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# Global shocks and the debt-growth nexus

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**Abstract**

This paper re-examines the relationship between debt and growth with and without the influence of global shocks for a panel of 22 economies. The analysis introduces an approach that accounts for the complexity of global factors and estimates the debt-to-growth and growth-to-debt nexus for household, corporate, and public debt from a purely idiosyncratic perspective. The results reveal a multifactor structure: global shocks drive variation in household and public debt, whereas corporate debt exhibits predominantly idiosyncratic dynamics. These global shocks alter the magnitude and statistical significance of the idiosyncratic debt-growth nexus, demonstrating their critical role in identifying the underlying relationship.

**KEYWORDS**

debt, growth, Cross-Sectional Dependence, common factors

**JEL CLASSIFICATION**

C33, C38, D14, E32, E44, E51, G01

## 1 | INTRODUCTION

The debate on the relationship between debt, whether public or private, and growth is cyclically characterized by strains in public and private finances triggered by large shocks, such as the global financial crisis first, the COVID-19 pandemic later, and the recent energy shocks, among others. While access to private credit is essential for growth (Beck & Levine, 2004; Klein, 2017), history also shows that credit booms often go hand-in-hand with risky leveraged bubbles, eventually leading to resource misallocation, credit busts, and economic slowdowns (Asea & Blomberg, 1998; Jordà et al., 2013). A similar argument holds for public debt (Beck et al., 2014, 2016; Cheron et al., 2019; Mian et al., 2017).[1] On the one hand, control over excessive debt is crucial for national growth, and on the other, credit rationing and fiscal consolidations can lead to economic stagnation.[2]

At the same time, globalization increases financial and economic integration and adds complexity to the relationship between debt and growth, as both become exposed to idiosyncratic and international shocks (Chudik

**Abbreviations:** AIC, Akaike Information Criterion; ARDL, Autoregressive Distributed Lag; CSA, Cross-Sectional Average; CSD, Cross-Sectional Dependence; ECB, European Central Bank; ER, Eigenvalue Ratio; Fed, Federal Reserve; GDP, Gross Domestic Product; GR, Growth Ratio; IC, Information Criterion; PANIC, Panel Analysis of Non-stationarity in Idiosyncratic and Common components; PCA, principal component analysis; PMG, Panel Mean Group; VAR, Vector Auto-Regression; VECM, vector error correction model.

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et al., 2018). The extant literature demonstrates that a small number of underlying global factors can drive financial asset prices and private debt aggregates, and that these factors affect security valuations and credit conditions across national economies (Miranda-Agrippino & Rey, 2020a). Focusing on financial prices, Miranda-Agrippino and Rey (2020a) show that a single global factor accounts for about 25% of the variability across a large cohort of international stocks, corporate bonds, and commodity prices. In a companion study, Miranda-Agrippino and Rey (2022) examine corporate and household lending and find that a single global factor accounts for up to 31% of global private liquidity variability.[3] Several studies have documented that the policies of the Federal Reserve (Fed), the European Central Bank (ECB), and the People's Bank of China are key drivers of such global factors, leaving other countries exposed to forces beyond their control (Miranda-Agrippino & Nenova, 2022; Miranda-Agrippino & Rey, 2020a; Miranda-Agrippino & Rey, 2020b; Ca' Zorzi et al., 2020; Miranda-Agrippino et al., 2020).[4] More recently, scholars unraveled the presence of global factors in public debt aggregates as well. For example, Isomitdinov et al. (2024) examine the debt-to-Gross Domestic Product (GDP) ratios of 115 countries and find that a single global factor accounts for about 38% of the panel variation. In a companion study, Bhatt et al. (2017) analyze the long-term sovereign bond yields of 21 Organization for Economic Co-operation and Development (OECD) economies, showing that one common factor plays a dominant role for most countries, with its strength weakening in the post-2008 period. A parallel strand of research documented that global factors influence the business cycle, inflation, and interest rates. For example, Kose et al. (2012) extract a single global factor from the business cycles of a cohort of countries, showing that the factors characterizing developed and emerging economies differ (see e.g., Crucini et al., 2011).[5] Auer et al. (2017) use global value chains as a proxy for global trade conditions to show that these last play a growing role in influencing inflation compared to domestic conditions. Finally, Byrne et al. (2012) find that a global component, possibly linked to international saving, affects long-term interest rates across industrial countries.

Thus, disentangling idiosyncratic from global sources of shock variation is critical in the debt-growth nexus, especially amid higher financial connectedness among countries. From an empirical standpoint, the growing influence of global shocks gives rise to Cross-Sectional Dependence (hereafter, CSD), which undermines the reliability of standard estimators. Previous studies have addressed this issue by supplementing baseline panel specifications of economic relationships of interest with Cross-Sectional Averages (hereafter, CSA) of the observed variables (Pesaran, 2006). This approach, however, can efficiently account for CSD only if the data have a simple common factor structure. Indeed, Sul (2019) shows that CSAs can serve as reasonable proxies for the common factor and account for CSD when a single common factor can summarize it. When, instead, CSD has a complex factor structure—that is, multiple common factors that vary in number and influence across series and countries—CSAs lose their ability to fully account for CSD. Sul (2019) also points out that the common factor may influence each country with a specific weight (factor loading). To this end, the principal component analysis (hereafter, PCA) approach accounts for this heterogeneity while allowing for multiple common factors. Thus, under conditions of multiple common factors and heterogeneous factor loadings, the PCA approach is better suited than the CSA approach for capturing the influence of global shocks.[6] From a policy standpoint, understanding the impact of global shocks on national macroeconomic variables is essential for gauging the limits of domestic policymaking in a globalized economy (Breitung & Eickmeier, 2016; Igan et al., 2011; Rey, 2016), especially in the context of the changing dynamics of the debt-growth nexus over the business cycle (Kilinc & Ulussever, 2024).

Against this background, this paper empirically reassesses the debt-growth nexus by accounting for the CSD arising from global shocks. Specifically, we model the relationship between debt and growth, with and without global-shock effects, for a balanced panel of 22 countries from 2000Q1 to 2019Q4. To this end, we use a two-step procedure: first, we exploit the flexibility of the PCA approach to identify global shocks, as proposed by Sul (2019), and then filter them out of the original series to obtain the de-factored series, that is, the idiosyncratic component. We then estimate the relationship of interest using these de-factored series, whose variation must, by construction, be driven solely by idiosyncratic country-level shocks. This modeling strategy enables us to better account for the increasing international synchronization of credit cycles while also considering potential asymmetric adjustment at the country level due to structural and policy differences (Aikman et al., 2015; Miranda-Agrippino & Rey, 2022).

Our results highlight a complex factor structure that cannot be fully captured by using CSAs. After isolating the idiosyncratic part of the series, we use a panel Autoregressive Distributed Lag (ARDL) model to reassess the debt-growth relationship in both directions: from debt to growth, and from growth to debt. This approach allows us to control for potential non-stationarity and endogeneity (see e.g., Chudik & Pesaran, 2015), with the latter being particularly concerning due to feedback effects between the financial and real sides of the economy.[7] At the same time, our approach removes the influence of global shocks from both the short and long-run dynamics of the series. In our analysis, we consider both public and private debt, with the latter further partitioned into household and corporate debt. We compare the results of the de-factored series with those from the original series. Hence, compared with previous studies, we provide a more comprehensive set of results that accounts for global factors, CSD, and endogeneity across different forms of debt.

Our evidence underscores the importance of global shocks in the relationship between debt and growth. Before defactoring—that is, under the influence of global shocks—the panel ARDL analysis shows that all types of debt significantly affect economic growth. A 1% increase in debt affects growth either positively (household debt) or negatively (corporate and public debt). However, after controlling for global shocks, household debt no longer significantly affects growth, whereas both corporate and public debt exert a more substantial and persistent negative effect. Global shocks also play a role when investigating the impact of growth on debt. We find a negative association between growth and debt, with a stronger effect on public debt than on private debt. However, the size of these effects differs after the influence of global shocks is removed. In the idiosyncratic part of the relationship, we find that a 1% increase in growth is associated with a decline in public debt of roughly 0.56 percentage points, and in household and corporate debt of 0.12 and 0.19 percentage points, respectively, relative to GDP.

Therefore, global shocks influence the significance, size, and direction of the relationships. This finding has important implications for the debate on the debt-growth nexus and, more broadly, for understanding the relative role of global versus national sources of transmission between the real and financial shocks, with potential repercussions for national policymaking under globalization, as discussed in the conclusions.

The remainder of this paper is organized as follows. Section 2 reviews key studies on debt and economic growth and positions our contribution within the existing literature. Section 3 describes the data, Section 4 presents the modeling strategy, Section 5 discusses the results, and Section 6 concludes.

## 2 | PREVIOUS EVIDENCE ON DEBT AND GROWTH

A large body of literature has investigated the relationship between debt and growth, differing in terms of direction (debt on growth vs. growth on debt), type of debt (private or public), and modeling strategies that account for nonlinearities, CSD, and time horizons. In this section, we summarize key studies and highlight our contribution.

Early studies by Hofmann (2004) and Goodhart and Hofmann (2008) analyze the determinants of bank credit to the private sector. Using a vector error correction model (VECM) on a sample of 16 industrial economies from 1980 to 1998, Hofmann (2004) finds that real GDP and property prices positively influence private credit, while interest rates have a negative impact. Goodhart and Hofmann (2008), using panel Vector Auto-Regressions (VARs) for 17 countries (1973–2006), find bi-directional causality between credit, house prices, and economic activity, mediated by housing wealth and collateral effects.

Credit determinants can be grouped into demand- and supply-side factors. On the demand side, household credit demand often reflects the desire to smooth consumption over time, influenced by savings, wealth, demographics, and business cycles (Coletta et al., 2019). Modigliani's (1986) life-cycle hypothesis suggests that anticipated future income increases—due to, for example, technology and trade shocks—can drive up current borrowings (Aguiar & Gopinath, 2007). However, such booms may be followed by slower growth due to nominal rigidities and monetary policy constraints (Guerrieri & Lorenzoni, 2017). On the supply side, credit is sensitive to interest rates, a mechanism central to the monetary policy transmission channel (Bernanke, 2005; Capolupo, 2018; Kashyap et al., 1993). Adrian et al. (2010) show that interest rates affect financial intermediaries' profitability and risk-taking behavior. These findings extend to low-interest-rate environments, as demonstrated by studies on quantitative easing (e.g., Kapetanios et al., 2012; Sleibi et al., 2023).

Inflation also influences credit markets, with higher inflation often inducing conservative bank behavior (Caglayan & Xu, 2016; Debelle, 2004). Regarding private debt, while initial credit expansion can stimulate demand and short-run output growth (Kilinc & Ulussever, 2024), excessive optimism and borrowing can lead to financial vulnerabilities, defaults, and stagnation (Barbaglia et al., 2024; Gu et al., 2022; Jordà et al., 2013; Mian et al., 2013). Mian et al. (2020) and Verner and Gyöngyösi (2020) emphasize the amplification of the business cycle through elevated household credit. Several studies highlight how credit booms and busts can be driven by global liquidity trends emanating from hegemon economies like the US, which are beyond the control of the central banks in recipient countries (Miranda-Agrippino & Nenova, 2022; Miranda-Agrippino and Rey, 2020a, 2020b; Miranda-Agrippino et al., 2020; Rey, 2016). Lombardi et al. (2017), using CSA-augmented panel ARDL models for 54 economies (1990–2015), show that household credit boosts GDP in the short run but reduces long-term growth. Similarly, Mian et al. (2017) use panel VARs for 30 countries (1960–2012) and find that household debt temporarily increases growth, while corporate debt initially reduces it, with a reversal after approximately 5 years. These findings highlight the heterogeneous impact of the different types of debt on growth.

