Unveiling Asymmetries: Savings-Investment Dynamics Across Quantiles

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Abstract

This paper examines the relationship between the tails of the investment distribution and savings shocks. We focus on potential asymmetries and heterogeneous effects across different quantiles of investment. Drawing on stylized facts, we investigate whether the association between savings and investment varies depending on the state of the economy, particularly during the period of decapitalization of the economy versus the period of significant capital accumulation. Contrary to the assumption of symmetric effects commonly found in the literature, our empirical analysis reveals significant asymmetries in the relationship between savings shocks and investment changes, with stronger links observed for negative shocks compared to positive ones. Furthermore, we find that the strength of this link varies across quantiles of investment and differs between developed and developing countries. Specifically, while negative savings shocks exhibit stronger connections with investment changes during periods of economic stagnation or decapitalization, positive shocks show a more robust association during periods of growth. Our findings suggest a nuanced understanding of the dynamics between savings and investment, highlighting the importance of considering asymmetries and quantile-specific effects.

1 Introduction

The outcomes of research on the link between investment and savings in the economy are associated with two important puzzles in international economics. It is a Feldstein-Horioka puzzle proposed by Feldstein and Horioka (1980) and the recently widely studied allocation puzzle by Gourinchas and Jeanne (2013).

Many theoretical and empirical papers are motivated by the Feldstein-Horioka model (FH puzzle), but the literature is divided into two groups. The first group tries to explain both the puzzle and the relationship between investment and savings using economic theory and the second group tries to find the answer to the puzzles in econometric modeling using the empirical data. We are witnessing a feedback loop as theoretical articles respond to empirical ones and empirical ones respond to theoretical.

The econometric group attempt to identify the parameters of the model with a causal interpretation. However, the focus is overwhelmingly put on the conditional mean (more likely a linear projection), implicitly assuming a symmetric link between investment and a positive or negative shock to savings while also implicitly treating data sets as random sample.

In this paper, we do not attempt to contribute to the vast literature in an attempt to explain the Feldstein-Horioka puzzle or determine a possible causal relationship between saving and investment. Our goal is to focus on the above strong assumptions and provide new interesting empirical results to the discussion.

If we focus on the analysis of the conditional mean we lose information about the association between the investment and savings in atypical (non-average) periods. However, as policy makers, we may be interested in what the relationship between investment and saving is if the economy shows a slump or stagnation in the capital stock. Or conversely, how strong is the link in the case of the significant increase in the capital stock. Our motivation arises from the stylized facts: the number of GDP growth periods is more frequent than the number of slump periods, but the slumps in investment are more severe than the increases. The relationship between savings and investment may therefore depend on the quantile of investment. In this case, we believe savings would have a heterogeneous distributional effect.

Similarly, by focusing on conditional mean, the assumption about the symmetrical strength of the relationship between investment and savings is implicitly placed. However, this assumption is very strong and we would say unrealistic – we can mention the breakthrough works Kahneman and Tversky (2013) and Shiller (2015) emphasizing that nonlinearity is widespread in the economics (social) sciences and that asymmetry is a fundamental aspect of the human judgment . Thus, one might expect the link between a change in investment and a positive/negative shock to saving to be statistically distinguishable and economic agents can be predicted to react markedly different in negative periods.

The study of both problems can help the understanding of the distributional impact of policies in periods of turmoil vs. period of expansion. Knowing the strength of the link between investment and a positive/negative shock in savings in periods that cannot be considered normal (we look at the left and right edges of the investment distribution) can help explain the flows of international capital in turbulent periods, effect of reminiscences and foreign investments on investments in developing countries.

In this paper, we show that a negative shock in savings is significantly strongly associated with investment in the period of decapitalization of the economy, than a positive shock in savings is linked to investment during a period of significant growth. On the contrary, a negative shock has almost no effect on the economy in a period of high investment, and on the contrary, a positive shock in saving is almost not associated with investment in a period when the capital stock in the economy decreases.

Lastly, we also focus on the econometric modeling aspects for the panel data. Various estimators for panel data are currently used in investment-savings analysis, however; the vast majority of authors implicitly assume random selection, i.e. that the cross-sectional units are independent of each other. However, in this case, we are interested in macroeconomic panels where the assumption of independence of cross-sectional units is not realistic, for example, because of common factors causing cross-sectional dependence (Pesaran, 2006). For this reason we construct a model based on FH puzzle extended by effect of global common factors. Our proposed model further assumes a slope heterogeneity of positive and negative shocks in savings across countries and allows us to capture short-term heterogeneous distributional effect of positive/negative saving shocks on the respective quantiles of logarithmic changes in investment.

The rest of the paper is structured as follows. In Section 2, we present a brief overview of the relevant literature alongside the used methodology. In Section 3, we present our results and discuss our findings. We conclude the paper in Section 4.

2 Conceptual framework

The analysis of investments and saving is frequently based on the model by Feldstein and Horioka Feldstein and Horioka (1980) (FH). Feldstein and Horioka (1980) investigate the degree of linear relationship between ratio of investment (I) to GDP and savings (S) to GDP. The form of FH model is then following:

$$\frac{I}{GDP} = \beta_0 + \beta_1 \frac{S}{GDP} + u, \tag{1}$$

where the variable u is a random component. The relationship has been empirically verified many times, in cross-sectional, time series and panel data analysis (Singh, 2016). Although the empirical findings agree on a statistically significant positive linear relationship between $\frac{I}{GDP}$ and $\frac{S}{GDP}$, there is no consensus on the strength of this relationship. Nowadays, the economic theory continues to attempt to provide justifications and theoretical assumptions that correspond to empirical reality, usually through the use of structural models in order to explain this puzzle (Abel and Blanchard, 1983; Coeurdacier et al., 2020).

2.1 Proposed model

In this paper we create our own panel version of the FH model, because we see several significant pitfalls in both the original FH model and its other augmentations that are used in the empirical literature.

The first problem in estimating FH model (1) is the use of the denominator GDP. Under relatively general conditions, regressing the I/GDP and S/GDP ratios yields results in favor of statistically significant relationship between the two variables, even when I and S are independent (Chu, 2012). For these reasons we do not work with the ratio to GDP in this paper, but only with investment I and savings S.

Second, another problem from an econometric point of view is related to the stationarity/non-stationarity of both variables. The literature provides results on unit root testing, where a common conclusion is to reject the hypothesis of the absence of unit root. Subsequently, the conclusion of a cointegrating relationship between the two ratios is often stated (Singh, 2016). Given the jumps in I and S, the high autocorrelation, and the relatively few observations, unit root tests have low power. The same problem is then associated with cointegration testing for which the theory of cointegrated panels is still developing. Thus, the conclusions about the cointegration relationship may be erroneous. On the other hand, it should be mentioned here that there are theoretical justifications for the cointegration relationship between the two variables. Many articles on the topic simply assume the existence of a cointegrating relationship and estimates the long-run relationship from Equation (1).

We want to avoid these problems so we work with logarithmic differences, which remove a possible unit root while mitigating the negative effect of structure breaks in the data. As a result, we analyze the short-run relationship between I and S. A version of the FH model with differenced variables is commonly employed in the literature because of the analysis of the short-run elasticity of capital.

