World Financial Cycles*

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Abstract

From 1994 to 2023, the world financial cycle has exhibited four phases with different patterns of comovements between U.S. corporate spreads, U.S. stocks, and spreads on emerging market (EM) sovereign debt. We build a state-of-the-art asset-pricing model of the world economy in which the global intermediaries of a large developed economy, the *North*, lend to both northern firms and many small EM economies using defaultable debt. In the phases of the cycle in which the comovement of all asset prices is high, this comovement arises from the time-varying price of risk emanating from the global intermediary's discount factor. In other phases, when southern spreads move sharply even though northern asset prices do not, these southern spreads are mainly driven by changes in the quantity of risk in the South. Taken together, these findings suggest a new view of the world financial cycle. We propose a model that is consistent with this view.

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A recent literature has documented interesting patterns of comovements between asset prices in advanced economies, such as stock markets and corporate spreads and spreads on sovereign debts in emerging market economies. In particular, Longstaff et al. (2011) documented that for some periods, sovereign bond spreads are more related to U.S. stock and U.S. corporate spreads than they are to measures of economic activity in emerging market countries, such as their output growth. Moreover, they documented that there is a large common component in sovereign bond spreads. These findings led them and others to argue that there is a common movement in risk premia across countries that arises from shocks to global investors' pricing kernels that jointly price U.S. stock, U.S. corporate bonds, and emerging market sovereign bonds. In short, these authors have argued that there is a global financial cycle driven by global investors.

We begin our paper by considering comovements between these asset prices over a longer period than that studied in this *global cycle* literature. We find that instead of there being a single phase in which all of these prices move closely together, the data is best described as consisting of four phases, shown in Figure 1a and 1b.

The first, the *emerging market crises* phase (1994-2002), exhibits small comovements between U.S. asset prices and sovereign spreads. Indeed, during this period, the U.S. stock market, as measured by price-dividend ratios, booms and corporate spreads are low, while at the same time, emerging market spreads are high and volatile. In the second, the *great spread moderation* phase (2002-2007), U.S. stock prices and corporate spreads are fairly stable, whereas sovereign spreads on emerging market debt fall drastically. In the *global cycle phase* (2008-2016), U.S. stocks and corporate spreads move closely with sovereign spreads. Finally, in the *geoeconomic fragmentation phase* (2016-2024), U.S. stocks start off fairly stable and then boom after 2021. Concurrently, U.S. corporate spreads are fairly stable, except for a small uptick in the middle of this period. In contrast, in the middle of this period, sovereign spreads experience a very large spike.

We refer to these four phases as the *world financial cycle* and argue that, currently at least, existing models struggle to simultaneously account for them. The goal of this paper is to document these phases and then develop a parsimonious framework that can quantitatively account for them.

Our model consists of a large developed economy, called the *North*, many small open emerging market economies, called the *South*, and *global intermediaries*. The global intermediaries are owned by northern households. They pay the risk-free rate on deposits from northern households and lend to both northern firms and southern countries by purchasing long-term defaultable bonds from them. Output in the North is produced by firms that choose inputs of labor and capital and finance their operations by optimally issuing defaultable debt and paying dividends. The setup of the North extends the pure exchange model of Bansal and Yaron (2004) to a production economy with defaultable debt and equity and draws on elements of Gourio (2013) and Gomes, Jermann, and Schmid (2016).

The southern countries face endowment risk, and their governments issue defaultable debt to smooth their consumption as in Eaton and Gersovitz (1981) and Arellano (2008). Southern consumers are less patient than northern consumers, so southern countries borrow from global intermediaries, whereas northern consumers lend to them by holding deposits.

A fundamental difference between our model and the vast majority of those in the sovereign debt literature is that the preferences we use and the output processes we consider are those popular in finance, as in Bansal and Yaron (2004), rather than the standard ones in the sovereign debt literature. In terms of preferences, we assume that consumers in all countries have Epstein-Zin preferences. In terms of output processes, the growth rates of productivity of firms in the North is the sum of a highly serially correlated component referred to as *northern long-run risk* and an i.i.d. component referred to as North growth rate shocks. Both of these components are also subject to a serially correlated *northern volatility shock* that affects their volatilities.[1]

The growth rate of output in each southern country is also the sum of two components. One is a highly serially correlated component that is also correlated across southern countries, referred to as *southern long-run risk.* The other is a country-specific idiosyncratic i.i.d. growth shock. Notably, as the data suggests, there is essentially no correlation between North and South output. To capture this feature, we assume the primitive stochastic processes in the North are independent of those in the South. Nonetheless, our model endogenously generates a correlation between northern and southern spreads because both northern firms and southern countries borrow from the same global intermediaries.