Some authors examine debt through the lens of financial innovation. Beck et al. (2016) find that, in mostly high-income countries, private credit is not significantly linked to growth, whereas financial innovation is. Zhu et al. (2020), using Generalized Method of Moments and threshold models for over 50 countries from 1990 to 2016, show that the positive impact of innovation on growth diminishes once private credit exceeds 60% of GDP. This finding suggests that expanding credit markets may crowd out investment in risky but productive innovation, thereby dampening productivity growth.

Sleibi et al. (2020) study the nexus between shocks to large banks' lending, real output growth, and aggregate leverage for a panel of 15 advanced economies from 1989 to 2016. Using panel VAR methods, they find that following banking shocks, the credit-to-GDP ratio deviates from its long-term trend, exposing the banking system to default risk. Similarly, shocks to real output growth increase aggregate leverage. These findings are also consistent with the literature on credit procyclicality, which documents how credit is amplified and becomes more attractive to borrowers during the expansionary phase of the business cycle.

Public debt has also received considerable attention. Reinhart and Rogoff (2010), analyzing 44 countries, find that growth significantly slows once public debt exceeds 90% of GDP. However, their assumptions of homogeneity and cross-sectional independence were later challenged. Chudik et al. (2017) address this using a panel ARDL framework supplemented with CSAs for 40 countries (1965–2010), finding long-run negative effects of public debt and inflation on growth, but no clear threshold effects. More recently, Isomitdinov et al. (2024) examine the presence of global shocks in the public debt of 115 countries (1980–2015), finding that common factors, influenced by GDP growth, explain a large share of debt variation. Their findings support decomposing debt into common and idiosyncratic components for improved policy guidance.

Overall, while the relationship between debt and growth remains inconclusive, key themes emerge: the short-run stimulus versus long-run drag of credit, the distinct roles of household and corporate debt, and the influence of external and common global shocks. Our paper contributes to this strand of literature in three ways. First, we examine both directions of the association: debt on growth and growth on debt. Second, we differentiate between public and private debt, and within the latter, between household and corporate borrowing. Third, while we control for CSD as in previous studies, we follow Sul (2019) in explicitly accounting for multiple unobserved common factors. By filtering these out, we analyze the debt-growth nexus from a purely idiosyncratic perspective.

# 3 | DATA

Our analysis is based on a balanced panel dataset of quarterly series for 22 advanced and developing countries, observed over the period 2000Q1-2019Q4, yielding a panel with dimensions $N = 22$ and $T = 80$.[8] We consider public debt and two measures of private debt—household debt and non-financial corporate debt—sourced from the *BIS Statistical Warehouse*. To obtain the largest possible balanced panel while preserving the time dimension, we exclude countries with debt series beginning after 2000. The database defines debt as loans and debt instruments from banks and non-bank institutions at the end of each quarter. Private non-financial debt is divided into household debt (including non-profit institutions serving households) and non-financial corporate debt. Household debt includes, inter alia, consumer, real estate, automobile, credit card, and student loans. Non-financial corporate debt includes mainly commercial and industrial loans. The measure of government debt is the broadest possible, including currency and deposits, that is, special drawing rights, insurance, pension and standardized guarantee schemes, and other accounts receivable or payable.[9] Consistent with previous studies, we normalize the three types of debt by GDP, so that we capture aggregate indebtedness relative to the size of the economy (see e.g., Jordà et al., 2013; Mian et al., 2017). We then gather the series for real GDP, consumer prices, and short-term interest rates from the OECD database. Please refer to Table A1 in Appendix A for the summary statistics of the variables.[10]

# 4 | MODELING STRATEGY

## 4.1 | Identifying the global factors and the de-factoring procedure

Ignoring CSD would lead to biased and inconsistent results, especially when it is pervasive and driven by unobserved common factors (Moon & Weidner, 2017; Sarafidis & Wansbeek, 2012). To address this, we employ the Panel Analysis of Non-stationarity in Idiosyncratic and Common components (PANIC) approach of Bai and Ng (2004), which is based on PCA, to detect the latent common factors in the series. Once the common factors are extracted, we gauge their influence on the series under scrutiny to determine whether the non-stationarity is a feature of the idiosyncratic components, the common factors, or both.[11] In notational terms, we consider the following factor structure in a panel context:

$$Z_{it} = c_i + \Lambda_{i1}F_{1t} + \Lambda_{i2}F_{2t} + \ldots + \Lambda_{ik}F_{kt} + \upsilon_{it} = c_i + \Lambda_i'\zeta_t + \upsilon_{it}, \tag{1}$$

where $Z_{it}$ is any dependent ($y$) or independent variable ($x$) in our panel ARDL specification. Such variables are observed over $i = 1, \ldots, N$ cross-sectional units and $t = 1, \ldots, T$ time (quarterly) periods. According to Equation (1), such a variable is explained by country-fixed effects, $c_i$, $k$ unobserved common factors, $\zeta_t = (F_{1t}, F_{2t}, \ldots, F_{kt})'$, and a country-specific time-varying component, $\upsilon_{it}$, which is entirely idiosyncratic. The unobserved factors influence each cross-sectional unit differently through the factor loadings $\Lambda_i' = (\Lambda_{i1}, \Lambda_{i2}, \ldots, \Lambda_{ik})'$.[12] To avoid spurious regression results and enable standard inference for the de-factoring process, the factors are obtained by differencing the original data, extracting the principal components from the differenced data, and re-cumulating the principal components back to levels (Bai & Ng, 2004; Reese & Westerlund, 2016).[13] Similar to the factors, the varying components, $\upsilon_{it}$, are also re-cumulated to recover estimates of the idiosyncratic components for each cross-sectional unit.

We apply the previous modeling strategy to the complete set of variables of Section 3. As discussed later, the country-specific components $\upsilon_{it}$ exhibit high persistence over time, thus signaling that they retain substantial information content. Considering this, we focus on the dynamics of $Z_{it}$ after removing the recommended common factors $F_{kt}$, so that our variables of interest become the de-factored (idiosyncratic) series. We compute the de-factored series by removing only the significant factors as recommended by standard information criteria. Throughout the paper, we will refer to this component as the de-factored series, which can be thought of as the counterpart of the original series $Z_{it}$.

## 4.2 | The "globally de-factored" debt-growth nexus

Armed with the original and de-factored series, we proceed to carry out two parallel analyses of the debt-growth nexus, where the international dimension of such a relationship, as proxied by the common factors, is initially embedded in the series $Z_{it}$ and then removed in the de-factored equivalent.

To this end, in line with Chudik et al. (2017), we estimate a panel ARDL specification that can detect long-run estimates that are valid irrespective of whether the regressors are exogenous or endogenous (Chudik et al., 2016; Pesaran, 1997; Pesaran et al., 1999). This feature is reassuring since endogeneity could be an issue in our empirical analysis, as the credit market is vulnerable to macroeconomic fluctuations with feedback effects on economic activity, further amplified throughout credit booms and busts (Baltas et al., 2017; Sleibi et al., 2020).

### 4.2.1 | Panel Autoregressive Distributed Lag

We implement the panel ARDL model using the VECM estimator proposed by Pesaran and Smith (1995), which allows for heterogeneous dynamic panels. We specify the error correction representation of the panel ARDL($p$,$q$) model as follows[14]:

$$\Delta y_{it}^d = \alpha_i + \phi_i\left(y_{i,t-1}^d - \theta_i' x_{it}^d\right) + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta y_{i,t-j}^d + \sum_{j=0}^{q-1} \delta_{ij}^{*\prime} \Delta x_{i,t-j}^d + \varepsilon_{it}, \tag{2}$$

where $i = 1, 2, \ldots, N$ represents the cross-sectional units; $t = 1, 2, \ldots, T$ represents time (quarterly) periods; $y_{it}^d$ is the de-factored dependent variable; $x_{i,t}^d$ is a $k$-dimensional de-factored vector of explanatory variables; $p$ and $q$ are the lag lengths of the dependent and independent variables respectively; $\alpha_i$ represent the country-specific effects; the coefficients attached to the lagged dependent variables, $\lambda_{ij}^*$ are scalars; and $\delta_{ij}^*$ are $k$-dimensional coefficient vectors attached to the vector of de-factored explanatory variables. The disturbance terms $\varepsilon_{it}$ are independently distributed across $i$ and $t$, with zero mean and variances $\sigma_i^2$. The parameters $\phi_i$, $\lambda_{ij}^*$, and $\delta_{ij}^*$ of Equation (2) are defined as

$$\phi_i = -\left(1 - \sum_{j=1}^{p} \lambda_{ij}\right), \beta_i = \sum_{j=0}^{q} \delta_{ij}, \tag{3}$$

$$\lambda_{ij}^{*} = -\sum_{m=j+1}^{p} \lambda_{im}, j = 1, 2, \ldots, p-1, \tag{4}$$

$$\delta_{ij}^{*} = -\sum_{m=j+1}^{q} \delta_{im}, j = 1, 2, \ldots, q-1, \tag{5}$$

where $\theta_i = -(\beta_i/\phi_i)$ is the long-run coefficient attached to the vector of explanatory variables. In contrast, $\lambda_{ij}^{*}$ and $\delta_{ij}^{*'}$ are the short-run coefficients relating the dependent variable to its past values and the set of explanatory variables, respectively. Finally, the coefficient $\phi_i$ attached to the error-correction mechanism represents the speed of adjustment of the dependent variable toward the long-run equilibrium following a change in the explanatory variables $x_{it}^{d}$. A significant and negative value of $\phi_i$ is an endorsement of the long-run association between the variables of interest.

We start the analysis using the original series to estimate Equations (2–5). Then, we replace such series with the defactored ones (i.e., without the presence of common shocks) to compare the results. In doing so, we consider real GDP growth as the dependent variable and each of the three debt variables as explanatory variables. Then, we reverse the relationship and set each debt series as the dependent variable and real GDP growth as the explanatory variable. In all specifications, short-run interest rates and inflation are also included as control variables. Furthermore, as shown in Pesaran et al. (1999), the Pooled-Mean-Group (PMG) estimator allows the intercepts, short-run parameters, and error variances to differ across groups but constrains the long-run parameters to be identical across groups.

## 5 | RESULTS

### 5.1 | CSD and the unobserved common factors

As a preliminary step, we gauge the presence of CSD. Table 1 reports the Pesaran (2015a) statistic for the null hypothesis of weak CSD, along with the average pairwise absolute correlations. The null is soundly rejected at the 1% level for all variables. Household debt exhibits the largest absolute cross-correlation (0.31), followed by public debt (0.24), and corporate debt (0.14).[15] This preliminary evidence underscores the need to investigate the pervasiveness of CSD using the PANIC approach.

Next, following Sul (2019), we apply the principal components approach to the series after pre-whitening the data, which includes demeaning and standardizing. Throughout the analysis, we allow for up to five factors. We use different types of information criteria suggested by Bai and Ng (2002) (hereafter, $IC_1$, $IC_2$, and $IC_3$), as well as the procedures of Onatski (2010) (hereafter, ON) and Ahn and Horenstein (2013) (hereafter, AN), presented as the Eigenvalue Ratio and the Growth Ratio.[16] The recommended number of factors derived from the IC2 criterion should exhibit better statistical properties, especially for relatively short samples (Moon & Perron, 2007).

