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Debt Sustainability in Low-Income Countries: Policies, Institutions, or Shocks?

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Debt Sustainability in Low-Income Countries: Policies, Institutions, or Shocks?

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Abstract

This paper estimates the determinants of external debt distress in low-income countries (LICs), disentangling the roles of institutions, shocks, and policies. The most prominent factors in raising the risk of debt distress are the weak protection of private property rights, adverse shocks to real non-oil commodity prices, and a high debt burden. Results also suggest that weak economic institutions tend to raise the probability of debt distress through persistently weak economic policies and high vulnerability to external shocks. The model enables a more granular analysis of debt sustainability in LICs and has a higher predictive power compared to the earlier scant literature.

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I. INTRODUCTION

Despite waves of debt relief for more than three decades, many low-income countries (LICs) experienced prolonged periods of debt distress, a legacy of the sovereign debt crises that started in the late 1970s and 1980s. Official creditors only gradually recognized the problem of unsustainable debt in LICs. Early on, Paris Club (PC) creditors used mainly nonconcessional "flow reschedulings" to address short term liquidity problems, while failing to tackle the solvency issue at the core.[2] Over time, PC rescheduling evolved to more complex mechanisms aiming to reduce the present value of debt in LICs, which led to increasingly concessional rescheduling terms.[3] Finally, in 1996, the Heavily Indebted Poor Countries (HIPC) Initiative included, for the first time, debt relief on amounts owed to multilateral institutions.[4] During 2000-2015, of the 39 countries eligible or potentially eligible for HIPC Initiative assistance, 36 received full and irrevocable reductions in their external debt. In the aftermath of the debt relief granted under the HIPC Initiative, public debt ratios declined considerably in LICs.[5]

Obviously the pivotal question is how/why these LICs became heavily indebted. Easterly (2001) suggests that growth implosions played an important role in the LIC debt crises. Several studies recognize that repeated debt relief is not a panacea for restoring debt sustainability and that debt distress in LICs might be related to factors hindering sustained economic growth.[6] This paper aims to identify the determinants of debt distress in LICs.[7] The key objective is to look beyond traditional debt burden and liquidity indicators, and examine the effects of various factors closely associated with the long-term growth performance of LICs, including economic institutions, macroeconomic policies, and vulnerability to external shocks.

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[2] Daseking and Powell (1999) present the history of the LIC debt crisis against the backdrop of various debt relief initiatives launched since 1987 to deal with official debt. From 1976 to 1988 the Paris Club agreed upon 81 nonconcessional flow reschedulings with 27 of the countries now identified as HIPCs.

[3] These terms are labelled as Toronto (1988), London (1990), and Naples (1994) terms, which reduced net present value of debt by 33, 50, and 67 percent respectively.

[4] The HIPC Initiative was enhanced to provide faster, deeper and broader debt relief in 1999, and complemented in 2005 by the Multilateral Debt Relief Initiative (MDRI). PC creditors granted Lyon (1996) and Cologne (1999) terms (with 80 and 90 percent reduction in net present value of debt respectively) in the context of concerted action by all creditors under the HIPC initiative.

[5] IMF (2014).

[6] Arslanalp and Henry (2006), Easterly (2001, 2002 and 2005), Rajan (2005), Asideu (2003), Presbitero (2009), Chauvin and Kraay (2005).

[7] Debt distress is identified by the presence of (i) arrears on the external debt exceeding a certain threshold; (ii) Paris Club debt restructuring or rescheduling; or (iii) Substantial amount of IMF lending for urgent financing needs.

The vast empirical literature on the determinants of debt crisis focuses mainly on middle income countries (MICs), or mixed samples of LICs and MICs.[8] This literature finds that the probability of a debt crisis is positively associated with higher levels of total debt and higher shares of short-term debt, and negatively associated with GDP growth and the level of international reserves. As for the structural variables, defaults are related to more volatile and persistent output fluctuations, less trade openness, weaker institutions, income inequality, and a previous history of defaults.

Empirical estimation of the determinants of debt distress among LICs has received little attention. Only Kraay and Nehru (2006, KN henceforth) look into the determinants of debt distress specifically for LICs. Using probit regressions to explain the likelihood of debt distress, they find that debt burden, quality of institutions and policies, and shocks that affect real GDP growth are highly significant predictors of debt distress, and that their relative importance differs between LICs and MICs. The findings of this influential paper played a pivotal role in shaping the lending strategies of multilateral concessional creditors such as the World Bank and the International Monetary Fund (IMF), particularly by shifting the focus of the Debt Sustainability Framework (DSF) introduced in 2005 from pure debt burden indicators to quality of policies and institutions.[9] The DSF is a framework for conducting debt sustainability analysis (DSA) in LICs by analyzing the country's projected debt burden over the next twenty years along with its vulnerability to shocks to assess the risk of debt distress in reference to five debt thresholds. Despite some relatively minor revisions over the years, the KN panel probit regressions remain the backbone of the analytical framework that justifies the policy-dependent debt thresholds underpinning the DSF's rule-based approach (Appendix I).[10]

One of the main premises of this paper is that some LICs would be fundamentally more vulnerable to debt distress because of their weak economic institutions. The impact of weak institutions would likely be transmitted through the weak quality of macroeconomic policies as well as economic structures that are highly exposed to adverse external shocks, which eventually hinder sustained economic growth. It is important to note that the extensive literature on debt overhang theory looks into reverse causality, i.e., the effect of debt on growth. Krugman (1988) and Sachs (1986) argue that a high level of debt reduces the supply of new loans by scaring off creditors, and also acts like a high marginal tax on investment. Private investors fear that the debt will eventually be repaid by levying extra taxes on corporations. Similarly, government investment is discouraged because the returns largely go

[8] See Panizza, Sturzenegger, and Zettelmeyer (2009) for a comprehensive survey. This literature includes Cline (1985); McFadden et al. (1985); Berg and Sachs (1988); Detragiache and Spilimbergo (2001); Catão and Sutton (2002); Manasse, Roubini, and Schimmelpfennig (2003); Reinhart, Rogoff, and Savastano (2003); Van Rijckeghem and Weder (2009); Kraay and Nehru (2006); Kruger and Messmacher (2004); Kohlscheen (2007, 2010); and Pescatori and Sy (2007).
[9] IMF and the World Bank (2004).
[10] IMF and the World Bank (2010, 2012, 2013).

to service debt. Furthermore, some studies report a negative correlation between debt and growth in LICs, at least above a certain threshold level.[11]

Rajan (2005) does not consider these arguments compelling for LICs owing to the existence of more significant impediments to investment, such as a discouraging business climate and uneven regulation. Moreover, as opposed to middle income countries, resource flows to LICs have not been reduced because of excessive debt since official creditors have continued to provide new concessional financing.[12] Therefore, he argues that the causality could run from low growth to high debt in that countries with weak growth are likely to run larger deficits and thus borrow more. If this is the direction of causality, then debt relief will not spur more growth.

Koeda (2008) shows that a one-time debt relief could be effective only if debt relief resources are allocated to total factor productivity enhancing uses. But doing just that proved difficult for some LICs caught in a persistent low-growth and high-debt steady state, despite repeated debt reliefs. Easterly (2002) argues that a country that has accumulated an ‘‘excessive’’ external debt may be one with a high discount rate against the future—reflecting factors such as a profligate government, political instability, or interest group polarization. If the government’s discount rate is unchanged before and after debt relief, then the high discount rate country would like to accumulate the same amount of external debt, or if borrowing is constrained, would run down its assets to restore the old level of net worth. Similarly, Asideu (2003) presents a model that links debt relief to the quality of institutions in a country, the latter represented by idiosyncratic country-specific divergence of policy-makers’ discount rates. She finds that a country needs to achieve a minimum threshold of institutional quality in order to benefit from debt relief.

This paper contributes to the scarce literature on the determinants of external debt distress in LICs in several ways: first, it offers a comprehensive analysis of debt distress that disentangles the impact of highly persistent factors, such as of the quality of institutions, the record of macroeconomic policies, the concentration of exports in commodities, and the exposure to adverse external shocks, from the relatively transitory ones. The latter set includes the contemporaneous external environment represented by various common as well as country-specific exogenous shocks, recent policies, debt burden, and liquidity indicators. Second, the estimated models, encompassing a wide range of covariates, enable a more country-specific and granular analysis of debt sustainability and have a higher predictive power compared to earlier studies. Third, the empirical methodology models the unobserved country heterogeneity and its potential correlation with the covariates, which leads to

[11] Pattillo et al. (2002), Clements et al. (2003), Chowdhury (2001). Nevertheless, Patillo et. al. (2002) acknowledge that returns might not improve for HIPC cases as other macroeconomic and structural distortions as well as political factors might still be binding.

[12] Arslanalp and Henry (2006) also make the same point. Furthermore, Powell and Bird (2010) examine the relationship between foreign aid and debt relief and show that HIPC debt relief has been, on average, additional for recipient countries.

interesting insights: LICs that experience debt distress also tend to have a record of weaker macroeconomic policies as well as higher exposure to adverse external shocks over the sample period compared to the LICs with no debt distress.

A closer comparison of this paper with KN is warranted as the latter is the only empirical paper looking into the determinants of debt distress in LICs using parsimonious probit regressions with three explanatory variables: the Country Policy and Institutional Assessments indicator (CPIA) of the World Bank, real GDP growth, and an indicator of debt burden.

The KN uses the CPIA as a joint measure of quality of policies and institutions.[13] When a single composite indicator is used to measure quality of both policies and institutions, it is not possible to identify their relative significance and the underlying country-specific vulnerabilities. This study measures the quality of economic institutions by private property rights, the relevance of which to long-term growth is established by several influential papers.[14] The results indicate that the protection of private property rights, which is highly persistent, is among the most influential factors in explaining the likelihood of debt distress. On the policy side, the impact of both the recent policies and the policy record over the sample period are examined using various indicators, including a composite indicator of inflation, fiscal balance, exchange rate depreciation, change in international reserves, and the black market premium. The significance of subcomponents is also tested individually. In addition, current account balance and the reserve coverage capture the combined impact of policies and external shocks that would widen the external imbalances.

KN include real GDP growth to represent various shocks to the economy and find significant effects only for the mixed sample, not for the sample composed only of LICs. This paper comprehensively looks into the direct effects of various exogenous shocks, and it is the first to examine the impact of common exogenous shocks originating from commodity prices. Results indicate that common, relatively persistent, adverse shocks to real non-oil commodity prices could lead to clustering of LIC debt distress episodes, depending on initial debt burdens, policies, and institutions.

Finally, this study makes three improvements to the KN methodology. First, it carefully models the unobserved country heterogeneity and its correlation with covariates, which is crucial to obtain consistent and efficient estimates of coefficients. Second, it extends the set of LICs included in KN and refines KN's definition of debt distress episodes by dropping

[13] The World Bank's CPIA (the Country Policy and Institutional Assessment) is a broad indicator of the quality of a country's present policy and institutional framework. It is based on 16 criteria which are grouped into four clusters: economic management, structural policies, policy for social inclusion and equity, and public sector management and institutions. While CPIA has been used as a measure of policies and institutional quality in several studies it has also attracted some criticism, see for example Herman (2005).

