ESSAYS ON SOVEREIGN DEBT AND DEFAULT

A Dissertation

Presented to

The Faculty of the Department

of Economics

University of Houston

In Partial Fulfillment

Of the Requirements for the Degree of

Doctor of Philosophy

By

Jarrod E. Hunt

May, 2014

ESSAYS ON SOVEREIGN DEBT AND DEFAULT

Jarrod E. Hunt

APPROVED:

David Papell, Ph.D.
Committee Chair

Bent Sørensen, Ph.D.

Dietrich Vollrath, Ph.D.

Raul Susmel, Ph.D.
University of Houston

John W. Roberts, Ph.D.
Dean, College of Liberal Arts and Social Sciences
Department of English

ESSAYS ON SOVEREIGN DEBT AND DEFAULT

An Abstract of a Dissertation

Presented to

The Faculty of the Department

of Economics

University of Houston

In Partial Fulfillment

Of the Requirements for the Degree of

Doctor of Philosophy

By

Jarrod E. Hunt

May, 2014

Abstract

This dissertation is comprised of two essays focused on the central theme of sovereign default. In the first essay, I detail a method to improve forecasting models of sovereign default by evaluating the impact of a country's composition of debt. For my second essay, I assess the long-horizon impact of a sovereign default episode on a country's economic volatility.

A country's external debt relative to gross domestic product is positively associated with the probability of being in default. Aggregate measures of external debt are commonly used for this type of risk analysis. However, based on the details of each loan, there are numerous subsets of external debt. Using a dataset of 32 developing countries from 1971-2010, I find that short-term debt, commercial bank loans, and concessional debt owed to other countries are the categories responsible for the positive relationship between the aggregate and the probability of being in default. In addition to isolating the categories driving the relationship between total external debt and sovereign default, I distinguish between the associated impact of each debt category on the probability of *entering* default and the probability of *prolonging* default. This is an important distinction as some subsets, such as bonds and multilateral concessional debt, are only related to the probability of entering default, while others, such as the use of IMF credit, are only significant when a country is already in default. Additionally, I find that short-term debt, commercial bank loans, and concessional bilateral debt positively affect both the probability of entering default as well as the probability of remaining in default. Focusing on the composition of external debt provides a more complete picture of the effect of debt

on the probability of default, allowing for more precise forecasts of default probabilities.

In my second chapter, I evaluate the impact of sovereign default on the volatility of gross domestic product, a relationship related to two strands of literature: one focused on the impact of sovereign default on output and another that evaluates the impact of economic volatility on growth in output. In addition to bridging the gap between the existing strands of literature, the dataset and techniques employed in this analysis offer advantages over those currently in use. First, the use of the Beveridge-Nelson decomposition addresses issues encountered by other, common trend-cycle decomposition methods. Second, this dataset, which spans 1870-2008, includes more sovereign default episodes per country, allowing for a richer region-specific evaluation. Using a dataset of 7 South American countries, I find that the volatility of output decreases following a sovereign default episode. Taking advantage of the considerable longitudinal dimension, I am also able to assess the impact of volatility on economic growth by looking at different sub-periods. I show evidence that from 1870-1959, economic volatility is positively related to growth while from 1960-2008, a commonly used time period in the literature, there is no effect. These findings suggest that volatility's influence on economic growth may change over time.

Acknowledgements

With so few words, it will be impossible to fully convey the magnitude of the impact so many people have had on my journey to the realization of this moment. The first that comes to mind is David Papell, and not because I have visited his office at least four-thousand times in the last six months with what was certainly an exasperating barrage of questions, concerns, and doubts, all of which he handled with grace. I am thankful not just for his support and guidance in my development as a student and as a researcher, but for the example he has set as an advisor.

I want to thank Bent Sorensen, who despite having handwriting even worse than my own, was able to clearly communicate potential ways to improve my research. His support has been unwavering and I will always appreciate what I have learned from Bent. I have long admired the ability of Dietrich Vollrath both to simplify and effectively communicate the complex. In addition to his guidance, I appreciate the fact that Dietz is the most absurdly normal person I have ever met. I am grateful to Rebecca Thornton for always having an open door and a willingness to lend an ear. And I find it only fitting that Rauli Susmel, who was there at the beginning of this chapter in my educational journey, also be present at the end.

In the past five years, I have made numerous friends that I hope to keep in my life indefinitely. Whether it was enduring exhausting study groups, sharing a nice meal and a beer, or simply enjoying a few moments of conversation when I probably should have been doing something more productive, I will always cherish the memories made during my time in the Econ Department at the University of Houston.

I want to thank Amber Pozo for her patience and willingness to point me in the right direction regarding any, and all, confusions. And I am happy for the opportunity to have met Chris Murray. Though most conversations started on some noble, typically econometric topic, I will always recall fondly the inevitable divergence into areas of shared interest, particularly of the culinary persuasion.

I find it appropriate to reflect briefly on the previous chapter of my educational experience, at the University of Memphis. Without the people I met during that period of my life, I would certainly not be where I am today. William Smith has made a profound impact on my life, which began years ago in an unforgettable Intermediate Macroeconomics class. Alex Nikolsko-Rzhevskyy is also deserving of special consideration as he is not only a mentor, but the primary force behind my discovery of this wonderful department at the University of Houston.

None of this would be possible without the love and support of my family. I am grateful for my mother's unconditional love and support and her infectious positivity. From my father, in addition to his love and support, I have learned both an acute attention to detail as well as a habit of talking to myself while I work through my various projects. I want to thank my sisters, Kelsey and Diana, and my Hotard family, Kristin, Alex, Collin, and Betty for their tolerance of my insufferable weirdness. I also appreciate the support of my in-laws, Mike and Dianne, who have accepted me into their family. I am so fortunate to have you all in my life.

At this point, there are but two more I must mention and to whom, I am forever indebted. Because of Sasha and her unending resolve to maintain a level of emotion

well above neutral, I am able to reflect fondly on even the most stressful periods of this process. And to my best friend, wife, and benefactor, Lara, I cannot put into words what you mean to me or how much I appreciate the sacrifices you have made to allow me to reach for, and to achieve, my dreams. Thank you so much, not just for what you have done, but for who you are.

Contents

To my girls

Chapter 1

Debt, Default, and Disaggregation

1.1 Introduction

The probability of sovereign default is positively related to external debt relative to GDP. Reinhart and Rogoff (2011) show that, for developing economies from 1970 to 2009, "increases in external debt systematically help predict increases in the share of countries in default."[1] In this literature, aggregate measures of external debt are commonly used. However, external debt can take many different forms. Different maturities, sources, and types of borrowers are just a few of the variable factors related to loans. For example, a sovereign state may borrow from another country, from a multilateral entity such as the World Bank, or issue bonds directly. Private corporations within a country may borrow externally as well. Figure 1 illustrates the World Bank's decomposition of total external debt into the subsets used in this analysis, showing 10 distinct categories that could potentially be driving the aggregate result. In this paper, I use disaggregated measures of external debt to provide a more complete picture of the effect of debt on the probability of default.

This paper aims to answer two questions. First, which subsets of debt are driving the aggregate result that external debt is positively associated with sovereign default? To answer this, I progressively disaggregate total external debt. Starting with the most aggregated measure, total external debt relative to GDP, I continue decomposing external debt to isolate which categories are significantly related to a country's likelihood of default. Of the 10 possible subsets, only short-term debt, commercial bank loans, and bilateral

[1] Because of its influence on the risk of default, sovereign debt is also a reasonable choice as an explanatory variable. Afonso (2003) uses external debt relative to GDP for the determination of credit ratings. In another example, Ağca and Celasun (2012) analyze how external debt in the public sector affects corporate borrowing costs.

concessional debt (i.e., debt owed to other countries with a grant element of at least 25%) are positively associated with the probability of default. For purposes of evaluating a country's default risk level, these 3 subsets are sufficient to capture all the relevant information.

Consider Figure 2, which shows two plots of the predicted probabilities of default for Brazil from 1972 to 2010, one using total external debt and the other using the three subsets driving the aggregate result. During this period, Brazil experiences two defaults, one lasting from 1983 until 1994 (indicated by the grey area), and the other in 2002 (indicated by the vertical line in 2002). The dashed line shows Brazil's predicted probabilities over time using total external debt relative to GDP, while the solid line uses only short-term debt, commercial bank loans, and bilateral concessional debt. The predicted probabilities track closely, showing that short-term debt, commercial bank loans, and bilateral concessional debt are responsible for the relationship between total external debt and sovereign default.

The importance of these 3 subsets appears to stem from the response of lenders to default risk. From a borrower's point of view, some types of debt are more attractive than others. For example, a borrower would prefer to borrow at a lower interest rate or at a longer maturity at a given interest rate. As a country's financial health weakens, the risk of default increases. To offset the increased risk of possible non-repayment, creditors will likely charge higher interest rates, which only compounds the problem; at higher interest rates, debts are more difficult to service, increasing the probability of default. Commercial bank loans are one example of debt with relatively high interest rates. Greater reliance on commercial bank loans, therefore, should be positively associated with the probability of default. In this paper, I show evidence of this positive association. Evaluated at the mean, a 1 percentage point increase in commercial bank loans relative to GDP is correlated with a 1.2% higher probability of default.

The maturity of a loan is another channel through which creditors can compensate for a country's increased risk of default. As the country's long-term financial health becomes more uncertain, creditors are likely to offer loans with shorter maturities. I find that a one percentage point increase in short-term debt relative to GDP is associated with a 0.7% increased probability of default.

Finally, the last category that appears to be significantly associated with the probability of default is bilateral concessional debt. Typically, the poorest countries rely more on bilateral concessional loans. As these very poor countries are typically more sensitive to financial shocks, they are more prone to suffer a default. The bilateral concessional debt variable seems to capture this increased sensitivity to shocks. A one percentage point increase in bilateral concessional debt relative to GDP corresponds to a 1% higher probability of default.

To illustrate the importance of distinguishing these 3 types of debt from simple total external debt, consider Ecuador and Paraguay. In 2002, a year in which neither country is in default, total external debt relative to GDP was 59.7% in Paraguay and 65.6% in Ecuador. Only taking into consideration the impact of total external debt on default, Ecuador would appear more likely to enter default. However, in 2003, Paraguay enters default, while Ecuador does not. This is one example of how the composition of debt can provide a better assessment of a country's default risk. Short-term debt in Paraguay was 9.5% in 2002, comparable to the 9.4% of Ecuador. However, bilateral concessional debt and commercial bank loans, both relative to GDP, were 8.3% and 8.2% respectively, in Paraguay, but only 5.4% and 3.6% in Ecuador. In this case, focusing on the composition of total external debt provides more information than the aggregate about the country's default risk.

The second question I answer is: Does the impact of a debt category depend on whether or not the country is *in* default? By disentangling the channel through which each debt subset impacts the probability of default, I can determine whether the debt category's impact on the probability of *being in* default is driven by its impact on the probability of *entering* default, its impact on the probability of *prolonging* default, or both. Bonds, for example, are associated with the probability of entering default. But once a country is already in default, a change in bond debt relative to GDP has no impact on the probability of extending the default episode. Considering very few investors, if any, will purchase bonds from a country currently in default, this result is intuitive. The use of IMF credit is another example where the default status of a country matters. The use of IMF credit has no impact on the probability of entering default, but is negatively related to the probability of remaining in default. This finding suggests that IMF programs are effective in helping countries emerge more quickly from default.

Decomposing external debt has several advantages. In addition to identifying the specific channels through which various subsets of debt impact the probability of suffering a default, I uncover situations where information otherwise goes undetected. One potential issue with aggregation stems from combining subsets with offsetting effects. Suppose one debt category is composed of two subsets, one with a positive impact on the probability of default and the other negative. If only the aggregate impact were considered, a change in either subset may, incorrectly, be interpreted to have no effect on the the probability of sovereign default. For instance, I find that official public and publicly guaranteed debt (i.e., debt from other countries or multilateral entities) relative to GDP has no effect on the likelihood of default in this sample. This result may be misleading, however. One subset of official public and publicly guaranteed debt, bilateral debt (i.e., debt from other countries), is associated with a significant increase in the probability of default while the other, multilateral debt (i.e., debt from multilateral entities), is associated with a significant decrease in the probability of default.