Table 2 presents the results of the PANIC approach, including the unit-root tests for each factor series, panel unit-root tests of the residuals of Equation (1), and the information criteria. The same table also reports (in square brackets) the ratio of eigenvalues for each detected factor, which indicates how strongly each underlying factor influences the original series.

The ON and AN criteria recommend a single factor for all series, except for corporate debt, for which the AN criterion indicates no factors. Among the information criteria, $IC_1$ is the least conservative, recommending between five factors (for household debt) and one factor (for corporate debt), whereas $IC_3$ is the most conservative, recommending one factor for all series except corporate and public debt, for which it suggests no factors. The $IC_2$ criterion, which, as explained earlier, is the preferred criterion, recommends three, one, and two factors for household, corporate, and public debt, respectively, one factor for output, and four factors for both prices and short-term interest rates.

In terms of overall variance, as indicated by the eigenvalue magnitudes, the first common factor explains 38.2%, 17%, and 28.7% of the variation in household, corporate, and public debt, respectively, with the remaining variation mainly due to the country-specific component. We obtain similar results for output, prices, and short-term rates, where the first common factor explains between 44% and 68% of the total variability.[17]

**TABLE 1** CSD for the panels of household debt, corporate debt, public debt, output growth, prices, and short-term interest rate.

| Variable | CD *t*-statistic | $\overline{\widehat{\rho}_{ij}}$ | $\overline{\lvert\widehat{\rho}_{ij}\rvert}$ |
|---|---|---|---|
| $\Delta C^{hh}$ | 36.98*** | 0.27 | 0.31 |
| $\Delta C^{cor}$ | 13.93*** | 0.10 | 0.14 |
| $\Delta C^{pub}$ | 28.43*** | 0.21 | 0.24 |
| $\Delta Y$ | 49.82*** | 0.37 | 0.37 |
| $\Delta P$ | 51.72*** | 0.38 | 0.39 |
| $\Delta R^{short}$ | 80.65*** | 0.60 | 0.60 |

*Note*: This table presents the results of the CD test of Pesaran (2015a) under the assumption of covariance stationarity. $\overline{\widehat{\rho}_{ij}}$ denotes the average mean of the correlation coefficient between the residuals of the $(i, j)$ units once the original series are filtered using AR(1) specifications. $\overline{\lvert\widehat{\rho}_{ij}\rvert}$ denotes the average mean of the same correlation coefficient taken in absolute value. $C^{hh}$, $C^{cor}$, $C^{pub}$, $Y$, $P$, $R^{short}$ denote household credit-to-GDP, corporate credit-to-GDP, public debt-to-GDP, real output, consumer prices, and short-term interest rate, respectively. $\Delta$ denotes that all series are taken in first differences. Sample period 2000Q1-2019Q4 for 22 countries ($N = 22$, $T = 80$). *, **, *** indicate rejection of the null hypothesis of weak CSD at the 10/5/1 percent levels.

Abbreviations: AIC, Akaike Information Criterion; CSD, Cross-Sectional Dependence; GDP, Gross Domestic Product.

**TABLE 2** PANIC results for the panels of household debt, corporate debt, public debt, output growth, prices, and short-term interest rate.

| Sample | $F_{kt}$ | $\upsilon_{it}$ | $IC_1$ | $IC_2$ | $IC_3$ | ON | AN(ER) | AN(GR) |
|---|---|---|---|---|---|---|---|---|
| $\Delta C^{hh}$ | −2.234, −1.094, −3.430**, −0.788 [0.382, 0.119, 0.087, 0.063] | 10.66*** | 4 | 3 | 1 | 1 | 1 | 1 |
| $\Delta C^{cor}$ | −0.900, −1.455, −2.122, −1.935 [0.170, 0.106, 0.081, 0.072] | 4.000*** | 1 | 1 | 0 | 1 | 0 | 0 |
| $\Delta C^{pub}$ | −2.377, −2.332, −5.946***, −0.172 [0.287, 0.120, 0.082, 0.068] | 4.622*** | 2 | 2 | 0 | 1 | 1 | 1 |
| $\Delta Y$ | −2.301, −1.798, −1.341, −1.462 [0.440, 0.074, 0.065, 0.054] | 5.701*** | 1 | 1 | 1 | 1 | 1 | 1 |
| $\Delta P$ | −2.059, −2.577, −3.143*, −2.235 [0.450, 0.124, 0.076, 0.057] | 5.003*** | 4 | 4 | 1 | 1 | 1 | 1 |
| $\Delta R^{short}$ | −3.555**, −3.734**, −3.333*, −2.633 [0.673, 0.061, 0.054, 0.047] | 3.338*** | 4 | 4 | 1 | 1 | 1 | 1 |

*Note*: This table presents the results of standard Dickey–Fuller unit-root tests on the factors $F_{kt}$ and Fisher-type panel unit root tests on the idiosyncratic components $\upsilon_{it}$ using Bai and Ng (2004) PANIC method. Sample period 2000Q1-2019Q4 for 22 countries ($N = 22$, $T = 80$). $IC_1$, $IC_2$, and $IC_3$ are the numbers of factors recommended by the information criteria of Bai and Ng (2004). ON is the number of factors recommended by Onatski (2010). ER and GR are the number of factors recommended by the Ahn and Horenstein (2013) procedure. *, **, *** indicate rejection of the null of unit-root at the 10/5/1 percent levels. Ratio of eigenvalues in square brackets [.]. $C^{hh}$, $C^{cor}$, $C^{pub}$, $Y$, $P$, $R^{short}$ denote household credit-to-GDP, corporate credit-to-GDP, public debt-to-GDP, real output, consumer prices, and short-term interest rate, respectively. All series are demeaned and standardized.

Abbreviations: AIC, Akaike Information Criterion; GDP, Gross Domestic Product; PANIC; Panel Analysis of Non-stationarity in Idiosyncratic and Common components.

Tests for the null of non-stationary idiosyncratic components strongly reject it for all variables. In contrast, the first and second factors (and the third factor for some variables) are non-stationary for all our variables except the short-term interest rate. Hence, suggesting that the global components may be an important source of non-stationarity in the data.[18]

Figure 1 displays the evolution of the first global common factor extracted from each of the three debt series over the full period. To facilitate interpretation, we follow Eickmeier et al. (2014) and normalize all factors so that each factor has the same standard deviation as its corresponding growth term.[19] The diagram illustrates how the three factors capture the effects of the Global Financial Crisis. The common factors of household and corporate debt exhibit marked downward trends, culminating in both factors taking negative values in correspondence with the outbreak of the crisis, and then taking a steep upward trend from 2009Q3 onward, when major central banks implemented asset purchase programs. The household and corporate debt factors tend to move in tandem, turning from positive to negative just before the crisis. Then, household debt recovers faster than its corporate counterpart, with the former returning to positive territory by 2012Q3, while the latter takes an additional 6 quarters to do so. Such dynamics can reflect the greater elasticity of household borrowing to debt supply shocks than that of the corporate sector (Mian et al., 2017). In contrast, the common factor of public debt takes a different trajectory. Before the Subprime crisis, it drifts upward and reaches its peak in 2008Q3. It then declines, turning negative by 2012Q3, and remains so until it becomes positive again from 2019Q3 onward.

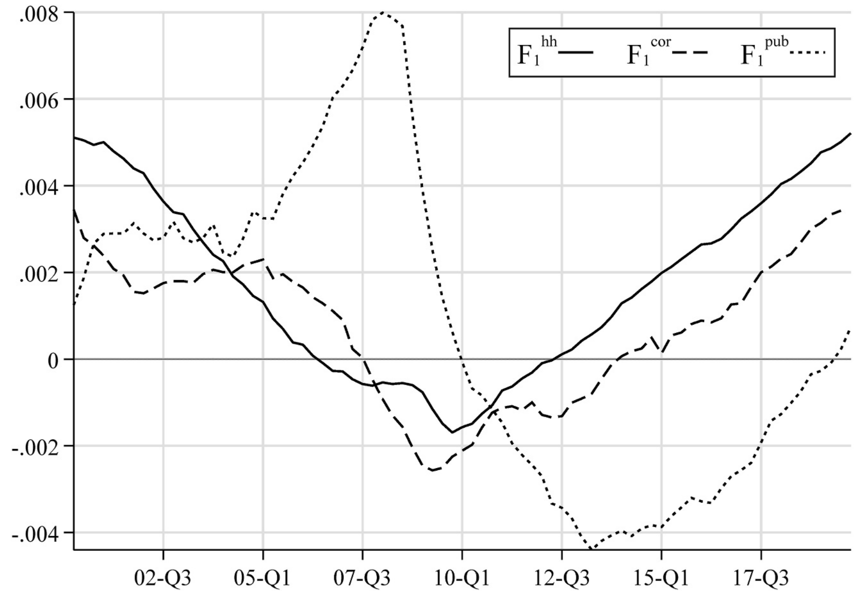


**FIGURE 1** Estimated (first) common factor extracted from the household debt (hh), corporate debt (cor) and public debt (pub) series using the PCA approach. Sample period 2000Q1-2019Q4 for 22 countries ($N = 22$, $T = 80$). Series are rescaled following Eickmeier et al. (2014) and standardized.

## 5.2 | Heterogeneous adjustments to the common factors

Following Sul (2019), we evaluate the extent to which the common factors influence the original series of the three debt aggregates, as well as real GDP, prices, and short-term interest rates. We do so by regressing the original series (taken in first differences) against the set of obtained common factors (recommended by $IC_2$) and computing the $R_i^2$ statistics.[20] In this setting, if all variations are idiosyncratic, then the $R_i^2$ statistic should take values close to zero, whereas whenever the factors load on the series, the same statistic would take values close to one. Table 3 displays these statistics for the six considered series. Results show that the common factors for household debt explain a significant portion of the fluctuations in most countries, albeit with some heterogeneity. Four countries are significantly dominated by the common factors, with an $R_i^2 > 80\%$: Greece, Spain, Italy, and Portugal.[21] Other countries with a high proportion of variation explained by the factors include Canada, the UK, Finland, and the Netherlands, with an average $R_i^2$ of 75%. At the other end of the spectrum, Brazil, Poland, and Austria are far less tied to the common factors, each with $R_i^2$ below 25%. For these three countries, the country-specific characteristics seem more important than global common factors in shaping the evolution of household debt.

Corporate debt is less closely tied to common factors than household debt. The largest variation explained by these factors is in Spain (up to 41%), whereas the lowest is in the Czech Republic (close to zero). Differences in labor markets and institutions could generate such marked differences across countries. To summarize, we find that household debt is remarkably tied across countries, whereas corporate debt is more reflective of idiosyncratic dynamics.

