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Balance Sheets and Debt Crises

Empirical Regularities for Modern Cases of Sovereign Distress

by Gonzalo Huertas and Alexis Meyer-Cirkel

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Balance Sheets and Debt Crises – Empirical Regularities for Modern Cases of Sovereign Distress[1]

Prepared by Gonzalo Huertas and Alexis Meyer-Cirkel

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Abstract

Sovereign debt crises are more than just a story about debt levels and primary balances. Sectoral balance sheets, and in particular the net worth of households and banks, play an important role in determining whether an episode of increased rollover risk will deteriorate into full-blown default. This paper characterizes the stylized facts surrounding debt crises from 1990 to 2019: the behavior of government finances, aggregate macroeconomic variables, and the accompanying changes in the net worth of the private sector. We then use a logistic model to estimate the probability of undergoing default for a panel of 75 countries, and find that the net worth of the household and banking sectors is a significant predictor in addition to the usual flow variables included in standard debt sustainability analyses.

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Author's E-Mail Address: gonzalo_huertas@hks18.harvard.edu; ameyercirkel@imf.org

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Contents

1 Introduction

There have been almost a hundred episodes of debt distress since 1990. Situations in which the liquidity or solvency of the public sector is compromised, with rising bond yields, increasing perceptions of rollover risk, and, often, a need for governments to request financial assistance from multilateral institutions. Of these hundred distress episodes, almost forty ended in default, either through outright cessation of payments or a rescheduling of principal and interest.

Debt sustainability analysis (DSA) frameworks are typically concerned with identifying vulnerabilities that may trigger an episode of distress, as well as determining if 'surviving' the crisis without default is possible. To make such predictions, most DSAs focus on the state of government finances, with primary balances and interest payments playing a central role in the assessment.

In this paper, we argue that the overall health of sectoral balance sheets provides important information for understanding and predicting the likelihood of default.

We do this in three steps: first, we describe the stylized facts regarding the components of government finances during times of fiscal distress. Next, we provide a similar description for the changes public and private sector net worth during a debt crisis, with a specific focus on the household and banking sectors. Finally, we show that including sectoral wealth in a logistic probability model of sovereign default can provide additional insights than those based on a model relying only on macroeconomic flows.

Over the past three decades, theory and practice have advanced a great deal, and debt crises triggered by severe macroeconomic distortions –the type experienced by the economic transitions in Eastern Europe during the 1990s, or the hyperinflationary crises in Latin America of the late 1980s– have, fortunately, become less frequent.

Modern debt crises are harder to predict, can develop unexpectedly, and require a higher degree of case-by-case consideration. Japan has run consolidated fiscal deficits over 5 percent of GDP on average for the past 20 years, reaching gross debt-to-output levels of over 200%, and demand for the government's bonds has remained strong. In contrast, recent events such as Argentina in 2019, Jamaica in 2013, or Greece in 2011 featured distress under debt-to-output levels ranging from 89% (Argentina) to 180% (Greece). Defaults can even occur

at debt levels that had proven sustainable for a given country less than two decades earlier, such as Lebanon in 2020.

More nuanced debt crises led to more nuanced research, and recent literature has provided further explanations for these differences across countries, including debt intolerance (serial defaults associated with weak fiscal structures and financial systems, as in Reinhart, Rogoff & Savastano, 2003), fiscal fatigue (debt levels beyond which primary balance adjustments cannot not keep up with growth-adjusted interest rates, as in Ghosh et al., 2013), and political economy constraints (Andreasen, Sandleris & Van der Ghote, 2019).

Our contribution to this discussion is to present empirical regularities for public and private sector balance sheets during times of sovereign distress, and explain how changes in sectoral net worth fit into the broader question of government and market behavior during a crisis.

Balance sheet data availability has improved in recent years, but is still far from perfect, which leads us to be careful when interpreting the results from our quantitative analysis. It is also the reason why we choose to complement the results from our logistic model with qualitative discussions, focusing on specific country cases.

A combination of quantitative and qualitative assessments is also useful when considering causality. The relationship between balance sheets and fiscal stress can run in either direction: on the one hand, many debt crises in the past have been triggered or accelerated by distress in the banking sector's liabilities, highlighting how vulnerable private sector balance sheets can jeopardize public solvency. On the other hand, when the private sector's balance sheets are resilient, they have the potential to become an additional source of revenues for the sovereign, such that countries with higher net private wealth may be able to sustain higher levels of public debt. Causality is hard to disentangle, and context-specificity is a prerequisite.

Some of our findings describe empirical regularities that, to our knowledge, have been mostly unexplored in recent research, such as tax rate patterns in the runup to a sovereign default. Other findings are supportive of existing notions in the literature, such as the fact that investors perceive countries with a recent history of default to be inherently riskier than those with similar macro fundamentals. And yet other results provide suggestive evidence against existing hypotheses; for instance, our estimates suggest that, after controlling for

public debt, the net worth of the public sector's balance sheet may not be the central driver behind the likelihood of undergoing default.

1.1 Related Literature

Three strands of literature are especially relevant to the empirical regularities we present in this paper. First, there are studies describing the relationship between government operating balances and the propensity to undergo a default. Second, there is a strand that explores the linkages between the deterioration of the government's balance sheet and that of the private sector. Third, there is the literature on how market expectations of default react to macroeconomic fundamentals.

Starting with the first of these categories, regarding government finances during times of fiscal stress, there are competing narratives on whether governments purposefully implement fiscal adjustment when faced with the possibility of a debt crisis. Conesa & Kehoe (2017) highlight that the drop in fiscal revenues during a recession is the main driver of self-fulfilled debt crises, with some governments choosing to "gamble for redemption" by continuing to run deficits and hoping for an economic upturn. In contrast, Reinhart & Rogoff (2009) hold that countries may fail to adjust not out of some optimizing behavior, but due to the misplaced belief that "this time is different".

Even if adjustment were the optimal decision, there are many possible combinations of tax hikes and expenditure reduction measures, each with different tradeoffs for the sovereign, which in turn may vary on a case-by-case basis. On the revenue side, for example, the political cost of raising taxes may differ across countries depending on the progressivity of their tax schedules, as described by Ferriere (2015) and Andreasen, Sandleris & Van der Ghote (2016). On the spending side, public investment often becomes the adjustment variable of choice when governments are unable to tax the private sector, as explained by Joo (2014).

These studies raise the issue of whether countries experiencing fiscal stress can (and do) successfully fend off default by implementing adjustment. The answer is not straightforward – even credit rating agencies have pointed out that austerity, through its effects on aggregate demand, can erode fiscal revenues and weaken, not bolster, debt sustainability (Standard & Poor's, 2012). The type of discussion that featured prominently during policy debates surrounding the Eurozone debt crisis.

The discussion presented above motivates the first stage of our paper, where we explore the dynamics of government finances during times of sovereign distress.

A second strand of the literature deals with the relationship between government and private sector balance sheets, and their implications for debt distress. We are far from the first to highlight the importance of stocks rather than flows for debt sustainability. Notably, Allen et al. (2002) introduced a theoretical framework showing how financial vulnerabilities can develop from maturity, currency or capital structure mismatches within the balance sheets of either the public or private sector, which together compose a country's aggregate consolidated balance sheet. Our paper builds on their key notion that a country's balance sheet, and hence its financial vulnerabilities, can be obtained from the aggregation of the government, household, bank and nonbank commercial sectors.

Possibly because of data unavailability at the time, Allen et al. provide only a theoretical framework; we explore the issue empirically by considering the behavior of sectoral net wealth during times of sovereign distress.

Many important contributions to this strand of literature have focused on the health of the banking system. Reinhart & Rogoff (2010) emphasized that a banking sector under duress often precedes or coincides with a debt crisis. Whether causality runs from the banks to the government (the contingent liability story) or from the government to the banks (as would happen if authorities coerce banks into purchasing public debt) is less clear. We will also urge caution when considering the direction of causality in relation to our findings.

Gennaioli et al. (2014) show that during times of default, financial intermediaries reduce their credit supply in proportion to the amount of government securities that they hold, reflecting the deterioration in their net worth. This magnifies the output contraction associated with credit events, and acts as a further disincentive to default. Of course, not all default episodes feature a banking sector with overexposure to government securities – but those that do tend to be much more strongly associated with subsequent banking crises, as described in Balteanu & Erce (2017) and much of the European "doom loop" literature.

Research is scarcer when it comes to the role played by the balance sheets of the rest of the private sector – in particular, households and corporates. Du & Schreger (2017) study the impact of corporate financing in foreign currency on the likelihood of sovereign default, but the impact of changes in corporate net worth is less clear. Wu (2020) finds that corporate

external debt denominated in foreign currency increases sovereign risk premiums in the home country by changing the covariance of sovereign defaults and the state of foreign lenders. A better understanding of the role played by the resilience and composition of private balance sheets is needed. The literature is also less abundant when it comes to the balance sheet of the government. Typical studies of sovereign default focus on the level of public debt rather than net worth. Of note is the work in Yousefi (2019), which constructs a measure of public sector balance sheet strength and finds that financial markets account for government assets, not just liabilities, when pricing sovereign bonds.

The findings and limitations of the existing literature on the relationship between sovereign debt sustainability and sectoral balance sheets motivates the second stage of this paper, where we explore the evolution of certain components of private and public balance sheets – and consider who is financing whom.

A third and final strand of the literature relates to the interplay between market expectations of default and macroeconomic fundamentals. When it comes to debt distress, the traditional view in macroeconomics has been that such events arise as a combination of conjunctural factors – growth, interest rates, and fiscal imbalances. In more recent times, this basic explanatory pattern was expanded by focusing on the linkages between financial duress, banking crises and sovereign defaults (Reinhart & Rogoff, 2011).

If and when the government attempts to reallocate wealth away from the private sector and towards its own assets during a crisis, in an effort to meet debt maturities, there are political economy considerations involved. Costs and constraints are certainly country specific, but four common ones have been laid out in Borensztein & Panizza (2008): reputational costs, international trade exclusion costs, costs to the domestic economy through the financial system, and political costs to the authorities. The first three will be quantifiable, while the fourth one, political costs, are much harder to assess. They will depend on the political business cycle, on the type of political system and coalition setup, on the degree of "capture" by specific interest groups, to name a few.

Markets, in turn, may form their expectations of the probability that a government will default based on the interplay of these variables: ongoing macroeconomic conditions, political and institutional constraints, and the availability of resources beyond the government's own balance sheet that may act as extra sources of funding. The third, and central stage of this paper seeks to explain whether the likelihood of default (both in terms of ex-ante market

expectations and in terms of ex-post actual realizations) is influenced by the net worth of the private sector.

1.2 Paper Structure

The remainder of this paper is organized as follows:

- Section 2 describes our methodology for identifying sovereign distress events, which we separate into two possible outcomes: defaults and survivors. We then characterize the stylized facts surrounding debt crises from 1990 to 2019: the behavior of government finances, aggregate macroeconomic variables, and the accompanying changes in the net worth of the private sector.
- Section 3 presents the dynamics of sectoral balance sheets during times of sovereign distress during the 21st century. In particular, the behavior of the assets, liabilities and net worth of the government, banking and household sectors.
- Section 4 applies this data to a logistic model, showing that changes in private sector net worth are a significant predictor of the probability of experiencing a sovereign default, in addition to the standard variables typically considered in a debt sustainability analysis.
- Section 5 concludes.

2 Government Finances in times of Distress

2.1 Defining Sovereign Distress: Defaults and Survivors

By "sovereign distress" we mean a situation in which either the liquidity or the solvency of the public sector is compromised. Other labels used in the literature are "fiscal crisis", "debt distress", or more commonly "debt crisis".

During an episode of sovereign distress, fiscal authorities find it difficult to service their debt payments. Bond yields widen and CDS spreads rise. The onset of distress may occur as a result of fiscal imbalances, exogenous shocks, sudden shifts in market sentiment, or

any number of related factors. If the situation persists and risk perceptions remain high, authorities often request exceptional assistance from the IMF.

Episodes of sovereign distress end in one of two ways: either the country eventually undergoes a credit event, in which payments are rescheduled (with or without a haircut on outstanding principal)[1] or it avoids a restructuring and manages to normalize the situation. We refer to country cases of the first kind as "defaults", and to episodes of the second kind as "survivors".

To identify default episodes, we rely on the panel dataset by Asonuma & Trebesch (2016), which provides a yearly account of the start and end of all credit events from 1975 to 2016. In recent years, the authors have extended their data all to way to 2020.

To identify survivors, we consider country episodes of fiscal stress whose resolution did not involve a default. By "fiscal stress" we mean the definition used by Baldacci et al. (2011), where a country is considered to be undergoing stress if any of the following are present:

i. Sovereign spreads greater than 1,000 basis points,
ii. Inflation rates exceeding 500% for emerging markets (or 35% for advanced economies),
iii. Access to a large IMF-supported program, or
iv. A public debt default or restructuring.[2]

A survivor, then, is a country case experiencing any of the "fiscal stress" items i) through iii), but not iv). Such an episode can last multiple years. Next, we construct a panel of fiscal stress episodes, separating each case into a default or a survivor. Throughout the rest of this paper, we refer to these events as "sovereign distress", "debt crises" or "fiscal stress" interchangeably. Our analysis focuses on two periods of interest: first, we provide an introductory snapshot of the behavior of government finances during episodes of distress from 1990 to 2019. Then we move on to the core focus of the paper: the dynamics of public

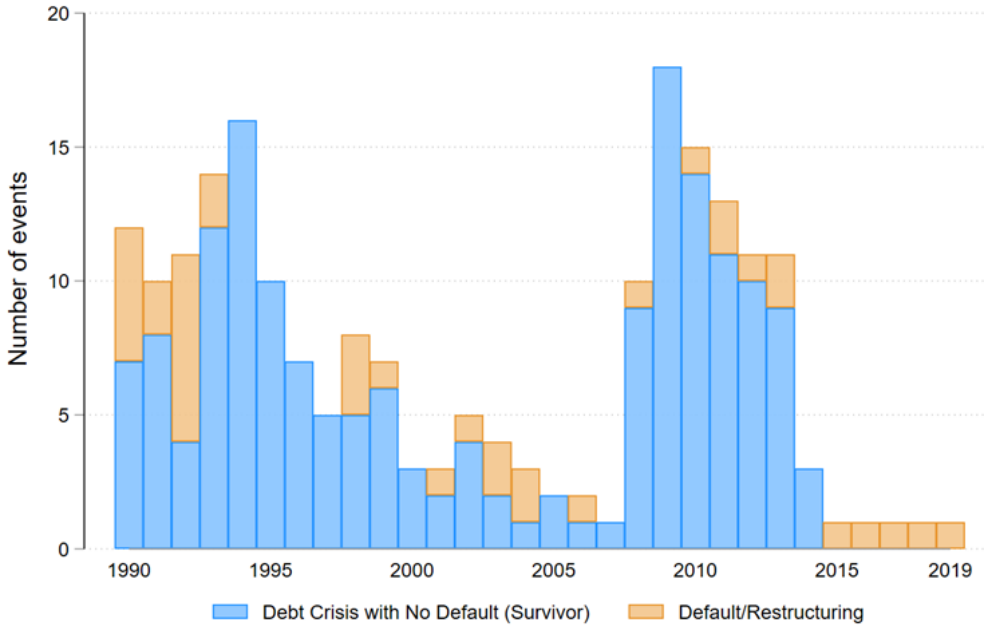
[1]For expositional simplicity, we use the term "default" to describe any type of credit event and ignore the distinction between an explicit default (a haircut on principal or interest) and a restructuring (a rescheduling of outstanding payments). Most, but not all credit events feature some measure of debt reduction.