Another issue arises when a potentially informative subset is aggregated with one that has zero impact. In this case, it is possible for information from the potentially useful category to be "drowned out." As with the situation of offsetting effects, focusing solely on the aggregate effect could lead to mistakenly disregarding information from an important subset. Such aggregation issues could result in a country appearing less susceptible to default than it actually is, potentially leading to undesired consequences for both the country and its creditors. I show evidence that multilateral debt relative to GDP has no impact on the probability of default. However, nonconcessional multilateral debt (i.e., multilateral debt with no grant component), a subset of multilateral debt, is significant at the 5% level. Concessional multilateral debt (i.e., debt from multilateral entities with a grant component of at least 25%), on the other hand, is the insignificant category drowning out the information from its counterpart.

In the following pages, I outline my strategy of decomposing and evaluating the impact of the various classifications of total external debt. I show that the composition of debt matters in regard to the probability a country will default. In particular, not all external debt is associated with increased likelihood of default. While some categories are responsible for the aggregate result, a number of the other included subsets are potentially problematic. My method of disaggregation allows for isolation of the informative measures, while also ameliorating issues stemming from a number of aggregation issues. This paper is organized as follows. Section 1.2 describes the dataset used for analysis. Section 1.3 discusses the methods of estimation. In section 1.4, the reported estimates are considered. Section 1.5 concludes.

1.2 Data

I am focusing solely on the link between external debt and external sovereign default. Utilizing data from the World Bank on thirty-two developing nations from 1971-2010, I examine the impact on the risk of sovereign default using various measures of external debt. The World Bank defines external debt as "debt owed to nonresidents repayable in foreign currency, goods, or services." All measures of debt and GDP are denominated in current US dollars. Figure 1 illustrates the decomposition of total external debt into the available subsets. Total external debt is broken down into short-term external debt, long-term debt, and the use of IMF credit. The use of IMF credit is defined as "drawings on the IMF other than amounts drawn against the country's reserve tranche position." Short-term debt obligations have a maturity of less than one year. Long-term debt, for which the maturity is greater than one year, is further broken down into three categories: public, publicly guaranteed, and private nonguaranteed debt. Public debt refers to the debt owed by the central government, state and local governments, central bank, etc., while private debt is owed by private banks and private entities. Public and publicly guaranteed debt combines the public debt with any private debt that is backed by a public entity. The remaining portion of long-term debt is classified as private nonguaranteed debt, which measures the private debt not backed by a public entity.

Public and publicly guaranteed debt can be disaggregated into even more narrowly defined measures. There are two broader classifications of public and publicly guaranteed debt that are categorized by the type of creditor. Public and publicly guaranteed debt from private creditors includes loans from commercial banks, bonds, and other private financial entities. Public and publicly guaranteed debt from official creditors includes loans from international organizations (e.g., the World Bank) as well as loans from governments. Loans from international organizations (i.e., multilateral debt) and from other governments (i.e., bilateral debt) can have concessional and non-concessional components. A loan is considered to be concessional if it has a grant element of at least twenty-five percent.

For external defaults, I will be following the method proposed in Reinhart and Rogoff (2011). Their data on defaults come from several Standard and Poor's studies augmented by information from Lindert and Morton (1989), Suter (1992), and Tomz (2007). Following Standard and Poor's definition: a default is defined as either an outright default (i.e., where the country fails to make an interest or principal payment within the grace period) or when the sovereign renegotiates the debt (Beers and Chambers, 2006). A renegotiation or restructuring results in worse terms for the lender. For example, the restructuring of the Greek debt in 2012 is considered a default even though Greece never missed a payment (Tomz and Wright, 2013). Defaults can last for many years and end when "a settlement occurs and no further near-term resolution of creditors' claims is likely" (Beers and Chambers, 2006). The data on external defaults dates to 1824, considerably farther back in time than the available World Bank debt data. From 1971-2010, there are 57 default episodes in total. The average length of time spent in default is 5.2 years.

Having additional data on defaults experienced prior to 1970 will allow for additional controls and robustness checks. A country that has previously experienced a default would likely have a different level of risk than a country with no history of default. As well, it is reasonable that the probability of default is not independent of the length of time since a previous default, or since becoming a sovereign entity. For instance, it is conceivable that the longer a country goes without experiencing a default, the less likely it is for one to occur. However, it also seems plausible to argue that perhaps after enough time, a country may be "due" for a default. Some combination of these two effects is entirely possible. In other words, the probability of default over time is not necessarily a monotonic function. Having additional longitudinal information about default histories allows for a more accurate analysis of the effects of debt on the likelihood of default.

1.3 Estimation

For this analysis, I run a series of similar regressions. The dependent variable, external default in period t by country i, is binary and coded as a 1 during a default and 0 otherwise. Each regression uses the same basic framework (i.e., all non-debt variables are the same in every regression) with the only variation between specifications being the breakdown of external debt. The debt relative to GDP variables are measured in percentages.

Table 1 shows basic summary statistics of the variables used in this analysis. On average, most of a country's external debt is comprised of long-term external commitments. That is, around 81% of an average country's debt has a maturity greater than one year. Short-term debt commitments account for slightly less than 15% of external debt and the use of IMF credit represents the remaining external debt. Public and publicly guaranteed debt accounts for the majority of long-term debt. Most of the public and publicly guaranteed debt is owed either to other governments (i.e., bilateral debt) or multilateral organizations (e.g., the World Bank).

Considering the binary nature of the dependent variable, external sovereign default, a logit specification is a natural choice. I use first lags of all the debt variables relative to GDP. Lags allow for investigation into how the level of the given year's external debt relative to the given year's GDP impacts the likelihood that a default will be experienced in the following year. In addition to the controls described below, I also include year fixed effects and country fixed effects to capture as much of the remaining unmeasured heterogeneity between the countries and years as possible.

1.3.1 Baseline Estimating Equations

The first step in this analysis is to assess the impact of the most aggregated measure (i.e., total external debt relative to GDP) by estimating equation 1:

$$p[default_{it}] = g[\beta_{tot} * (total)_{i,t\text{-}1} + X_{it} * \gamma] \tag{1}$$

where i denotes the country, t denotes the year, and *total* denotes the total external debt relative to GDP. X_{it} is a matrix of controls that includes the simple duration variable, cubic splines in duration, the number of defaults, and dummy variables for country and time fixed effects.

For the next part of the analysis, I decompose total external debt into three subcomponents: short-term debt, long-term debt, and the use of IMF credit (all relative to GDP). To evaluate these individual components, I use equation 2:

$$p[default_{it}] = g[\beta_{st} * (ST)_{i,t\text{-}1} + \beta_{imf} * (IMF)_{i,t\text{-}1} + \beta_{lt} * (LT)_{i,t\text{-}1} + X_{it} * \gamma] \tag{2}$$

where i, t, and X_{it} are defined as before. The short-term debt is represented by ST, long-term debt by LT, and the use of IMF credit by IMF.

Long-term debt can be further disaggregated into public and publicly guaranteed debt and private nonguaranteed debt. To determine the effect of public and publicly guaranteed debt and private nonguaranteed debt, I estimate equation 9:

$$p[default_{it}] = g[\beta_{st} * (ST)_{i,t\text{-}1} + \beta_{imf} * (IMF)_{i,t\text{-}1}$$
$$+\beta_{png} * (PNG)_{i,t\text{-}1} + \beta_{ppg} * (PPG)_{i,t\text{-}1} + X_{it} * \gamma] \tag{3}$$

where i, t, X_{it}, ST, and IMF are defined as before. The long-term debt (denoted LT in equation 2) is broken down into public and publicly guaranteed debt, denoted PPG, and private nonguaranteed debt, denoted PNG.

Public and publicly guaranteed debt can come either from official sources (e.g., other countries) or from private sources (e.g., commercial banks). Equation 10 is used to determine how debt from these different sources affects the likelihood of default:

$$p[default_{it}] = g[\beta_{st} * (ST)_{i,t\text{-}1} + \beta_{imf} * (IMF)_{i,t\text{-}1} + \beta_{png} * (PNG)_{i,t\text{-}1}$$
$$+\beta_{off} * (Off)_{i,t\text{-}1} + \beta_{pri} * (Pri)_{i,t\text{-}1} + X_{it} * \gamma] \tag{4}$$

where i, t, X_{it}, ST, IMF, and PNG are defined as before. Off represents debt from official sources, while Pri represents debt from private sources.

Official sources include other nations (i.e., bilateral) as well as multinational organizations like the World Bank or regional development banks (i.e., multilateral). Private sources of debt include loans from commercial banks, the sale of bonds, and private credits from manufacturers, exporters, and other suppliers of goods. This breakdown is evaluated in equation 11:

$$
\begin{aligned}
p[default_{it}] = g[&\beta_{st} * (ST)_{i,t\text{-}1} + \beta_{imf} * (IMF)_{i,t\text{-}1} + \beta_{png} * (PNG)_{i,t\text{-}1} \\
&+\beta_{bi} * (Bi)_{i,t\text{-}1} + \beta_{mu} * (Mul)_{i,t\text{-}1} \\
&+\beta_{bon} * (Bonds)_{i,t\text{-}1} + \beta_{com} * (Com)_{i,t\text{-}1} + \beta_{opr} * (Opri)_{i,t\text{-}1} + X_{it} * \gamma] \qquad (5)
\end{aligned}
$$

where i, t, X_{it}, *ST*, *IMF*, and *PNG* are defined as before. Bilateral is denoted as *Bi*, while multilateral debt is denoted as *Mul*. *Bonds* represents debt from bonds, *Com* represents loans from commercial banks, and *Opri* represents debt from other private sources.

Official public and publicy guaranteed debt can take two forms, concessional and non-concessional. A concessional loan is defined as a loan with a grant element of at least a 25%. Multilateral and bilateral debt are decomposed into concessional and nonconcessional subsets in equation 12:

$$p[default_{it}] = g[\beta_{st} * (ST)_{i,t\text{-}1} + \beta_{imf} * (IMF)_{i,t\text{-}1} + \beta_{png} * (PNG)_{i,t\text{-}1}$$
$$+ \beta_{nbi} * (Nbi)_{i,t\text{-}1} + \beta_{cbi} * (Cbi)_{i,t\text{-}1} + \beta_{nmu}(Nmul)_{i,t\text{-}1} + \beta_{cmu} * (Cmul)_{i,t\text{-}1}$$
$$+ \beta_{bon} * (Bonds)_{i,t\text{-}1} + \beta_{com} * (Com)_{i,t\text{-}1} + \beta_{opr} * (Opri)_{i,t\text{-}1} + X_{it} * \gamma] \qquad (6)$$

where i, t, X_{it}, *ST*, *IMF*, *PNG*, *Com*, *Bonds*, *Opri* are defined as before. Nonconcessional multilateral debt is denoted by *Nmul*, concessional multilateral debt is denoted by *Cmul*, nonconcessional bilateral debt is denoted by *Nbi*, and concessional bilateral debt is denoted by *Cbi*.

1.3.2 Time Dependence

The length of time before, and between, default episodes is important to consider. Specifically, one should ask whether the amount of time that has passed impacts the probability a default will occur. If a given number of years has passed without a country defaulting, is said country more likely to default? Could the country be less likely to default? Is it possible that there is some nonlinearity in the likelihood of default over time? For instance, a country may be more likely to default within the first five or ten years following a previous default and then, over time, become less likely to default. A number of situations could be plausibly argued such that the answer to at least one of the questions is *yes*. And if the answer to any of the three previous questions can be a *yes*, there is an issue that must be addressed.

Time dependence refers to the situation where the probability of failing depends on the length of time since the last failure. In the context of duration modeling, time dependence implies that the hazard rate, or the instantaneous probability of failure conditional on having survived for a given duration, is not flat over time. The failure in this analysis refers to experiencing a default and how long a country has "survived" is the number of years the country has been default free. If the observations are temporally related (i.e., if time dependence is present), the results of an ordinary logit may be misleading (Beck, Katz, and Tucker 1998). The presence of time dependence can lead to statistical inefficiency. Reported standard errors could be understated by 50 percent (Beck and Katz 1997). Understated standard errors inflate t-statistics, potentially leading to incorrect inferences. To improve efficiency, I control for the impact of duration before, and between, defaults by implementing additional controls.

The first control for duration is defining a simple duration variable that tracks the number of years between defaults. This variable measures how many years have passed since the last year without a default. Thus, the duration variable becomes a 1 in the second year after a default has ended (i.e., two years after the default variable was last coded as a 1).

The second control is done by employing natural cubic splines in the duration variable, following the method described in Beck, Katz, and Tucker (1998). I use 3 evenly spaced subintervals between which cubic polynomials (splines) are fit. The splines, as well as their first and second derivatives, are forced to agree at each knot (subinterval). The result of this process is a smoothed path of duration dependence. This smooth path can be thought of as the baseline hazard function, or the hazard function with all covariates set to 0. By including these "duration controls," I can ameliorate the effects of time dependence, allowing for better inference when evaluating the independent variables of interest.