Third, with regard to Kahneman and Tversky (2013) and Shiller (2015), we relax a very strong assumption about the symmetric effect of the change in savings. Raza et al. (2018) investigates the asymmetric version of FH, where the results indicate that negative changes in saving have a stronger effect on investment than positive change. The possible transmission mechanism is justified by the close connection of savings and investments with GDP as GDP reacts asymmetrically to monetary policy. In the case of an expansionary monetary policy, GDP responds less than to a contractionary monetary policy (Cover, 1992). Next, consider variables affecting savings, such as the interest rate. Because of behavioural factors, such as risk-averse agents, rigidity in decision making, etc., people react differently to an increase/decrease in the interest rate, see Grigoli et al. (2018). To test the asymmetric relationship between investment and saving, we work with an extended FH model of the following form:

$$\begin{aligned}\Delta inv_{it} &= \alpha_i + \beta_{1i}\Delta s^{+}_{it} + \beta_{2i}\Delta s^{-}_{it} + \boldsymbol{\omega}_i^T \boldsymbol{f}_t^l + \epsilon_{it}\\ \Delta s^{+}_{it} &= \alpha_i^{+} + \boldsymbol{\psi}_{1i}^T \boldsymbol{f}_{it}^o + \boldsymbol{\gamma}_{1i}^T \boldsymbol{f}_t^l + \epsilon_{1it}\\ \Delta s^{-}_{it} &= \alpha_i^{-} + \boldsymbol{\psi}_{2i}^T \boldsymbol{f}_{it}^o + \boldsymbol{\gamma}_{2i}^T \boldsymbol{f}_t^l + \epsilon_{2it}\end{aligned} \quad , \qquad (2)$$

where subscripts $i = 1,\dots,N$ and $t = 1,\dots,T$ denote the country and the year, respectively, and

- $inv := \log I$, $s := \log S$,
- $\Delta s_{it}^{+} = \max(0,\Delta s_{it})$ a $\Delta s_{it}^{-} = \min(\Delta s_{it},0)$, see Shin et al. (2014),
- $\boldsymbol{f}_t^l$ is an $r \times 1$ vector of latent common factors following covariance stationary process and distributed independently of ϵ_{it}, ϵ_{1it},ϵ_{2it},
- $\boldsymbol{f}_{it}^o$ is an $r \times 1$ vector of observed country specific factors following covariance stationary process and distributed independently of ϵ_{it}, ϵ_{1it},ϵ_{2it},
- $\boldsymbol{\gamma}_i$, $\boldsymbol{\omega}$, $\boldsymbol{\psi}$ is a vector of factor loadings,
- α_i, α_i^{+}, α_i^{-} are national fixed factors possibly correlated with regressors,
- ϵ_{it}, ϵ_{1it},ϵ_{2it}, are exogenous random components that we assume to have zero mean and serially and cross-sectionally independent.

2.2 Common factors

Controlling the common factors $\boldsymbol{f}_t^l$ using the parameter vector $\boldsymbol{\omega}_i$ has its justification in the literature. Giannone and Lenza (2010) demonstrate that the strong correlation between domestic savings and investment can be explained by global shocks, which may have diverse impacts on saving and investment at the country level. Kose et al. (2003) show that all economies share common factors that link them to the global economy. These results are supported by Crucini et al. (2011) who find that the common factors may largely stem from the common technology shocks. We consider that both the change in investment and the change in savings are affected by the same global factors $\boldsymbol{f}_t^l$, but with different intensities – those are included in the vectors of parameters $\boldsymbol{\omega}_i$, $\boldsymbol{\gamma}_{1i}$, and $\boldsymbol{\gamma}_{2i}$. The presence of common factors affecting the correlation between I and S is supported by the literature. The common factors can be considered the world interest rate, global productivity shock, technology shocks (Baxter and Crucini, 1993; Glick and Rogoff, 1995; Tesar, 1991, 1993; Obstfeld, 1986)), uncertainty, international trading cost (Obstfeld and Rogoff, 2000) global GDP development, global investors' risk perceptions Kalemli-Özcan (2019) Specifically, Kalemli-Özcan (2019) shows the impact of U.S. monetary policy and its spillover effects to the rest of the world. Risk perceptions represent a common factor through which the spillover effect is realized. A positive correlation between I and S across time and cross-sectional units is demonstrated by Tesar (1991); Raza et al. (2018); Pata (2018).

The analysis of FH in the presence of cross-sectional dependence can be found, for example, in Pata (2018); Murthy and Ketenci (2020); Raza et al. (2018). However, all the mentioned articles try to explain the FH puzzle using econometrics. At the same time, they interpret the link between investment and savings as an indicator of capital mobility. Raza et al. (2018) conclude that cross-sectional dependence is present in the data, but do not consider cross-section dependencies both in the regression model and in the estimation of the variation matrix.

A list of nationally specific factors $\boldsymbol{f}_{it}^o$ such as demographic structure of the population, productivity shock, financial frictions etc. affecting savings can be found in a large study of the determinants of savings by Grigoli et al. (2018). Further, Chang and Smith (2014) demonstrate that national transitory shocks in the form of productivity shock produce strong co-movement of savings and investment. National fixed factors α_i^+, α_i^-, α_i represent specific factors for a given cross-sectional unit. These are, for example, the development and protection of the capital market.

Crucini et al. (2011) suggest that the common factors may largely stem from common technology shocks. Countries facing different depreciation rates or different capital structure respond to the same technology shock differently (Cesa-Bianchi et al., 2019). However, the assumption of homogeneity of the parameter governing the effect of savings on investment is hard to meet. Moreover, Pesaran (2006) demonstrates that under relatively general assumptions, violation of the parameter homogeneity assumption leads to inconsistent estimates. In our model (2) we therefore work with less restrictive assumption of the random coefficient representation:

$$\mathbf{B}_i = \mathbf{B} + \mathbf{v}_i, \tag{3}$$

where $\mathbf{B}_i = (\beta_{1i}, \beta_{2i}, \omega_i, \gamma_{1i}, \gamma_{2i})$, $\mathbf{B} = (\beta_1, \beta_2, \omega, \gamma_1, \gamma_2)$, $\mathbf{v}_i \sim IID(\mathbf{0}, \boldsymbol{\Omega})$ when $\boldsymbol{\Omega}$ is a symmetric positive definite matrix.

