Saving in the World[1]

Francesco Grigoli[2], Alexander Herman[3], Klaus Schmidt-Hebbel[4]

Abstract

This paper presents new evidence on the behavior of saving in the world, by extending previous empirical research in several dimensions. After extensively surveying the relevant theoretical and empirical literature, the paper reports estimates of saving determinants relying on the newly constructed and largest available database covering 165 countries over 1981-2012. The empirical specification includes determinants not considered in the literature, explores differences in saving behavior nesting the 2008-10 crisis period and four different country groups, searches for commonalities across key saving aggregates (national, private, household, and corporate saving rates), and is subject to a robustness analysis based on different estimation techniques. The results confirm in part existing research, but also shed light on some ambiguous or contradictory findings and highlight the role of neglected determinants. Compared to the literature, we find a larger number of significant determinants, changes across periods and country groups, and similarities across different saving aggregates.

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[2] International Monetary Fund, Research Department, fgrigoli@imf.org.
[3] U.S. Department of Treasury, Office of International Affairs, alexander.herman@treasury.gov.
[4] Pontificia Universidad Católica de Chile, Instituto de Economía, kschmidt-hebbel@uc.cl.

I. INTRODUCTION

What does consumption theory say about the main determinants of private saving decisions and which are the empirical measures that should be used to test for their relevance in explaining aggregate consumption/saving patterns? What determines the behavior of national, private, household, and corporate saving rates in the world? Did the exceptional depth of the Global Financial Crisis change the behavioral relationships of private saving and its determinants? And do saving determinants change across different country groups?

There is a small body of empirical saving studies using macroeconomic panel datasets that address some of these questions. A review of 15 empirical studies of mostly private saving rates reveals large differences in their sample size and coverage, data sources, saving rate definitions, model specifications, and estimation methodologies. Unsurprisingly, they also show large differences in empirical results that are difficult to reconcile.

This paper addresses limitations and contradictory findings of previous empirical research, extending it in six dimensions. First, we survey consumption theories to identify expected signs of potential saving determinants and review the previous empirical saving studies based on aggregate panel data. Then, we construct and use the largest available panel database for world saving, covering 165 countries from 1981 to 2012.[5] This is almost four times the size of the most comprehensive panel study published to date, by Loayza et al. (2000). Third, we specify and estimate a baseline saving specification and subject it to robustness analysis by applying different estimation techniques. Fourth, the empirical search is expanded by including potential saving determinants identified by theory but not previously considered in the empirical literature. Then, the paper explores differences in saving behavior across time and space, nesting the 2008-10 crisis period and four different country groups. Finally, while this paper's focus is on private saving, we also search for commonalities and differences in behavior across national, private, household, and corporate saving rates.

Our results confirm some of the findings of the previous literature and unveil many novel features. Private saving rates are generally persistent and positively associated with income levels and income growth. Permanent components of income and the terms of trade increase saving, and temporary parts of the terms of trade are saved to a larger extent than permanent parts. Saving is spurred by inflation, possibly due to precautionary motives. Increased credit availability, which is often associated with a process of financial liberalization, depresses private saving. A higher old-age dependency ratio reduces saving as the elderly finance their consumption needs with accumulated savings. Urbanization lowers

[5] The dataset is available from the authors upon request.

private saving rates. Higher public saving reduces private saving, but exhibiting only partial Ricardian offsetting. Higher expected future growth has a positive effect on private saving, as does access to foreign borrowing. A higher share of young dependents reduces saving. Importantly, we find that these results generally hold for other saving aggregates but they differ somewhat across time periods and country groups.

The paper structure is the following. In the next section we review briefly the determinants of private saving by discussing the main underlying consumption theories and previous panel data studies on the behavior of private saving rates. Section III summarizes our data sources and construction and presents some stylized facts on saving patterns. Section IV outlines our empirical strategy, describing our choice of regression models. The empirical results are reported in Section V. Section VI concludes.

II. Survey of Consumption Theories and Empirical Saving Determinants

The starting point of modern theoretical research on consumption and saving is defined by two dominant models: the permanent-income hypothesis (PIH) and the life-cycle hypothesis (LCH). In contrast to the preceding Keynesian hypothesis (KH), in which consumption is determined by current income, PIH focuses on a representative, infinitely-lived consumer who equates consumption to permanent income net of the present value of taxes (Friedman, 1957; Hall, 1978). As a variant of PIH, the Ricardian-equivalence hypothesis (REH) derives permanent income as net of the present value of government spending, by linking the representative consumer's and the government's budget constraint (Barro, 1974). If a large number of stringent (and empirically implausible) conditions are satisfied (Seater, 1993), REH predicts that an increase in permanent government consumption is fully offset by lower private consumption.

The PIH assumption of homogeneous consumers contradicts observed consumer heterogeneity along several dimensions, including age, income, and access to borrowing. This leads to the main competitor of the PIH, the LCH, which introduces age-related consumer heterogeneity (Modigliani and Brumberg, 1954; Attanasio and Weber, 2010). Here, aggregate saving reflects the addition of saving by different age specific, finitely-lived cohorts who save for their old-age while working, dissave during retirement, and do not leave bequests.[6] However, these LCH predictions are at odds with the evidence. Planned bequests are

[6] Winter et al. (2012) show that complex life-cycle saving decisions that require computationally demanding tasks can be replaced by simple rules of thumb that yield results consistent with LCR.

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empirically large and sensitive to income levels, implying elasticities of consumption to permanent income that are significantly lower than one.

Contradicting PIH and LCH, consumption tends to exhibit excess sensitivity, i.e., its change is correlated with predictable changes in other variables.[7] This is partly explained by the presence of durable goods (Caballero, 1991), consumption habits (external habits—Abel, 1990—or internal habits—Ferson and Constantinides, 1991), or consumer time inconsistency reflected in hyperbolic discounting (Laibson, 1997).[8]

Uncertainty can also explain the failures of the deterministic versions of PIH-REH and LCH. Classical uncertainty or risk about future realizations of stochastic variables (but not about distributions of stochastic variables, which are assumed to be known and stationary) leads to precautionary saving by risk-averse consumers (Skinner, 1988; Zeldes, 1989). When risk-averse consumers face additional Knightian uncertainty (i.e., distributions of stochastic variables are unknown), precautionary saving is raised further (Miao, 2004; Hansen and Sargent, 2010).

Other theories substantially modify several key assumptions of PIH-REH and LCH to derive behavioral predictions that are more consistent with the data. Borrowing constraints—the fact that interest rates on loans cannot be expected to rise to clear financial markets because they raise default risks (Stiglitz and Weiss, 1981) or because human capital cannot be used as collateral (Hayashi, 1982)—push consumers toward corner solutions and make borrowers' consumption levels more sensitive to credit volumes and current income than to interest rates and wealth. When precautionary saving and borrowing constraints are combined, forward-looking, risk-averse consumers incur in buffer-stock saving, anticipating tighter future borrowing constraints (Schechtman, 1976).[9]

According to the "capitalist spirit" model, which traces back to Smith and Marx, both consumption and wealth are valued by consumers (Cole et al., 1992; Fershtman and Weiss, 1993). If consumption and wealth are gross substitutes in utility, higher wealth does not raise consumption; instead, it is largely saved, contradicting PIH-REH and LCH.

Another dimension of consumer heterogeneity reflects differences in income and wealth across different population groups. Absolute poverty affects aggregate

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[7] Related to excess consumption sensitivity is the empirical rejection of stochastic versions of the consumption Euler equation (Hansen and Singleton, 1982) and evidence of excessive equity return premiums over fixed-income asset returns (Mehra and Prescott, 1985).

[8] Hyperbolic discount functions present a high discount rate over short horizons and a low discount rate over long horizons. This discount structure induces dynamically inconsistent preferences, implying a motive for consumers to constrain their future choices.

[9] Challe and Ragot (2015) derive a precautionary saving model for risk-averse consumers that face borrowing constraints. The time-series behavior of aggregate consumption fits better the latter model than either the hand-to-mouth or the representative-agent models.

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consumption because the poor save little. Then, utility is a positive function of the difference between current consumption and a subsistence consumption level (Christiano, 1989).[10] Therefore, the saving rate declines with absolute poverty (given income distribution) and rises with the level of income—a refined version of autonomous consumption in a conventional KH model.

Post-Keynesian models stress the positive effect of functional income inequality on aggregate saving based on the observation that workers save less than capitalists (Lewis, 1954; Kaldor, 1957). More recent models focus on various channels from personal income inequality to saving, which, taken together, suggest that the effect of income distribution on saving is ambiguous.[11]

We end this brief survey of consumption theories by referring to the integration of household and corporate saving behavior. If a set of strict (and empirically implausible) assumptions are met, household owners of corporations are indifferent between saving as households or through their corporations. They are then able to "pierce the corporate veil," offsetting one-to-one higher corporate saving by lower household saving. This hypothesis is the household-corporate saving analogue to REH for government-private saving decisions.

How do general consumption theories map into specific consumption or saving determinants and their expected signs? Table 1 summarizes categories of saving determinants, specific variables in each category, expected signs of their saving effects according to consumption theories, and the empirical counterparts in country-panel studies based on aggregate saving data. Expected variable signs identified in column (3) of Table 3 reflect the mapping from consumption theories to individual variables, which is discussed in detail in Grigoli et al. (2014).[12]

The last column of Table 1 lists the sign results of the estimated coefficients of saving determinants reported in 15 empirical studies on mostly private saving

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[10] Variants of this theory specify the intertemporal elasticity of substitution as an increasing function of wealth (Atkeson and Ogaki, 1993) or of the distance between permanent income and subsistence consumption (Ogaki et al., 1995). An implication of the two latter hypotheses is that the sensitivity of consumption substitution grows with the level of income.

