Clustered Sovereign Defaults*

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Abstract

Clustered sovereign default is a recurring phenomenon, yet there is a lack of quantitative models to study it. This paper introduces a quantitative framework aimed at untangling various latent shocks and examining the mechanisms that precipitate clustered defaults among countries. The model incorporates financial frictions into a sovereign default framework and accommodates global shocks that impact both borrowing countries and lenders. Through a joint estimation of structural parameters governing the output process of multiple countries, the global shocks are extracted. The ability of the framework to effectively capture and analyze multiple crisis episodes, such as the 1980s Latin American debt crisis, the Asian financial crisis, and the European debt crisis, validates the joint robustness of the model and the estimation process of the driving forces. The framework uncovers the crucial role of global transitory shocks in producing clustered defaults, especially in the presence of convex default costs. Additionally, contrary to what is commonly believed, the framework shows that the Volcker interest rate hike was not a decisive factor for the 1980s clustered default.

JEL classification: F34, F44, H63.
Keywords: Sovereign default, Clustered default, Latin-American debt crisis, Sovereign debt

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1 Introduction

Mexico's economic problems stemmed from both external and internal factors. The external causes were a weakening world oil market since 1981 and higher world interest rates beginning in 1980.

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A recurring theme among instances of clustered defaults is the influence of global shocks. Notably, in the 1980s, Mexico and several other Latin American countries had similar experiences with global shocks such as a decrease in oil prices and an increase in the world interest rate. These shocks resulted in output declines and more expensive borrowing conditions. Similarly, the European debt crisis was triggered by the Great Recession, which caused a global slowdown. The Asian financial crisis, on the other hand, was sparked by a loss of investor confidence and currency speculation in the affected countries. Despite the recurrence of clustered defaults and the fact that such defaults generally follow global output slumps or hikes in world interest rates, there is still a lack of a quantitative framework that examines the contributions of various global and country-specific shocks to the occurrence of clustered defaults.[1] The absence of such a framework makes it difficult to differentiate the impact of interest rate hikes from that of output shocks in causing clustered defaults. Therefore, this study aims to develop a comprehensive quantitative framework that combines a multicountry econometric estimation with a sovereign default model to identify and disentangle the factors that lead to clustered defaults.

To ascertain the plausibility of global shocks as a primary cause of clustered defaults, it is necessary to include both global and country-specific output shocks in the framework.[2] Therefore, this paper incorporates global shocks to both the transitory and permanent components of output, country-specific shocks to both the transitory and permanent components of output, as well as fluctuations in the world interest rates. Within this framework, the study assesses the significance of global output shocks (transitory vs permanent) and interest rate fluctuations in causing clustered defaults by posing three questions: (1) Are global shocks essential for explaining clustered defaults? (2) Which global shocks (i.e., global shocks to transitory or permanent components of output or world interest rate fluctuations) are relevant? (3) Can an interest rate hike cause clustered defaults? The first main finding of the

[1]The recurrence is highlighted by the periods in the late 1820s, early 1870s, early 1930s, and early 1980s which were all periods in which many countries defaulted in a relatively short time.

[2]The empirical literature by Reinhart and Rogoff (2011), Bordo and Murshid (2000), and Kaminsky and Vega-Garcia (2016) suggested an important role of global shocks in causing clustered defaults.

paper is that the primary driver of clustered defaults is a global shock to the transitory component of output. The second finding reveals that a world interest rate hike can sometimes result in clustered defaults. However, contrary to popular belief, the Volcker interest rate hike was not a decisive factor for the clustered default of 1982. Moreover, the results indicate that the interest rate did not have a notable impact on the Asian financial crisis or European debt crisis, as the fluctuations in global interest rates were relatively subdued during both periods.

The quantitative framework in this paper consists of two parts: a sovereign default model and a multicountry econometric estimation. These two parts are tightly connected, as the reduced-form estimation equation can be derived from the microfounded model. The estimation part of the framework disentangles various shocks experienced by countries, while the model explains the underlying economic mechanisms through which these shocks lead to defaults. By feeding the model with the shock processes obtained from the estimation, the paper investigates the impact of various shocks on default decisions.

The estimation part is crucial because it expands significantly on the existing sovereign default literature. It postulates output processes for multiple countries and accommodates the presence of five shocks—country-specific transitory and permanent shocks to output; global transitory and permanent shocks to output; and world interest rate fluctuations. The presence of two global shocks and the world real interest rate fluctuations in the output process of every country makes it necessary to perform a joint estimation. Thus, the estimation of the parameters is performed with the output growth of all the countries and the world interest rate as observables.

The model part is built on the quantitative work of Arellano (2008) and Aguiar and Gopinath (2006). The model incorporates various elements from existing work in the literature to derive a microfounded estimation equation, which shows the tight connection with the estimation and provides a structural interpretation of the estimated parameters. A significant aspect of the model is its ability to capture the effects of global interest rate fluctuations on countries' output, allowing an examination of the quantitative impact of interest rate hikes in comparison to other output shocks.

The combination of the estimation and the model enables the identification of four distinct channels through which global shocks can impact defaults. The estimation captures the effect of global output shocks and interest rate hikes on the output of borrowing countries. The former includes global output declines due to various factors, such as oil shocks; a global recession, etc. This is the first channel that can impact clustered defaults and is called the *global output shocks* channel. The latter pertains to the endogenous response of output in the borrowing economy to a world interest rate hike. Although this can arise for various reasons, the model microfounds this channel through the labor market. The second channel is therefore called the *output response to world interest rate* channel. Having a fluctuating, rather than fixed, world interest rate can also make borrowing more expensive for the countries after interest rate hikes. This is the third channel, which is called the *debt pricing through world interest rate* channel. Although the main part of the paper considers risk-neutral lenders, in the last section, the paper allows for risk-averse lenders. This introduces the fourth channel, which is called the *correlated shocks to risk-averse lenders* channel.

The *debt pricing through world interest rate* channel works through an increase in the risk-free rate, which also raises the interest rate on the debt of the borrowers in order for lenders to remain indifferent between holding risk-free and risky assets. This increase causes a decrease in the price of government debt, thereby making borrowing costly and influencing default decisions. The *output response to world interest rate* channel is captured through the labor market and the financial friction. The presence of working capital constraint requires firms to borrow a fraction of their wage bill in advance. This borrowing through intraperiod loans becomes more costly whenever the world interest rate rises. This causes the equilibrium quantities of labor and output to decrease. Thus, an increase in the interest rate endogenously affects output and influences the default decision. Although a tightly connected estimation is essential to quantitatively capture the impact of interest rates on output, the model provides a structural insight into the underlying mechanism.

Equipped with a general framework to investigate clustered defaults, this paper focuses on identifying such episodes in the data to apply the framework. The analysis reveals the 1980s as a period of clustered default at the global level, while the Asian financial crisis and the European debt crisis stand out as regional episodes. Among these three episodes, the Latin American debt crisis was unique as the crisis was preceded by both global output shocks and world interest rate hikes and consisted of 22 defaults within six years.[3] This makes the 1980s an ideal period for assessing the impact of global shocks and the Volcker interest rate hike on clustered defaults. Therefore, this paper primarily examines the 1980s episode while also analyzing other significant default episodes, such as the Asian financial crisis and the European debt crisis. An important contribution of this paper is the development of a framework that can be applied to various default episodes involving multiple global shocks. Therefore, in addition to analyzing past episodes, this framework can also be utilized to understand the potential effects of the current interest rate increases if they are accompanied by a global recession.

[3]This period is marked by large global output shocks as well as interest rate increases: Many countries faced a 10-15% fall in GDP over 2-3 years and a 13 p.p. increase in the fed-funds rate over 3 years.

Applying the framework to the Latin American debt crisis by feeding the model with the shock processes, the clustered default of 1982 is reproduced, providing joint validation for both the model and the estimation process. However, despite incorporating four channels through which the world interest rate can have an effect on default decisions, the Volcker interest rate increase was not a decisive factor for the clustered default of the 1980s. Moreover, this paper finds that a global shock to the transitory component of productivity is most important in generating the clustered defaults. This result contradicts the findings of Aguiar and Gopinath (2006), who attributed defaults to permanent rather than transitory shocks. The mechanism that drives this counterintuitive result depends on three features: the convex output costs of default, the high standard deviation, and the high persistence of global transitory shocks. The convex output cost assumption is key because it makes transitory shocks more important than permanent shocks in leading countries to default. The rationale behind this outcome lies in the way in which convex costs interact with transitory and permanent shocks. Following a negative transitory shock, the detrended output briefly declines, but eventually rebounds. Consequently, considering the convex cost of default, deferring default until the following period would result in substantially greater output costs compared to defaulting today. As a result, countries tend to frontload the default decisions following transitory shocks. However, following a negative permanent shock, the detrended output declines not only today but even more in the future. With the convex cost of default, postponing default until the following period would incur a much lower output cost than defaulting today, leading countries to delay default decisions.

Finally, it is important to highlight the tightly connected nature of the estimation and model. This nature provides a structure to the quantitative analysis and, at the same time, keeps the results independent of the model. The independence stems from the simplicity of the reduced-form estimation equation which can be used even in the absence of the model. However, the model provides a structure for the estimation equation. For instance, the estimation uncovers the global output shocks that countries face while the model captures all such shocks as TFP shocks; the estimation uncovers the output decline coming from the world interest rate increase while the model captures this endogenous channel through the labor market. Without the estimation component, any claim downplaying the impact of the Volcker interest rate hike and attributing the 1980s clustered default solely to the output decline would have been incomplete. This is because the possibility that output decline is an endogenous response to increased interest rates cannot be ruled out. By capturing the effect of interest rate fluctuations on the output process of borrowing countries, the estimation process not only makes a significant contribution to this literature but also resolves this issue.

Related Literature The model built in this paper is founded on the seminal work of Eaton and Gersovitz (1981); and the subsequent works of Arellano (2008) and Aguiar and Gopinath (2006). In contrast to those papers, this paper focuses on clustered defaults by studying the impact of global shocks on default decisions. An important element of the model is capturing the effect of the world interest rate shocks, through the *debt pricing through world interest rate* channel and the *output response to world interest rate* channel, on default decision. However, the key element is the multicountry estimation, which is tightly connected with the model. To capture the effect of changes in world interest rate shocks through a model, this paper uses working capital constraint, which is borrowed from the small open economy setting of Neumeyer and Perri (2005) and Uribe and Yue (2006). This constraint is specifically important here because it enables a parallel between the estimation and the model by capturing the *output response to world interest rate* channel in both places.

The joint Bayesian estimation of 196 parameters with data on the output of 24 countries and world interest rate is unique, both in type and scale, in the sovereign default literature. This idea of the estimation process is borrowed from Kose et al. (2003), Kose et al. (2008), Miyamoto and Nguyen (2017), etc., which use a similar dynamic factor method approach to disentangle different global and country-specific shocks. Among the various parameters, the interest rate elasticity of output is also estimated for all 24 countries. This elasticity, estimated using the Bayesian methodology, matches those obtained in the empirical literature on monetary policy transmission, thereby providing another validation to the model and the estimation procedure. Georgiadis (2016) and Dedola et al. (2017) use the VAR methodology for estimating the effect of monetary shocks in the US on the rest of the world, while Iacoviello et al. (2018) use the local projections method. In contrast, this paper microfounds a transmission mechanism in a general equilibrium model and estimates the structural parameters of the model to capture the effect of interest rate changes, making a methodological contribution to the literature.

The multicountry setup used in this paper differs from recent contagion papers such as Arellano et al. (2017) and Park (2014) which study risk contagion between countries. While contagion papers tend to concentrate on the contemporary European debt crisis, this paper develops a framework that can be used to study any such crisis episode, including the clustered defaults of the 1980s, the European debt crisis, and the Asian financial crisis. In contrast to contagion papers, which emphasize the role of risk-averse lenders in facilitating cross-country interactions, this study highlights the impact of global output shocks and world interest rate fluctuations. In the robustness analysis, this paper also incorporates risk-averse lenders in addition to the existing channels to study the effect of correlated shocks between lenders and borrowing countries.

The result that the Volcker interest rate hike was not a decisive factor for the clustered default of 1982 concurs with Almeida et al. (2018) who also conclude that, for the Mexican default of 1982, Mexico would have defaulted even in the absence of an interest rate hike. In a slightly different model setting, Tourre (2017) studies the Volcker period but concludes that high short-term US interest rates and floating rate dollar-denominated debt led to a wave of sovereign defaults. The results in this paper also concur with Johri et al. (2022) about the role that shocks to the world interest rate play in explaining variation in sovereign spreads, borrowing levels, and cross-country correlation in spreads. However, the main focus of this paper remains to capture the effect of world interest rate fluctuations on clustered default decisions.

The rest of the paper is structured as follows. Section 2 defines idiosyncratic and clustered defaults. Section 3.1 builds the model of clustered sovereign default. Section 3.2 discusses the estimation process of global and country-specific shocks. Section 3.3 discusses the estimation results. Section 3.4 discusses the model results. Section 4 concludes.

2 Clustered and Idiosyncratic Sovereign Defaults

This paper refers to the definition of clustered defaults from Kaminsky and Vega-Garcia (2016). This definition involves identifying periods in which a significant number of countries defaulted on their external debt obligations and grouping all the defaults that occurred during these periods as clustered defaults.

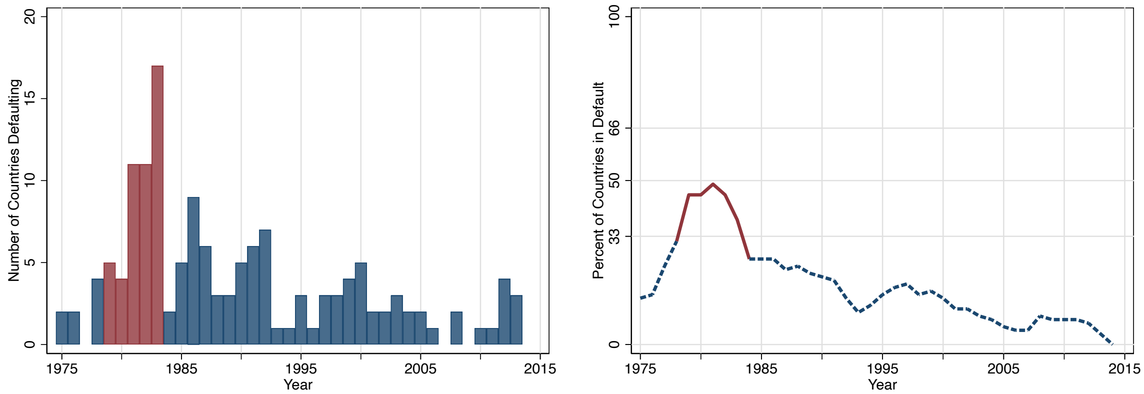
I start by constituting 5-year rolling windows for every year.[4] For each window, I count the number of countries that defaulted in the 5-year window. If the total number of defaulting countries is more than one-third of all the countries (defaulted at least once during 1975-2014), I call this a "window of clustered default". All the default episodes that belong to the starting year of that 5-year window are subsequently called "clustered default episodes".[5] All the remaining defaults are "idiosyncratic defaults".

Given the definition of clustered and idiosyncratic defaults and a total of 92 countries that defaulted at least once in the period 1975-2014, any 5-year window with 31 or more countries defaulting is classified as a clustered default window. This leads to the defaults in 1979, 1980, 1981, 1982, and 1983 being classified as clustered defaults as evident from Figure 1. It is important to highlight that while the definition may appear to be constrained by the use

[4]The data contains defaults from 1975 to 2014 and, therefore, the rolling windows are from 1975 to 2010.

[5]The window 1983-1987 contains 35 different defaulters. Of these, 17 countries defaulted in 1983, 2 in 1984, 5 in 1985, 7 in 1986, and 4 in 1987. Only the defaults in the first year of the window–i.e., 1983–are considered a part of the clustered default episode, and not those in the subsequent years of this 5-year rolling window.

Figure 1: Countries defaulting in a 5-year rolling window



The left panel shows the number of countries in default every year from 1975 to 2014. The right panel shows the fraction of countries defaulting in a 5-year rolling window starting every year. The maroon line highlights the period of clustered defaults, and the blue line highlights idiosyncratic defaults. Data source: Uribe and Schmitt-Grohé (2017).

of a one-third fraction, the primary objective is to identify situations in which a significant number of countries defaulted simultaneously. The defaults that took place between 1979 and 1983 are clear illustrations of such cases, irrespective of the specific threshold employed.

Table 1 looks at the data of 92 defaulting countries in more detail. A total of 146 defaults by 92 countries are identified: 48 of these defaults are classified as clustered defaults and 98 of these as idiosyncratic defaults.

Table 1: Default classification: World level and region level

Region Name	No. of Defaulting Countries	Total Number of Defaults	Number of Clustered Defaults	Years of Default for Clustered Defaults
World	92	146	48	1979-1983
Africa & Middle East	42	65	34	1979-1985
Latin America & Caribbean	28	51	22	1978-1983
Europe & Central Asia	15	19	8	1988-1991
Rest of Asia & Pacific	7	11	4	1981-1983,1993-1997

Alternatively, if one believes that the shocks, defaults, business cycles, etc., are more strongly correlated across countries that are geographically close, systemic and idiosyncratic defaults can also be defined at the regional level. Table 1 shows that a regional classification is also able to capture default episodes such as the Latin American debt crisis, the Asian financial crisis, the African debt crisis, and the Russian default. Although most of this paper focuses on the Latin American debt crisis, I show robustness to other regional classifications.