While, in principle, differences in labor markets and institutional frameworks could generate such marked heterogeneity across countries, in practice, there is limited theoretical and empirical research on cross-country differences in household and corporate debt co-movement. Some scholars have investigated why household debt may be strongly interlinked across countries. One explanation lies in the link between the households' balance sheet and the housing market, where mortgage borrowing and changes in collateral values expose households to potentially significant cross-country interconnectedness. Hence, households in different countries face similarly high sensitivity to shocks affecting the housing market, as shown by the Subprime mortgage crisis. In contrast, corporates have access to other forms of collateral in their financing decisions and are therefore less exposed to housing market dynamics (Jordà et al., 2016; Mian et al., 2013). Another explanation could be the similarity in household characteristics regarding their financing decisions and behavioral responses to increases in the availability of credit, with such characteristics including overconfidence in the ability to repay loans and the risk associated with future income (Agarwal et al., 2018; Brunnermeier & Parker, 2005). In contrast, corporate debt is less elastic to changes in debt supply, as firms are generally more cautious

**TABLE 3** Country-level variations and the importance of common factors for each series.

| | $C^{hh}$ | $C^{cor}$ | $C^{pub}$ | $Y$ | $P$ | $R^{short}$ |
|---|---|---|---|---|---|---|
| Australia | 0.619 | 0.130 | 0.551 | 0.017 | 0.376 | 0.738 |
| Austria | 0.231 | 0.178 | 0.569 | 0.604 | 0.678 | 0.987 |
| Belgium | 0.696 | 0.330 | 0.761 | 0.656 | 0.673 | 0.987 |
| Brazil | 0.134 | 0.002 | 0.007 | 0.227 | 0.784 | 0.812 |
| Canada | 0.784 | 0.046 | 0.630 | 0.434 | 0.773 | 0.870 |
| Czech Republic | 0.347 | 0.004 | 0.210 | 0.703 | 0.775 | 0.680 |
| Denmark | 0.578 | 0.200 | 0.531 | 0.315 | 0.774 | 0.802 |
| Finland | 0.743 | 0.116 | 0.349 | 0.611 | 0.692 | 0.987 |
| France | 0.686 | 0.200 | 0.576 | 0.781 | 0.878 | 0.987 |
| Germany | 0.353 | 0.094 | 0.227 | 0.560 | 0.648 | 0.987 |
| Greece | 0.860 | 0.278 | 0.231 | 0.195 | 0.880 | 0.630 |
| Israel | 0.459 | 0.030 | 0.159 | 0.214 | 0.556 | 0.684 |
| Italy | 0.826 | 0.305 | 0.724 | 0.761 | 0.713 | 0.987 |
| Japan | 0.334 | 0.003 | 0.328 | 0.401 | 0.510 | 0.365 |
| Netherlands | 0.717 | 0.004 | 0.524 | 0.646 | 0.613 | 0.987 |
| Norway | 0.601 | 0.230 | 0.012 | 0.031 | 0.590 | 0.759 |
| Poland | 0.217 | 0.166 | 0.301 | 0.057 | 0.715 | 0.715 |
| Portugal | 0.813 | 0.260 | 0.268 | 0.424 | 0.774 | 0.987 |
| Spain | 0.832 | 0.410 | 0.654 | 0.648 | 0.782 | 0.987 |
| Sweden | 0.697 | 0.360 | 0.334 | 0.465 | 0.758 | 0.807 |
| United Kingdom | 0.753 | 0.226 | 0.642 | 0.503 | 0.806 | 0.800 |
| United States | 0.686 | 0.181 | 0.374 | 0.426 | 0.829 | 0.853 |
| $\overline{R^2}$ | 0.590 | 0.170 | 0.407 | 0.440 | 0.708 | 0.836 |

*Note*: This table examines the degree to which the optimal number of estimated common factors explains the variation in each country's macro variable, that is, household debt, corporate debt, public debt, output, prices, and short-term interest rates. Sample period 2000Q1-2019Q4 for 22 countries ($N = 22$, $T = 80$) using differenced and standardized data. The variance decomposition is calculated from Equation (1) as $R_i^2 = 1 - V(\tilde{v}_{it})/\sigma_i^2$, where $V(\tilde{v}_{it})/\sigma_i^2$ denotes the share explained by the idiosyncratic component. If all variations are idiosyncratic then $R_i^2 \to 0$. $\overline{R^2}$ is the average variation, corresponding to the aggregate variation explained by the recommended number of factors for each variable across $N$ and $T$, and it is equal to the sum of the ratios of each factor's eigenvalue reported in Table 2 (as recommended by the $IC_2$ criterion).

in assessing debt service costs and future cash flows (Mian et al., 2017). As reported in Table 3, the variance decompositions for household and corporate debt align with the observed pairwise cross-country correlations in Table 1, with household debt exhibiting weaker idiosyncratic forces than corporate debt.

Regarding public debt, the common factors are more closely associated with Italy, Belgium, and Spain, whereas in countries like Brazil and Norway, these common factors are largely irrelevant. Similarly, for output, the common factors are more important for France, the Czech Republic, and Italy, and less so for Australia, Norway, and Poland, which appear less connected to the global business cycle. US output is comparatively less affected by the common factors, with an $R_i^2$ of 42.6%, signaling that country-specific factors may be important. The significance of idiosyncratic shocks to US output can, in itself, be a source of disturbance for the rest of the world via trade and financial market linkages, rather than the reverse (Kwark, 1999; Nadal-De Simone, 2002).

The common factors of prices exhibit a more significant influence than those of output, dominating variations in Greece, France, the US, and the UK, with Australia being the least influenced, where less than 50% of the variation is attributable to the common factors. Looking at the full set of countries, these results yield an average common variation ($\overline{R^2}$) of 44% and 71% for output and prices, respectively. This finding confirms that a substantial share of output and price dynamics is driven by global common factors (see e.g., Ciccarelli & Mojon, 2010; Eickmeier et al., 2014; Kose et al., 2003). In this respect, the role of global commodity price shocks in driving national inflation cannot be underestimated. The evidence presented is also in line with the tendency of central banks to respond to shocks to output growth and inflation that co-move internationally (Breitung & Eickmeier, 2016). Finally, short-term interest rates are strongly dominated by the common factors, with the majority of countries' variations featuring an $R_i^2$ around 90%, which is in line with the findings of Byrne et al. (2012).[22] Such a degree of co-movement in the term structure reflects similar monetary policy stances, global monetary policy spillovers (Hofmann & Bogdanova, 2012), as well as global interdependence in money markets.

Building on these findings, we proceed to investigate the debt-growth nexus, after de-factoring the data to remove the influence of the significant common factors. Given the complex structure of these factors, this approach offers an alternative—and potentially superior—modeling strategy compared to panels augmented with CSAs.

## 5.3 | Panel ARDL estimation

### 5.3.1 | Baseline estimates

Our framework is similar to the panel ARDL setting applied by Lombardi et al. (2017) and Chudik et al. (2017), which is designed to estimate the long-run relationship between the series in growth terms. However, our specification departs from those in these studies in several important aspects. First, by employing globally de-factored series—that is, the idiosyncratic components—we do not need to supplement our specifications with CSAs. Second, we investigate and compare the relationship between growth and both public and private debt, rather than focusing on only one type of debt. Third, we examine both the effects of debt on growth and growth on debt without taking any a priori stance on the direction of the relationship. Finally, our panel ARDL specification allows for slope heterogeneity in the relationship between growth and debt, thereby accommodating country-specific features. This last condition is particularly relevant, as Table 3 shows that the loading of common factors onto the original series is remarkably heterogeneous.

For comparison purposes, and to highlight the role of common factors, we first present the results obtained using the original series in Tables 4 and 5, where global shocks are expected to influence the debt-growth relationship. Then, we repeat the analysis in Tables 6 and 7 using the de-factored series, so that global shocks are purged out, and the resulting estimates of the debt-growth nexus reflect only country-specific dynamics. We first specify the model with output growth as the dependent variable and the debt series (household, corporate, public) as explanatory variables in Tables 4 and 6. Then, we reverse the ordering and use the debt series as the dependent variable and output growth as an explanatory variable in Tables 5 and 7.

We begin our analysis by presenting the estimates of the impact of each type of debt—taken one at a time—inflation, and short-term interest rate variables (denoted by $\Delta C^{hh}$, $\Delta C^{cor}$, $\Delta C^{pub}$, $\Delta P$, and $\Delta R^{short}$, respectively) on output growth ($\Delta Y$). The speed of adjustment in the error correction mechanisms is captured by the parameter $\phi$, and is expected to be negative, less than one, and significant for the variables to share a long-run association and converge toward the steady state (Chudik et al., 2017).

Table 4 presents the results for the original series when household debt (Panel (a)), corporate debt (Panel (b)), and public debt (Panel (c)) are considered with inflation and short-term interest rates at different lag orders. While household debt exerts a positive and significant effect on growth, corporate and public debt display significant negative effects on growth of similar magnitude. The effect of inflation on growth is always negative, ranging from 0.328 percentage points for household debt to 0.179 when public debt is considered. The speed of adjustment lies between 56.3% and 65.1%, which compares with 68.7% and 83.6% reported by Chudik et al. (2017) for specifications that do not include CSAs. However, these figures are based on the assumption of cross-sectional independence, a condition that is likely to be violated given the variables' exposure to common shocks.

Table 6 presents the results based on the de-factored series for the same specifications with output growth as the dependent variable. First, we notice that household debt in Panel (a) is no longer in a significant long-run relationship with growth across the different lags, despite a significant speed of adjustment. Compared with the results from the original series in Table 4, these findings indicate that the common factors underlying household debt play a significant role in shaping the relationship between household debt and growth. Further, while the impact of the short-term rate is negative and significant across all lag lengths, the inflation rate is negative but significant only at the 5% level with 2 and 3 lags. This finding suggests that a tightening of monetary policy negatively affects output growth, consistent with the bank lending channel literature. Turning to corporate debt, a different pattern emerges. The empirical results in Panel

**TABLE 4** Panel ARDL estimates of the long-run effects of inflation, short-term interest rates, and the debt measures on output growth using the original series (i.e., without de-factoring).

| | **Dep. $\Delta Y$** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Panel (a)** | | | **Panel (b)** | | | **Panel (c)** | | |
| | **Lag = 2** | **Lag = 3** | **Lag = 4** | **Lag = 2** | **Lag = 3** | **Lag = 4** | **Lag = 2** | **Lag = 3** | **Lag = 4** |
| $\Delta P$ | −0.296*** | −0.328*** | −0.328*** | −0.238*** | −0.271*** | −0.277*** | −0.236*** | −0.179** | −0.215** |
| | (0.082) | (0.055) | (0.063) | (0.079) | (0.082) | (0.087) | (0.075) | (0.080) | (0.089) |
| $\Delta R^{short}$ | 0.207** | 0.217** | 0.001 | 0.103 | 0.157 | 0.008 | 0.002 | −0.026 | −0.146 |
| | (0.089) | (0.099) | (0.132) | (0.090) | (0.097) | (0.115) | (0.092) | (0.103) | (0.126) |
| $\Delta C^{hh}$ | 0.048*** | 0.051** | 0.052** | | | | | | |
| | (0.019) | (0.021) | (0.023) | | | | | | |
| $\Delta C^{cor}$ | | | | −0.057*** | −0.080*** | −0.100*** | | | |
| | | | | (0.018) | (0.020) | (0.021) | | | |
| $\Delta C^{pub}$ | | | | | | | −0.042*** | −0.032*** | −0.037*** |
| | | | | | | | (0.010) | (0.011) | (0.011) |
| $\phi$ | −0.631*** | −0.623*** | −0.563*** | −0.619*** | −0.635*** | −0.621*** | −0.651*** | −0.639*** | −0.608*** |
| | (0.057) | (0.054) | (0.055) | (0.059) | (0.061) | (0.068) | (0.056) | (0.064) | (0.063) |
| $N \times T$ | 1672 | 1650 | 1628 | 1672 | 1650 | 1628 | 1672 | 1650 | 1628 |

*Note*: Empirical estimates for the panel ARDL specification of Equation (2) where the dependent variable is output growth ($\Delta Y$), and the vector $X$ contains the series of inflation ($\Delta P$), short-term interest rate ($\Delta R^{short}$), and each debt variable taken one at a time. Lag order of $p$ and $q$ is set to 2, 3, and 4 in each column. $\phi$ is the speed of adjustment to the long-run equilibrium. Sample period 2000Q1-2019Q4 for 22 countries ($N = 22$, $T = 80$) using original series. Standard errors in parentheses. *, **, *** indicate statistical significance at the 10/5/1 percent levels. All specifications contain a constant, which is not reported for brevity.