[11] On the one hand, according to LCH with bequests, wealthier individuals should have higher saving rates as bequests are a luxury (Kotlikoff and Summers, 1981 and 1988). Thus a larger share of poorer individuals can depress private saving. Similarly, the inability to borrow generally affects the poorest and this is likely to negatively affect saving (Deaton, 1991). On the other hand, income inequality may positively affect private saving through the precautionary motive (Carroll and Kimball, 1996). Moreover, if the poor face more limited access to risk diversification options or are more risk averse (especially in light of higher uncertainty), they would increase saving.

[12] Each potential saving determinant is listed only once in Table 1, under the variable category to which it is most closely related by theory. However, both the expected theoretical sign and the signs reported in the empirical literature reflect the combined effects on saving predicted by different theoretical hypotheses.

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rates based on panel samples.[13] Sample size and coverage, data sources, saving rate definitions, model specifications, and estimation methodologies vary significantly across studies.[14] For example, sample sizes range between a low of 66 country-year observations (for 12 countries) in Horioka and Terada-Hagiwara (2012) and a high of 872 country-year observations (for 69 countries) in Loayza et al. (2000).

We conclude the following points from the heterogeneous empirical literature. First, most individual studies include few potential saving determinants in the specification—on average, six regressors out of 49 potential saving determinants listed in Table 1. Second, while signs of several reported coefficients tend to be consistent with theory, signs reported for other coefficients by several previous studies either contradict theory or results of other studies. Third, the dispersion of parameter point estimates (and their confidence intervals) is very large—including those that are consistent with theory. Fourth, while a core set of potential saving determinants is included in most studies, only a few studies include non-standard variables like temporary/permanent components of income flows, income distribution, public consumption, and pension-system variables. Finally, variables for which empirical measures are not readily available or theory has been developed more recently are fully absent.

III. Data and Stylized Facts

The world dataset constructed for this study is, to our knowledge, the most comprehensive on saving aggregates and their determinants. With respect to saving aggregates, we first compile national, private, and public saving data from the IMF World Economic Outlook (WEO) database. Second, we fill missing series and splice existing ones with data from the UN National Accounts (UNNA) database and the World Bank Saving database to obtain the longest series as possible. Third, we apply the UNNA saving ratios of private and public saving to our national saving series to add additional observations. Fourth, we generate household and corporate saving series by applying the OECD saving ratios of household and corporate saving to our augmented national saving series. Fifth, we repeat the latter process using UNNA-based household and corporate saving ratios. Sixth, we (i) impose that data for at least 50 percent of the countries have

[13] Exceptions are two studies for private consumption rates (Corbo and Schmidt-Hebbel, 1991; López et al. 2000) and three studies for national saving rates (IMF, 2005; Gutiérrez, 2007; Horioka and Terada-Hagiwara, 2012). In Table 1, we interpret the latter studies' reported coefficient estimates as those for private saving.

[14] Except López et al. (2000), which reports estimates for a structural consumption function, all other studies are based on reduced-form equations.

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to available in any given year, (ii) omit observations in which public saving is reported as exactly zero or constant values as a share of GDP, (iii) drop observations for which observed annual inflation rates and real interest rates fall outside the ± 50 percent range to reduce contamination from bouts of high inflation, which distort public and private saving and cause National Accounts statistics to be unreliable. We impose the same restriction on the real interest rate.[15] As for the saving determinants, we obtain data from a large set of databases.[16] The resulting panel dataset contains a maximum of 4,137 observations, spanning from 1981 to 2012 and covering 165 countries, and is unbalanced, with the number of time observations varying across countries.[17] We define the national saving rate as the ratio of gross national saving to gross national disposable income (GNDI). Similarly, the private saving rate is defined as the gross private saving scaled by gross private disposable income (GPDI).[18]

Figure 1 presents the trends in world saving rates over the sample period 1981-2012.[19] As shown in panel (a), the average national saving rate remained moderately stable around 19 percent of GNDI until the late 1990s. Since then, it climbed to 22.6 percent of GNDI in 2006, but then progressively fell to 19.5 percent in 2012. Panel (a) of Figure 1 also describes how the national saving composition changed over time. The average private saving component largely dominates the public counterpart, at about four-fifths of national saving. However, while the private saving rate remained virtually constant at 16.3 percent of GNDI, changes in public saving largely drove the changes observed in national saving after 2000. In particular, after fluctuating between 2 and 3 percent until the

[15] This process suffers two exceptions. In the case of Spain, we use saving data provided by the authorities, and for a handful of countries for which data appear faulty, we replace WEO series with OECD ones when available.

[16] This includes the following: IMF WEO, IMF International Financial Statistics, World Bank World Development Indicators, Haver Analytics, Bank of International Settlements database, Quinn index database, Standardized World Income Inequality database, and the IMF Fiscal Monitor database,

[17] More information on the database, including descriptive statistics and simple data correlations, are reported in Grigoli et al. (2014).

[18] Differently from Loayza et al. (2000), we do not construct alternative private saving measures, adjusted for capital gains and losses due to domestic inflation and exchange-rate devaluation. These corrections, while analytically desirable, are unlikely to affect empirical results, as shown by Loayza et al. (2000).

[19] Figures 1 is based on the unbalanced panel of 165 countries to provide the most comprehensive picture of trends in the world. In the construction of the database, however, we impose that at least 50 percent of the countries have data available for every year to obtain representative averages. Using averages of a balanced sample return similar results, with the exception of oil exporters, which show higher private saving rates.

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end of the 1990s, the public saving rate peaked at 6 percent in 2006 and remained high until the recent Great Recession, when it declined significantly.[20]

Panel (b) shows the dispersion of private saving during the sample period. While the sample median private saving rate is remarkably stable at 20.5 percent of GPDI, the bands calculated for the percentile distribution of the private saving rate are wide, reflecting a large variability across countries. For example, about one half of the countries show, on average, private saving rates between 15.5 percent of GPDI and 28.5 percent of GPDI, and one-fifth shows private saving rates of more than 35 percent and less than 5 percent.

Panels (c) and (d) take a closer look at private saving rates. Panel (c) depicts the average private saving rate across different country groups. Advanced economies had, on average, private saving rate of 27.2 percent of GPDI, about 7 percentage points higher than the sample average. Oil exporters experienced even higher private saving rates than advanced economies at times, but these countries are prone to a much higher volatility, associated to variations in oil prices. Over the sample period, average private saving rates for oil exporters fluctuated between 15.0 and 37.2 percent of GPDI. On the contrary, high-growth Asian economies show a steady upward trend since the 1980s. By the end of 2012, their average private saving rate stood at 34.7 percent of GPDI. Finally, the average private saving rate in low-income developing countries (LIDCs) is only 12.0 percent of GPDI over the sample period, at about 8 percentage points below the sample average.

Panel (d) presents the private saving composition. Available data is limited to 48 countries and 674 observations for household and corporate saving.[21] The average private saving rate in this country subset is 16.3 percent of GPDI, almost 4 percentage points below the average private saving rate for the whole sample, and declines slightly over time. The average household saving rate followed a downward trend since the mid-1990s, which was almost fully offset by an increasing corporate saving rate.

IV. EMPIRICAL STRATEGY

[20] This short-lived "global saving glut" was hypothesized by Bernanke (2005) as a major cause of global imbalances. Contrary to the latter view, Laibson and Mollerstrom (2010) show that national asset bubbles were behind large trade deficits in the U.S. and other countries.

[21] Despite the balanced regional and income group coverage, results should be taken with caution, considering likely measurement problems of household and corporate saving (Schmidt-Hebbel and Servén 1997).

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Let $Y_{i,t}$ denote, alternatively, the private, national, household, and corporate saving rate.[22] It can be modelled as:

$$Y_{i,t} = bX_{i,t} + dZ_{i,t} + \varepsilon_{it} \quad (1)$$

where $X_{i,t}$ includes the endogenous (and predetermined) covariates for country i at time t, $Z_{i,t}$ includes (strictly) exogenous variables and an intercept, b and d are the relative coefficients, and ε_{it} is a mean zero error term that captures unobserved heterogeneity.

The selection of variables $X_{i,t}$ and $Z_{i,t}$ to be included in the baseline specification relies on consumption theory, previous empirical research (in particular, Loayza et al., 2000). At a later stage, this set of regressors is complemented by other variables that are included in the specification to study their relationship with the dependent variable or to justify their exclusion from the baseline specification. Consistent with the aim of the paper of analyzing saving determinants in the world, we select variables available for a large set of countries and that lead to sacrifycing the least number of observations. In the case of private saving, and in line with Loayza et al. (2000), we treat the log of real per capita GPDI in PPP terms, real growth rate of per capita GPDI in PPP terms, public saving in percent of GPDI, inflation, the real deposit rate, and the flow of private sector credit in percent of GPDI as endogenous variables, assuming that they are correlated with present, past or future error terms.[23] On the other hand, we treat the log of the terms of trade, the old-age dependency ratio, the share of urban population, and the log of the real oil price as exogenous variables. Consumption theory provides limited guidance on the specification for saving aggregates other than private saving. Thus, we employ a similar specification for other saving rates, but we exclude public saving in percent of GPDI from the specification for national saving, and we include corporate (household) saving in percent of GPDI in the specification for household (corporate) saving.

We estimate the static model (1) using ordinary least squares (OLS) applied to both a cross-section sample of country averages and a pooled panel sample of annual observations, correcting standard errors for heteroskedasticity and autocorrelation. Comparing OLS cross-section and pooled results is informative with respect to the between and within variation in the data, and one could interpret the results as long- and short-term coefficients, however OLS

[22] While saving rates are conceptually bounded between zero and one, we also perform panel unit root tests that allow unbalanced panel with gaps (i.e., Fisher-type tests). The results of the tests confirm the stationarity of the series.