3 Model and the Multicountry Estimation

This section presents a sovereign-default model and a corresponding multicountry estimation exercise. Section 3.1 begins with a basic sovereign default model where the model accounts for the influence of global shocks on the economic output of individual countries, while recognizing the additional impact of interest rate fluctuations on the output dynamics. Subsequently, In Section 3.2 I introduce a comprehensive estimation framework in a multicountry setting that captures the impact of global shocks on the output of each country. The reduced-form estimation process for global and country-specific shocks, despite being virtually independent of the model, elaborates the possible structural relationship between the estimation framework and various model components.

3.1 The Model Economy

The model is based on the framework of Eaton and Gersovitz (1981) and is related to the quantitative work of Arellano (2008) and Aguiar and Gopinath (2006). It consists of four agents: households, firms, a benevolent planner or government, and foreign lenders. Unlike households, which do not engage in direct borrowing from the global economy, the government issues debt and allocates the proceeds to households. Within this framework, households make decisions related to consumption and labor supply, while the government solves the borrowing and repayment problem.

Firms produce the final good by employing labor, but their labor demand is limited by the working capital requirement. Firms secure intraperiod loans to finance the working capital and do not default on these loans. The government, however, has no commitment device and is free to default if it is optimal. Foreign lenders charge a rate to the government, adjusted for the risk of default.

The equilibrium output is determined by the labor supply choice of households and labor demand from firms. Thus, the equilibrium output is influenced by country-specific and global TFP shocks, as well as the world interest rate through the working capital constraint. This equilibrium output corresponds to the general framework of the estimation.

Households: The household utility function takes the form of GHH preferences from Greenwood et al. (1988) and is concave, strictly increasing and twice differentiable.

$$U(C_t, L_t^s) = \left[\frac{\left(C_t - \frac{\Gamma_{t-1}(L_t^s)^{\omega}}{\omega} \right)^{1-\gamma}}{1-\gamma} \right]$$

where C_t denotes consumption, and L_t^s denotes labor supply. γ is the Arrow-Pratt measure of relative risk-aversion, $1/(\omega-1)$ is the Frisch elasticity of labor supply, and Γ is the scaling factor used to detrend the variables that grow over time.

In each period, households receive wage income, $w_t L_t^s$, as well as profits generated by the firms, Π_t^f. While households cannot borrow from international sources, the government acts as their proxy in making borrowing decisions, and households receive financial transfers, T_t, from the government. Consequently, the household's budget constraint can be expressed as follows:

$$C_t = w_t L_t^s + \Pi_t^f + T_t \tag{1}$$

Taking wages, profits and transfers as given, households maximize the present discounted value of their lifetime utility subject to the budget constraint. The first-order conditions with respect to labor and consumption can be reduced to:

$$(L_t^s)^{\omega-1} = w_t/\Gamma_{t-1} \tag{2}$$

which is the standard labor supply equation. Equations 1 and 2 together constitute the household equilibrium conditions.

Firms: At each time period t, firms demand labor to produce output. To hire labor, firms need working capital as a portion of the wage expenditure that must be kept in advance. To finance working capital, firms secure intraperiod loans from foreign lenders. Firms meet their obligations on these intraperiod loans, ensuring the repayment of $(1+r_t^*)M_t$ at the end of period t for a loan amount M_t that they received at the start of the same period.

Assuming that the technology in country c at time t is $A_t^c = e^{z_t^c + \alpha_z^c z_t^w} X_t^c (X_t^w)^{\alpha_X^c}$, the output of country c at time t is written as:

$$Y_t^c = A_t^c (L_t^{d,c})^{\alpha_L^c}$$

where $L_t^{d,c}$ represents the labor demand of country c at time t, and α_L^c mimics the labor share in output. Moreover, the technology for every country c depends on four components of TFP (a superscript c represents a country, and a superscript w represents the world). There are two country-specific components of TFP: z^c and X^c, a transitory and a permanent component, respectively. Similarly, there are two global components of TFP: z^w and X^w, once again, a transitory and a permanent component. The growth rate in the permanent components of productivity is given as: $g_t^c = X_t^c/X_{t-1}^c$ and $g_t^w = X_t^w/X_{t-1}^w$. Finally, the global components affect the TFP of every country in a different way, governed by parameters α_z^c and α_X^c. Henceforth, I omit the country superscript c for convenience.

Firms maximize the present discounted value of lifetime profit, where the profit of the firm at time t is given as:

$$\Pi_t^f = A_t(L_t^d)^{\alpha_L} - w_t L_t^d + M_t - (1+r_t^*)M_t \tag{3}$$

subject to the period-by-period working capital constraint:

$$M_t \geq \eta w_t L_t^d \tag{4}$$

The two first-order conditions, with respect to L_t^d and M_t, can be condensed into a labor demand equation:

$$\alpha_L A_t (L_t^d)^{\alpha_L - 1} = (1 + \eta r_t^*) w_t \tag{5}$$

which captures the essence of the working capital constraint. Thus, Equations 4 and 5 summarize the equilibrium condition for the firm, where the former holds with an equality.

Solving Equations 2 and 5 provides us with the equilibrium quantity of labor, which can subsequently be employed to derive the output as a function of technological shocks and the global interest rate:

$$\frac{Y_t}{\Gamma_{t-1}} = \left(\frac{e^{z_t + \alpha_z z_t^w} X_t (X_t^w)^{\alpha_X}}{\Gamma_{t-1}}\right)^{\frac{\omega}{\omega - \alpha_L}} \left(\frac{\alpha_L}{1 + \eta r_t^*}\right)^{\frac{\alpha_L}{\omega - \alpha_L}}$$

where the scaling factor, $\Gamma_{t-1} = \bar{\Gamma} \cdot g_{ss} \, (g_{ss}^w)^{\alpha_X} \cdot X_{t-1}(X_{t-1}^w)^{\alpha_X}$, is chosen to have a detrended output of 1 in the steady state.[6] Using this equation, the growth rate of output can be expressed as:

$$\begin{aligned}\Delta y_t \equiv \Delta \ln Y_t = {} & [\ln(g_{ss}) + \alpha_X \ln(g_{ss}^w) - (\psi - 1)\eta \Delta r_t^*] + \psi \Delta z_t + \psi \alpha_z \Delta z_t^w + \psi \ln(g_t / g_{ss}) \\ & + \psi \alpha_X \ln(g_t^w / g_{ss}^w) - (\psi - 1)\ln(g_{t-1}/g_{ss}) - (\psi - 1)\alpha_X \ln(g_{t-1}^w / g_{ss}^w)\end{aligned}$$

Derived from the model, this equation possesses the requisite generic qualities in its reduced form for empirical applications. Thus, the estimation framework utilizes this equation effectively to disentangle latent global shocks that influence the output of multiple countries. Section 3.2 presents this output equation and provides the details of the multicountry estimation.

The estimation equation, however, emerges directly from the model, and as a consequence, the parameters it encompasses have well-defined structural microfoundations. As an illustrative example, the coefficient $\psi \equiv \omega/(\omega - \alpha_L)$, depends on two key structural parameters: the labor share and the Frisch elasticity of labor supply. Notably, when ψ equals 1,

[6] A value of $(\alpha_L/(1+\eta r^*))^{\frac{\alpha_L}{\omega - \alpha_L}}$ for $\bar{\Gamma}$ reduces the detrended output to 1 in the steady state.

it is essential to emphasize that this estimation equation simplifies to a scenario in which a country's economic output remains unaffected by fluctuations in the global interest rate. Intuitively, if the economic output is entirely decoupled from labor (i.e., $\alpha_L = 0$), ψ becomes equal to 1, resulting in the output being the same as the productivity. Similarly, when the Frisch elasticity is remarkably low (indicating a high value of ω), this implies a vertical labor supply curve. Consequently, the equilibrium labor quantity becomes fixed once again, causing the output to be determined exclusively by productivity. Finally, it is noteworthy that the sensitivity of output to global interest rates is contingent not only on ψ but also on η, the fraction of the wage bill that is required in advance due to the working capital constraint. Thus, the interplay of all three elements—labor supply, labor demand, and the working capital constraint—is of paramount importance in comprehending the impact of fluctuations in the world interest rate on a borrower's economic output.

Government: The aim of the government is to maximize the utility of households. Unlike households, the government has access to foreign credit markets and can borrow by issuing single-period non-state-contingent debt at price q_t. Additionally, the government repays any debt that is outstanding from the previous period. However, repayment of the outstanding debt is costly; thus, the government might find it optimal to default.

If the government chooses not to default and repays its debt d_t, it can choose a new debt level d_{t+1} to borrow. In this case, the amount borrowed, the net of repayments, is transferred by the government to the household.

$$T_t = q_t d_{t+1} - d_t \tag{6}$$

The continuation payoff from not defaulting (and repayment of the debt), is:

$$V^C(d_t; s_t) = \max_{C_t, d_{t+1}} [U(C_t, L_t) + \beta E_s[V^G(d_{t+1}; s_{t+1})] \tag{7}$$

subject to the equilibrium conditions of households and firms, along with the government transfer condition. Here, $s_t \equiv \{z_t, z_t^w, X_t, X_t^w, r_t^*\}$, and V^G represents the value function when the agent enters the period with good financial standing.

A country starts a period in good standing, $f_t = 0$, when it possesses access to credit markets. In such circumstances, as previously illustrated, the government has the option to honor the debt, thereby ensuring continued access in the subsequent period, $f_{t+1} = 0$. Alternatively, the government may opt for immediate default ($F_t = 1$). In the event of default, the government's financial status shifts to unfavorable, $f_t = 1$, as it loses access to debt for the current period. Furthermore, with no debt to repay, government transfers automatically diminish to zero, accompanied by an exogenously determined reduction in economic output. This decline in output is governed by a nonzero function ϕ, which, in turn, curtails both output and consumption, C_t^A. The continuation payoff resulting from default is expressed as follows:

$$V^B(s_t) = U(C_t^A, L_t^A) + \beta E_s\{\lambda V^G[(0; s_{t+1}) + (1-\lambda)V^B(s_{t+1})\} \tag{8}$$

subject to the equilibrium conditions of both households and firms, and in the absence of government transfers, $T_t = 0$. Furthermore, we have $C_t^A = Y_t^A = (1 - \phi(s_t))A_t L_t^{\alpha_L}$ where ϕ represents a function governing the exogenously determined reduction in output, which assumes a value of 0 under normal circumstances. The superscript A denotes the autarky scenario. When the government defaults in the current period, there exists a probability of λ for it to be redeemed in the subsequent period. In the event of redemption, the government commences the next period with no debt and regains access to financial markets, $f_{t+1} = 0$. However, should the government remain in a precarious financial state with a probability of $(1-\lambda)$, it will be devoid of market access in the following period, $f_{t+1} = 1$.

As indicated, when the government commences a specific period in a favorable financial position, it faces a choice between two actions—either continuing the debt repayment or opting for default—with the decision contingent upon the evaluation of flow utilities:

$$V^G(d_t; s_t) = \max\{V^C(d_t; s_t), V^B(s_t)\} \tag{9}$$

The default rule can be expressed as follows:

$$F(d_t; s_t) = \begin{cases} 1 & \text{if } V^B(s_t) > V^C(d_t; s_t) \\ 0 & \text{otherwise} \end{cases} \tag{10}$$

Foreign Lenders: For the majority of the analysis, it is assumed that lenders exhibit risk neutrality, and this choice is motivated by two primary considerations. First, the model features five exogenous state variables, denoted as $s_t \equiv \{z_t, z_t^w, X_t, X_t^w, r_t^*\}$, alongside one endogenous state variable, d_t, which renders the process of solving the model and calibration notably time-consuming. Second, a risk premium, constructed by contrasting Moody's BAA-rated and AAA-rated bonds, has already been incorporated into the world interest rate to account for the heightened risk aversion among lenders during financial crises. Nevertheless, for the sake of comprehensiveness, Section 3.4.5 explores the scenario in which lenders exhibit risk aversion. Given that the equations associated with risk-neutral lenders are encapsulated within the framework of risk-averse lenders, the equations applicable to risk-averse lenders are presented.

Foreign lenders are considered to effectively hedge against all idiosyncratic shocks by diversifying their investments. However, global shocks do exert an influence on the wealth of these foreign lenders, as indicated by the parameters α_z^{US} and α_X^{US}. The estimated values for these parameters are determined to be $\alpha_z^{US} = 0.0006$ and $\alpha_X^{US} = 0.01$, respectively. This shows that the impact of global transitory shocks is insignificant compared to the impact of global permanent shocks. Thus, only the latter is included to capture the wealth of lenders.

Following Du et al. (2020), it is postulated that risk-averse foreign lenders adhere to a utility function characterized by Constant Relative Risk Aversion (CRRA), featuring a risk-aversion coefficient denoted as γ^* and a discount rate of β^*. Consequently, their stochastic discount factor (SDF) can be expressed as follows:

$$M_{t+1}^* = \beta^* \left(\frac{(X_{t+1}^w)^{\alpha_X^{US}}}{(X_t^w)^{\alpha_X^{US}}} \right)^{-\gamma^*} = \beta^* (g_{t+1}^w)^{-\gamma^* \alpha_X^{US}}$$

where a risk-aversion coefficient of zero, $\gamma^* = 0$, takes us to the case of risk-neutral lenders. In this case, the SDF is equivalent to the discount rate, leading to $M_{t+1}^* = \beta^*$.

In this particular scenario, the asset pricing equation for sovereign lending can be defined as follows:

$$q_t = E_s[M_{t+1}^* \mathbb{I}\{V^C(d_{t+1}; s_{t+1}) > V^B(s_{t+1})\}] \tag{11}$$

where the symbol $\mathbb{I}$ denotes the indicator function. An analogous pricing condition applies to the risk-free asset:

$$1 = (1 + r_t^*) E_t[M_{t+1}^*]$$

Equilibrium: In equilibrium, households, firms, the government, and lenders engage in the optimization of their respective objectives, while ensuring equilibrium in the markets for goods, labor, and debt (lenders choose a price level of debt so that they obtain zero expected profits). Formally:

A sequence of variables: $\{C_t, L_t, M_t, \Pi_t^f, d_{t+1}, F, T_t, w_t, q_t\}$ and value functions $\{V_t^C, V_t^B, V_t^G\}$ constitute a recursive equilibrium, provided the initial debt level, d_t, TFP processes: $\{z_t, z_t^w, g_t, g_t^w\}$ and the world real interest rate process, $\{r_t^*\}$, if:

1. Households choose $\{C_t, L_t^S\}$ to solve Equations 1 and 2 given the wage rate w_t, government transfers T_t, and profits from firms Π_t^f.

2. Firms choose $\{\Pi_t^f, M_t, L_t^D\}$ to solve Equations 3, 4, and 5 given wage rate w_t and world real interest rate r_t^*.

3. The wage rate, w_t, is such that the labor market clears $L^S = L^D$ in cases of both

default and continuation.

4. The government chooses $\{d_{t+1}, F_t, T_t\}$ to solve Equations 6, 7, 8, 9 and 10 given the starting debt level, d_t, the world real interest rate process, $\{r_t^*\}$, and the solutions to household and firm optimization problems.

5. Lenders choose the equilibrium bond price, q_t, Equation 11, to clear the debt market.

3.1.1 Calibration of Parameters

The calibration process involves the determination of individual parameters for each country. Specifically, three of these parameters, namely the coefficient of relative risk aversion for the borrowing country (γ), the world interest rate (r^*), and the coefficient of relative risk aversion for the lender (γ^*), are assumed to be uniform across all countries. The CRRA coefficient (γ) is set at a value of 2, in accordance with the literature: Mendoza (1991), Arellano (2008), etc. Similarly, γ^* is set at 0 for cases in which lenders exhibit risk neutrality, and 2 when lenders demonstrate risk aversion. The annual world interest rate, denoted as r^*, is calibrated based on the average value spanning from 1960 to 2014, resulting in $r^* = 3.67\%$. This figure not only encompasses the fed-funds rate but also accounts for a risk premium, which is quantified using the spread between Moody's AAA-rated and BAA-rated bonds.

The steady-state growth rate varies across countries. Consequently, g_{ss}^c is determined by computing the average annual growth rate based on data spanning from 1960 to 2014 for the respective countries. To calibrate the probability of re-entry into financial markets, denoted as λ, data from sources such as Reinhart and Rogoff (2011) and Uribe and Schmitt-Grohé (2017) is employed. For instance, in the case of Argentina, the exclusion period averages 10.5 years, resulting in a re-entry probability of $\lambda^{Arg} = 0.095$.

The final three parameters encompass the impatience parameter, denoted as β, as well as the parameters that dictate the output loss function:

$$\phi_t = \max\{0, a_1 + a_2 \cdot \tilde{y}\}$$

which adds two more parameters (a_1, a_2). Here, $\tilde{y}$ denotes the detrended output; thus it is dependent on the following shocks: $s_t \equiv \{z_t^c, z_t^w, g_t^c, g_t^w, r_t^*\}$. This specification for output loss is akin to the one utilized in previous studies by Chatterjee and Eyigungor (2012) and Aguiar et al. (2016). Calibration of these three parameters, β, a_1, a_2, is carried out to align with the average number of defaults over a 100-year span and the average debt-to-GDP ratio when the country maintains a favorable financial status.