[2]The original bond spread criterion in Baldacci et al. is a 1,000 bp spread or any bond spread that is above two standard deviations of the country average. We deliberately exclude the second part of the criterion because it would imply, by definition, that every country has experienced fiscal stress at some point during our period of interest.

and private sector balance sheets during times of distress. For data availability reasons, our balance sheet assessments are limited to 2000-2019.

For the 1990-2019 period, our dataset contains 57 episodes of fiscal stress without default (survivors) and 40 instances of default/restructuring. Figure 1, below, shows the occurrence of distress events on a yearly basis. Our sample for balance sheet assessments, limited to the 21st century, includes a total of 38 events, of which 12 are defaults and 26 are survivors.

Figure 1: Sovereign Distress Episodes (1990-2019)



Note: A single debt crisis episode can stretch over multiple years. Defaults are single-year events.

Our goal is to understand what happens to the balance sheet of the public and private sectors during an episode of sovereign distress, and the effect of their overall resilience on the likelihood of undergoing default. Changes could come about by market-related movements in asset prices, as well as through the impact of flow variables (e.g., drops in public and private investment, changes in revenue collection, etc.) or stock components when the crisis persists over multiple years.

Since our interest is on the dynamics of public and private sector variables around the peak of each crisis, we choose a specific year as the height of the event's fiscal tension ($t = 0$). For defaults, we choose the year in which a restructuring began or a payments suspension

occurred. For survivors, the ideal criterion is less obvious; we choose the year with the highest bond spread.

Summary statistics for both types of sovereign distress groups, as well as mean difference tests, are presented in Appendix 5. In general, we do not find sectoral net wealth to be markedly different between survivor and default groups, with the exception of Depository Corporations' net worth at the end of our period of interest, highlighting that by 2019 the banking sector in defaulting countries was less wealthy than that of survivors.

2.2 Fiscal Reactions to Sovereign Distress: Stylized Facts

Episodes of sovereign distress are, first and foremost, a story about the sharp deterioration of the government's net operating balance – both on the revenue and the expenditure side.

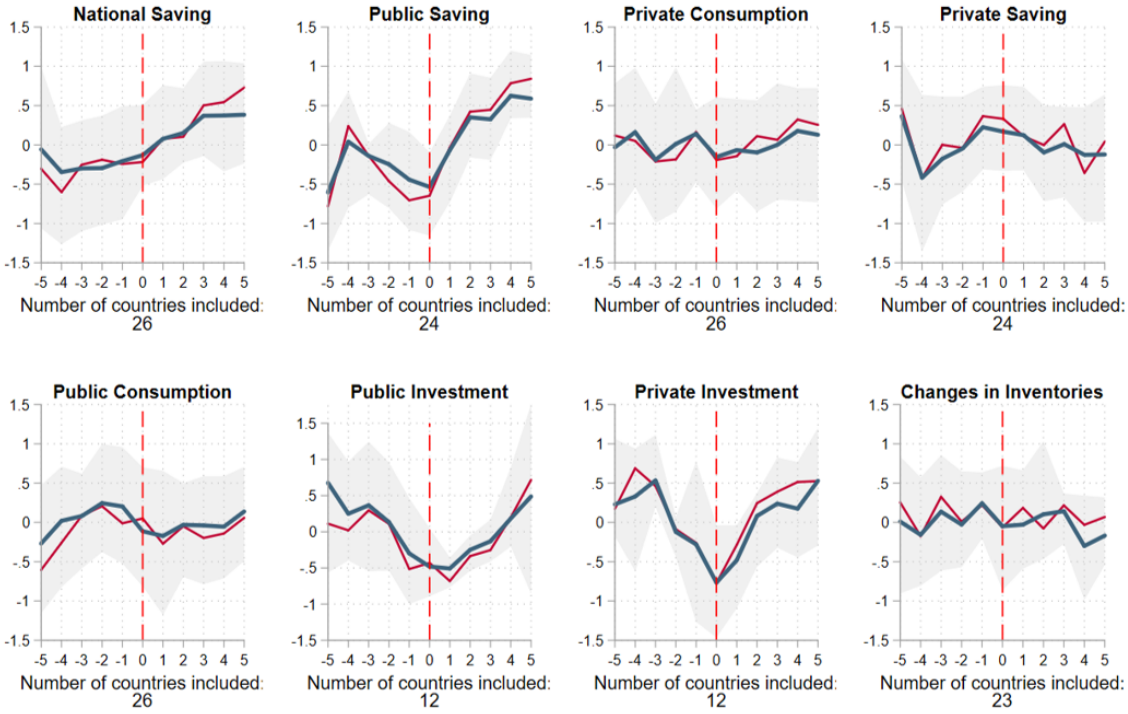
There tends to be a notable decrease in public saving in the years leading up to the event, as well as a retraction in private investment. The behavior of some of these macroeconomics variables is supportive of the interpretation that survivors have more fiscal space to deal with a mounting economic crisis: public consumption rises before the event peak, and public investment is not slashed. Meanwhile, when debt distress ends in default, there are strong contractions in public investment before the fact, possibly reflecting authorities' efforts to balance the budget by focusing on expenses that are considered less politically sensitive.

Turning to the composition of government finances, sovereign distress is characterized by a fall in net operating balances and tax revenues. For the case of defaults, there is a pronounced increase in interest expenses in the years leading up to the credit event, as is to be expected. For survivors, interest expense is higher after the crisis, partly reflecting increases in public debt during the episode.

Figures 2 and 3, below, show the evolution of key macroeconomic variables and government finances during times of distress. We display a variable's average value using a blue line, and the median is shown with a red line. The grey area around the lines represents the 25th to 75th percentiles. Values are normalized by subtracting the country-specific mean and dividing by the country-specific standard deviation. Details about the construction and aggregation of these time series are provided in Appendix 1.

The magnitude of the fall in net operating balances is similar for both types of crises:

Figure 2a: Aggregate Macroeconomic Variables (Defaults)

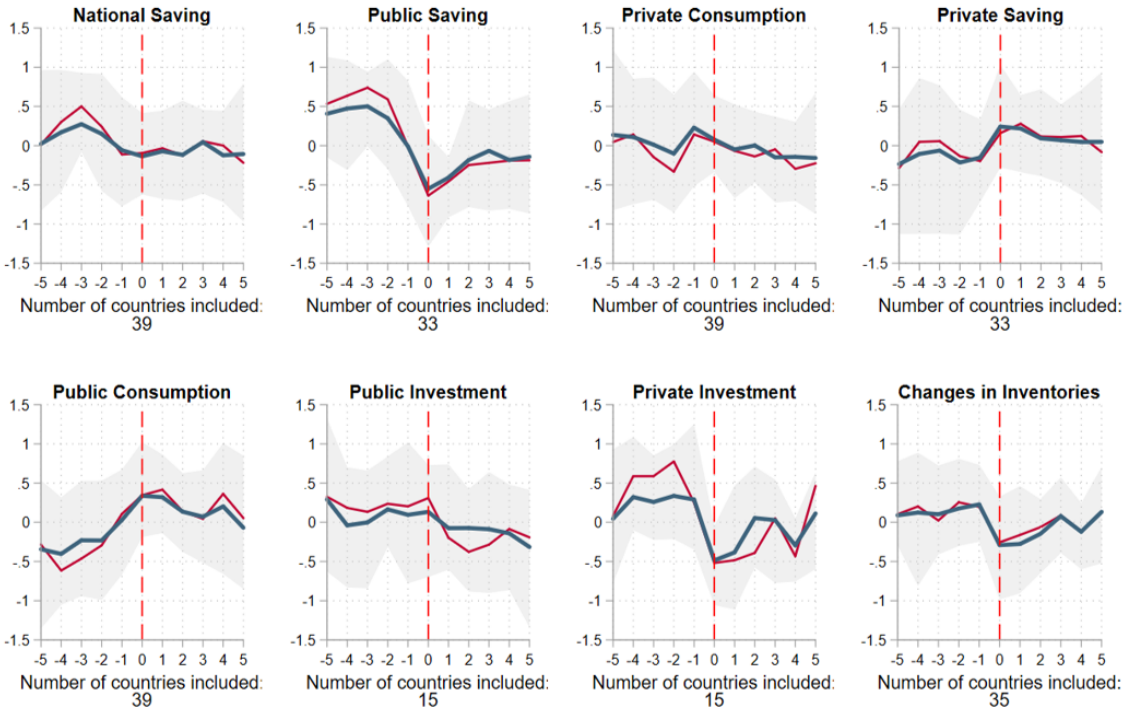


close to one within-country standard deviation from peak to trough. The deterioration is more protracted in episodes of default, however: for the average case, operating balances decrease two years before the credit event, compared to one year before the crisis peak for the average survivor.

Additional figures showing the behavior of government finances around episodes of fiscal stress are provided in Appendix 3. Of special note is the evolution of net financing needs: survivors experience a deterioration when the crisis reaches its peak (a one-standard deviation change in their net incurrence of liabilities) and a matching shift in net borrowing. Defaults do not feature this same financing-needs trough around $t = 0$. Instead, the increase in net borrowing is more commonly seen two years before the credit event. One possible explanation is that, in the five to two years prior to the crisis, governments finance an increasing amount of their overall expenses through net borrowing with a parallel increase in their interest expense line, overstretching the state's debt servicing capacity and eventually leading to default.

Since our goal is to understand the interaction between wealth stocks and debt sustainability, it is natural to explore the fiscal reactions of survivors and defaults during times of

Figure 2b: Aggregate Macroeconomic Variables (Survivors)



Note: All variables are originally in % of GDP, then normalized by subtracting the country-specific mean and dividing by the country-specific standard deviation.

debt distress. Do governments raise taxes in an attempt to stave off the fiscal crisis? The behavior of tax revenues as a share of GDP does not tell the whole story, because debt distress tends to have an impact on economic activity; for this reason, we now turn to changes in tax rates during times of fiscal stress. Our source is the IMF Fiscal Affairs Department Tax Policy Rates Database. Although data is less abundant for this topic, we find suggestive evidence that defaults and survivors might exhibit different fiscal reactions to distress.

Defaulting countries do not appear to raise taxes during a crisis, in general. Neither income, nor VAT, nor indirect tax rates, nor social contributions display any strong movements until and including the very year of the cessation in debt payments. The fact that defaults feature nonresponsive tax rates accompanied by sharp cuts in public investment could imply that governments are more likely to default when they enter a crisis in a relatively more constrained fiscal position. As a further test of this notion, we construct a fiscal effort index and a tax effort index (following the work of Le, Moreno-Dodson & Bayraktar, 2012; see Appendix 2 for details) and find average index values of 1.25 for defaults, compared to 1.1

Figure 3a: Government Finances (Defaults)

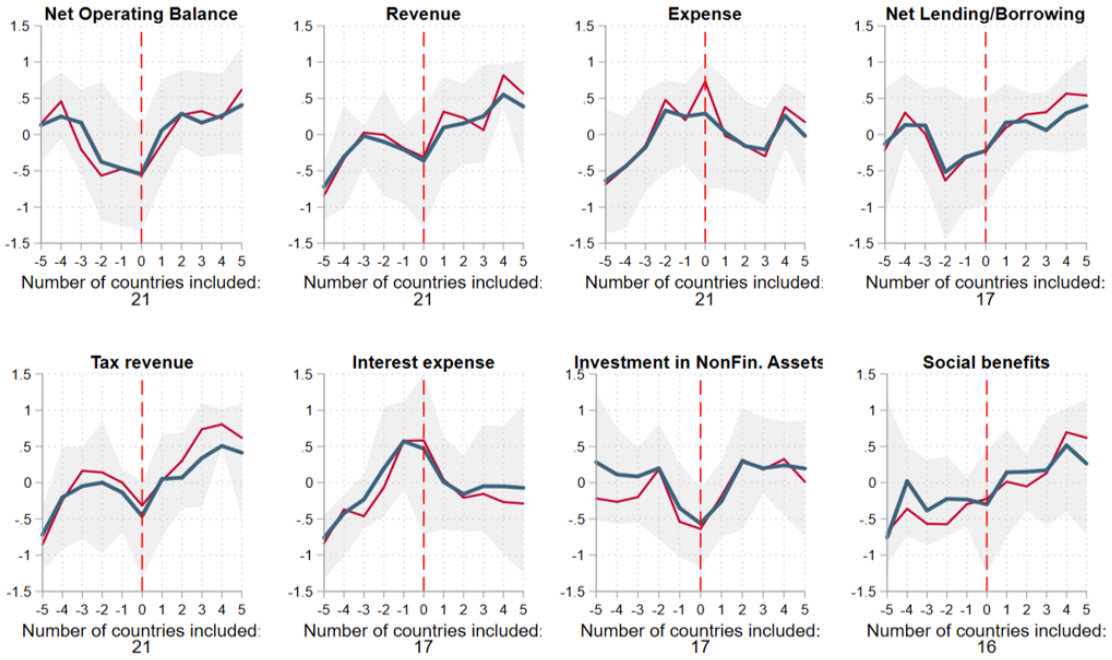


Figure 3b: Government Finances (Survivors)

for survivors, implying that, given their macroeconomic and demographic characteristics, the former tend to have a higher overall tax burden than the latter (see the Appendix for details on these indices).