[23] One can argue that some of these variables are predetermined (or determined prior to the current period) rather than endogenous, suggesting that they are uncorrelated with the past error term. However, this distinction does not imply any change in treatment.

estimations suffer from potentially severe econometric problems: lack of dynamics, omitted variable bias due to absent country- and time-fixed effects, and endogeneity of the $X_{i,t}$ variables.

Dynamics of the dependent variable are likely to be an important factor in the estimation because changes in private saving generally occur over a long period of time. More specifically, the observed private saving rate in a given year and for a given country $y_{i,t}$ may deviate from its target level $Y_{i,t}$ due to, for example, adjustment costs, consumption habits, consumption smoothing, or the lagged effects of the explanatory variables on private saving. Thus we specify a target adjustment model:

$$y_{i,t} - y_{i,t-1} = (1-\gamma)(Y_{i,t} - y_{i,t-1}) \quad (2)$$

where γ is the adjustment speed. This means that if $\gamma = 0$, then $y_{i,t} = Y_{i,t}$, and the adjustment toward the target value takes place immediately. Combining equations (1) and (2), we specify the following dynamic model for the observables:

$$y_{i,t} = \gamma y_{i,t-1} + \beta X_{i,t} + \delta Z_{i,t} + u_{it} \quad (3)$$

where coefficients and the error term are defined as: $(\beta, \delta, u_{i,t}) = (1-\gamma)(b, d, \varepsilon_{it})$. Therefore, incomplete adjustment ($\gamma \neq 0$) leads to a form of state dependence where last period's $y_{i,t-1}$ determines this period's $y_{i,t}$. When this is not accounted for, correlation between $y_{i,t}$ and $y_{i,t-1}$ could result from unobserved heterogeneity. Hence, a more general version of model (3) would include the time-invariant unobserved country-specific heterogeneity term c_i, leading to the following specification:

$$y_{i,t} = \gamma y_{i,t-1} + \beta X_{i,t} + \delta Z_{i,t} + c_i + u_{it} \quad (4)$$

This dynamic panel model also partially controls for possible reverse causality.[24] For example, if past private saving performance $y_{i,t-1}$ affects current income growth $X_{i,t}$, then this feedback is accounted for in model (4). Thus, we first estimate model (4) with the OLS estimator. To address endogeneity more comprehensively, we then estimate model (4) with the two-stage least squares (2SLS) estimator, which uses the lags of endogenous variables $X_{i,t}$ as instruments.

Yet the dynamic structure of the model would make OLS estimates biased downward and inconsistent even with a fixed-effects estimator because the error

[24] The Hausman test rejects the null hypothesis that the random effects model is the preferred one for the baseline specification of all saving rates, justifying the introduction of fixed effects.

term u_{it} is correlated with the lagged dependent variable $y_{i,t-1}$ (Nickel, 1981). An alternative approach is to first-difference the model in equation (4) to eliminate the fixed effects c_i. However, the OLS estimator would still be inconsistent because this transformation does not affect the correlation between $y_{i,t-1}$ and u_{it}.

Under appropriate identification assumptions (or moment conditions), the difference Generalized Method of Moments (GMM) estimator would be consistent (Arellano and Bond, 1991). In particular, this estimator assumes that the idiosyncratic error u_{it} is serially uncorrelated and that past values of the endogenous variables $y_{i,t-s}$ are not correlated with the current error u_{it}. These conditions allow using the second (and higher) lags of $y_{i,t}$ as instruments for $y_{i,t-1}$, and second (and higher) lags of $X_{i,t}$ as instruments for $X_{i,t}$.

Blundell et al. (2000) and Bond et al. (2001) show that the difference GMM estimator has poor finite sample properties and that the estimator performs weakly when the dependent variable is persistent. Arellano and Bond (1997) and Blundell and Bond (1998) propose the system GMM (S-GMM) estimator, which increases efficiency by estimating a system of two simultaneous equations, one in levels (with lagged first differences as instruments) and the other in first differences (with lagged levels as instruments). This estimator requires the additional identifying assumption that the instruments are exogenous to the fixed effects. Thus, we estimate model (4) with the asymptotically more efficient two-step S-GMM. The two-step variant presents estimates of the standard errors that tend to be severely downward biased (see Arellano and Bond, 1991, and Blundell and Bond, 1998). However, we implement the finite-sample correction of the two-step covariance matrix derived by Windmeijer (2005), which produces unbiased standard errors.

Finally, we estimate the following more comprehensive model that includes time-fixed effects τ_t (but excludes the real oil price from the set of strictly exogenous variables $X_{i,t}$) with the two-step S-GMM estimator:

$$y_{i,t} = \gamma y_{i,t-1} + \beta X_{i,t} + \delta Z_{i,t} + c_i + \tau_t + u_{it} \qquad (5)$$

While our preferred specification uses annual data with time-fixed effects, we also test the robustness of the results averaging all variables over five years. The latter specification has the advantage of abstracting from the business cycle and reducing the impact of measurement error, but at the cost of distorting and losing information about temporal dynamics of saving rates.

With the aim of testing for differences in saving behavior in specific time periods or selected country groups compared to the rest of the whole sample, we extend our preferred specification with interaction terms between our $X_{i,t}$ and $Z_{i,t}$ variables, and a dummy variable $D_{i,t}$, which takes a value of one for the specific

time period or country group. More formally, we estimate the following nested model:

$$y_{i,t} = \gamma y_{i,t-1} + \beta X_{i,t} + \delta Z_{i,t} + \xi D_{i,t} y_{i,t-1} + \varphi D_{i,t} X_{i,t} + \omega D_{i,t} Z_{i,t} + c_i + \tau_t + u_{it} \quad (6)$$

where ξ, φ, and ω are the coefficients of the interaction terms. The dummy variable $D_{i,t}$ is not included as a separate regressor because it would be perfectly collinear with time-fixed effects τ_t (in the case of time periods) or the country-fixed effects c_i (in the case of country groups). The effect of the corresponding regressor $X_{i,t}$belonging to a specific time period or country group $D_{i,t}$, on the dependent variable $y_{i,t}$, is given by $\beta + \varphi$. Analogously, the effect of $Z_{i,t}$ ($y_{i,t-1}$) belonging to the same country group or time period on the dependent variable $y_{i,t}$ is given by $\delta + \omega\ (\gamma + \xi)$. We refrain, however, from analyzing other possible interactions or non-linearities as this is beyond the scope of this paper.

The S-GMM identification assumptions are tested applying a second-order serial correlation test for the residuals and the Hansen J-test for overidentifying restrictions. While the latter test is limited in that it hinges on the untestable assumption that at least one instrument is valid, it is still useful in spotting violations of validity.

V. RESULTS

We present the estimation results in the following order. We start by reporting the regression results of a baseline specification for private saving, obtained by using different estimators. Then, we extend the baseline specification by including additional regressors. Subsequently, we analyze differential saving behavior in a particular time period and in selected country groups. Finally, we discuss empirical results for other saving aggregates.

A. Baseline Specification

Table 2 reports the results for our baseline specification, applying seven estimators in Columns 1 to 7. Results are generally robust across different estimation methodologies.[25] More specifically, the introduction of fixed effects in a dynamic context is relevant to obtain consistent signs. Moreover, even when comparing estimations including and excluding fixed effects, coefficient signs are always the same when they are statistically significant. Most variables also show

[25] Correcting standard errors for cross-sectional dependence does not affect the results. Results are available from the authors upon request.

similar coefficient magnitudes, and most of the observed differences are observed in coefficients for which the expected signs are ambiguous, i.e., real deposit rate and inflation. The lagged dependent variable is not significant when averaging variables over five-year periods, as autocorrelation of the dependent variable is severely reduced.[26]

Overall, goodness of fit reported for estimators other than two-step S-GMM ranges between 39 and 52 percent. Allowing for dynamics and fixed effects is instrumental to improved goodness of fit. Conventional test results for the S-GMM estimations suggest that the equation is well-specified. In particular, the results of the over-identification restrictions tests suggest that using one lag of the endogenous variables is sufficient to have a valid set of instruments. Similarly, the autocorrelation test applied to the differenced residuals returns the expected autocorrelation of order one, but no autocorrelation of order two, suggesting no autocorrelation of order one in levels and, therefore, that the lags of endogenous variables used as instruments are exogenous.

As discussed in Section II, our preferred results are reported in Column 6, which applies two-step S-GMM with time-fixed effects on annual observations. The results reveal that, out of 10 regressors, eight are statistically significant at one percent, one is significant at five percent, and one is not statistically different from zero. The point estimate of 0.59 for the lagged dependent variable suggests a fairly high degree of persistence, implying that changes in saving determinants take time to exert their full impact on the private saving rate. The long-run effect of permanent changes in saving determinants is, in fact, 2.5 times the size of their effect observed in the first year.

In line with most of the existing literature, higher income levels and income growth accelerations contribute to higher private saving. A one pp (percentage point) increase in the level of per capita GDPI raises the private saving rate by 0.17 pp, while a one pp increase in its growth rate raises the private saving rate by 0.25 pp. These results suggest that policies aimed at boosting income are also effective in raising private saving rates.[27]

The impact of the real deposit rate is not different from zero. This finding is consistent with the ambiguous theoretical prediction, based on offsetting substitution, income, and human-wealth effects. Despite the result that its coefficient is not significant, we opt to leave the real deposit rate in the baseline

[26] In absence of time-fixed effects, Columns 2 to 5 include the (log) real price of oil to proxy global events.

[27] Of course causality could also run the other way, from higher saving (and investment) to growth. As noted in Loayza et al. (2000), as long as increased saving is invested productively, effective growth policies and effective saving policies have the potential to start a virtuous circle of saving, investment, and growth.

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specification because of its centrality in consumption theory. Terms-of-trade improvements bring about a proportionate increase in private income, raising the private saving rate. A one pp improvement in the terms of trade raises the private saving rate by 0.05 pp.