3.2 The Multicountry Estimation

Sovereign default models typically incorporate an exercise defining the output process. This aspect is pivotal since equilibrium choices in the model are contingent upon exogenous output shocks. In this paper, the estimation process represents a more intricate rendition of this idea. Instead of a straightforward output process, this paper posits that a country's economic output is influenced by both country-specific and global TFP shocks. Furthermore, fluctuations in the world interest rate also impact the output of all nations, albeit in distinct ways. To formalize this, this paper adopts a simple expression for the output:[7]

$$Y_t^c = \left(e^{z_t^c + \alpha_z^c z_t^w} X_t^c (X_t^w)^{\alpha_X^c}\right)^{\psi_1^c} (1 - r_t^*)^{\psi_2^c}$$

where the superscript c denotes a specific country, while the superscript w signifies the world. There are two country-specific components of TFP: z^c and X^c, encompassing a transitory and a permanent element. Similarly, there are two global components of TFP: z^w and X^w, also comprising both transitory and permanent elements. Finally, the world interest rate is anticipated to exert an influence on the output as well. The growth rates of the permanent components of productivity are determined as: $g_t^c = X_t^c / X_{t-1}^c$ and $g_t^w = X_t^w / X_{t-1}^w$.

Before delving into the specific components of the output process, it is important to provide a rationale for the chosen output process. The output process here is very elaborate, and it subsumes the canonical ways used in the literature. For instance, the widely adopted approach proposed by Arellano (2008) can be derived here by (1) setting $\psi_1^c = 1$, (2) excluding global shocks, $\alpha_z^c = \alpha_X^c = 0$, (3) assuming a constant GDP growth, $\ln(X^c) = \ln(X_0) + g \cdot t$, (4) assuming an AR(1) process for z^c, and (5) considering no influence from world interest rates, $\psi_2^c = 0$. On the other hand, the alternative approach, akin to that used by Aguiar and Gopinath (2006), closely resembles the output process in this paper and can be achieved by assuming $\alpha_z^c = \alpha_X^c = \psi_2^c = 0$ along with $\psi_1^c = 1$.

Returning to the discussion of the output process, output growth (after adjusting for the trend) can be formulated as:

$$\begin{aligned}\Delta y_t^c = &-\psi_2^c \Delta r_t^* + \psi_1^c \Delta z_t^c + \psi_1^c \alpha_z^c \Delta z_t^w + \psi_1^c \ln(g_t^c) + \psi_1^c \alpha_X^c \ln(g_t^w) \\ &+ (1 - \psi_1^c) \ln(g_{t-1}^c) + (1 - \psi_1^c) \alpha_X^c \ln(g_{t-1}^w)\end{aligned}$$

which matches the equation for the growth rate of output in the previous section, with $\psi_1^c \equiv \psi$ and $\psi_2^c \equiv (\psi - 1)\eta$. This demonstrates the equivalence between the estimation

[7] Following the result from most of the standard models in macroeconomics, the equilibrium quantity of labor is assumed to depend on TFP. Moreover, the world interest rate is assumed to impact the output inversely as shown in Neumeyer and Perri (2005) and subsequent papers.

equation proposed here and the output growth derived from the model.

We assume that both transitory components, z^c and z^w, adhere to an AR(1) process characterized by persistence parameters ρ_z^c and ρ_z^w, as well as the standard deviations σ_z^c and σ_z^w, respectively. Furthermore, it is assumed that the long-term mean for both transitory components is zero.

$$z_t^c = \rho_z^c z_{t-1}^c + \epsilon_{z,t}^c$$

$$z_t^w = \rho_z^w z_{t-1}^w + \epsilon_{z,t}^w$$

The natural logarithm of the growth rate in the permanent components, denoted $\ln(g^c)$ and $\ln(g^w)$, is governed by an AR(1) process featuring persistence parameters ρ_g^c and ρ_g^w, along with the standard deviations σ_g^c and σ_g^w, respectively. The steady-state growth rates values in the permanent components are denoted as g_{ss}^c and g_{ss}^w.

$$\ln(g_t^c/g_{ss}^c) = \rho_g^c \ln(g_{t-1}^c/g_{ss}^c) + \epsilon_{g,t}^c$$

$$\ln(g_t^w/g_{ss}^w) = \rho_g^w \ln(g_{t-1}^w/g_{ss}^w) + \epsilon_{g,t}^w$$

It is assumed that all persistence levels meet the condition $|\rho_{z/g}^{c/w}| < 1$, and the shocks are postulated to follow a normal distribution, with $\epsilon_{z/g}^{c/w}$ being distributed as $N(0, (\sigma_{z/g}^{c/w})^2)$. For additional information on the estimation process, including the state space representation and the estimation approach, please refer to Section A of the Appendix.

3.3 Estimation Results

Posterior distributions: The first set of estimation results, presented as posterior means and standard deviations, is detailed in Table B5. The structural parameter driven by the Frisch elasticity and the labor share, ψ^c, exhibits a posterior mean closer to 2 in contrast to the prior mean of 2.5. A value of ψ^c close to 2 implies a Frisch elasticity value of 2.5, assuming a labor share, α_L, of 0.7. The values of the working capital constraint parameter, η^c, range from 0.07 to 0.90.

With knowledge of ψ^c and η^c, the value of $-(\psi^c - 1) \cdot \eta^c$ signifies the elasticity of output (for the borrowing country) concerning changes in the interest rate (in the US). For most countries, this coefficient's magnitude hovers around -0.5, indicating that a 1% increase in the world interest rate would lead to a nearly 0.5% decrease in the output of countries such as Argentina, Guatemala, Belize, and Uruguay. Some countries, such as Brazil, Panama, and Nicaragua display higher sensitivity in output, while others, such as Mexico, Chile, and

Peru exhibit lower sensitivity.

This elasticity parameter, which characterizes the output's responsiveness to interest rate fluctuations, plays a pivotal role in assessing the endogenous impact of the Volcker interest rate hike on the economic output of borrowing countries. Thus, the parameter enables us to examine the hypothesis that an interest rate hike may influence the default decision through mechanisms beyond merely raising the cost of debt and creating challenging borrowing conditions.

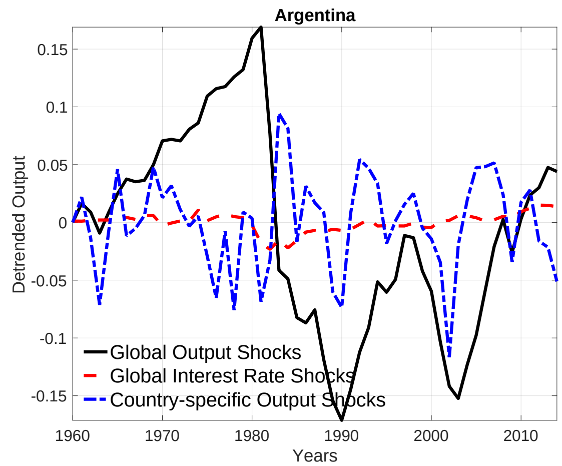
Kalman smoothed time-series of shock processes: The subsequent estimation results involve the utilization of the Kalman smoothing algorithm alongside the mean values derived from posterior estimates. This process enables the generation of time series data that represent the latent shocks experienced by different countries.

This analysis lucidates the *output response to world interest rate* channel, specifically the influence of world interest rates in endogenously reducing the output of borrowing economies. The effectiveness of this channel is illustrated by contrasting the output decline resulting from the Volcker interest rate hike with the decrease in output attributed to other factors. Figure 2 and Figure C15 illustrate the decomposition of detrended output into three sources: global fluctuations in TFP, country-specific TFP fluctuations, and fluctuations in the world interest rate.[8] Figure 2 indicates that for Argentina, during the early 1980s, the interest rate hike had a notably smaller impact on output decline compared to global TFP shocks (2.5% versus 20%). Many other countries exhibit similar patterns, as depicted in Figure C15. For several nations, including Belize, Brazil, Costa Rica, the Dominican Republic, Guatemala, Honduras, and Nicaragua, even when the magnitudes of the two effects are not vastly different, global TFP shocks still result in a substantial reduction in output that is approximately twice as large.

Thus, prima facie, it appears that the Volcker interest rate hike did not exert a substantial impact on the output decline experienced by these countries in the early 1980s. Consequently, the estimation results suggest that the *output response to world interest rate* channel may be relatively weak in an absolute sense. In the marginal sense, however, the Volcker interest rate hike could still be effective, and the sovereign default model is employed to evaluate its effectiveness through a series of counterfactual scenarios.

[8]As a validation measure, the time series of shock processes is employed to assess the alignment of country-specific shocks with documented historical events. Several significant output declines resulting from country-specific TFP shocks can be directly linked to specific historical episodes, providing reassurance regarding the accuracy and effectiveness of the estimation process. For instance, the military takeover of the Chilean government in 1973, the Mexican tequila crisis of 1995, the Venezuelan coup attempt of 2002, and similar events are effectively captured as major country-specific shocks.

Figure 2: Decomposing fluctuations in detrended output



3.4 Model Results

The results from the model are sequentially presented in three steps, each incorporating distinct specifications of the model and the estimation process. The first specification examines the role of world interest rate fluctuations. This is detailed in the first row of Table 2 where the model is as described in Section 3.1 with risk-neutral lenders ($\gamma^* = 0$). The estimation procedure remains consistent with the description in Section 3.2, and the results of this specification are discussed in Section 3.4.2. This specification considers the influence of fluctuations in the world interest rate on default decisions through two distinct channels: the *debt pricing through world interest rate* channel and the *output response to world interest rate* channel.

The second specification focuses on the role of the world interest rate fluctuations exclusively through the *debt pricing through world interest rate* channel. This specification can be obtained from the previous specification by shutting down the labor supply, labor demand, and working capital constraints. The world interest rate is allowed to fluctuate. The price of debt, determined by the world interest rate and the probability of default, captures the impact of the world interest rate fluctuations, but the interest rate has no impact on the output of borrowing countries. The results of this specification are discussed in Section 3.4.3.

In the third specification, the paper emphasizes the impact of TFP shocks by muting the influence of interest rate fluctuations. This is demonstrated in Table 2 by assuming a constant world interest rate and excluding considerations of labor supply, labor demand, and working capital constraints. The results of this specification are discussed in Section 3.4.4.

Finally, as part of a robustness exercise, Section 3.4.5 presents results in which the lender is assumed to be risk averse, in addition to all the other components of the paper. Before

Table 2: Model and estimation specifications

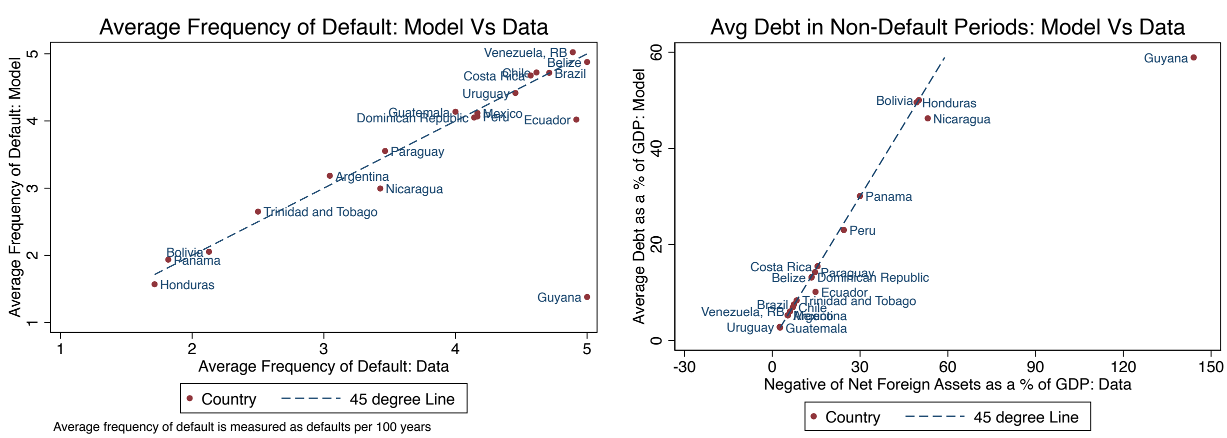
SN	Sec.	Estimation	Model				Comments
			H	F	G	L	
1	3.4.2	$Y_t \equiv A_t L_t^{\alpha_L}$ r_t^* AR(1)	C_t L_t^s	L_t^d WCC	$r_t^w = r_t^*$	RNL	4 TFP shocks + Debt pricing channel of r^* + Output response channel of r^*
2	3.4.3	$Y_t \equiv A_t$ r_t^* AR(1)	C_t No L_t^s	No L_t^d No WCC	$r_t^w = r_t^*$	RNL	4 TFP shocks + Debt pricing channel of r^*
3	3.4.4	$Y_t \equiv A_t$	C_t No L_t^s	No L_t^d No WCC	$r_t^w = \bar{r}$	RNL	4 TFP shocks
R	3.4.5	$Y_t \equiv A_t L_t^{\alpha_L}$ r_t^* AR(1)	C_t L_t^s	L_t^d WCC	$r_t^w = r_t^*$	RAL	Correlated shocks to lender + 4 TFP shocks + Debt pricing channel of r^* + Output response channel of r^*

Note: H, F, G, and L represent households, firms, government, and the lenders respectively. A_t is TFP which is given as: $A_t = e^{z_t + \alpha_z z_t^w} X_t (X_t^w)^{\alpha_X}$; C_t represents the household is making consumption choice; L_t^s represents labor supply choice by the household, L_t^d represents labor demand choice by the firms, WCC indicates the presence of working capital constraints on the firm side; RNL represents risk-neutral lenders; and RAL represents risk-averse lenders.

proceeding with these specifications, however, it is essential to present the results that discuss the model's performance.

3.4.1 Model Performance

Figure 3: Targeted moments



The model's performance is assessed by matching a set of moments from the data with their corresponding values in the model. The moments presented here pertain to Specification 3 of Table 2. However, the model parameters are re-estimated and recalibrated for each specification, resulting in similar performance across all specifications.

Figure 3 shows the targeted moments: average default frequency and average debt. As expected, the match between moments generated by the model and those observed in the data is highly favorable, with one notable exception, which is Guyana.[9]

Figure 4: Non-targeted moments

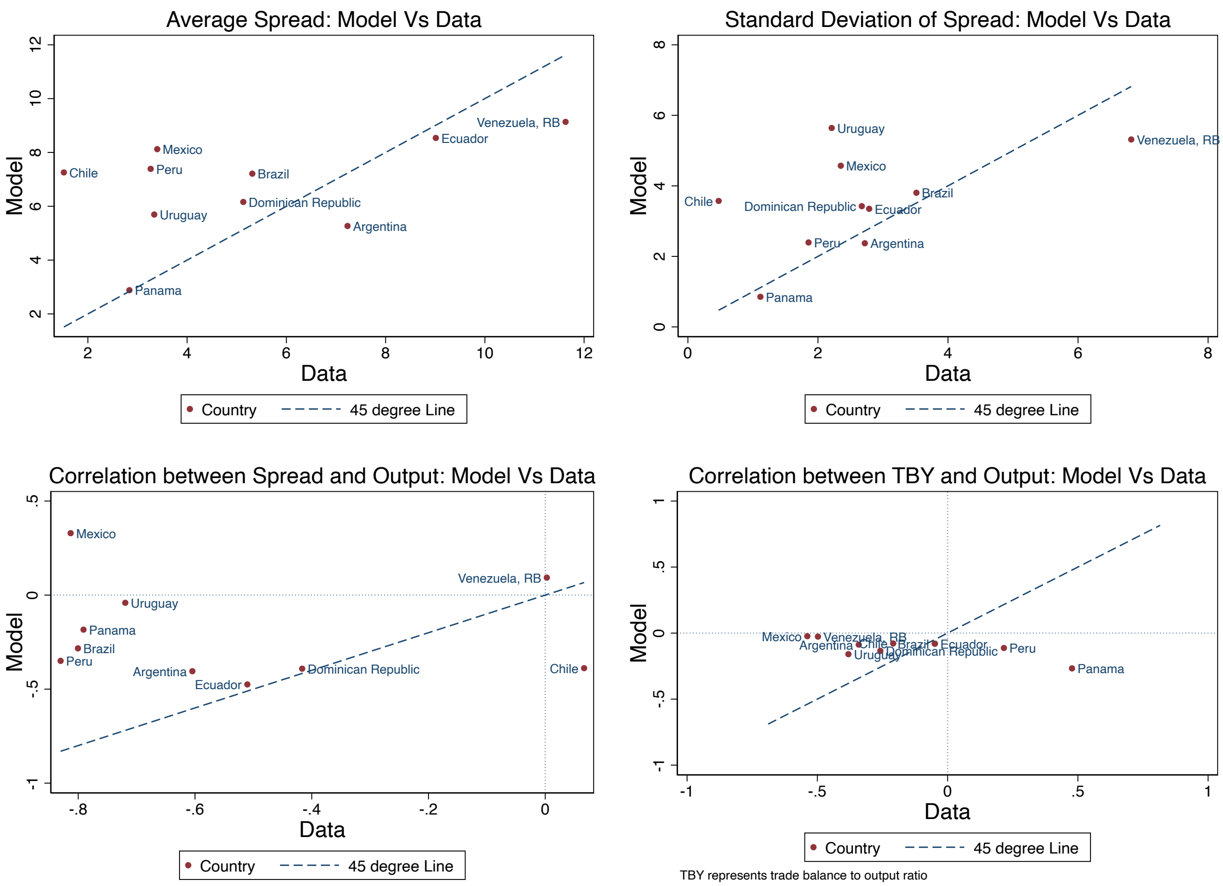


Figure 4, exhibits non-targeted moments, specifically focusing on country spreads, sourced from the J.P. Morgan Emerging Markets Bond Index (EMBI) database. It is important to note that the database provides spread data for only 10 out of the 19 countries included in this study. Consequently, these moments are matched only for these 10 countries. In the top panel, the means and standard deviations of spreads during non-default periods are presented. For the average spread, most countries (excluding Chile, Mexico, and Peru) cluster around the 45-degree line, indicating a strong alignment. The standard deviation of spreads during non-default periods is matched even more closely, with most countries, with the except exception of Chile and Uruguay, tracking close to the 45-degree line. The bottom panel introduces two additional non-targeted moments, focusing on the correlation between