2.3 Parameter estimation

Let us return to the Equation (2) and the effect of common latent factors. The effect of latent factors would results in omitted variable bias. The conditional mean value of Δinv_{it} leads to the following equation:

$$E[\Delta inv_{it}|\boldsymbol{y}_{it},\boldsymbol{f}_t^l] = \alpha_i + \beta_{1i}(\alpha_i^+ + \boldsymbol{\psi}_{1i}^T \boldsymbol{f}_{it}^o + \boldsymbol{\gamma}_{1i}^T \boldsymbol{f}_t^l) + \beta_{2i}(\alpha_i^- + \boldsymbol{\psi}_{2i}^T \boldsymbol{f}_{it}^o + \boldsymbol{\gamma}_{2i}^T \boldsymbol{f}^l) + \boldsymbol{\omega}_i^T \boldsymbol{f}_t^l \tag{4}$$

where $\boldsymbol{y}_{it} = (\Delta s_{it}^+, \Delta s_{it}^-, \boldsymbol{f}_{it}^o)$. To estimate and identify parameters from Equation (2), we use the methodology by Pesaran (2006). However, by focusing only on the conditional mean, we overlook other interesting relationships between the distribution of the dependent variable and the regressors. By estimating the conditional mean, we only get a generalized picture of what is happening on average. But the relationship between I and S is strongly influenced by frictions and market failures (Bai and Zhang, 2010; Coeurdacier et al., 2020, 2015; Eaton et al., 2016), and the impact of frictions and market failures is different in the case of a growing economy or a shrinking economy. Coeurdacier et al. (2015) show how the strength of the correlation increases in turbulent periods and decreases in good times – the heterogeneity in the tightness of the constraint leads to different responses of investments. Different quantiles can be associated with different power of frictions and market failures. For example credit constraints manifest themselves differently depending on the phase of the business cycle (Lown and Morgan, 2006; Jensen et al., 2018). Thus, a quantile-dependent effect of investments on savings can be expected. For this reason, in addition to estimating the conditional mean value from Equation (2), we estimate the heterogeneous distributional effects of the shocks using conditional quantile regression:

$$Q_{\Delta inv_{it}}(\tau|\boldsymbol{x}_{it},\boldsymbol{\Theta}_i(\tau),\boldsymbol{f}^l_t) = \alpha_i(\tau)+\beta_1(\tau)\Delta s^+_{it}+\beta_2(\tau)\Delta s^-_{it}+\boldsymbol{\omega}^T_i(\tau)\boldsymbol{f}^l_t, \tag{5}$$

where $\boldsymbol{x}_{it} = (\Delta s^+_{it}, \Delta s^-_{it})$, $\boldsymbol{\Theta}_i(\tau) = (\alpha_i(\tau), \beta_1(\tau), \beta_2(\tau), \boldsymbol{\omega}^T_i(\tau))$, $Q(.|.)$ represents the function for conditional quantile τ and regressors defined as

$$Q_{\Delta inv_{it}}(\tau|\boldsymbol{F}_{it}) := \inf\{\Delta inv : P(\Delta inv_{it} \leq \Delta inv|\boldsymbol{F}_{it}) \geq \tau\}, \tag{6}$$

where and $\boldsymbol{F}_{it} = (\boldsymbol{x}_{it}, \boldsymbol{\Theta}_i(\tau), \boldsymbol{f}^l_t)^T$. However, Equation (5) cannot be estimated due to unobserved factors $\boldsymbol{f}^l_t$. To include additional global latent common, we follow the approach by Harding and Lamarche (2014); Harding et al. (2020) and approximate these common factors $\boldsymbol{f}^l_t$ by cross-sectional averages of dependent and independent variables. The model is built in a following way:

$$\Delta inv_{it} = a_{0i} + \beta_{1i}\Delta s^+_{it} + \beta_{2i}\Delta s^-_{it} + \delta^T_i \bar{\boldsymbol{z}}_t + u_{it}, \tag{7}$$

where $a_{0i} = \alpha_i + \omega^T_i \boldsymbol{f}_0$ [1], $\bar{\boldsymbol{z}}_t = (\Delta\overline{inv}_t, \bar{\boldsymbol{x}}_t)^T$, $u_{it} = \epsilon_{it} + O_p(N^{-1/2})$ where $O_p(N^{-1/2})$ is associated with approximation of latent factors $\boldsymbol{f}^l_t$ with cross-section averages. The approximate quantile function of (5) is then:

$$Q_{\Delta inv_{it}}(\tau|\boldsymbol{x}_{it},\bar{\boldsymbol{z}}_t,\boldsymbol{\Theta}_i(\tau)^T) = a_{0i}(\tau) + \beta_1(\tau)\Delta s^+_{it} + \beta_2(\tau)\Delta s^-_{it} + \boldsymbol{\delta}^T_i(\tau)\bar{\boldsymbol{z}}_t, \tag{8}$$

where $\boldsymbol{\pi}_i(\tau) = (a_{0i}(\tau), \beta_1(\tau), \beta_2(\tau), \boldsymbol{\delta}^T_i(\tau))^T$. The estimation of the unknown parameters $\boldsymbol{\pi}_i(\tau)$ is obtained by solving the following optimization problem:

$$\hat{\pi}_i(\tau) = \underset{\pi\in\pi_{;i}}{\arg\min} \frac{1}{T}\sum_{t=1}^{T} \rho_\tau(\Delta inv_{it} - a_{0i} - \beta_{1i}\Delta s^+_{it} - \beta_{2i}\Delta s^-_{it} - \delta^T_i \bar{\boldsymbol{z}}_t), \tag{9}$$

where $\pi_i(\tau) := (\boldsymbol{B}_i(\tau), a_{0i}(\tau), \boldsymbol{\delta}^T_i(\tau))$, $\pi_{;i}$ is a compact set, $\rho_\tau(u) = u(\tau - I(u \leq 0))$ represents standard quantile regression loss function Koenker and Bassett Jr (1978) and $u_{it} = \epsilon_{it} + [\alpha_i + \beta_{1i}\Delta s^+_{it} + \beta_{2i}\Delta s^-_{it} + \boldsymbol{\omega}^T_i \boldsymbol{f}^l_t - Q_{\Delta inv_{it}}(\tau|\boldsymbol{x}_{it}, \boldsymbol{\Theta}_i(\tau), \boldsymbol{f}^l_t)]$, for details see Harding et al. (2020). The resulting parameter estimates are obtained as:

$$\hat{\boldsymbol{\pi}}(\tau) = \frac{1}{N}\sum_{i=1}^{N} \hat{\boldsymbol{\pi}}_i(\tau). \tag{10}$$

This approach is called quantile common correlated effect mean group estimator (QMG) (Harding et al., 2020). Such estimator is robust to cross-sectional dependence and allows slope heterogeneity. Variance covariance matrix for $\hat{\boldsymbol{\pi}}(\tau)$ allow for possible spatial forms of weak cross-sectional dependence

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[1] $\boldsymbol{f}_0$ is defined in Harding et al. (2020)

and autocorrelation (Pesaran, 2006; Harding and Lamarche, 2014). The estimation of the variance covariance matrix $Var(\hat{\boldsymbol{\pi}}(\tau))$ is conducted using the bootstrap method according to Hagemann (2017). At the same time, consistent estimates of (8) require the assumption that $\boldsymbol{f}_t^l$ is a covariance stationary process (Pesaran, 2006; Harding et al., 2020).

3 Empirical part

3.1 Data

We employ unbalanced panel data from the World Bank database. The data was obtained for 217 countries for a period from 1994 to 2019 – the analyzed data does not include the pandemic Covid-19. We removed observations from the dataset for periods in which there was a war in the country and we further excluded countries with more than 10 missing observations for the dependent variable to at least partially balance the panel. After these adjustments, we obtained a panel with a cross-sectional dimension of 132 countries. We define investment as *Gross fixed capital formation (current US)*, and we define savings as *Gross domestic savings (current US)*. The approximation of investment by *Gross fixed capital formation* is used, for example, by Drakos et al. (2017). Countries are further categorized into *High* income and *Low and Middle* income categories, using the well-established Atlas method [2] employed by the World Bank. For the newly created panel, we introduce a dummy variable LOW-MID, where LOW-MID $= 1$ denotes a country in the *Low and Middle* cluster and LOW-MID $= 0$ represents countries in HIGH cluster.