These shocks give our model the potential to generate changing patterns in the world financial cycle. The two key northern shocks, namely long-run risk and volatility shocks, both operate through the *global intermediary mechanism*. Specifically, both of these shocks change the price

[1]Our framework for modeling preferences and shock structure extends to a model with one large country and many small open economies, a version of the two-country models implemented in Colacito and Croce (2011) and Colacito and Croce (2013)

of risk underlying the pricing of all assets because they impact the stochastic discount factor of these intermediaries. For example, *bad times* in the North, which can arise either from poor growth prospects—a negative long-run risk shock—or high volatility, makes the intermediary cautious and generates high spreads on both northern and southern debt as well as a declining stock market.

The key southern shocks, namely the common component of southern long-run risk shocks, operate through a *common shock mechanism*. Specifically, they directly affect southern countries' choices about default and thus affect the quantity of risk in the stream of payments they promise to the global intermediary. For example, *bad times* in the South arising from poor growth prospects lead them to default more both now and in the future and thus generate high spreads on the southern debt even though the global intermediary's pricing kernel is not directly affected. In terms of quantification, we discipline our model's parameters using quarterly data from 12 emerging market economies and the United States. We focus on moments of output growth, corporate spreads, and price-dividend ratios from the United States, as well as output growth and EMBI spreads from emerging market economies.

We then provide intuition for how the mechanisms work in practice by examining the resulting impulse responses. They show that bad times in the North, resulting from either negative long-run-risk shocks or high volatility shocks, lead to an increase in both northern and southern spreads and a decline in northern stocks. The key difference between the resulting responses is how they affect stocks and corporate bonds in the North. Negative long-run-risk shocks imply a long-lasting period of poor growth and lead to sharp falls in the stock market but only modest increases in corporate spreads. In contrast, high volatility shocks lead to sizable increases in corporate spreads but only modest falls in the stock market. For the South, bad times resulting from negative long-run-risk shocks there lead to large increases in southern spreads without any change in northern asset prices.

We then feed the particle filter the observed growth rates of output and spreads for the United States and the 12 emerging market economies along with the price-dividend ratios for the United States. This filter uses the model's decision rules to infer the most likely shocks for each period in the sample.

Here we give some intuition for the patterns of shocks that the filter finds drive these four phases. As Figure 1a and 1b show, during the emerging market crises phase the U.S. stock market booms, and corporate spreads are low, while at the same time, emerging market spreads are high and volatile. These exuberant patterns of asset prices in the North lead the filter to infer that growth prospects are good and volatility is low. Through the lens of the model, these patterns imply that global intermediaries in the North are happy to lend. Using a combination of the realized growth rates in the South and the high spreads on sovereign debt, the filter infers that there are poor and volatile growth prospects in the South, namely large negative and volatile southern long-run-risk shocks. Given these shocks, the global intermediary forecasts that southern bonds have become more risky and hence charges higher spreads on sovereign debt.

Next, during the great spread moderation phase, both stocks and spreads in the North are fairly stable, but spreads in the South fall sharply, nearly 450 basis points. Through the lens of the model, the patterns in the North imply that global intermediaries have no substantial changes in their cautiousness in lending. Hence, using a combination of the realized growth rates in the South and the falling spreads on sovereign debt, the filter infers that the growth prospects in the South markedly improve. So, the global intermediary forecasts that southern bonds have much less risk, and thus, it charges much lower spreads.

During the global cycle phase, there are huge spikes in both the southern and northern spreads and a collapse in the stock market. These patterns, along with the output data, imply that there are bad times in the North and the South and the filter ends up blaming the bulk of these movements on a combination of increased volatility in the North and poor growth prospects there.

Finally, during the geoeconomic fragmentation period, in the North there are stable then booming stocks and fairly stable spreads on corporate debt. In the South, however, there is a huge spike in spreads. These patterns lead the filter to attribute the movements in southern spreads to bad long-run risk shocks there.