Increased macroeconomic uncertainty, proxied by higher inflation, leads to increased private precautionary saving.[28] An increase of inflation by one pp is associated with a 0.39 pp rise in the private saving rate. According to this result, the moderation of inflation rates observed around the world since the 1990s contributed to a decline in private saving.[29] A relaxation of domestic borrowing constraints reduces private saving. An increase of one pp in the private credit ratio to GPDI reduces the private saving rate by 0.08 pp.

Consistent with the hump-shaped saving-age pattern of the LCH, we find that a one pp increase in the old-age dependency ratio is associated with a reduction of the private saving rate by 1.13 pp.[30] Also, a more urbanized population leads to lower private saving. An increase of one pp in the urbanization rate reduces the private saving rate by 0.39 pp. This result is consistent with larger consumption opportunities in urban areas and higher precautionary saving in rural areas due to larger uncertainty from volatile agricultural income.

Finally, we find that fiscal contractions reduce private saving, but the offset is only partial. A rise of one pp in the public saving rate leads to a decline in the private saving rate by 0.25 pp in the same year, a magnitude well below the unit coefficient implied by the REH. Therefore, considering also the coefficient estimate for the lagged dependent variable, an increase of one pp in the public

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[28] Inflation is widely used in the literature to proxy general macroeconomic uncertainty. However, as inflation generally declined over the past few decades, its relevance as a measure of uncertainty may be reduced. Alternative proxies available for a large set of countries, such as the standard deviation (over the past three and five years, alternatively) of inflation, the standard deviation of real GDP growth, or the standard deviation of the real effective exchange rate (REER), generally return statistically insignificant coefficients.

[29] As discussed in Section II, high inflation may generate additional effects on private saving. Thus, we estimate an alternative specification by adding the square of inflation but find its coefficient to be not significant. Furthermore, when we add the interaction of the standard deviation of inflation (over the past three and five years, alternatively) with a dummy taking value one if inflation is higher than 10 percent, we do not find any significant effect. As an alternative way to identify acute episodes of uncertainty, we add the standard deviation of real GDP growth (over the past three and five years) with a dummy taking value one if real GDP growth is negative. Once again, the estimations generally return insignificant coefficients.

[30] Lee et al. (2008), Lane and Milesi-Ferretti (2011), and Phillips et al. (2013) run regressions of the current account balance on the dependency ratio defined as the ratio of the population above 65 years old to the population between 30 and 64 years old, finding a stronger statistical significance compared to the indicator using the population between 15 and 64 years old as a denominator. Our results are robust to the use of this alternative ratio.

(continued…)

saving rate increases the national saving rate by 0.75 pp in the same year.[31] This result is in line with the literature and the coefficient magnitude is similar to the result reported by Loayza et al. (2000).

B. Alternative Specifications

In Table 3, we explore the empirical relevance of other saving hypotheses extending our preferred specification (Table 2, Column 6) by including additional explanatory variables. The additional regressors are suggested by consumption theory and some of them were used—but only exceptionally— in previous empirical work, as summarized in Table 1. However, these are not added all at once because either they are substitutes for variables present in the baseline specification or they bring about a substantial loss of observations and a proliferation of instruments.

To study the effects of permanent and temporary components of income and terns of trade empirically, we construct these measures by applying the Hodrick-Prescott (HP) filter to the (log) real GPDI per capita (PPP) and the (log) terms-of-trade index, and add them to the baseline specification. As shown in Columns 1 and 2, higher permanent components of income and terms of trade are mostly saved, in contrast to PIH and LCH predictions. However, while higher temporary components of income have no significant effects on the private saving rate, higher temporary components of the terms of trade are partly saved—and to a larger extent than permanent components—supporting the PIH and the LCH.[32] Only Loayza et al. (2000) conduct a similar analysis, but find no significant effect of the income components on private saving and a larger positive effect of the temporary component of terms of trade compared to the permanent component.

A better economic growth outlook boosts private saving, as presented in Column 3. A one pp increase in expected GDP growth (five years ahead) raises the private saving rate by 0.25 pp—slightly larger than the saving response to higher current growth. Conflicts can affect private saving by raising uncertainty and therefore precautionary saving or, if extreme, destroying financial institutions

[31] The long-run impact of the increase in public saving rate on private saving is statistically different from one, as the Wald test rejects the null hypothesis of complete offsetting with a *p*-value of 0.003.

[32] We also investigate potential asymmetric effects of increases and reductions in the temporary components of GPDI and terms of trade shocks using interaction terms between the temporary component of GPDI (terms of trade) and a dummy variable taking value one when the temporary component of GPDI (terms of trade) is positive. We find that in the case of GPDI, there is no statistical difference between positive and negative shocks. In the case of terms of trade, however, we find that positive shocks in the temporary component have a larger effect than negative ones.

and access to saving opportunities, hence reducing saving. Consistent with this, the results in Column 4 show that the coefficient on conflict is not significant.

The current account balance (more precisely, its negative, equivalent to foreign saving) is often used as a proxy for foreign borrowing constraints. However, it may be endogenously determined when countries do not face restricted access to international markets. In light of this, we treat this variable as endogenous. Also, we control for capital account openness, as restrictions imposed on capital inflows and outflows can raise saving. The results of Column 5 suggest that lower foreign saving by one pp is associated with higher private saving by 0.54 pp. Regarding capital controls, fewer restrictions on capital account transactions are associated with lower private saving, but the corresponding coefficient is not significant at conventional levels.

Financial deepening reflected in increased financial assets could raise saving, while higher wealth derived from more financial assets affects saving ambiguously. Consistent with this, the corresponding coefficient estimate reported in Column 6 is not significant.

In Column 7, we include the young-age dependency ratio. In contrast to the predictions of the LCH, this yields a positive and significant estimate. However, this finding is driven by the strong negative correlation (-0.83 percent) between the young-age dependency ratio and the income level, which is consistent with the negative correlation between development and fertility levels. The results of the multicollinearity diagnostics suggest that the variables are nearly collinear and therefore one should be dropped from the specification.[33] Once we drop the income variable (Column 8), the young-age dependency ratio takes the expected negative sign, suggesting that an increase in the young-age dependency ratio by one pp depresses the private saving rate by 0.09 pp.

Finally, we include the Gini coefficient as an additional determinant of private saving in Column 9 and government spending on health and education in Columns 10 and 11. The estimated coefficients are not statistically different from zero, consistent with the theoretical ambiguity.[34]

C. Time Periods and Country Groups

We now turn to analyze differential effects in saving behavior that could be expected in a particular time period and in specific country groups. In Table 4 we

[33] Multicollinearity diagnostics for the specification including both the young-age dependency ratio and the log of real per capita GPDI (PPP) present a variance inflation factor close to the threshold value of 10 for these variables.

[34] In some studies on the current account determinants (Kerdrain et al., 2010; Phillips et al., 2013) health expenditure reduces the need for precautionary saving and therefore the current account balance.

report our findings for one selected time period, the 2008-10 Global Financial Crisis (Column 1). Focusing only on this particular crisis is warranted by the exceptional depth of the Great Recession and its global repercussions. We then report results for four different country groups, selected by their economic o structural significance (Columns 2 to 5). We continue using our preferred baseline specification (Table 2, Column 6), based on the two-step S-GMM estimator applied to annual observations. The estimates for the coefficients of the core variables are robust to inclusion of the additional interaction terms, except those reported in Column 3, when the subsample of LIDCs is analyzed.[35]

The results in Column 1 suggest that the 2008-10 Global Financial Crisis had a significant impact on some coefficients of private saving determinants. The degree of persistence of the private saving rate fell significantly, with a point estimate reduced from 0.62 to 0.46, reflecting a temporary decline in consumption and saving inertia and a relatively higher sensitivity to the combined effect of contemporaneous changes in saving determinants. The effect of the income level on the private saving rate fell during the crisis period. While a one pp increase in the income level raises the private saving rate by 0.13 pp in non-crisis times, its impact declined to 0.07 pp during 2008-10, reflecting a higher propensity to consume due to the impoverishment caused by the downturn.

The role of demographics in driving saving changed significantly during the crisis years. On one hand, the negative impact of old-age dependency on private saving declined during the crisis, but this reduction was not significant at conventional levels. However, a very significant and large reduction of the saving response to urbanization was observed during the crisis. While in normal times urban residents save less than rural inhabitants, this difference almost disappeared during the crisis, when the private saving response to a one pp rise in the share of urban population declined to -0.06 pp from -0.28 pp in non-crisis times. Hence, the rural population was relatively more affected by the crisis than urban residents. [36]

Now we turn to the differential saving behavior in four distinct country groups. The results in Column 2 for 33 advanced economies show that private saving is more sensitive to growth in advanced economies than in the rest of the world. A one pp increase in income growth rate raises the private saving rate by 0.44 pp in advanced economies, compared to 0.26 pp in non-advanced economies.

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[35] This reflects both the large size of the subsample of LIDCs (almost one-third of the 153 countries) and their distinctive private saving behavior.

[36] We also perform an estimation for which the selected time period covers the aftermath of the Global Financial Crisis through the end of the sample (2008-12). The results are similar to the ones in Column (1), suggesting a structural change in saving determinants. However, results should be taken with caution as it is possibly too early to discern a permanent structural change and the fading away of the crisis effects, and because the identification tests suggest that instruments are not valid at 5 percent significance level.

Similar to the results obtained for the crisis years, the urban population saves more in advanced economies than in other countries. This reflects that the latter demographic groups are relatively larger in advanced than in other economies and that they hold higher levels of wealth, saving more. A one pp increase in the old-age dependency ratio lowers the private saving rate by 0.99 pp in non-advanced economies, and only by 0.05 pp in advanced economies. Likewise, a one pp increase in the share of urban population reduces the private saving rate by 0.34 pp in non-advanced economies, while its effect is almost nil in advanced economies.