3.2 Sample

Basic descriptive statistics are summarized in Table 1. The column labeled N represents the total number of observations, the last column labeled NA represents the number of missing observations. Countries in LOW-MID group show higher variability in all three observed variables. This high variability is reflected in a significantly larger range of minima and maxima. However, in absolute value, the higher minimum and maximum is mainly due to extreme observations. If we look at the values of the 10 % (q_{10}) and 90 % (q_{90}) quantiles, the differences between the two groups of countries are not as pronounced. The dependent variable Δinv for both groups shows only a slight negative skewness. In contrast, kurtosis is very significant for countries in LOW-MID group, which corresponds to a significant standard error.

Table 2 shows the number of observations for the selected quantiles of the Δinv distribution. The higher proportion of positive observations relative to negative observations in savings corresponds to the stylized fact that there are more up periods than down periods. The number of observations for

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[2] `https://datahelpdesk.worldbank.org/knowledgebase/articles/378832-the-world-bank-atlas-method-detailed-methodology`

each quantile suggests that we might expect a relationship between conditional quantiles up to 50% quantile and a negative shock in savings, and vice versa for conditional quantiles above 50% and a positive shock in savings.

Table 1: Summary Statistics

Country	Variable	N	Mean	Std.	Min	q_{10}	Median	q_{90}	Max	Skew.	Kurt.	NA
HIGH	Δinv	1233	0.05	0.15	−0.82	−0.12	0.05	0.22	0.68	−0.27	5.85	67
HIGH	Δs^{+}	1230	0.09	0.12	0.00	0.00	0.06	0.23	1.21	3.06	19.7	70
HIGH	Δs^{-}	1230	−0.03	0.09	−1.37	−0.11	0.00	0.00	0.00	−5.58	54.64	70
LOW-MID	Δinv	2031	0.08	0.24	−2.33	−0.13	0.08	0.29	2.95	−0.23	25.88	101
LOW-MID	Δs^{+}	1969	0.16	0.28	0.00	0.00	0.08	0.37	3.98	5.82	56.75	163
LOW-MID	Δs^{-}	1969	−0.08	0.27	−6.46	−0.24	0.00	0.00	0.00	−10.20	182.66	163

Table 2: Number of observations for each quantile

Country	Quantile	N	$N_{\Delta s^{+}}$	$N_{\Delta s^{-}}$
HIGH	q_{10}	103	22	81
HIGH	$q_{10} - q_{25}$	168	65	103
HIGH	$q_{25} - q_{75}$	530	423	107
HIGH	$q_{75} - q_{90}$	160	149	11
HIGH	$q_{90}+$	69	65	4
LOW-MID	q_{10}	200	51	149
LOW-MID	$q_{10} - q_{25}$	278	95	183
LOW-MID	$q_{25} - q_{75}$	896	624	272
LOW-MID	$q_{75} - q_{90}$	290	243	47
LOW-MID	$q_{90}+$	249	223	26

3.3 Preliminary analysis

The unit root test is performed for the variable s and inv for lags 0 to 3. We choose the number of lags according to the rule of thumbs (Pesaran, 2007). We apply first generation unit root test by Maddala and Wu (1999) and second generation unit root test CIPS by Pesaran (2007). For both tests we test the version with drift and the version with drift and deterministic trend. For both variables we can not reject the null hypothesis of a unit root presence in all cases. After the first logarithmic difference, we can reject H_0 for $\alpha = 0.01$. The data suggest that both variables follow an $I(1)$ process.

Further, we test the presence of cross-sectional dependence by the Pesaran CD test for weak cross-sectional dependence (Pesaran, 2021). In the case of Δinv, the test statistic is equal to 110.44 and the p-value is < 0.01. We reject H_0 for no cross-sectional dependence. In the case of Δs, the value of the test statistic is equal to 84.55 and the p-value is < 0.01. Again, we reject H_0 for no cross-sectional dependence. Corresponding conclusions about the presence of cross-sectional dependence can be found, for example, in Pata (2018); Murthy and Ketenci (2020); Raza et al. (2018).

3.4 Main analysis

In the empirical part we employ the extended Equation (8) in the following form:

$$Q_{\Delta inv_{it}}(\tau|\boldsymbol{x}_{it},\bar{\boldsymbol{z}}_t) = \alpha_i(\tau) + \beta_1(\tau)\Delta s_{it}^{+} + \beta_2(\tau)\Delta s_{it}^{-} + \gamma_{i0}(\tau)D + \gamma_{i1}(\tau)D\Delta s_{it}^{+} + \gamma_{i2}(\tau)D\Delta s_{it}^{-} + \boldsymbol{\delta}_i^T(\tau)\bar{\boldsymbol{z}}_t, \tag{11}$$

where D represents a dummy variable for countries in the LOW-MID income group. The estimation results of Equation (11) are shown in Table 3. The columns labeled q represent the estimation for the respective quantile. The last column, labeled CCEMG, represents the estimate of the conditional mean using the CCEMG estimator by Pesaran (2006).

The testing of the quantile-dependent effect is based on the Wald-type statistics (Koenker and Bassett, 1982). The test is robust to cross-sectional dependence by using the variance matrix estimator by Hagemann (2017). The hypothesis for a positive shock has the following form:

$$\begin{aligned} H_0 &: \beta_1(\tau_i) + \gamma_1(\tau_i)\text{LOW-MID} = \beta_1(\tau_j) + \gamma_1(\tau_j)\text{LOW-MID}, \\ H_1 &: \beta_1(\tau_i) + \gamma_1(\tau_i)\text{LOW-MID} \neq \beta_1(\tau_j) + \gamma_1(\tau_j)\text{LOW-MID}, \end{aligned} \tag{12}$$

where $i \neq j$ for LOW-MID $= 0$ (HIGH) and for LOW-MID $= 1$ and $\tau \in (10, 25, 50, 75, 90)$ represents quantile. In the case of negative shocks, the hypothesis has the following form:

$$\begin{aligned} H_0 &: \beta_2(\tau_i) + \gamma_2(\tau_i)\text{LOW-MID} = \beta_2(\tau_j) + \gamma_2(\tau_j)\text{LOW-MID}, \\ H_1 &: \beta_2(\tau_i) + \gamma_2(\tau_i)\text{LOW-MID} \neq \beta_2(\tau_j) + \gamma_2(\tau_j)\text{LOW-MID}, \end{aligned} \tag{13}$$

where $i \neq j$ for LOW-MID $= 0$ (HIGH) and for LOW-MID $= 1$. The results are shown in Table 4. The Table contains the results of the test statistics for all combinations of parameters. Since we are interested in distributional heterogeneity, we evaluate the test results for consecutive quantiles. That is, q_{10} vs q_{25}, q_{25} vs q_{50}, q_{50} vs q_{75}, and q_{75} vs q_{90}.