Figure 4a: Tax Rates (Defaults)

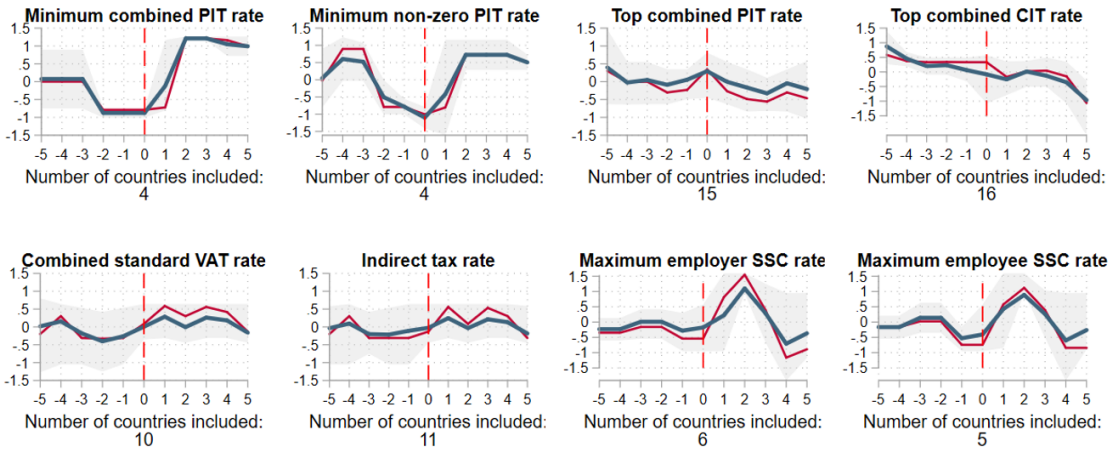
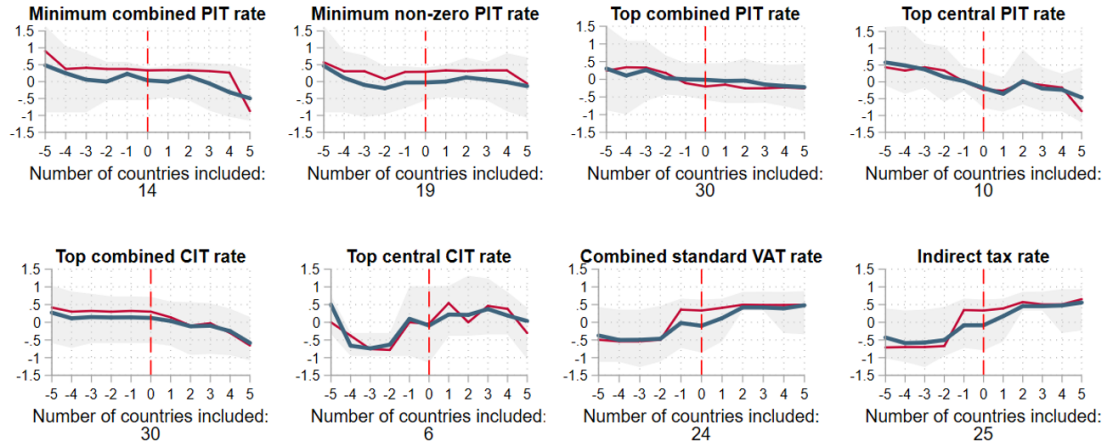


Figure 4b: Tax Rates (Survivors)



Tax rates appear to rise after a sovereign default. One possible explanation is that, after losing access to capital markets, governments are forced to finance public expenditures with a larger share of domestic resources. VAT, personal income tax rates, and employee and employer social security contributions all show increases between 0.5 and 1.5 standard deviations.

It should be noted, however, that our tax rate sample size for defaults is much smaller than for survivors, and further research is needed once more tax data becomes available.

Overall, our findings suggest that:

- Sovereign distress is characterized by a rapid decline in government net operating

balances, both for defaults and survivors.

- Defaults are more likely to feature a sharp reduction in public investment in the runup to the credit event, while the same is not true for survivors. In all cases, however, private investment and public saving feature a marked deterioration.
- Countries that default may be entering the crisis in a more fiscally constrained position than survivors. The higher average fiscal effort and tax effort indices for defaults, as well as the strong decrease in public investment, appear supportive of this idea.
- For the episodes for which we have tax rate data, debt crises that end in default feature higher rates in the years after the credit event, possibly as a result of financial autarky. There is no evident increase in tax rates before the credit event.
- Defaulting countries tend to face a sharper rise in interest expenditures, which may reflect the higher risk premia assigned by markets as the crisis unfolds.

Having explored the stylized facts surrounding the fiscal nature of sovereign distress, we turn to the main focus of this working paper: how changes in the public and private sectors' net worth, as determined by their balance sheets, can alleviate or heighten the probability of undergoing default.

3 Sectoral Wealth in times of Distress

3.1 Definitions and Data Sources

This section introduces the reader to the behavior of public and private balance sheets during episodes of sovereign distress, with a particular focus on sectoral net wealth.

Our balance sheet data considers the general government, households, and the banking sector. The last two serve as a proxy for the overall state of private sector wealth. Unfortunately, there is a lack of representative data for corporate balance sheets at the country level, so we are unable to include corporates to construct a fully consolidated private sector balance sheet. Furthermore, in this section we restrict our period of interest to the 21st century alone, again for data limitation reasons.

For government wealth, we draw on the IMF's Public Sector Balance Sheet (PSBS) dataset. Our sample covers 43 countries for the 2000-2016 period, with 13 survivors and 3 defaults. Since three default cases are insufficient to draw meaningful empirical conclusions, we limit our discussion of public sector balance sheets to survivor episodes.

For household data, we use the Credit Suisse Global Wealth reports. Created by the Credit Suisse Research Institute, this publication compiles estimates on global household wealth using a combination of household surveys, financial balance sheets for the household sector, and econometric estimation when other data is unavailable. Our household wealth dataset covers 172 countries, with 29 survivors and 12 defaults during the 2000-2019 period.

Banking sector balance sheet data is drawn from the Monetary and Financial Statistics (MFS) database. Our sample covers 67 countries, with 32 survivors of distress and 14 defaults across the 2001-2019 period.

Whenever we discuss sectoral wealth, we do so in terms of its share of GDP. This is both in keeping with the standard practice in the literature, and to capture the potential role for this wealth to service public debt, which is usually reported as a percentage of output.

A complete set of charts for sectoral balance sheets in constant 2014 US dollars, rather than as a share of GDP, is included in Appendix 4. Measuring stocks in real US dollars, and not just in terms of output, is important to determine whether the fluctuations we observe are not entirely driven by changes in economic activity. In general, we find that sectoral net wealth accumulation in real dollars stops during default episodes and remains muted for a few years; for survivors, net wealth accumulation tends to decelerate rather than halt altogether. Government accumulation of financial and nonfinancial assets grinds to a halt on the year in which the crisis reaches its peak, but liabilities, including debt securities and loans, continue to increase over the entire ten-year window.

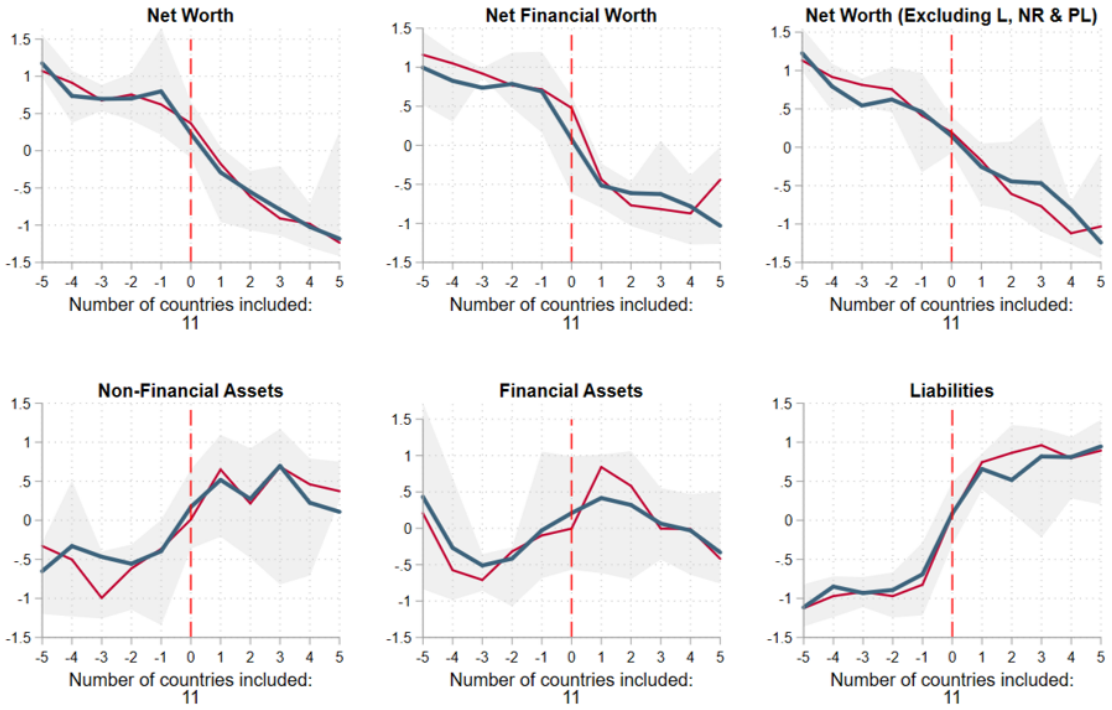
For the figures presented in this section, which show the evolution of balance sheet components during times of sovereign distress, we normalize the data using the same procedure applied in Section 2: we subtract the country-specific mean and divide by the country-specific standard deviation. As a result, figures show the movement of these variables measured in standard deviations away from the mean.

3.2 Balance Sheet Dynamics: Government, Households and Banks

Sectoral balance sheets exhibit a marked deterioration in the aftermath of a distress event. Below we present the stylized facts for the government, household and banking sectors. As before, figures include a blue line to represent the average value in the sample, and a red line for the median, with grey bands representing the 25th and 75th percentiles.

Public net worth and public net financial worth both decline by close to 1 standard deviation from the year before the crisis peak to the year after, and then continue to deteriorate. In general, government assets as a share of output increase (the economic downturn implies a reduction in the denominator, GDP) but do not exhibit the sudden jump that liabilities do.

Figure 5: Public Sector Balance Sheets (Survivors)



Note: "Net Worth (Excluding L., NR & PL)" refers to Net Worth excluding Land, Natural Resources and Pension Liabilities.

Turning to the household sector, we find that wealth accumulation slows down as sovereign distress builds up and unfolds. For survivors, net wealth accumulation stops around a year

before the crisis peak and resumes between two to three years after. Debt per adult also stalls, possibly highlighting the effects of economic uncertainty on the credit market.

For default episodes, the scenario is more severe: household wealth accumulation for the average country appears to stall up to five years before the credit event, and actively decreases (falling about 0.5 standard deviations) a year before the default.

Figure 6a: Net Household Wealth (Defaults)

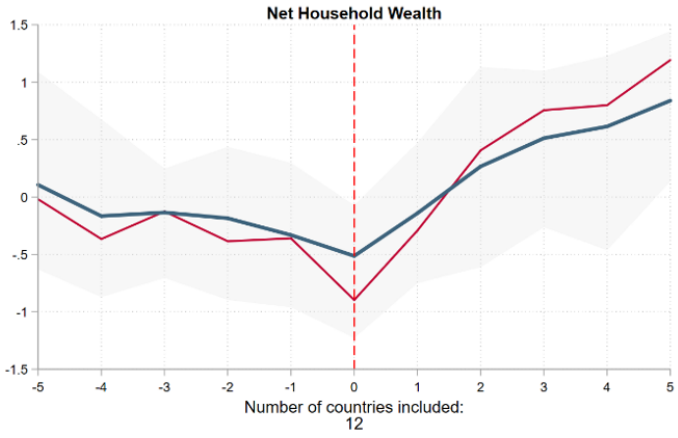
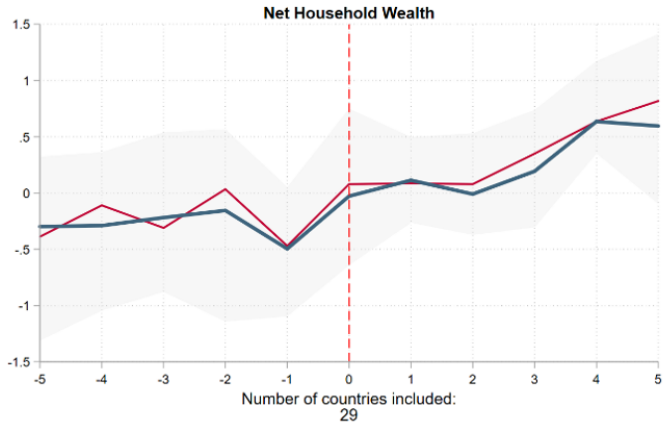


Figure 6b: Net Household Wealth (Survivors)

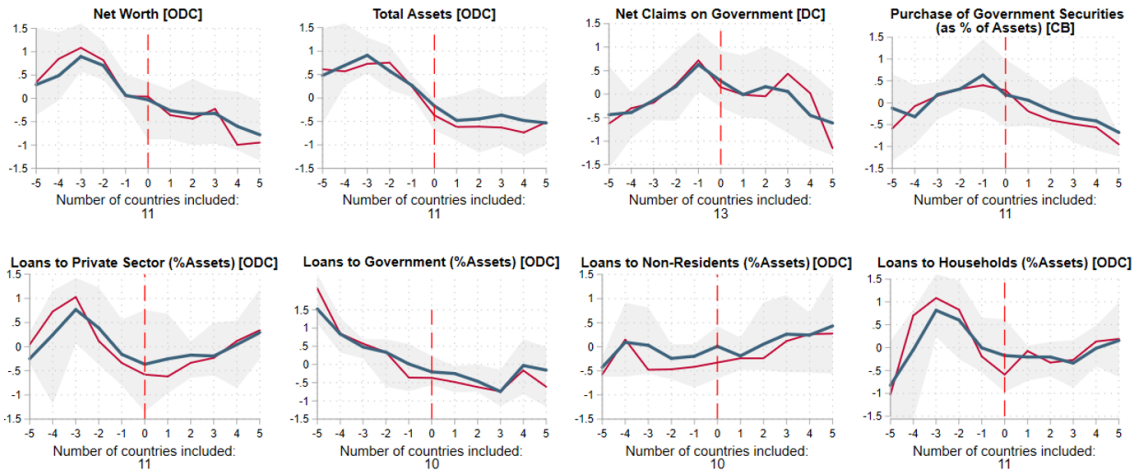


Surprisingly, for most default cases in our sample, household net wealth begins an uninterrupted increase a year after the credit event. Since household wealth is strongly related to economic performance, it is likely that the post-crisis recovery is a key driver of these developments, but it is also possible that home bias in investment (as explored in Chan, Covrig,

& Ng 2005) may be excessively exposing domestic households to movements in government asset prices.