We summarize these findings with some variance decompositions. Overall, the southern shocks by themselves account for over 80% of the fluctuations in southern spreads. During the global cycle phase, however, they account for the bulk of the fluctuations in southern spreads–about two-thirds. In the North, the fluctuations in stocks are mostly accounted for by movements in long-run risk, and the fluctuations in corporate spreads are mostly accounted for by the fluctuations in volatility.

The key discipline our model uses to identify the underlying forces driving the world financial cycle is that it must simultaneously account for the movements in both northern and southern asset prices along with their fluctuations in output. To highlight the crucial role of this discipline, we ask what happens if we drop it. In particular, we ask suppose we do not force the filter to justify the movements in northern asset prices at all, but instead focus only on southern spreads and growth rates in northern and southern countries. In this case we find that the global intermediary mechanism can account for nearly all of the movements in southern spreads. However, when we check what the shocks identified in this manner imply for northern asset prices, we find that they are both highly volatile and highly correlated with southern spreads. Indeed, the counterfactual northern spreads and price-dividend ratios have correlations of 95% and 69% with southern spreads, whereas the actual northern spreads and price-dividend ratios have correlations of only 5% and 6%, respectively. In this sense, our model implies that the global intermediary mechanism can account for nearly all of the movement in southern spreads, but only if, counterfactually, northern asset prices are very highly correlated with these spreads.

We also run a counterfactual using junk bond yields for our U.S. corporate spread series. Specifically, in the baseline model, we focused on investment grade spreads, Baa yields minus Aaa yields, as our measure of corporate spreads. The reason we did so is that the vast majority of corporate bonds are investment-grade bonds—on the order of 85%. Interestingly, however, as authors such as Longstaff et al. (2011) have documented, spreads on noninvestment grade bonds or *junk bonds* are more correlated with southern spreads than are investment-grade bonds. When we replace our baseline investment grade spread series with a junk bond spread series we find that our results change little.

Next, we run a counterfactual in which we replace our broad measure of the stock market with one reflecting only financial stocks. We do so in the spirit of some of the work on global cycles, such as Morelli, Ottonello, and Perez (2022), which focuses on intermediaries that represent the financial sector. When we do so, we also find little change in our results. Finally, we run a counterfactual in which use both junk bond spreads for our corporate spreads and financial stocks for our stock market measure and again find little change in our results.

Related literature. Our work documents that the world financial cycle moves through phases in which the comovements among key asset prices in the North and the South are very different. We propose a parsimonious model that can account for these patterns well and have identified the roles of several mechanisms that generate them. Our model builds on a vast body of work in international economics and asset pricing.

The underlying structure of the southern countries builds on the work on sovereign default, including the work of Eaton and Gersovitz (1981), Arellano (2008), and the vast literature surveyed by Aguiar et al. (2016). These papers mostly focus on models of a single southern country that borrows from a northern lender, often risk neutral, and focuses on the comovements between this country's spreads and local economic conditions. In contrast, the focus of our work is on the joint comovement between asset prices in the South and the North, and we emphasize the changing phases of the world financial cycle.

Our work is also motivated by a burgeoning literature on global financial cycles. In terms of empirical work, Longstaff et al. (2011) documents the high comovement between southern spreads and northern asset prices in their sample. Based on this data, they argue that a promising model is one in which all of these assets are priced by an investor with a global portfolio. The empirical work in this area has been surveyed and extended by Miranda-Agrippino and Rey (2022) in a comprehensive handbook chapter. Our model builds in this feature but, critically, we find the role of the global intermediary mechanism is small in three of the four phases we identify.

The most closely related paper to ours is Morelli, Ottonello, and Perez (2022). This work assumes that northern consumers are risk-neutral and that a global intermediary prices all financial assets subject to a collateral constraint and an equity issuance cost. The focus of their work is to link the fall in net worth of the global intermediary to increases in spreads in emerging market economies, with the main episode of interest being the global cycle phase. Both our model and our focus differs from theirs. In terms of the model, we use an extension of a state-of-the-art asset pricing model with Epstein-Zin preferences and Bansal-Yaron-type shocks. We also explicitly model the decision to default by northern firms and, hence, have endogenous default rates and endogenous corporate spreads.[2] Finally, our model simultaneously accounts for the comovements between northern stock prices and northern corporate spreads with southern sovereign spreads.