Though the data on debt measures is only available starting in 1971, the default data goes back considerably further. Since the default history (i.e., the number of defaults and length of time without a default prior to 1971) differs across countries, this additional longitudinal default data can allow for a clearer picture of each country's relative situation in 1971, when the debt data becomes available. The simple duration variable described above is defined specifically as the number of years that have passed since the last year with a default. However, if no default has been experienced, the count begins either in 1950 or in the year the country gained independence, whichever occurs later. To stay consistent, the first year (e.g., 1950) is coded as a 0 and then 1951 is coded as a 1. The year 1950 was chosen to avoid any capital flow issues resulting from World War II.

1.3.3 Previous Defaults

Another potential concern is the number of defaults a country has previously experienced. The likelihood a country will default again reasonably depends on whether, and how many times, the country has defaulted in the past. Perhaps a country is more likely to default if they have defaulted in the past. If a country defaulted and was allowed to continue borrowing, suffering no consequence, what incentive would it have to avoid default in the future? Conversely, it may be the case that a country who has defaulted can no longer access capital markets and, thus, cannot default again since it would be unable to accumulate debt on which to default. Though these extreme cases are somewhat unrealistic, it seems likely that there is some continuum over which the blemish of a previous default affects the process of debt accumulation, and subsequently, the likelihood of a future repeat event. For this paper, I include a simple default count variable to control both for countries that have defaulted, as well as how many times they have defaulted.

The default count variable is defined as a 0 starting in 1950 or when the country gains independence. In the first year of the first default, the default count variable becomes a 1. This variable stays coded as a 1 until the first year of the second default, at which point the default count variable becomes a 2, and so on. The inclusion of this variable controls for the difference between countries who have defaulted and those who have not. Additionally, this variable distinguishes between countries with only one default and those with numerous defaults, commonly referred to as serial defaulters.

1.3.4 Alternative Estimation Strategy

The baseline estimating equations, described above, rely on an important assumption: that the various classifications of debt relative to GDP affect both the likelihood of entering a default and the probability of remaining in a default in the same way. In other words, the baseline strategy merely estimates how the various subsets of debt impact the likelihood of being in a default. However, the transition into, as well as out of, a crisis is reasonably as interesting, if not more so. As an alternative to the baseline strategy, I employ a modified set of equations. The primary difference between the baseline and alternative specifications is that in the alternative, the impacts of the debt variables are allowed to differ between the two states (i.e., default or no default). To accomplish this, I have added an interaction term between each debt/GDP variable and the first lag of the default variable. The alternative version of equation 1 is

$$p[default_{it}] = g[\beta_{1tot} * (total)_{i,t\text{-}1} + \beta_{2tot} * \{(total)_{i,t\text{-}1} * (default)_{i,t\text{-}1}\} + X_{it} * \gamma]$$

with all variables defined as before. For the alternative specification, I have added the first lag of the default variable to the set of controls, X_{it}. With this set of augmented equations, it is now possible to disentangle the effects of debt on the likelihood of entering a default when the country is not currently in default from the likelihood of staying in default.

The estimates of the non-interacted debt/GDP variables, "β_{1j}", capture the impact of debt category "j" on the likelihood of default when a country is not currently in default. The sum of the estimates for the non-interacted and interacted variables of a given debt subset, "$\beta_{1j} + \beta_{2j}$", yields the impact of debt category "j" on the likelihood of staying in default when a country is currently in default.

The alternative strategy is essentially an additional method of disaggregation. The estimates generated from the baseline strategy are weighted averages of the impact of the debt variables on the probability of entering default and of the impact on the probability of staying in a default. Now, it is possible to not only see which variables are driving the aggregate result, but also to determine how the debt measures are driving the baseline results.

1.4 Results

Tables 2 through 4 report the estimated coefficients for both estimation strategies described above, the baseline and the alternative. In each table, the first column reports the estimated coefficients from the baseline specification. Estimates of "β_j", from column 1, can be interpreted as the impact of debt category "j" on the probability of being in default. The estimated coefficients from the alternative strategy are reported in the remaining two columns. In column 2, estimates of "β_{1j}" can be interpreted as the impact of debt category "j" on the probability of entering default when a country is not currently in default. The impact of debt category "j" on the probability of staying in default when a country is already in default, "$\beta_{1j} + \beta_{2j}$" is reported in the final column. All regressions contain a base set of controls that includes total number of defaults, duration since previous default, cubic splines in duration since previous default, country fixed effects, and year fixed effects. The significance of each reported variable will be conventionally denoted with a single asterisk representing a 10% level of significance, two asterisks representing a 5% level of significance, and three asterisks representing a 1% level of significance.

It is important to note that the inclusion of lagged dependent variables, country fixed effects, and year fixed effects has reduced the usable sample from 1280 (32 countries × 40 years) observations to 1064 observations. The use of lagged terms reduces the longitudinal dimension of each country by 1, to 39 years. From 1971-2010, four countries (Colombia, El Salvador, Malaysia, and Thailand) are default free, resulting in these countries being dropped from the sample. Additionally, in 1977, no country experienced a default, requiring all observations from 1977 to be dropped.

Panel A of Table 2 reports coefficients from the baseline and alternative specifications of Equation 1, which evaluates the impact of total external debt on the probability of default. According to the estimate reported in column 1, total external debt is positively and significantly associated with an increased probability of being in default. Columns 2 and 3 indicate that total external debt is associated with an increased probability both of entering default when a country is not currently in default as well as staying in default when a country is already in default.

Total external debt can be decomposed into three components: short-term debt (i.e., debt with a maturity less than one year), long-term debt (i.e., debt with a maturity greater than one year), and the use of IMF credit. Equation 2 evaluates the impact of short-term debt, long-term debt, and the use of IMF credit on the probability of default. Panel B of Table 2 reports the estimates from the baseline and alternative specifications of equation 2. Both short-term and long-term debt are positively and significantly associated with the probability of experiencing a default. Higher levels of both short-term and long-term debt are associated with an increased probability of entering default when the country is not in default, as well as a greater probability of remaining in default. The use of IMF credit is negatively associated with the probability of being in default. IMF credit appears to have no impact on the probability of entering default when a country is not currently in default. Thus, the negative and significant baseline result is being driven by the impact of IMF credit on the probability of staying in default.

At this point in the decomposition, neither short-term debt nor the use of IMF credit can be further disaggregated. Long-term debt, however, can be broken into a number of increasingly disaggregated components. Two broad classifications of long-term debt will be assessed in this analysis. The first, private nonguaranteed debt, is debt owed externally by private entities and is not backed by the government. The second, public and publicly guaranteed debt, includes both debts backed by the government, but owed by private entities, as well as debt owed by the government itself. Equation 3 evaluates the impact of these subsets of long-term debt on the probability of default.

The impacts of private nonguaranteed debt and public and publicly guaranteed debt on the probability of default are the focus of Panel A in Table 3. Private nonguaranteed debt appears to have no impact on the probability of being in default, entering default, or staying in default. Public and publicly guaranteed debt, by contrast, is positively and significantly associated with an increased probability of being in default, entering default, and staying in default. According to Panel B in Table 2, long-term debt is estimated to be positively associated with the probability of default. This result seems to be driven by the influence of public and publicly guaranteed debt rather than private nonguaranteed debt. Consistent with the estimated coefficients reported in Panel B of Table 2, short-term debt is positively and significantly associated with the probability of being in default, entering default, and staying in default. The use of IMF credit is negatively associated with being in default, a result driven by the impact of IMF credit when a country is currently in default.

Equation 4 is used to evaluate the impact of public and publicly guaranteed debt from different types of lenders. Official lenders include other governments as well as multilateral entities such as the World Bank and regional development banks. Private lenders include commercial banks, holders of bonds, and other private companies (e.g., exporters, manufacturers). Panel B of Table 3 reports the results from estimating equation 4. Public and publicly guaranteed debt from official sources is estimated to be positively associated with the probability of default, but only at a 10% level of significance. Looking at columns 2 and 3, it appears that official public and publicy guaranteed debt has no correlation with the probability of entering default, but is significantly related to staying in default. As before, short-term debt is positively, and significantly, associated with being in default, entering default, and staying in default. The use of IMF credit is negatively correlated with staying in default, resulting in a negative association with being in default.

Official public and publicy guaranteed debt's lack of impact seems suspicious considering this debt category accounts for around 45% of total external debt. As it turns out, official public and publicy guaranteed debt having no impact is an example of one of the issues with aggregation. As Panel A of Table 4 will show, the two subsets of official public and publicy guaranteed debt, multilateral public and publicy guaranteed debt and bilateral public and publicy guaranteed debt, are both significantly associated with the probability of default. However, the sign of the estimated coefficient for multilateral public and publicy guaranteed debt is negative, while the sign for bilateral public and publicy guaranteed debt is positive. These offsetting subsets result in their aggregate's lack of impact.

In Panel A of Table 4, we can see the coefficients estimated using equation 5. Official public and publicly guaranteed debt is decomposed into bilateral debt and multilateral debt while private public and publicly guaranteed debt is split into bonds, commercial bank loans, and other private credits. Bilateral debt is positively associated with being in default. This result is driven by the impact on default of bilateral debt when a country is not in default. Multilateral debt is estimated to have no impact on the probability of being in default. However, according to columns 2 and 3, multilateral debt is negatively associated with the probability of entering default, and positively associated with the probability of staying in default. Recall that the baseline strategy is a weighted average of these two effects. In this case, the effects offset each other, resulting in the zero impact from the baseline specification. Bonds are positively associated with the probability of entering default, but not with the probability of staying in default. The impact of bonds when a country is already in default appears to be drowning out the information from bonds when a country is not in default. Thus, the baseline result is that bonds have a zero impact, which is misleading. Commerical bank loans are significantly correlated with the probability of being in default, entering default, and remaining in default. Other private credits appears to be only weakly negatively associated with the probability of entering default. Short-term debt is positively and significantly associated with the probability of being in default, entering default, and staying in default.

Multilateral debt, as well as bilateral debt, can be disaggregated into concessional and nonconcessional components. A loan is considered to be concessional if there is a grant element of at least 25%. Panel B in Table 4 shows the effects of the concessional and nonconcessional components for bilateral and multilateral debt. Nonconcessional bilateral debt is positively associated with the probability of entering default, but has no impact when a country is already in default. This is a situation similar to bonds from Panel A of Table 4. Specifically, nonconcessional bilateral debt only has an effect when the country is not in default, but this information is drowned out by the (lack of) impact when the country is in default. Concessional bilateral debt, on the other hand, is positively and significantly associated with the probability of being in default, entering default, and remaining in default. Concessional multilateral debt is negatively associated with the probability of entering default, but has no impact on the probability of staying in default. Short-term debt and commercial bank loans, as before, are positively and significantly associated with the probabiilty of being in default, entering default, and staying in default.

1.4.1 Summary of results

Though the levels of significance of several subsets are sensitive to different specifications, the estimates for a number of variables are more robust. Short-term debt is positive and significant for every specification in which it is included. Intuitively, this result seems reasonable. As a country's risk level for default increases, lenders may worry more about the probability of receiving repayment. To offset this increased risk, loans may include higher interest rates and/or shorter maturities. With higher interest rates and shorter maturities, countries may find it increasingly difficult to cover their debt obligations, resulting in a country's increased level of risk of defaulting. As well, countries that are more likely to default may only have access to certain types of loans, such as those that would be classified as short-term debt. While it is not possible with this strategy to isolate the direction of the causality, short-term debt appears to contain valuable information about default risk.

In addition to short-term debt, commercial bank loans are positively and significantly associated with the probability of default across specifications. As preferred sources of borrowing (e.g., loans with lower interest rates and longer maturities) become increasingly scarce, a country may need to rely on commercial bank loans to cover various obligations. This reliance on commercial bank loans may be the result of a country lacking a financial buffer, potentially increasing its sensitivity to a large financial shock. As with short-term debt, the direction of causality can not be identified with this strategy. A country may be more likely to default at higher levels of commercial bank loan debt, but the variable may be capturing the fact that countries in poor financial health rely on commercial bank loans when preferred avenues for borrowing are no longer available. For both short-term debt and commercial bank loans, it seems likely that there is some feedback between the two possibilities. Being in poor financial health results in increased borrowing from less preferred sources. These relatively expensive loans are more difficult to service, which results in a decrease in the financial health of the country. Though it is not possible with this analysis to determine how the cycle starts, both categories appear to contain useful information.