Turning to the banking sector, we find that defaults feature a collapse in the assets and net worth of commercial banks (formally "Other depository corporations", or "ODC") starting a year before the credit event. As a share of output, assets decrease 1 standard deviation from peak to trough, reflecting a shrinkage in the overall size of the commercial banking sector; net worth falls close to 1 standard deviation in the two years before the default, and then continues to decrease during and after the credit event.

Figure 7a: Banking Sector Balance Sheets (Defaults)

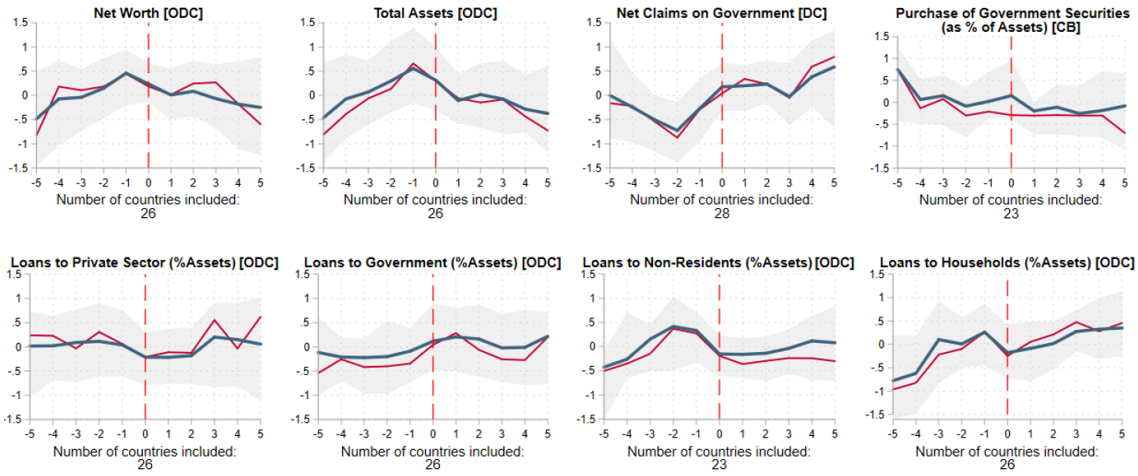


For survivors, this deterioration is less pronounced, with little movement in net worth and a decrease in assets of less than 1 standard deviation around the crisis peak.

Banks are often very attuned to sovereign risk and fiscal imbalances, leading to a retraction in lending activity during the early stages of a crisis buildup. For default episodes, loans to the private sector as a share of total assets peak out three years before the credit event; loans to the government decrease gradually and continuously, while loans to households show a large buildup up to three years before the default, followed by a rapid contraction of around 1.5 standard deviations, reflecting both the interplay between deteriorating household wealth and banks' balance sheets, and the overall decline in economic activity.

For survivors, there is a much more muted reaction in loans to the private and public sector, but loans to non-residents tend to build up between five to two years before the crisis peak, with an increase of 1 standard deviation, and then reverts with a fall of the same

Figure 7b: Banking Sector Balance Sheets (Survivors)



Note: Net Worth is defined as "Liabilities: Shares and Other Equity". "Loans to Households" includes nonprofit organizations serving households, under the category "NPISH".

magnitude as the crisis nears its peak. This may be indicative of vulnerabilities triggered by banks' foreign exposure, currency-related financial instability, or even carry trade operations for those countries with perceived exchange rate imbalances.

Monetary financing of the government is not a salient characteristic for survivors of fiscal stress, but can be a feature of default episodes. Central Bank purchases of government securities as a share of total assets display a slow but continuous increase up to three years before default, with an uptick of 1 standard deviation from trough to peak. This behavior reverses once the credit event occurs, and tapers out over subsequent years. One possible interpretation is that defaults are more likely to exhibit monetary financing of the deficit because those country cases entered the crisis with a relatively more fiscally constrained fiscally position; an explanation that would coincide with some of the evidence presented in the previous section.

Depository corporations' net claims on the central government, as a share of output, feature a rapid increase during episodes of default, up to the year preceding the credit event. The trend reverses thereafter. For survivors, net claims on government also display a similar increase in the year leading to the peak of the crisis. This evidence appears to support the "moral suasion" argument in the literature, whereby governments facing significant rollover pressures may in turn sway domestic banks to increase their holdings of sovereign bonds (Ongena, Popov & Van Horen, 2019).

Overall, our findings suggest that:

- Episodes of distress, even without a default, can be very damaging to government wealth. The decline in net worth tends to begin at the peak of the crisis, but continues for many years.
- Survivors are not associated with severe declines in household wealth, but cases ending in default feature a strong impact: household wealth accumulation stops years before the credit event. Surprisingly, it tends to resume quickly once the default or restructuring takes place.
- The *commercial* banking sector's net worth tends to stop growing a year before the peak of a survivor's crisis episode, and then falls continuously afterwards, albeit at a measured pace. For defaults, net worth declines sharply the year before and continues a considerable downward trend over the entire five-year post-crisis observation window.
- Defaults feature a sharp contraction in loans to the private sector (both corporates and households) as a share of total assets, while for survivors this only occurs for non-residents.
- Central bank purchases of government securities are more likely to play a role in defaults, where they display an inverse V-shape, whereas survivors distress feature no such movement. However, the net claims on government of the banking sector as a whole tends to increase for both crisis types.

4 Predicting Default using Sectoral Wealth

4.1 Baseline Model

The overall health of the public and private sectors' balance sheets has direct consequences on debt sustainability, with effects running in both directions: a government facing a liquidity crisis may levy additional resources from financially robust households, corporates and banks; but, at the same time, private sector liabilities can become a public sector concern during times of stress.

In this section, we use a random effects logit model to show that: a) the probability of undergoing default is well explained by macroeconomic fundamentals; b) the state of the private sector's balance sheet adds important information to this prediction; and c) market expectations of default, as implied by CDS spreads, internalize this balance sheet information often, but not always.

Our starting point is a logit model relying solely on the basic components of a standard equation of motion for debt: interest payments, real output growth, the primary balance, and the public debt stock. Formally:

$$P(Default = 1|\mathbf{X}) = \frac{1}{1 + e^{-(\beta X)}} \tag{1}$$

Where the left-hand side variable is the occurrence of default at time t, and on the right-hand side is a matrix of regressors. We choose to focus on the components of a standard equation of motion for debt, as opposed to, for instance, the regressors in the IMF's Debt Sustainability Analysis (DSA) framework, because the former allows us to make use of a much larger number of country-year observations. We then consider alternative models with additional controls, including many of those present in the DSA framework, to test the robustness of our estimates. In particular, we run a logit model where we distinguish between revenues and expenditures rather than interest expenses and the primary balance; and another where we include relevant controls from the literature such as global risk appetite (as proxied by the VIX), changes in the nominal exchange rate, and a binary variable for "serial defaulters" (Reinhart & Rogoff, 2004; Asonuma, 2016) which is meant to capture the additional risk premia faced by countries with a recent history of sovereign default.

Results are presented below. Our model of choice is specification (4), where the probability of default is a function of the components of an equation of motion for debt, plus a control for "serial default" behavior. The explanatory variables are statistically significant and have the expected sign, regardless of the specification chosen. This model specification suits our purposes as a baseline with minimal noise, against which to compare an extended model that incorporates sectoral wealth data.

Further robustness checks are included in Appendix 6. Restricting our sample to the years 2000-2019 (that is, omitting the Eastern European economic transition of the 1990s, as well as Latin America's hyperinflationary crises) does not lead to substantial changes in the coefficients' statistical or economic significance. Another way to describe this result is to

state that, had we first run the base logit model using only 21st century data, we would find that it performs well out of sample when extended to the 1990s. The Appendix also presents endogeneity tests and collinearity diagnostics; we find that most of the regressors have a VIF close to 1, and all have a VIF < 2, which reinforces our belief that multicollinearity is not a concern for our model of choice.

Next, we use the baseline model to compute the predicted probability of default for each country-year pair, and compare these predictions with market expectations of default, using 5-year CDS spreads since the 2000s obtained from Bloomberg to assess the extent to which market concerns of a credit event move in tandem with deteriorating fundamentals. We find that CDS spreads and logit predictions move closely together during times of crisis most of the time, although there are specific cases where their magnitudes are off.

Figure 8, below, presents this comparison for a subset of selected countries. The black line shows the logit model's estimated probability that, at any time t, there will be a default within the next year; the dotted red line shows the 5-year CDS spread for that same year t. Grey shaded areas indicate years with a default or the start of a restructuring process.

Figure 8: Predicted Default Probabilities vs. Actual CDS Spreads (2000-2019)

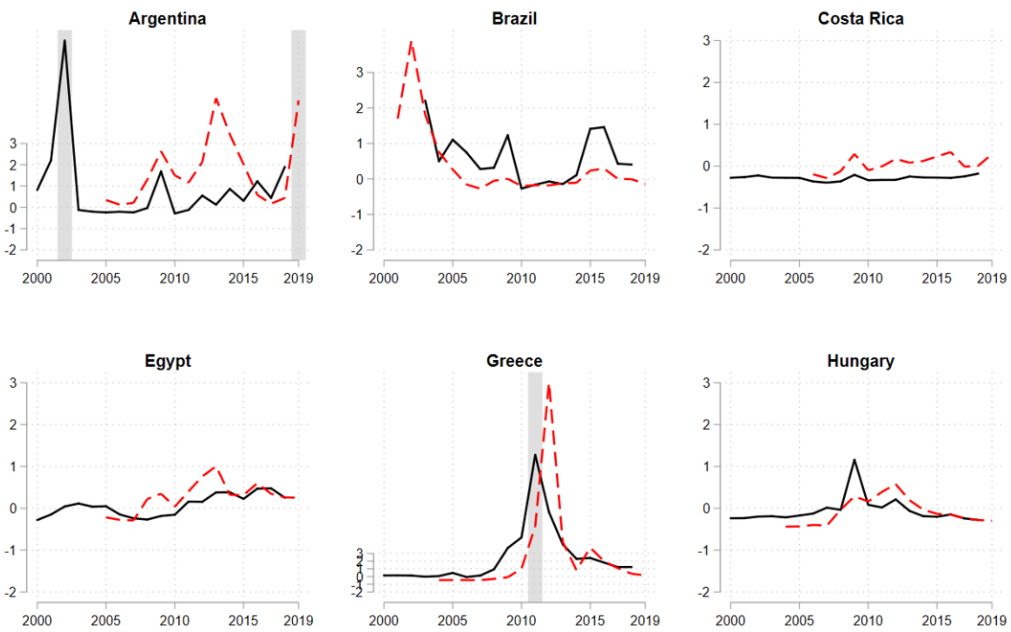
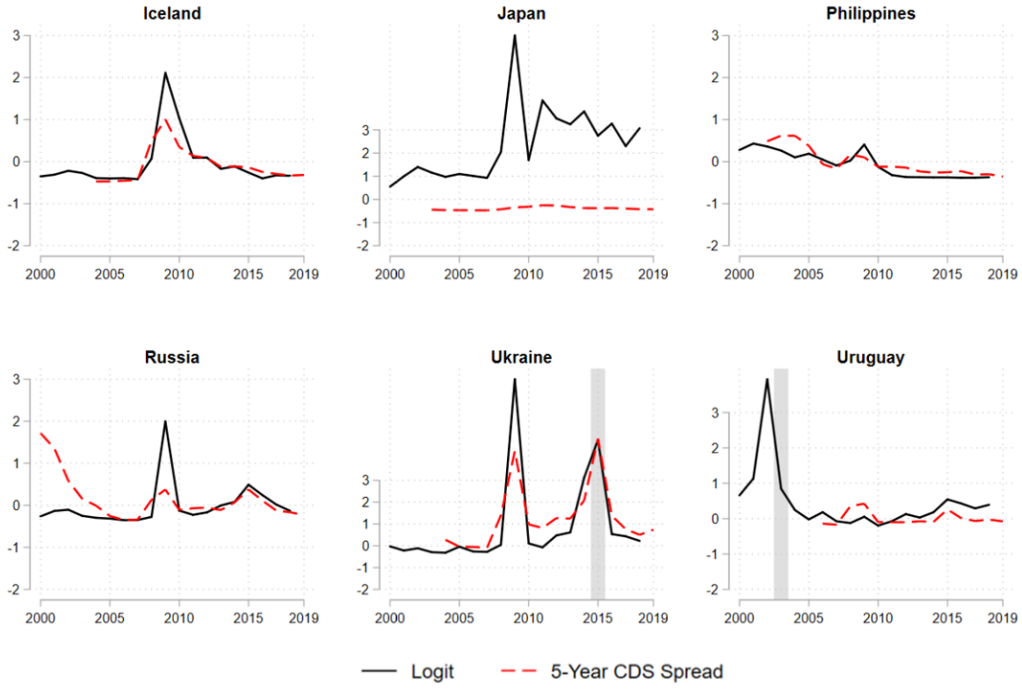


Table 1: Probability of Default (1990-2019)

	(1) P(Default)	(2) P(Default)	(3) P(Default)	(4) P(Default)
(L) Debt/GDP	0.0140*	0.0213***	0.0174**	0.0113*
	(1.86)	(3.24)	(1.98)	(1.76)
(L) GDP Growth	-0.162***	-0.163***	-0.180***	-0.156***
	(-3.17)	(-3.39)	(-3.21)	(-3.28)
(L) Interest Expense/GDP	0.227**		0.168*	0.170*
	(1.96)		(1.66)	(1.78)
(L) Primary Balance/GDP	-0.0473		-0.0516	-0.0643
	(-0.56)		(-0.62)	(-1.15)
(L) Interest Expense * PB	-0.00194		0.00140	
	(-0.14)		(0.12)	
(L) Revenue/GDP		-0.0814		
		(-0.70)		
(L) Expenditure/GDP		0.0951		
		(1.09)		
(L) Revenue * Expenditure		-0.00149		
		(-0.56)		
(L) VIX			0.00147	
			(0.04)	
(L) %Change in Exchange Rate			-0.00132	
			(-0.31)	
(L) %Change in Commodity ToT			-0.0478	
			(-0.64)	
(L) Default in last 20yrs			1.756*	1.092*
			(1.72)	(1.83)
(L) Debt * Default in last 20yrs			-0.0107	
			(-0.94)	
Constant	-7.146***	-6.142**	-7.167***	-6.773***
	(-6.72)	(-2.43)	(-5.41)	(-8.00)
F-Statistic	26.05	30.68	32.33	34.28
Countries	113	117	109	113
N	2783	2930	2669	2783

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$



Note: Shaded areas indicate a sovereign default.