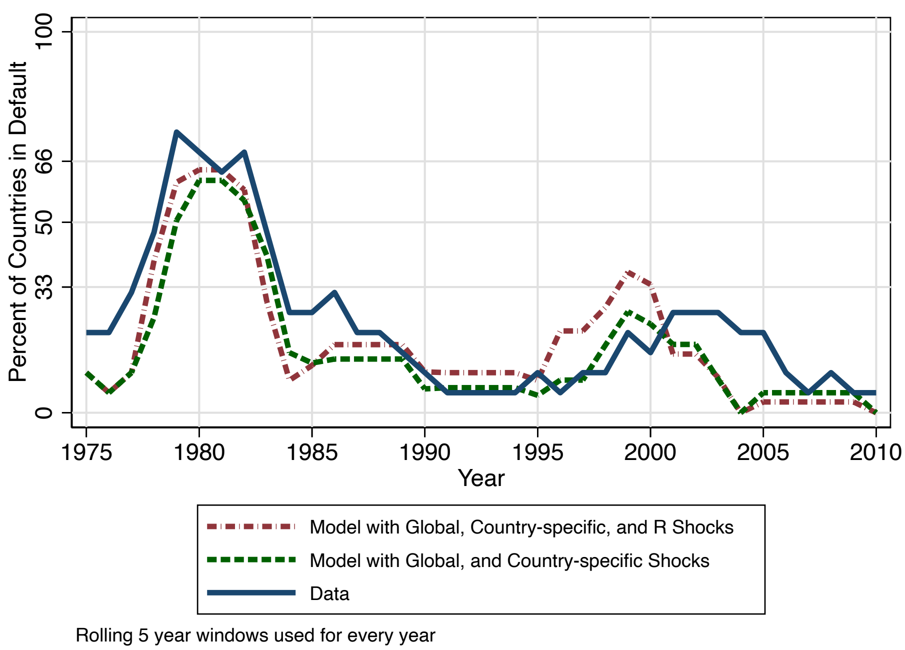
[9]The data reveals that Guyana typically maintained a negative net foreign asset position equivalent to 144% of its output. The combination of substantial debt and a high default rate (5 times per 100 years) results in a less accurate match for Guyana.

output and spread, as well as between output and the trade-balance-to-output ratio. This panel highlights the model's capacity to capture the countercyclical behavior of both the country premium and the trade-balance-to-output ratio. The model effectively reproduces the countercyclical nature of these variables, with the exception of Mexico, Venezuela, and Chile in the case of the country premium, and Peru and Panama in the case of the trade-balance-to-output ratio. Although the actual magnitudes may deviate from the 45-degree line, the observed countercyclical patterns are consistent with prior findings in the literature, attesting to the model's ability to capture the essential features of emerging economies.

3.4.2 Simulations: Interest Rates Affecting Borrower's Output and Debt-Pricing

Model simulations are performed by conducting a country-by-country simulation of default decisions. To generate these results, the study uses the time series of state variables, which includes four Kalman smoothed TFP shocks, the interest rate process, and the initial level of debt, as inputs to the simulation process. The model then produces optimal default decisions by each country, which are aggregated in 5-year rolling windows. The model-predicted default cluster is then compared to the corresponding data, as shown in Figure 1 of Section 2.

Figure 5: Aggregated default decisions of all countries: Model (Specification-1) vs data



The first set of simulation results is based on Specification 1 of Table 2. This specification holds significance in understanding the impact of world interest rate fluctuations on defaults, as it accounts for both dimensions of these fluctuations: not only does it encompass the pricing effects of an interest rate increase but also considers the potential impact on the endogenous decline in output for borrowing countries in response to such an interest rate hike.

Figure 5 presents convincing evidence of the effectiveness of this specification in reproducing the clustered defaults observed in the 1980s. The time series of subsequent defaults closely matches the empirical data, with the only deviation being the defaults in the early 2000s, anticipated by the model a few years in advance of the actual occurrences. However, this specification incorporates all four TFP shocks and both channels through which world interest rate fluctuations influence the default decision. Consequently, it becomes challenging to attribute defaults to one or more of these six potential pathways. Given the multitude of shocks involved, this specification focuses on investigating the role of interest rate increases in the 1980s as a factor that caused the default cluster. To achieve this, simulations are run both with and without fluctuations in interest rates, revealing an unexpected finding: the Volcker interest rate hike did not serve as the primary driver of the 1982 cluster.

Figure 5 illustrates that the model effectively reproduces the time series of defaults even when the interest rate fluctuations are shut down. While this observation diminishes the significance of the Volcker interest rate hike in triggering the clustered defaults of the 1980s, it does not discount the potential role of interest rate fluctuations in causing such clusters. As indicated in the estimation results presented in Figure 2 and Figure C15, the influence of interest rate fluctuations in endogenously reducing the output of borrowing countries is undeniable. Their role was negligible during the 1980s due to substantial output declines driven by factors orthogonal to interest rate increases. However, in an alternate scenario characterized by the absence of additional output shocks (induced by adverse shocks to TFP), an increase in interest rates could trigger substantial output declines for numerous borrowers. Alongside the rising cost of debt, these two channels have the potential to precipitate defaults across multiple countries. The crucial caveat for world interest rate shocks to play a significant role in causing defaults is that the upswing in the world interest rate must not coincide with other adverse output shocks. Under such circumstances, the *output response to world interest rate* channel becomes formidable, potentially leading to defaults.

3.4.3 Simulations: Interest Rates Affecting Debt-Pricing

The subsequent simulations, following Specification 2 outlined in Table 2, enhance our understanding of *debt pricing through world interest rate* channel. In this setting, the *output response to world interest rate* channel is deactivated by excluding labor supply, labor demand, and working capital constraints, from the model. The estimation equations are also modified accordingly to abstain from capturing the effect of the world interest rate fluctuations on the decline in output of borrowing countries.

Figure 6: Aggregated default decisions of all countries: Model (Specification-2) vs data

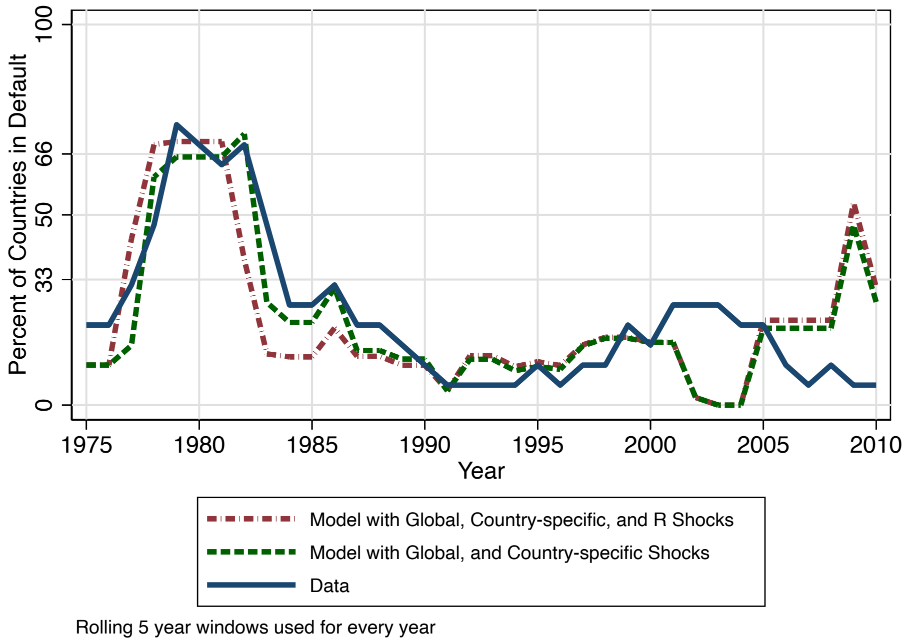


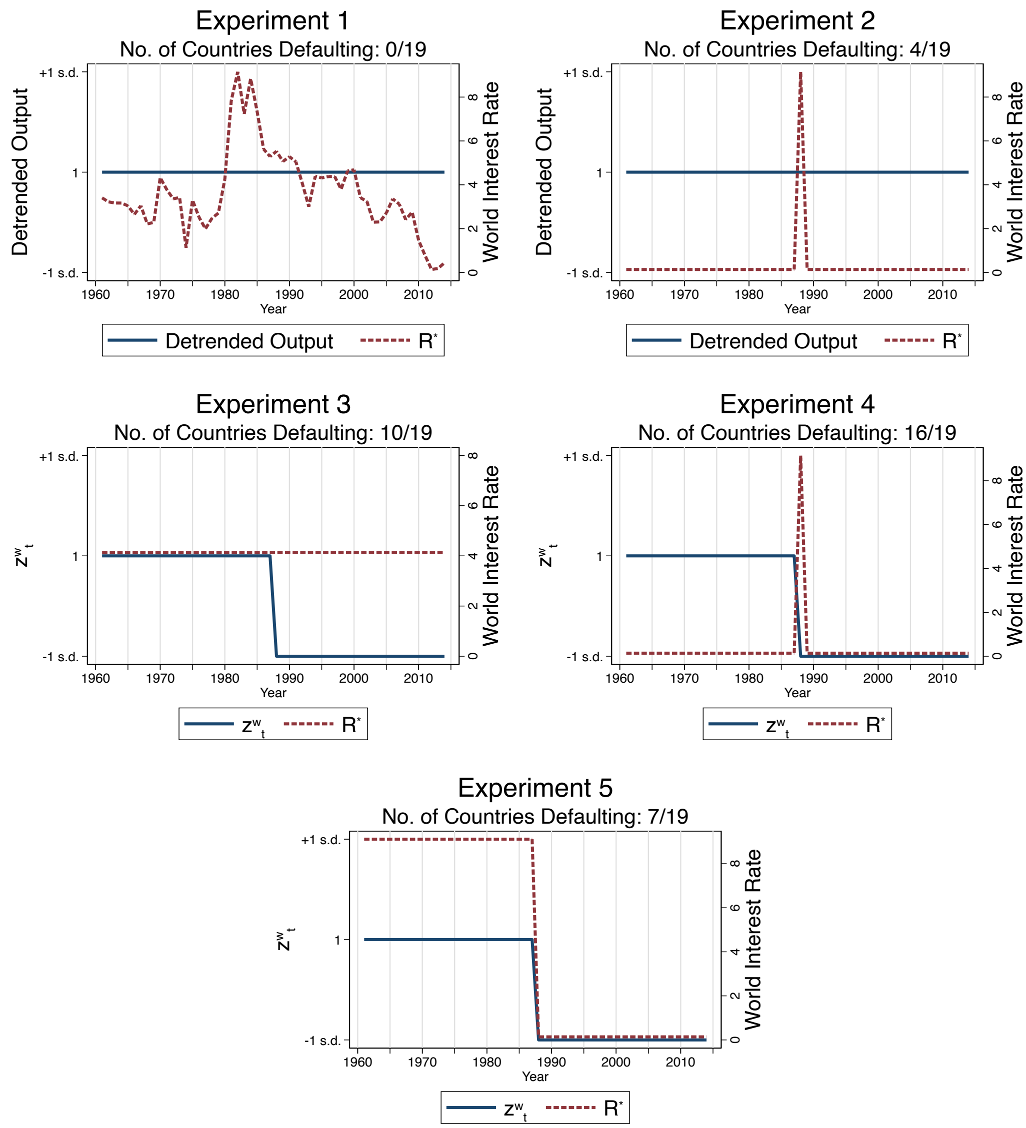
Figure 6 shows that Specification 2 is also effective at matching the clustered defaults of the 1980s.[10] Nevertheless, as expected, the results remain the same when the interest rate fluctuations are shut down, indicating that the role of interest rate shocks remains insignificant. This observation is consistent with the earlier finding in Section 3.4.2, where the interest rate fluctuations did not induce the cluster even when both channels were active. In the current scenario, with only one active channel—*debt pricing through world interest rate*—the contribution of interest rate shocks in causing the cluster is understandably minimal.

The primary finding of this section is not the limited impact of the Volcker interest rate increase; Section 3.4.2 had already reached the same conclusion within a setting which encapsulates the current one. The principal objective of this section is to assess the efficacy of the *debt pricing through world interest rate* channel in instigating clustered defaults within

[10]There is one noteworthy exception: the model predicts another clustered default during the 2009 period. This period, following the Great Recession and the subsequent global capital flow reversal, presents a perplexing absence of defaults in the data. However, this issue is a well-known 'missing defaults puzzle' that has been discussed by Reinhart et al. (2016) and others. This paper, in contrast, ascribes a crucial role to the world interest rate decreases following the Great Recession, providing a plausible explanation for the 'missing defaults puzzle'. A comparison between Figures 5 and 6 reveals that the absence of a clustered default during the 2009 period might be attributed to endogenous improvements in output resulting from the world interest rate decreases.

a broader context. This is accomplished through a series of experiments, as illustrated in Figure 7.

Figure 7: Percentage of countries defaulting when faced with different output and interest rate shocks



In the first two experiments, I simulate the time series of all the countries assuming the detrended output remains constant at unity throughout the entire period (i.e., the output continues to grow at the steady-state rate, g^c_{ss}, for every country c). Various forms of interest rate shocks are introduced sequentially. In the first experiment, the time series of the interest rate precisely replicates that observed in the data, featuring an 8% increase over three years in the early 1980s. The outcome of Experiment 1 in Figure 7 indicates that, with robust output growth, an interest rate hike akin to the Volcker interest rate increase cannot compel any country to default. Consequently, output shocks play a pivotal role in causing defaults. While the Volcker interest rate hike appears ineffective, Experiment 2 reveals that a single-period increase in the interest rate by 9% prompts four out of the 19 countries to default at the onset of the interest hike: Bolivia, Costa Rica, Guyana, and Honduras. The common trait among these defaulting countries is their substantial debt levels, intensifying the incentives to default. Therefore, if the interest rate increase is sufficiently high, countries with elevated debt levels have an impetus to default, even in the absence of output shocks. Consequently, the *debt pricing through world interest rate* channel can exert a substantial impact on countries with relatively high levels of debt. This result is further accentuated when the interest rate hikes coincide with output declines, as demonstrated in the remaining three experiments.

Experiments 3 to 5 delve into the repercussions of interest rate variations when coupled with a decline in output. In these experiments, the global transitory component of output experiences a lasting decrease of 1 standard deviation in 1988. Experiment 3 reveals that even with a stable interest rate, 10 out of 19 countries default, signifying a substantial impact of a 1 standard shock to the global transitory component of the output. Should the interest rate surge by 9% for one period, coinciding with the output decline observed in Experiment 4, an additional six countries default, resulting in a total of 16 defaulting nations. Conversely, Experiment 5 demonstrates that a 9% reduction in the interest rate prevents three countries from defaulting, reducing the total number of defaulters to 7. Thus, Experiments 3 to 5 underscore the significance of interest rate shocks as both catalysts for defaults and deterrents to defaulting countries through the *debt pricing through world interest rate* channel. This outcome aligns with recent literature emphasizing the pivotal role of fluctuations in the world interest rate. Given that a substantial portion of the literature does not account for the endogenous impact on output, this result, coupled with the findings in Section 3.4.2, underscores an even more significant role that interest rate shocks can play across various scenarios. However, the clustered defaults of the 1980s appear to be driven primarily by TFP shocks. The subsequent set of simulations scrutinizes the role of diverse TFP shocks in instigating the cluster.

3.4.4 Simulations: TFP Shocks with Constant World Interest Rate

Having ruled out the impact of the Volcker interest rate hike, the subsequent simulations aim to uncover the contribution of TFP shocks in causing the clustered default of the 1980s. This is executed using Specification 3 from Table 2, which shuts down the fluctuations in the world interest rate, directing attention solely to TFP shocks. The model and estimation equations are adjusted accordingly. Given the presence of four distinct TFP shocks, the simulations initially concentrate on two overarching categories: country-specific and global shocks. Subsequent simulations delve into transitory and permanent shocks.