[14] Acemoglu, Johnson, and Robinson (2001, 2002, 2005a, 2005b), Knack and Keefer (1995), and North (1990).

some episodes solely identified by the IMF's Extended Fund Facility (EFF).[15] Third, KN defines normal episodes as non-overlapping periods of five consecutive years without any indication of debt distress, which drastically reduces their LIC sample.[16] Differently from KN, this paper allows for overlapping five year episodes while appropriately modeling the correlation in error terms arising from the unobserved country effects. As expected, the results show that increasing the time dimension is crucial to capture the impact of external shocks.

The paper is organized as follows: Section II discusses the hypotheses; Section III introduces the empirical methodology; and the results are presented in Section IV. Finally, main conclusions and policy implications are summarized in Section V.

II. HYPOTHESES

In light of the discussions in the preceding section, this paper tests three hypotheses related to the determinants of debt distress in LICs.

Hypothesis 1: H.1.1 Structural variables determined by underlying economic and political institutions are highly influential in predicting debt distress in LICs. H.1.2 Weak economic institutions lead to higher probability of debt distress through persistently poor policies and high vulnerability to adverse external shocks.

Long-lasting distress episodes in LICs are deeply rooted in solvency problems, which suggests that persistent structural rather than short-term liquidity factors are at play. The weak quality of economic and political institutions could persistently affect the likelihood of debt distress through several channels. First, LICs with weak institutions tend to have low growth and high macroeconomic instability, which raises their debt burden relative to their capacity to repay. The literature on the effect of institutions on growth has recently grown rapidly.[17] Weak institutions could hinder sustained growth. Second, weak institutions are also associated with less diversified and typically commodity-dependent economic structures, which increases the vulnerability to external shocks. Adverse external shocks combined with the weak capacity to formulate appropriate macroeconomic policies may lead to a high debt burden over time. Third, weak institutions, i.e., the extractive economic and political institutions protecting the interests of the ruling elite, result in a high discount rate against the future, which leads to excessive debt accumulation and/or extraction of government assets.

[15] As opposed to KN's use of commitments under Stand-by Arrangements (SBAs) and EFFs in their identification scheme, this study considers only the actual IMF financing provided under IMF-supported programs addressing immediate balance of payments needs, not the ones providing longer-term external financing for members undertaking structural economic reforms. Moreover, it uses a higher threshold in relation to the country quotas at the IMF to capture programs addressing large financing needs.
[16] KN LIC specification had only 83 observations.
[17] See for example North and Thomas (1973), Hall and Jones (1999), Acemoglu, Johnson, and Robinson (2001, 2002).

The impact of institutions and policies are intertwined as extractive economic institutions also lead to poor macroeconomic policies. Acemoglu, Johnson, and Robinson (2005) note that good economic institutions create effective property rights for a broad cross-section of society so that all individuals have an incentive to invest, innovate, and take part in economic activity. Acemoglu and Johnson (2005) estimate that property rights institutions, which protect citizens against expropriation by the government and powerful elites, have a large effect on current economic outcomes, including substantially higher income per capita and greater investment rates. Acemoglu and Robinson (2008) argue that reforming economic institutions is difficult because economic institutions depend on the nature of political institutions and the distribution of political power in society, which tend to be persistent. Therefore, if institutions, as measured by private property rights, have a significant impact on the external debt sustainability, then the countries with weak protection of private property rights would be persistently more vulnerable to debt defaults.

Hypothesis 2: Adverse external shocks raise the default probability in LICs both in the short-term and in the long-term. Persistent adverse global shocks to LICs could lead to clustering of debt defaults.

In the short-term, adverse external shocks are likely to help predict the timing of the debt default. For a country with weak fundamentals (i.e., high debt, weak institutional quality, and significant macroeconomic imbalances), adverse global and country-specific external shocks could tilt the balance towards a debt default. Conversely, a highly benign global and country-specific external environment could shield a country with weak fundamentals from default. Common external shocks to LICs, such as adverse shocks to commodity prices, could lead to a wave of defaults.

In the long-term, external shocks could have a cumulative effect of elevating the probability of default over time. For instance, persistent or repeated adverse external shocks may erode capacity to repay debt while also accelerating debt accumulation. Adverse shocks in LICs, on average, translate into substantial persistent output losses over the medium-term.[18] The impact of exogenous shocks on growth and consumption volatility is particularly pronounced in LICs.[19] Moreover, LICs affected by severe adverse shocks may be prone to internal conflict.[20]

Hypothesis 3: Liquidity conditions have an impact on the timing of default.

[18] Papageorgiou, Pattillo, Spatafora and Berg (2010).
[19] Becker and Mauro (2006) and Perry (2009).
[20] Bruckner and Ciccone (2010) suggest a robust effect of commodity price downturns on the outbreak of civil wars in Sub-Saharan Africa.

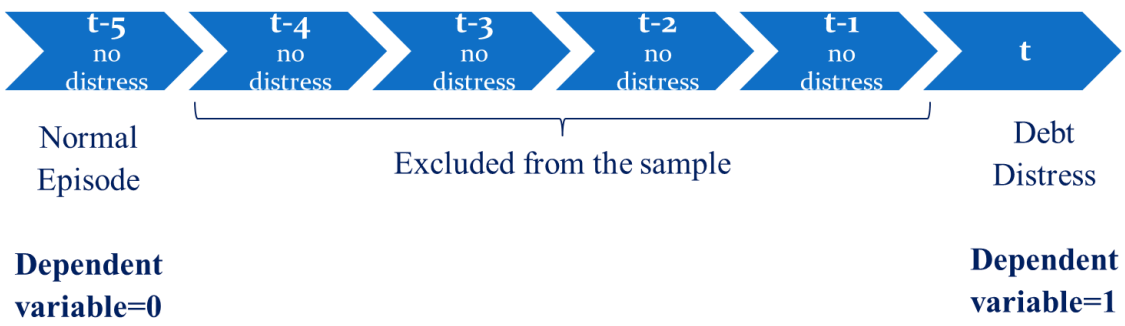
After controlling for the effects of institutions, shocks, and policies, liquidity conditions are likely to have a marginal effect on the probability of default in LICs and help mainly to predict the timing of default for a country with weak fundamentals.

III. EMPIRICAL METHODOLOGY

A. Identification of Debt Distress Episodes

The qualitative dependent variable is a panel dummy variable that takes the value of one for the start year of a debt distress episode[21] and zero for a normal episode, which is defined as the initial year of five consecutive years without debt distress (Figure 1). This approach helps to isolate key determinants that keep LICs safely away from debt distress. Allowing normal episodes to get closer to debt distress episodes could potentially blur the distinction among them, and thereby, weaken the identification of conditions supporting external debt sustainability. Five years of distress-free episodes are chosen on balance to confidently distinguish between normal versus crisis episodes, while not reducing the sample size unnecessarily.[22]

Figure 1. Identification of Normal Episodes



Identification of debt distress episodes is pivotal to derive the qualitative dependent variable. The identification method used in this study is similar to that of KN. A country is defined as being in debt distress in period *t* if any one or more of the following conditions hold: (i) the sum of interest and principal arrears exceeds five percent of total long term public and publicly guaranteed (PPG) external debt; or (ii) the Paris Club rescheduling and/or debt reduction is granted: the year of debt relief and two subsequent years are classified as debt

[21] As the focus of this study is to identify factors leading to debt distress episodes, only the start year takes the value of 1 and consecutive years during which a country remains in debt distress are excluded from the sample.
[22] As robustness check, when three-year spells of distress-free episodes are chosen the results remain qualitatively the same.

distress episodes; or (iii) IMF lending for immediate balance of payments needs[23] exceeds 80 percent of the quota.[24] Distress episodes lasting only one year are removed in order to capture severe episodes of prolonged debt distress. Moreover, all distress episodes preceded by periods of distress in any of the prior three years are also excluded as they may represent the continuation of an earlier debt distress episode.

The country coverage is wider than the LIC sample in the KN study. In the broad sample, forty-two debt distress episodes for forty countries are identified (See Appendix II). The estimation sample uses thirty-one distress episodes for which explanatory variables are available. The average duration of distress episodes is slightly longer than 20 years, indicating the persistent nature of debt distress for most LICs.

Differences in the identification methodology vis-à-vis the KN study lead to interesting differences in the classification of distress episodes. In measuring the Fund's balance of payments support, the KN study includes commitments, rather than actual purchases, under both Stand-By Arrangements (SBAs) and the Extended Fund Facility (EFFs). If Fund support exceeds 50 percent of the quota a country is classified as being in debt distress. This study uses actual amount purchased, i.e., drawn down, under SBAs, Compensatory Financing Facility (CFF), and Oil Facility in order to address immediate balance of payment needs of members.[25] Arrangements under the Extended Fund Facility (EFF) are not included since they do not address immediate balance of payments needs, but rather provide longer-term external financing for members undertaking needed structural economic reforms to correct external imbalances in production, trade, and prices. In the KN methodology, the period from 1981-1983 in which India obtained substantial Fund financing under the EFF is classified as a distress episode.[26] However, India has no history of external debt default. Classifying it as such, based on the EFF financing, could be seriously misleading. Bangladesh is another case similarly classified as in distress during 1979–81 owing to substantial EFF drawings.

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[23] Actual purchases, i.e., Fund financing disbursed, under Stand-By Arrangements (SBAs), Compensatory Financing Facility (CFF), and Oil Facility are included as they address immediate balance of payments needs of members.

[24] An alternative definition complementing this definition with the S&P classification of countries in debt default is tested. S&P defines a sovereign default as (1) an instance where debt service is not paid as scheduled within the grace period; or (2) an exchange offer with terms less favorable than the original. The data cover local and foreign currency bonds and bank loans, and thus exclude debt to official creditors. Taking also into account these defaults to private creditors leads to identifying several debt distress episodes earlier than in the KN study. Overall, the results remain qualitatively the same.

[25] The Fund's concessionary arrangements under Extended Credit Facility (ECF) and its predecessors, Poverty Reduction and Growth Facility (PRGF), Structural Adjustment Facility (SAF) and Enhanced Structural Adjustment Facility (ESAF), address a "protracted balance of payments problem" that needs to be addressed over medium-term structural reforms.

[26] For India's 1981 EFF program, Boughton (*Silent Revolution*, 2001) notes that "despite the role of the EFF, a program that was primarily structural was still seen in Washington as fundamentally the province of the World Bank, not the IMF. On the macroeconomic side, it was not clear that India had a balance of payments problem that justified drawing on a substantial volume of Fund resources." Further he adds that "…India's long run of good years in the 1970s had left it with a quite modest debt burden (less than 15 percent of GDP)".

Apart from the difference in the coverage of Fund financing, this study also chooses a higher threshold at 80 percent of the quota, compared to 50 percent of the quota in the KN study, to avoid identifying distress episodes solely based on Fund financing unless it is exceptionally high. As an important robustness check for this threshold, instances identified solely through Fund financing are usually followed by sustained periods of arrears.

B. Explanatory Variables

Explanatory variables represent five dimensions that could potentially affect a country's capacity to repay its debt: institutional quality, exogenous shocks, macroeconomic policies, debt burden, and liquidity (Appendix III). Debt burden is measured in both stock and flow terms by the present value of the Public and Publicly Guaranteed (PPG) external debt (scaled by both GDP and exports of goods and services), and the PPG external debt service (scaled by exports of goods and services). [27]

Private property rights are chosen as the core measure of the quality of institutions. A variant of institutional quality is constructed as defined by the property rights index of Keefer and Knack (1995), which is a weighted average of ICRG components of bureaucratic quality, corruption, rule of law, and protection of property rights.