We also differ in terms of focus. Instead of focusing on the global cycle phase, we focus on the changing phases of the world financial cycle. We emphasize that these different phases exhibit

[2]Notably, our model does not exhibit a corporate spread puzzle.

very different patterns between northern stocks and corporate debt with southern spreads than those in the global cycle phase. For example, in the emerging market crises phase, U.S. stocks boom and spreads on corporate debt are tiny even though southern spreads are vastly increasing. Likewise, during the great spread moderation, spreads on sovereign debt fall by over 450 basis points, whereas spreads on northern debt barely move. In these two phases, northern intermediaries account for only a very modest fraction of the movements in southern spreads of 25% and 12%, respectively. In all of these senses, we view our work as complementary to their important work.

1 Motivating Evidence

In the literature, there are two main views of how asset prices in emerging markets and those in advanced economies interact. Conventional models of sovereign defaults, developed by Eaton and Gersovitz (1981) and Arellano (2008), consider small open economies that borrow from an international risk-neutral lender, say from the United States. By construction, these models build in no interaction between asset prices in developed countries and emerging market economies. Instead, the local economic conditions in EM countries determine their asset prices and the relation between them and the movements in asset prices in developed countries are abstracted because they are not thought to be of first-order importance. We refer to these modeling choices as reflecting the *standard view*.

An alternative theory of the relation between asset prices in emerging markets and those in advanced economies comes from the recent literature on global cycles, Longstaff et al. (2011) and Morelli, Ottonello, and Perez (2022) that we refer to as the *global cycle view*. This work emphasizes the comovements of asset prices in emerging markets and advanced economies. In that view, the time-varying stochastic discount factor from a global intermediary connects these asset prices. Indeed, since a single discount factor prices US corporate bonds, US stocks, and emerging country bonds, when there are large movements in discount for bearing risk, then the returns on the assets being priced by this discount factor will tend to move relatively closely together. The key prediction of these models is that asset prices in EM economies, such as EM spreads, move closely with US spreads and US stock returns.

Next, guided by these predictions, we document facts about the relation between EM asset prices, focusing on sovereign spreads, their connection to local real economic activity, and their connection to both stock markets and real economic activity in the United States. These facts will help us put these two views in perspective and establish features of the data about that models of the world financial cycle must confront.

For this purpose, we use interest spreads on dollar-denominated sovereign bonds from EMBI Global for 12 emerging countries with at least 80% of observations of monthly spread data and quarterly GDP between 1994Q1 and 2023Q2. The countries in our sample are Argentina, Brazil, Chile, Colombia, Hungary, Malaysia, Mexico, Peru, Philippines, Poland, South Africa, and Turkey. We also include US GDP, corporate spreads, and stock returns in the study.

Figure 2a shows the spreads for the countries in our sample.[3] These spreads are defined as the dollar yield on an emerging market sovereign bond minus the dollar yield on a U.S. Aaa bond of similar maturity. Based on the patterns of these spreads along with the comovement with U.S. stocks and corporate bond spreads, we divide the data into four periods.

First, the period from 1994 to 2003, termed the *emerging market crises*, contains a series of crises in emerging markets. For example, in the *Tequila crisis* at the end of 1994 through the beginning of 1995 Argentina (not shown), Mexico, and Brazil had large increases in their spreads. Then in 1997 and 1998, there were large spikes in the spread of Malaysia and the Philippines associated with the *Asian financial crisis*. In the same time frame, there were spikes in many of the other countries, including Brazil, Mexico, South Africa, and Turkey, among others. Next, in 2001 Argentina and Turkey experienced financial crises largely driven by poor government policies, and in 2002 Brazil had a similar economic crisis.

During the emerging market crises phase, there are scant comovements between the U.S. corporate spreads and sovereign bond spreads. Figure 1a shows this pattern for the average spread. As Table 1 shows, during this phase, the mean correlation of these spreads across countries is low at 12.1%, but there is a fair bit of heterogeneity across countries. There are even smaller comovements between the U.S. stock market and sovereign bond spreads. Figure 1b shows this pattern for the average spread. As Table 1 shows, during this phase, the mean correlation of the U.S. stock market with sovereign bond spreads is only 7.3% There is also substantial heterogeneity in this correlation across countries, with Turkey being quite positively correlated (60.7%), whereas Hungary is negatively correlated (−44.2%). The standard deviation

[3] In the Figure, we do not include Argentina, but we do include it in our calculations and in Figure A1 in the Appendix.

across countries of this correlation is 36.8%.