For ease of visual comparison across countries, we normalize both variables by subtracting the sample mean and dividing by the sample standard deviation.[3]

The base model's predictions track movements in CDS spreads fairly well for most countries in the sample. Estimates perform adequately for years before and after 2008, despite a large amount of variation being driven by the Global Financial Crisis.

Some country episodes where market perceptions and logit predictions of default do not react together merit further discussion. For the case of Japan in 2008, for example, the logit model would estimate a default probability of over 10%, but average yearly spreads remained consistently below 100 basis points around that year. On the other end of the spectrum, CDS spreads for Ukraine in 2015 rose well above 2000 basis points, while the probability estimates from the logit model would be below 5%: high for the sample, but nevertheless out of sync with the strong reaction in markets.

Some of these cases may be reflecting additional, non-macroeconomic sources of uncertainty, such as geopolitical risk – with Ukraine being a prime example. But other cases may be signaling the existence of additional liquid resources that could make debt repayment feasible, and which are not being adequately captured by the base logit model.

4.2 Sectoral Wealth and Default Probabilities

To better explain these nuanced episodes of distress, we extend the baseline model by incorporating measures of balance sheet resilience as additional regressors. Conceptually, our intent is to capture both the availability of additional resources within the private sector that could become potential sources of revenue for the sovereign, as well as potential private liabilities that could exacerbate an already compromised fiscal position.

We run three new specifications, each controlling for net worth-to-GDP in one specific sector: households, banks, and general government. Including a time trend does not alter

[3]Note that we normalize by the entire sample and standard deviation, unlike the figures presented in the previous section, where variables were normalized using country-specific means and standard deviations. We use the entire sample because, when it comes to CDS spread levels and the probability of default, all countries are evaluated against the same common baseline of zero risk. In contrast, the variables assessed in the previous section, such as Tax Revenue-to-GDP, may be at very different levels in "normal" times for any two countries.

the results. Results are presented in Table 2, below.

We find that a higher household net wealth and a higher banking sector net worth are negatively associated with the probability of experiencing default. This relationship is statistically and economically significant.

An interesting finding is that a deterioration in the banking sector's net worth has a much stronger association with the probability of default than a similar deterioration in household balance sheets. The effect of a 1 percentage point decline in depository corporations' net worth on the probability of default is almost ten times that of a decrease in net household wealth. We see this as indicative of the interplay between sovereign and banking sector distress: a troubled banking sector will often require government assistance, just as a troubled public sector may have an impact on bank solvency if the latter holds a large amount of government securities (a fact that has been extensively discussed in the "twin crises" literature; see Kaminsky & Reinhart 1999, and, more recently, Balteanu & Erce 2017).

We do not find government net worth to be significantly associated with the likelihood of default after controlling for public debt - irrespective of whether the variable used is net government worth or net government financial worth.[4] This result should be taken with caution: as previously mentioned, our PSBS database only has three default cases against which to compare non-default episodes. For this reason, we prefer to see this finding as only suggestive. It could, however, be interpreted in a number of ways, and merits further research once more data becomes available: first, it is possible that investors do not have full access to government balance sheets, so changes in public sector assets vis-à-vis liabilities might not lead to higher bond yield pressure. Second, for a given level of public debt, it is possible that other government liabilities do not have an immediate impact on sustainability, while at the same time public assets may not represent a significant source of short-term resources (particularly for fixed assets and for income streams with a long time horizon).

Figure 9, below, presents the default probability predictions of the logit model when extended using sectoral net wealth, for selected country cases. Charts for the entire sample are provided in the Appendix. The black line shows the estimated default probabilities from the base logit model; the blue line represents the base model with the added control for net

[4]We net out public debt from our measure of government net worth, since we already include Debt/GDP as a regressor in the logit model, and our goal is to understand the role played by the remainder of the government's balance sheet.

Table 2: Probability of Default, with Sectoral Wealth (2000-2019)

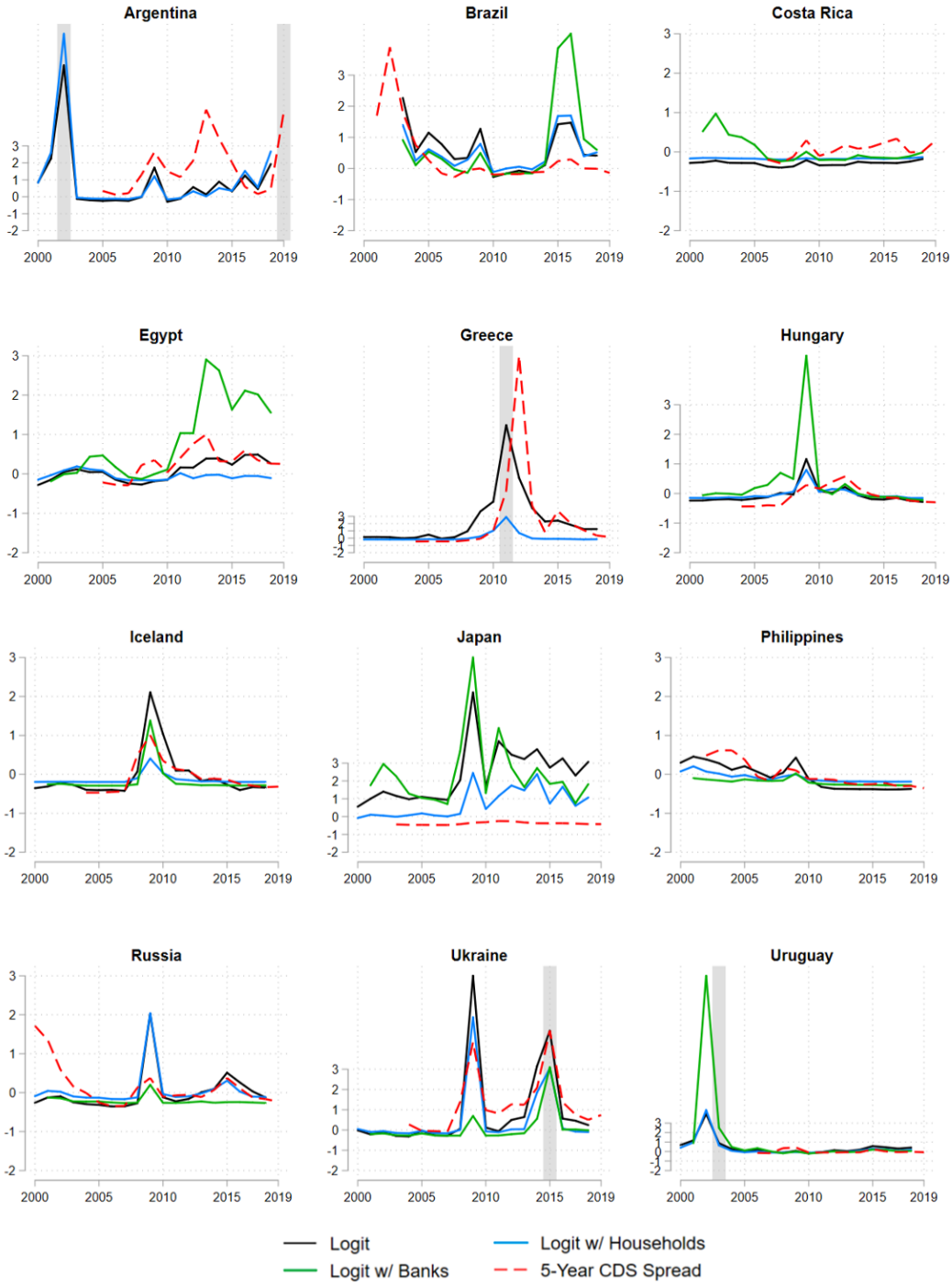
	(1) P(Default)	(2) P(Default)	(3) P(Default)	(4) P(Default)
(L) Debt/GDP	0.0210***	0.00557	0.0182**	0.0279***
	(2.93)	(0.32)	(2.24)	(3.14)
(L) Interest Expense/GDP	0.190**	0.448	0.237**	0.216**
	(2.23)	(1.10)	(2.20)	(2.06)
(L) GDP Growth	-0.192***	-0.313**	-0.227***	-0.211***
	(-3.28)	(-2.26)	(-3.06)	(-2.93)
(L) Primary Balance/GDP	-0.0827	-0.0478	-0.0838	-0.0936
	(-1.25)	(-0.21)	(-1.08)	(-1.15)
(L) Default in last 20yrs	0.415	1.676	0.470	0.231
	(0.61)	(1.09)	(0.63)	(0.30)
(L) Net HH Wealth/GDP	-0.0107***			
	(-3.05)			
(L) Gov. Net Worth/GDP		-0.00211		
		(-0.17)		
(L) Banking Sector (DC) Net Worth/GDP			-0.115**	
			(-2.24)	
(L) Private Sector (HH+DC) Net Worth/GDP				-0.0114***
				(-2.60)
Constant	-5.908***	-21.63	-6.373***	-6.455***
	(-4.49)	(-1.38)	(-4.93)	(-4.29)
F-Statistic	30.10	8.263	25.99	23.91
Countries	104	55	83	75
N	1951	760	1402	1266

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

household wealth; the green line charts the base model controlling for the net worth of the banking sector (depository corporations). Shaded grey areas indicate a default year.

Figure 9: Predicted Default Probabilities, Sectoral Wealth Model (2000-2019)



Note: Shaded areas indicate a sovereign default.

With these results in mind, we now turn to some qualitative assessments. Our contention is that these wealth-augmented models, which reflect the resilience of the private sector's balance sheet, can help understand a number of country cases where market expectations appeared to under or overreact to fundamentals (tracked by the black line in the above figure). Consider Uruguay in 2002. From the perspective of the baseline model, there was a marked deterioration in fundamentals which explains the almost 2-standard deviation increase in the probability of default. However, the signal provided by the extended model incorporating Uruguayan depository corporations' net worth is even stronger – which may reflect the massive run on deposits triggered by the financial crisis in neighboring Argentina at the time.

For the case of Japan during the global financial crisis of 2008, the muted reaction in CDS spreads stands in stark contrast to the large shift in the baseline logit's estimates – but the probability of default appears much lower once household wealth is taken into account. The role played by the stock of wealth owned by Japanese households, and the expectation that the country has plenty of fiscal space to raise taxes should the need arise, has been discussed often in financial commentaries on the low yields on Japanese bonds (Japan Times, 2019; Financial Times, 2017).

A strong reaction in one of the extended models' estimates may point to an important vulnerability even when an episode of stress does not end in default. One such case is Hungary, 2008, where the estimate from the extended model with banking sector net worth is especially high. The country had experienced serious financing problems on the government securities market, and a stand-by credit facility was arranged in 2008. Its SBA with the Fund specifically committed resources to the banking sector, which had been experiencing liquidity pressures as a result of foreign exchange market stress. A stronger prediction of default based on a weak banking sector balance sheet appears reasonable in this context.

There are also a small number of cases where CDS spread hikes appear to overreact, vastly outpacing the increase in the base logit models' estimated default probabilities – even for episodes of stress that do not end in default. Examples include Argentina 2013, Ecuador 2013 and Pakistan 2011. This behavior is not unexpected: it is consistent with the findings in the literature on "serial defaulters".

In summary, our results suggest that:

- Market expectations of default tend to track deteriorations in macroeconomic fundamentals.
- The overall health of the private sector's balance sheet can provide important information on the sustainability of public debt.
- More specifically, the resilience of the banking and household sectors' balance sheets may help explain why market expectations of default sometimes do not react to deteriorations in macroeconomic fundamentals. Conversely, a compromised banking system can signal mounting risks for the government.
- There is some suggestive evidence that the state of the public sector's balance sheet may not have a relevant influence on the probability of default, in contrast to its net operating balances, which are a central part of the story.
- Countries with a recent history of default are more likely to undergo another credit event, a finding that is in line with the existing literature on serial defaults and which may reflect higher risk premia imposed by markets.

5 Conclusion

The resilience of sectoral balance sheets matters when assessing debt sustainability. The deterioration in net worth of the household or banking sectors can make a country more vulnerable to default than would otherwise be expected given its macroeconomic fundamentals; conversely, wealthy households and a resilient banking sector can bolster a government's ability to weather a crisis.

Modern cases of sovereign distress continue to be, first and foremost, a story about deteriorating government operating balances, and macroeconomic fundamentals are important explanatory variables: debt-to-output ratios, sudden declines in economic growth, and a deterioration in the interest burden or in primary expenditures can all point to a compromised fiscal position and a rising probability of default.

But stocks, particularly sectoral net worth, are also an important part of this narrative: a sovereign will find itself in a much tighter situation if private sector net worth deteriorates rapidly –as would be the case with implicit public guarantees during a banking crisis– just

as a robust private sector balance sheet could signal a potential source of additional revenues if the need were to arise.

There are distinct patterns across countries that manage to survive a fiscal crisis and those that default. The options available to a government can vary depending on its starting fiscal position. Episodes ending in default are more likely to see adjustment implemented through a reduction in public investment, for instance, highlighting the limitations to raising short-term resources. In such scenarios of fiscal distress, the state of the private sector's balance sheets can become an important signal.

Markets are not oblivious to this state of affairs. Assessments of the probability of default based on CDS spreads suggest that, for many countries, market participants are attuned to issues such as the state of the banking sector or the availability of net household wealth.

Our results suggest that assessments of debt sustainability could benefit from the inclusion of balance sheet robustness measures, in order to fully capture vulnerabilities that are not immediately revealed by models based on the typical components of a standard equation of motion for debt.

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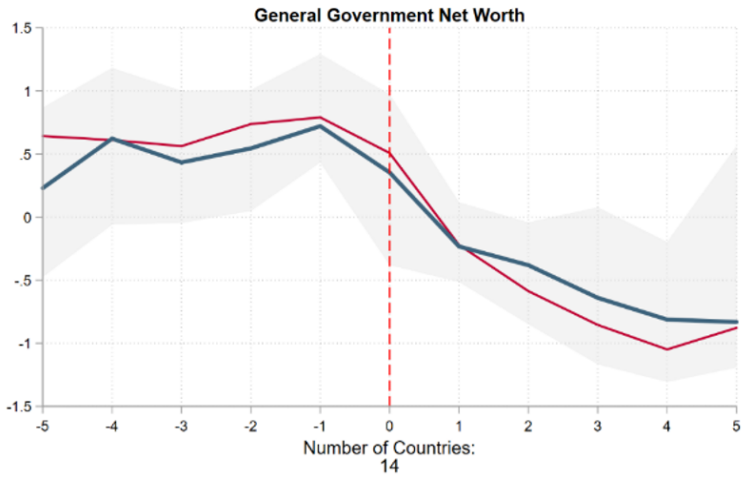
Appendices

Appendix A. Data Aggregation Methodology

To produce the charts presented in Sections 2 and 3, we aggregate observations across countries for each year and variable of interest. This Appendix describes our aggregation criteria.