Column 3 reports the differential effects for 47 LIDCs, in comparison to all other countries. Predictably, the persistence of private saving rates in LIDCs is relatively lower (the point estimate declines from 0.85 for non-LIDCs to 0.41 for LIDCs), reflecting higher saving volatility. While for advanced economies we document a higher income growth sensitivity of private saving in Column 1, for LIDCs we observe a result that is consistent with the latter. Namely, their sensitivity to saving is much lower than that of non-LIDC countries. An increase of one pp in income growth raises the private saving rate by 0.10 pp, compared to 0.37 for non-LIDCs.

In Column 4, we report differences in private saving behavior of 20 oil-exporting countries. In these countries, the share of the elderly is smaller than in other countries but they tend to be richer. Hence, here we observe not only what we document for advanced economies, i.e., private saving is almost insensitive to the number of elderly, but the evidence fully contradicts the LCH as the share of elderly raises private saving. While a one pp increase in the old-age dependency ratio lowers the private saving rate by 0.99 pp in non-oil exporters, it raises the private saving rate by 0.58 pp in oil exporters.

Finally, Column 5 highlights differences in private saving behavior in 10 high-growth Asian economies. High-growth Asian countries are significantly different from the rest of the world in their interest rate sensitivity to saving. While in other countries private saving is insensitive to the real deposit rate, a one pp rise in the real deposit rate in high-growth Asia largely increases the private saving rate by 2.8 pp. High-growth Asia's sensitivity to inflation appears also to be larger than in the rest of the world, but this difference is not significant at conventional levels.

D. Other Saving Aggregates

Table 5 presents the results for national saving rate regressions. As in Loayza et al. (2000), we assume it is driven by the same determinants included in our baseline regression for private saving, with the exception of the public saving rate, which we exclude from the specification because it is part of the dependent

variable. However, our scale variable for national saving is GNDI. As in Table 2 for the private saving rate, we apply different estimators to check for robustness. Again, we refer to the results in Column 6 as our preferred estimation model, in light of using the two-step S-GMM estimator based on annual observations, including country and time-fixed effects. The sample used for our national saving regressions is very similar in size and coverage to the sample for the private saving regressions.

The results of our preferred specification are remarkably similar to those obtained for private saving regarding sign, size, and significance of coefficient estimates. One moderate difference is that the negative influence of demographic variables on private saving is smaller in magnitude in the case of national saving. The one major difference is the following. While the real deposit rate has no significant impact on private saving, it turns out to be positive and significant for national saving, as a one pp increase in the real deposit rate raises the national saving rate by 0.15 pp. This may be explained by the fact that national saving includes saving of the public sector. In most countries, the government is a net debtor and has issued significant amounts of gross fixed-income debt, implying that the income effect of higher interest rates on saving is positive.

Now we separately analyze the saving determinants for the two components of private saving, household and corporate saving. Our unbalanced panel sample is significantly reduced, comprising 48 countries over the period 1981-2012, corresponding to 674 observations. While data availability for household and corporate saving is limited in comparison to private and national saving, the sample covers a balanced subset of countries in different regions and across different income levels.

In Table 6 we report the results of the estimations using the two-step S-GMM estimator. However, we do not introduce time-fixed effects as they would raise the number of instruments beyond the number of the countries in the sample. As a substitute, we use the (log) real oil price. The S-GMM identification tests suggest that the instrument set is valid and that the lags of the endogenous variables are exogenous.[37]

As a benchmark reference, we report in Column 1 the results for private saving as the dependent variable, for the same restricted sample we use subsequently for household and corporate saving regressions. Except for the terms of trade, the signs, significance levels, and magnitudes of coefficients for our core private saving determinants are similar in this small sample to those reported for the full sample before (Table 2, Column 5). Based on the same baseline specification, Columns 2 and 3 (4 and 5) report the results for the household (corporate) saving rate. Column 3 (5) adds the corporate (household) saving rate

[37] The goodness of fit measured in a dynamic OLS model with fixed effects (not reported here but available upon request), using the same explanatory variables, is 55 percent.

to the core regressors to test for substitution between corporate and household saving rates, i.e., to check the extent to which households (corporations) pierce the corporate (household) veil.

Columns 2 and 4 show similar results for five saving determinants to those reported for private saving in Column 1. Yet important differences emerge. Household saving, like private saving, responds significantly and positively to the real deposit rate and to inflation, while corporate saving is insensitive to the two latter variables. Private credit flows lower significantly both private and corporate saving but not household saving. While the urban population share and public saving reduce national saving, neither variable affects household and corporate saving separately.

Both household and corporate saving react negatively and significantly to higher corporate and household saving, respectively. The magnitude of offset coefficients, reported in Columns 3 and 5, is large: 0.58 and 0.79, respectively. Hence, while households pierce the corporate veil to a large degree, corporations pierce the household veil to an even larger degree. Much of an increase in one component of private saving is offset by a reduction in the other.[38]

We also explore the impact of additional explanatory variables on household saving.[39,40] The results for the baseline regressors are generally robust to the inclusion of other variables. We briefly refer to the differences in results reported here, in comparison to those for private saving. In contrast to private saving, household saving does not react to the temporary and permanent components of the terms of trade (nor does it react to total terms of trade), the five-year growth forecast, and the young-age dependency ratio. Also in contrast to private saving, household saving reacts negatively and significantly to larger capital account openness.

VI. CONCLUSIONS

Consumption theory often provides ambiguous theoretical predictions about the determinants of private saving. While the empirical literature on the topic has grown considerably in recent years, it frequently reports large differences in findings. From a review of the literature using panel data, we note that although a core set of potential saving determinants is included in most studies, these tend to be few and inclusion of non-standard variables is exceptional. Signs of reported

[38] The extent to which households pierce the corporate veil is about double of that estimated in Bebczuk and Cavallo (2014), who also find less persistence in household saving rates.
[39] While the same extensions to the baseline specification can be estimated for corporate saving, we limit our focus to household saving as consumption theory is developed for households.
[40] Results are not reported, but are available in Grigoli et al. (2014),

coefficients are not always consistent with theory, and the dispersion of individual point estimates is very large, including those that are consistent with theory. In addition, variables for which empirical measures are not readily available, or theory has been developed more recently, are fully absent.

In this paper, we address limitations and contradictory findings of previous empirical research, extending it in six dimensions. First, we survey consumption theories to identify expected signs of potential saving determinants and review previous empirical saving studies. Second, we construct and exploit a very large and more recent panel database for world saving, covering 163 countries from 1981 to 2012. Then, we conduct a robustness analysis for our baseline private saving specification across different estimators. Fourth, we expand the empirical search by including potential saving determinants identified by theory but neglected in the empirical literature. Then, we explore differences in saving behavior across time and space, nesting the 2008-10 crisis period and four different country groups. Finally, while our focus is on private saving, we also search for commonalities and differences in behavior across national, private, household, and corporate saving rates.

The results of our preferred baseline specification for the private saving rate are encouraging. In our preferred estimation, of 10 private saving regressors consistent with theory, we report nine statistically significant coefficients: the lagged dependent variable, the real income level, real income growth, the terms of trade, inflation, private credit flows, old-age dependency, urban population, and public saving (confirming partial Ricardian offsetting). Only the real deposit rate is not significantly different from zero, consistent with its theoretical ambiguity.

Then we include 13 additional potential determinants of private saving—also suggested by theory—four not considered before and most of the nine other determinants included only in Loayza et al. (2000). Six of the latter variables are not significantly different from zero, while the other seven are significant: the permanent component of income, the permanent and temporary components of the terms of trade, future growth forecasts, and young-age dependency have a positive effect on saving, while foreign saving and capital account openness present a negative one.

An overview of regional trends suggests that private saving rates evolved heterogeneously in the last three decades, for example, booming in high-growth Asia and experiencing great volatility in oil-exporting countries. In addition, the depth of the recent Global Financial Crisis raises questions on whether private saving behavior changed during those years. We find that private saving rates were less persistent, and less sensitive to income levels and urbanization than in other periods during 1981-2012. Private saving rates in advanced economies are relatively more responsive to income growth and almost non-sensitive to demographic variables, while for LIDCs we report a lower response of private

saving to income growth and less persistence. For oil exporters, we find that their sensitivity of private saving to the share of old-age population is positive, contradicting the LCH. High-growth Asian economies' private saving rates are highly sensitive to real deposit rates, in contrast to other countries, where saving does not respond to real deposit rates.

We then replicate our empirical search for other saving aggregates. The results for national saving are largely in line with those reported for private saving, which possibly reflects that 80 percent of national saving is private. We then disaggregate private saving into its household and corporate components. To a significant extent, we confirm many of the empirical findings reported for private saving at the household and corporate levels. However, we do not find evidence that higher public saving reduces either household or corporate saving separately. Finally, we report strong evidence for significant but incomplete substitution between corporate and household saving, both for households and corporations separately.