In the great spread moderation phase, almost all the countries in our sample had a sharp decrease in their spreads. Brazil had the largest fall of 19%. This period was characterized by robust economic growth and lower interest rates. Many of them also implemented significant economic reforms that stabilized their domestic economies and financial systems. Some countries, such as Hungary and Poland, had undertaken ambitious economic reforms after the collapse of the Soviet Union and had low spreads throughout this period.

As Figures 1 and 2 show, even though EM spreads were falling greatly, both U.S. corporate spreads and the U.S. stock market are fairly flat. Moreover, there is a modest correlation between EM spreads and U.S. corporate spreads but effectively no correlation between EM spreads and the U.S. stock market. Indeed, Table 1 shows that the mean correlation of these spreads is 49.6% whereas the mean correlation of EM spreads and U.S. stocks is only −3.4%. Both have substantial standard deviations of 30.8% and 23.4%, respectively.

The Global Financial Cycle phase stands out as being completely different than all the other phases. At the beginning of this period, namely from 2007Q4 to 2009Q2, the world experienced the Great Recession. During this crisis, all of the countries in our sample experienced a rise in their spreads. There was also a rise in spread among many of these countries in 2011-2012. During this period, there were rising fears of a global economic slowdown as well as political instability and increased uncertainty over many countries' economic policies.

As Figures 1 and 2 show, during this phase, U.S. corporate spreads shot up, and the U.S. stock market crashed at the same time as sovereign spreads shot up. The distinctness of this phase and its uniform pattern across countries is apparent from Table 1. Indeed during it, every single country has both a large positive correlation between their sovereign spreads and the U.S. corporate spreads and a large negative correlation between their sovereign spreads and U.S. stocks. The mean of these correlations is 75.0% and −72.5% respectively, and both have small standard deviations of 15.3% and 14.0%.

Finally, as the IMF discusses in several reports, in the geoeconomic fragmentation, there was a steady retreat from globalization. A notable event at the beginning was the Brexit referendum in June 2016. This event foreshadowed the sharp turn towards more nationalistic protectionist policies and a general drawing back from multilateralism in trade. Countries also turned away from general outsourcing of supply chains toward more local *near-shoring* and *friend-shoring* strategies. Figure 2b plots the interquartile range of spreads shows that spreads in this period have the opposite pattern as they did in the great spread moderation: spreads across countries gradually fan out rather than quickly converge.

Even though Table 1 points to a sizable positive correlation between U.S. corporate spreads and sovereign spreads during this period, Figure 1a shows that the increase in U.S. corporate spreads is tiny relative to the increase in the average sovereign spread. From Figure 1b we see that the spike in average EM spreads is unrelated to the U.S. stock market. Table 1 confirms this lack of connection since the mean correlation between EM spreads and the U.S. stock market is only 9.5%.

In summary, the EM crisis phase features high, volatile, and diverse sovereign spreads across countries that are not very related to U.S. asset prices. During the great spread moderation phase, spreads across countries all converged together to much lower levels, whereas U.S. stocks and corporate spreads are fairly flat. The global cycle phase stands out in that asset prices in the U.S. and across emerging market countries all get worse together. Finally, in the geoeconomic fragmentation phase, sovereign spreads start diverging, and there is a large spike in them that is little related to asset prices in the United States. the spreads became divergent, showing the opposite pattern as the great spread moderation or Global Financial Cycle.

Based on this data, we argue that a model which successfully accounts for the time-varying patterns of the relationship between emerging market spreads and US asset prices must be able to produce phases in which the standard view prevails and phases in which the global cycle prevails. We turn to developing a model that can account for these patterns.

2 Model of the World Economy

The world is composed of a northern country, referred to as the North, and a continuum of small southern countries, collectively referred to as the South. All countries have Epstein-Zin preferences. The North is a production economy with a continuum of firms issuing long-term debt with default risk. Northern households lend to both northern firms and southern countries with long-term defaultable debt. Each southern country is a pure exchange economy with sovereign default risk. Southern countries are more impatient than northern ones, and on average, they borrow from the North. We assume that the South as a whole is small in the world economy. This framework is set up to analyze the behavior of spreads between developed economies and emerging market economies that perennially borrow from developed economies. As such, we exclude countries that perennially save, such as China, and may indeed be large in the world economy.

All countries have shock structures that feature long-run risk shocks, time-varying volatility shocks, and idiosyncratic shocks. In the North, these shocks are to the productivity of firms, whereas in the South, these shocks are to each country's endowments.