The third robust variable is concessional bilateral debt. This debt, which is owed to other sovereign nations and includes a grant element of at least 25%, is positively and significantly related the likelihood that a country will default. Loans of this type are commonly used to further development in emerging economies. Intuitively, bilateral concessional loans should account for a larger percentage of debt relative to GDP in the poorest countries. In other words, the poorest countries rely on concessional loans from other governments proportionately more than the "richer" countries. In this dataset, the bottom 33% of countries in income have, on average, a concessional bilateral debt/GDP ratio of about 12.7%, substantially higher than the overall average of 8.2%.[2] Concessional bilateral debt may simply be a proxy for the higher level of default risk associated with the poorest countries.

1.5 Conclusion

The premise of this analysis is to determine which components of total external debt convey useful information about the likelihood a country will suffer a default. To accomplish this, I have incorporated a process of progressive disaggregation. Starting with the most aggregated measure of external debt, total external debt, I continued to disaggregate and ultimately determine which measures are consistently, in sign and significance, associated with default. In particular, I show evidence that short-term debt, commercial bank loans, and bilateral concessional debt are all positively associated with a country's risk of default. Each measure is significantly associated with the probability of entering default from a non-default status as well as with the probability of staying in default after having already defaulted. Isolating the variables driving the aggregate result highlights how a country's debt composition impacts the probability of default.

[2]The bottom 33% of countries in income is based on the average real GDP per capita (using 2005 dollars) over the entire sample period

In addition to determining which variables are consistently informative, progressive disaggregation addresses certain issues with aggregate measures. For instance, if an aggregate measure is composed of two components whose effects are offsetting (i.e., one is positively associated with the outcome while the other has a negative correlation), it is possible to estimate zero effect in the aggregate. In my analysis, I show that, when a country is not in default, increases in bilateral debt are positively related to default while increases in multilateral debt are negatively related. However, the aggregate of bilateral and multilateral debt, official public and publicy guaranteed debt, is estimated to have zero impact on the probability of default. Through disaggregation, information about the individual components of official public and publicy guaranteed debt is detectable.

It is also possible for a category with no impact to "drown out" the information from an informative subset. For example, bonds are only correlated with the probability of default when a country is not in default. If the effect of this debt category is not allowed to vary based on whether the country is currently in default or not (i.e., if one were to just look at the impact of bonds on the probability of being in default), one might conclude that bonds have no impact when, in fact, they do.

A useful exercise in evaluating the default risk of a country would be to focus on the categories of debt that are significantly associated with the probability of default, as opposed to the aggregate of all categories (which includes subsets with no effect). Looking more deeply into the variables driving the aggregate result, as well as how their influence differs between states of default, can paint a clearer picture of how these debt measures are correlated with the probability of default.

References

[1] Afonso, Antonio. 2003. “Understanding the Determinants of Sovereign Debt Ratings: Evidence for the Two Leading Agencies.” *Journal of Economics and Finance* 27 (1), 56-74.

[2] Ağca, Şenay, and Oya Celasun. 2012. “Sovereign Debt and Corporate Borrowing Costs in Emerging Markets.” *Journal of International Economics* 88, 198-208.

[3] Beck, Nathaniel, Jonathan N. Katz, and Richard Tucker. 1998 “Taking Time Seriously: Time-Series-Cross-Section Analaysis with a Binary Dependent Variable.” *American Journal of Political Science* 42(4), 1260-1288.

[4] Beck, Nathaniel, and Jonathan N. Katz. 1997. “The Analysis of Binary Time-Series-Cross-Section Data and/or The Democratic Peace.” Paper presented at the Annual Meeting of the Political Methodology Group, Ohio State University.

[5] Beers, Daveid, and John Chambers. 2006. “Sovereign Defaults at 26-Year Low, To Show Little Change in 2007.” *Standard & Poor's Commentary*, September 18.

[6] Eaton, Jonathan, and Mark Gersovitz. 1981. “Debt with Potential Repudiation: Theoretical and Empirical Analysis.” *The Review of Economic Studies* 48(2), 289-309.

[7] Eggertsson, Gauti B., and Paul Krugman. 2012. “Debt, Deleveraging, and the Liquidity Trap: A Fisher-Minsky-Koo Approach.” *The Quarterly Journal of Economics*, 1469-1513.

[8] Lindert, Peter H., and Peter J. Morton. 1989. "How Sovereign Debt Has Worked." In *Developing Country Debt and Economic Performance Volume 1 the International Financial System*, ed. J.D. Sachs, 30-106. Chicago:University of Chicago Press.

[9] Manasse, Paolo, and Nouriel Roubini. 2009. "'Rules of Thumb' for Sovereign Debt Crises." *Journal of International Economics* 78: 192-205.

[10] Poirer, Dale, and Paul Ruud. 1988. "Probit with Dependent Observations." *Review of Economic Studies* 55:593-614.

[11] Reinhart, Carmen M., and Kenneth S. Rogoff. 2011. "From Financial Crash to Debt Crisis." *American Economic Review* 101,1676-1706.

[12] Reinhart, Carmen M., and Kenneth S. Rogoff. 2008. "This Time Is Differnt: A Panoramic View of Eight Centuries of Financial Crises." National Bureau of Economic Research Working Paper 13882.

[13] Reinhart, Carmen M., Kenneth S. Rogoff, and Miguel A. Savasatano. 2003. "Debt Intolerance." *Brookings Papers on Economic Activity* 1, 1-74.

[14] Suter, Christian. 1992. *Debt Cycles in the World-Economy: Foreign Loans, Financial Crises, and Debt Settlements, 1820-1990*. Boulder, CO: Westview Press.

[15] Tomz, Michael. 2007. *Reputation and International Cooperation: Sovereign Debt across Three Centuries*. Princeton, NJ: Princton University Press.

[16] Tomz, Michael, and Mark L. J. Wright. 2013. "Empirical Research on Sovereign Debt and Default." forthcoming. *Annual Reviews of Economics*, doi:10.1146/annurev-economics-061109-080442.