In addition to the quantile-dependent effect, we test whether there is an asymmetric response of investment to a positive/negative shock in savings. The Wald-type statistics by Koenker test (Koenker and Bassett, 1982) with robust covariance matrix estimator by Hagemann (2017) is again used for this purpose. The hypothesis has the following form

$$\begin{aligned} H_0 &: \beta_1(\tau_i) + \gamma_1(\tau_i)\textsc{Low-Mid} = \beta_2(\tau_i) + \gamma_2(\tau_i)\textsc{Low-Mid}, \\ H_1 &: \beta_1(\tau_i) + \gamma_1(\tau_i)\textsc{Low-Mid} \neq \beta_2(\tau_i) + \gamma_2(\tau_i)\textsc{Low-Mid}. \end{aligned} \tag{14}$$

The results of the test are shown in Table 5. Further analysis is divided into a section on HIGH income countries and for LOW-MID income countries. In addition, the section on LOW-MID income countries contains a more detailed discussion of the empirical findings.

3.4.1 High income countries

Positive shocks. Significant parameters governing link between Δs^+ and Δinv for HIGH income countries are associated with quantiles q_{25}, q_{50}, q_{75}, and q_{90} and we can see the strength of the link grows with increasing quantile, when $\hat{\beta}_1(0.25) = 0.255$ to $\hat{\beta}_1(0.90) = 0.503$. The upward trend in the parameter, the presence of a quantile effect, is also supported by the hypothesis assessment of (12) in Table 4. With increasing quantile, the strength of link between Δs^+ and Δinv rises, from q_{10} to q_{75}. Only for quantiles q_{75} vs. q_{90}, we are unable to distinguish the strength of the link between Δs^+ and Δinv. The left-hand side of the distribution Δinv is either not at all or only weakly linked to Δs^+, and conversely the right-hand side of the distribution Δinv shows a statistically significant stronger link with Δs^+.

Negative shocks. The effect of negative shock Δs^- is statistically significant for quantiles q_{10}, q_{25}, and q_{50}, as presented in Table 3. Although the parameter $\beta_2(0.75)$ is not statistically significant for the quantile q_{75}, the parameter estimate is nevertheless not negligible, with $\hat{\beta}_2(0.75) = 0.194$. However, because of the large variance, the null hypothesis of statistical insignificance cannot be rejected. Again, we can see the trend behaviour of the parameter estimate β_2 with increasing quantiles. But in this case the trend is negative and the strength of the link between Δs^- and Δinv decreases from q_{10} to q_{50}. The presence of a heterogeneous distributional effects are again indicated by the rejection of the null hypothesis (13) for the Wald test whose results are in Table 4. For the quantiles q_{75} and q_{90}, the variable Δs^- is no longer a statistically significant factor. Interestingly, for $\beta_2(0.10)$ the null hypothesis of unit elasticity cannot be rejected. In this case we see the opposite phenomenon to Δs^+. The left-hand side of the distribution Δinv is very strongly linked to Δs^- and, conversely, the right-hand side of the distribution Δinv shows no statistically significant link to Δs^-.

Discussion. Simultaneously, upon examining the individual quantiles, our assessment of the hypothesis concerning an asymmetrical connection between savings and investment (see (14)) leads to the conclusion that there exists a statistically significant disparity in the relationship between Δinv and Δs^+, as well as between Δinv and Δs^-. The findings of the Wald test can be found in Table 5.

The quantile effect is present for the left-hand side of the Δinv distribution and the negative shock Δs^-. In contrast, for the right-hand side of the distribution Δinv and the positive shock Δs^+, the data do not favor the quantile effect. Results from Table 3 show that the left part of the distribution Δinv is more strongly linked to the negative shock Δs^- than the right part of the distribution Δinv is linked to the positive shock Δs^+. One possible explanation is the more intense influence of financial frictions (Bai and Zhang, 2010), whose intensity increases during turmoils periods (David et al., 2020; Coeurdacier et al., 2015).

In Table 3 the estimates of the parameters β_1 and β_2 for the conditional mean are also presented. The results are in the column named CCEMG. The parameters for the conditional mean are statistically significant. The estimate of the effect of Δs^+ is $\hat{\beta}_1 = 0.287$ and the estimate of the effect of Δs^- is $\hat{\beta}_2 = 0.379$. Comparing the results with the conditional quantiles, the estimate of the effect of the positive shock (0.287) corresponds approximately to the parameter estimate for the quantile q_{25} and the estimate of the effect of the negative shock (0.379) corresponds to the range of quantiles q_{50}-q_{75}. The reason for this substantial heterogeneity is higher kurtosis of the distribution.

In the case of the conditional mean, the data support the presence an asymmetric effect since there is a statistically significant difference between parameter β_1 and parameter β_2. Furthermore, the data indicates a stronger link between Δinv & Δs^- compared to Δinv & Δs^+. These findings are consistent with the results from the quantile regression.

3.4.2 Low-Middle income countries

We now turn to an assessment of the effect for countries in the LOW-MID group. The differential strength of the link between shocks Δs^+ / Δs^- and Δinv between HIGH income and LOW-MID income countries is tested in rows named with $\Delta s^+ \times$ LOW-MID and $\Delta s^- \times$ LOW-MID in Table 3. These are estimates of the parameters γ_0, γ_1 and γ_2 from Equation (11). For both positive and negative shocks, the link between Δinv and the savings shock comes out lower, than for countries in HIGH group.

Positive shocks. In the case of positive shock (Δs^+) statistically significant parameters are associated with the quantiles q_{25},q_{50}, q_{75}. For the negative shock Δs^-, statistically significant parameters are associated with the quantiles q_{25} and q_{50}. However, when we look at the estimate for q_{10} $\hat{\gamma}_2(0.10) = -0.262$ and q_{75} $\hat{\gamma}_2(0.75) = -0.156$ we see relatively high values. Although the parameters $\gamma_2(0.10)$ and $\gamma_2(0.75)$ are not statistically significant we acknowledge the possibility that we are introducing an error type II. More significant drop in the parameter estimate is associated with a negative shock and we can see stronger promotion of negative shock than positive shock.

The last two lines from Table 3 show the estimates of parameters $\phi_1 = \beta_1(\tau_i) + \gamma_1(\tau_i)$ and $\phi_2 = \beta_2(\tau_i) + \gamma_2(\tau_i)$ from (11). These are parameters controlling the strength of link between Δinv

& Δs^- and Δinv & Δs^+. A statistically significant positive shock effect Δs^+ is associated with quantiles q_{25}, q_{50}, q_{75} and q_{90}. However, we do not interpret the parameter estimate for q_{25} despite its statistical significance. The estimated parameter is equal to 0.044 and we do not consider an effect to be economically significant. From Table 4 we can see again the presence of a quantile effect for q_{25}, q_{50}, q_{75}. The strength of the link increases from the quantile q_{25} $\hat{\phi}_1(0.25) = \hat{\beta}_1(0.25) + \hat{\gamma}_1(0.25) \approx 0$ to the quantile q_{75} $\hat{\phi}_1(0.75) = \hat{\beta}_1(0.75) + \hat{\gamma}_1(0.75) = 0.311$. In the case of quantile q_{75} and q_{90}, we can no longer distinguish the quantile effect of the positive shock on Δinv. The conclusions are similar to those for High group, except that the effects are significantly smaller for countries in Low-Mid group.