The figure below serves as an example, showing the behavior of "General government net worth" in the years before and after a debt crisis. The crisis year is set at $t = 0$, and values are displayed yearly from $t - 5$ to $t + 5$.



To produce this graph, we proceed in three steps.

First, we construct a time window for every country's debt crisis. For example, if Country A underwent default in 2002, then we set 2002 as $t = 0$. The years 1997 through 2001 comprise the range $t - 5$ to $t - 1$, while the years 2003 to 2007 represent $t + 1$ to $t + 5$. This produces us a "crisis window" for every country in the panel.

One potential problem is that countries with more than one crisis in a 10-year period would feature overlapping "crisis windows". Although this is infrequent, we deal with the issue by cropping the overlapping windows and assigning each year to its closest crisis. For instance, consider a Country B that experienced default in years 2005 and 2008. Both episodes are considered separate events, and so years 2005 and 2008 are set to be $t = 0$. Years 2006 and 2009 are $t = 1$. Years 2004 and 2007 are $t = -1$. But year 2006 would

not be set to $t = -2$, even though it comes two years before the 2008 default, because it is closer to the default from 2005, and so its relationship to that credit event is considered more relevant. In this case, the first default's window of analysis ranges from $t = -5$ to $t = 1$ (from 2000 to 2006), and the second default ranges from $t = -1$ to $t = 5$ (from 2007 to 2013).

Next, we apply a within-country normalization of the variable of interest, for ease of comparison. That is, for Country A, we subtract the country's average "General Government Net Worth" value and divide by the country-specific standard deviation. The same is done for countries B, C, etc.

Finally, we aggregate across countries by computing the mean, median, and 25th and 75th percentiles of each crisis window period. In other words, the value represented by the red line in the above figure at time $t = 3$ is the mean of all crisis countries' normalized variable at $t = 3$.

Often, countries will have missing observations for some years within a crisis window; this is especially true for events occurring before 1995. Since we are aggregating across countries, an unbalanced panel dataset is not an immediate problem. However, if a country's crisis window does not have at least 5 observations overall (say, $t = -3$ to $t = 1$), then the entire crisis episode is omitted from the figure computations.

Each figure states the "number of countries" represented in the chart after data has been aggregated for that variable. The sample figure shown above includes information from 14 country cases.

It is worth restating that this does not mean that each t period has 14 countries represented at that point. It is possible, for example, that at $t = -3$ only 12 countries had five or more observations, while at $t = -1$ the observations from 13 countries were represented (and the previously mentioned 12 countries from $t = -3$ may or may not be exactly the same ones as those represented among the 13 countries at $t = -1$).

Appendix B. Data Aggregation Methodology

We make use of the tax effort and fiscal effort indices originally developed by Le, Moreno-Dodson & Bayraktar (2012) as a proxy for the degree to which governments are 'fiscally

constrained': the goal is to measure how high the tax burden is for a given country, so as to get a sense of whether fiscal pressure could be increased further during times of distress.

The two indicators are defined as the ratio of actual tax (fiscal) revenues over estimated tax (fiscal) revenues, respectively. The estimated values each variable are obtained from the following regressions:

$$\frac{Revenue}{GDP_{i,t}} = \alpha_0 + \alpha_1 \cdot GDPpc_{i,t} + \alpha_2 \cdot DEMOG_{i,t} + \alpha_3 \cdot TRADE_{i,t} + \alpha_4 \cdot AGR_{i,t} + \alpha_5 \cdot GOVERNANCE_{i,t} + RegionalDummies + TimeDummies + \epsilon_t$$

$$\frac{Tax}{GDP_{i,t}} = \alpha_0 + \beta_1 \cdot GDPpc_{i,t} + \beta_2 \cdot DEMOG_{i,t} + \beta_3 \cdot TRADE_{i,t} + \beta_4 \cdot AGR_{i,t} + \beta_5 \cdot GOVERNANCE_{i,t} + RegionalDummies + TimeDummies + \epsilon_t$$

In summary, then, the indices seek to capture the expected level of revenue given some combination of economic, demographic, and governance characteristics for a country at a certain point in time, and compare it to the actual observed values, to determine whether actual revenues are above or below "normal".

The figure below shows the behavior of these indices around times of debt distress, for our entire sample of countries. The red line shows the median index value for each period, and the blue line shows the average. (Unlike in most other charts presented in this paper, the values shown in the figure are not normalized by subtracting the mean and dividing by the standard deviation).

Figure 10a: Tax Effort Index (Defaults)

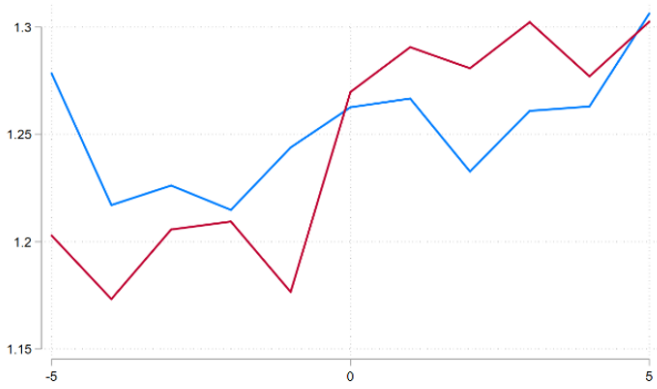
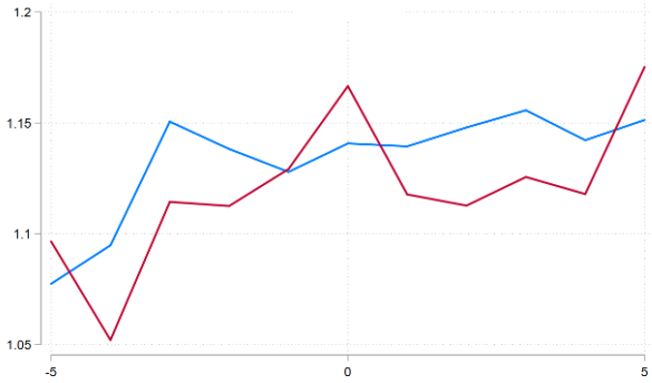


Figure 10b: Tax Effort Index (Survivors)



Note: Charts show index levels without any normalization.

Appendix C. Additional Figures: Government Finances and Aggregate Macroeconomic Variables

Figure 11a: Government Finances during Debt Distress (Defaults)

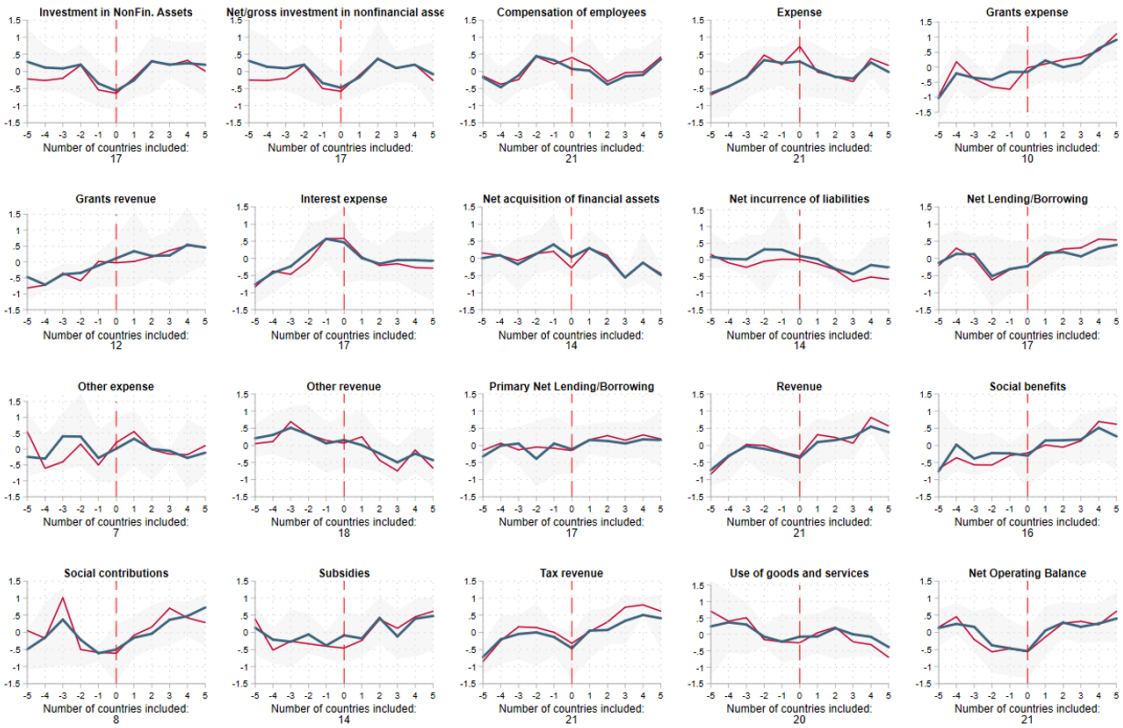
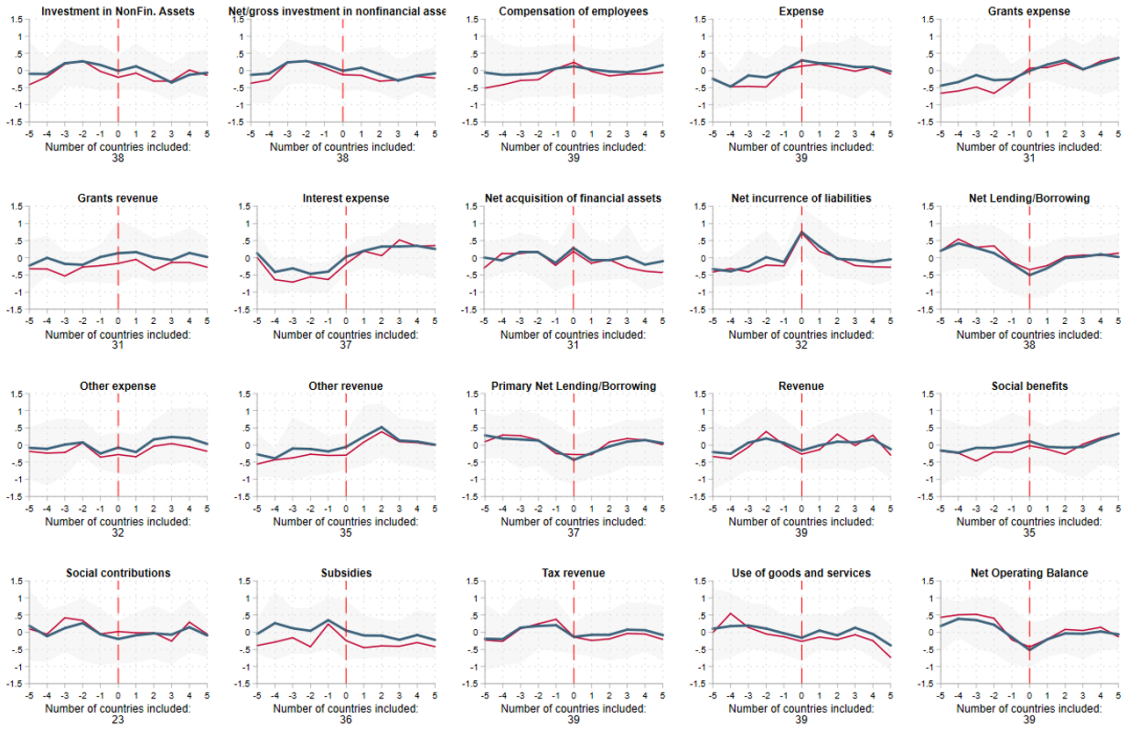


Figure 11b: Government Finances during Debt Distress (Survivors)



Appendix D. Balance Sheet Dynamics, in Constant 2014 USD

This appendix shows the behavior of stock data for government and private sector balance sheets, denominated in constant 2014 USD, rather than as a share of GDP as shown in Section 3. All variables are normalized by subtracting the country mean and dividing by the country standard deviation, to make visual comparisons feasible.

