nominal interest rates and bonds, similar to the findings documented in Volosovych (2011). At the same time, by

examining real long-term interest rates, our study corroborates the earlier literature's proposition of a U-shaped trend in international financial markets (Obstfeld and Taylor 2003, 2004 and Goetzmann et al. 2001). We confirm and expand upon the findings of Bekaert and Mehl (2019) by demonstrating that financial integration in equities has increased in recent years.

In our future research, we aim to obtain higher-frequency data to investigate financial crises, such as banking, exchange rate, or debt crises, and their international transmission mechanisms across countries. In particular, it would be interesting to model the probability of a country (or a group of countries) experiencing a joint financial crisis and to identify the major determinants of such crises.

Appendix

Monte Carlo simulation

In this section in the Appendix, we study the finite-sample properties of the Dynamic Common Correlated Effects Model (DCCE, Chudik and Pesaran 2015) by Monte Carlo simulations. Specifically, the parameter values for the data generating processes (DGPs) are as in Ditzen (2018) but using smaller samples of size $N = \{10, 15, 20\}$ and $T = \{20, 25, 30, 35, 40\}$. We test the performance of the proposed methodology to those sample sizes, which are used in our empirical analysis. The number of simulations is set to $M = 500$, but the results are found to be stable to $M > 500$ (Table 14).

As expected, and in line with the results reported in Ditzen (2018), both the Bias and the RMSE values decrease as the number of time-series observations increases. Conversely, the number of cross-sectional units does not greatly affect the results. Overall, we conclude that the DCCE model's performance remains adequate even with small samples.

Table 14 Monte Carlo simulations

(N, T)	Bias (×100)					RMSE (×100)				
	20	25	30	35	40	20	25	30	35	40
$\phi = 1/N \sum_{i=1}^{N} \phi_i$										
10	− 66.27	− 44.11	− 43.28	− 33.32	− 26.26	26.67	11.84	11.21	6.91	4.24
15	− 69.01	− 49.22	− 45.86	− 36.84	− 28.71	27.31	13.74	12.10	7.76	4.93
20	− 68.09	− 48.48	− 47.13	− 36.79	− 28.07	26.41	13.05	12.37	7.56	4.51
$\beta_0 = 1/N \sum_{i=1}^{N} \beta_{0i}$										
10	0.00	2.63	0.22	0.40	1.96	16.27	6.48	5.03	3.70	2.24
15	− 2.00	2.12	1.13	2.62	0.39	15.01	5.97	5.09	3.55	2.44
20	− 0.84	− 0.15	2.25	1.39	− 0.12	14.61	5.26	4.59	2.66	1.84
$\beta_1 = 1/N \sum_{i=1}^{N} \beta_{1i}$										
10	− 72.26	− 45.84	− 44.09	− 35.81	− 24.25	33.77	12.06	10.87	7.42	4.20
15	− 66.79	− 44.96	− 42.12	− 33.51	− 28.26	27.81	11.65	10.15	6.62	4.98
20	− 61.02	− 46.74	− 41.73	− 32.46	− 26.16	25.27	11.62	9.68	6.04	4.36

Small-sample properties DCCE model

Bias and Root Mean Squared Error (RMSE). The sample sizes are $N = \{10, 15, 20\}$ and $T = \{20, 25, 30, 35, 40\}$. The number of Monte Carlo simulations is 500. For more details on the data-generating process, see Ditzen (2018)

Dynamic common correlated effects estimation without debt-to-GDP ratio

Tables 15, 16, 17.

Table 15 Real long-term interest rate

	Estimation period 1871–1913	Estimation period 1950–1973	Estimation period 1974–2016
	Dynamic CCE	Dynamic CCE	Dynamic CCE
Dependent variable			
Real long-term interest rate			
Control variables			
Real long-term interest rate lag(1)	1.242***	0.226	0.466***
	(0.020)	(0.439)	(0.000)
Inflation lag(1)	1.376***	0.061	0.152*
	(0.009)	(0.837)	(0.072)
Number of cross-country lags	3	2	3
Number of obs	585	336	624
Cross-country dependence			
(average correlation) applies to u_{it}(CD)	0.278	0.152	0.239
Cross-country dependence (CD-tests):			
CD	18.65***	8.18***	17.14***
	(0.000)	(0.000)	(0.000)
CDw	− 3.19***	0.57	− 3.13***
	(0.001)	(0.568)	(0.002)
CDw+	224.23***	151.02***	352.64***
	(0.000)	(0.000)	(0.000)
CDˆ	0.45	− 1.59	− 2.77***
	(0.653)	(0.111)	(0.006)

The table displays results examining heterogeneous-coefficient panel models. Estimation methods are the dynamic common correlated effects (DCCE, Chudik and Pesaran 2015). Dependent variable is the real long-term interest rate (long-term nominal interest rate minus inflation). Control variables are the lagged values of real long-term interest rate, inflation and debt-to-GDP ratio. CD, CDw, CDw+ and CDˆ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021; Juodis and Reese, 2021; Fan et al. 2015; Pesaran and Xie 2021, respectively). (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively

Table 16 Long-term nominal interest rate

	Estimation period 1871–1913	Estimation period 1950–1973	Estimation period 1974–2016
	Dynamic CCE	Dynamic CCE	Dynamic CCE
Dependent variable			
Long-term nominal interest rate			
Control variables			
Long-term nominal interest rate lag(1)	0.928***	0.648***	0.613***
	(0.000)	(0.000)	(0.000)
Inflation lag(1)	0.002	0.047	0.151*
	(0.609)	(0.195)	(0.089)
Number of cross-country lags	3	2	3
Number of obs	545	336	624
Cross-country dependence			
(average correlation) applies to u_{it}(CD)	0.179	0.353	0.623
Cross-country dependence (CD-tests):			
CD	11.14***	18.93***	44.78***
	(0.000)	(0.000)	(0.000)
CDw	− 1.68	− 2.12**	− 3.14***
	(0.092)	(0.034)	(0.000)
CDw+	131.45***	226.16***	487.51***
	(0.000)	(0.000)	(0.000)
CD^	− 0.21	18.76***	10.02***
	(0.832)	(0.000)	(0.000)

The table displays results examining heterogeneous-coefficient panel models. Estimation method is the dynamic common correlated effects DCCE, Chudik and Pesaran 2015). Dependent variable is the long-term nominal interest rate. Control variables are the lagged values of long-term nominal interest rate, inflation and debt-to-GDP ratio. CD, CDw, CDw+ and CD^ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021; Juodis and Reese, 2021; Fan et al. 2015; Pesaran and Xie 2021, respectively). (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively

Table 17 Bond total return

	Estimation period 1881–1913	Estimation period 1950–1973	Estimation period 1974–2015
	Dynamic CCE	Dynamic CCE	Dynamic CCE
Dependent variable			
Bond			
Control variables			
Bond lag(1)	0.083	− 0.173	− 0.128
	(0.245)	(0.039)	(0.163)
Inflation lag(1)	− 0.001	0.005***	0.01**
	(0.128)	(0.007)	(0.033)
Number of cross-country lags	3	2	3
Number of obs	319	336	608
Cross-country dependence			
(average correlation) applies to u_{it}(CD)	0.166	0.156	0.350
Cross-country dependence (CD-tests):			
CD	7.07***	8.37***	27.69***
	(0.000)	(0.000)	(0.000)
CDw	− 1.47	− 0.35	− 1.53
	(0.141)	(0.724)	(0.127)
CDw+	74.90***	119.17***	314.23***
	(0.000)	(0.000)	(0.000)
CD^	2.54**	3.91***	10.20***
	(0.011)	(0.000)	(0.000)

The table displays results examining heterogeneous-coefficient panel models. Estimation method is the dynamic common correlated effects (DCCE, Chudik and Pesaran 2015). Dependent variable is the government bond total return. Control variables are the lagged values of bond return, inflation and debt-to-GDP ratio. CD, CDw, CDw+ and CD^ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021; Juodis and Reese, 2021; Fan et al. 2015; Pesaran and Xie 2021, respectively). (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively

Heterogeneous coefficient DCCE model (excluding Spain, Italy and Portugal)

Tables 18, 19, 20, 21.

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Table 18 Real long-term interest rate

	Estimation period 1871–1913	Estimation period 1950–1973	Estimation period 1974–2016
	Dynamic CCE	Dynamic CCE	Dynamic CCE
Dependent variable			
Real long-term interest rate			
Control variables			
Real long-term interest rate lag(1)	1.877	− 1.143	0.248**
	(0.190)	(0.292)	(0.045)
Inflation lag(1)	1.997	− 2.667	0.019
	(0.154)	(0.269)	(0.861)
Debt/GDP lag(1)	0.005	0.082	0.007
	(0.873)	(0.375)	(0.497)
Number of cross-country lags	3	2	3
Number of obs	437	265	502
Cross-country dependence			
(average correlation) applies to u_{it}(CD)	0.274	0.018	0.368
Cross-country dependence (CD-tests):			
CD	16.73***	1.11	24.66***
	(0.000)	(0.268)	(0.000)
CDw	0.63	− 1.73	5.52***
	(0.527)	(0.084)	(0.000)
CDw+	139.06***	162.72***	282.16***
	(0.000)	(0.000)	(0.000)
CDˆ	0.71	2.51**	5.06***
	(0.477)	(0.012)	(0.000)

The table displays results examining heterogeneous-coefficient panel models. Estimation methods are the dynamic common correlated effects (DCCE, Chudik and Pesaran 2015). Dependent variable is the real long-term interest rate (long-term nominal interest rate minus inflation). Control variables are the lagged values of real long-term interest rate, inflation and debt-to-GDP ratio. CD, CDw, CDw+ and CDˆ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021; Juodis and Reese, 2021; Fan et al. 2015; Pesaran and Xie 2021, respectively). (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively

Table 19 Long-term nominal interest rate

	Estimation period 1871–1913	Estimation period 1950–1973	Estimation period 1974–2016
	Dynamic CCE	Dynamic CCE	Dynamic CCE
Dependent variable			
Long-term nominal interest rate			
Control variables			
Long-term nominal interest rate lag(1)	0.733***	0.356***	0.521***
	(0.000)	(0.003)	(0.000)
Inflation lag(1)	0.002	− 0.016	0.081
	(0.540)	(0.859)	(0.250)
Debt/GDP lag(1)	− 0.934	31.563	− 1.891
	(0.181)	(0.310)	(0.123)
Number of cross-country lags	3	2	3
Number of obs	397	265	498
Cross-country dependence			
(average correlation) applies to u_{it}(CD)	0.255	0.169	0.495
Cross-country dependence (CD-tests):			
CD	10.24***	8.39***	28.30***
	(0.000)	(0.000)	(0.000)
CDw	1.22	0.17	− 3.39***
	(0.223)	(0.866)	(0.001)
CDw+	115.4***	145.18***	256.71***
	(0.000)	(0.000)	(0.000)
CDˆ	18.05***	3.52***	30.99***
	(0.000)	(0.000)	(0.000)

The table displays results examining heterogeneous-coefficient panel models. Estimation method is the dynamic common correlated effects DCCE, Chudik and Pesaran 2015). Dependent variable is the long-term nominal interest rate. Control variables are the lagged values of long-term nominal interest rate, inflation and debt-to-GDP ratio. CD, CDw, CDw+ and CDˆ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021; Juodis and Reese, 2021; Fan et al. 2015; Pesaran and Xie 2021, respectively). (∗∗∗), (∗∗), and (∗) indicate 1%, 5% and 10% significance levels, respectively

Table 20 Bond total return

	Estimation period 1881–1913	Estimation period 1950–1973	Estimation period 1974–2015
	Dynamic CCE	Dynamic CCE	Dynamic CCE
Dependent variable			
Bond			
Control variables			
Bond lag(1)	0.0.61	− 0.762	− 0.252**
	(0.354)	(0.132)	(0.039)
Inflation lag(1)	0.001	0.015	0.01
	(0.386)	(0.155)	(0.14)
Debt/GDP lag(1)	0.001**	− 0.007	0.001
	(0.024)	(0.277)	(0.217)
Number of cross-country lags	3	2	3
Number of obs	261	265	489
Cross-country dependence			
(average correlation) applies to u_{it}(CD)	0.167	0.093	0.367
Cross-country dependence (CD-tests):			
CD	5.75***	5.83***	23.75***
	(0.000)	(0.000)	(0.000)
CDw	1.42	− 0.03	− 3.05***
	(0.156)	(0.979)	(0.002)
CDw+	46.85***	89.42***	207.09***
	(0.000)	(0.000)	(0.000)
CD^	1.57	0.79	3.5***
	(0.115)	(0.428)	(0.000)

The table displays results examining heterogeneous-coefficient panel models. Estimation method is the dynamic common correlated effects (DCCE, Chudik and Pesaran 2015). Dependent variable is the government bond total return. Control variables are the lagged values of bond return, inflation and debt-to-GDP ratio. CD, CDw, CDw+ and CD^ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021; Juodis and Reese, 2021; Fan et al. 2015; Pesaran and Xie 2021, respectively). (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively

Table 21 Equity total return

	Estimation period 1881–1913	Estimation period 1950–1973	Estimation period 1974–2015
	Dynamic CCE	Dynamic CCE	Dynamic CCE
Dependent variable			
Equity			
Control variables			
Equity lag(1)	0.102	0.206	− 0.064
	(0.467)	(0.226)	(0.657)
Inflation lag(1)	0.001	− 0.014	0.020**
	(0.799)	(0.246)	(0.039)
Equity dividend lag(1)	− 0.03	0.765***	0.222
	(0.678)	(0.000)	(0.141)
Number of cross-country lags	3	2	3
Number of obs	261	189	342
Cross-country dependence			
(average correlation) applies to u_{it}(CD)	0.201	0.089	0.307
Cross-country dependence (CD-tests):			
CD	6.94***	2.61***	11.93***
	(0.000)	(0.009)	(0.000)
CDw	2.51**	1.52	2.11**
	(0.012)	(0.127)	(0.035)
CDw+	46.35***	36.17***	78.13***
	(0.000)	(0.000)	(0.000)
CD^	0.97	3.18***	− 0.99
	(0.330)	(0.001)	(0.322)

The table displays results examining heterogeneous-coefficient panel models. Estimation method is the dynamic common correlated effects (DCCE, Chudik and Pesaran 2015). Dependent variable is the equity total return. Control variables are the lagged values of equity total return, inflation, and the log of the equity dividend yield. CD, CDw, CDw+ and CD^ tests for the null hypothesis of weak against strong cross-country dependence (Pesaran 2015, 2021, Juodis and Reese, 2021, Fan et al. 2015; Pesaran and Xie 2021, respectively). (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively

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