**TABLE 5** Panel ARDL estimates of long-run effects among output growth, inflation, and short-term interest rates on the three types of debt using the original series (i.e., without de-factoring).

| | **$\Delta C^{hh}$** | | | **$\Delta C^{cor}$** | | | **$\Delta C^{pub}$** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **(a)** | **(b)** | **(c)** | **(a)** | **(b)** | **(c)** | **(a)** | **(b)** | **(c)** |
| $\Delta Y$ | −1.041*** | −0.845*** | −0.550** | −0.172 | −0.092 | −0.389** | −3.223*** | −3.190*** | −2.886*** |
| | (0.155) | (0.200) | (0.239) | (0.128) | (0.140) | (0.172) | (0.183) | (0.189) | (0.214) |
| $\Delta P$ | | 1.924*** | 2.039*** | | 0.291 | 0.542** | | 0.116 | −0.108 |
| | | (0.359) | (0.363) | | (0.253) | (0.253) | | (0.217) | (0.232) |
| $\Delta R^{short}$ | | | −2.896*** | | | 1.454*** | | | −1.217*** |
| | | | (0.484) | | | (0.316) | | | (0.315) |
| $\phi$ | −0.298*** | −0.252*** | −0.252*** | −0.589*** | −0.580*** | −0.560*** | −0.670*** | −0.649*** | −0.630*** |
| | (0.055) | (0.047) | (0.059) | (0.071) | (0.070) | (0.068) | (0.068) | (0.065) | (0.060) |
| $N \times T$ | 1650 | 1650 | 1650 | 1650 | 1650 | 1650 | 1650 | 1650 | 1650 |

*Note*: Empirical estimates for the panel ARDL specification of Equation (2) where the dependent variable consists of either household, corporate, or public debt ($\Delta C^{hh}$, $\Delta C^{cor}$, $\Delta C^{pub}$) and the vector $X$ contains the series of inflation ($\Delta P$), short-term interest rate ($\Delta R^{short}$), and output growth ($\Delta Y$). Lags order of $p$ and $q$ is set to 3 according to the minimum AIC. Sample period 2000Q1-2019Q4 for 22 countries ($N = 22$, $T = 80$) using original series. Standard errors in parentheses. *, **, *** indicate statistical significance at the 10/5/1 percent levels. All specifications contain a constant, which is not reported for brevity.

(b) corroborate the evidence in Table 4 that corporate debt is negatively associated with growth at different lags, so global factors exert only a limited influence on the corporate aggregate. More specifically, we find that a 1% increase in corporate debt is associated with a statistically significant decline in economic growth of 0.058 and 0.071 percentage points after two and three quarters, respectively, which are close to the impacts found when the original series are considered. The evidence of a negative effect of public debt on growth survives also when the de-factored series are used

**TABLE 6** Panel ARDL estimates of the long-run effects of inflation, short-term interest rates, and the debt measures on output growth using the de-factored series.

| | Dep. $\Delta Y$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Panel (a) | | | Panel (b) | | | Panel (c) | | |
| | Lag = 2 | Lag = 3 | Lag = 4 | Lag = 2 | Lag = 3 | Lag = 4 | Lag = 2 | Lag = 3 | Lag = 4 |
| $\Delta P$ | −0.129** | −0.124** | −0.107 | −0.113** | −0.127** | −0.092 | −0.128** | −0.114** | −0.058 |
| | (0.052) | (0.056) | (0.065) | (0.052) | (0.055) | (0.065) | (0.051) | (0.053) | (0.063) |
| $\Delta R^{short}$ | −0.231*** | −0.281*** | −0.408*** | −0.253*** | −0.246*** | −0.336*** | −0.324*** | −0.361*** | −0.476*** |
| | (0.084) | (0.094) | (0.119) | (0.083) | (0.091) | (0.111) | (0.085) | (0.094) | (0.114) |
| $\Delta C^{hh}$ | −0.023 | −0.002 | 0.033 | | | | | | |
| | (0.048) | (0.053) | (0.064) | | | | | | |
| $\Delta C^{cor}$ | | | | −0.058* | −0.071** | −0.103** | | | |
| | | | | (0.032) | (0.036) | (0.041) | | | |
| $\Delta C^{pub}$ | | | | | | | −0.141*** | −0.171*** | −0.168*** |
| | | | | | | | (0.046) | (0.048) | (0.057) |
| $\phi$ | −0.840*** | −0.800*** | −0.726*** | −0.833*** | −0.809*** | −0.743*** | −0.844*** | −0.834*** | −0.754*** |
| | (0.088) | (0.100) | (0.092) | (0.090) | (0.099) | (0.090) | (0.086) | (0.095) | (0.093) |
| $N \times T$ | 1650 | 1628 | 1606 | 1650 | 1628 | 1606 | 1650 | 1628 | 1606 |

*Note*: Empirical estimates for the panel ARDL specification of Equation (2) where the dependent variable is output growth ($\Delta Y$), and the vector $X$ contains the series of inflation ($\Delta P$), short-term interest rate ($\Delta R^{short}$), and each debt variable taken one at a time. Lag order of $p$ and $q$ is set to 2, 3, and 4 in each column. $\phi$ is the speed of adjustment to the long-run equilibrium. Sample period 2000Q1-2019Q4 for 22 countries ($N = 22$, $T = 80$) after de-factoring all series using Equation (1). Standard errors in parentheses. *, **, *** indicate statistical significance at the 10/5/1 percent levels. All specifications contain a constant, which is not reported for brevity.

**TABLE 7** Panel ARDL estimates of the long-run effects among output growth, inflation, and short-term interest rates on the three types of debt using the de-factored series.

| | $\Delta C^{hh}$ | | | $\Delta C^{cor}$ | | | $\Delta C^{pub}$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | (a) | (b) | (c) | (a) | (b) | (c) | (a) | (b) | (c) |
| $\Delta Y$ | −0.110*** | −0.104** | −0.117*** | −0.224*** | −0.219*** | −0.189** | −0.598*** | −0.589*** | −0.557*** |
| | (0.042) | (0.043) | (0.044) | (0.077) | (0.073) | (0.076) | (0.061) | (0.060) | (0.063) |
| $\Delta P$ | | 0.035 | 0.004 | | 0.317*** | 0.275*** | | −0.001 | −0.031 |
| | | (0.067) | (0.068) | | (0.099) | (0.102) | | (0.073) | (0.074) |
| $\Delta R^{short}$ | | | 0.072 | | | 0.070 | | | −0.131 |
| | | | (0.114) | | | (0.160) | | | (0.137) |
| $\phi$ | −0.623*** | −0.583*** | −0.554*** | −0.672*** | −0.661*** | −0.628*** | −0.760*** | −0.752*** | −0.712*** |
| | (0.054) | (0.049) | (0.050) | (0.071) | (0.069) | (0.067) | (0.066) | (0.064) | (0.061) |
| $N \times T$ | 1628 | 1628 | 1628 | 1628 | 1628 | 1628 | 1628 | 1628 | 1628 |

*Note*: Empirical estimates for the panel ARDL specification of Equation (2) where the dependent variable consists of either household, corporate, or public debt ($\Delta C^{hh}$, $\Delta C^{cor}$, $\Delta C^{pub}$) and the vector $X$ contains the series of inflation ($\Delta P$), short-term interest rate ($\Delta R^{short}$), and output growth ($\Delta Y$). Lags order of $p$ and $q$ is set to 3 according to the minimum AIC. Sample period 2000Q1-2019Q4 for 22 countries ($N = 22$, $T = 80$) after de-factoring all series using Equation (1). Standard errors in parentheses. *, **, *** indicate statistical significance at the 10/5/1 percent levels. All specifications contain a constant, which is not reported for brevity.

in place of the original ones. Indeed, the figures in Table 6 show that the impact of public debt on growth remains negative and significant, with a larger magnitude in the de-factored series. Empirical estimates of Panel (c) show that a 1% increase in public debt is associated with a decline of output growth of 0.171 percentage points at three lags, and 0.168 percentage points at four lags. This result is close to Chudik et al. (2017), who also report a negative impact of about 0.12 percentage points of public debt on output growth. To sum up, the evidence obtained so far suggests that global factors exert a strong influence on household and public debt, whereas their role appears weaker for corporate debt.

Tables 5 and 7 present the empirical estimates of the impact of inflation, short-term interest rates, and output growth on the three debt aggregates for the original and de-factored series, respectively. Column (a) displays the results when only output growth is included in the specification, column (b) when both output growth and inflation are included, and column (c) when output, inflation, and short-term interest rates are considered all at once. The figures displayed in Table 5 for the original series suggest an inverse long-run association between output and the three debt aggregates, where the sensitivity of debt to output is, in most cases, negative and significant, regardless of the specification in use. In the case of corporate and public debt, inflation plays a marginal role, significant at the 5% level only for corporate debt. The speed of adjustment is negative, with an absolute value lower than one, and is strongly significant across the three debt aggregates. However, since these results are likely to be affected by CSD, we conduct a companion analysis using the de-factored series.

Table 7 reports the estimates obtained from the panel ARDL applied to the de-factored series. The results provide additional evidence of an inverse relationship between output growth and the three debt aggregates. The coefficients attached to output for household and public debt are, in general, smaller compared to their counterparts based on the original series. In contrast, for corporate debt, the magnitude is roughly the same. For example, a 1% increase in output growth is associated with a 0.117 percentage points decline in household debt as reported in column (c), whereas for the same specification applied to the original series, the decrease is −0.550. A similar pattern emerges for public debt, where the association with growth is about six times larger when we do not purge global factors out. The finding that such sensitivities are smaller than those obtained from the original series (i.e., under the influence of global factors) underscores the role of global interdependence in amplifying the effect of output growth on household and public debt. In other words, these results show that part of the effects of growth on the two debt aggregates is due to international spillovers. These figures also suggest that national policymakers can use growth strategies to reduce both private and public debt. However, in the case of household and public debt, the effectiveness of such policies is constrained by global factors.[23]

Using the de-factored series substantially reduces the significance of short-term interest rates and inflation, suggesting that the global factors in both these variables play an important role. Notably, inflation remains significant, with a positive coefficient of about 0.275 for corporate debt only. This result aligns with prior studies showing that interest rates and inflation incorporate global factors, and it should be interpreted alongside the evidence reported in Tables 2 and 3 (Auer et al., 2017; Byrne et al., 2012).

The speeds of adjustment for household, corporate, and public debt (55.4%, 62.8%, 71.2%, respectively) are negative, lower than one in absolute terms, and statistically significant at the 1% level. These estimates indicate that public debt converges to its long-run equilibrium with output growth faster than household and corporate debt. As argued by Chudik et al. (2017), a quick speed of adjustment is in line with the low persistence of economic growth.