Figure 12: Public Sector Balance Sheets during times of Distress, in Constant US Dollars (Survivors only)

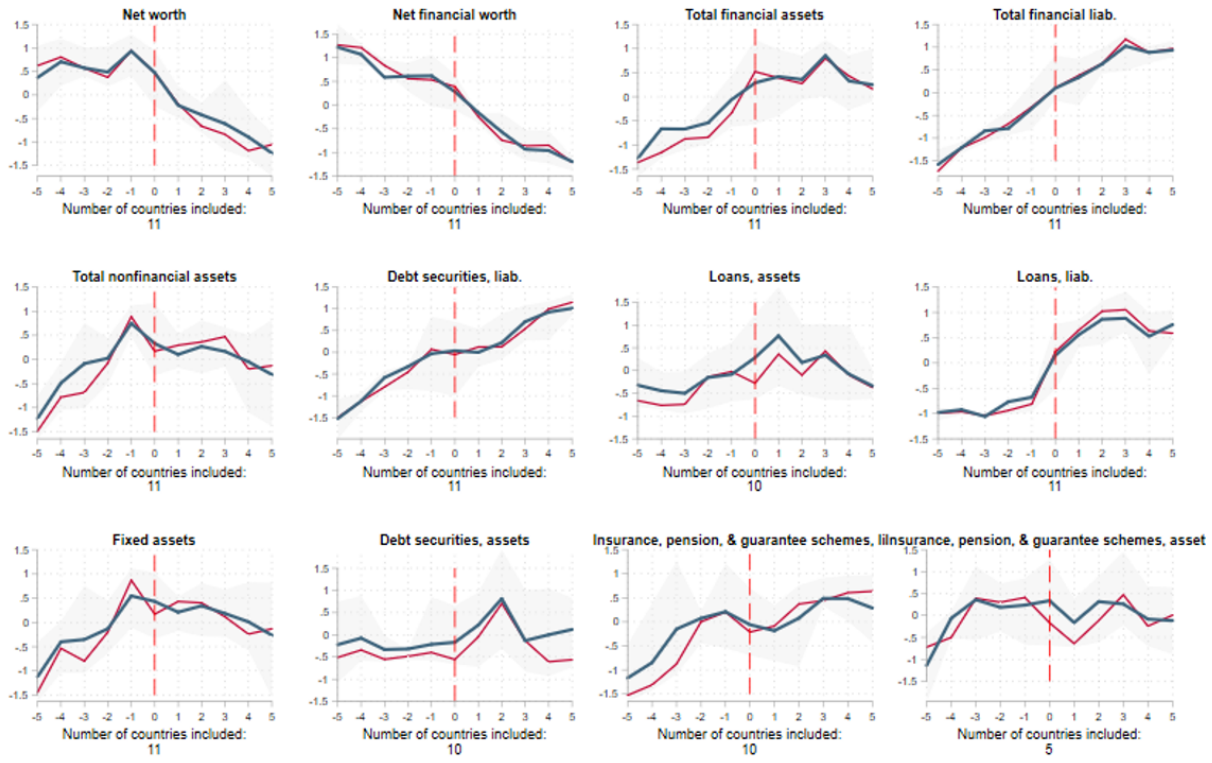


Figure 13a: Household Wealth, in Constant US Dollars (Defaults)

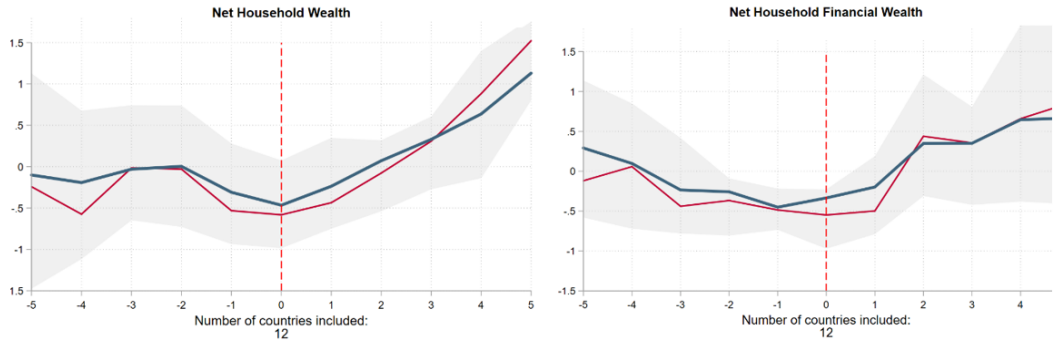
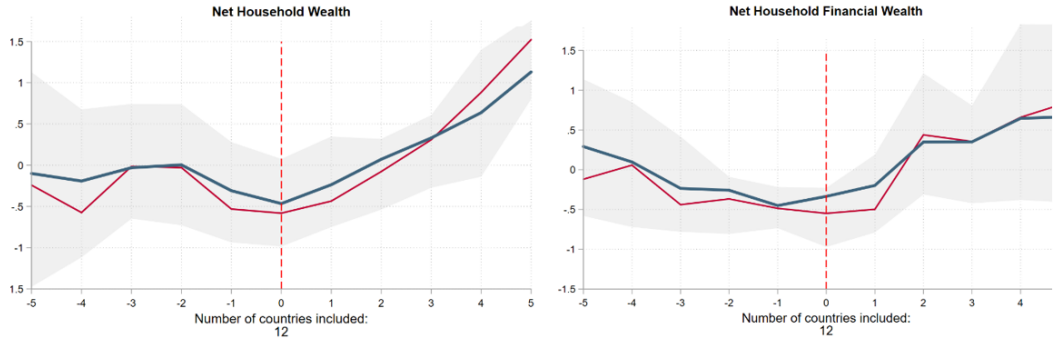


Figure 13b: Household Wealth, in Constant US Dollars (Survivors)



Appendix E. Summary Statistics and Mean Difference Tests

Given the absence of one single panel dataset for public and private balance sheet information, this paper resorts to a piecemeal approach to data construction for sectoral wealth. Said approach, however, may raise questions about the comparability of the data, as well as to what extent the differences identified across sectors are being driven by differences between the countries in the "survivor" and "default" groups.

In this Appendix, we conduct mean difference tests for a set of relevant variables, to provide a better sense of the differences between distress cases. The standard approach would be to conduct independent sample t-tests that allow for unequal variances. However, given that t-tests cannot be performed on panel data, we instead report t-test results conducted separately on the first and last years of our sample (usually 2000 and 2019).

Table 3: Summary Statistics: Debt Crises (1990-2019)

	Defaults	**Survivors**
Number of Episodes	39	57
Debt-to-GDP at event peak, average	94%	55%
Debt-to-GDP at event peak, maximum in sample	181%	114%
Debt-to-GDP at event peak, minimum in sample	24%	7%
Primary Balance on year prior to event peak, average	0%	-1.2%

Table 4: T-test for Household Net Wealth as %GDP (Year 2019)

Group	**Observations**	**Mean**	**Std. Err**	**Std. Dev.**	**95% Confidence**	**interval**
Default	12	223.00	30.45	105.51	155.96	290.04
Survivor	26	275.75	21.50	109.67	231.45	320.05
Combined	38	259.09	17.81	109.79	223.00	295.18
Diff		52.74	37.83		-23.99	129.48
Diff =	mean(survivor) - mean(default)					t=1.39
H0: diff=0						
Ha: diff<0			Ha: diff != 0			Ha:diff>0
P($T < t$)=0.91			P($T < t$)=0.17			P($T < t$)=0.08

Table 5: T-test for Household Net Wealth as %GDP (Year 2000)

Group	**Observations**	**Mean**	**Std. Err**	**Std. Dev.**	**95% Confidence**	**interval**
Default	12	160.88	30.61	106.06	93.49	228.27
Survivor	26	199.38	17.40	88.73	163.54	235.22
Combined	38	187.22	15.38	94.83	156.05	218.39
Diff		38.50	32.93		-28.28	105.29
Diff =	mean(survivor) - mean(default)					t=1.16
H0: diff=0						
Ha: diff<0			Ha: diff != 0			Ha:diff>0
P($T < t$)=0.87			P($T < t$)=0.25			P($T < t$)=0.12

The comparison groups for the t-tests are: those countries that featured a default at any point in the 2000-2019 period, and those countries that featured a "survivor" distress episode over the same timeline. If a country experienced both types of crises, it is categorized under the default group. Note that 'default' groups may include countries for which we do not have wealth data on the year in which default happened. Specifically, there are three country cases for which we have government net worth data on their year of default: Greece, Ukraine, and Uruguay. However, the t-test for government net worth includes other countries, such as Barbados, Moldova or Russia, because government net worth data exists for those countries during periods outside of their default year.

Table 6: T-test for Depository Corporations' Assets as %GDP (Year 2019)

Group	**Observations**	**Mean**	**Std. Err**	**Std. Dev.**	**95% Confidence**	**interval**
Default	11	87.56	8.62	28.59	68.34	106.77
Survivor	21	89.42	6.17	28.29	76.54	102.30
Combined	32	88.78	4.94	27.94	78.70	98.86
Diff		1.86	10.56		-19.71	23.45
Diff =	mean(survivor) - mean(default)					t=-0.176
H0: diff=0						
Ha: diff<0			Ha: diff != 0			Ha:diff>0
P($T < t$)=0.56			P($T < t$)=0.86			P($T < t$)=0.43

Table 7: T-test for Depository Corporations' Assets as %GDP (Year 2001)

Group	**Observations**	**Mean**	**Std. Err**	**Std. Dev.**	**95% Confidence**	**interval**
Default	11	68.05	10.60	35.16	44.43	91.68
Survivor	21	54.87	5.37	24.64	43.65	66.09
Combined	32	59.40	5.09	28.82	49.00	69.80
Diff		-13.18	10.64		-34.91	8.54
Diff =	mean(survivor) - mean(default)					t=-1.23
H0: diff=0						
Ha: diff<0			Ha: diff != 0			Ha:diff>0
P($T < t$)=0.11			P($T < t$)=0.22			P($T < t$)=0.88

Table 8: T-test for Depository Corporations' Net Worth as %GDP (Year 2019)

Group	**Observations**	**Mean**	**Std. Err**	**Std. Dev.**	**95% Confidence**	**interval**
Default	11	7.60	1.41	4.67	4.45	10.74
Survivor	21	12.61	1.02	4.71	10.47	14.76
Combined	32	10.89	0.92	5.22	9.01	12.77
Diff		5.01	1.75		1.44	8.59
Diff =	mean(survivor) - mean(default)					t=2.865
H0: diff=0						
Ha: diff<0			Ha: diff != 0			Ha:diff>0
P($T < t$)=0.99			P($T < t$)=0.007			P($T < t$)=0.003

Table 3 also provides basic summary statistics for debt ratios and primary balances. Since that data exists for the entire 1990-2019 period, Table 1 covers that entire range, unlike the remainder of the mean difference test results which focus on the 21st century only.

Table 9: T-test for Depository Corporations' Net Worth as %GDP (Year 2001)

Group	**Observations**	**Mean**	**Std. Err**	**Std. Dev.**	**95% Confidence**	**interval**
Default	11	6.46	1.06	3.52	4.09	8.82
Survivor	21	9.93	2.04	9.38	5.66	14.20
Combined	32	8.74	1.41	7.97	5.86	11.61
Diff		3.47	2.95		-2.55	9.50
Diff =	mean(survivor) - mean(default)					t=1.17
H0: diff=0						
Ha: diff<0			Ha: diff != 0			Ha:diff>0
P($T < t$)=0.87			P($T < t$)=0.24			P($T < t$)=0.12

Table 10: T-test for Government Net Worth as %GDP (Year 2016)

Group	**Observations**	**Mean**	**Std. Err**	**Std. Dev.**	**95% Confidence**	**interval**
Default	11	0.46	0.26	0.88	-0.13	1.05
Survivor	16	0.47	0.24	0.99	-0.05	1.00
Combined	27	0.46	0.18	0.93	0.09	0.83
Diff		0.01	0.37		-0.75	0.78
Diff =	mean(survivor) - mean(default)					t=0.03
H0: diff=0						
Ha: diff<0			Ha: diff != 0			Ha:diff>0
P($T < t$)=0.51			P($T < t$)=0.97			P($T < t$)=0.48

Table 11: T-test for Government Net Worth as %GDP (Year 2000)

Group	**Observations**	**Mean**	**Std. Err**	**Std. Dev.**	**95% Confidence**	**interval**
Default	4	0.70	0.46	0.93	-0.77	2.18
Survivor	8	0.84	0.32	0.91	0.08	1.61
Combined	12	0.80	0.25	0.87	0.24	1.35
Diff		0.14	0.56		-1.10	1.40
Diff =	mean(survivor) - mean(default)					t=0.26
H0: diff=0						
Ha: diff<0			Ha: diff != 0			Ha:diff>0
P($T < t$)=0.60			P($T < t$)=0.79			P($T < t$)=0.39

Table 12: List of Defaults and Survivors

Year	Defaults	Survivors (Crisis Peak)
1990	Algeria, Jamaica, Chile, Bulgaria, Philippines	Iceland, Peru
1991	Albania, Russia	Czech Republic, Sri Lanka, Hungary
1992	Slovenia, South Africa, North Macedonia, Bosnia and Herzegovina, Croatia, Serbia, Montenegro	
1993	Algeria, Guyana	Peru
1994		Estonia, Lithuania, Philippines
1995		Mexico, Brazil, Argentina
1996		Georgia
1997		Korea, Thailand, Croatia
1998	Russia, Ukraine, Pakistan	Albania, Philippines
1999	Ecuador	Colombia, Mexico, Turkey
2000	Côte d'Ivoire	
2001	Moldova	
2002	Argentina	Brazil, Serbia, Turkey
2003	Uruguay, Dominica	Colombia
2004	Dominican Republic, Grenada	
2005		Turkey
2006	Belize	
2007		Kazakhstan, Hungary, Latvia, Iceland
2008	Ecuador	
2009		Colombia, Serbia, Poland, El Salvador, Ukraine, Sri Lanka, Bosnia and Herzegovina, Mexico, Georgia, Guatemala, Belize, Argentina, Pakistan, Angola
2010	Jamaica	Ireland, Iraq
2011	Côte d'Ivoire, Greece	Belarus, Portugal, North Macedonia
2012	Belize	Bosnia and Herzegovina, Romania, Jordan
2013	Jamaica, Grenada	Morocco, Tunisia, Argentina
2014		Albania
2015	Ukraine	
2016	Belize	
2017	Mongolia	
2018	Barbados	
2019	Argentina	

Appendix F. Logit Model Results and Collinearity Diagnostics

This Appendix presents three sets of results. First, we report the regression output for the base logit model, under different specifications and covering both the 1990-2019 and the 2000-2019 period. The key takeaway is that the main explanatory variables are Debt/GDP, Real GDP growth and Interest Expense/GDP, and that model coefficients are fairly stable under both the extended and the restricted sample.

Second, we show the results from extending the base logit model to incorporate sectoral net wealth data. As explained in the main body of the paper, we find that the coefficients for net worth of the banking sector and net household wealth are statistically significant and have the expected sign.

Finally, we conduct robustness tests. There are two possible sources of bias in our estimates that are of particular concern: endogeneity and multicollinearity.

Endogeneity would be of concern if, for instance, household wealth affects the probability of default next period but, simultaneously, the probability of default next period affects household wealth today (perhaps through an expectations channel). We check for this possibility by regressing each of our sectoral net wealth variables on the probability of default the following period, as well as on the other logit regressors, and find that the probability of default is not a statistically significant explanatory variable for net wealth of any of the three sectors considered.

Turning to multicollinearity, we report the results from collinearity diagnostics. Although collinearity is present, the variance inflator factors (VIFs) for the statistically significant variables in our model are not high enough to cast serious doubts on our results. The two variables that exceed a VIF of 5 are primary expenditures and revenue. We note, however, that removing either of these two regressors, as in logit specification (5), does not lead to important changes in the remaining coefficients.