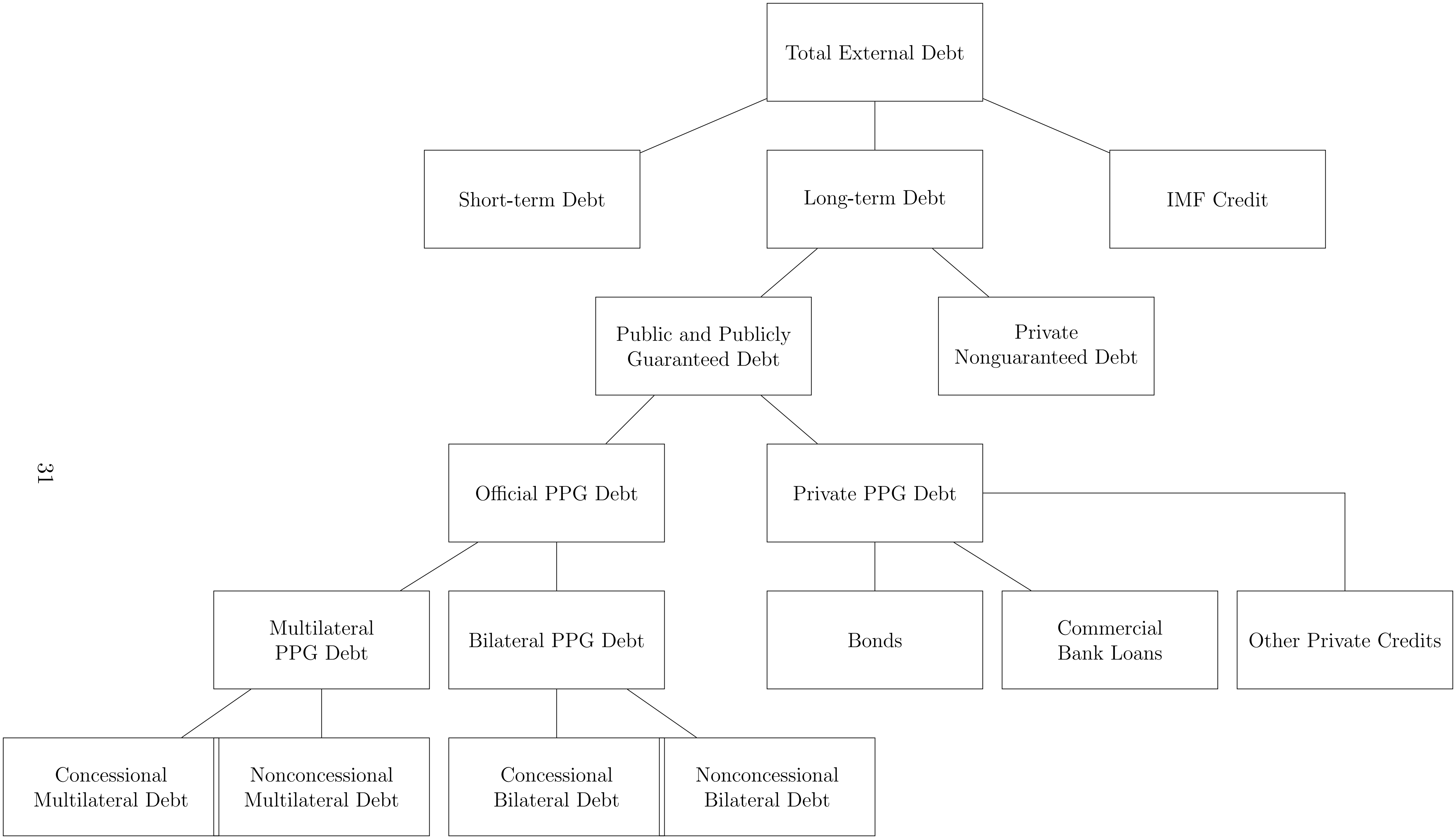

Figure 1: Breakdown of Total External Debt

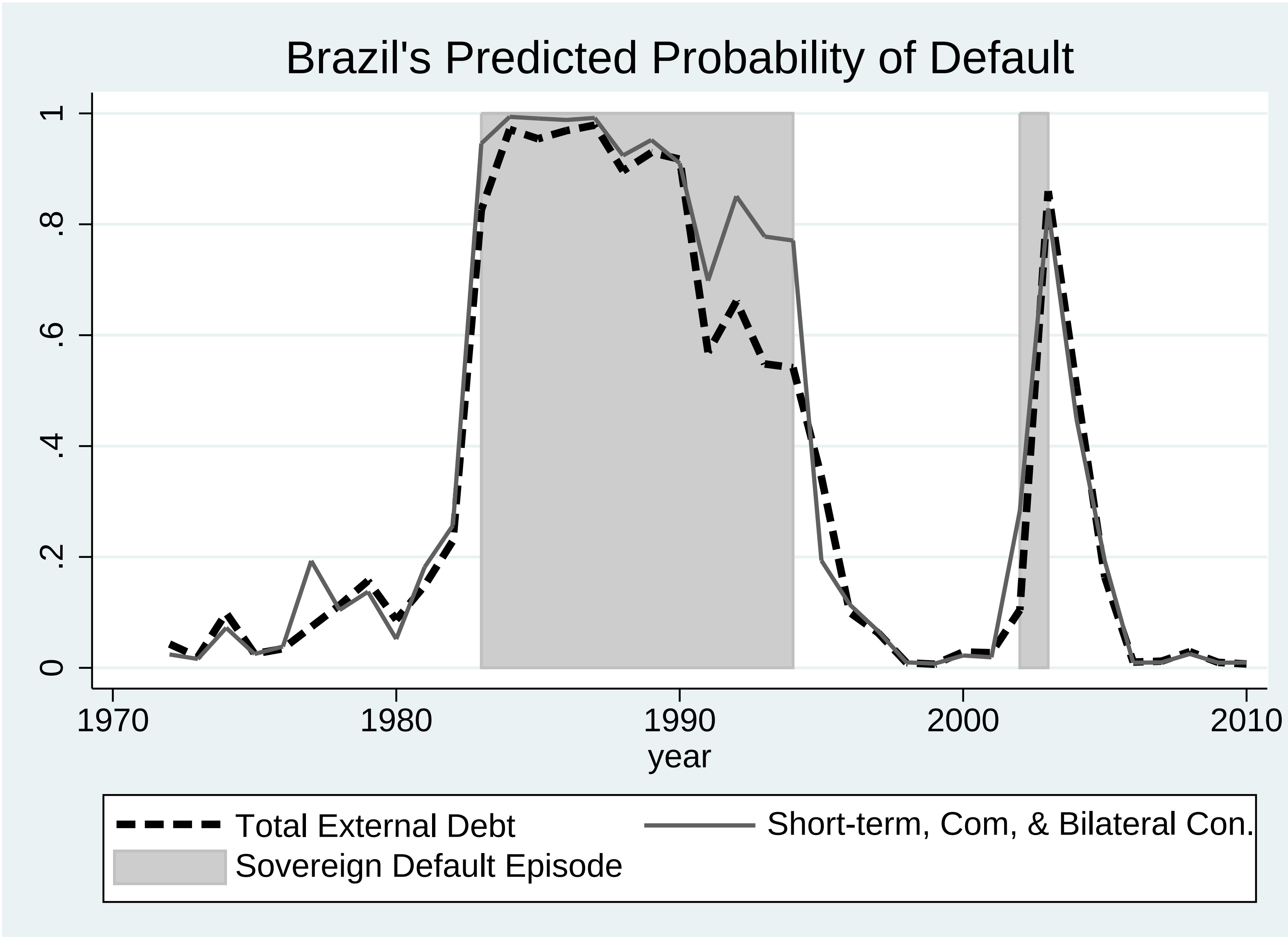

Figure 2: Predicted Probability of Default

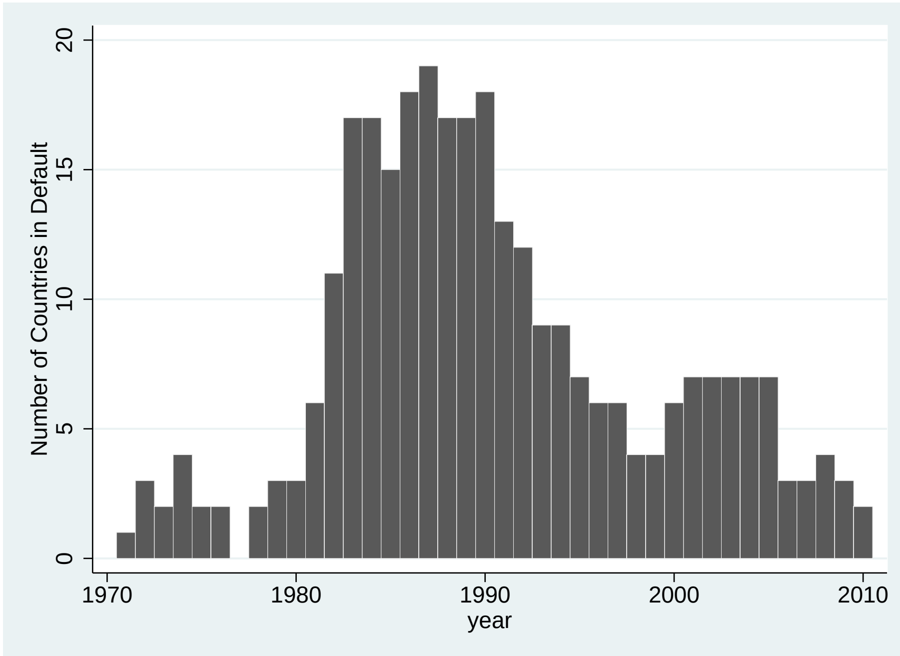

Figure 3: Number of Countries in Default

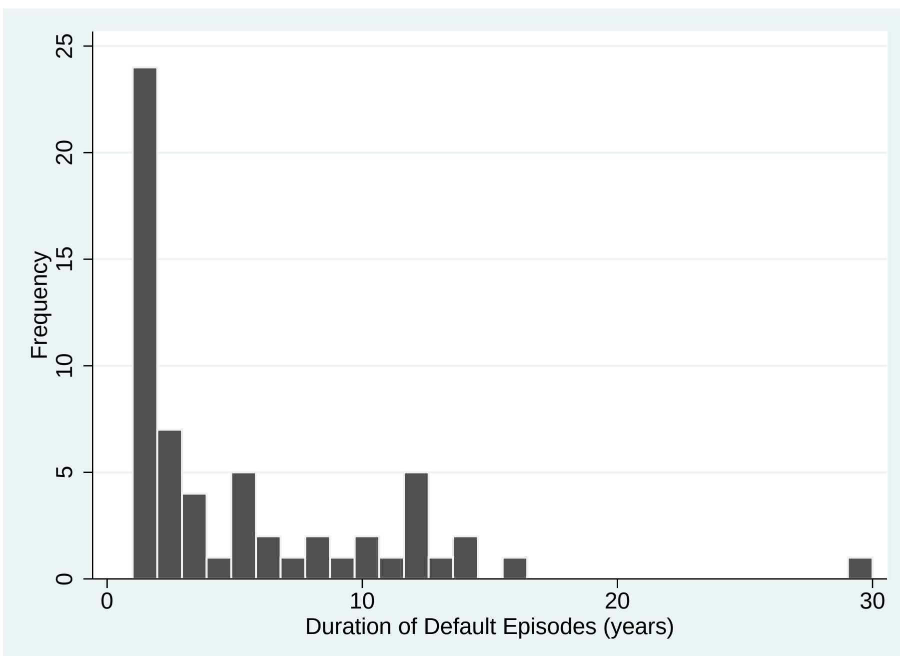

Figure 4: Duration of Default Episodes

Table 1: Summary Statistics

Variable	Mean:	Max:
Total External Debt/GDP	50.753 (34.819)	338.456
Short-term Debt/GDP	7.377 (6.421)	62.468
IMF Credit/GDP	2.243 (4.700)	51.562
Long-term Debt/GDP	41.134 (27.819)	224.427
Public and Publicly Guaranteed Debt/GDP	35.313 (27.276)	224.427
Private Nonguaranteed Debt/GDP	5.821 (6.693)	57.340
Official Public and Publicly Guaranteed Debt/GDP	23.287 (23.682)	189.340
Private Public and Publicly Guaranteed Debt/GDP	12.025 (11.386)	73.391
Bilateral Public and Publicly Guaranteed Debt/GDP	12.367 (14.590)	131.443
Multilateral Public and Publicly Guaranteed Debt/GDP	10.920 (11.861)	65.251
Bonds/GDP	3.406 (6.228)	64.251
Commercial Bank Loans/GDP	5.594 (8.446)	62.111
Other Private Credits/GDP	3.026 (4.600)	46.089
Concessional Bilateral Debt/GDP	8.202 (9.059)	66.849
Concessional Multilateral Debt/GDP	4.896 (9.369)	70.535
Observations:	1,280	

Notes: Standard deviations are in parentheses. All means are reported as percentages.

Table 2: Total External Debt

Estimation Method: Logit	Dependent Variable: External default in Year t		
Explanatory Variable	**Baseline:** β_j	**Alternative:** β_{1j}	$\beta_{1j} + \beta_{2j}$
Panel A: Total External Debt			
(Total External Debt/GDP)$_{t\text{-}1}$	0.03***	0.04***	0.03***
	(0.01)	(0.01)	(0.01)
Panel B: External Debt Decomposed			
(Short-term Debt/GDP)$_{t\text{-}1}$	0.13***	0.17***	0.11***
	(0.04)	(0.06)	(0.04)
(IMF Credit/GDP)$_{t\text{-}1}$	-0.13***	-0.01	-0.17***
	(0.06)	(0.06)	(0.06)
(Long-term Debt/GDP)$_{t\text{-}1}$	0.03***	0.02*	0.03***
	(0.01)	(0.01)	(0.01)
Observations:	1,064	1,064	

Notes: Standard errors are in parentheses.
The subscript j refers to the category of debt. "β_{1j}" captures the average change in the log odds of entering default when the country is not in default. "$\beta_{1j} + \beta_{2j}$" captures the average change in the log odds of staying in default.
Other Controls: total number of defaults, duration since previous default, cubic splines in duration since previous default, country fixed effects, and year fixed effects
* denotes $p < 0.1$, ** denotes $p < 0.05$, *** denotes $p < 0.01$

Table 3: Long-term Debt

Estimation Method: Logit	Dependent Variable: External default in Year t		
	Baseline:	**Alternative:**	
Explanatory Variable	β_j	β_{1j}	$\beta_{1j} + \beta_{2j}$
Panel A: Long-term Debt Decomposed			
(Short-term Debt/GDP)$_{t\text{-}1}$	0.13***	0.18***	0.12***
	(0.03)	(0.06)	(0.04)
(IMF Credit/GDP)$_{t\text{-}1}$	-0.13**	0.00	-0.18***
	(0.06)	(0.06)	(0.06)
(Private Nonguaranteed Debt/GDP)$_{t\text{-}1}$	0.00	0.01	-0.03
	(0.03)	(0.04)	(0.03)
(Public and Publicly Guaranteed Debt/GDP)$_{t\text{-}1}$	0.03***	0.03**	0.04***
	(0.01)	(0.01)	(0.01)
Panel B: PPG Debt Decomposed by Lender			
(Short-term Debt/GDP)$_{t\text{-}1}$	0.14***	0.15**	0.13***
	(0.04)	(0.06)	(0.04)
(IMF Credit/GDP)$_{t\text{-}1}$	-0.12**	0.04	-0.19***
	(0.06)	(0.07)	(0.06)
(Private Nonguaranteed Debt/GDP)$_{t\text{-}1}$	-0.02	0.00	-0.04
	(0.03)	(0.04)	(0.03)
(Official PPG Debt/GDP)$_{t\text{-}1}$	0.02*	0.01	0.04***
	(0.01)	(0.02)	(0.02)
(Private PPG Debt/GDP)$_{t\text{-}1}$	0.06***	0.09***	0.04*
	(0.02)	(0.03)	(0.02)
Observations:	1,064	1,064	

Notes: Standard errors are in parentheses.
The subscript j refers to the category of debt. "β_{1j}" captures the average change in the log odds of entering default when the country is not in default. "$\beta_{1j} + \beta_{2j}$" captures the average change in the log odds of staying in default.
Other Controls: total number of defaults, duration since previous default, cubic splines in duration since previous default, country fixed effects, and year fixed effects
* denotes $p < 0.1$, ** denotes $p < 0.05$, *** denotes $p < 0.01$

Table 4: Public and Publicly Guaranteed Debt

Estimation Method: Logit	Dependent Variable: External default in Year t		
	Baseline:	**Alternative:**	
Explanatory Variable	β_j	β_{1j}	$\beta_{1j} + \beta_{2j}$
Panel A: PPG Debt Decomposed by Type			
(Short-term Debt/GDP)$_{t\text{-}1}$	0.12***	0.16**	0.10**
	(0.04)	(0.07)	(0.05)
(IMF Credit/GDP)$_{t\text{-}1}$	-0.05	0.09	-0.14**
	(0.07)	(0.08)	(0.06)
(Bilateral Debt/GDP)$_{t\text{-}1}$	0.07***	0.13***	0.03
	(0.02)	(0.04)	(0.03)
(Multilateral Debt/GDP)$_{t\text{-}1}$	-0.03	-0.16***	0.08*
	(0.03)	(0.05)	(0.04)
(Bonds/GDP)$_{t\text{-}1}$	0.01	0.14***	0.01
	(0.03)	(0.05)	(0.03)
(Commercial Bank Loans/GDP)$_{t\text{-}1}$	0.20***	0.33***	0.20***
	(0.04)	(0.07)	(0.06)
(Other Private Credits/GDP)$_{t\text{-}1}$	-0.02	-0.15*	-0.01
	(0.05)	(0.09)	(0.06)
Panel B: Official PPG Debt Decomposed			
(Short-term Debt/GDP)$_{t\text{-}1}$	0.12***	0.15**	0.10**
	(0.04)	(0.08)	(0.05)
(IMF Credit/GDP)$_{t\text{-}1}$	-0.04	0.15*	-0.13*
	(0.07)	(0.09)	(0.08)
(Nonconcessional Bilateral Debt/GDP)$_{t\text{-}1}$	0.02	0.11**	-0.02
	(0.03)	(0.05)	(0.04)
(Concessional Bilateral Debt/GDP)$_{t\text{-}1}$	0.18***	0.25***	0.17***
	(0.05)	(0.06)	(0.07)
(Nonconcessional Multilateral Debt/GDP)$_{t\text{-}1}$	-0.11**	-0.10	-0.08
	(0.05)	(0.07)	(0.10)
(Concessional Multilateral Debt/GDP)$_{t\text{-}1}$	-0.04	-0.27***	0.11
	(0.03)	(0.07)	(0.09)
(Bonds/GDP)$_{t\text{-}1}$	0.02	0.10**	0.04
	(0.03)	(0.05)	(0.04)
(Commercial Bank Loans/GDP)$_{t\text{-}1}$	0.21***	0.33***	0.23***
	(0.04)	(0.07)	(0.06)
(Other Private Credits/GDP)$_{t\text{-}1}$	-0.03	-0.16	0.06
	(0.05)	(0.10)	(0.07)
Observations:	1,064	1,064	

Notes: Standard errors are in parentheses.
The subscript j refers to the category of debt. "β_{1j}" captures the average change in the log odds of entering default when the country is not in default. "$\beta_{1j} + \beta_{2j}$" captures the average change in the log odds of staying in default.
Other Controls: total number of defaults, duration since previous default, cubic splines in duration since previous default, country fixed effects, and year fixed effects
* denotes $p < 0.1$, ** denotes $p < 0.05$, *** denotes $p < 0.01$

Chapter 2

The Impact of Sovereign Default on Economic Volatility

2.1 Introduction

The aim of this analysis is to empirically evaluate the impact of a sovereign default on the volatility of gross domestic product, where volatility of gross domestic product refers to the deviation of output from a long-run trend; the greater the deviation, the more volatility. This paper bridges the gap between two strands in the literature; one focused on the impact of sovereign default on output and another studying how volatility affects output. The first, still nascent, strand evaluates the impact of sovereign default on output. In one paper, Furceri et al. (2012) uses a panel of 154 countries from 1970 to 2008 to show that debt crises negatively affect output in both the short-term (by about 6 percentage points) and in the medium-term (by 10 percent after 8 years). Other studies, including Borenszstein and Panizza (2009) and Sturzenegger (2004), also show evidence of a negative impact of sovereign default on growth. This negative impact is not found universally, however; Levy-Yeyati and Panizza (2011) show evidence that economic growth recovers in the quarters immediately following a debt crisis.