Negative shocks. The negative shock Δs^- is a statistically significant factor for the quantile q_{10} when $\hat{\phi}_2(0.10) = \hat{\beta}_2(0.10) + \hat{\gamma}_2(0.10) = 0.833$ up to the quantile q_{75} where $\hat{\phi}_2(0.75) = \hat{\beta}_2(0.75) + \hat{\gamma}_2(0.75) = 0.038$. However, we again consider the parameter $\phi_2(0.75) = \beta_2(0.75) + \gamma_2(0.75)$ to be economically insignificant. Furthermore, we cannot reject the null hypothesis of unit elasticity for the parameter $\phi_2(0.10) = \beta_2(0.10) + \gamma_2(0.10)$, as was the case for High countries. The quantile effect of the negative shock is present for q_{10}, q_{25}, q_{50}, q_{75}, see Table 4. In contrast, the quantile effect is absent for the right side of the distribution Δinv and the negative shock Δs^-, the data do not support a quantile effect for Δs^- for q_{75} and q_{90}. These conclusions are identical to the analysis of countries in High cluster.

Discussion. The conclusions about the effect of positive and negative shocks on individual quantiles of Δinv can be summarized as follows. The right side of the Δinv distribution is more strongly linked with Δs^+ than the left side of the Δinv distribution and next the left side of the Δinv distribution is more strongly linked with Δs^- than the right side of the Δinv distribution, see Table 4. At the same time, the left-hand side of the distribution Δinv is more strongly linked to Δs^- than the right-hand side of the distribution is linked to Δs^+. The findings are consistent with those in High income group, only Low-Mid income group showing a weaker link.

An explanation of this empirical finding can be found in the literature. The stronger link between domestic savings and investment for High than for Low-Mid group can be explained by the allocation puzzle. Gourinchas and Jeanne (2013) show that capital tends to flow more to countries with lower productivity growth and investment. Developing countries with low productivity growth tend to experience higher inflows of foreign capital than developed countries with high productivity growth. At the same time, Low-Mid countries relies heavily on foreign aid and remittances (Baldé, 2011). Remittances represent the prevailing source of financing for low-income countries and these financial flows are critical to finance development (Combes et al., 2019). Moreover, during periods of crises remittances work as a buffer to smooth consumption when when the economy suffers an economic contraction (Bahadir et al., 2018). Nevertheless only part of the allocation puzzle can be explained by foreign aid (Gourinchas and Jeanne, 2013). Another factor contributing to the attenuation of the connection between investment and savings in LOW-MID countries is the influence of Chinese credit. China is the largest creditor developing and emerging economies (Horn et al., 2021).

Further, the strength of the link between investment and savings is influenced by common factors. Kose et al. (2003) find that all economies share common factors that link them to the global economy; these common factors have a stronger effect in advanced economies. As advanced economies have a larger common component with the global economy compared to emerging economies, they are also expected to have a higher correlation between savings and investment. Another common factor is the local capital market(financial system). HIGH income countries have a more developed capital market with a significant banking sector. Domestic funds are a more important source of economic growth than foreign direct investment in bank-centered economies, where these resources are distributed through the banking sector (Bermejo Carbonell and Werner, 2018; Werner, 2002). This again creates a stronger link between investment and domestic savings.

The explanation for the very strong link between the negative shock Δs^{-} and the left-hand side of the distribution Δinv can be further supported by the presence of frictions. Bai and Zhang (2010) show that the relationship between I and S can be deduced from two types of financial frictions, namely limited enforcement and limited spanning. A negative saving shock arising during a period when the economy is on the left-hand side of the Δinv distribution corresponds to a decapitalisation or stagnation in investment. In turmoils, financial frictions increase in relevance, strengthening the link between investment and savings (Coeurdacier et al., 2015). In negative periods, adverse selection problem increases and the correlation between investment and savings increases (David et al., 2020). In terms of FH, we could refer to near capital immobility. The reason why LOW-MID countries exhibit a lower coupling between the left-hand side of the Δinv and Δs^{-} distributions can be attributed again to the inflow of foreign aid and remittances (Baldé, 2011; Bahadir et al., 2018; Combes et al., 2019) and Chinese credit (Horn et al., 2021).

In contrast to HIGH income countries, the data do not support an asymmetric link between Δinv & Δs^{+} vs Δinv & Δs^{-}. for q_{50}, see Table 5. For the remaining quantiles, the data already support an asymmetric link between the related quantile of Δinv and the positive/negative shock in savings. Again, this phenomenon can be explained by the strength of financial frictions for a negative shock to savings (Bai and Zhang, 2010; David et al., 2020) and turmoils periods (Coeurdacier et al., 2015). In contrast, the asymmetric behaviour for the right-hand side of the distribution can be explained by international borrowing (Benigno et al., 2022) constraints and insufficient liquidity access for firms to finance investments during periods of rapid expansion (Bacchetta and Benhima, 2015).

If we compare the quantile regression results with the conditional mean value estimates (CCEMG) we see an interesting puzzle. The conditional mean estimate indicates a positive and statistically significant effect for both Δs^+ ($\hat{\gamma}_1 = 0.095$) and Δs^- ($\hat{\gamma}_2 = 0.131$). Based on the conditional mean analysis, we would conclude that the link between Δinv and $\Delta s^+/\Delta s^-$ is stronger for countries in the Low-Mid group than for countries in High group.

For instance, the study by Kalemli-Özcan (2019) indirectly supports a stronger correlation between I and S for Emerging Market Economies through the concept of "global investors' risk perceptions." Kalemli-Özcan (2019) contends that due to country-specific risks, Emerging Market Economies exhibit greater sensitivity to shifts in global investors' risk perceptions compared to Advanced Economies. Consequently, capital flows to Emerging Market Economies are reduced, thereby potentially amplifying the relationship between investment and savings. Similar conclusions are also reported in Baldé (2011). Nevertheless, our analysis reveals differences when comparing results based on conditional quantiles versus the conditional mean in the leptokurtic distribution of the variable Δinv.

Table 3: Estimated coefficients with standard errors in parenthesis.