2.1 The Northern Country

The North has a representative household, a continuum of competitive intermediaries, and a continuum of heterogeneous firms. The setup of the North is similar to that in Miao and Wang (2011), Gomes, Jermann, and Schmid (2016), and Gourio (2013).

2.1.1 Northern Household

The households in the North have Epstein-Zin preferences over aggregate consumption C_{Nt} given by

$$V_{Nt} = (1-\beta)\log(C_{Nt}) + \beta\log(G_{Nt}), \quad G_{Nt} = \left(E_t V_{Nt+1}^{1-\gamma}\right)^{\frac{1}{1-\gamma}}$$

where $1/\gamma$ is the elasticity of intertemporal substitution. In period t, households purchase a financial asset B_{Nt+1} from the intermediaries with a stochastic return R_{Nt+1} in period $t+1$. Households earn labor income $W_{Nt}N_{Nt}$, receive aggregate dividends D_{Nt} from all firms, and pay lump-sum taxes T_{Nt} to the northern government. The budget constraint of the households is given by

$$C_{Nt} + B_{Nt+1} \leq W_{Nt}N_{Nt} + R_{Nt}B_{Nt} + D_{Nt} - T_{Nt}. \tag{1}$$

In the initial period, the households have no debt, and they own the capital stock K_{j0} in each firm j. We can write the stochastic discount factor of the households as

$$M_{Nt+1} = \beta\left(\frac{C_{Nt}}{C_{Nt+1}}\right)\left(\frac{V_{Nt+1}}{G_{Nt}}\right)^{1-\gamma}. \tag{2}$$

2.1.2 Northern Firms

Firms face an aggregate labor-augmenting technology shock A_{Nt} and an idiosyncratic capital quality shock κ_{jt}. They produce with a constant returns to scale production function using capital and labor given by

$$Y_{jt} = (A_{Nt}N_{jt})^{1-\alpha_k}K_{jt}^{\alpha_k}.$$

Capital accumulation follows

$$K_{jt+1} = (1-\delta)K_{jt} + I_{jt}.$$

We assume a process for labor-augmenting technology $a_{Nt} = \log A_{Nt}$ which includes long-run risk and stochastic volatility along the lines of Bansal and Yaron (2004). The (log of) the growth rate of productivity is the sum of a serially correlated component, $x_{Nt} = \log(X_{Nt})$, referred to as *long-run risk* and a serially uncorrelated component, $\sigma_{Nt-1}v_{Nt}$, referred to as *short-run risk*, where σ_{Nt} is the stochastic volatility of all northern shocks. Specifically, we assume that the growth rate of productivity follows the process

$$\Delta a_{t+1} = \mu_N + x_{Nt} + \sigma_{Nt}u_{Nt+1}, \tag{3}$$

where the long-run risk component satisfies

$$x_{Nt+1} = \rho_{xN}x_{Nt} + \phi_{xN}\sigma_{Nt}u_{xNt+1}.$$

The volatility shock follows

$$\sigma^2_{Nt+1} = (1-\rho_{\sigma N})\sigma^2_N + \rho_{\sigma N}\sigma^2_{Nt} + \phi_{\sigma N}\sigma_{Nt}u_{\sigma Nt+1},$$

where the shocks $[v_{Nt}, v_{xNt}, v_{\sigma Nt}]$ are independent of each other, i.i.d. over time, and normally distributed with zero means.

A firm j chooses labor to maximize its operating profits

$$\pi_{jt} = \max_{N_{jt}} \ (A_{Nt}N_{jt})^{1-\alpha_k}K_{jt}^{\alpha_k} - \kappa_{jt}K_{jt} - W_{Nt}N_{jt}$$

where W_{Nt} is the wage rate. Here κ_{jt} is an i.i.d normally distributed random variable with mean zero and standard deviation σ_κ with c.d.f. Ψ. We adopt the specification from Gomes, Jermann, and Schmid (2016), which interprets these shocks as direct shocks to firms' operating income and not necessarily to their output. The shocks are meant to capture the overall firm-specific component of their business risk, and following Gomes, Jermann, and Schmid (2016) refer to them as *idiosyncratic profit shocks*. Note that even though these shocks average to zero in the cross-section, they can potentially be large for any individual firm. These shocks will turn out to be a crucial driving force behind the default behavior of firms.