The impact of sovereign default on output is typically attributed to three main channels. One channel is the exclusion from international capital markets. Gelos et al. (2011) and Richmond and Dias (2008) both find that countries are excluded from international capital markets for 4 years and 2.5-5.5 years, respectively. Increased cost of borrowing is the second channel. Borensztein and Panizza (2009) find, when compared to crisis-free periods, increased spreads of about 400 basis points immediately following a sovereign default. The third channel potentially responsible for the impact of sovereign default on output is international trade. This mechanism is studied by Rose (2005) who shows that after a sovereign default, bilateral trade is significantly reduced.

The second strand of literature related to this paper concerns the impact of volatility on growth. Though considerable attention has been paid to this relationship, there is little consensus whether volatility has a positive, negative, or neutral impact on growth. For instance, Mirman (1971) argues that higher volatility can lead to higher growth through a precautionary savings motive. Savings should be higher when faced with increased volatility, which results in higher investment. Black (1987) argues that choosing high-variance, high-expected return technology instead of the lower-variance, lower-expected return alternative would result in countries with higher growth having higher volatility. On the opposite side of the argument, Bernanke (1983) and Pindyck (1991) demonstrate that if investments are irreversible, increased volatility can lead to lower investment, and consequently, lower growth. Ramey and Ramey (1995) use a sample of 92 countries to empirically evaluate the link between volatility and growth, establishing a negative link. It is possible that volatility has no impact on growth. Lucas (1987) posits that there is little to be gained from understanding business cycles due to the classical dichotomy, that business-cycle volatility is unrelated to growth.

Based on the related literature, it is reasonable to assume that there is some relationship between sovereign default and volatility. Figure 1, which plots a 5-year rolling standard deviation in the cycle over time, shows evidence of this relationship. During sovereign default episodes, which are represented by the shaded regions, there are large increases, followed by sharp decreases in the volatility of the economic cycle. The average standard deviation in non-default times is clearly less than 2, while during default episodes the standard deviation surges in excess of 4. This plot suggests that in the preceding and early years of a sovereign default, volatility increases, supporting the findings of Catão and Sutton who show that "countries with historically higher macroeconomic volatility are more prone to default." As can be seen in Figure 1, the volatility declines sharply prior to the country exiting default. This decrease in volatility toward the end of the default episode and in the default-free period following is the primary focus of this paper. To my knowledge, the relationship between sovereign default episodes and future volatility has not been studied, allowing for this paper to uniquely contribute to the existing literature.

This paper finds evidence of a highly statistically significant impact of sovereign default on economic volatility. In a sample of 7 South American countries from 1870 until 2008, the impact of sovereign default negatively impacts future volatility. Specifically, the presence of a sovereign default episode in the previous years is strongly associated with a decreased volatility. This could be a result of reduced capital inflows from foreign investors, lending support to the current explanation that countries lose access to international capital markets.

In addition to addressing the primary question of how sovereign defaults impact future economic volatility, I also perform a basic evaluation of the impact of volatility on economic growth. The considerable longitudinal dimension of the dataset allows for an investigation that begins decades prior to the start of many studies included in the recent literature on this topic. For the entire time period, from 1870 until 2008, I find economic volatility is positively associated with economic growth, lending support to Mirman (1971) and Black (1987). This impact, however, appears to be driven by the time period from

1870 until 1959. From 1960 until 2008, I find that volatility has no impact on economic growth. One possible explanation for this neutral effect is offered by Lucas (1987), that business-cycle volatility is unrelated to growth. However, it is also possible that, at least to some extent, both those who believe in the positive relationship between volatility and growth and those who feel the impact is negative are actually correct. In other words, if the increases in growth attributable to volatility (e.g., choosing high-variance, high expected return projects) are offset by decreases in growth also attributable to volatility (e.g., irreversible investments decrease investment when volatility is high).

This paper is organized as follows. Section 2.2 will discuss the Beveridge-Nelson decomposition, including its relevance to this analysis. Section 2.3 will discuss the empirical strategy. Section 2.4 will describe the data. Section 2.5 will evaluate the results. Section 2.6 will conclude.

2.2 Beveridge-Nelson Decomposition

As the focus of this paper is to evaluate the impact of a sovereign default on volatility, it is crucial to specifically define what is meant by volatility. In this paper, volatility refers to the magnitude of fluctuations in economic activity. These fluctuations stem from different sources, including long-run growth and the business cycle. Though a number of definitions exist for the business cycle, this paper will consider a business cycle to be "the transitory fluctuation of the economy away from a long-run, or trend, level," following Morley and Piger (2011). For my purposes, economic volatility will simply be the variance of the cyclical component of gross domestic product. However, even a simple definition brings up an important question: How exactly is this cyclical component determined? Gross domestic product, y_t, can be decomposed into two components: the trend, or long-run level and the cyclical component, or the fluctuation in output around the trend. The decomposition employed by this paper will follow one approach outlined by Morley and Piger (2011). Following this output-gap definition of the business cycle, gross domestic product can be represented as:

$$y_t = \tau_t + c_t \tag{7}$$

$$\tau_t = \mu + \tau_t - 1 + \eta \tag{8}$$

$$_t = \sum_{j=0}^{\infty} \Psi_j \omega_{t-j}^* \tag{9}$$

where $\Psi_0 = 1$ and $\omega_{t-j}^* = \bar{\omega} + \omega_t$. η_t and ω_t follow martingale difference sequences. The trend component, τ_t, is considered permanent in that the effects of realized innovations, η_t, are expected to last indefinitely. c_t is the cyclical, or transitory component and μ and $\bar{\omega}$ allow for nonzero means in the trend and cycle, respectively. Though it is possible for a nonzero mean in the cyclical component, the standard identification assumption is that $\bar{\omega} = 0$.

Several methods are available for isolating the cyclical component from the trend. For instance, one could employ a mathematical filter, such as Hodrick-Prescott or Baxter-King. Such filters, however, rely on theory that, while applicable to stationary time series, can be problematic when applied to non-stationary time series such as GDP (Nelson 2008). For instance, Cogley and Nason (1995) demonstrates that the Hodrick-Prescott filter generates business cycles in data where no cycles are present. Murray (2003) shows a similar result using the Baxter-King filter. To avoid issues surrounding the use of these filters to non-stationary data, I will instead employ the Beveridge-Nelson decomposition, outlined in their 1981 paper. The Beveridge-Nelson trend is the minimum mean squared error forecast of the long-horizon level of the series, less any deterministic drift. Represented mathematically, the Beveridge-Nelson trend is:

$$\hat{\tau}_t \equiv \lim_{j\to\infty}\{E^M[y_{t+j}|\Omega_t] - j \cdot E^M[\Delta y_t]\} \tag{10}$$

where $E^M[\cdot]$ is the expectations operator for an assumed forecasting model and Ω_t contains all information available at time t. The cycle of the series is simply the deviation of from the trend or:

$$c_t = y_t - \tau_t \tag{11}$$

and is shown by Beveridge and Nelson (1981) to be a stationary process with zero mean.

Since the Beveridge-Nelson decomposition relies on an assumed forecasting model, this assumption deserves additional consideration. Though one could simply assume an autoregressive model for the first differences and impose this structure on the data for every country. For example, it could be assumed that every country's gross domestic product follows an autoregressive process of order 2. However, it is likely that an autoregressive model of order 2 is not a good fit for any country, let alone for all countries. Following Morley and Piger (2011), I consider autoregressive models for the first differences of y_t:

$$\phi(L)(\Delta y_t - \mu) = e_t \tag{12}$$

where $\phi(L)$ is pth order and p ranges from 0 to 12. The autoregressive models considered in this paper are assumed to have Gaussian errors ($e_t \sim (0, \sigma_e^2)$). The optimal number of lags to be included in the autoregressive model is determined using the Akaike information criteria defined as in Davidson and MacKinnon (2004) where log-likelihood measures the goodness of fit with a penalty imposed based on the number of parameters.

2.3 Empirical Strategy

The primary question addressed in this study is, "what is the impact of a sovereign default on future economic volatility?" Though economic volatility can refer to several variables (e.g., inflation, the exchange rate, terms of trade), volatility is defined in this paper as the magnitudes of deviations of gross domestic product from its long-horizon trend. Specifically, I define volatility as the one-year variance of the Beveridge-Nelson cycles derived following the process described above. To evaluate the impact of sovereign default on economic volatility, I estimate the following equation:

$$y_{it} = \alpha + \beta * default_{i,(t-1\ to\ t-3)} + X_{it} * \gamma \tag{13}$$

where y_{it} is the variance of the Beveridge-Nelson cycle, *default* is a moving average of sovereign default episodes from period $t-1$ to $t-3$, and X_{it} is a matrix of control variables. The *default* variable is constructed as:

$$default_{i,(t-1\ to\ t-3)} = \frac{[default_{i,t-1} + default_{i,t-2} + default_{i,t-3}]}{3} \tag{14}$$

where the default variable is binary and takes the value of 1 if the country i is in default in year t and 0 otherwise. β from equation 14 measures the impact on volatility in period t from sovereign default(s) experienced in the preceding 3 years. A positive value of β corresponds to an increase in volatility following one to three of the previous years in a state of default and is the coefficient of interest for this analysis.

Experiencing a sovereign default is certainly not the only thing that impacts gross domestic product, and consequently, its volatility. Controlling for other factors is necessary to isolate the impact of the sovereign default on future volatility. Lucas (1988) notes that the growth rates of developing countries is more likely to exhibit sharper fluctuations than those experienced by developed countries. I use the level of income per capita in period $t-1$ to control for the differences in the level of development. Since countries at higher levels of gross domestic product per capita typically experience less volatility in their growth, this control helps disentangle the impact of a country's volatility due to a relative income disparity from that caused by a sovereign default.

Another factor that potentially affects growth is discussed in Reinhart and Rogoff (2010), who find that at higher levels of debt relative to gross domestic product growth rates fall. If gross domestic product grows at a slower rate then it is likely volatility will also be affected. Thus, it is important to control for a country's debt obligations. In this study, I control for the country's central government debt as a percentage of their gross domestic product. Countries that experience high volatility in one year, or for several years, are likely to experience volatility in future years. To control for the influence of volatility in the previous years, I include a 3-year, backward moving average of the volatility variable.

Sovereign default episodes typically occur in waves and often affect entire regions. To address this issue, I focus only on countries included in South America. While it is possible to extend this analysis directly to include countries in Western Europe, a lack of sovereign default episodes limits the usefulness of cross-region comparison. [3]

2.3.1 Volatility and Default

While this paper inspects the relationship between sovereign default episodes and future volatility, it is important to also consider how past volatility affects the likelihood of experiencing a sovereign default. Catão and Sutton (2002) show that aggregate volatility is positively related to the probability of experiencing a sovereign default. I perform a basic investigation of this relationship between past volatility and the probability a country is in default using:

$$default_{it} = \alpha + \beta * y_{i,(t-1\ to\ t-3)} + X_{it} * \gamma \tag{15}$$

where *default* is binary and takes the value of 1 if the country i is in default in year t, y is the 3-year backward moving average of volatility of output, as defined above, and X_{it} is a matrix of control variables.