It is worthwhile noting how the idiosyncratic part of the relationships, after de-factoring the series, displays a faster speed of adjustment toward the long-run equilibrium (almost double, in the case of household debt). These results indicate that global common shocks may slow down the speed of adjustment between the financial and the real sectors. This evidence is not affected by the inclusion of inflation and short-term interest rates, with speeds of adjustment ranging from 55.4% to 71.2% for de-factored series compared with 25.2% and 63% for the original ones.

These empirical results bear some important implications. We argue that common factors are a defining element of household debt and its relationship with growth. We conjecture that these factors are likely related to international liquidity spillovers, primarily originating with central banks such as the Fed and the ECB. In turn, such liquidity spillovers might be amplified by retail banks' ability to leverage inflows of credit from abroad. The inflows and outflows of global liquidity can harm domestic economies when they trigger credit booms and busts that domestic central banks cannot tame, creating conditions for systemic crises. Once we purge the influence of such factors, the explanatory power at the idiosyncratic level in the household aggregate is limited, thereby weakening the linkage with growth. Thus, household debt exerts an impact on the real economy mainly through global factors. In this vein, national authorities face a choice: either letting such factors influence their economies, thereby accepting a limitation of monetary policy sovereignty and the exposure of the domestic economy to global liquidity trends, or implementing regulatory frameworks aimed at muting their effects.[24] In this second instance, the benefits of isolating the domestic economy from global liquidity trends come with the flipside of household debt that exerts little impact on the real economy.

Focusing on corporate debt, we find that global factors do not matter much. Clearly, the patterns of results from the original and de-factored series are similar, suggesting that corporate debt is a domestically driven aggregate, less exposed to international shocks. This is not surprising given the evidence in Tables 2 and 3, which suggests that such factors are weaker than those behind household debt. We postulate that corporate debt instruments, being characterized by short-term maturities and their non-collateralized nature, are inherently less susceptible to fluctuations in global financial conditions. This is because such instruments are quickly re-priced in response to local credit supply conditions, rather than broader global liquidity cycles. Moreover, firms in different countries operate under diverse legal and institutional regimes, ranging from bankruptcy codes to bank regulation and bond market depth, which further localize corporate debt behavior and act as constraints on capital flows. Consequently, corporate debt is primarily shaped by country-specific lending standards, financial structures, and regulations with less synchronization across borders (Jordà et al., 2022; Mian et al., 2017). This finding is reassuring for national policymakers as it indicates that corporate debt aggregates remain largely insulated from global spillovers, suggesting that additional capital controls and macroprudential regulations may be less necessary, thus preserving monetary policy sovereignty.

Finally, while global factors exert a strong influence on public debt, it is the interplay of global and domestic shocks that shapes its impact on economic growth. For national policymakers, this again suggests that domestic fiscal tools can be used to manage public debt and its link to growth. In practical terms, this may imply using fiscal policy to reduce debt-to-income ratios or, alternatively, pursuing effective debt sustainability policies by boosting growth.[25]

## 5.4 | Robustness analysis

We carry out a battery of robustness checks on our estimated common factors. First, we modify the method for computing the common factors by not applying standardization to the estimated factors. Instead, we use the non-standardized factors to produce non-standardized versions of the de-factored series. Second, we examine changes in the sample's composition by excluding countries where common factors either dominate the series or are weakly relevant (i.e., those with an $R_i^2$ statistic in Table 3 greater than 70% or less than 25%, respectively). Third, we re-estimate the common factors by using a different dataset consisting of annual series from Jordà et al. (2017) for private debt, and from Chudik et al. (2017) for public debt. In all cases, we find no substantial difference in the results.[26]

We then check the robustness of the panel ARDL results by performing a full array of additional estimations, starting with different lag lengths (one, two, and four). In Appendix A, we report the results of this analysis when the de-factored series of household, corporate, and public debt are used, one at a time, as the dependent variable, with output growth, inflation, and the short-term interest rate as explanatory variables. For household debt in Table A2, the speed of adjustment remains negative and statistically significant across the three specifications, but it varies slightly with the number of lags, ranging from 60.2% to 74.5%. Inflation and the short-term rate play a marginal role in the long-run equilibrium, whereas output growth is always negative and significant, consistent with our previous results. Furthermore, the inflation rate appears to converge toward the long-run equilibrium with output growth and corporate debt, as shown in Table A3, with values ranging between 0.260 and 0.386 percentage points. In the case of public debt, Table A4 shows that the inflation rate and the short-term rate appear to negatively affect public debt in specifications with one and two lags. However, such an effect becomes insignificant with four lags. We also notice that the output growth coefficient ranges from −0.357 to −0.592 percentage points, indicating that the effect of growth is higher on public debt than on the other two private debt aggregates, regardless of the selected lag length. Additionally, one may argue that long-term interest rates are more suitable than short-term rates for our estimations, since the average maturity of the stock of public debt is about 3 years or longer, with corporate debt featuring similar maturities. Therefore, we replace the short-term interest rate with the long-term interest rate when output growth is the dependent variable. The estimates in Table A5 display a pattern of results very similar to those already obtained for the specification that includes the short-term rate, with output growth as the dependent variable.

Finally, in Appendix C we perform an additional robustness check by comparing our approach based on the de-factored series with the CSA-augmented panel ARDL approach used in previous studies on the debt-growth nexus (see e.g., Chudik et al., 2017; Lombardi et al., 2017). Such an analysis makes it possible to assess the implications of alternative strategies for handling CSD.[27] The CSA-augmented panel ARDL specifications yield broadly similar results to those obtained with the de-factored series. However, diagnostic tests based on the Gagliardini et al. (2019) residual-based estimator verify that, unlike our approach based on the de-factored series, the CSA approach does not fully eliminate CSD, as common factors remain in the residuals. These findings confirm the appropriateness of our approach.[28]

## 6 | CONCLUSIONS

In this paper, we reassess the relationship between debt (private and public) and output growth by explicitly controlling for CSD, which the interplay of multiple global unobservable factors may induce. Using a principal component approach, we examine the factor structure of household, corporate, and public debt using a panel of 22 major economies over the period 2000Q1-2019Q4. We find substantial differences among the three aggregates, where household debt and public debt exhibit strong co-movement driven by multiple common factors. In contrast, the influence of common factors on corporate debt is much weaker.

We also find differences in the way the three debt aggregates embed the global common factors at the country level. While some countries' household debt is characterized by strong commonality, where the first common factor explains up to 86% of the series' variability (Greece), other countries are less tied to the same factor, accounting for as little as 13.4% (Brazil). These results likely reflect the diversity of institutional frameworks across countries, which could be a source of divergence, as is the case, especially for corporate debt, where we find greater heterogeneity. Nevertheless, our analysis suggests that empirical models addressing debt in cross-country studies should account for the fact that debt aggregates and their macro determinants embed a complex structure of global factors, which single-factor indicators like CSAs may not always capture. To the best of our knowledge, we are the first to examine the debt-growth nexus from this angle and present evidence in this direction.

When we reassess the debt-growth nexus by contrasting the results from the original series and their de-factored counterparts, we obtain robust evidence that the common factors significantly influence the relationship. The impact of debt on output growth is more negative at the idiosyncratic level than in the original series, where global factors seem to weaken the relationship. There is, however, a weaker idiosyncratic relationship from output growth to debt, with the global factors that appear to strengthen it. It is also compelling that household debt increases output growth when we consider the original series, but it does not when we estimate the relationship at the idiosyncratic level using the de-factored series. This result is interesting from the policy standpoint, indicating that an increase in output growth can lead to a reduction in national public or private debt, even after controlling for the effect of global common factors.

However, globalization, as substantiated in the common factors, matters, and it seems responsible for the propagation of shocks from the financial sector to the real economy in individual countries. This implies that debt sustainability should be modeled and addressed as a global rather than just a local phenomenon. This evidence calls for greater international cooperation in both fiscal and monetary policies and credit market regulation.

Our analysis comes with some caveats. First, the relatively short sample used in the paper limits our ability to assess whether these factors affect the linearity of the relations considered, which would require further investigation in a larger sample. Second, further investigation is needed to understand the observed differences across debt types and the channels of asymmetric transmission of common factors across countries. Finally, our analysis uses private and public debt. Given the role of equity finance in channeling funds to the real economy, the relationship between equity finance and growth, and the roles of global and idiosyncratic shocks are fertile topics for future research.

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### DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in openICPSR at https://doi.org/10.3886/E237688V4, reference number openICPSR-237688 (Casalin et al., 2025).

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### ENDNOTES

[1] In the literature, private "debt" and "credit" are used interchangeably for household and corporate lending. Throughout the paper, we will be using the term private debt.

[2] According to Klein (2017), the impact of fiscal consolidations critically depends on the level of private indebtedness.

[3] These two factors are dubbed the Global Financial Cycle and the Global Trade and Commodity Cycle because they correlate with risk appetite measures, and with commodity, international trade, and world output indices, respectively.

[4] Limited to the post-2008 period, Miranda-Agrippino and Nenova (2022) document that both the Fed and the ECB exert qualitatively similar impacts on global factors (Ca' Zorzi et al., 2020). Miranda-Agrippino and Rey (2020b) show that the shift from conventional to unconventional monetary policies did not affect the Fed's ability to drive global factors.

[5] Isomitdinov et al. (2024), Bhatt et al. (2017), Crucini et al. (2011), and Kose et al. (2012) rely on dynamic factor models to extract common factors from panels of debt-to-GDP ratios and GDP growth. While these models have several desirable properties, they can extract only one common factor from the panel under scrutiny.

[6] Bai (2003) also shows that in panels with $T > N$, PCA has better asymptotic and finite sample performance than the CSA approach.

[7] These feedback effects have been extensively discussed in the literature. For example, Goodhart and Hofmann (2008) argue that the interplay between monetary aggregates and the macroeconomy is multifaceted. Governments, households, and firms might adjust their borrowing habits and leverage structure in response to changing economic conditions, which are in turn correlated with the supply of credit (Beck et al., 2000; Demirci et al., 2019). For example, high indebtedness may have an adverse impact on economic growth, while low GDP growth could also lead to high debt (Beck et al., 2016; Chudik et al., 2016).

[8] The list of countries includes Austria, Australia, Belgium, Brazil, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Israel, Italy, Japan, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, the United Kingdom, and the United States. The need for a balanced panel is dictated by the approach used to account for common factors.

[9] We use the break-adjusted data, as for some countries we observe changes in the sources and measurement methods that might induce breaks in the series.

[10] The data and replication codes used in this study are openly available in openICPSR https://doi.org/10.3886/E237688V4, reference number openICPSR-237688.

[11] The stationarity of common factors $F_{kt}$ is assessed by means of standard univariate unit root tests (Dickey & Fuller, 1979), whereas the stationarity of the idiosyncratic components $\upsilon_{it}$ is assessed by means of pooled Fisher-type tests (Choi, 2001).

[12] The number of factors is unknown and must be defined prior to estimating Equation (1).

[13] Prior to the factor extraction process, the original data are demeaned to account for the observed time trend across $i$. The data are also standardized to remove excessive heteroskedasticity in the panel. Such a pre-whitening procedure is required for consistent estimation of the number of factors (see e.g., Greenaway-McGrevy et al., 2012). Further, the PCA estimator is consistent even in the presence of certain types of unknown breaks or time variation in the factor loadings (Stock & Watson, 2009).