Variable	$q_{0.1}$	$q_{0.25}$	$q_{0.5}$	$q_{0.75}$	$q_{0.9}$	CCEMG
Intercept	−0.0785***	−0.0511***	−0.0092*	0.0298***	0.0877***	
	(0.0124)	(0.0068)	(0.0052)	(0.0051)	(0.0105)	
Δs^+	−0.0053	0.2548***	0.3594***	0.4654***	0.5027***	0.2871***
	(0.1057)	(0.0627)	(0.0642)	(0.0561)	(0.0684)	(0.0293)
Δs^-	1.0951***	0.7676***	0.5464***	0.1942	0.0744	0.3788***
	(0.2065)	(0.1113)	(0.1221)	(0.1324)	(0.0572)	(0.0684)
Low-Mid	−0.0055	0.0195**	0.0302***	0.0452***	0.0558***	0
	(0.0159)	(0.0089)	(0.0082)	(0.0094)	(0.0138)	0
$\Delta s^+ \times$ Low-Mid	0.0347	−0.2106***	−0.2180***	−0.1547**	−0.0813	0.0950***
	(0.1079)	(0.0648)	(0.0707)	(0.0682)	(0.0822)	(0.0139)
$\Delta s^- \times$ Low-Mid	−0.2621	−0.4241***	−0.4391***	-0.1559	−0.0960	0.131***
	(0.2363)	(0.1525)	(0.1278)	(0.1334)	(0.0672)	(0.0444)
$\Delta s^+_{\text{Low-Mid}}$	0.0293	0.0442**	0.1414***	0.3106***	0.4214***	-
	(0.0247)	(0.0162)	(0.0335)	(0.0447)	(0.0499)	-
$\Delta s^-_{\text{Low-Mid}}$	0.8330***	0.3435***	0.1073**	0.0382***	−0.0216	-
	(0.1359)	(0.1339)	(0.0607)	(0.0169)	(0.0372)	

Note: Asterisks denote significance at the 10% (*), 5% (**), and 1% (***) levels. Data in brackets represent standard errors.

3.5 Robustness analysis

Other variables were also examined in the analysis. Specifically, the effect of economics uncertainty (*Total finance uncertainty* and *Economic inance uncertainty*), measured using indices constructed from the article Jurado et al. (2015). We measured the effect of uncertainty at time t as well as for lags $t-1$ and $t-2$. However, this modification of the model had a negligible effect on the results.

We also tested extended model (8) to include the change in net foreign investment at time t. However, due to the loss of degrees of freedom, it was not possible to include all variables. Therefore, different combinations of extensions to the (8) model were explored. All of these variations ultimately had a negligible effect on the main results, so we only present a model with savings and control variables for common effects.

Unlike other studies, we do not include regressor GDP in the model due to the overcontrolling effect. Investment and savings are part of the computation of GDP and for this reason it is misleading to assume a ceteris paribus effect. Thus, it is not possible to consider the change in savings with a zero change in GDP.

4 Conclusion

The results from our model show a statistically significant link between the right-hand side distribution of the Δinv and a positive shock to savings Δs^{+}, and between the left-hand side distribution of the Δinv and a negative shock to savings Δs^{-}. The results support a quantile-dependent effect between Δinv and Δs^{+} / Δs^{-}. Asymmetric link between Δinv and the shocks Δs^{+} / Δs^{-} are also present, when the negative shock Δs^{-} shows a stronger link than the positive shock Δs^{+}. Indeed, one reason for the presence of the quantile effect is the kurtosis of the distribution Δinv and so the estimation of the conditional mean provides a oversimplified picture of the link between Δinv and Δs^{+} / Δs^{-}. The analysis is presented for two groups of countries, divided into HIGH and LOW-MID income countries. All these phenomena are exhibited by both HIGH and LOW-MID income countries. However, countries in the LOW-MID income exhibit a weaker quantile-dependent link for negative and positive shocks to savings. Specifically for LOW-MID income countries, our results suggest that if countries are in a period of investment stagnation or even decapitalization, the link between a positive shock in savings Δs^{+} and Δinv is statistically or economically insignificant. Conversely, a negative shock in savings Δs^{-} is strongly associated with a period of stagnation/decapitalization. On the other hand, if there is a significant increase in capital in the economy, a negative saving shock Δs^{-} is not associated with an increase in investment Δinv. Conversely, a positive saving shock Δs^{+} shows a statistically and economically significant association with investment Δinv. However, this link is weaker than in the case of decapitalisation and the negative savings shock Δs^{-}. Throughout the paper, we avoid a causal interpretation, and therefore we do not intend to argue that, for example, in the case of a period of economic decapitalization in LOW-MID income countries, a positive shock in savings will not affect the quantity of capital in the same way as a negative shock in a period of strong investment activity. In this paper, we only want to highlight the interesting pattern between investment Δinv and savings shocks $\Delta s^{+}/\ \Delta s^{-}$ with respect to parameter identification in the presence of global factors.

References

Abel, A.B., Blanchard, O.J., 1983. An intertemporal model of saving and investment. Econometrica: Journal of the Econometric Society , 675–692.

Bacchetta, P., Benhima, K., 2015. The demand for liquid assets, corporate saving, and international capital flows. Journal of the European Economic Association 13, 1101–1135.

Bahadir, B., Chatterjee, S., Lebesmuehlbacher, T., 2018. The macroeconomic consequences of remittances. Journal of International Economics 111, 214–232.

Bai, Y., Zhang, J., 2010. Solving the feldstein–horioka puzzle with financial frictions. Econometrica 78, 603–632.

Baldé, Y., 2011. The impact of remittances and foreign aid on savings/investment in sub-saharan africa. African Development Review 23, 247–262.

Baxter, M., Crucini, M.J., 1993. Explaining saving–investment correlations. The American Economic Review , 416–436.

Benigno, G., Fornaro, L., Wolf, M., 2022. Reserve accumulation, growth and financial crises. Journal of International Economics 139, 103660.

Bermejo Carbonell, J., Werner, R.A., 2018. Does foreign direct investment generate economic growth? a new empirical approach applied to spain. Economic geography 94, 425–456.

Cesa-Bianchi, A., Imbs, J., Saleheen, J., 2019. Finance and synchronization. Journal of International Economics 116, 74–87.

Chang, Y., Smith, R.T., 2014. Feldstein–horioka puzzles. European Economic Review 72, 98–112.

Chu, K.H., 2012. The feldstein-horioka puzzle and spurious ratio correlation. Journal of International Money and Finance 31, 292–309.

Coeurdacier, N., Guibaud, S., Jin, K., 2015. Credit constraints and growth in a global economy. American Economic Review 105, 2838–2881.

Coeurdacier, N., Rey, H., Winant, P., 2020. Financial integration and growth in a risky world. Journal of Monetary Economics 112, 1–21.

Combes, J.L., Kinda, T., Ouedraogo, R., Plane, P., 2019. Financial flows and economic growth in developing countries. Economic Modelling 83, 195–209.

Cover, J.P., 1992. Asymmetric effects of positive and negative money-supply shocks. The Quarterly Journal of Economics 107, 1261–1282.

Crucini, M.J., Kose, M.A., Otrok, C., 2011. What are the driving forces of international business cycles? Review of Economic Dynamics 14, 156–175.

David, A., Goncalves, C., Werner, A.M., 2020. Reexamining the national savings-investment nexus across time and countries1. IMF Working Papers 2020.

Drakos, A.A., Kouretas, G.P., Stavroyiannis, S., Zarangas, L., 2017. Is the feldstein-horioka puzzle still with us? national saving-investment dynamics and international capital mobility: A panel data analysis across eu member countries. Journal of International Financial Markets, Institutions and Money 47, 76–88.

Eaton, J., Kortum, S., Neiman, B., 2016. Obstfeld and rogoff's international macro puzzles: A quantitative assessment. Journal of Economic Dynamics and Control 72, 5–23.

Feldstein, M., Horioka, C., 1980. Domestic saving and international capital flows. The economic journal 90, 314–329.

Giannone, D., Lenza, M., 2010. The feldstein-horioka fact, in: NBER International Seminar on Macroeconomics, The University of Chicago Press Chicago, IL. pp. 103–117.