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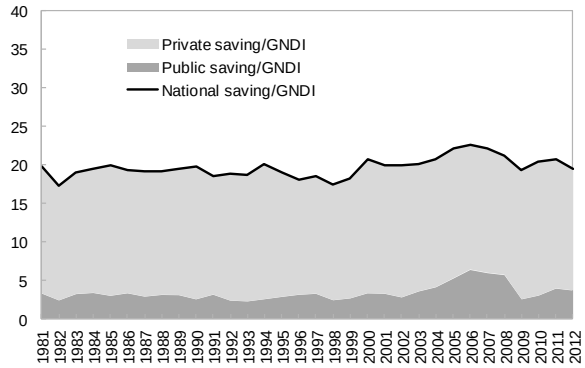
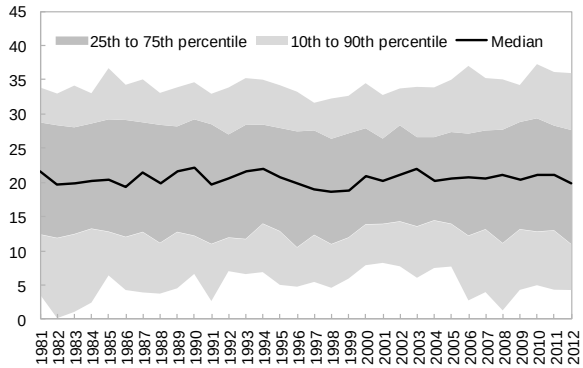
Figure 1. World Saving Rates, 1981-2012

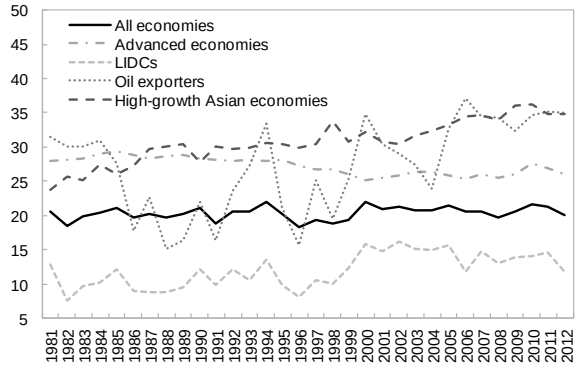
(a) Average national, private, and public saving rates



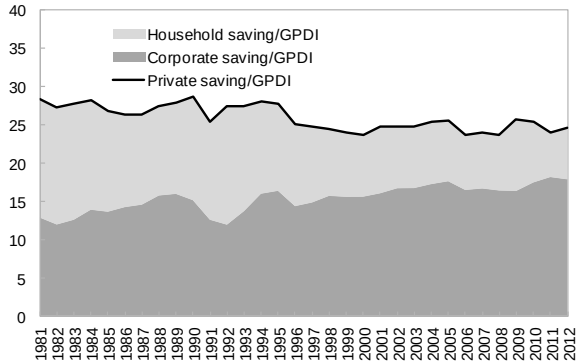
(b) Distribution of private saving rates



(c) Average private saving rates (percent of GPDI) across country groups



(d) Average private, household, and corporate saving rates



Notes: Year averages in panels (a) and (c), and year percentiles in panel (b) are calculated on the unbalanced panel of 165 countries. Year averages in panel (d) are calculated on the unbalanced panel of 48 countries.
Source: Authors' calculations.

Table 1. Private Saving Determinants According to Consumption Theory and Empirical Studies

Variable Category	Specific Variable	Expected Sign	Empirical Findings
Income	Income level: current	Ambiguous	0 (5, 6, 13), + (1, 2, 3, 4, 7, 15), 0 or + (9)
	Income level: estimated temporary / permanent	(+) / 0 or (+)	0 (7) / 0 (7)
	Gap of current to estimated potential income	(+)	
	Income growth: current	Ambiguous	+ (7, 9, 10, 11, 12, 13, 14), 0 (15)
	Income growth: expected future	Ambiguous	+ (14)
Wealth	Total wealth	Ambiguous	
	Net assets	Ambiguous	
	Net foreign assets	Ambiguous	
Rates of return on financial assets	Real interest rate	Ambiguous	- (7, 10), 0 (1, 3, 5, 6, 11), + (2, 12, 14), 0 or + (15)
	Real return on variable-income assets	Ambiguous	
Relative prices	Consumer price index (CPI): current level	(+)	
	CPI inflation: current	(+)	- (4), 0 (1, 2, 3, 6, 10, 15), + (7, 12, 13)
	CPI inflation: expected future	Ambiguous	
	Terms of trade: current	Ambiguous	0 (13, 15), + (2, 4, 6, 7, 10, 11)
	Terms of trade: estimated temporary / permanent	Ambiguous	+ (7) / + (7)
	Real exchange rate: level	Ambiguous	
	Real exchange rate: expected future change	Ambiguous	
Classical uncertainty (risk)	Financial risk, financial instability, financial crisis	(+) Ambiguous	
	Macroeconomic instability, macroeconomic crisis	Ambiguous	
	Political instability or political risk	Ambiguous	
	Violent conflict, war	Ambiguous	
	Variance of innovations to saving determinants	(+)	
Knightian uncertainty	Measures of Knightian uncertainty	(+) or ambiguous	
Domestic borrowing constraints	Current credit flows, current money flows	(-)	- (7, 11, 12), + (3), + or - (14)
Foreign borrowing constraints	Foreign lending	(-)	
	Current account deficit	(-)	- (1, 2, 3, 7)
	Foreign saving	(-)	- (13)
	Sovereign debt premium	(+)	
	Capital flow restrictions	(+)	0 (7)
Financial depth	Bank credit stock	Ambiguous	-(5), 0 (7)
	Financial assets	Ambiguous	
	Broad money stock	Ambiguous	0 (7, 15), + (1, 3, 4, 13)
Demographics	Old-age dependency	(-)	- (2, 3, 4, 7, 10, 11, 14, 15), 0 (5, 6, 13, 15), + (12)
	Young-age dependency	(-)	- (7, 14, 15), 0 (9)
	Urbanization	Ambiguous	- (3, 7, 15)
Poverty and distribution	Poverty	(-)	
	Income concentration	Ambiguous	- (13), 0 (3, 9)
	Wealth concentration	Ambiguous	
	Capital income share	(+)	
Fiscal policy	Public sector saving	(-)	- (1, 3, 7, 10, 15)
	Public sector budget balance	0 or (-)	- (2, 5, 6, 8, 11, 13), 0 (4), + or - (12)
	Public consumption	Ambiguous	- (2, 6) 0 (8)
Government spending components	Education and health	Ambiguous	
	Pensions	Ambiguous	
	In-kind transfers	Ambiguous	
Pension System	Pay-as-you-go pension transfers to old	Ambiguous	- (3, 4, 5)
	Mandatory fully-funded pension system contributions	0 or (+)	+ (4)
	Fully-funded pension assets	Ambiguous	0 or + (5)
Households and firms	Corporate saving effect on household saving	0 or (-)	- (15)

Notes: The qualitative results listed in the last column of this table summarize signs of saving regressors reported in 16 panel studies of private saving. Positive and negative signs correspond to statistically significant coefficient estimates, while 0 denotes coefficient estimates that are not significantly different from zero. The sources are the corresponding tables and specific columns, rows, or regressions of the following studies: 1. Corbo and Schmidt-Hebbel (1991) (table 4); 2. Masson, Bayoumi, and Samiei (1995) (table 2, "restricted model" column); 3. Edwards (1996) (table 2, column 5); 4. Dayal-Ghulati and Thimann (1997) (table 4, column 2); 5. Bailliu and Reisen (1998) (table 1, columns 3 and 4); 6. Haque, Pesaran, and Sharma (1999) (table 6, columns 4 and 5); 7. Loayza, Schmidt-Hebbel, and Servén (2000) (table 4, column 6; table 7); 8. López, Schmidt-Hebbel, and Servén (2000) (tables 4 to 6); 9. Schmidt-Hebbel and Servén (2000) (table 6, columns 7 and 8); 10. De Serres and Pelgrin (2003) (table 2); 11. IMF (2005) (table 2.2, column 1); 12. Hondroyiannis (2006) (table 5, last row); 13. Gutiérrez (2007) (table 5, regression 9); 14. Horioka and Terada-Hagiwara (2012) (table 1, models 7 to 9); and 15. Bebczuk and Cavallo (2014) (table 3.1, columns 2 and 4). Significant coefficient signs are identified by a plus or a minus. Results identified by a zero mean either an insignificant coefficient in the corresponding column of the original study or, when the variable is omitted from the particular specification reported in the column, a significant or insignificant variable in a different column of the same table. When denoted by two signs separated by "or", it denotes that the coresponding signs are reported in different columns. Real rates of return are measured either on deposits or loans. Each study is identified in the table by the corresponding number in parentheses.

Table 2. Determinants of Private Saving, Different Estimators

(Dependent variable: Private saving/GPDI)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Average CS OLS	Pooled OLS	OLS FE	2SLS FE	Two-step S-GMM	Two-step S-GMM	Two-step S-GMM (Five-year averages)
Lag dependent variable	.	.	0.623***	0.599***	0.600***	0.593***	0.246
	.	.	(0.027)	(0.050)	(0.077)	(0.066)	(0.155)
Ln real per capita GPDI (PPP)	0.051***	0.065***	0.062***	0.061***	0.154***	0.171***	0.235***
	(0.014)	(0.012)	(0.015)	(0.022)	(0.034)	(0.032)	(0.052)
Real growth rate of per capita GPDI (PPP)	0.650**	0.203***	0.270***	0.239	0.251***	0.255***	0.237***
	(0.311)	(0.038)	(0.037)	(0.204)	(0.038)	(0.041)	(0.080)
Real deposit rate	-0.665***	-0.231***	0.049	0.141	0.055	0.141	0.120
	(0.243)	(0.084)	(0.037)	(0.099)	(0.089)	(0.098)	(0.230)
Ln terms of trade	0.047	0.034*	0.022**	0.020**	0.048***	0.051***	0.056**
	(0.058)	(0.020)	(0.009)	(0.010)	(0.015)	(0.015)	(0.023)
Inflation	-0.144	-0.050	0.123***	0.049	0.269**	0.387***	0.328
	(0.211)	(0.096)	(0.045)	(0.096)	(0.106)	(0.124)	(0.264)
Flow of private sector credit/GPDI	0.121	-0.044	-0.076***	-0.070*	-0.075**	-0.081**	-0.091*
	(0.278)	(0.058)	(0.023)	(0.036)	(0.031)	(0.039)	(0.049)
Old-age dependency ratio	-0.387**	-0.401***	-0.142**	-0.165*	-1.032***	-1.127***	-1.662***
	(0.153)	(0.129)	(0.065)	(0.092)	(0.263)	(0.242)	(0.388)
Share of urban population	0.076	0.034	-0.069	-0.104	-0.338***	-0.391***	-0.463***
	(0.053)	(0.052)	(0.052)	(0.069)	(0.099)	(0.099)	(0.169)
Public saving/GPDI	-0.012	-0.038	-0.120***	-0.052	-0.243***	-0.252***	-0.394***
	(0.106)	(0.070)	(0.042)	(0.128)	(0.065)	(0.064)	(0.117)
Ln real oil price	.	-0.017***	-0.008**	-0.006	-0.012**	.	.
	.	(0.006)	(0.003)	(0.005)	(0.005)	.	.
Time-fixed effects	.	No	No	No	No	Yes	Yes
Lags/Instruments	.	.	.	.	1/19	1/48	1-3/37
AR(1) *p*-val.	.	.	.	.	0.000	0.000	0.206
AR(2) *p*-val.	.	.	.	.	0.318	0.286	0.388
Hansen *J*-test *p*-val.	.	.	.	.	0.627	0.753	0.220
Observations	153	3,341	3,254	2,969	3,254	3,254	671
Number of countries	.	.	153	152	153	153	153
R-squared	0.390	0.306	0.523	0.493	.	.	.