Figure 8: Aggregated default decisions of all countries: Model (Specification-3) vs data

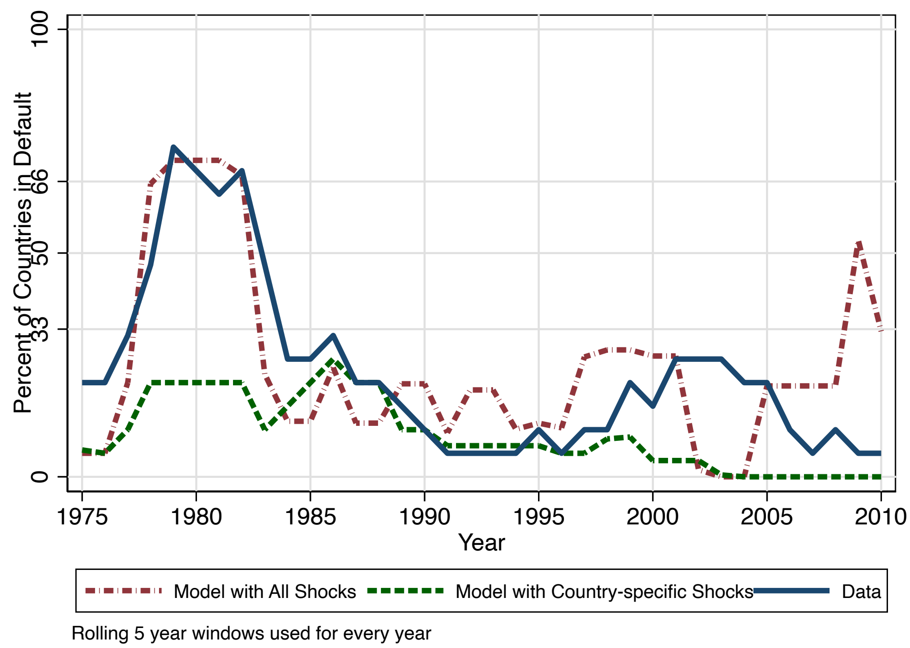
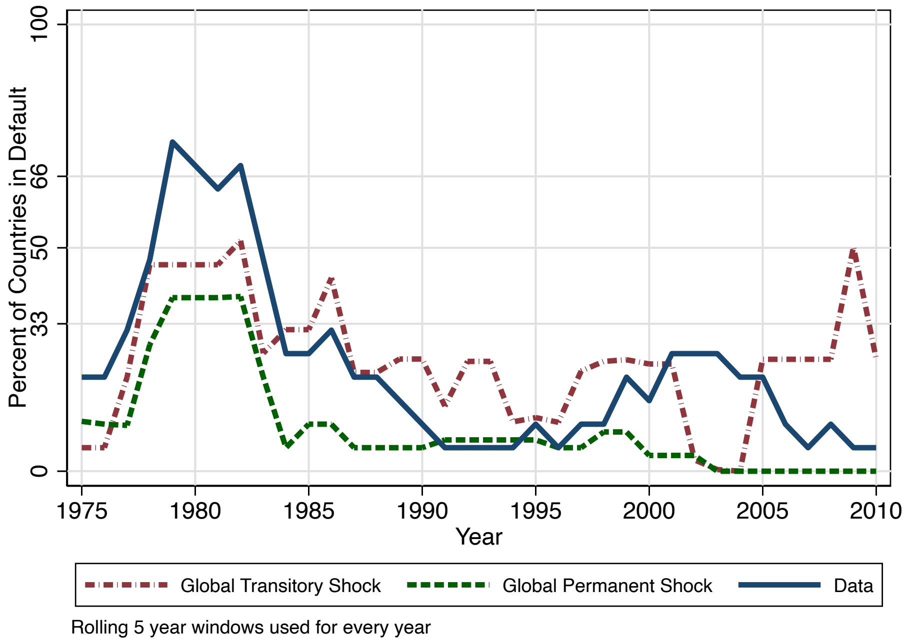


Figure 8 illustrates that in the presence of all four TFP shocks, the model adeptly replicates the clustered default of the 1980s and subsequent defaults. This outcome aligns with the findings in Figures 5 and 6, where the model effectively captures the data even when the interest rate shocks are shut down, leaving only TFP shocks in the model. While the model successfully generates the cluster, it does not untangle the impact of various global and country-specific shocks. To isolate the effect of global shocks, a counterfactual simulation exercise is conducted, suppressing all global shocks (by setting the global transitory component, z_t^w, to 0 and the growth rate in the global permanent component, g_t^w, to 1). Consequently, the simulations exclusively capture the influence of country-specific shocks, revealing a subpar performance by the model in Figure 8. Notably, the model not only fails to replicate the 1980s cluster but also overlooks the smaller cluster in the early 2000s.

There is a lingering question that pertains to discerning the specific type of global shocks that predominantly contribute to the clustered default phenomenon of the 1980s. To delve deeper into this inquiry, the subsequent set of simulations scrutinizes the influence of different global shocks—namely, global transitory shocks and global permanent shocks—in inducing clustered defaults. This is achieved through two distinct counterfactual exercises: one in which country-specific shocks are accompanied by global transitory shocks and another in which they are accompanied by global permanent shocks. Figure 9 illustrates that global transitory shocks exhibit relatively greater impact than global permanent shocks in replicating the cluster of the 1980s. Furthermore, the subsequent defaults are attributed to the presence of global transitory shocks.

Figure 9: Aggregated default decisions of all countries: Model (Specification-3) vs data



The unexpected and counterintuitive discovery that transitory shocks outweigh permanent shocks is noteworthy, especially considering its contradiction to the findings of Aguiar and Gopinath (2006) (AG) regarding sovereign defaults in general. Given the significance of this result in the context of the literature, the subsequent focus is directed toward elucidating the factors that magnify the role of global transitory shocks in precipitating clustered defaults. Three pivotal elements contribute to the heightened importance of global transitory shocks: 1) Larger fluctuations in global transitory shocks, 2) Convex cost of default, and 3) High persistence of global transitory shocks. The first and third elements are intertwined and stem from empirical observations, while the second element delves into more fundamental considerations, examining the interaction between convex default costs and transitory and permanent shocks. In the ensuing discussion within this section, I elucidate the significance of each of these three elements, addressing them individually.

Larger fluctuations in global transitory shocks: Figure 2 and Figure C15 illustrate the results of the estimation process, revealing a consistent pattern across countries. Notably, in the early 1980s, the majority of countries experienced more substantial global shocks than country-specific shocks. Additionally, concerning global shocks, the global transitory shock had a disproportionately greater effect on 8 out of 19 countries. Despite this disproportionate impact, the significance of global transitory shocks is brought into question by the findings of AG. They show that the model incorporating transitory shocks resulted in ten times fewer defaults than the model incorporating permanent shocks. Consequently, in light of their results, the greater influence of transitory shocks, despite their more significant fluctuations, remains perplexing. This underscores the importance of examining the convex cost assumption.

Convex cost of default with transitory and permanent shocks: The shift toward incorporating convex default costs in sovereign default models, as opposed to proportional costs, stems from a desire to better capture the empirical reality that defaults tend to coincide with adverse economic conditions.[11] However, it is crucial to acknowledge that the choice of a convex cost assumption alters the impact of transitory and permanent shocks on default decisions compared to a proportional cost assumption.

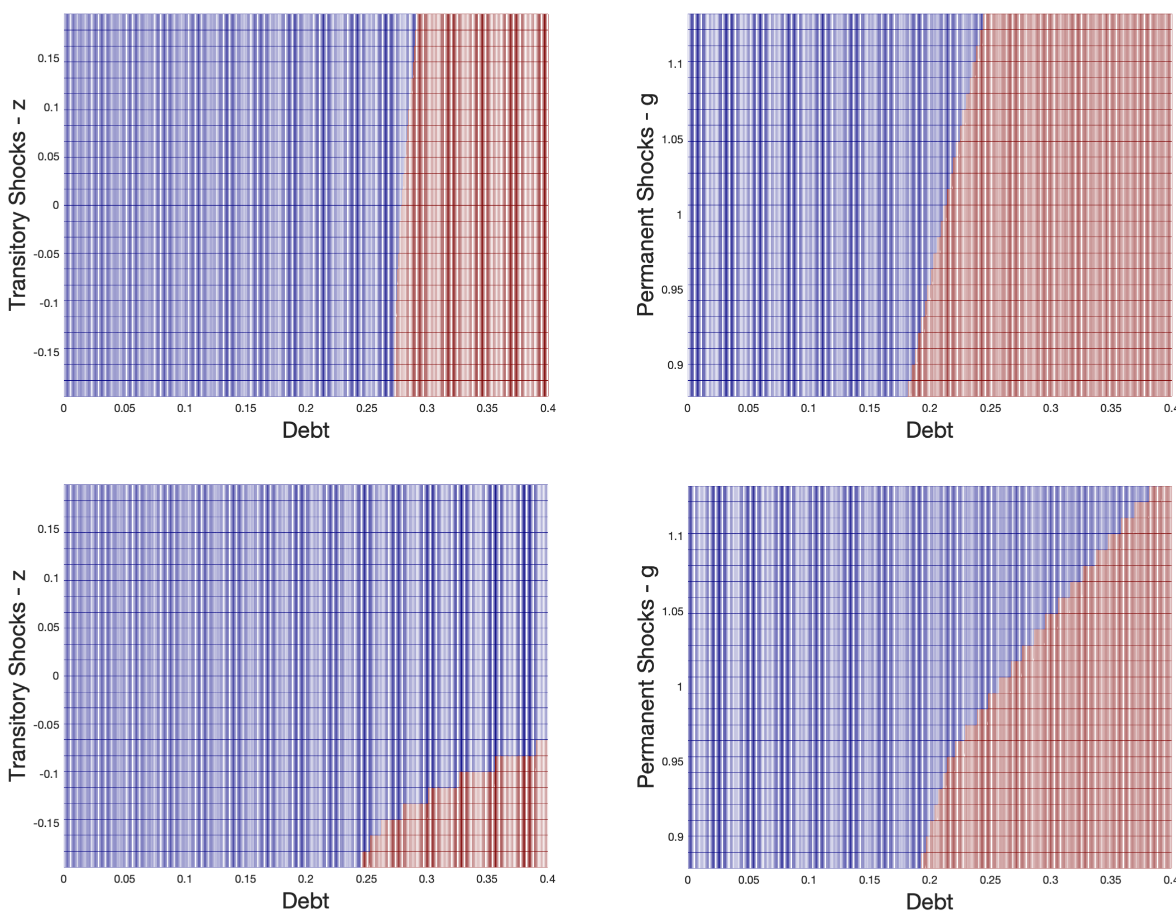
To demonstrate the significance of the convex cost assumption in relation to proportional cost and to maintain comparability with the framework of AG, I adopt parameter values identical to those in AG. Subsequently, I plot the default (shaded red) and non-default (shaded blue) regions with respect to two state variables: the TFP shock and the debt level. The top panel of Figure 10 illustrates the default and non-default regions under the proportional cost assumption. As expected, this is an exact replica of the corresponding figure in AG due to identical parameter values. In contrast, the bottom panel of Figure 10 presents the default and non-default regions under the convex cost assumption. Figure 10 unveils two key findings related to convex costs. First, the convex cost leads to a flatter boundary between the default and non-default regions, as shown in the bottom panel. Second, this boundary is relatively flat when exposed to transitory shocks compared to permanent shocks, in contrast to the proportional cost results presented by AG.

The first finding can be explained by the inherent characteristics of the convex cost assumption. Under a convex cost structure, defaulting in a high-output state leads to a disproportionately substantial decline in output. Consequently, defaults become exceedingly costly in good economic conditions. Thus, countries are inclined to refrain from defaulting when economic conditions are good. Consequently, lenders are more likely to extend higher

[11] The convex cost assumption is well supported by both empirical evidence and theoretical frameworks. Hébert and Schreger (2017) conducted estimations of the output costs associated with the Argentinean default of 2001, and their findings align with the notion of convex costs. Theoretical works, such as those by Mendoza and Yue (2012) and Na et al. (2015), offered insights demonstrating the endogenous emergence of convex costs within the model, thereby providing microfoundations for the assumption of convex output costs associated with default.

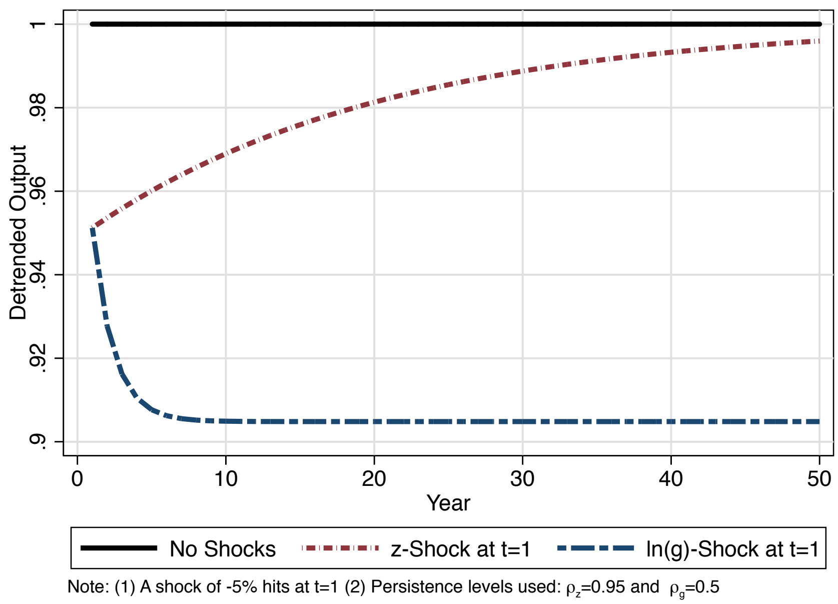
levels of debt financing when output is robust, while curtailing debt financing during periods of economic downturn. This heightened sensitivity to output renders the boundary between the default and non-default regions notably flatter, as evidenced in the bottom panel.

Figure 10: Regions of default and non-default: In the graphical representation, the blue-shaded area denotes the combination of TFP shock and debt level where the country opts not to default. Conversely, the red-shaded area represents the combination of TFP shock and debt level leading to the country's decision to default. The vertical axis corresponds to the TFP shock realization, while the horizontal axis represents the debt level (as a fraction of output). The top panel illustrates default and non-default regions under the proportional default cost assumption, while the bottom panel depicts the same under the convex default cost assumption. On the left side, the state variable used as a TFP shock is the transitory shock to TFP, while on the right side, it is the permanent shock to TFP. Across all four scenarios, countries exhibit a preference for defaulting when faced with high debt levels and/or negative TFP shocks.



The second finding pertains to the dynamics of transitory and permanent shocks and their interplay with default costs. Illustrated in Figure 11, when a country experiences a negative transitory shock, its detrended output undergoes a momentary decrease but rebounds in the future. Therefore, given the convex cost of default, delaying default until a later date results in a significantly greater output cost than defaulting promptly. In contrast, Figure 11 illustrates that when a country faces a negative permanent shock, its detrended output decreases today but decreases even further in the future. In the context of convex default costs, postponing default to a later time incurs a much lower output cost than defaulting immediately. Lenders also internalize this dynamic, leading to a more pronounced response in debt levels after a negative transitory shock compared to a negative permanent shock. Consequently, the demarcation between default and non-default regions exhibit a flatter boundary in the former scenario.

Figure 11: Illustration of a 5% transitory shock vs a 5% permanent shock



By comprehending the role of convex costs compared to proportional costs and understanding their interaction with transitory and permanent shocks, the intuition behind Figure 10 becomes apparent. Starting from the upper left corner and following the arguments in AG, the default decision hinges on the value function linked to continuation and the value function associated with defaulting. When transitory shocks mimic a random walk, there is minimal need for borrowing or lending across time. The additional endowment is consumed, resulting in little disparity between continuation and defaulting. Conversely, if transitory shocks exhibit zero persistence, there is a strong incentive for borrowing or lending. However, due to the lack of persistence, the impact of transitory shock is confined to the current period. Consequently, the present discounted values over the lifetime do not vary significantly for continuation or defaulting in either case—a random walk or independent and identically distributed (iid) shock. In such scenarios, the default decision remains largely unresponsive to transitory shocks, leading to a nonresponsive boundary between default and non-default regions. This is depicted by a vertical boundary in the top-left corner of Figure 10. Progressing clockwise to the upper-right corner, when the country experiences permanent shocks, these shocks affect not only current output but they have a bigger effect on the endowment in all future periods. Consequently, defaulting is typically associated with costs, even when considering the proportional cost of default. Therefore, in the presence of positive permanent shocks, borrowers find it preferable to continue servicing their debt rather than opting for default. Hence, a flatter boundary emerges in the upper-right corner. Moreover, in the context of convex default costs, defaulting after a positive permanent shock becomes even more onerous. This results in significantly fewer defaults during good economic conditions, allowing borrower countries to sustain higher levels of debt without defaulting. Consequently, the boundary becomes even flatter in the lower-right corner of Figure 10. Finally, the lower-left corner corresponds to the impact of convex costs in the presence of transitory shocks. To draw a comparison with the lower-right corner, consider Figure 11 with positive transitory and permanent shocks. Following a permanent shock, output continues to grow, eventually settling at a higher level in the future. In contrast, a transitory shock causes output to jump initially but gradually decreases until returning to the original steady state. Thus, with convex costs, the decision to default is postponed in the case of a transitory shock (as output and, consequently, the output loss will be lower in the future). Conversely, default is frontloaded after permanent shocks to avoid even larger output losses in the future. Consequently, the frequency of defaults is significantly lower during good times following positive transitory shocks. This, once again, leads to countries sustaining higher levels of debt without defaulting after positive transitory shocks, ultimately resulting in the flattest boundary between default and non-default regions.