Note that once we maximize the choice of labor, the firm's operating profit is linear in its capital. Specifically,

$$\pi_{jt} = \alpha_k \left(\frac{A_{Nt} (1 - \alpha_k)}{W_{Nt}} \right)^{\frac{1-\alpha_k}{\alpha_k}} K_{jt} - \kappa_{jt} K_{jt},$$

and that $\left(\frac{A_{Nt}(1-\alpha_k)}{W_{Nt}} \right)^{\frac{1-\alpha_k}{\alpha_k}} = Y_{Nt}/K_{Nt}$ whereY_{Nt} and K_{Nt} are the aggregate output and capital in the economy. We let $R_{kt} = \alpha_k Y_{Nt}/K_{Nt} + 1 - \delta$ denote the aggregate return on capital.

Financial Frictions We consider financial frictions that break the Modligliani-Miller theorem and lead to a determinate capital structure with positive amounts of both capital and debt. We do so in a way that extends the setup in Gourio (2013) to include long-term debt.

In period t each firm j issues claims to B_{jt+1} units of long-term defaultable bonds. One unit of such a claim represents a promise to pay the sequence of payments

$$1, (1 - \varphi), (1 - \varphi)^2, ...$$

which begins with one unit at period $t + 1$ and then decays at a geometric rate.

A firm j can default on its inherited debt B_{jt}. After a default, the household, in its role as a shareholder in the firm, receives zero value whereas in its role as the debt holder of the firm, receives the residual value of the firm after a costly restructuring. We assume that the debt holders end up with a fraction θ of firm value and are entitled to that fraction of the flow of future dividends. We think of the remaining fraction $1 - \theta$ in firm value as being distributed in a lump-sum manner to all northern households. In this sense, the northern households are always entitled to all of the dividend flows of the firm.

As we discuss below, with firm default risk the bond price Q_{jt} will be firm-specific. Firms also receive a subsidy on their borrowing from the northern government. In particular, if a northern firm has an outstanding B_{jt+1} units of claims to long terms bonds at t with value $Q_{jt}B_{jt+1}$ the northern government gives a subsidy to the firm of $(\chi - 1)Q_{jt}B_{jt+1}$ with $\chi > 1$ which it finances with a lump-sum tax on households. As discussed by Gourio (2013), one interpretation of the subsidy is that it captures the tax advantage of debt. Alternatively, we can think of it as capturing in a reduced-form way the various advantages that debt has over equity discussed in the corporate finance literature (see Tirole 2005).

We assume throughout that $\theta\chi < 1$, which is necessary for debt and equity to both be used. Note that when $\chi = \theta = 1$, the capital structure is indeterminate, and the Modigliani-Miller theorem holds. When $\chi = 1$ debt has no advantage, and firms issue only equity. When $\theta = 1$, or more generally, when $\theta\chi \geq 1$, the subsidy to debt outweighs the cost of default, and firms issue only debt.

Here if a firm pays its coupon on outstanding debt B_{jt} at t and issues L_{jt} new units of debt, the outstanding debt at $t + 1$ is

$$B_{jt+1} = (1 - \varphi)B_{jt} + L_{jt}. \tag{4}$$

At date t, after the firm issues L_{jt} units of new debt, the total resources received by the firm from this debt is

$$Q_{jt}\left[L_{jt} + (\chi - 1)B_{jt+1}\right] \tag{5}$$

where $Q_{jt}L_{jt}$ is the revenue from the new issues and the subsidy from the government on the value of the stock of outstanding debt is $Q_{jt}(\chi - 1)B_{jt+1}$. Using (4) to substitute for L_{jt} in (5) the total resources become

$$Q_{jt}\left[B_{jt+1} - (1 - \varphi)B_{jt} + (\chi - 1)B_{jt+1}\right] = Q_{jt}\left[\chi B_{jt+1} - (1 - \varphi)B_{jt}\right]. \tag{6}$$

Individual Firm's Problem A firm's state includes its capital K_{jt}, debt B_{jt}, idiosyncratic shock κ_{jt}, and the aggregate state. At the beginning of the period, the aggregate and idiosyncratic shocks are realized. The firm then makes its default decision.