To control for differences in the probability of experiencing a default driven by differences

[3] For the 7 countries in Western Europe who had data available for the entire 1870-2008 period, only 10 default episodes occur with half occurring as a result of World War II.

in income, I include the natural log of gross domestic product per capita in the matrix of control variables. Several papers have shown that the level of sovereign debt held by the central government is positively associated with the probability of experiencing a default (see Reinhart and Rogoff (2011) and Hunt (2014)). Thus, in addition to including the level of income, I also add a control for the level of central government debt owed by the country.

2.3.2 Volatility and Growth

As section 1 of this paper details, there is considerable discrepancy in the impact of economic volatility on output growth. Considering the dataset used in this paper already contains enough relevant variables to investigate this relationship between growth and volatility, it only seems natural to offer an additional perspective to the literature. To accomplish this, I first define output growth as the first difference of the natural log of gross domestic product per capita or:

$$\Delta Y_t = Y_t - Y_{t-1} \tag{16}$$

where Y_t is the natural log of gross domestic product in period t.

I estimate the impact of economic volatility on future economic growth using:

$$\Delta Y_{it} = \alpha + \beta * y_{i,(t-2\ to\ t-4)} + X_{it} * \gamma \tag{17}$$

where $y_{t-2\ to\ t-4}$ is defined as the 3-year backward moving average of the variance of the

Beveridge-Nelson cycle and X_{it} is a matrix of controls including the log of gross domestic product per capita in period $t-2$ and the level of central government debt relative to gross domestic product, also in period $t-2$.

One of the goals for this part of the analysis is to take advantage of the extensive longitudinal dimension of the data. Several studies in the literature concerning the impact of volatility on growth (e.g, Ramey and Ramey (1995) and Aghion et al. (2005)) use data going back no further than 1960. Using the Maddison data allows me to look at a much longer time period, from 1870 until 2008. In addition to evaluating this relationship for the entire time period, I am able to look at separate time periods including from 1870-1959 and from 1960-2008.

2.4 Data

The data used for this analysis includes 7 countries from South America spanning 1870-2008. This dataset draws from two sources: The Maddison Project, an updated version of the original Maddison dataset, and the dataset used by Reinhart and Rogoff in their 2011 paper, "From Financial Crash to Debt Crisis." The primary variables employed by this analysis are gross domestic product and sovereign default episodes.

For the measures of gross domestic product, I use data from the Maddison Project. This dataset has measures of, gross domestic product, population, and gross domestic product per capita for more than 180 countries. All observations are recorded at an annual frequency. Though there is data for some countries from more than two-thousand years ago, this analysis will focus on the period from 1870 until 2008. The countries included in this analysis are Argentina, Brazil, Chile, Colombia, Peru, Uruguay, and Venezuela, all of which are emerging economies in South America. The primary reasoning behind choosing these 7 countries is twofold. First, the gross domestic product data is available for every year from 1870 until 2008, providing a larger longitudinal dimension. Second, due to the increased sensitivity of emerging economies to financial and economic shocks, this set of countries experiences a considerable number of default episodes. Specifically, 47 total sovereign default episodes occurred in these 7 countries between 1870 and 2008. The average default episode lasts 5.5 years, with the longest lasting 21 years and the shortest lasting one year.

The data on sovereign default episodes is the same employed by Reinhart and Rogoff (2011) and comes from several Standard and Poor's Studies augmented by information from Lindert and Morton (1989), Suter (1992), and Tomz (2007). According to Standard and Poor's, a default is defined as either an outright default (i.e., a country failing to make a payment on their debt or principal prior the expiration of the grace period) or after a renegotiation of the debt into terms less favorable to the lender. A recent example of a debt restructuring is that of Greece in 2012. Though Greece never technically missed a payment, the restructuring of its debt is still considered a sovereign default under Standard and Poor's definition. A sovereign default ends when "a settlement occurs and no further near-term resolution of creditor's claims in likely" (Beers and Chambers, 2006). All observations in this dataset are at the annual frequency. A major advantage to using the Reinhart and Rogoff (2011) data on sovereign defaults is the considerable longitudinal dimension. This dataset spans from 1824 until 2010, much farther back in time than the Maddison data that is used for this analysis. The richness of this dataset provides sovereign default observations that correspond to the gross domestic product data for every country in every year from 1870 until 2008.

The Reinhart and Rogoff dataset also provides measures of central government debt relative to gross domestic product. These data are measured in percentages. Unfortunately for several countries, the measures of central government debt relative to gross domestic product are unavailable. To allow for comparison across specifications, all observations that did not include the full set of variables (i.e., gross domestic product, sovereign default episodes, and central government debt relative to gross domestic product) have been dropped from the dataset.

2.5 Results

In this section, I will discuss the results from the three specifications detailed in section 2.3. The first specification, which is estimated using equation 13 evaluates the impact of sovereign default(s) experienced in the previous 3 periods on the volatility in the current period. Table 5 contains the results from this estimation. Column 1 of Table 5 is reports the impact of past default on current volatility, absent of any additional controls. The impact of default is negative and significant at the 5% level, suggesting that economic volatility is negatively impacted following sovereign default.

Other factors aside from previous defaults are related to the volatility of the cycle. Ramey and Ramey (1995) show evidence of statistically significant relationship between volatility and growth. Thus, anything that affects growth is likely to also affect volatility.

Lucas (1988) shows evidence that fluctuations in growth rates tend to be greater for lower income countries. To account income disparities, I include gross domestic product per capita, in logs. Reinhart and Rogoff (2010) find that economic growth slows when countries have higher levels of debt relative to gross domestic product. The second column of Table 5 reports the impact of previous default on current volatility while controlling for both gross domestic product per capita and central government debt relative to income. The negative relationship between past sovereign default and economic volatility is greater in both magnitude and significance after including these additional controls.

It is reasonable to assume that a country's volatility is persistent over time, at least to some extent. Typically countries experiencing high volatility in one year are likely to experience high volatility in the near future. To account for the potential persistence of high volatility eras, I include a 3-year backward moving average of volatility measure, variance in the cycle. Column 3 reports the impact of past sovereign default on current volatility after controlling for previous cycles in addition to gross domestic product per capita and the level of central government debt relative to gross domestic product. The impact of previous sovereign default, relative to the previous columns, is more negative and significant at the 1% level.

The negative relationship between sovereign default and volatility is consistent with the literature on sovereign default and output, as well as on volatility and output. One reasonable explanation for the change in volatility concerns access to international capital markets. As expectations of a country's impending default are formed, investors are less likely to lend, resulting in a decreased level of investment. Considering that defaults often result following a negative shock, the impact on gross domestic product in exacerbated by this lack of access to foreign capital, resulting in increased volatility. After suffering a default, and settling or renegotiating its debts, the country is able to move forward in a less volatile environment. This reasoning is also consistent with a negative relationship between economic volatility and economic growth. When a country is on the verge of default, and experiencing high economic volatility, they are also typically growing more slowly. After the default occurs, and volatility decreases, the country is able to grow again at a quicker pace than during the higher volatility period.

2.5.1 Volatility and Default

As I have shown in Table 5, there is a decrease in volatility following sovereign default. The results presented to this point only evaluate the impact of sovereign default on future volatility, telling only one side of the story. As other studies have demonstrated, economic volatility also affects the likelihood that a country experiences a default. To evaluate the impact of economic volatility on the probability of default, I estimate Equation 15, reporting the results in Table 6. For the estimates reported in column 1, I find that the impact of volatility in the preceding three years is positively related to the likelihood of a country experiencing a sovereign default when no controls are included. This result is significant at the 1% level. After including controls for gross domestic product per capita and debt relative to gross domestic product, the associated impact of economic volatility on default remains positive and highly significant. This positive relationship between economic volatility and sovereign default is consistent with Catão and Sutton (2002) who show that countries that experience higher macroeconomic volatility are more likely to suffering a sovereign default.

In addition to supporting the existing literature on this topic, evaluating the impact of volatility on sovereign default also serves to more accurately characterize the dynamic relationship between these two economic features. A higher level of volatility typically precedes a country's decision to default on its debt obligations. Once the default has occurred, and the country is able to settle or renegotiate their debt, the volatility of the economy decreases. This dynamic evolution is illustrated in Figure 2.6. In the early years of the longer default episodes, there are clear spikes in the average volatility for the preceding 5 years. In the later years of each episode, the volatility declines sharply and remains relatively low during the default-free years that follow.

2.5.2 Volatility and Growth

The literature surrounding the impact of volatility on growth is filled with discord. Some researchers, such as Mirman (1971) and Black (1987) support a positive relationship between volatility and growth while others, such as Bernanke (1983), Pindyck (1991), and Ramey and Ramey (1995) detail how the relationship could be negative. Still others, see Lucas (1987) believe there is no relationship between the two. While their arguments one way or another are compelling, the lack of consensus suggests that the results are sensitive to the strategy implemented for evaluating the relationship between volatility and growth. The dataset used in this paper provides an opportunity to provide an additional perspective on this debate. With data going back to 1870, I am able to evaluate the impact of volatility on growth over a much longer horizon.

Table 7 reports the results from estimating equation 17. I evaluate the entire sample period, from 1870-2008, as well as subsamples from 1870-1959 and 1960-2008. I choose the break at 1960 as numerous studies use the post 1960 years for their analyses. In column 1 of each panel, the impact of volatility on growth is evaluated without any additional controls. In column 2, controls for gross domestic product per capita and the level of debt relative to gross domestic product are included.

When considering the entire sample period, volatility is positively related to future growth. This result is consistent even when the additional controls (i.e., gross domestic product per capita and debt relative to gross domestic product) are included. The estimates reported in Panel B, which focuses on the years 1870 until 1959, indicate that the positive relationship between volatility and growth is being driven by the earlier portion of the sample. From 1870-1959, the impact of volatility on future growth is positive and significant when no controls are present as well as when controls are included. The final panel, Panel C, shows that from 1960-2008, there is no significant relationship between volatility and growth.

On the surface, these findings appear to lend support to Mirman (1971) and Black (1987) that volatility positively impacts growth, potentially through a precautionary savings motive or the selection of higher-volatility, higher-return investment decisions. With regard to Panel C, it is also possible that my findings support an independence of business cycles and growth suggested by Lucas (1987). However, it is also reasonable that both positive and negative forces are at work. If both positive and negative forces are present, the aggregate result will be driven by the force that dominates. If neither force is dominant, it is possible that there could be no effect. The limited cross-sectional element of this dataset also poses a potential issue. With only 7 countries, all of which are from the same region, it is hard to argue that this result has much external validity. The point of this exercise is not to attempt to lend definitive support to one side of the debate, but rather to highlight the sensitivity of the results to a number of factors.

2.6 Conclusion

Using a dataset of 7 South American countries from 1870-2008, I have shown evidence of a negative relationship between sovereign default and future economic volatility, where volatility refers to deviations of gross domestic product from their long-horizon trend. I find the negative relationship is robust to, and actually strengthened by, the inclusion of controls. This paper contributes to the existing literature by providing a bridge between two separate, but related, strands: one focused on the impact of sovereign default on output and another concerning the impact of volatility on output.

In addition to evaluating the impact of sovereign default on future volatility, I am also able to study the impact of volatility on economic growth. I show evidence that the results in the current literature are potentially sensitive to a number of factors, including the choice of countries and years analyzed. Specifically, I find a positive relationship between economic volatility and economic growth from 1870-2008. After splitting the sample into two time periods, 1870-1959 and 1960-2008, I find that the earlier sample period appears to be driving the positive relationship between volatility and growth when the entire sample is considered. For the later sample, from 1960-2008, there is no statistically significant relationship between economic volatility and future economic growth.

The techniques and data employed in this analysis offer an alternative to those commonly found in the literature. Use of the Beveridge-Nelson decomposition, for instance, addresses potential issues encountered by the use of other available trend-cycle decomposition methods, such as the Hodrick-Prescott and the Baxter-King filters. The dataset created for this analysis, which combines the Maddison data with the sovereign default data used by Reinhart and Rogoff (2011) allows for a much longer time horizon for each cross-sectional element. This investigation provides a unique perspective into topics surrounding sovereign default, volatility, and economic growth by taking advantage of the dataset's considerable longitudinal dimension.

A number of potential directions for future research exist. One such avenue could be a simple redefining of the dataset to include more countries. To do so would require a decrease in the number of available years (assuming no additional gross domestic product data becomes available in the near future), but could potentially allow for an increased level of confidence in the external validity of this analysis. The inclusion of additional variables to capture, empirically, the specific channels through which default affects volatility would allow for a more detailed characterization of the relationship. Though this research has many possible extensions, it provides a solid foundation for the existence of a link between sovereign default and future volatility.