With a flatter boundary for transitory shocks, the resulting higher default rate has a more straightforward explanation. When countries are doing relatively well in terms of transitory shocks, they accumulate significant debt (as evident in the shaded blue region in the bottom-left diagram). If, at this juncture, they encounter a negative transitory shock, substantial deleveraging becomes necessary to stay within the non-default region. Given the sensitivity of the price schedule to transitory shocks, the price of debt decreases. Consequently, the country might opt for default rather than undergo a significant deleveraging process.

High persistence of global transitory shocks: In contrast to country-specific transitory shocks, global transitory shocks exhibit greater persistence, as demonstrated in Table B5. Following highly persistent positive shocks, agents anticipate a continued high output in the near future with a high probability. This results in a substantial accumulation of debt compared to scenarios where shocks lack persistence. Such a heightened level of debt renders the country more susceptible to default in the event of a significant negative shock, as the necessary deleveraging to maintain a non-default state becomes substantial.

The three elements—bigger and highly persistent global transitory shocks, and convex default costs—make defaults more likely after a negative global transitory shock leading to the result in Figure 9.

3.4.5 Robustness Exercise: Adding Risk-Averse Lenders

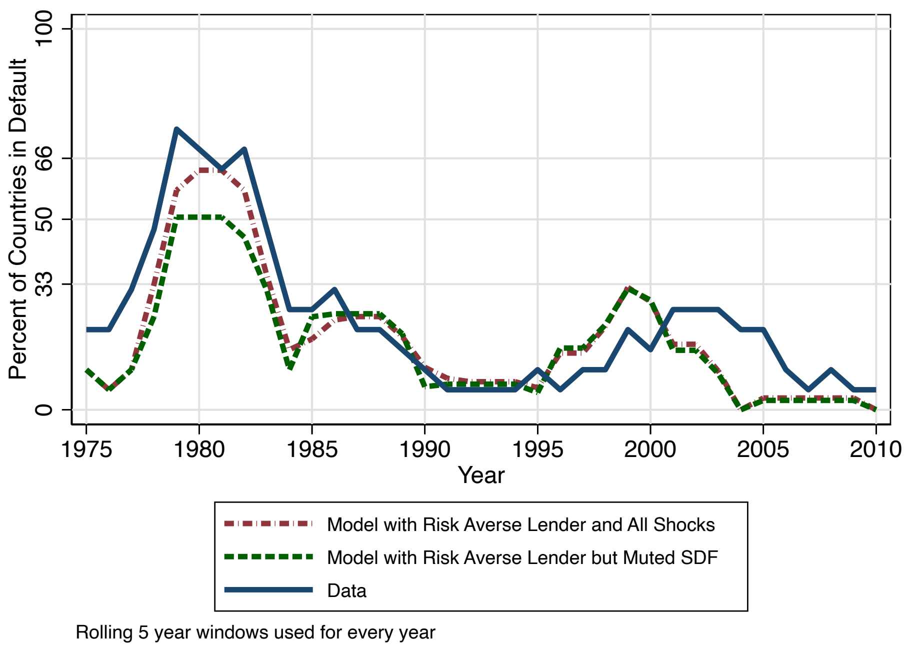
As the influence of interest rate fluctuations on the clustered defaults of the 1980s appears minimal based on the examined channels, a final examination involves assessing the impact of replacing risk-neutral lenders with risk-averse lenders in the model. Risk-averse lenders, operating at a global level, introduce an additional channel through which shocks can affect the default decisions of multiple borrowers. Consequently, clustered defaults may occur if risk-averse lenders make borrowing more expensive precisely when borrowing countries are facing challenges. Arellano et al. (2017), for example, develop a model that endogenously introduces such a channel. While incorporating such a channel into the model at this scale involves significant computational costs, a reduced-form approach employing stochastic shocks to the lender's wealth provides an alternative method for achieving a similar effect from the lender side. This paper follows a reduced-form approach to introduce risk-averse lenders with stochastic wealth, following the spirit of previous works by Du et al. (2020), Aguiar et al. (2016), and others. However, for risk-averse lenders to impact clustered defaults, a correlation must exist between stochastic fluctuations in the lender's wealth and the shocks experienced by borrowers. While the contagion literature often endogenously incorporates such a channel, it can also be introduced exogenously, as demonstrated in Borri and Verdelhan (2011). Given the scale of the model and the estimation in this paper, the latter approach is more practical.

The model and the estimation process employed in this paper facilitate the capture of the correlation between stochastic fluctuations in the lender's wealth and the shocks experienced by borrowers. This correlation is realized through the incorporation of global output shocks in the estimation process, encompassing both borrowing and developed countries, including the United States. Consequently, the estimation accounts for the impact of global shocks on the wealth of both borrowers and lenders. This results in a decrease in the SDF of the lender precisely when borrowing countries face negative output shocks. The substantial decrease in this SDF, leading to a significant credit tightening during the early 1980s, is evident in Figure C14 of the appendix. This successful representation highlights the model's capability to capture correlated shocks between borrowers and lenders, showcasing their influence on the

SDF, particularly during pivotal events such as the 1980s defaults and the Great Recession.

Incorporating the impact of correlated shocks, I investigate the influence of a risk-averse lender using Specification R from Table 2. Figure 12 illustrates simulations with a risk-averse lender, comparing scenarios with and without fluctuations in the SDF, and the latter is akin to assuming a risk-neutral lender. The findings reveal that TFP shocks continue to be the primary driver of the 1980s cluster and subsequent defaults. Nevertheless, a small marginal impact is observed from the presence of risk-averse lenders during the defaults of the 1980s.

Figure 12: Aggregated default decisions of all countries: Model (Specification-R) vs data



The discernible but limited impact of risk-averse lenders on the clustered defaults of the 1980s is not at odds with the literature. Lizarazo (2009) reports that contagion models successfully capture a substantial increase in spread before crises compared to models without financial links. However, this improvement in the mean and the standard deviation of spread does not result from a higher predicted probability of default, as the annual probability remains the same as in the models without financial links.[12] Furthermore, research on

[12] In a subsequent study, Arellano et al. (2017) emphasize the potential significance of incorporating haircuts and renegotiations into a contagion framework, particularly in the context of the European debt crisis. Nevertheless, data from Cruces and Trebesch (2013) suggest a diminished role for this channel in the defaults of the 1980s. Their findings reveal that most instances of debt rescheduling during the 1980s did not entail changes in the face value of the debt. Even when considering a market value measure of haircuts, they report average haircuts of 25% from 1978 to 1989, doubling to approximately 50% in later periods. Thus, the importance of including haircuts and renegotiations in a contagion framework appeared to be less pronounced in the 1980s compared to its relevance during the European debt crisis.

global financial cycles indicates a stronger role of global factors in more recent times. For instance, Miranda-Agrippino and Rey (2020) obtained higher volatility in the time series of global factors since the early 2000s compared to the 1980s and 1990s. Bai et al. (2019) emphasize the influential role of global factors on investors in advanced economies, influencing emerging market spreads. However, this emphasis becomes particularly prominent in the period following the great financial crisis and preceding the COVID pandemic. In the period of 1995-2007, despite including events such as the Argentine crisis and the Asian financial crisis, they conclude that world financial cycles play a relatively small role. Thus, considering these findings, the result that the presence of risk-averse lenders contributes only marginally to default decisions during the 1980s appears to be consistent.

The results indicate that the primary drivers of the clustered default in the 1980s were the global output shocks affecting all the countries. Importantly, these global output shocks cannot be attributed to the rise in the world interest rate. Even the change in the price of debt resulting from the Volcker interest rate hike played a limited role on the margin. While a potential channel involving risk-averse lenders and correlated shocks between borrowers and lenders shows some promise in comparison to other channels, the marginal effect of risk-averse lenders remains notably small.

4 Conclusion

While clustered defaults are both frequent and economically impactful, existing theoretical research on multicountry defaults has predominantly centered on the lender side, examining contagion through lenders. This paper takes a different approach by addressing clustered defaults through the examination of correlated output shocks experienced by borrowing countries. The framework of this paper is characterized by: (1) the disentanglement of global shocks—specifically, global output shocks and world interest rate shocks—faced by different countries, and (2) an exploration of the mechanisms through which these global shocks contribute to defaults. The first aspect necessitates a multicountry estimation capable of capturing global shocks, while the second demands a sovereign default model intricately linked to the estimation process. Leveraging this estimation and model, the paper quantifies the significance of various shocks in instigating clustered defaults. Additionally, it showcases the utility of such a comprehensive framework in examining crisis episodes across diverse temporal and regional contexts, encompassing events like the 1980s Latin American debt crisis, the Asian financial crisis, and the European debt crisis.

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Clustered Sovereign Defaults: Appendix

A Estimation Details

A.1 State-Space Form

Measurement Equation

The growth rate of output for each country is considered observable. Therefore, the measurement equation for country c can be expressed in state-space form, involving four global state variables: z_t^w, z_{t-1}^w, $\ln(g_t^w/g_{ss}^w)$, $\ln(g_{t-1}^w/g_{ss}^w)$, and four country-specific state variables: z_t^c, z_{t-1}^c, $\ln(g_t^c/g_{ss}^c)$, $\ln(g_{t-1}^c/g_{ss}^c)$

$$\begin{aligned}\Delta y_t^c = {} & \ln(g_{ss}^c) + \alpha_X^c \ln(g_{ss}^w) - (\psi^c - 1)\eta^c \Delta r_t^* + \psi^c \Delta z_t^c + \psi^c \alpha_z^c \Delta z_t^w + \psi^c \ln(g_t^c/g_{ss}^c) \\ & + \psi^c \alpha_X^c \ln(g_t^w/g_{ss}^w) - (\psi^c - 1)\ln(g_{t-1}^c/g_{ss}^c) - (\psi^c - 1)\alpha_X^c \ln(g_{t-1}^w/g_{ss}^w)\end{aligned}$$

The four global state variables, z_t^w, z_{t-1}^w, $\ln(g_t^w/g_{ss}^w)$, and $\ln(g_{t-1}^w/g_{ss}^w)$, exert an impact on the growth rate of output not just for a specific country c, but for all countries. Given that the state-space equations for all countries include these global state variables, the contemporaneous observable comprises an $(nc \times 1)$ vector, where nc represents the total number of countries. This vector encompasses the output growth of each individual country. To estimate the parameters associated with these global state variables, it is necessary to stack the state-space equations of all countries on top of each other for each time period t and consider them to be observables at that time t. This combined state-space equation can be employed to estimate the parameters for all countries collectively. The measurement equation in this state-space framework is thus formulated as:

$$\Delta y_t = W_t + V \cdot \theta_t$$

where,

$$\Delta y_t = \left[\Delta y_t^1, \cdot, \Delta y_t^c, \cdot, \Delta y_t^{nc}\right]^{\mathrm{T}}$$

$$\begin{aligned}W_t = {} & \left[\ln(g_{ss}^1) + \alpha_X^1 \ln(g_{ss}^w) - (\psi^1 - 1)\eta^1 \Delta r_t^*, \cdot, \ln(g_{ss}^c) + \alpha_X^c \ln(g_{ss}^w) - (\psi^c - 1)\eta^c \Delta r_t^*, \cdot \right. \\ & \left. , \ln(g_{ss}^{nc}) + \alpha_X^{nc} \ln(g_{ss}^w) - (\psi^{nc} - 1)\eta^{nc} \Delta r_t^*\right]^{\mathrm{T}}\end{aligned}$$

$$\theta_t = \big[z_t^w, z_{t-1}^w, \ln(g_t^w/g_{ss}^w), \ln(g_{t-1}^w/g_{ss}^w), z_t^1, z_{t-1}^1, \ln(g_t^1/g_{ss}^1), \ln(g_{t-1}^1/g_{ss}^1), \cdot, z_t^c, z_{t-1}^c, \ln(g_t^c/g_{ss}^c), \ln(g_{t-1}^c/g_{ss}^c), \cdot, z_t^{nc}, z_{t-1}^{nc}, \ln(g_t^{nc}/g_{ss}^{nc}), \ln(g_{t-1}^{nc}/g_{ss}^{nc})\big]^{\mathrm{T}}$$

and

$$V = \begin{bmatrix} \psi^1\alpha_z^1 & \cdot & \psi^c\alpha_z^c & \cdot & \psi^{nc}\alpha_z^{nc} \\ -\psi^1\alpha_z^1 & \cdot & -\psi^c\alpha_z^c & \cdot & -\psi^{nc}\alpha_z^{nc} \\ \psi^1\alpha_X^1 & \cdot & \psi^c\alpha_X^c & \cdot & \psi^{nc}\alpha_X^{nc} \\ -(\psi^1-1)\alpha_X^1 & \cdot & -(\psi^c-1)\alpha_X^c & \cdot & -(\psi^{nc}-1)\alpha_X^{nc} \\ \psi^1 & \cdot & 0 & \cdot & 0 \\ -\psi^1 & \cdot & 0 & \cdot & 0 \\ \psi^1 & \cdot & 0 & \cdot & 0 \\ -(\psi^1-1) & \cdot & 0 & \cdot & 0 \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ 0 & \cdot & \psi^c & \cdot & 0 \\ 0 & \cdot & -\psi^c & \cdot & 0 \\ 0 & \cdot & \psi^c & \cdot & 0 \\ 0 & \cdot & -(\psi^c-1) & \cdot & 0 \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ 0 & \cdot & 0 & \cdot & \psi^{nc} \\ 0 & \cdot & 0 & \cdot & -\psi^{nc} \\ 0 & \cdot & 0 & \cdot & \psi^{nc} \\ 0 & \cdot & 0 & \cdot & -(\psi^{nc}-1) \end{bmatrix}^T$$

The size of Δy_t is $(nc \times 1)$, where nc stands for the total number of countries. The matrix W_t is not constant over time as it depends on variations in the world interest rate, and its dimensions are also $(nc \times 1)$. The matrix V is sized $(nc \times (4 * nc + 4))$ and remains constant across time. The state variable θ_t is a $((4 * nc + 4) \times 1)$ vector.

Finally, the dynamics of the world interest rate, r_t^*, are assumed to follow an AR(1) process.[13] Given that it does not influence the output of countries in this simplified model, the observed interest rate can be regressed against past values to derive the pertinent parameters.

Transition Equation

The evolution of the state-vector (transition equation) in this state-space framework is formulated as:

[13] For robustness, an alternative specification is tested where the world interest rate is allowed to respond to global shocks: $r_t^* - \bar{r} = \rho_r(r_{t-1}^* - \bar{r}) + \alpha_z^r z_t^w + \alpha_X^r(\ln g_t^w/g_{ss}^w) + \epsilon_t^r$. The results remain the same as those with simple AR(1) specification.

$$\theta_t = K \cdot \theta_{t-1} + \lambda_t$$

where $\lambda_t = [\epsilon^w_{z,t}, 0, \epsilon^w_{g,t}, 0, \epsilon^1_{z,t}, 0, \epsilon^1_{g,t}, 0, \cdot, \epsilon^c_{z,t}, 0, \epsilon^c_{g,t}, 0, \cdot, \epsilon^{nc}_{z,t}, 0, \epsilon^{nc}_{g,t}, 0]^{\mathrm{T}}$, $\epsilon^w_z \sim N(0, (\sigma^w_z)^2)$, $\epsilon^w_g \sim N(0, (\sigma^w_g)^2)$, $\epsilon^c_z \sim N(0, (\sigma^c_z)^2)$, $\epsilon^c_g \sim N(0, (\sigma^c_g)^2)$ and

$$K = \begin{bmatrix}
\rho^w_z & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 \\
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 \\
0 & 0 & \rho^w_g & 0 & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & \rho^w_z & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & \rho^w_g & 0 & \cdot & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & \cdot & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 \\
\cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdot & \rho^w_z & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdot & 1 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & \rho^w_g & 0 & \cdot & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 1 & 0 & \cdot & 0 & 0 & 0 & 0 \\
\cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 & \cdot & \rho^w_z & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 & \cdot & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & \rho^w_g & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 1 & 0\cdot
\end{bmatrix}$$

A.2 Data and Estimation of the Parameters

To estimate the parameters, both the output growth and the world interest rate are considered observable data. To ensure the suitability in capturing business cycles and output shocks, a criterion is applied, stipulating that countries must possess an uninterrupted time series of real GDP data starting from 1960. This criterion trims the initial sample size of 92 countries, as presented in Section 2, down to 49 countries. Moreover, given that the Latin American debt crisis of the 1980s is comprehensively examined as the most significant clustered default in Section 2, the analysis predominantly focuses on 19 Latin American countries.[14] Nevertheless, to assess the robustness of the findings, the analysis also explores

[14] One potential concern when conducting the estimation with only 19 of these countries is the potential for bias in global output shocks, given that all these countries are categorized as defaulting countries. To mitigate the risk of bias, I have incorporated five developed countries—France, Japan, Italy, the United

other regional clustered defaults presented in Section 2, such as the Asian financial crisis and the European debt crisis.