Notes: Standard errors in parentheses are corrected for heteroskedasticity and autocorrelation of the error term. System GMM estimations in columns (5) to (7) use a collapsed instrument matrix and perform the Windmeijer (2005) correction of the covariance matrix. Column (7) uses the sample 1983-2012 to have 6 periods of 5 years. The null hypothesis for the Hansen *J*-test is that the full set of instruments is valid. All estimations include a constant term. ***, **, * next to a number indicate statistical significance at 1, 5 and 10

Source: Authors' calculations.

Table 3. Determinants of Private Saving, Additional Explanatory Variables

(Two-step S-GMM; dependent variable: private saving/GPDI)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Lag dependent variable	0.639***	0.599***	0.600***	0.591***	0.400***	0.621***	0.633***	0.662***	0.749***	0.592***	0.653***
	(0.131)	(0.065)	(0.064)	(0.067)	(0.133)	(0.065)	(0.085)	(0.081)	(0.079)	(0.070)	(0.076)
Ln real per capita GPDI (PPP)	.	0.171***	0.165***	0.170***	0.137***	0.155***	0.154***	.	0.159***	0.129***	0.127***
	.	(0.032)	(0.041)	(0.031)	(0.030)	(0.035)	(0.046)	.	(0.045)	(0.036)	(0.032)
Real growth rate of per capita GPDI (PPP)	0.313***	0.263***	0.236***	0.255***	0.168***	0.266***	0.268***	0.193***	0.236***	0.217***	0.175***
	(0.079)	(0.040)	(0.039)	(0.040)	(0.056)	(0.050)	(0.047)	(0.043)	(0.048)	(0.036)	(0.054)
Real deposit rate	0.168	0.140	0.163	0.139	0.081	0.147	0.049	0.156	0.049	0.066	0.158
	(0.104)	(0.096)	(0.107)	(0.097)	(0.095)	(0.109)	(0.093)	(0.150)	(0.105)	(0.110)	(0.137)
Ln terms of trade	0.046**	.	0.051***	0.051***	-0.023	0.052***	0.043***	0.044***	0.037**	0.051***	0.049***
	(0.021)	.	(0.017)	(0.015)	(0.022)	(0.018)	(0.014)	(0.010)	(0.018)	(0.016)	(0.015)
Inflation	0.344***	0.390***	0.398***	0.383***	0.202**	0.349**	0.248*	0.349*	0.207*	0.240*	0.300*
	(0.120)	(0.123)	(0.132)	(0.124)	(0.100)	(0.138)	(0.128)	(0.190)	(0.120)	(0.133)	(0.169)
Flow of private sector credit/GPDI	-0.058	-0.081**	-0.070**	-0.082**	0.012	-0.103***	-0.088*	-0.067	-0.052	-0.072**	-0.069*
	(0.043)	(0.040)	(0.033)	(0.039)	(0.020)	(0.033)	(0.047)	(0.075)	(0.038)	(0.034)	(0.037)
Old-age dependency ratio	-1.124***	-1.122***	-1.066***	-1.117***	-0.795***	-1.045***	-0.455***	-0.214**	-1.412***	-0.769***	-0.785***
	(0.348)	(0.245)	(0.283)	(0.239)	(0.223)	(0.261)	(0.159)	(0.105)	(0.437)	(0.236)	(0.223)
Share of urban population	-0.352***	-0.396***	-0.381***	-0.386***	-0.308***	-0.340***	-0.237***	0.079***	-0.392***	-0.263**	-0.285***
	(0.132)	(0.099)	(0.126)	(0.098)	(0.082)	(0.105)	(0.090)	(0.028)	(0.133)	(0.112)	(0.099)
Public saving/GPDI	-0.345***	-0.251***	-0.227***	-0.250***	-0.344***	-0.243***	-0.205**	-0.245***	-0.162**	-0.204***	-0.151**
	(0.095)	(0.063)	(0.053)	(0.064)	(0.102)	(0.063)	(0.086)	(0.071)	(0.069)	(0.065)	(0.062)
Permanent component of GPDI	0.159***	.	.	.	.	.	.	.	.	.	.
	(0.044)	.	.	.	.	.	.	.	.	.	.
Temporary component of GPDI	-0.021	.	.	.	.	.	.	.	.	.	.
	(0.155)	.	.	.	.	.	.	.	.	.	.
Permanent component of terms of trade	.	0.048***	.	.	.	.	.	.	.	.	.
	.	(0.018)	.	.	.	.	.	.	.	.	.
Temporary component of terms of trade	.	0.086***	.	.	.	.	.	.	.	.	.
	.	(0.022)	.	.	.	.	.	.	.	.	.
5-year forecast of real GDP growth	.	.	0.252***	.	.	.	.	.	.	.	.
	.	.	(0.077)	.	.	.	.	.	.	.	.
Conflict	.	.	.	1.242	.	.	.	.	.	.	.
	.	.	.	(1.556)	.	.	.	.	.	.	.
Current account balance/GPDI	.	.	.	.	0.543***	.	.	.	.	.	.
	.	.	.	.	(0.050)	.	.	.	.	.	.
Capital account openness	.	.	.	.	-0.069*	.	.	.	.	.	.
	.	.	.	.	(0.041)	.	.	.	.	.	.
Financial system assets/GPDI	.	.	.	.	.	0.000	.	.	.	.	.
	.	.	.	.	.	(0.011)	.	.	.	.	.
Young-age dependency ratio	.	.	.	.	.	.	0.287**	-0.092***	.	.	.
	.	.	.	.	.	.	(0.116)	(0.029)	.	.	.
Gini	.	.	.	.	.	.	.	.	-0.299	.	.
	.	.	.	.	.	.	.	.	(0.223)	.	.
Public health expenditure/GPDI	.	.	.	.	.	.	.	.	.	-0.301	.
	.	.	.	.	.	.	.	.	.	(0.316)	.
Public education expenditure/GPDI	.	.	.	.	.	.	.	.	.	.	-0.258
	.	.	.	.	.	.	.	.	.	.	(0.256)
Time-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lags/Instruments	1/50	1/49	1/42	1/47	1/51	1/50	1/49	1-3/59	1/48	1/46	1/49
AR(1) *p*-val.	0.000	0.000	0.000	0.000	0.013	0.000	0.000	0.000	0.028	0.000	0.000
AR(2) *p*-val.	0.310	0.268	0.340	0.287	0.382	0.285	0.288	0.494	0.348	0.301	0.153
Hansen *J*-test *p*-val.	0.190	0.690	0.519	0.748	0.112	0.692	0.126	0.102	0.546	0.115	0.272
Observations	3,141	3,245	2787	3,254	2,292	3,073	3,254	3,254	2,094	2,818	2,563
Number of countries	144	152	153	153	110	151	153	153	137	152	148

Notes: Standard errors in parentheses are corrected for heteroskedasticity and autocorrelation of the error term. System GMM estimations use a collapsed instrument matrix and perform the Windmeijer (2005) correction of the covariance matrix. The null hypothesis for the Hansen *J*-test is that the full set of instruments is valid. All estimations include a constant term. ***, **, * next to a number indicate statistical significance at 1, 5 and 10 percent, respectively.

Source: Authors' calculations.

Table 4. Determinants of Private Saving, Interactions

(Two-step S-GMM; dependent variable: private saving/GPDI)