For the policy block, a number of variables are tested: inflation, fiscal deficits, exchange rate depreciation, change in reserves, a composite indicator of macroeconomic (in)stability (MI index) and current account balance to GDP.[28] Jaramillo and Sancak (2009) proposed a composite indicator of inflation, fiscal balance, the nominal exchange rate depreciation, and changes in international reserves, arguing that any variable taken in isolation provides only partial information.[29] Bal Gündüz (2009, 2016) added the black market premium as a separate component of this index, inspired by Fischer (1993).

The formula for the composite indicator is given by:

$$mitot_{it} = \frac{\ln(\frac{cpi_{it}}{cpi_{it-1}})}{\sigma_{\Delta\ln(cpi)}} + \frac{\ln(\frac{xr_{it}}{xr_{it-1}})}{\sigma_{\Delta\ln(xr)}} - \frac{\frac{res_{it}-res_{it-1}}{mgs_{t-1}}}{\sigma_{\Delta res/mgs_{t-1}}} - \frac{\frac{gbal_{it}}{gdp_{it}}}{\sigma_{gbal/gdp}} + \frac{\ln(1+blackpr_{it})}{\sigma_{\Delta\ln(xr)}}$$

where *mitot* is the MI index for country *i* at time *t*, *cpi* is the consumer price index, *xr* is the exchange rate of the national currency to the U.S. dollar (increase indicates a nominal depreciation), *res* is the stock of international reserves, *mgs* is the imports of goods and

[27] Data based on an internal study by Dikhanov (2003) is generously shared by the World Bank.
[28] The MI index originates from Jaramillo and Sancak (2009). The index used in this paper is the modified version in Bal Gündüz (2009, 2016).
[29] Fischer (1993) and Sahay and Goyal (2006) also advocate a combined indicator.

services, g*bal* is the government balance, *gdp* is the nominal GDP, *blackpr* is the black market premium, and σ is the standard deviation of each variable. Weights are the inverse of standard deviation for each component for all countries over the full sample, after removing the outliers (Appendix IV).[30] Higher levels of *mitot* indicate increased macroeconomic instability.

Components of this indicator are also tested for robustness. Inflation should, in principle, be the most obvious indicator of macroeconomic instability. However, in many developing countries controlled and/or fixed prices were common practices during the sample period, and prices of utilities were heavily regulated. Fischer (1993) argues that countries may for a long time succeed in maintaining low and stable inflation through policies that are not ultimately sustainable. Direct price controls are likely to lead to higher fiscal deficits owing to higher subsidies to state agencies incurring losses. Therefore, fiscal deficit is a good indicator of unsustainable policies. However, problems in measuring the broader coverage of fiscal deficit in low-income countries—inadequate coverage of the public sector and quasi-fiscal deficits—may render fiscal deficit less useful. Exchange rate developments, both in the official and the parallel market, and reserve losses are more likely to reflect underlying macroeconomic problems despite measurement issues. If the exchange rate is de jure or de facto pegged or highly managed, then efforts to defend the parity would lead to a loss of international reserves.

If the government tries to ration the foreign currency to prevent further reserve losses, the black market premium would emerge. Satyanath and Subramanian (2004) find that, as a market-based measure, the change in the nominal parallel market exchange rate is a better measure of nominal macroeconomic instability compared to inflation since it responds to underlying macroeconomic conditions more clearly. In this study it is not feasible to rely exclusively on the black market premium for two reasons. First, the short dataset for this variable would constrain the estimation, and would not be suitable for a forecasting framework. Second, while the existence of a substantial premium indicates an overvalued exchange rate and unsustainable policies, the absence of a premium does not ensure sustainable policies.

In order to assess the impact of liquidity on debt defaults, two variables are tested: reserve coverage (in months of imports of goods and services) and net resource transfers (scaled by GDP). The former also indicates the quality of policies and is affected by external shocks. A country is more likely to default on its debt when creditors become unwilling to finance its current account deficit or roll over its debt because they are concerned about its repayment ability. For LICs the resource envelope is determined not only by creditor resources but also by donor assistance. This study uses net resource transfers, as defined in the World Bank's

[30] Observations above the 95th percentile for inflation and depreciation, above the 97.5th percentile or below the 2.5th percentile for the change in reserve coverage and below 5th percentile for government balance to GDP are considered as outliers.

Global Development Finance (GDF) database, to capture the effect of overall country specific resource availability:

$$nrt = D - P - I + short + fdi - profit + port + grant$$

Where *nrt* is net resource transfers; *D* is disbursements on long-term debt and IMF purchases/loans; *P* is repayments on long-term debt and IMF repurchases; *I* is total interest payments; *short* is the change in short-term debt; *fdi* is the foreign direct investment; *profit* is profit remittances of FDI; *port* is portfolio investment flows; and *grant* is official grants excluding technical cooperation.

In order to examine the effect of exogenous shocks, both country- and time-specific variables representing exogenous shocks are tested in this study. Country-specific variables are terms of trade shocks, real export growth, and an indicator of damage by natural disasters. Time-specific variables include change in real oil and non-oil commodity prices, real U.S. interest rates, and the cyclical component of world trade. Finally, the significance of the share of exports of primary commodities in total merchandise exports is tested as a structural variable capturing the vulnerability to exogenous shocks.

C. Econometric Specification

This paper aims to estimate the effect of a set of *k* independent explanatory variables on the probability of experiencing debt distress. The relevant class of estimators is binary response models for panel data. The general specification for panel probit models is given by:

$$\begin{aligned} &y_t = 1 \quad \text{if debt distress is observed} \\ &y_t = 0 \quad \text{normal episodes} \\ &P(y_{it} = 1 \mid x_{it}) = \Phi(x_{it}'\beta + c_i) \quad i = 1,...,n \text{ and } t = 1,...,T \end{aligned} \tag{1}$$

where *y* is the observed outcome, Φ is the cumulative normal density function (c.d.f.), x is a 1*xk* vector of strictly exogenous explanatory variables, and β is the vector of coefficients associated with x. Depending on their assumptions with regard to the panel heterogeneity (country-specific effects), i.e., how they treat c_i, different estimators are constructed.

Pooled probit models assume independence of observations over both *t* and *i*, which implies $P(y_t = 1 \mid x_{it}) = \Phi(x_{it}'\beta)$. A panel-robust or cluster-robust estimate of the variance-covariance matrix of the estimator is then used to correct standard errors for any dependence over time for a given country. A *random effects (RE) probit* model treats the country-specific effect, c_i, as an unobserved random variable with $c_i \mid x_{it} \sim IN(0, \sigma_c^2)$ if an overall intercept is included. The RE model corrects for the correlation of observations over time for a given country. The correlation between two successive error terms for the same country, $v_{it} = c_i + u_{it}$ with $u_{it} \sim IN(0, \sigma_u^2)$, is a constant given by $\rho = cor(v_{it}, v_{it-1}) = \sigma_c^2 / (\sigma_c^2 + \sigma_u^2)$.

The traditional RE model assumes that c_i and x_i are independent. Pooled estimation in nonlinear models leads to inconsistent parameter estimates if the assumed RE model is appropriate and vice versa. A fixed effects (FE) probit model treats c_i as parameters to be estimated along with β, therefore, it does not make any assumptions about the distribution of c_i given x_i. In long panels, this poses no problems. However, in short panels, both β and c_i are inconsistently estimated due to the incidental parameters problem. A c*orrelated RE* model relaxes independence between c_i and x_i using the Chamberlain (1982)-Mundlak (1978) device under conditional normality as below (assuming that an overall intercept is included). In this specification, the time averages of covariates (only over the sample observations for an unbalanced panel) are often used to save on degrees of freedom. Henceforth this estimator is called *Chamberlain's correlated RE*.

$$c_i = \bar{x}_i \xi + a_i \text{ where } a_i \sim IN(0, \sigma_a^2) \tag{2}$$

Finally, after including the time averages of covariates if ρ becomes insignificant, the model is estimated by pooled probit with an extended set of covariates. This estimator is called *Chamberlain's probit*. As a robustness check for the estimation, each benchmark specification is also estimated by the generalized estimating equation (GEE) with an exchangeable correlation structure and robust standard errors as it exploits the within-country correlation to obtain a more efficient estimator compared to the pooled probit estimator.[31]

This paper estimates each model specification by six estimators: *pooled probit*, *Chamberlain's (or correlated) probit*, *random effects probit*, *Chamberlain's (or correlated) random effects prob*it, *GEE*, and *Chamberlain's GEE*. It then tests the validity of their underlying assumptions, i.e., whether ρ and/or the time average of covariates are significant, to choose the appropriate estimator for each benchmark specification.

The increase in the probability depends upon the initial values of all the covariates and their coefficients. This derives from $P_{it} = \Phi(x_{it}'\hat{\beta} + c_i)$, and the marginal effect of the *kth* covariate x_{it}^k is given by $\partial P_{it} / \partial x_{it}^k = \phi(x_{it}'\hat{\beta} + c_i) \cdot \hat{\beta}_k$, where $\phi(\cdot)$ is the normal pdf. While the sign of the estimated coefficients does indicate the direction of change, magnitude depends on $\phi(x_{it}'\hat{\beta} + c_i)$, which reflects the steepness of the c.d.f. at $x_{it}'\hat{\beta}$. Naturally, the steeper the c.d.f. the greater the impact a change in the explanatory variable has on the predicted probability.

[31] Introduced by Liang and Zeger (1986), GEE is as a multivariate weighted nonlinear least squares (WNLS) estimator, with a misspecified conditional variance-covariance matrix. For cluster samples and panel data, the "exchangeable" matrix is typically imposed, which assumes a constant correlation within each cluster.

IV. RESULTS

A. Estimation Results: Benchmark Specifications

Three models are estimated to explain the probability of debt distress in LICs differentiated by three indicators for debt burden: present value of PPG external debt to GDP, present value of PPG external debt to exports, and PPG external debt service to exports. For each model, two benchmark specifications are estimated to explore the role of structural variables. The first specification includes the protection of private property rights, which reduces the sample size owing to data limitations. The second specification excludes private property rights, thereby expanding the sample size, and tries to capture the impact of institutions through sample averages of macroeconomic policies and shocks.[32] As discussed earlier, the econometric methodology controls for the correlation between the unobserved heterogeneity and covariates by including the sample averages of all explanatory variables in both the first and the second specifications. However, the change in their significance in the presence (or absence) of the protection of private property rights offers insights into the key transmission channels from weak institutions to persistent macroeconomic instability and/or high exposure to external shocks. Furthermore, for each benchmark specification, two versions using the macroeconomic (in)stability indicator versus its components are estimated to examine the significance of policy variables both separately and as part of a composite indicator.