Glick, R., Rogoff, K., 1995. Global versus country-specific productivity shocks and the current account. Journal of Monetary economics 35, 159–192.

Gourinchas, P.O., Jeanne, O., 2013. Capital flows to developing countries: The allocation puzzle. Review of Economic Studies 80, 1484–1515.

Grigoli, F., Herman, A., Schmidt-Hebbel, K., 2018. Saving in the world. World Development 104, 257–270.

Hagemann, A., 2017. Cluster-robust bootstrap inference in quantile regression models. Journal of the American Statistical Association 112, 446–456.

Harding, M., Lamarche, C., 2014. Estimating and testing a quantile regression model with interactive effects. Journal of Econometrics 178, 101–113.

Harding, M., Lamarche, C., Pesaran, M.H., 2020. Common correlated effects estimation of heterogeneous dynamic panel quantile regression models. Journal of Applied Econometrics 35, 294–314.

Horn, S., Reinhart, C.M., Trebesch, C., 2021. China's overseas lending. Journal of International Economics 133, 103539.

Jensen, H., Ravn, S.H., Santoro, E., 2018. Changing credit limits, changing business cycles. European Economic Review 102, 211–239.

Jurado, K., Ludvigson, S.C., Ng, S., 2015. Measuring uncertainty. American Economic Review 105, 1177–1216.

Kahneman, D., Tversky, A., 2013. Prospect theory: An analysis of decision under risk, in: Handbook of the fundamentals of financial decision making: Part I. World Scientific, pp. 99–127.

Kalemli-Özcan, S., 2019. US monetary policy and international risk spillovers. Technical Report. National Bureau of Economic Research.

Koenker, R., Bassett, G., 1982. Tests of linear hypotheses and l" 1 estimation. Econometrica: Journal of the Econometric Society , 1577–1583.

Koenker, R., Bassett Jr, G., 1978. Regression quantiles. Econometrica: journal of the Econometric Society , 33–50.

Kose, M.A., Otrok, C., Whiteman, C.H., 2003. International business cycles: World, region, and country-specific factors. american economic review 93, 1216–1239.

Lown, C., Morgan, D.P., 2006. The credit cycle and the business cycle: new findings using the loan officer opinion survey. Journal of Money, Credit and Banking , 1575–1597.

Maddala, G.S., Wu, S., 1999. A comparative study of unit root tests with panel data and a new simple test. Oxford Bulletin of Economics and statistics 61, 631–652.

Murthy, V.N., Ketenci, N., 2020. Capital mobility in latin american and caribbean countries: new evidence from dynamic common correlated effects panel data modeling. Financial Innovation 6, 1–17.

Obstfeld, M., 1986. Capital mobility in the world economy: Theory and measurement, in: Carnegie-Rochester Conference Series on Public Policy, Elsevier. pp. 55–103.

Obstfeld, M., Rogoff, K., 2000. The six major puzzles in international macroeconomics: is there a common cause? NBER macroeconomics annual 15, 339–390.

Pata, U.K., 2018. The feldstein horioka puzzle in e7 countries: Evidence from panel cointegration and asymmetric causality analysis. The Journal of International Trade & Economic Development 27, 968–984.

Pesaran, M.H., 2006. Estimation and inference in large heterogeneous panels with a multifactor error structure. Econometrica 74, 967–1012.

Pesaran, M.H., 2007. A simple panel unit root test in the presence of cross-section dependence. Journal of applied econometrics 22, 265–312.

Pesaran, M.H., 2021. General diagnostic tests for cross-sectional dependence in panels. Empirical economics 60, 13–50.

Raza, H., Zoega, G., Kinsella, S., 2018. Asymmetries exist in the feldstein–horioka relationship. The Journal of International Trade & Economic Development 27, 667–684.

Shiller, R.J., 2015. Irrational exuberance: Revised and expanded third edition. Princeton university press.

Shin, Y., Yu, B., Greenwood-Nimmo, M., 2014. Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ardl framework. Festschrift in honor of Peter Schmidt: Econometric methods and applications , 281–314.

Singh, T., 2016. Rhetorics of saving–investment correlations and the international mobility of capital: A survey. The Journal of International Trade & Economic Development 25, 636–690.

Tesar, L.L., 1991. Savings, investment and international capital flows. Journal of International economics 31, 55–78.

Tesar, L.L., 1993. International risk-sharing and non-traded goods. Journal of international Economics 35, 69–89.

Werner, R.A., 2002. A reconsideration of the rationale for bank-centered economic systems and the effectiveness of directed credit policies in the light of japanese evidence. Japanese Economy 30, 3–45.

A Tables

Table 4: Quantile effects – test results

Model		$q_{0.1}$	$q_{0.25}$	$q_{0.5}$	$q_{0.75}$	$q_{0.9}$
s^+ (Low-Mid)	$q_{0.1}$	-	−0.68	-2.73***	−5.55***	−7.84***
	$q_{0.25}$	−0.68	-	−3.02***	−6.09***	−8.29***
	$q_{0.5}$	2.73***	3.02***	-	−5.71***	−7.06***
	$q_{0.75}$	5.55***	6.09***	5.71***	-	−3.09***
	$q_{0.9}$	7.84***	8.29***	7.06***	3.08***	-
s^- (Low-Mid)	$q_{0.1}$	-	5.79***	7.30***	7.06***	7.11***
	$q_{0.25}$	−5.79***	-	2.63***	2.70***	2.79***
	$q_{0.5}$	−7.30***	−2.63***	-	1.92**	1.86**
	$q_{0.75}$	−7.06***	−2.70***	−1.92**	-	0.58
	$q_{0.9}$	−7.11***	−2.79***	−1.86	−0.58	-
s^+ (High)	$q_{0.1}$	-	−3.89***	−3.76***	−4.66***	−4.71
	$q_{0.25}$	3.89***	-	−2.22**	−3.57***	−3.38***
	$q_{0.5}$	3.76***	2.22**	-	−2.46***	−2.04**
	$q_{0.75}$	4.66***	3.57***	2.46***	-	−0.74
	$q_{0.9}$	4.71***	3.38***	2.04**	0.74	-
s^- (High)	$q_{0.1}$	-	1.95**	3.01***	4.60***	4.77***
	$q_{0.25}$	−1.95**	-	2.82***	5.72***	6.29***
	$q_{0.5}$	−3.01***	−2.82***	-	4.20***	3.64***
	$q_{0.75}$	−4.60***	−5.72***	−4.20***	-	0.98
	$q_{0.9}$	−4.77***	−6.29***	−3.64***	−0.98	-

Note: Asterisks denote significance at the 10% (*), 5% (**), and 1% (***) levels. The numerical values represent the values of the test statistic.

Table 5: Asymmetric effects – test results

Variable	s (Low-Mid)	s (High)
$q_{0.1}$	-6.77***	-4.58***
$q_{0.25}$	-2.57***	-4.61***
$q_{0.5}$	0.67	-1.60
$q_{0.75}$	5.09***	2.13**
$q_{0.9}$	6.29***	5.03***

Note: Asterisks denote significance at the 10% (*), 5% (**), and 1% (***) levels. The numerical values represent the values of the test statistic.