[14] See Pesaran (2015b) for a comprehensive review of the panel ARDL framework.

[15] We notice a lower correlation between corporate debt in our panel. In the following sections, therefore, we use different information criteria to assess the existence of common components in corporate credit.

[16] See online Appendix B1 for specifications of all information criteria used to estimate the number of common factors.

[17] Similar variations for output and prices common factors are also found in Arsova (2020).

[18] The results of Table 2 are consistent with the findings of previous studies on the presence of global factors in private debt, public debt, business cycle, stock markets, inflation, and interest rates (Auer et al., 2017; Byrne et al., 2012; Isomitdinov et al., 2024; Kose et al., 2012; Miranda-Agrippino and Rey, 2015, 2022; Sleibi, 2025; Sleibi et al., 2023).

[19] The growth rate for each type of debt is computed as quarter-on-quarter growth of the average debt for the full cross-section of 22 countries.

[20] Refer to online Appendix B2 for details on the computation of the variance decompositions.

[21] Such a result is in line with the evidence that shocks to debt follow a common pattern in these peripheral Euro countries.

[22] For the evidence of global factors and co-movement in inflation and interest rates, see also, Rogoff (2006), Borio and Filardo (2007), and Ciccarelli and Mojon (2010).

[23] As a back-of-the-envelope robustness check, we apply the Gagliardini et al. (2019) information criterion to the residuals of our panel ARDL estimations using de-factored series. The test indicates that no common factors remain in the panel residuals. For brevity, we do not report these results.

[24] Recently, policymakers have experimented with several measures that have focused on this goal; for example, the Basel III capital cushion that can be activated in boom times, leverage ratios to prevent banks from leveraging up when financing costs are cheap, and loan-to-value ratios to restrain borrowing. Scholars have emphasized how the effectiveness of such measures of capital control is conditional on international cooperation, which may be unfeasible when economies are in different phases of the cycle, and feature different banking sectors, property markets, aggregate demand composition, and central bank preferences (see e.g., Rey, 2014).

[25] The results for public debt are consistent with the prescriptions of standard sustainability analyses positing that the debt-income ratio must be a negative function of GDP growth and inflation (see among others, Bohn, 1998).

[26] These results are available upon request.

[27] We would like to thank an anonymous referee for this suggestion.

[28] For brevity, we do not report these results.

## REFERENCES


Adrian, T., Estrella, A. & Shin, H.S. (2010) Monetary cycles, financial cycles and the business cycle. FRB of New York Staff Report (421).

Agarwal, S., Chomsisengphet, S., Mahoney, N. & Stroebel, J. (2018) Do banks pass through credit expansions to consumers who want to borrow? *Quarterly Journal of Economics*, 133(1), 129–190. Available from: https://doi.org/10.1093/qje/qjx027

Aguiar, M. & Gopinath, G. (2007) Emerging market business cycles: the cycle is the trend. *Journal of Political Economy*, 115(1), 69–102. Available from: https://doi.org/10.1086/511283

Ahn, S.C. & Horenstein, A.R. (2013) Eigenvalue ratio test for the number of factors. *Econometrica*, 81(3), 1203–1227.

Aikman, D., Haldane, A.G. & Nelson, B.D. (2015) Curbing the credit cycle. *The Economic Journal*, 125(585), 1072–1109. Available from: https://doi.org/10.1111/ecoj.12113

Arsova, A. (2020) Exchange rate pass-through to import prices in Europe: a panel cointegration approach. *Empirical Economics*, 61, 1–40. Available from: https://doi.org/10.1007/s00181-020-01858-8

Asea, P.K. & Blomberg, B. (1998) Lending cycles. *Journal of Econometrics*, 83(1), 89–128. Available from: https://doi.org/10.1016/s0304-4076(97)00066-3

Auer, R., Borio, C.E. & Filardo, A.J. (2017) The globalisation of inflation: the growing importance of global value chains. *BIS Working Papers*, 602(300), 1–23. Available from: https://doi.org/10.24149/gwp300

Bai, J. (2003) Inferential theory for factor models of large dimensions. *Econometrica*, 71(1), 135–171. Available from: https://doi.org/10.1111/1468-0262.00392

Bai, J. & Ng, S. (2002) Determining the number of factors in approximate factor models. *Econometrica*, 70(1), 191–221. Available from: https://doi.org/10.1111/1468-0262.00273

Bai, J. & Ng, S. (2004) A PANIC attack on unit roots and cointegration. *Econometrica*, 72(4), 1127–1177. Available from: https://doi.org/10.1111/j.1468-0262.2004.00528.x

Baltas, K.N., Kapetanios, G., Tsionas, E. & Izzeldin, M. (2017) Liquidity creation through efficient M&As: a viable solution for vulnerable banking systems? Evidence from a stress test under a panel VAR methodology. *Journal of Banking & Finance*, 83, 36–56.

Barbaglia, L., Manzan, S. & Tosetti, E. (2024) Household debt and economic growth in Europe. *Macroeconomic Dynamics*, 29, 1–19. Available from: https://doi.org/10.1017/s1365100524000117

Beck, T. & Levine, R. (2004) Stock markets, banks, and growth: panel evidence. *Journal of Banking & Finance*, 28(3), 423–442. Available from: https://doi.org/10.1016/s0378-4266(02)00408-9

Beck, T., Levine, R. & Loayza, N. (2000) Finance and the sources of growth. *Journal of Financial Economics*, 58(1), 261–300. Available from: https://doi.org/10.1016/s0304-405x(00)00072-6

Beck, T., Degryse, H. & Kneer, C. (2014) Is more finance better? Disentangling intermediation and size effects of financial systems. *Journal of Financial Stability*, 10, 50–64. Available from: https://doi.org/10.1016/j.jfs.2013.03.005

Beck, T., Chen, T., Lin, C. & Song, F.M. (2016) Financial innovation: the bright and the dark sides. *Journal of Banking & Finance*, 72, 28–51. Available from: https://doi.org/10.1016/j.jbankfin.2016.06.012

Bernanke, B. (2005) *The global saving glut and the U.S. current account deficit*. Board of Governors of the Federal Reserve System (U.S.). [Online]. Available at: https://EconPapers.repec.org/RePEc:fip:fedgsq:77

Bhatt, V., Kishor, N.K. & Ma, J. (2017) The impact of EMU on bond yield convergence: evidence from a time-varying dynamic factor model. *Journal of Economic Dynamics and Control*, 82, 206–222. Available from: https://doi.org/10.1016/j.jedc.2017.06.008

Bohn, H. (1998) The behavior of US public debt and deficits. *Quarterly Journal of Economics*, 113(3), 949–963. Available from: https://doi.org/10.1162/003355398555793

Borio, C.E. & Filardo, A.J. (2007) Globalisation and inflation: New cross-country evidence on the global determinants of domestic inflation. BIS working paper, no. 227. Bank for International Settlements.

Breitung, J. & Eickmeier, S. (2016) Analyzing international business and financial cycles using multi-level factor models: a comparison of alternative approaches. In: Jan Koopman, S. & Hillebrand, E. (Eds.) *Dynamic factor models*. Leeds: Emerald Group Publishing Limited, pp. 177–214.

Brunnermeier, M.K. & Parker, J.A. (2005) Optimal expectations. *The American Economic Review*, 95(4), 1092–1118. Available from: https://doi.org/10.1257/0002828054825493

Byrne, J.P., Fazio, G. & Fiess, N. (2012) Interest rate co-movements, global factors and the long end of the term spread. *Journal of Banking & Finance*, 36(1), 183–192. Available from: https://doi.org/10.1016/j.jbankfin.2011.07.002

Caglayan, M. & Xu, B. (2016) Inflation volatility effects on the allocation of bank loans. *Journal of Financial Stability*, 24, 27–39. Available from: https://doi.org/10.1016/j.jfs.2016.04.008

Capolupo, R. (2018) Finance, investment and growth: evidence for Italy. *Economic Notes: Review of Banking, Finance and Monetary Economics*, 47(1), 145–186. Available from: https://doi.org/10.1111/ecno.12097

Casalin, F., Fazio, G. and Sleibi, Y. (2025) Replication data and codes for: 'Global shocks and the debt-growth nexus'. Version 4. Available from: https://doi.org/10.3886/E237688V4

Ca' Zorzi, M., Dedola, L., Georgiadis, G., Jarocinski, M., Stracca, L. & Strasser, G. (2020) Monetary policy and its transmission in a globalised world. ECB working papers, 2407. European Central Bank.

Cheron, A., Nishimura, K., Nourry, C., Seegmuller, T. & Venditti, A. (2019) Growth and public debt: what are the relevant trade-offs? *Journal of Money, Credit, and Banking*, 51(2-3), 655–682. Available from: https://doi.org/10.1111/jmcb.12543

Choi, I. (2001) Unit root tests for panel data. *Journal of International Money and Finance*, 20(2), 249–272. Available from: https://doi.org/10.1016/s0261-5606(00)00048-6

Chudik, A. & Pesaran, M.H. (2015) Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors. *Journal of Econometrics*, 188(2), 393–420. Available from: https://doi.org/10.1016/j.jeconom.2015.03.007

Chudik, A., Mohaddes, K., Pesaran, M.H. & Raissi, M. (2016) Long-run effects in large heterogeneous panel data models with cross-sectionally correlated errors. In: *Essays in honor of Aman Ullah. Advances in econometrics*, vol. 36. Leeds: Emerald Group Publishing Limited.

Chudik, A., Mohaddes, K., Pesaran, M.H. & Raissi, M. (2017) Is there a debt-threshold effect on output growth? *The Review of Economics and Statistics*, 99(1), 135–150. Available from: https://doi.org/10.1162/rest_a_00593

Chudik, A., Mohaddes, K., Pesaran, M.H. & Raissi, M. (2018). Rising public debt to GDP can harm economic growth. In: *Economics Letters*. Federal Reserve Bank of Dallas, vol. 13, pp. 1–4.

Ciccarelli, M. & Mojon, B. (2010) Global inflation. *The Review of Economics and Statistics*, 92(3), 524–535. Available from: https://doi.org/10.1162/rest_a_00008

Coletta, M., De Bonis, R. & Piermattei, S. (2019) Household debt in OECD countries: the role of supply-side and demand-side factors. *Social Indicators Research*, 143(3), 1185–1217. Available from: https://doi.org/10.1007/s11205-018-2024-y

Crucini, M.J., Kose, M.A. & Otrok, C. (2011) What are the driving forces of international business cycles? *Review of Economic Dynamics*, 14(1), 156–175. Available from: https://doi.org/10.1016/j.red.2010.09.001

Debelle, G. (2004) Macroeconomic implications of rising household debt. BIS working paper, no. 153. Bank for International Settlements.