Benchmark probit regressions are derived through a general-to-specific model reduction approach[33]. All explanatory variables are lagged by one year, except for the variables capturing exogenous shocks, and are thus predetermined with respect to crises. The overall sample covers fifty-seven PRGF eligible countries for the period 1975–2010, excluding only PRGF-eligible small states with per capita income above the IDA operational income cut-off. The estimation sample is restricted by the availability of explanatory variables and the identification of normal episodes, and includes forty-three to fifty-three countries, depending on the specification, over 1975–2006 (Appendix V).[34]

Table 1 presents the estimation results for the first model. When the protection of private property rights is included (columns 1 and 2), the estimation sample is composed of forty-three countries and the sample probability of default corresponds to 12 percent.[35] When the

[32] The other structural variable excluded from the second specification is the share of primary commodities in total exports owing to data limitations.
[33] Results for the general model and the alternative estimators are available upon request.
[34] As the normal episodes are defined as five consecutive years with no debt distress, estimation sample is restricted to 1975-2006.
[35] For each model, the specifications are estimated by seven estimators making different assumptions for the correlation structure between the unobserved country heterogeneity and explanatory variables: pooled probit, Chamberlain's probit, random effects probit, Chamberlain's random effects probit, GEE with exchangeable correlation structure and robust standard errors and Chamberlain's GEE. For each specification, the appropriate probit and GEE estimators are reported depending on the significance of ρ and the sample averages of

protection of private property rights and the share of primary commodities in total exports are excluded (columns 3-5), the sample size increases from 257 to 388 and covers fifty-three countries with a default probability of 10 percent, very similar to that of the first specification.

Results show that a weak protection of private property rights and a high share of primary commodities in total exports significantly increase the probability of debt distress in LICs, which validates *hypothesis 1* (*H.1.1*). When they are included in the specification, none of the country-specific averages of explanatory variables turn significant and ρ is insignificant as well, which indicates the lack of serial autocorrelation in consecutive error terms. On the other hand, in specification 2 the country-specific averages of both policy and shock variables turn highly significant and ρ is significant at 10 percent as well. Therefore, the protection of private property rights seems to account for the country heterogeneity in the first specification.

explanatory variables. For each model, columns 1 and 3 are the benchmark estimates for specifications 1 and 2. Columns 2 and 5 present robustness of the results when the model is estimated by the closest alternative estimator robust to autocorrelation, typically GEE or Chamberlain's GEE. Column 4 presents the specification with the components of the macroeconomic instability index for benchmark specification 2.

Table 1. Estimation Results: Determinants of Probability of Debt Distress in LICs (PV of PPG external debt/GDP)

	Benchmark 1				Benchmark 2					
	(1)		(2)		(3)		(4)		(5)	
Present value of PPG external debt to GDP (t-1)	0.0277***	(0.0105)	0.0274**	(0.0129)	0.0193**	(0.00890)	0.0165*	(0.00875)	0.0152*	(0.00828)
Reserve coverage in months of imports (t-1)	-0.178**	(0.0850)	-0.182	(0.115)						
Inflation (t-1)							0.0156**	(0.00686)		
Change in reserve coverage in months of imports (t-1)							-0.277*	(0.156)		
Cumulative three year change in terms of trade	-0.0134**	(0.00571)	-0.0137**	(0.00554)						
Cumulative three year change in real non-oil commodity prices	-0.0361***	(0.00780)	-0.0359***	(0.00766)	-0.0228***	(0.00873)	-0.0219**	(0.00914)	-0.0194***	(0.00745)
Cumulative three year change in real oil prices for oil importers	0.00657	(0.00411)	0.00666	(0.00441)						
Cumulative three year change in real oil prices for oil exporters					-0.159**	(0.0742)	-0.164**	(0.0775)	-0.152***	(0.0429)
Private property rights (t-1)	-0.583***	(0.208)	-0.587**	(0.266)						
Current account balance to GDP (t-1)	-0.0455**	(0.0177)	-0.0453**	(0.0179)						
Share of primary commodities in total exports (t-1)	0.0175**	(0.00756)	0.0170*	(0.00960)						
Constant	-0.286	(0.681)	-0.201	(0.625)	-2.759***	(0.590)	-2.515***	(0.521)	-2.520***	(0.504)
Country Specific Averages										
Current account balance to GDP					-0.0979***	(0.0353)	-0.108***	(0.0356)	-0.0856**	(0.0390)
Cumulative three year change in terms of trade					-0.0508***	(0.0163)	-0.0479***	(0.0166)	-0.0466***	(0.0134)
Cumulative three year change in real non-oil commodity prices					-0.0653**	(0.0271)	-0.0675**	(0.0269)	-0.0611***	(0.0224)
Cumulative three year change in real oil prices for oil importers					0.0138**	(0.00603)	0.0110**	(0.00556)	0.0130***	(0.00408)
Macroeconomic (in)stability indicator					0.0935**	(0.0426)			0.0843***	(0.0278)
Reserve coverage in months of imports					-0.370***	(0.119)	-0.404***	(0.119)	-0.322***	(0.0973)
Pseudo R2	0.52				0.38		0.40			
LR test : $\beta_2 = \ldots = \beta_k = 0$ χ^2(Prob)					86(0.00)		90(0.00)			
LR test : $\rho = 0$ χ^2(Prob)					1.93(0.08)		1.95(0.08)			
# of observations	257		257		388		388		388	
Debt distress episodes	31		31		39		39		39	
Normal episodes	226		226		349		349		349	
Sample probability	0.12		0.12		0.10		0.10		0.10	
# of countries	43		43		53		53		53	

Source: Author's calculations.
Note: Dependent variable is a binary outcome indicator for debt distress versus normal episodes. Specifications are estimated by the following models respectively: (1) pooled probit with cluster robust standard errors (POOL); (2) Generalized estimating equation with exchangeable correlation structure and robust standard errors (GEE); (3) and (4) Chamberlain's random effects probit; (5) Chamberlain's GEE. Significant at 10%:*; 5%:**; and 1%:***, standard errors in paranthesis.

As proposed in *hypothesis 1*, results seem to support the notion that weak economic institutions do raise the probability of debt distress through weak economic policies and higher vulnerability to external shocks (*H.1.2*). For benchmark specification 1 (column 1), neither the composite indicator of macroeconomic instability nor its components are significant when the protection of the private property rights is included in the model. However, when it is excluded the composite indicator turns highly significant.[36] Furthermore, in benchmark specification 2, country-specific sample averages of policy and shock variables become significant in the absence of the protection of private property rights, therefore, they are correlated with country heterogeneity. This finding suggests that countries that defaulted on their debt during the sample period also had a worse policy record (high macroeconomic instability, large external deficits, and low level of reserves) compared to the countries without such distress episodes. Moreover, these countries were more exposed to adverse external shocks during the sample period.

In benchmark specification 1, a widening current account deficit and declining reserve coverage also significantly increase the likelihood of default. These variables are contemporaneously affected by both macroeconomic policies and shocks. For example, inflation and the change in reserve coverage become significant only when current account deficit is excluded from the first specification. In benchmark specification 2, the lower the sample averages of current account balance and reserve coverage the higher the probability of debt distress. This finding validates the second part of *hypothesis 1* (*H.1.2*) in that it likely reflects both the tendency to build-up debt (i.e. a high discount rate against the future) and persistent vulnerabilities to policy or external shocks that would widen the external imbalances and deplete reserves.

Results also confirm the premise of *hypothesis 2*, that adverse external shocks raise the default probability in LICs both in the short-term and in the long-term. In benchmark specification 1, persistent declines in real non-oil commodity prices, increases in real oil prices for oil importers, and country-specific adverse terms of trade shocks are significantly associated with increased likelihood of debt distress. This finding suggests that defaults are likely to cluster around adverse global shocks. When hit by these shocks, whether a country experiences debt distress is explained by differences in fundamentals, i.e., their debt burden, policies, and institutions, and the initial level of liquidity. A high reserve coverage also could delay the timing of default, as predicted by *hypothesis 3*. In benchmark specification 2, both the contemporaneous and the country-specific sample averages of real non-oil commodity prices and increases in real oil prices for oil importers are significant. The contemporaneous effect captures the short-term impact of shocks that tilts the balance for a country with weak fundamentals towards a default. The significance of sample averages of these shocks shows the long-term, persistent effects of shocks in terms of the heterogeneity among countries in

[36] The result for this specification is available from the author upon request. In this specification, the effect of the current account balance also gets weaker while still remaining significant at 5 percent.

their exposure to adverse shocks over the sample period, validating the second part of *hypothesis 1* (*H.1.2).*

It is noteworthy that KN report no significant effect from terms of trade shocks, possibly driven by the very small sample for the LIC specification. Their sample size is reduced by the identification scheme for normal episodes as *non-overlapping* five-year windows with no symptoms of debt distress. This paper allows for overlapping five-year windows, which are still independent observations, to increase the time dimension. This empirical strategy facilitates the exploration of the role of external shocks through more variation in both global and country-specific shock variables.

Finally, as expected, a higher debt burden as measured by the NPV of external debt to GDP significantly increases the probability of default in both benchmark specifications.

For benchmark specification 1, Table 2 presents the marginal effects of a covariate on the probability of debt distress when that covariate moves from its median to its worst quartile or decile while other covariates are kept at their medians.[37] The most influential variables are the protection of private property rights, real non-oil commodity prices, and the debt burden. Table 3 presents the marginal effects for benchmark specification 2 under the same settings. The sample averages of current account balance and reserve coverage followed by the real non-oil commodity prices are the most influential variables. In the absence of the protection of private property rights, the former two variables possibly reflect the impact of institutions as well as the persistent impact of policies and the exposure to adverse external shocks.

[37] The worst quartile or decile corresponds to the highest (lowest) quartile or decile of the sample distribution of a covariate if its impact on the probability of debt distress is positive (negative).

Table 2. Marginal Effects of Explanatory Variables on Crisis Probability (Benchmark 1)
(Percentage point, unless otherwise indicated)

	Median to worst quartile	Change in predicted crisis probability	Median to worst decile	Change in predicted crisis probability
Present value of PPG external debt to GDP (%)	23.8 → 34.8	1.5	23.8 → 47.0	4.5
Reserve coverage in months of imports	2.8 → 1.6	1.0	2.8 → 0.7	1.9
Cumulative three year change in terms of trade	0.8 → -9.3	0.5	0.8 → -22.1	1.5
Cumulative three year change in real non-oil commodity prices	-7.6 → -24.4	4.1	-7.6 → -31.2	7.4
Cumulative three year change in real oil prices for oil importers	-4.3 → 25.1	0.8	-4.3 → 67.8	2.8
Private property rights	6.3 → 5.2	2.7	6.3 → 4.2	24.6
Current account balance to GDP (%)	-2.4 → -7.0	0.9	-2.4 → -12.7	2.7
Share of primary commodities in total exports (%)	69.5 → 92.6	2.2	69.5 → 97.2	2.9

Source: Author's calculations.

Note: Model I, benchmark specification 1. Each covariate is set to its worst quartile and decile respectively while the rest of the covariates set at their median.

Table 3. Marginal Effects of Explanatory Variables on Crisis Probability (Benchmark 2)
(Percentage point, unless otherwise indicated)

	Median to worst quartile	Change in predicted crisis probability	Median to worst decile	Change in predicted crisis probability
Present value of PPG external debt to GDP (%)	21.5 → 34.9	1.7	21.5 → 48.8	4.6
Cumulative three year change in real non-oil commodity prices	-6.9 → -20.4	2.2	-6.9 → -31.2	5.0
Country-specific averages				
Macroeconomic (in)stability indicator	2.3 → 3.4	0.6	2.3 → 5.7	2.3
Current account balance to GDP (%)	-3.2 → -8.6	4.6	-3.2 → -12.4	11.0
Reserve coverage in months of imports	2.9 → 1.8	3.1	2.9 → 1.3	5.6
Cumulative three year change in terms of trade	-1.0 → -4.3	1.1	-1.0 → -10.8	4.3
Cumulative three year change in real non-oil commodity prices	-8.7 → -10.4	0.7	-8.7 → -14.0	2.6
Cumulative three year change in real oil prices for oil importers	7.4 → 13.9	0.5	7.4 → 34.3	2.8

Source: Author's calculations.