The world interest rate is constructed using the 5-year constant maturity treasury rate, a risk spread derived from the difference between Moody's seasoned BAA-rated and AAA-rated corporate bonds, and the one-year-ahead expected inflation data from the Survey of Professional Forecasters. I also make use of the dataset providing the average growth rates of countries, which are denoted as g^c_{ss}. This paper assumes that the steady-state growth rate in the country-specific permanent component, g^c_{ss}, is equivalent to this average growth rate. Additionally, the paper assumes $g^w_{ss} = 1$.

To analyze the dataset on the Latin American defaults, a subset of 24 countries is used. In this specific group of countries, the study estimates a total of 96 parameters associated with country-specific shocks which include ρ^c_z, ρ^c_g, σ^c_z, and σ^c_g for each country c. In the case of global shocks, the standard deviation of the shocks is normalized to 1 without loss of generality, as α^c_z and α^c_X can account for any scale-effect arising from a different value of standard deviation.[15] Thus, the direction and the magnitude with which global shocks affect a specific country is governed by country-specific factors: α^c_z, α^c_X. This introduces an additional 48 parameters. Furthermore, there are two persistence parameters which are associated with the global shock processes. Finally, the impact of TFP shocks and interest rate fluctuations on the output growth are distinct for each country. TFP shocks are accompanied by a coefficient $(\psi^c - 1)$ while interest rate fluctuations appear along with $(\psi^c - 1) \cdot \eta^c$. Consequently, ψ^c and η^c can be estimated separately for all countries. The parameter ψ^c, however, depends on two structural parameters—ω^c and α^c_L—which relate to the Frisch elasticity of labor supply and the coefficient of labor in the output process. As both of these parameters, ω^c and α^c_L, always appear in the same way in the equations, they can not be estimated separately and only $\psi^c = \omega^c/(\omega^c - \alpha^c_L)$ is estimated.[16] Altogether, there are 194 parameters to estimate. To ensure parameter identification, a restriction is imposed on Venezuela, where $\alpha^{VEN}_z > 0$ and $\alpha^{VEN}_X > 0$.[17]

Kingdom, and the United States—into the analysis. These five nations were among the largest at the outset of the data period.

[15] Both z^w and $\ln(g^w)$ appear along with α^c_z and α^c_X for each country. Writing the process of z^w in $MA(\infty)$ rather than $AR(1)$ form, we obtain: $\alpha^c_z z^w = \alpha^c_z(\epsilon^w_{z,t} + \rho^c_z \epsilon^w_{z,t-1} + (\rho^c_z)^2 \epsilon^w_{z,t-2} + (\rho^c_z)^3 \epsilon^w_{z,t-3} + ...\infty) = \alpha^c_z \cdot \sigma^w_z (e^w_{z,t} + \rho^c_z e^w_{z,t-1} + (\rho^c_z)^2 e^w_{z,t-2} + (\rho^c_z)^3 e^w_{z,t-3} + ...\infty)$, where $e = \epsilon/\sigma$ is a standard normal. This shows that we can observe only the product, $\alpha^c_z \cdot \sigma^w_z$. Hence, it is safe to normalize σ^z_w as well as σ^g_w to 1.

[16] Although ω^c and α^c_L cannot be estimated separately, we need those two values for solving the model. Thus, the estimated value of ψ^c is used along with the assumption that $\alpha^c_L = 0.72$ to obtain the respective values of ω^c.

[17] Let us say z^w and $\ln(g^w)$, and the corresponding multiplicative parameter values, α^c_z and α^c_X, respectively, generate a particular time series of global shocks to every country's output. If there are no restrictions on α, a time series that is negative of z^w and $\ln(g^w)$ along with the opposite signs of α^c_z and α^c_X will also generate the same contribution to every country's output.

This paper estimates the parameters for the output process of all countries through the Bayesian method. A uniform prior is assumed for all the parameters, as detailed in Table B4.[18] The likelihood is computed using the Kalman filter and the Metropolis-Hastings algorithm is employed to generate an approximate posterior distribution for all the parameters. The model parameters are derived from the mean values of the posterior estimates for all parameters. These parameters, in combination with the Kalman smoothing algorithm, are then used to generate the time series of all shocks.

B Generating the Defaults in the Model

To determine the optimal default decisions, I utilize the time series for all four output shocks obtained through the Kalman-smoothing algorithm, along with the world interest rate obtained from the available data. These inputs collectively drive the time series of the output process for all countries and the world interest rate that these countries face. The model's debt level is initialized as 0 for the year 1960, given that the time series of output shocks commences from 1961 onwards. While the primary focus of the paper is on comparing clustered defaults in the 1980s, choosing an earlier starting point, the 1960, ensures that the results for the 1980s remain unaffected by historical conditions. This would not have been the case if the starting period was closer to 1980s. After incorporating all five shocks, the countries optimize and determine their default dates. In the case of a country defaulting, and the default aligning with the data, the country remains in default for the same duration as observed in the data, with a re-entry shock set to 0. Outside the default periods in the data, the re-entry shock is randomly assigned as 0 or 1 based on a draw from a uniform distribution. This simulation is repeated 100 times for each country, collecting default dates and average probabilities of default for each date. Subsequently, the results are aggregated across all 19 countries and compared with their data counterparts.

[18]For two parameters: ψ and η, I analyze their corresponding structural counterparts in the model. In the model, $\psi = \omega/(\omega - \alpha_L)$ is contingent on the labor share and the Frisch elasticity of labor supply. To establish informed priors for these parameters, I draw upon relevant studies from the literature. The model's expression for the Frisch elasticity of labor supply is represented as $1/(\omega - 1)$. Given that microeconometric estimates of Frisch elasticity often fall within the range of 0.3 to 0.5, while macroeconomists frequently employ estimates between 2 and 4, I consider ω to range from 1.2 to 6. This allows the Frisch elasticity to vary between 0.2 and 5. Additionally, α_L represents the labor share, which is typically around 0.7, and I assume it can vary from 0.3 to 0.9. These assumptions pertaining to these two parameters result in ψ varying from 1.0526 to 4. Consequently, I establish a uniform prior ranging from 1.01 to 4 for ψ, which is a superset of the narrower interval spanning from 1.0526 to 4. Furthermore, within the model, η denotes a fraction of the wage bill that must be secured in advance. I assume a uniform prior between 0.0001 and 0.9999 for η.

C Other Crisis Episodes

The setup is also used to test the robustness of the main results to other crisis episodes highlighted in Table 1. The results remain robust for the Asian financial crisis and the European Debt Crisis but not for the African Debt Crisis. There seem to be very little impact of global output shocks that drive African countries to default during the period of early 1980s.

However, there is a key difference between defaults in the African debt crisis and others. When most of the countries received debt from private creditors, the debt during the African debt crisis was coming mainly from official lenders (bilateral loans from governments and from international institutions such as the World Bank, regional development banks etc.). Thus, this setup is less suited for studying the African debt crisis. For this reason, only the results for the Asian financial crisis and the European Debt Crisis are produced in the following.

C.1 Asian Financial Crisis

Figure C16 shows the decomposition of the shocks faced by the affected countries. It confirms the disproportional effect of global output shocks on defaults during the Asian financial crisis of 1997. Moreover, the countries also show little response to world interest rate increases.

Once more, it is important to note that the estimation exercise accurately reflects most country-specific shocks. For example, the military coup in South Korea led by General Chun Doo-hwan is captured as a large country-specific shock to the Republic of Korea even when it overlaps with the Volcker period. Similarly, the period after the assassination of the opposition leader Benigno Aquino Jr. in 1983 is captured as a large country-specific shock to the Philippines. For Thailand, where the Asian financial crisis began, a large country-specific shock precedes the global shock of 1997. This likely reflects weakness in the Thai economy, the current account problems coupled with the rise in short-term debt, leading up to the Asian financial crisis of 1997.

C.2 European Debt Crisis

To disentangle the effect of various shocks during the European debt crisis, Figure C17 shows the decomposition of these shocks for European countries. As expected, the period of the great recession and the European debt crisis is accompanied by a large global output shock for all the countries. Moreover, European countries show a very muted response to world interest rate fluctuations, including the Volcker hike period. Unlike all other European countries, where there were none or relatively small country-specific output shocks during the debt crisis, Greece shows a large drop in global and country-specific components of the output. Thus, like Thailand in the case of the Asian financial crisis, Greece also displays country-specific weakness in the economy when it faced the global output shocks.

As before, there are some notable historic episodes that are captured with great accuracy by country-specific shocks. For example, the regime change in Greece and the end of the Greek junta is captured by a large drop in Greek output during 1984. For Spain, the end of the Franco era and the subsequent transition to democracy is captured by a weak country-specific output decline during the latter half of the 1970s. Similarly, the military coup of Lisbon in 1974 is followed by a large country-specific output decline.

Overall, for both crises: the Asian financial crisis and the European debt crisis, the broad results remain the same. The countries defaulted during these crises mainly because of global output shocks rather than the effect of interest rates. However, the world interest rate was not as prohibitively high during the Asian financial crisis or during the European debt crisis as it was during the Latin-American debt crisis.

D Tables

Table B3: Calibrated parameter values

	Parameter Value	Example	Comments
γ	2	Standard	
γ^*	0 or 2	Standard	
r^*	3.67% pa	Standard	Average value from 1960 to 2014
g^c_{ss}	C-specific	1.025 for Arg	Average value from 1960 to 2014
λ	C-specific	0.095 for Arg	Matched 10.5 years in default on an average in 200 years
β	C-specific	0.83 for Arg	$\sim$ 0.95 quarterly; Matches defaults/100yr, NFA/Y
a_1	C-specific	-0.26 for Arg	Matches defaults/100yr, NFA/Y
a_2	C-specific	0.27 for Arg	Matches defaults/100yr, NFA/Y

The table provides an example of parameter values that are calibrated for Argentina. As shown, other than γ, γ^* and r^*, all parameters are estimated for every country separately.

Table B4: Prior distribution for Bayesian estimation

	Uniform Prior Distributions	
Parameter	Min	Max
ρ^c_z	0.0001	0.99
ρ^c_g	0.0001	0.99
σ^c_z	0.0001	0.9
σ^c_g	0.0001	0.9
ρ^w_z	0.0001	0.99
ρ^w_g	0.0001	0.99
ψ^c	1.01	4
η^c	0.0001	0.9999
α^{VEN}_z	0.0001	2
α^{VEN}_X	0.0001	2
α^c_z	-2	2
α^c_X	-2	2

σ^w_z and σ^w_g are normalized to 1

Table B5: Bayesian estimation results: Posteriors

Country	Statistic	Posterior (Mean & Standard Deviation)							
		ρ_z^c	ρ_g^c	σ_z^c	σ_g^c	ψ^c	η^c	α_z^c	α_X^c
Argentina	Mean	0.2813	0.6431	0.0134	0.0141	2.0832	0.3924	0.0196	0.0029
	Std. Dev.	0.2314	0.0743	0.0064	0.0076	0.0769	0.0895	0.0055	0.0057
Belize	Mean	0.4934	0.7748	0.0028	0.0138	2.5386	0.3669	0.0041	0.0017
	Std. Dev.	0.0906	0.0757	0.002	0.0017	0.1036	0.148	0.0033	0.0033
Bolivia	Mean	0.9477	0.2448	0.0136	0.0036	2.3502	0.0713	0.0086	-0.0003
	Std. Dev.	0.041	0.1542	0.002	0.0026	0.1037	0.0506	0.0033	0.0032
Brazil	Mean	0.2023	0.8617	0.0025	0.0122	2.2738	0.6329	0.0078	0.0065
	Std. Dev.	0.1091	0.0538	0.0017	0.0016	0.1897	0.1084	0.0034	0.0033
Chile	Mean	0.9267	0.6321	0.011	0.021	1.7075	0.1645	0.0126	0.0082
	Std. Dev.	0.0446	0.1088	0.0067	0.0054	0.0786	0.0873	0.0065	0.0062
Costa Rica	Mean	0.2902	0.5339	0.0039	0.0069	2.3393	0.9032	0.0073	0.0092
	Std. Dev.	0.1159	0.1386	0.0023	0.0024	0.1737	0.0572	0.0028	0.0026
Dominican Republic	Mean	0.3735	0.543	0.0135	0.0235	1.7342	0.8289	0.0078	0.0089
	Std. Dev.	0.0965	0.0731	0.0069	0.0058	0.1156	0.0916	0.0068	0.0054
Ecuador	Mean	0.4392	0.7825	0.0084	0.0142	1.4405	0.7039	0.0092	0.002
	Std. Dev.	0.0925	0.0928	0.004	0.0034	0.1037	0.0857	0.0047	0.0044
Guatemala	Mean	0.7671	0.7034	0.0025	0.0083	1.7201	0.6772	0.0054	0.009
	Std. Dev.	0.0806	0.0687	0.0016	0.0013	0.1368	0.1588	0.0031	0.0029
Guyana	Mean	0.3798	0.6713	0.0037	0.0125	2.9785	0.3414	0.0159	-0.0035
	Std. Dev.	0.1044	0.1285	0.0024	0.002	0.1592	0.0869	0.0037	0.0044
Honduras	Mean	0.4223	0.6674	0.0043	0.0096	2.0775	0.5282	0.005	0.0103
	Std. Dev.	0.1067	0.0843	0.0022	0.0019	0.0552	0.1607	0.0035	0.0033
Mexico	Mean	0.7295	0.7787	0.0057	0.0104	2.0862	0.2603	0.0105	0.0107
	Std. Dev.	0.0982	0.0648	0.0033	0.003	0.0863	0.0706	0.004	0.0041
Nicaragua	Mean	0.9303	0.7011	0.0152	0.0254	2.0281	0.7145	0.0073	-0.0019
	Std. Dev.	0.0465	0.0787	0.0094	0.0082	0.1693	0.1683	0.0078	0.007
Panama	Mean	0.5375	0.8314	0.0039	0.0141	2.5912	0.4966	0.0129	-0.0016
	Std. Dev.	0.1635	0.075	0.0032	0.0026	0.2035	0.1027	0.0043	0.0039
Paraguay	Mean	0.5385	0.6997	0.0047	0.0162	1.8303	0.122	0.0121	0.0081
	Std. Dev.	0.1257	0.1002	0.003	0.0028	0.1154	0.0895	0.0048	0.0046
Peru	Mean	0.4378	0.7591	0.0051	0.0205	1.8	0.268	0.0239	-0.002
	Std. Dev.	0.1151	0.0907	0.0037	0.0029	0.1233	0.0781	0.0068	0.0062
Trinidad and Tobago	Mean	0.1823	0.8532	0.004	0.0177	1.9957	0.0632	0.0054	0.0079
	Std. Dev.	0.1085	0.049	0.0027	0.0022	0.0816	0.0516	0.0047	0.0045
Uruguay	Mean	0.9247	0.7466	0.0088	0.0117	1.7514	0.7631	0.0261	0.0001
	Std. Dev.	0.0489	0.107	0.0049	0.0051	0.0682	0.1214	0.0054	0.0065
Venezuela, RB	Mean	0.8535	0.5335	0.0174	0.0105	2.0829	0.3363	0.0129	0.008
	Std. Dev.	0.0943	0.1222	0.0062	0.0077	0.1941	0.1569	0.0054	0.0043
	Statistic	ρ_z^w	ρ_g^w						
World	Mean	0.8897	0.7555						
	Std. Dev.	0.0845	0.0957						

The countries included in the estimation process are 24. 19 defaulting countries from Latin America & Caribbean and 5 non-defaulting developed countries. Parameter estimates are reported only for 19 Latin America & Caribbean countries.