Demirci, I., Huang, J. & Sialm, C. (2019) Government debt and corporate leverage: international evidence. *Journal of Financial Economics*, 133(2), 337–356. Available from: https://doi.org/10.1016/j.jfineco.2019.03.009

Dickey, D.A. & Fuller, W.A. (1979) Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74(366a), 427–431. Available from: https://doi.org/10.1080/01621459.1979.10482531

Eickmeier, S., Gambacorta, L. & Hofmann, B. (2014) Understanding global liquidity. *European Economic Review*, 68, 1–18. Available from: https://doi.org/10.1016/j.euroecorev.2014.01.015

Gagliardini, P., Ossola, E. & Scaillet, O. (2019) A diagnostic criterion for approximate factor structure. *Journal of Econometrics*, 212(2), 503–521. Available from: https://doi.org/10.1016/j.jeconom.2019.06.001

Goodhart, C. & Hofmann, B. (2008) House prices, money, credit, and the macroeconomy. *Oxford Review of Economic Policy*, 24(1), 180–205. Available from: https://doi.org/10.1093/oxrep/grn009

Greenaway-McGrevy, R., Han, C. & Sul, D. (2012) Estimating the number of common factors in serially dependent approximate factor models. *Economics Letters*, 116(3), 531–534. Available from: https://doi.org/10.1016/j.econlet.2012.03.031

Gu, Y., Guo, J., Liang, X. & Zhao, Y. (2022) Does the debt-growth link differ across private and public debt? Evidence from China. *Economic Modelling*, 114, 105930. Available from: https://doi.org/10.1016/j.econmod.2022.105930

Guerrieri, V. & Lorenzoni, G. (2017) Credit crises, precautionary savings, and the liquidity trap. *Quarterly Journal of Economics*, 132(3), 1427–1467. Available from: https://doi.org/10.1093/qje/qjx005

Hofmann, B. (2004) The determinants of bank credit in industrialized countries: do property prices matter? *International Finance*, 7(2), 203–234. Available from: https://doi.org/10.1111/j.1367-0271.2004.00136.x

Hofmann, B. & Bogdanova, B. (2012) Taylor rules and monetary policy: a global 'Great Deviation'. In: *BIS Quarterly Review*. Bank for International Settlements. Available from: https://www.bis.org/publ/qtrpdf/r_qt1209f.pdf.

Igan, D., Kabundi, A., Nadal De Simone, F., Pinheiro, M. & Tamirisa, N. (2011) Housing, credit, and real activity cycles: characteristics and comovement. *Journal of Housing Economics*, 20(3), 210–231. Available from: https://doi.org/10.1016/j.jhe.2011.07.002

Isomitdinov, H., Arčabić, V., Lee, J., Yun, Y. & Payne, J.E. (2024) International comovements of public debt. *Economic Inquiry*, 62(2), 722–747. Available from: https://doi.org/10.1111/ecin.13204

Jordà, Ò., Schularick, M. & Taylor, A.M. (2013) When credit bites back. *Journal of Money, Credit, and Banking*, 45(s2), 3–28.

Jordà, Ò., Schularick, M. & Taylor, A.M. (2016) The great mortgaging: housing finance, crises and business cycles. *Economic Policy*, 31(85), 107–152.

Jordà, Ò., Schularick, M. & Taylor, A.M. (2017) Macrofinancial history and the new business cycle facts. *NBER Macroeconomics Annual*, 31, 213–263.

Jordà, Ò., Kornejew, M., Schularick, M. & Taylor, A.M. (2022) Zombies at large? Corporate debt overhang and the macroeconomy. *Review of Financial Studies*, 35(10), 4561–4586.

Kapetanios, G., Mumtaz, H., Stevens, I. & Theodoridis, K. (2012) Assessing the economy-wide effects of quantitative easing. *The Economic Journal*, 122(564), F316–F347. Available from: https://doi.org/10.1111/j.1468-0297.2012.02555.x

Kashyap, A.K., Stein, J.C. & Wilcox, D.W. (1993) Monetary policy and credit conditions: evidence from the composition of external finance. *The American Economic Review*, 83(1), 78–98.

Kilinc, M. & Ulussever, T. (2024) Changing landscape of the finance-growth nexus: industry growth, credit types, and external financial dependence. *Journal of International Financial Markets, Institutions and Money*, 91, 101961. Available from: https://doi.org/10.1016/j.intfin.2024.101961

Klein, M. (2017) Austerity and private debt. *Journal of Money, Credit, and Banking*, 49(7), 1555–1585. Available from: https://doi.org/10.1111/jmcb.12424

Kose, M.A., Otrok, C. & Whiteman, C.H. (2003) International business cycles: world, region, and country-specific factors. *The American Economic Review*, 93(4), 1216–1239. Available from: https://doi.org/10.1257/000282803769206278

Kose, M.A., Otrok, C. & Prasad, E. (2012) Global business cycles: convergence or decoupling? *International Economic Review*, 53(2), 511–538. Available from: https://doi.org/10.5089/9781451870015.001

Kwark, N.-S. (1999) Sources of international business fluctuations: country-specific shocks or worldwide shocks? *Journal of International Economics*, 48(2), 367–385. Available from: https://doi.org/10.1016/s0022-1996(98)00050-6

Lombardi, M.J., Mohanty, M.S. & Shim, I. (2017) The real effects of household debt in the short and long run. BIS working paper, no. 607. Bank for International Settlements.

Mian, A., Rao, K. & Sufi, A. (2013) Household balance sheets, consumption, and the economic slump. *Quarterly Journal of Economics*, 128(4), 1687–1726. Available from: https://doi.org/10.1093/qje/qjt020

Mian, A., Sufi, A. & Verner, E. (2017) Household debt and business cycles worldwide. *Quarterly Journal of Economics*, 132(4), 1755–1817. Available from: https://doi.org/10.1093/qje/qjx017

Mian, A., Sufi, A. & Verner, E. (2020) How does credit supply expansion affect the real economy? The productive capacity and household demand channels. *The Journal of Finance*, 75(2), 949–994. Available from: https://doi.org/10.1111/jofi.12869

Miranda-Agrippino, S. & Nenova, T. (2022) A tale of two global monetary policies. *Journal of International Economics*, 136, 103606. Available from: https://doi.org/10.1016/j.jinteco.2022.103606

Miranda-Agrippino, S. & Rey, H. (2015) *World asset markets and the global financial cycle*. Cambridge: National Bureau of Economic Research, vol. 21722, pp. 1–68.

Miranda-Agrippino, S. & Rey, H. (2020a) US monetary policy and the global financial cycle. *The Review of Economic Studies*, 87(6), 2754–2776. Available from: https://doi.org/10.1093/restud/rdaa019

Miranda-Agrippino, S. & Rey, H. (2020b) The global financial cycle after Lehman. *AEA Papers and Proceedings*, 110, 523–528. Available from: https://doi.org/10.1257/pandp.20201096

Miranda-Agrippino, S. & Rey, H. (2022) The global financial cycle. In Gopinath, G., Helpman, E. & Rogoff, K. (Eds.) *Handbook of international economics*. Amsterdam: Elsevier, vol. 6, pp. 1–43.

Miranda-Agrippino, S., Nenova, T. & Rey, H. (2020) *Global footprints of monetary policies*. London: CFM, Centre for Macroeconomics.

Modigliani, F. (1986) Life cycle, individual thrift, and the wealth of nations. *Science*, 234(4777), 704–712. Available from: https://doi.org/10.1126/science.234.4777.704

Moon, H.R. & Perron, B. (2007) An empirical analysis of nonstationarity in a panel of interest rates with factors. *Journal of Applied Econometrics*, 22(2), 383–400. Available from: https://doi.org/10.1002/jae.931

Moon, H.R. & Weidner, M. (2017) Dynamic linear panel regression models with interactive fixed effects. *Econometric Theory*, 33(1), 158–195. Available from: https://doi.org/10.1017/s0266466615000328

Nadal-De Simone, M.F. (2002) Common and idiosyncratic components in real output: Further international evidence. IMF working paper, no. 02/229. International Monetary Fund.

Onatski, A. (2010) Determining the number of factors from empirical distribution of eigenvalues. *The Review of Economics and Statistics*, 92(4), 1004–1016. Available from: https://doi.org/10.1162/rest_a_00043

Pesaran, M.H. (1997) The role of economic theory in modelling the long run. *The Economic Journal*, 107(440), 178–191. Available from: https://doi.org/10.1111/1468-0297.00151

Pesaran, M.H. (2006) Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica*, 74(4), 967–1012. Available from: https://doi.org/10.1111/j.1468-0262.2006.00692.x

Pesaran, M.H. (2015a) Testing weak cross-sectional dependence in large panels. *Econometric Reviews*, 34(6-10), 1089–1117. Available from: https://doi.org/10.1080/07474938.2014.956623

Pesaran, M.H. (2015b) *Time series and panel data econometrics*. Oxford University Press.

Pesaran, M.H. & Smith, R. (1995) Estimating long-run relationships from dynamic heterogeneous panels. *Journal of Econometrics*, 68(1), 79–113. Available from: https://doi.org/10.1016/0304-4076(94)01644-f

Pesaran, M.H., Shin, Y. & Smith, R.P. (1999) Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, 94(446), 621–634. Available from: https://doi.org/10.1080/01621459.1999.10474156

Reese, S. & Westerlund, J. (2016) PANICCA: PANIC on cross-section averages. *Journal of Applied Econometrics*, 31(6), 961–981. Available from: https://doi.org/10.1002/jae.2487

Reinhart, C.M. & Rogoff, K.S. (2010) Growth in a time of debt. *The American Economic Review*, 100(2), 573–578. Available from: https://doi.org/10.1257/aer.100.2.573

Rey, H. (2014) Capital account management. In Akerlof, G., Blanchard, O., Romer, D. & Stiglitz, J. (Eds.) *What have we learned?: Macroeconomic policy after the crisis*. Cambridge: MIT Press, pp. 307–314.

Rey, H. (2016) *International channels of transmission of monetary policy and the Mundellian trilemma*. NBER working paper no. 21852. National Bureau of Economic Research.

Rogoff, K. (2006) Impact of globalization on monetary policy. In: *The new economic geography: effects and policy implications, proceedings*. Kansas City: Federal Reserve Bank of Kansas City, pp. 265–305.

Sarafidis, V. & Wansbeek, T. (2012) Cross-sectional dependence in panel data analysis. *Econometric Reviews*, 31(5), 483–531. Available from: https://doi.org/10.1080/07474938.2011.611458

Sleibi, Y. (2025) Monetary policy shocks and sectoral heterogeneity in clean energy markets. *Journal of Environmental Management*, 395, 127868. Available from: https://doi.org/10.1016/j.jenvman.2025.127868

Sleibi, Y., Casalin, F. & Fazio, G. (2020) Bank-specific shocks and aggregate leverage: empirical evidence from a panel of developed countries. *Journal of Financial Stability*, 49, 100743. Available from: https://doi.org/10.1016/j.jfs.2020.100743

Sleibi, Y., Casalin, F. & Fazio, G. (2023) Unconventional monetary policies and credit co-movement in the Eurozone. *Journal of International Financial Markets, Institutions and Money*, 85, 101779. Available from: https://doi.org/10.1016/j.intfin.2023.101779

Stock, J.H. & Watson, M. (2009) Forecasting in dynamic factor models subject to structural instability. *The Methodology and Practice of Econometrics. A Festschrift in Honour of David F. Hendry*, 173, 205.

Sul, D. (2019) *Panel data econometrics: common factor analysis for empirical researchers*. Routledge.

Verner, E. & Gyöngyösi, G. (2020) Household debt revaluation and the real economy: evidence from a foreign currency debt crisis. *The American Economic Review*, 110(9), 2667–2702. Available from: https://doi.org/10.1257/aer.20181585

Zhu, X., Asimakopoulos, S. & Kim, J. (2020) Financial development and innovation-led growth: is too much finance better? *Journal of International Money and Finance*, 100, 102083. Available from: https://doi.org/10.1016/j.jimonfin.2019.102083

## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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