Note: Model I, benchmark specification 2. Each covariate is set to its worst quartile and decile respectively while the rest of the covariates set at their median.

As a robustness check for policy variables, column (4) in Table 1 presents the specification using the components of the macroeconomic (in)stability indicator. Results are broadly similar to those in column (3), only the contemporaneous values of policy variables rather than their sample averages enter into the specification. Among the components, inflation and change in reserve coverage turn out to be significant. Sample averages of these components

become significant only when the sample average of either reserve coverage or current account balance is excluded from the model, which indicates correlation among these variables.[38] While government balance to GDP is insignificant, it comes out with the correct sign. The specification with the composite indicator of macroeconomic stability is preferred as it is likely to cope better with the case-by-case importance of different components.

Variables capturing liquidity impact via creditors'/donors' willingness to meet financing needs of LICs, including net resource transfers and its components, are not significant. This finding could be explained by the peculiar circumstances of LICs as resource flows to these countries continued despite excessive debt and heightened risk of default thanks to concessional financing from official creditors. A rise in the U.S. real interest rates is not significant, possibly reflecting the primacy of concessional borrowing for the most part of the sample.

Real GDP growth and real export growth, partly capturing exogenous shocks, are not significant. This finding is consistent with the KN study, which includes real GDP growth as a crude way of capturing both exogenous and endogenous shocks. They find it highly significant for the medium-income countries while it becomes insignificant for the LIC sample. Finally, the share of people affected by natural disasters is also not significant. While in many cases these disasters lead to humanitarian crises, they do not appear to be associated with immediate defaults. This would, of course, not rule out their having an impact through the accumulation of debt and widening current account balances.

Tables 4 and 5 present the estimation results for the debt burden indicators of NPV of external debt to exports and external debt service to exports respectively. They broadly confirm the findings on the roles of institutions, policies, and shocks in explaining debt distress in LICs.

[38] Inflation and depreciation are highly correlated, therefore, enter into the model one at a time. Either the contemporaneous value or the sample average of depreciation becomes significant only when the sample average of reserve coverage is excluded from the model.

Table 4. Estimation Results: Determinants of Probability of Debt Distress in LICs (PV of PPG external debt/exports)

	Benchmark 1				Benchmark 2					
	(1)		(2)		(3)		(4)		(5)	
Present value of PPG external debt to exports (t-1)	0.00183**	(0.000884)	0.00187**	(0.000890)	0.00305**	(0.00122)	0.00315**	(0.00131)	0.00234	(0.00146)
Reserve coverage in months of imports (t-1)	-0.184*	(0.106)	-0.195	(0.120)	-0.191**	(0.0815)	-0.166*	(0.0947)	-0.260**	(0.103)
Inflation (t-1)	0.0309*	(0.0177)	0.0340*	(0.0192)						
Cumulative three year change in terms of trade					-0.00667**	(0.00306)	-0.00573*	(0.00345)	-0.00983**	(0.00426)
Cumulative three year change in real non-oil commodity prices	-0.0435***	(0.0154)	-0.0442**	(0.0185)	-0.0135***	(0.00417)	-0.0161***	(0.00501)	-0.0187***	(0.00605)
Constant	2.683*	(1.590)	2.551	(1.867)	-1.804***	(0.424)	-1.646***	(0.414)	-2.027***	(0.399)
Country Specific Averages										
Private property rights	-0.995***	(0.330)	-0.991**	(0.404)						
Current account balance to GDP	-0.172***	(0.0350)	-0.180***	(0.0385)	-0.0871**	(0.0352)	-0.0809*	(0.0422)	-0.0933***	(0.0287)
Cumulative three year change in terms of trade	-0.0433***	(0.0154)	-0.0427**	(0.0168)						
Macroeconomic (in)stability indicator					0.0671***	(0.0226)			0.0619***	(0.0219)
Inflation (t-1)							0.0124***	(0.00452)		
Change in reserve coverage in months of imports							-0.789**	(0.345)		
Pseudo R2	0.44								0.37	
# of observations	256		256		387		387		387	
Debt distress episodes	30		30		38		38		38	
Normal episodes	226		226		349		349		349	
Sample probability	0.12		0.12		0.10		0.10		0.10	
# of countries	42		42		52		52		52	

Source: Author's calculations.

Note: Dependent variable is a binary outcome indicator for debt distress versus normal episodes. Specifications are estimated by the following models respectively: (1) Chamberlain's pooled probit with cluster robust standard errors (POOL); (2) Chamberlain's generalized estimating equation with exchangeable correlation structure and robust standard errors (GEE); (3) and (4) Chamberlain's GEE; (5) Chamberlain's POOL. Significant at 10%:*; 5%:**; and 1%:***, standard errors in paranthesis.

Table 5. Estimation Results: Determinants of Probability of Debt Distress in LICs (PPG external debt service/exports)

	Benchmark 1				Benchmark 2					
	(1)		(2)		(3)		(4)		(5)	
Present value of PPG external debt service to exports (t-1)	0.0358**	(0.0178)	0.0357*	(0.0186)	0.0339***	(0.0129)	0.0410***	(0.0133)	0.0391**	(0.0157)
Macroeconomic (in)stability indicator (t-1)					0.0609***	(0.0166)			0.0720**	(0.0302)
Inflation (t-1)	0.0132**	(0.00534)	0.0132**	(0.00517)			0.0122**	(0.00560)		
Change in reserve coverage in months of imports (t-1)	-0.366**	(0.162)	-0.363**	(0.162)			-0.323***	(0.100)		
Cumulative three year change in terms of trade					-0.00937*	(0.00550)			-0.0103**	(0.00472)
Cumulative three year change in real non-oil commodity prices	-0.0357***	(0.0118)	-0.0356***	(0.0119)	-0.0183***	(0.00649)	-0.0180***	(0.00589)	-0.0214***	(0.00811)
Cumulative three year change in real oil prices for oil exporters					-0.0893***	(0.0324)	-0.0750**	(0.0317)	-0.0960*	(0.0518)
Constant	-2.898***	(0.601)	-2.890***	(0.595)	-2.155***	(0.435)	-2.121***	(0.391)	-2.343***	(0.473)
Country Specific Averages										
Private property rights										
Current account balance to GDP	-0.0942***	(0.0303)	-0.0936***	(0.0326)	-0.122***	(0.0312)	-0.118***	(0.0331)	-0.139***	(0.0329)
Share of primary commodities in total exports	0.0135**	(0.00538)	0.0135**	(0.00556)						
Reserve coverage in months of imports (t-1)	-0.438***	(0.116)	-0.437***	(0.120)	-0.269**	(0.105)	-0.240***	(0.0778)	-0.309***	(0.0985)
Pseudo R2	0.44								0.35	
LR test : $\rho = 0$ χ^2(Prob)									2.5(0.06)	
# of observations	255		255		386		386		386	
Debt distress episodes	29		29		37		37		37	
Normal episodes	226		226		349		349		349	
Sample probability	0.11		0.11		0.10		0.10		0.10	
# of countries	41		41		51		51		51	

Source: Author's calculations.

Note: Dependent variable is a binary outcome indicator for debt distress versus normal episodes. Specifications are estimated by the following models respectively: (1) Chamberlain's pooled probit with cluster robust standard errors (POOL); (2) Chamberlain's generalized estimating equation with exchangeable correlation structure and robust standard errors (GEE); (3) and (4) Chamberlain's GEE; (5) Chamberlain's random effects probit. Significant at 10%:*; 5%:**; and 1%:***, standard errors in paranthesis.

B. Goodness of Fit

Two measures are used frequently to assess model performance: the likelihood ratio test for the hypothesis $H_0 : \beta_2 = \beta_3 = ... = \beta_k = 0$ and a scalar measure called the *pseudo-R^2*. The latter is given by *pseudo-*$R^2 = 1 - (\ln L(\hat{\Omega}) / \ln L(\hat{\omega}))$ where $\ln L(\hat{\Omega})$ is the value of the likelihood function evaluated at $\hat{\beta}$ and $\ln L(\hat{\omega})$ is the maximum value of the likelihood function under the hypothesis $H_0 : \beta_2 = \beta_3 = ... = \beta_k = 0$. As a crude measure, it is 1 when the model is a perfect predictor and 0 when $\ln L(\hat{\Omega}) = \ln L(\hat{\omega})$, i.e., H_0 holds. However, between these limits it has no intuitive meaning. Hauser (1978) shows that in an information theoretic context, *pseudo-R^2* measures the percent of "uncertainty" in data explained by empirical results.[39] *Pseudo-R^2s* of the first model indicate that about 40 to 50 percent of the uncertainty in the data is explained by benchmark specifications. Moreover, H_0, i.e., coefficients of explanatory variables being jointly zero, is significantly rejected by the likelihood ratio test.

Measuring the "goodness" of fit of the predictions is not straightforward, since the statistical model predicts conditional probabilities that must be compared to actual events. A predicted probability of less than one still assigns a nonzero probability to the alternative event, i.e., by model predictions both outcomes are possible, albeit with different probabilities. Keeping this point in mind, it is, nevertheless, useful to examine the distribution of in sample predicted probabilities for debt distress events versus normal episodes (Tables 6, 7, and 8 for three debt burden indicators respectively). Distributions of predicted probabilities by type of event are quite distinct. Moreover, the predicted probabilities are well dispersed in the [0,1] interval, indicating that the empirical model is quite informative in distinguishing alternative outcomes.

[39] Cameron and Windmeijer (1997) use the Kullback-Leibler divergence to construct an R^2 measure of goodness of fit. It would measure the proportionate reduction in uncertainty due to the inclusion of regressors, lies between 0 and 1, and is non-decreasing as regressors are added. They note that in Bernoulli models, such as probit and logit, this measure coincides with the likelihood ratio index, supporting use of this index rather than the other competing R^2 measures.

Table 6. Predicted Probabilities (Percentiles), (PV of PPG external debt/GDP)

	(1)		(2)		(3)		(4)		(5)	
	Crisis events	Normal episodes	Crisis events	Normal episodes	Crisis events	Normal episodes	Crisis events	Normal episodes	Crisis events	Normal episodes
1%	0.00	0.00	0.01	0.00	0.01	0.00	0.02	0.00	0.02	0.00
5%	0.02	0.00	0.05	0.00	0.05	0.00	0.06	0.00	0.06	0.00
10%	0.14	0.00	0.12	0.00	0.07	0.00	0.06	0.00	0.08	0.00
25%	0.27	0.00	0.26	0.00	0.12	0.00	0.16	0.00	0.13	0.00
50%	0.61	0.01	0.61	0.01	0.49	0.02	0.57	0.01	0.46	0.02
75%	0.88	0.08	0.88	0.08	0.99	0.07	0.96	0.06	0.98	0.08
90%	1.00	0.16	1.00	0.16	1.00	0.21	1.00	0.18	1.00	0.20
95%	1.00	0.28	1.00	0.27	1.00	0.33	1.00	0.30	1.00	0.29
99%	1.00	0.51	1.00	0.50	1.00	0.54	1.00	0.64	1.00	0.50
Obs.	31	226	31	226	39	349	39	349	39	349

Source: Author's calculations.
Note: Specifications are estimated by: (1) pooled probit with cluster robust standard errors (POOL); (2) Generalized estimating equation with exchangeable correlation structure and robust standard errors (GEE); (3) and (4) Chamberlain's random effects probit; (5) Chamberlain's GEE.