E Figures

Figure C13: Kalman-Smoothed time series of global TFP shocks for Argentina

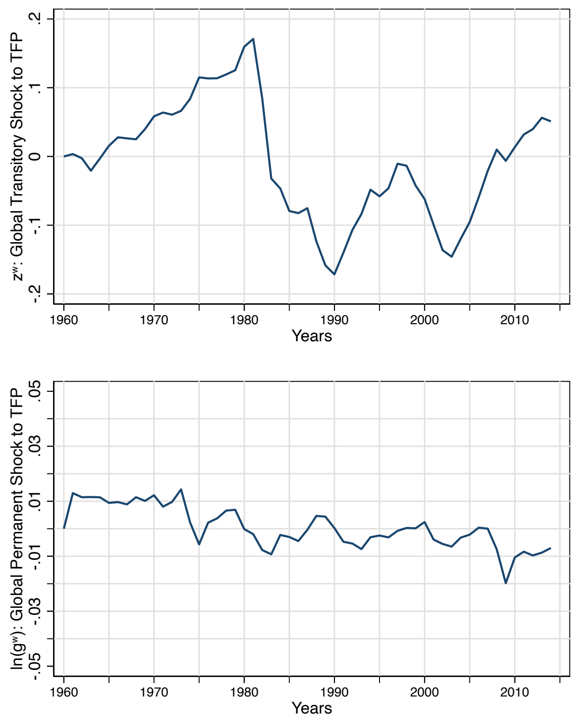


Figure C14: Stochastic Discount factor of Lender

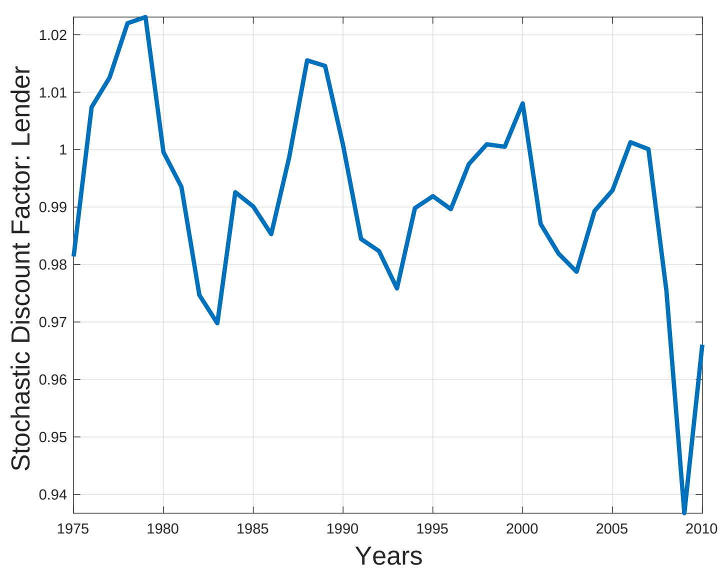
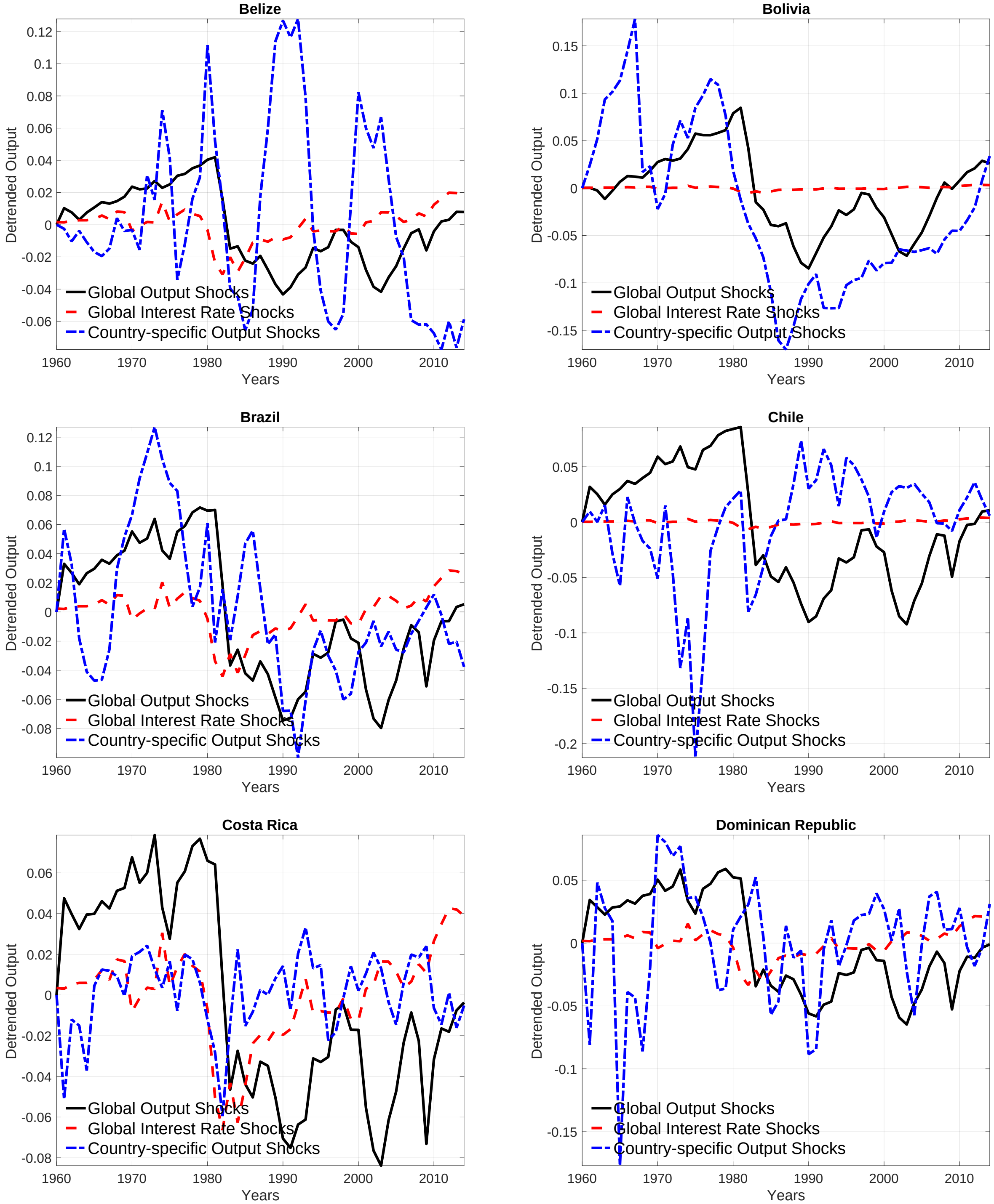


Figure C15: Decomposing fluctuations in detrended output (continues to next two pages)



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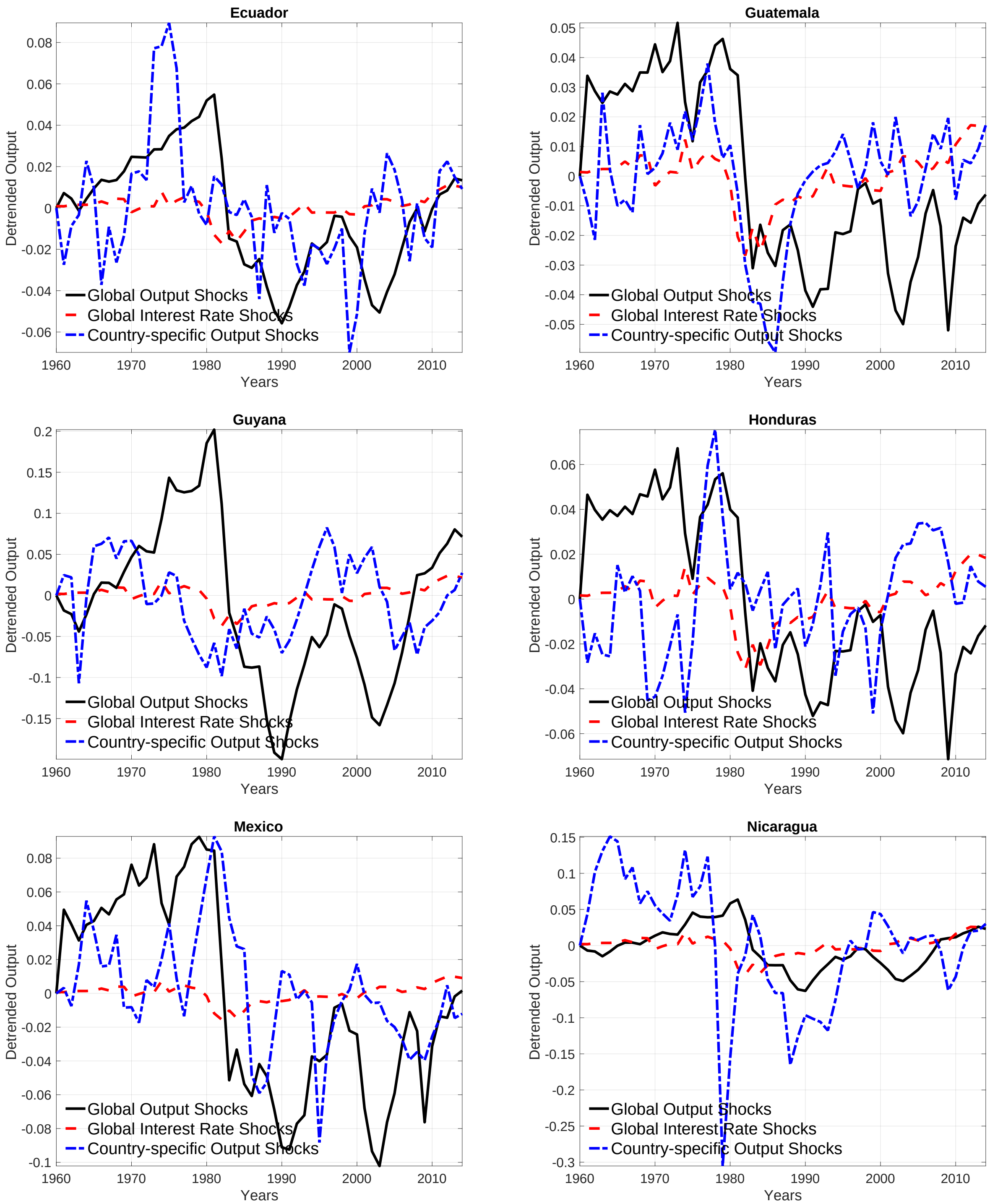

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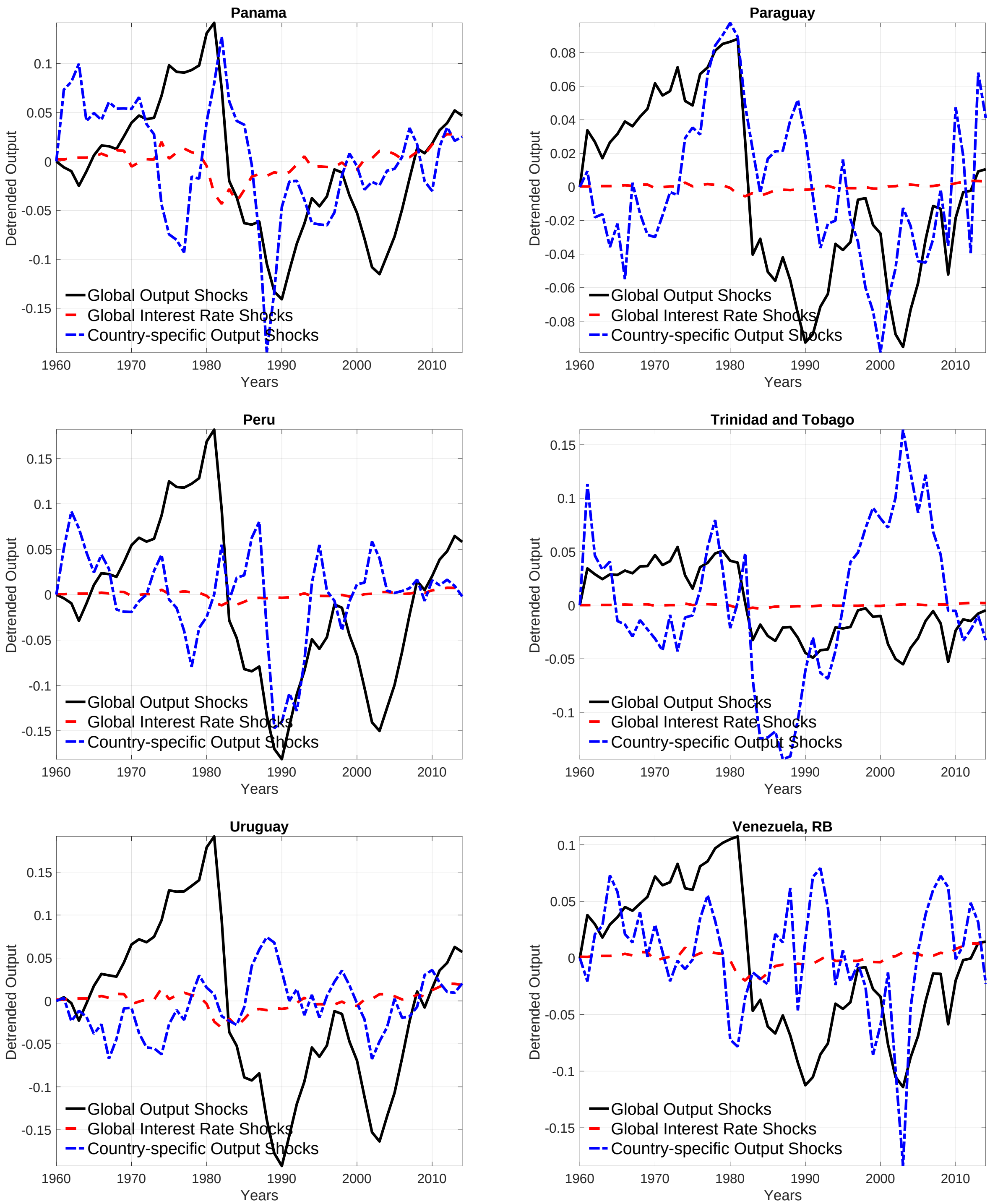
Panama
Paraguay
Peru
Trinidad and Tobago
Uruguay
Venezuela, RB
Detrended Output
Years
Global Output Shocks
Global Interest Rate Shocks
Country-specific Output Shocks

Figure C16: Decomposing fluctuations in detrended output

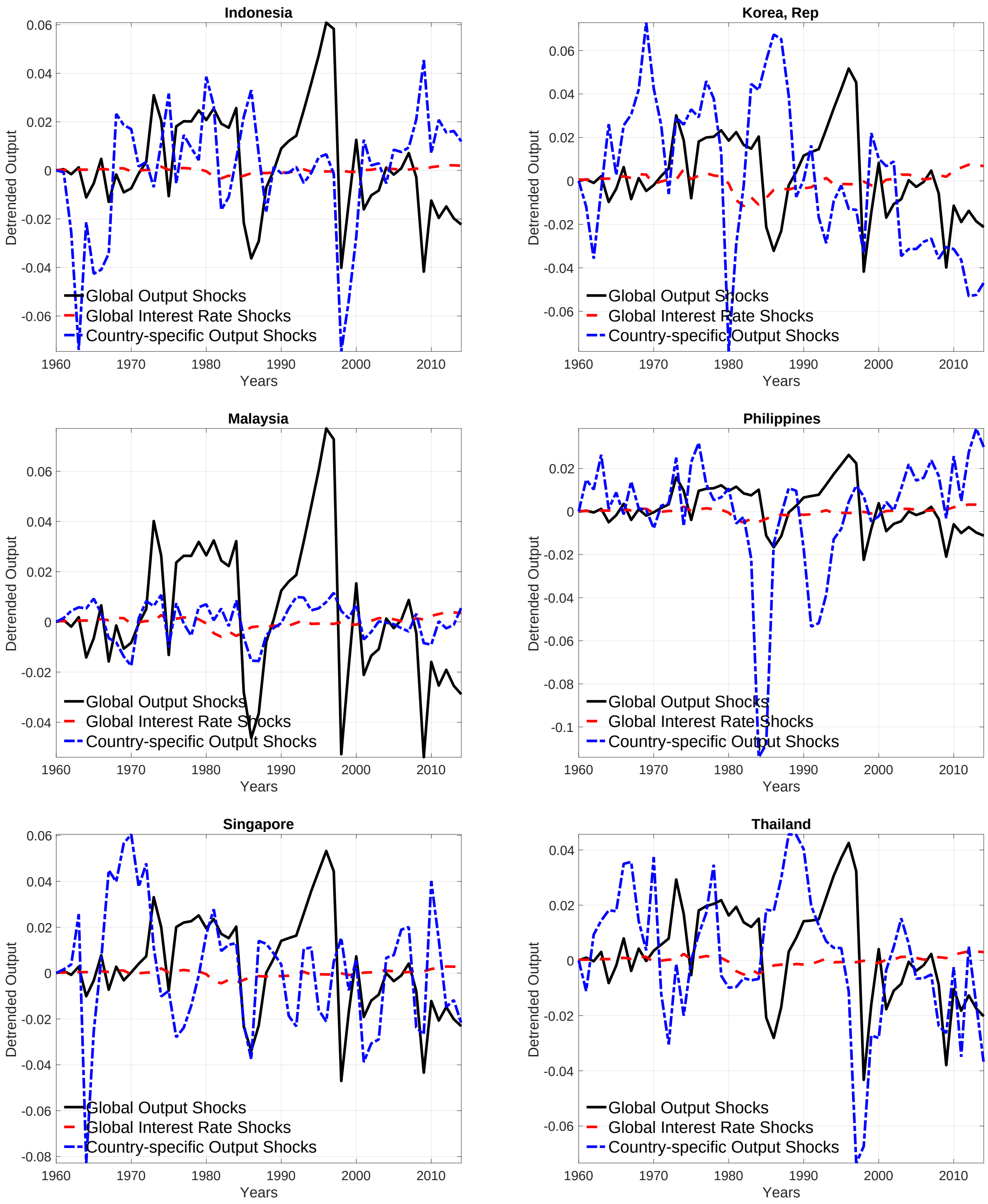

Figure C17: Decomposing fluctuations in detrended output