References

[1] Aghion, Philippe, George-Marios Angeletos, Abhijit Banerjee, and Kalina Manova. 2005. "Volatility and Growth: Credit Constraints and Productivity-Enhancing Investment." National Bureau of Economic Research Working Papers 11349.

[2] Beers, Daveid, and John Chambers. 2006. "Sovereign Defaults at 26-Year Low, To Show Little Change in 2007." *Standard & Poor's Commentary*, September 18.

[3] Bernanke, Ben S. 1983. "Irreversibility, Uncertainty, and Cyclical Investment." *Quarterly Journal of economics* 98, 85-106.

[4] Beveridge, Stephen, and Charles R. Nelson. 1981. "A New Approach to Decomposition of Economic Time Series into Permanent and Transitory Components with Particular Attention to Measurement of the Business Cycle. *Journal of Monetary Economics* 7, 151-174.

[5] Black, Fischer. 1987. *Business Cycles and Equilibrium.* Cambridge, MA: Blackwell.

[6] Bolt, J. and J. L. van Zanden. 2013. The First Update of the Maddison Project; Re-Estimating Growth Before 1820. Maddison Project Working Paper 4.

[7] Borensztein, Eduardo and Udo Panizza. 2009. "The Costs of Sovereign Default." IMF Staff Papers 56, 683 741.

[8] Catão, Luis, and Bennett Sutton. 2002. "Sovereign Defaults: The Role of Volatility." IMF Working Paper.

[9] Cogley, Timothy, and James Nason. 1995. "Effects of the Hodrick-Prescott Filter on Trend and Difference Stationary Time Series: Implications for Business Cycle Research. /emphJournal of Economic Dynamics and Control 19, 253-278.

[10] Davidson, Russell, and James G. MacKinnon. 2004. *Econometric Theory and Methods.* New York: Oxford University Press.

[11] Eaton, Jonathan, and Mark Gersovitz. 1981. "Debt with Potential Repudiation: Theoretical and Empirical Analysis." *The Review of Economic Studies* 48(2), 289-309.

[12] Furceri, Davide, and Aleksandra Zdzienicka. 2012. "How Costly are Debt Crises?" *Journal of International Money and Finance* 31, 726-742.

[13] Gelos, G., Ratna Sahay, and Guido Sandleris. 2011. "Sovereign Borrowing by Developing Countries: What Determines Market Access?" *Journal of International Economics* 83, 243-254.

[14] Hunt, Jarrod E. 2014. "Debt, Default, and Disaggregation." https://docs.google.com/file/d/0B2K2eyzvd2TITmM0YXVlaE5wTTg/edit.

[15] Levy Yeyati, Eduardo, and Ugo Panizza. 2011. "The Elusive Costs of Sovereign Defaults." *Journal of Development Economics* 94, 95-105.

[16] Lindert, Peter H., and Peter J. Morton. 1989. "How Sovereign Debt Has Worked." In *Developing Country Debt and Economic Performance Volume 1 the International Financial System*, ed. J.D. Sachs, 30-106. Chicago:University of Chicago Press.

[17] Lucas, Robert. 1987. *Models of Business Cycles.* Oxford: Blackwell.

[18] Lucas, Robert. 1988. "On the Mechanics of Economic Development." *Journal of Monetary Economics.* 22, 3-42.

[19] Mirman, Leonard. 1971. "Uncertainty and Optimal Consumption Decisions." *Econometrics* 39, 179-185.

[20] Morley, James, and Jeremy Piger. 2011. "The Asymmetric Business Cycle." *The Review of Economics and Statistics* 94, 208-221.

[21] Murray, Christian J. 2003. "Cyclical Properties of Baxter-King Filtered Time Series." *The Review of Economics and Statistics* 85, 472-476.

[22] Nelson, Charles R. 2008. "The Beveridge-Nelson Decomposition in Retrospect and Prospect." *Journal of Econometrics* 146, 202-206.

[23] Pindyck, Robert S. 1991. "Irreversibility, Uncertainty, and Investment." *Journal of Economic Literature* 29, 1110-1148.

[24] Ramey, Garey, and Valerie A. Ramey 1995. "Cross-country Evidence on the Link Between Volatility and Growth." *The American Economic Review* 85, 1138-1151.

[25] Reinhart, Carmen M., and Kenneth S. Rogoff. 2010. "Growth in a Time of Debt." *American Economic Review: Papers & Proceedings* 100, 573-578.

[26] Reinhart, Carmen M., and Kenneth S. Rogoff. 2011. "From Financial Crash to Debt Crisis." *American Economic Review* 101, 1676-1706.

[27] Richmond, Christine, and Daniel A. Dias. 2008. "Duration of Capital Market Exclusion: Stylized Facts and Determining Factors." http://personal.anderson.ucla.edu/christine.richmond/Marketaccess_0808.pdf.

[28] Rose, Andrew K. 2005. "One Reason Countries Pay Their Debts: Renegotiation and International Trade." *Journal of Development Economics* 77, 189-206.

[29] Sturznegger, Frederico. 2004. "Toolkit for the Analysis of Debt Problems." *Journal of Restructuring Finance* 1, 201-203.

[30] Suter, Christian. 1992. *Debt Cycles in the World-Economy: Foreign Loans, Financial Crises, and Debt Settlements, 1820-1990*. Boulder, CO: Westview Press.

[31] Tomz, Michael. 2007. *Reputation and International Cooperation: Sovereign Debt across Three Centuries*. Princeton, NJ: Princton University Press.

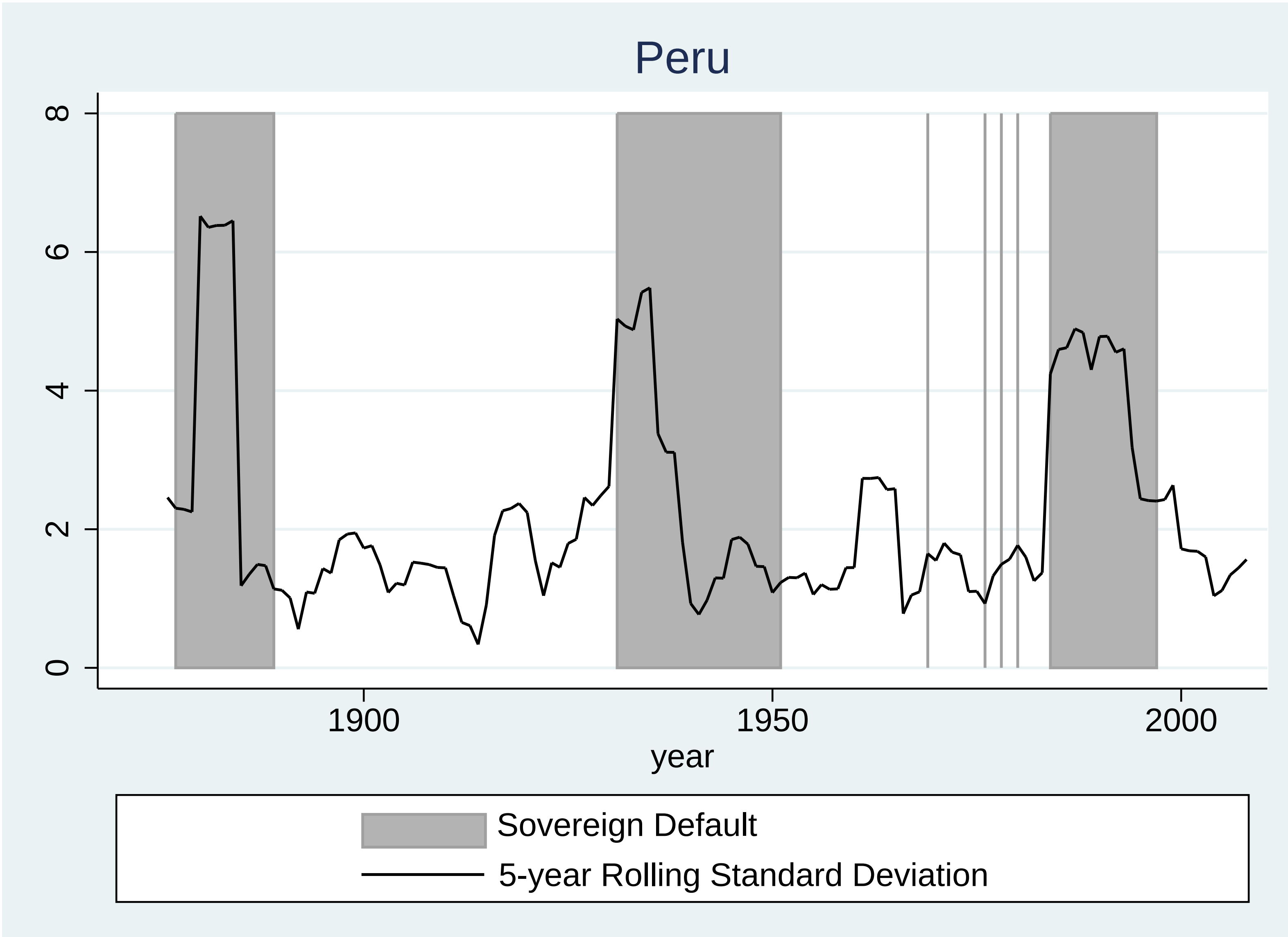

Figure 5: Rolling 5-year Standard Deviation

Table 5: Impact of Default on Future Volatility

Estimation Method: OLS	Dependent Variable: Variance of Cycle in Year t		
Explanatory Variable	(1)	(2)	(3)
Default ($t-1$ to $t-3$)	**-4.49****	**-7.49*****	**-8.35*****
	(2.10)	(2.18)	(2.00)
GDP Per Capita (In logs) ($t-1$)	–	0.03**	0.01
		(0.01)	(0.01)
Debt/GDP ($t-1$)	–	0.14***	0.10***
		(0.03)	(0.03)
Variance of Cycle ($t-1$ to $t-3$)	–	–	0.52***
			(0.04)
Constant	13.28***	-12.97	-4.10
	(1.01)	(9.09)	(8.36)
Observations:	829	829	829

Notes: Standard errors are in parentheses.
* denotes $p < 0.1$, ** denotes $p < 0.05$, *** denotes $p < 0.01$

Table 6: Impact of Volatility on Probability of Default

Estimation Method: OLS	Dependent Variable: Default in Year t	
Explanatory Variable	(1)	(2)
Standard Deviation of Cycle ($t-1$ to $t-3$)	**0.02*****	**0.01****
	(0.01)	(0.01)
GDP Per Capita (In logs) ($t-1$)	–	0.00
		(0.00)
Debt/GDP ($t-1$)	–	0.01***
		(0.00)
Constant	0.20***	0.23
	(0.02)	(0.15)
Observations:	829	829

Notes: Standard errors are in parentheses.
* denotes $p < 0.1$, ** denotes $p < 0.05$, *** denotes $p < 0.01$

Table 7: Impact of Volatility on Future Growth

Estimation Method: OLS	Dependent Variable: Δ(GDP Per Capita)$_t$	
Explanatory Variable	(1)	(2)
Panel A: 1870-2008		
Variance of Cycle ($t-2$ to $t-4$)	**0.04*****	**0.04*****
	(0.01)	(0.01)
GDP Per Capita (In logs) ($t-2$)	–	-0.01**
		(0.00)
Debt/GDP ($t-2$)	–	0.00
		(0.01)
Constant	1.34***	6.68***
	(0.25)	(2.31)
Observations:	807	807
Panel B: 1870-1959		
Variance of Cycle ($t-2$ to $t-4$)	**0.04*****	**0.05*****
	(0.01)	(0.01)
GDP Per Capita (In logs) ($t-2$)	–	-0.01**
		(0.01)
Debt/GDP ($t-2$)	–	-0.02*
		(0.01)
Constant	1.31***	11.80***
	(0.37)	(4.01)
Observations:	495	495
Panel C: 1960-2008		
Variance of Cycle ($t-2$ to $t-4$)	0.02	0.00
	(0.02)	(0.03)
GDP Per Capita (In logs) ($t-2$)	–	-0.02***
		(0.01)
Debt/GDP ($t-2$)	–	0.03**
		(0.01)
Constant	1.47***	16.35***
	(0.33)	(5.82)
Observations:	312	312

Notes: Standard errors are in parentheses.
* denotes $p < 0.1$, ** denotes $p < 0.05$, *** denotes $p < 0.01$