Table 7. Predicted Probabilities (Percentiles), (PV of PPG external debt/exports)

	(1)		(2)		(3)		(4)		(5)	
	Crisis events	Normal episodes	Crisis events	Normal episodes	Crisis events	Normal episodes	Crisis events	Normal episodes	Crisis events	Normal episodes
1%	0.01	0.00	0.01	0.00	0.04	0.00	0.03	0.00	0.02	0.00
5%	0.02	0.00	0.02	0.00	0.09	0.00	0.08	0.00	0.02	0.00
10%	0.06	0.00	0.06	0.00	0.12	0.00	0.09	0.00	0.06	0.00
25%	0.35	0.00	0.33	0.00	0.21	0.02	0.23	0.01	0.14	0.00
50%	0.67	0.00	0.69	0.00	0.38	0.06	0.44	0.05	0.29	0.02
75%	1.00	0.04	1.00	0.04	0.73	0.15	0.75	0.13	0.59	0.08
90%	1.00	0.19	1.00	0.19	0.96	0.29	0.99	0.25	0.94	0.18
95%	1.00	0.28	1.00	0.28	0.99	0.45	1.00	0.39	0.99	0.32
99%	1.00	0.44	1.00	0.46	1.00	0.70	1.00	0.67	1.00	0.59
Obs.	30	226	30	226	38	349	38	349	38	349

Source: Author's calculations.
Note: Specifications are estimated by the following models respectively: (1) Chamberlain's pooled probit with cluster robust standard errors (POOL); (2) Chamberlain's generalized estimating equation with exchangeable correlation structure and robust standard errors (GEE); (3) and (4) Chamberlain's GEE; (5) Chamberlain's POOL.

Table 8. Predicted Probabilities (Percentiles), (PPG external debt service/exports)

	(1)		(2)		(3)		(4)		(5)	
	Crisis events	Normal episodes	Crisis events	Normal episodes	Crisis events	Normal episodes	Crisis events	Normal episodes	Crisis events	Normal episodes
1%	0.01	0.00	0.03	0.00	0.01	0.00	0.05	0.00	0.01	0.00
5%	0.03	0.00	0.07	0.00	0.04	0.00	0.05	0.00	0.03	0.00
10%	0.04	0.00	0.07	0.00	0.07	0.00	0.07	0.00	0.06	0.00
25%	0.29	0.00	0.22	0.00	0.20	0.00	0.19	0.00	0.20	0.00
50%	0.49	0.01	0.49	0.01	0.37	0.02	0.38	0.02	0.41	0.01
75%	0.73	0.08	0.87	0.05	0.74	0.09	0.79	0.09	0.81	0.08
90%	0.93	0.24	0.99	0.18	0.97	0.21	0.98	0.21	0.99	0.21
95%	0.94	0.34	1.00	0.26	1.00	0.29	1.00	0.29	1.00	0.30
99%	0.98	0.55	1.00	0.66	1.00	0.55	1.00	0.59	1.00	0.63
Obs.	29	226	29	226	37	349	37	349	37	349

Source: Author's calculations.
Note: Specifications are estimated by the following models respectively: (1) Chamberlain's pooled probit with cluster robust standard errors (POOL); (2) Chamberlain's generalized estimating equation with exchangeable correlation structure and robust standard errors (GEE); (3) and (4) Chamberlain's GEE; (5) Chamberlain's random effects probit.

All three models with different debt burden indicators differentiate well between the distributions for debt distress events versus normal episodes. For example, in the first model with the specification including the protection of private property rights (Table 1 benchmark specification 1), the median predicted probability for debt distress events is 0.61 versus 0.01 for normal episodes. Seventy-five percent of predicted probabilities for debt distress events are above 0.27 while only two cases have probabilities below 0.06. Ten percent of normal episodes exceed the predicted probability of 0.16 with just four cases above 0.40. The distribution of predicted probabilities is fairly similar when the model is estimated by GEE in (Table 6 column 2).

C. The Threshold Probability Analysis

In order to set up a framework to identify countries highly vulnerable to debt defaults, the threshold probability—a predicted probability that exceeds this threshold signals a debt distress event- needs to be determined. The threshold probability is obtained by minimizing the expected loss function, i.e., the weighted average of missed debt distress events (type I error) versus false alarms (type II error).[40] This study calculates threshold probabilities for

[40] This approach is suggested by Demirgüc-Kunt and Detragiache (1999). The definition of type I and type II errors is relative to the formulation of the null hypothesis being tested. Here, as a matter of convenience, the null hypothesis is formulated around the outcome of interest: "the country will experience debt distress" versus the alternative of "the country will not experience debt distress."

asymmetrically-weighted loss functions penalizing missed crises more heavily.[41] Figure 2 plots missed debt distress events (also called as missed crises, type I error), false alarms (type II error), and the equally-weighted loss function (summation of type I and type II errors). An increase in the threshold probability raises type I error while reducing type II error.

Table 9 presents the threshold probabilities of benchmark specifications for models I-III. The primary and secondary threshold probabilities are derived from the minimization of asymmetrically-weighted and equally-weighted loss functions respectively. All three models have a better predictive power compared to that of the corresponding KN regressions, which shows that a more granular analysis of debt sustainability in LICs improves the model fit (Appendix VI).

Table 9. Threshold Probabilities and Model Fit Across Different Specifications

Model 1/		Crises	Normal Episodes	Threshold Probability 2/		Missed Crises (Type I)	False Alarms (Type II)	Overall Error 3/
I	1	31	226	Primary	0.137	0.097	0.133	0.128
		31	226	Secondary	0.137	0.097	0.133	0.128
	2	39	349	Primary	0.040	0.026	0.332	0.302
		39	349	Secondary	0.080	0.103	0.215	0.204
II	3	30	226	Primary	0.230	0.133	0.071	0.078
		30	226	Secondary	0.230	0.133	0.071	0.078
	4	38	349	Primary	0.091	0.026	0.393	0.357
		38	349	Secondary	0.150	0.105	0.255	0.240
III	5	29	226	Primary	0.060	0.034	0.230	0.208
		29	226	Secondary	0.180	0.138	0.102	0.106
	6	37	349	Primary	0.092	0.108	0.241	0.228
		37	349	Secondary	0.152	0.162	0.143	0.145

Source: Author's calculations.

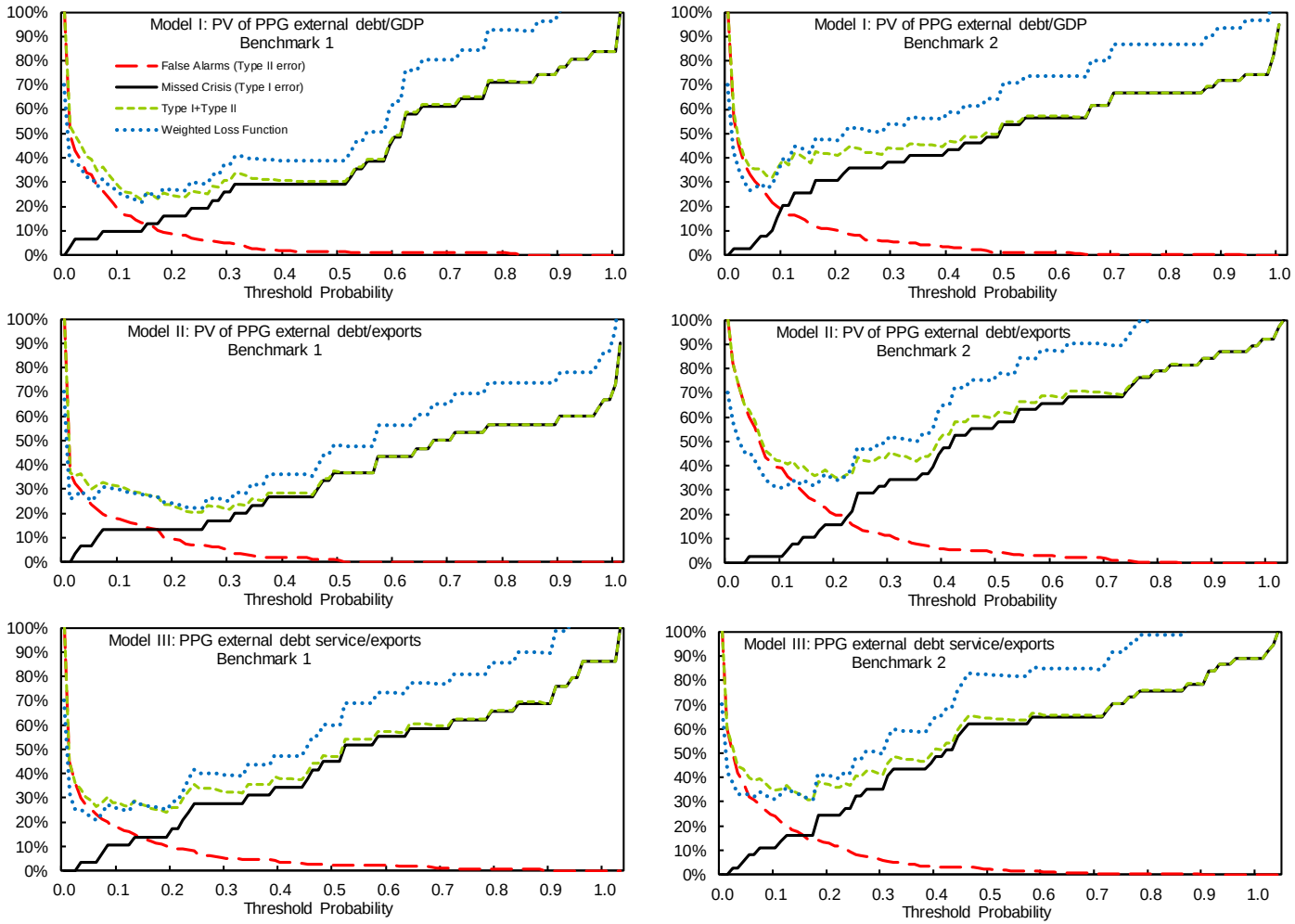
1/ Models I-III include debt burden indicators of NPV of PPG external debt to GDP, NPV of PPG external debt to exports, and PPG external debt service to exports respectively. For each model, two benchmark specifications are presented.

2/ Primary and secondary probability thresholds are drived from asymmetrically and equally weighted loss functions respectively.

3/ Missed crises plus false alarms in total observations.

[41] Weights are 0.65 and 0.35 respectively for type I and type II errors. It should be noted that since type I and type II errors are calculated as the share of missed crisis in total number of crisis observations and as the share of false alarms in normal episodes respectively even "equally" weighted loss function places a far greater weight on missed crises compared to false alarms (almost 10 fold as crises are very rare in the sample).

Figure 2. Threshold Probability Analysis



Source: Author's calculations.