Table 13: Probability of Default (1990-2019)

	(1) P(Default)	(2) P(Default)	(3) P(Default)	(4) P(Default)
(L) Debt/GDP	0.0140*	0.0213***	0.0174**	0.0150*
	(1.86)	(3.24)	(1.98)	(1.84)
(L) GDP Growth	-0.162***	-0.163***	-0.180***	-0.159***
	(-3.17)	(-3.39)	(-3.21)	(-3.31)
(L) Interest Expense/GDP	0.227**		0.168*	0.165*
	(1.96)		(1.66)	(1.68)
(L) Primary Balance/GDP	-0.0473		-0.0516	-0.0651
	(-0.56)		(-0.62)	(-0.80)
(L) Interest Expense * PB	-0.00194		0.00140	0.000936
	(-0.14)		(0.12)	(0.08)
(L) Revenue/GDP		-0.0814		
		(-0.70)		
(L) Expenditure/GDP		0.0951		
		(1.09)		
(L) Revenue * Expenditure		-0.00149		
		(-0.56)		
(L) VIX			0.00147	
			(0.04)	
(L) %Change in Exchange Rate			-0.00132	
			(-0.31)	
(L) %Change in Commodity ToT			-0.0478	
			(-0.64)	
(L) Default in last 20yrs			1.756*	1.674*
			(1.72)	(1.70)
(L) Debt * Default in last 20yrs			-0.0107	-0.00759
			(-0.94)	(-0.72)
Constant	-7.416***	-6.142**	-7.167***	-7.060***
	(-6.72)	(-2.43)	(-5.41)	(-7.27)
F-Statistic	26.05	30.68	32.33	33.37
Countries	113	117	109	113
N	2783	2930	2669	2783

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 14: Probability of Default (2000-2019)

	(1) P(Default)	(2) P(Default)	(3) P(Default)	(4) P(Default)
(L) Debt/GDP	0.0139*	0.0215***	0.0159*	0.0178*
	(1.66)	(3.10)	(1.68)	(1.86)
(L) GDP Growth	-0.202***	-0.226***	-0.211***	-0.194***
	(-3.33)	(-3.80)	(-3.21)	(-3.27)
(L) Interest Expense/GDP	0.276**		0.228**	0.220**
	(2.26)		(2.11)	(2.09)
(L) Primary Balance/GDP	-0.0237		-0.0368	-0.0366
	(-0.25)		(-0.41)	(-0.41)
(L) Interest Expense * PB	-0.00787		-0.00690	-0.00673
	(-0.51)		(-0.51)	(-0.49)
(L) Revenue/GDP		-0.0591		
		(-0.46)		
(L) Expenditure/GDP		0.126		
		(1.26)		
(L) Revenue * Expenditure		-0.00244		
		(-0.81)		
(L) VIX			-0.0308	
			(-0.73)	
(L) %Change in Nominal Exchange Rate			0.00312	
			(0.54)	
(L) %Change in Commodity ToT			-0.0547	
			(-0.68)	
(L) Default in last 20yrs			2.017*	2.015*
			(1.78)	(1.77)
(L) Debt * Default in last 20yrs			-0.0113	-0.0111
			(-0.87)	(-0.85)
Constant	-7.307***	-6.521**	-6.591***	-7.394***
	(-6.59)	(-2.30)	(-4.49)	(-6.28)
F-Statistic	26.71	29.83	32.69	31.80
Countries	113	117	109	113
N	2188	2280	2125	2188

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 15: Probability of Survivor-type Crisis Peak (1990-2019)

	(1) P(Crisis Peak)	(2) P(Crisis Peak)	(3) P(Crisis Peak)	(4) P(Crisis Peak)
(L) Debt/GDP	-0.0121*	-0.00940	-0.00544	-0.00903
	(-1.72)	(-1.60)	(-0.65)	(-1.06)
(L) GDP Growth	0.0000473	-0.00311	0.0410	0.00526
	(0.00)	(-0.09)	(1.20)	(0.15)
(L) Interest Expense/GDP	0.126		0.0976	0.119
	(1.41)		(1.08)	(1.35)
(L) Primary Balance/GDP	-0.141***		-0.130***	-0.149***
	(-3.01)		(-2.58)	(-3.12)
(L) Interest Expense * PB	0.0156		0.0142	0.0143
	(1.36)		(1.09)	(1.20)
(L) Revenue/GDP		-0.0733		
		(-1.20)		
(L) Expenditure/GDP		0.103**		
		(2.03)		
(L) Revenue * Expenditure		-0.000403		
		(-0.31)		
(L) VIX			0.124***	
			(4.83)	
(L) %Change in Exchange Rate			-0.000498	
			(-0.11)	
(L) %Change in Commodity ToT			-0.0188	
			(-0.45)	
(L) Default in Last 20yrs			1.225*	1.369**
			(1.90)	(2.08)
(L) Debt * Default in last 20yrs			-0.00914	-0.00830
			(-0.81)	(-0.72)
Constant	-4.182***	-4.642***	-7.392***	-4.559***
	(-10.90)	(-3.21)	(-9.21)	(-9.74)
F-Statistic	11.14	7.947	40.63	19.42
Countries	113	117	109	113
N	2783	2930	2669	2783

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 16: Endogeneity Test: GLS Estimation of Lagged Wealth Variables on Default Probability (2000-2019)

	(1)	(2)	(3)
	(L)HH Wealth	(L)Banking Sector Net Worth	(L)Gov. Net Worth (Excl. Debt)
Default	-13.66	-1.725	13.80
	(-1.39)	(-1.35)	(0.69)
(L) Debt/GDP	0.639***	0.0186	0.199**
	(8.93)	(1.60)	(2.04)
(L) GDP Growth	-0.434*	-0.278***	-0.144
	(-1.71)	(-7.60)	(-0.34)
(L) Interest Expense/GDP	-8.688***	-0.642***	-1.734
	(-8.51)	(-3.79)	(-0.86)
(L) Primary Balance/GDP	-0.443	-0.165***	1.668*
	(-1.48)	(-3.87)	(1.88)
(L) Default in Last 20yrs	21.50***	0.0733	21.52**
	(3.75)	(0.09)	(2.26)
(L) Interest Expense * PB	0.201*	0.0491**	-1.210***
	(1.79)	(2.54)	(-4.20)
(L) Debt * Defaul in Last 20yrs	-0.720***	-0.0285**	-0.0651
	(-8.61)	(-2.15)	(-0.51)
Constant	245.1***	14.58***	104.0***
	(20.88)	(12.03)	(8.03)
F-Statistic	173.9	111	50.86
Countries	104	83	55
N	1951	1402	760

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 17: Collinearity Diagnostics for specification using Net Household Wealth (2000-2019)

Variable	**VIF**	**SQRT VIF**	**Tolerance**	**R-Squared**
Debt/GDP	1.49	1.22	0.66	0.33
GDP Growth	1.06	1.03	0.94	0.05
Interest Expense/GDP	1.50	1.23	0.66	0.33
Primary Balance/GDP	1.10	1.05	0.90	0.09
Default in last 20 years	1.04	1.02	0.96	0.04
Net Household Wealth/GDP	1.04	1.02	0.95	0.04

Mean VIF 1.21

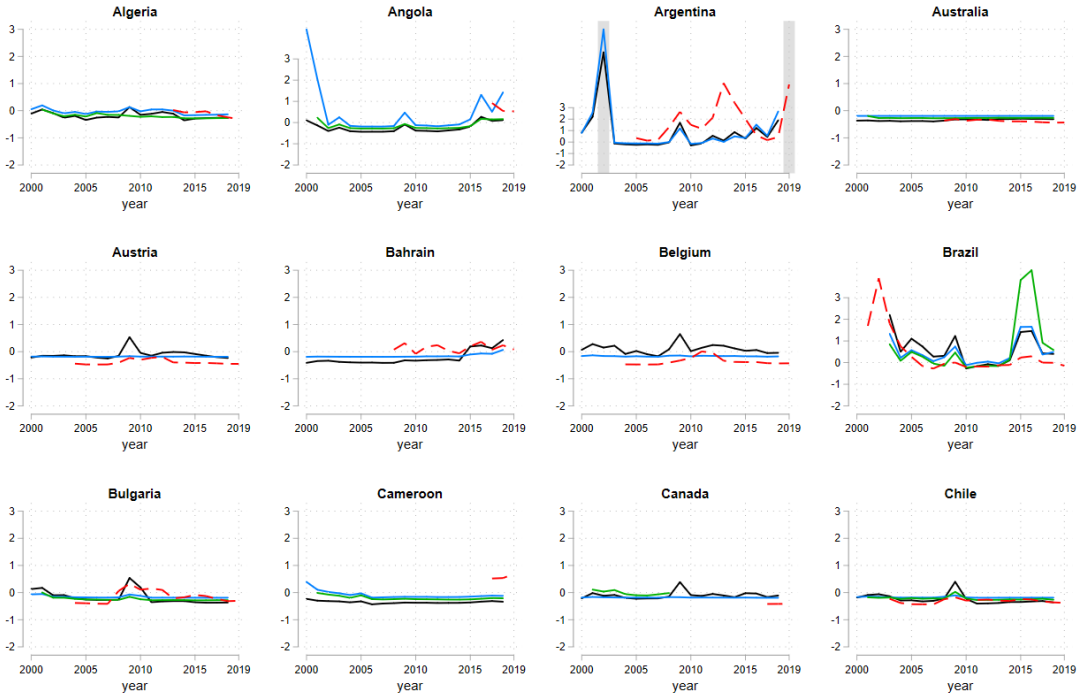
Table 18: Collinearity Diagnostics for specification using Government Net Worth (2000-2019)

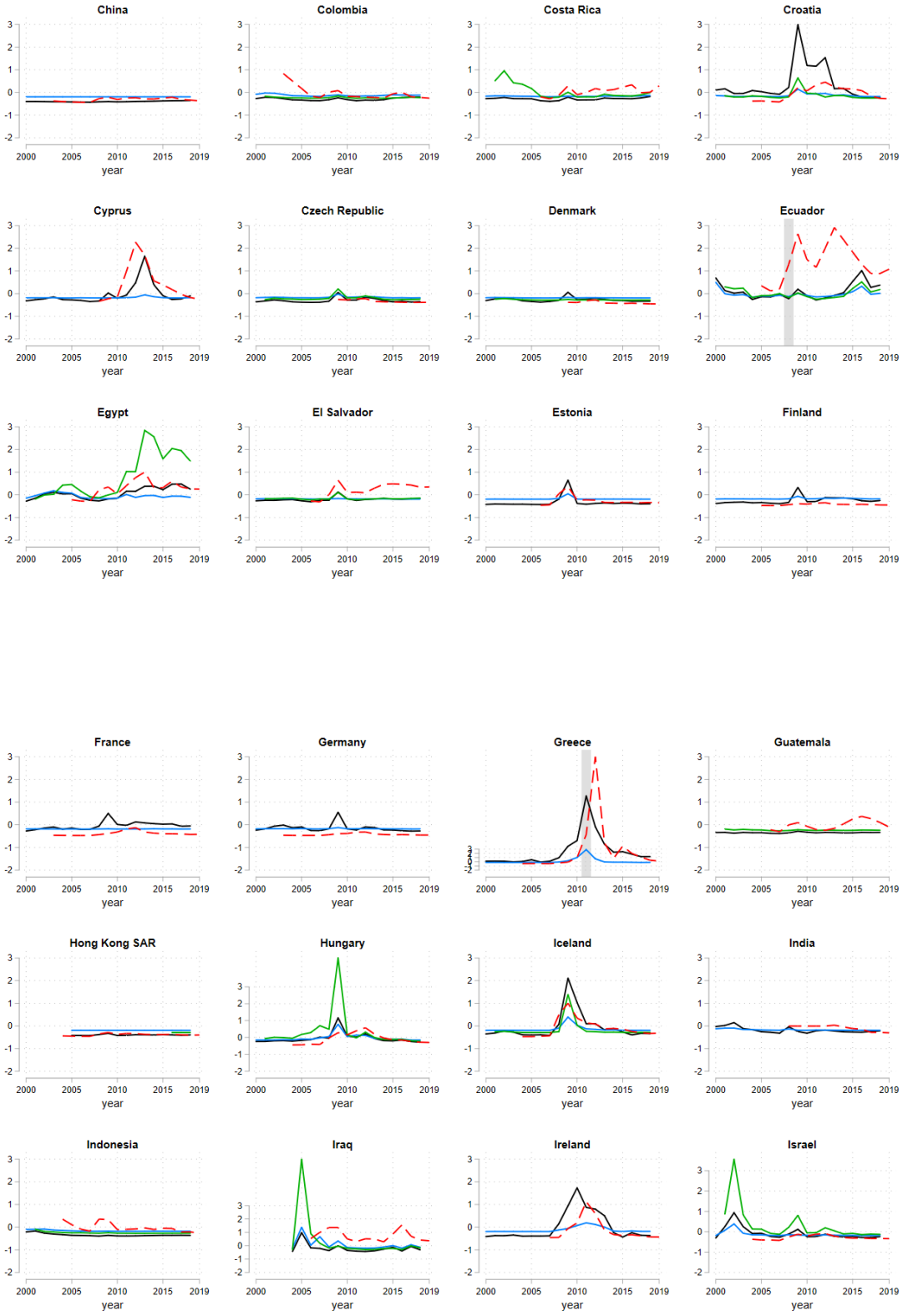
Variable	**VIF**	**SQRT VIF**	**Tolerance**	**R-Squared**
Debt/GDP	1.80	1.34	0.55	0.44
GDP Growth	1.19	1.09	0.83	0.16
Interest Expense/GDP	1.78	1.33	0.56	0.43
Primary Balance/GDP	1.25	1.12	0.80	0.19
Default in last 20 years	1.05	1.03	0.95	0.04
Government Net Worth/GDP	1.17	1.08	0.85	0.14
Mean VIF 1.37				

Table 19: Collinearity Diagnostics for specification using Banking Sector Net Worth (2000-2019)

Variable	**VIF**	**SQRT VIF**	**Tolerance**	**R-Squared**
Debt/GDP	1.45	1.20	0.68	0.31
GDP Growth	1.05	1.03	0.94	0.05
Interest Expense/GDP	1.49	1.22	0.67	0.32
Primary Balance/GDP	1.12	1.06	0.89	0.10
Default in last 20 years	1.06	1.03	0.94	0.05
Banking Sector (DC) Net Worth/GDP	1.03	1.02	0.96	0.03
Mean VIF 1.20				

Appendix G. Logit Model Figures (Baseline and Sectoral Wealth models)




China
Colombia
Costa Rica
Croatia
Cyprus
Czech Republic
Denmark
Ecuador
Egypt
El Salvador
Estonia
Finland
France
Germany
Greece
Guatemala
Hong Kong SAR
Hungary
Iceland
India
Indonesia
Iraq
Ireland
Israel
year


Italy
Japan
Kazakhstan
Kenya
Korea
Latvia
Lithuania
Malaysia
Mexico
Morocco
Netherlands
New Zealand
Nigeria
Norway
Oman
Pakistan
Panama
Peru
Philippines
Poland
Portugal
Qatar
Romania
Russia
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Saudi Arabia
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Serbia
Slovak Republic
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Uruguay
Vietnam
Zambia
Zambia
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