	(1)	(2)	(3)	(4)	(5)
	X= 2008-10	X= Advanced	X= LIDC	X= Oil exporters	X= High-growth Asian economies
Lag dependent variable	0.621***	0.612***	0.855***	0.588***	0.569***
	(0.067)	(0.071)	(0.058)	(0.083)	(0.066)
Ln real per capita GPDI (PPP)	0.131***	0.151***	0.086***	0.145***	0.161***
	(0.027)	(0.035)	(0.024)	(0.046)	(0.031)
Real growth rate of per capita GPDI (PPP)	0.252***	0.258***	0.373***	0.227***	0.228***
	(0.042)	(0.048)	(0.043)	(0.045)	(0.042)
Real deposit rate	0.147	0.112	0.335***	0.172*	0.087
	(0.116)	(0.102)	(0.076)	(0.096)	(0.095)
Ln terms of trade	0.042***	0.055***	0.020	0.037*	0.053***
	(0.016)	(0.017)	(0.037)	(0.022)	(0.015)
Inflation	0.454***	0.343***	0.448***	0.290**	0.300**
	(0.139)	(0.133)	(0.115)	(0.124)	(0.143)
Flow of private sector credit/GPDI	-0.067	-0.195*	-0.137***	-0.072	-0.083**
	(0.049)	(0.103)	(0.031)	(0.051)	(0.038)
Old-age dependency ratio	-0.868***	-0.997***	-0.375***	-0.992***	-1.054***
	(0.203)	(0.283)	(0.117)	(0.355)	(0.232)
Share of urban population	-0.276***	-0.345***	-0.128**	-0.307**	-0.356***
	(0.088)	(0.114)	(0.051)	(0.137)	(0.099)
Public saving/GPDI	-0.211***	-0.251***	-0.090	-0.370***	-0.246***
	(0.067)	(0.081)	(0.057)	(0.125)	(0.067)
X * Lag private saving/GPDI	-0.156***	0.132	-0.441***	0.047	0.099
	(0.055)	(0.099)	(0.090)	(0.143)	(0.165)
X * Ln real per capita GPDI (PPP)	-0.060***	-0.069	0.031	0.046	0.348
	(0.022)	(0.049)	(0.056)	(0.057)	(0.473)
X * Real growth rate of per capita GPDI (PPP)	-0.049	0.178***	-0.268***	0.059	0.594
	(0.079)	(0.059)	(0.078)	(0.079)	(0.411)
X * Real deposit rate	0.029	0.010	-0.272	-1.234*	2.783**
	(0.177)	(0.131)	(0.240)	(0.648)	(1.245)
X * Ln terms of trade	0.025	0.031	-0.005	-0.050	-0.492
	(0.021)	(0.076)	(0.069)	(0.076)	(0.607)
X * Inflation	-0.103	0.252	-0.278	-1.011	3.578*
	(0.192)	(0.172)	(0.299)	(0.785)	(1.957)
X * Flow of private sector credit/GPDI	0.031	0.126	0.452*	-0.101	0.027
	(0.037)	(0.107)	(0.255)	(0.142)	(0.079)
X * Old-age dependency ratio	0.343*	0.941***	-0.235	1.574**	-6.208
	(0.177)	(0.342)	(0.754)	(0.795)	(7.712)
X * Share of urban population	0.219***	0.353***	-0.054	-0.358	-0.322
	(0.070)	(0.132)	(0.130)	(0.282)	(0.852)
X * Public saving/GPDI	-0.137	-0.027	-0.223	0.322*	-2.392
	(0.122)	(0.101)	(0.147)	(0.168)	(2.270)
Time-fixed effects	Yes	Yes	Yes	Yes	Yes
Lags/Instruments	1/65	1/65	1/65	1/65	1/65
AR(1) *p*-val.	0.000	0.000	0.000	0.001	0.000
AR(2) *p*-val.	0.379	0.28	0.490	0.192	0.417
Hansen *J*-test *p*-val.	0.571	0.370	0.304	0.443	0.995
Observations	3,254	3,254	3,254	3,254	3,254
Number of countries	153	153	153	153	153

Notes: Standard errors in parentheses are corrected for heteroskedasticity and autocorrelation of the error term. System GMM estimations use a collapsed instrument matrix and perform the Windmeijer (2005) correction of the covariance matrix. The null hypothesis for the Hansen *J*-test is that the full set of instruments is valid. All estimations include a constant term. ***, **, * next to a number indicate statistical significance at 1, 5 and 10 percent, respectively.

Source: Authors' calculations.

Table 5. Determinants of National Saving, Alternative Estimators

(Dependent variable: national saving/GNDI)

	(1) Average CS OLS	(2) Pooled OLS	(3) OLS FE	(4) 2SLS FE	(5) Two-step S-GMM	(6) Two-step S-GMM	(7) Two-step S-GMM (Five-year averages)
Lag dependent variable	.	.	0.667***	0.643***	0.685***	0.686***	0.240
	.	.	(0.034)	(0.040)	(0.069)	(0.074)	(0.159)
Ln real per capita GNDI (PPP)	0.044***	0.058***	0.042***	0.050***	0.101***	0.101***	0.128**
	(0.011)	(0.011)	(0.010)	(0.012)	(0.025)	(0.026)	(0.058)
Real growth rate of per capita GNDI (PPP)	1.022***	0.297***	0.261***	0.305***	0.270***	0.273***	0.303*
	(0.295)	(0.046)	(0.021)	(0.054)	(0.024)	(0.029)	(0.170)
Real deposit rate	-0.650***	-0.283***	0.018	0.087	0.077	0.148**	0.159
	(0.198)	(0.075)	(0.025)	(0.080)	(0.052)	(0.060)	(0.250)
Ln terms of trade	0.030	0.040**	0.017**	0.015**	0.024***	0.025***	0.036*
	(0.049)	(0.019)	(0.007)	(0.007)	(0.009)	(0.010)	(0.020)
Inflation	-0.297*	-0.100	0.117***	0.063	0.293***	0.395***	0.320
	(0.170)	(0.080)	(0.030)	(0.050)	(0.066)	(0.080)	(0.279)
Flow of private sector credit/GNDI	0.322	0.043	-0.065***	-0.040**	-0.090***	-0.077**	-0.006
	(0.282)	(0.071)	(0.017)	(0.020)	(0.027)	(0.033)	(0.066)
Old-age dependency ratio	-0.641***	-0.647***	-0.124**	-0.153**	-0.657***	-0.631***	-0.993***
	(0.104)	(0.112)	(0.052)	(0.063)	(0.192)	(0.194)	(0.370)
Share of urban population	0.076*	0.033	-0.038	-0.078*	-0.241***	-0.246***	-0.240
	(0.043)	(0.046)	(0.033)	(0.046)	(0.077)	(0.082)	(0.176)
Ln real oil price	.	-0.008*	-0.005**	-0.005**	-0.010***	.	.
	.	(0.005)	(0.002)	(0.002)	(0.004)	.	.
Time-fixed effects	.	No	No	No	No	Yes	Yes
Lags/Instruments	.	.	.	.	1/17	1/46	1-4/39
AR(1) *p*-val.	.	.	.	.	0.000	0.000	0.228
AR(2) *p*-val.	.	.	.	.	0.299	0.264	0.359
Hansen *J*-test *p*-val.	.	.	.	.	0.955	0.966	0.127
Observations	154	3,382	3,278	3,007	3,278	3,278	679
Number of countries	.	.	154	153	154	154	154
R-squared	0.470	0.358	0.615	0.590	.	.	.

Notes: Standard errors in parentheses are corrected for heteroskedasticity and autocorrelation of the error term. System GMM estimations in columns (5) to (7) use a collapsed instrument matrix and perform the Windmeijer (2005) correction of the covariance matrix. Column (7) uses the sample 1983-2012 to have 6 periods of 5 years. The null hypothesis for the Hansen *J*-test is that the full set of instruments is valid. All estimations include a constant term. ***, **, * next to a number indicate statistical significance at 1, 5 and 10 percent, respectively.

Source: Authors' calculations.

Table 6. Determinants of Household and Corporate Saving, Baseline Specification

(Two-step S- GMM; dependent variable: household saving/GPDI, corporate saving/GPDI)

	(1) Y = Private saving/GPDI (restricted sample)	(2) Y= Household saving/GPDI	(3) Y= Household saving/GPDI	(4) Y = Corporate saving/GPDI	(5) Y = Corporate saving/GPDI
Lag dependent variable	0.817***	0.748***	0.619***	0.763***	0.573***
	(0.083)	(0.161)	(0.139)	(0.051)	(0.119)
Ln real per capita GPDI (PPP)	0.166***	0.111**	0.092**	0.085***	0.141*
	(0.045)	(0.048)	(0.036)	(0.027)	(0.072)
Real growth rate of per capita GPDI (PPP)	0.444***	0.105**	0.194***	0.315***	0.298***
	(0.042)	(0.042)	(0.047)	(0.045)	(0.065)
Real deposit rate	0.199*	0.401***	0.268**	-0.130	0.033
	(0.113)	(0.154)	(0.122)	(0.131)	(0.141)
Ln terms of trade	0.039	0.003	0.041*	0.020	0.033
	(0.033)	(0.020)	(0.025)	(0.025)	(0.031)
Inflation	0.370***	0.425***	0.326***	0.018	0.212*
	(0.135)	(0.165)	(0.103)	(0.176)	(0.118)
Flow of private sector credit/GPDI	-0.147***	-0.030	-0.059*	-0.075***	-0.120***
	(0.043)	(0.030)	(0.034)	(0.028)	(0.041)
Old-age dependency ratio	-0.941***	-0.631**	-0.431**	-0.442***	-0.766*
	(0.285)	(0.287)	(0.191)	(0.152)	(0.427)
Share of urban population	-0.438***	-0.292*	-0.140	-0.243**	-0.355
	(0.145)	(0.156)	(0.133)	(0.099)	(0.226)
Public saving/GPDI	-0.279***	-0.165	-0.095	-0.021	-0.088
	(0.069)	(0.118)	(0.079)	(0.060)	(0.062)
Ln real oil price	-0.005	-0.001	0.001	-0.005	-0.008
	(0.008)	(0.006)	(0.004)	(0.005)	(0.008)
Corporate saving/GPDI	.	.	-0.581***	.	.
	.	.	(0.150)	.	.
Household saving/GPDI	.	.	.	.	-0.790***
	.	.	.	.	(0.147)
Time-fixed effects	No	No	No	No	No
Lags/Instruments	1/20	1/20	1/20	1/20	1/20
AR(1) *p*-val.	0.018	0.000	0.004	0.000	0.005
AR(2) *p*-val.	0.728	0.389	0.852	0.274	0.371
Hansen *J*-test *p*-val.	0.864	0.694	0.360	0.541	0.924
Observations	674	674	674	674	674
Number of countries	48	48	48	48	48

Notes: Standard errors in parentheses are corrected for heteroskedasticity and autocorrelation of the error term. System GMM estimations use a collapsed instrument matrix and perform the Windmeijer (2005) correction of the covariance matrix. The null hypothesis for the Hansen *J*-test is that the full set of instruments is valid. All estimations include a constant term. ***, **, * next to a number indicate statistical significance at 1, 5 and 10 percent, respectively.

Source: Authors' calculations.