In model I, for the specification with the protection of private property rights both the primary and the secondary threshold probabilities are 0.14, which corresponds to 9.7 percent missed crises and 13.3 percent false alarms. For benchmark specification 2, which excludes the protection of private property rights, the primary threshold probability of 0.04 misses only one crisis (i.e., 2.6 percent of debt crises) while giving false alarms for 33.2 percent of normal episodes. The overall error, i.e. the share of missed crises plus wrong calls in total observations, is the lowest for model II benchmark specification 1 as it issues the lowest level of false alarms. For all three models, benchmark specification 1 has lower overall error compared to that of benchmark specification 2.

The predicted probabilities compared to the threshold probability constitute an operational forecasting framework. Countries with predicted probabilities exceeding the thresholds could be classified as having moderate to high likelihood of debt distress. The clarity of signals will increase for the secondary threshold probability, above which countries will be classified as at high risk of debt distress.

Recently Berg et al. (2014) examined how the DSF uses and aggregates the information contained in five separate debt indicators, taking as given the KN-based probit regressions in the current DSF. They found that using debt thresholds, rather than probability thresholds, results in a loss of country-specific information that reduces accuracy of predictions.[42] Moreover, they reported that the current DSF approach of calling a crisis whenever any one of five debt measures is above its threshold (dubbed as the worst-case aggregator, WCA) is implicitly biased and statistically inaccurate.[43]

D. Marginal Effects of Explanatory Variables on the Probability of Debt Distress

Using the probability thresholds derived in the previous section, this section illustrates the relative influence of each covariate in raising the predicted probability above the primary threshold.

As the model is nonlinear, the effect of a variable on the likelihood of debt distress depends not only on its coefficient but also on the values of other explanatory variables and their coefficients. Therefore, marginal effects of variables could only be reported and compared at preset values of other covariates, usually at their means or medians.

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[42] The 2012 review of the DSF introduced an additional approach for assessing debt sustainability in a limited number of borderline cases. The approach uses country-specific information to help determine the risk of external debt distress.

[43] For the WCA, the bias arises from calling crises more often than can be justified by the purported weights attached to missed crises and false alarms in the loss function. With regard to statistical inaccuracy, they show that, for any loss function weights, some simple alternative aggregators of five debt burden indicators have a better in-sample trade-off between missed crises versus false alarms compared to the WCA.

This study uses two counterfactual simulations to illustrate how a single explanatory variable affects the predicted probability over its sample range for different initial values of other covariates.[44] In simulations, other explanatory variables are fixed at two different sets of initial values corresponding to: (i) sample median and (ii) 75th (25th) percentile if their estimated coefficient is positive (negative). Table 10 presents initial values of covariates and the corresponding predicted probabilities for model I benchmark specification 1. Both simulations set changes in global variables to zero, thus highlighting the effect of each variable on a median LIC versus a LIC with weak fundamentals in the absence of common shocks. Naturally, simulations related to global variables would readily illustrate the effects of common shocks on these two differently situated countries.

The predicted probability for debt distress is zero for the median LIC whereas it increases to 0.27 for the LIC with weaker fundamentals. In reference to the threshold probabilities derived in the previous section, the median LIC will be safely away from debt distress while debt distress will be predicted with high confidence for the LIC with weaker fundamentals (with the 95 percent confidence band of the predicted probability above the threshold probability).

Table 10. Values of Explanatory Variables in Counterfactual Simulations

	Median	75th (25th) percentile
Present value of PPG external debt to GDP (%)	23.8	34.8
Reserve coverage in months of imports	2.8	1.6
Cumulative three year change in terms of trade	0.8	-9.3
Cumulative three year change in real non-oil commodity prices	0.0	0.0
Cumulative three year change in real oil prices for oil importers	0.0	0.0
Private property rights	6.3	5.2
Current account balance to GDP (%)	-2.4	-7.0
Share of primary commodities in total exports (%)	69.5	92.6
Threshold probability	0.14	
Predicted probability	0.007	0.267
95% confidence band	[0.001 0.033]	[0.143 0.465]

Note: Threshold and predicted probabilities are reported for benchmark specification 1 for model I with present value of PPG external debt to GDP (%).

Figure 3 presents counterfactual simulations for the specification with the protection of private property rights. An isolated change in a single explanatory variable within its sample range has a much larger effect on a LIC with weak fundamentals, in some cases swings the predicted probability of debt distress below the threshold probability to close to one. NPV of PPG external debt to GDP and the protection of private property rights are particularly

[44] These simulations are counterfactual since all other variables remain unchanged while a single variable is allowed to change over its entire sample range.

influential because adverse shocks to these variables raise the predicted probability above the threshold probability even for the median LIC. Extreme adverse shocks to current account balance to GDP and change in real non-oil commodity prices also result in predicting debt distress for the median LIC. While other covariates are not as influential, a large enough improvement in them, except for the change in real oil prices, could reduce the predicted probability below the threshold level for the LIC with weak fundamentals. Overall, the predicted probability increases sharply for a large deterioration in any of the covariates for the LIC with weak fundamentals, leading to the classification of more countries at high risk of debt distress with greater confidence. A more plausible case of combined deterioration would likely push the predicted probability above the threshold much faster.

The initial conditions determined by policies and institutions of a LIC has a profound influence on the level of debt it can safely carry. For the median LIC, the predicted probability goes above the threshold when NPV of PPG external debt exceeds 66 percent of GDP.[45] However, exposure to adverse exogenous shocks tend increase the likelihood of debt distress and reduce the safe level of debt. For example, a median LIC can accommodate an isolated decline in real non-oil commodity prices of 10 and 20 percent without exceeding the probability threshold if its pre-shock level of debt is below 53 and about 40 percent of GDP respectively.[46] The LIC with weak fundamentals exceeds the threshold probability at a much lower level of debt of only about 18 percent of GDP.[47] For these LICs, a debt distress event would be predicted with greater confidence at NPV of debt exceeding 21 percent of GDP, for which the lower bound of the confidence interval for the predicted probability exceeds the threshold.

Only a very significant improvement in policies and liquidity buffers could raise the level of debt a LIC with weak institutions could carry. For example, an increase in reserve coverage from 1.6 to 5.7 months of imports would bring the predicted probability below the threshold. Moreover, a very favorable external environment could also conceal the underlying vulnerabilities of the LIC with weak fundamentals to default. For example, an improvement in the cumulative three year change in terms of trade from -9.3 to 42 percent or in real nonoil commodity prices from 0 to about 20 percent is expected to delay a default for the LIC with weak fundamentals.

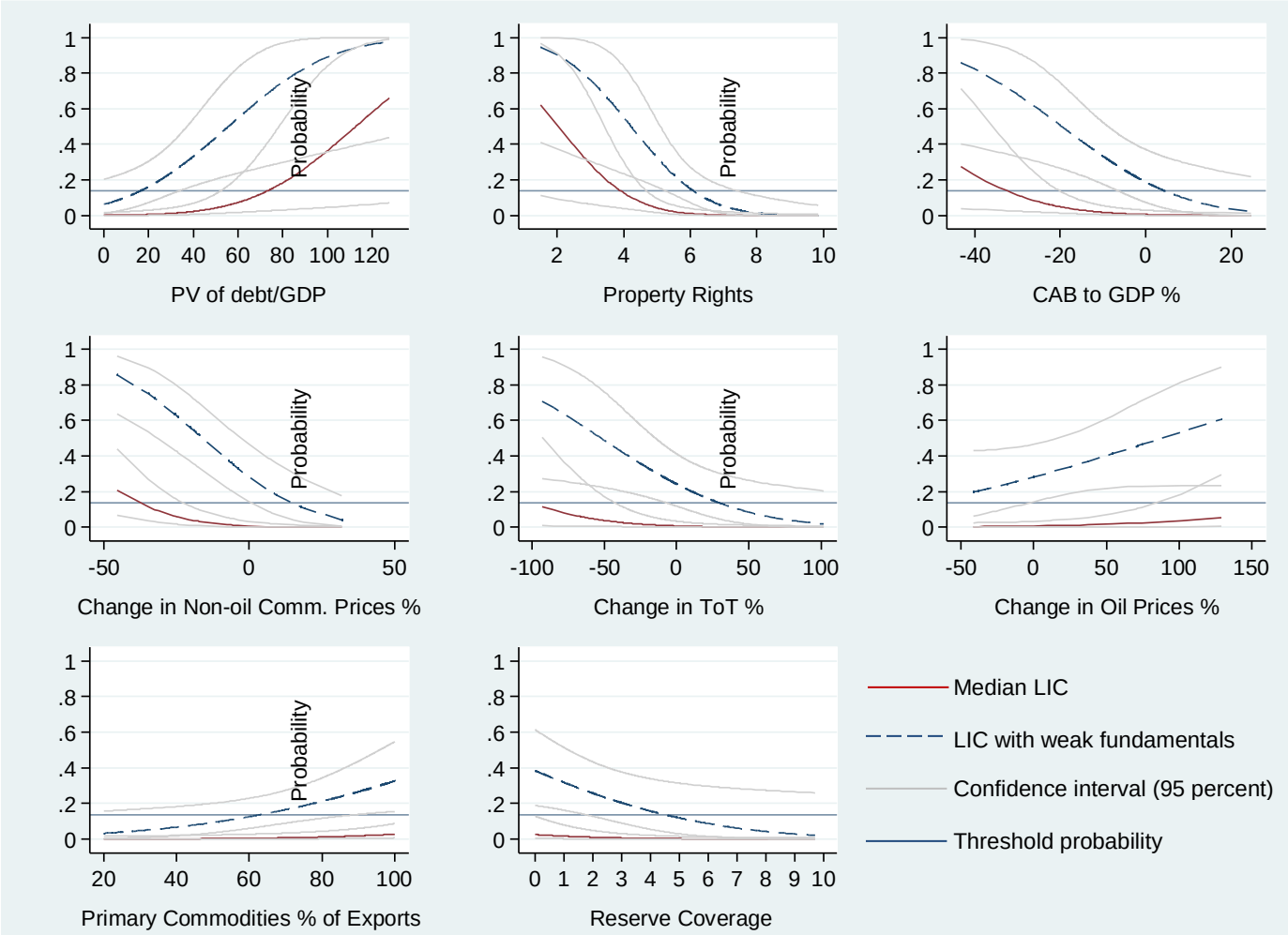
Conversely, despite a significant deterioration in policies and the external environment a debt distress episode will not be predicted for a LIC with higher institutional quality. An increase in the protection of private property rights from 5.2 to 6.5 would bring the predicted probability below the threshold.

[45] The IMF-WB DSF NPV of debt threshold for LICs with strong institutions is 50 percent of GDP.
[46] The other covariates are kept at their medians.
[47] The IMF-WB DSF NPV of debt threshold for LICs with weak institutions is 30 percent of GDP.

All these illustrative examples are simply counterfactual simulations as they assess the impact of an isolated change in a single variable while keeping all other covariates at their pre-set values. A more plausible risk scenario would incorporate simultaneous, correlated deterioration in covariates. For example, an adverse shock to the external environment would likely increase current account deficit and erode the level of reserves as well, which would further reduce the safe level of debt a LIC could carry without risking a debt default as a result of shocks.

The discussion in this section highlights the difficulty in deriving clear debt thresholds, above which a debt distress will be predicted, based on a rich model that includes a multitude of factors. Therefore, the use of the probability thresholds would be more suited to fully capture the impact of country-specific differences in policies and institutions as well as the external environment on the probability of debt distress.

Figure 3. Model I: Counterfactual Simulations—Effects of Explanatory Variables on the Probability of Debt Distress



Source: Author's calculations.

Note: Benchmark specification 1 of model I. Simulations present marginal effects of each covariate on the predicted probability of debt distress for a median LIC versus a LIC with weak fundamentals.

V. CONCLUDING REMARKS

Empirical literature examining the determinants of external debt distress in LICs is scant. This study examines a comprehensive set of factors that might explain external debt distress in LICs, including institutional quality, external shocks, debt burden, liquidity indicators, and macroeconomic policies. Three models are estimated for three indicators for debt burden: present value of PPG external debt to GDP, present value of PPG external debt to exports, and PPG external debt service to exports. For each model, two benchmark specifications are estimated to explore the role of structural variables. The first specification includes the protection of private property rights while the second excludes it to explore the transmission channels for the impact of institutions through macroeconomic policies and the exposure to shocks. Three hypotheses are tested:

Hypothesis 1: Structural variables determined by underlying economic and political institutions are highly influential in predicting debt distress in LICs.

Hypothesis 2: Adverse external shocks raise the default probability in LICs both in the short-term and in the long-term. Persistent adverse global shocks to LICs could lead to clustering of debt defaults.

Hypothesis 3: Liquidity conditions have an impact on the timing of default.

Results show that a weak protection of private property rights and a high share of primary commodities in total exports significantly raise the probability of debt distress in LICs, which validates *hypothesis 1*. As for the policies, a widening current account deficit and declining reserve coverage also significantly increase the likelihood of default. These two variables are contemporaneously affected by both macroeconomic policies and external shocks.

Results also confirm the premise of *hypothesis 2*. Persistent declines in real non-oil commodity prices, increases in real oil prices for oil importers, and country-specific adverse terms of trade shocks lead to significantly higher probability of default. This finding suggests that defaults are likely to cluster around adverse global shocks. When LICs are hit by common adverse shocks, the degree of clustering would depend on their initial debt burden, policies, and institutions. Results show that a large liquidity buffer in terms of reserve coverage could also delay the timing of default for a country with weak fundamentals, as predicted by *hypothesis 3*. As expected, a higher debt burden, in stock or flow terms, significantly raise the probability of default.

The variables that are most influential on the predicted probability of debt distress are institutions as measured by the protection of private property rights, real non-oil commodity prices, and the debt burden. When the protection of private property rights is excluded from

the model, the sample averages of current account balance and reserve coverage followed by the real non-oil commodity prices become the most influential variables.

When the protection of private property rights is excluded from the model two changes in results are noteworthy: (i) The country-specific averages of both policy and shock variables turn highly significant, which indicates that they are correlated with country heterogeneity; and (ii) Unobserved country heterogeneity becomes significant. The latter suggests that the protection of private property rights, i.e. the quality of institutions, explains the country heterogeneity in the model fully. The former finding indicates that weak economic institutions raise the probability of debt distress through weak economic policies and higher vulnerability to external shocks. In other words, countries that defaulted on their debt also had a worse policy record (high macroeconomic instability, large external deficits, and low level of reserves) and were more exposed to adverse external shocks over the sample period compared to the countries that did not experience debt distress. This finding is intuitive and probably reflects both the tendency to build-up debt (i.e. a high discount rate against the future) and persistent vulnerabilities to policy or external shocks that would widen the external imbalances and deplete reserves.

APPENDIX I. PPG EXTERNAL DEBT THRESHOLDS IN THE IMF-WORLD BANK DEBT SUSTAINABILITY FRAMEWORK

Quality of policies and institutions (CPIA)	PV of PPG external debt in percent of			PPG external debt service in percent of	
	GDP	Exports	Revenue	Exports	Revenue
Weak (*CPIA* ≤ 3.25)	30	100	200	15	18
Medium (3.25 < *CPIA* < 3.75)	40	150	250	20	20
Strong (*CPIA* ≥ 3.25)	50	200	300	25	22

Source: The IMF-World Bank Debt Sustainability Framework (DSF).

Note: The World Bank's CPIA (the Country Policy and Institutional Assessment) is a broad indicator of the quality of a country's present policy and institutional framework. It is based on 16 criteria which are grouped into four clusters: economic management, structural policies, policy for social inclusion and equity, and public sector management and institutions.

APPENDIX II. EXTERNAL DEBT DISTRESS EPISODES AND THE IDENTIFICATION CRITERIA

	Distress Episodes			Criteria for determining the start year			
	Start Year	End Year	Duration in years	Arrears>5 % of Debt	Paris Club	IMF Financing >80 % of Quota	KN Sample, Start Year
Armenia	1994	1997	4	√	-	-	…
Azerbaijan	1994	1996	3	√	-	-	…
Burundi	1998	2009	12	√	-	-	1998
Burkina Faso	1986	2002	17	√	-	-	1987
Cote D'Ivoire	1981	2009	29	-	-	√	1981
Cameroon	1986	Ongoing 1/	25	√	-	-	1987
Democratic Republic of Congo	1975	Ongoing 1/	36	√	-	-	…
Republic of Congo	1985	Ongoing 1/	26	√	-	-	1985
Comoros	1987	Ongoing 1/	24	√	-	-	1987
Ethiopia	1991	Ongoing 1/	20	√	-	-	1991
Georgia	1994	2004	11	√	-	-	…
Gambia	1982	1986	5	-	-	√	…
Guinea Bissau	1982	Ongoing 1/	29	√	-	-	1981
Guyana	1976	Ongoing 1/	35	-	-	√	1978
Honduras	1982	2005	24	-	-	√	1979
Haiti	1985	1995	11	√	-	-	1978
Kyrgyz Republic	2002	2005	4	-	√	-	…
Kenya	1991	2009	19	√	-	-	1992
Liberia	1979	Ongoing 1/	32	-	-	√	1980
Moldova	1994	Ongoing 1/	17	√	-	-	…
Madagascar	1980	Ongoing 1/	31	-	-	√	1980
Mozambique	1984	Ongoing 1/	27	-	√	-	…
Mauritania	1978	Ongoing 1/	33	√	-	-	…
Malawi	1979	1988	10	-	-	√	1979
Malawi	2001	2006	6	-	√	-	…
Niger	1983	Ongoing 1/	28	-	√	√	1983
Nigeria	1986	2005	20	-	-	-	1986
Nicaragua	1983	Ongoing 1/	28	√	-	-	…
Pakistan	1981	1983	3	-	√	-	…
Pakistan	1999	2001	3	-	-	-	1995
Rwanda	1994	2007	14	√	-	-	1994
Sudan	1977	Ongoing 1/	34	√	-	-	…
Senegal	1981	2004	24	-	√	√	1980
Sierra Leone	1976	Ongoing 1/	35	√	-	-	…
Somalia	1981	Ongoing 1/	30	√	-	-	1981
Sao Tome and Principe	1986	2007	22	√	-	-	…
Togo	1978	Ongoing 1/	33	√	-	-	…
Tajikistan	1994	2002	9	√	-	-	…
Uganda	1976	2007	32	√	-	-	…
Vietnam	1988	2005	18	√	-	-	1988
Zambia	1978	Ongoing 1/	33	-	-	√	…
Zimbabwe	2000	Ongoing 1/	11	√	-	-	2000

1/ Ongoing as of 2010.

Source: Author's calculations. Debt distress episodes are identified by the presence of (i) arrears on the external debt exceeding a certain threshold; (ii) Paris Club debt restructuring or rescheduling; or (iii) Substantial amount of IMF lending for urgent financing needs.

APPENDIX III. VARIABLES USED IN THE PROBIT REGRESSIONS

Variables	Description	Source
Identification of debt distress	*Arrears on the PPG external debt (principal and interest)*	WB International Debt Statistics
	Paris Club debt rescheduling and cancellations	Paris Club
	Purchases under IMF arrangements (SBAs, CFFs, and Oil Facility)	IMF International Financial Statistics.
Debt burden indicators	*Present value of PPG external debt*	World Bank internal study Dikhanov (2004) and later updates from WB
	Debt service on PPG external debt	WB International Debt Statistics
Growth	*Real GDP growth*	IMF WEO
Fiscal Policy	*Fiscal balance to GDP*	IMF WEO
Monetary policy	*Inflation rate*	IMF WEO
External vulnerability	*Gross international reserves in months of imports*	IMF WEO
	Current account deficit to GDP	IMF WEO
	Volume growth in exports of goods	IMF WEO
	Black market premium	Reinhart and Rogoff (2004)
	Net resource transfers (net transfers on debt+FDI+official grants-FDI profits)	WB International Debt Statistics
	Export concentration in commodities	WB WDI
Institutions	*Private property rights*	ICRG, Fraser Institute, Heritage Foundation
Shock variables	*Growth in terms of trade*	IMF WEO
	Natural Disasters (population affected)	Emergency Events Database (EM-DAT) published by the Center for Research on the Epidemiology of Disasters (CRED).
	Real oil prices (ASPS)	Oil prices deflated by US CPI (WEO)
	Real non-oil commodity prices	Non-oil commodity prices prices deflated by US CPI (IMF WEO)
	World trade (index number 2000=100)	IMF WEO
	Real US interest rate	IMF WEO

APPENDIX IV. STANDARD DEVIATIONS OF POLICY VARIABLES IN THE MI INDEX

Change in reserves (months of imports)	0.8
Inflation (%)	15.2
Exchange rate depreciation (%)	15.8
Government balance to GDP (%)	5.9
Black market premium	15.8

Source: Author's calculations.

Note: Standard deviations are calculated for the unrestricted sample after removing outliers.

APPENDIX V. THE LIST OF COUNTRIES

1	Albania	28	Mauritania
2	Armenia	29	Moldova
3	Azerbaijan	30	Mongolia
4	Bangladesh	31	Mozambique
5	Benin	32	Nepal
6	Bhutan	33	Nicaragua
7	Bolivia	34	Niger
8	Burkina Faso	35	Nigeria
9	Burundi	36	Pakistan
10	Cameroon	37	Papua New Guinea
11	Chad	38	Republic of Congo
12	Comoros	39	Rwanda
13	Côte d'Ivoire	40	Sao Tome and Principe
14	Democratic Republic of Congo	41	Senegal
15	Ethiopia	42	Sierra Leone
16	Gambia	43	Somalia
17	Georgia	44	Sri Lanka
18	Guinea Bissau	45	Sudan
19	Guyana	46	Tajikistan
20	Haiti	47	Tanzania
21	Honduras	48	Togo
22	India	49	Uganda
23	Kenya	50	Uzbekistan
24	Kyrgyz Republic	51	Vietnam
25	Lao PDR	52	Zambia
26	Madagascar	53	Zimbabwe
27	Malawi		

APPENDIX VI. INDICATORS OF MODEL FIT FOR THE KN REGRESSIONS

	False Alarms	Missed Crises	Overall Error
NPV of External Debt/GDP	0.28	0.42	0.29
NPV of External Debt/Exports	0.16	0.61	0.21
External Debt Service/Exports	0.21	0.38	0.23

Source: Data from Berg, Berkes, Pattillo, Presbitero, and Yakhshilikov (2014).

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