If the firm defaults its value is 0 and if it repays its value is J_{rt}. After the firm repays its debt, it chooses capital and debt holdings for the next period. Letting J_t denote the value of the dividend stream of the firm prior its default decision, we have

$$J_t(K_{jt}, B_{jt}, \kappa_{jt}) = \max\left\{0, J_{rt}(K_{jt}, B_{jt}, \kappa_{jt})\right\} \tag{7}$$

where we omit explicit dependence on the aggregate state. Here, the value under repayment is given by

$$J_{rt}(K_{jt}, B_{jt}, \kappa_{jt}) = (R_{kt} - \kappa_{jt})K_{jt} - B_{jt} + V_t(K_{jt}, B_{jt}). \tag{8}$$

where V_t is given by

$$\begin{aligned} V_t(K_{jt}, B_{jt}) = \max_{B_{jt+1}, K_{jt+1}} \; & Q_{jt}(K_{jt+1}, B_{jt+1})\left[\chi B_{jt+1} - (1-\varphi)B_{jt}\right] - K_{jt+1} \\ & - \Gamma_\omega\left(\frac{B_{jt+1}}{K_{jt+1}}\right)K_{jt+1} - \Gamma_K\left(\frac{K_{jt+1}}{K_{jt}}\right)K_{jt+1} + E_t M_{t+1}\int J_{t+1}(K_{jt+1}, B_{jt+1}, z)d\Psi(z) \end{aligned} \tag{9}$$

and $Q_{jt}(K_{jt+1}, B_{jt+1})$ is the schedule of bond prices that a firm faces for different choices of K_{jt+1} and B_{jt+1} and $\Gamma_K\left(K_{jt+1}/K_{jt}\right)K_{jt+1}$ and $\Gamma_\omega\left(B_{jt+1}/K_{jt+1}\right)K_{jt+1}$ captures the costs of adjusting capital and leverage B_{jt+1}/K_{jt+1}, respectively. Note that in (9) we used (6).

From the form of (7), clearly the firm defaults if and only if $J_{rt}(K_{jt}, B_{jt}, \kappa_{jt}) < 0$. It then follows from (8) that there exists a default cutoff $\kappa^*_{jt}(K_{jt}, B_{jt})$. In particular, the firm defaults if and only if it receives a sufficiently large shock, $\kappa_{jt} \geq \kappa^*_{jt}$ where the cutoff κ^*_{jt} satisfies $J_{rt}(K_{jt}, B_{jt}, \kappa^*_{jt}) = 0$ so that from (8) and (9) we have

$$\kappa^*_{jt} = \frac{R_{kt}K_{jt} - B_{jt} + V_t(K_{jt}, B_{jt})}{K_{jt}}.$$

The repayment probability is $\Psi(\kappa^*_{jt})$ where $\Psi(\kappa) = \Pr(\tilde{\kappa} \leq \kappa)$ is the cumulative distribution of the shock κ.

2.1.3 Financial Intermediaries

There are a large number of competitive financial intermediaries that are owned by households. Note that here the representative financial intermediary is used for convenience only and that, differently from other papers in the global cycle literature, there are no financial frictions on financial intermediaries. This implies that the price of assets is determined by the household stochastic discount factor. Hence, our results would be unchanged if we assumed that households hold directly the assets.

One motivation for this assumption comes from the evidence reported by Fang, Hardy, and Lewis (2022), which shows that, over the period 1995-2018, over 80% of new EM debt absorbed outside of the issuing country is held by non-bank investors.**careful... what really want is how much of the secondary debt held by private agents** In period t, the intermediary borrows a total of B_{Nt+1} from households and lends out these funds to the collection of firms so that the constraint

$$B_{Nt+1} = \int Q_{jt}(K_{jt+1}, B_{jt+1})B_{jt+1}dj,$$

holds. In period $t+1$, the intermediary pays households a total of $R_{Nt+1}B_{Nt+1}$ using the claims paid to it from the firms. Hence, the return R_{Nt+1} is implicitly defined by

$$\begin{aligned} R_{Nt+1}B_{Nt+1} = \int \Big\{ & \Psi(\kappa^*_{jt+1}) \left[1 + (1-\varphi)Q_{jt+1}\right] B_{jt+1} \\ & + \theta \int^{\kappa^*_{jt+1}} \left[J_{j,rt+1} + B_{jt+1} + (1-\varphi)Q_{jt+1}B_{jt+1}\right] d\Psi(\kappa) \Big\} dj. \end{aligned}$$

For any individual firm j, the no-arbitrage condition implies that the bond price $Q_{jt}(K_{jt+1}, B_{jt+1})$ satisfies

$$\begin{aligned} Q_{jt}B_{jt+1} = {} & E_t M_{t+1} \Psi(\kappa^*_{jt+1}) \left[1 + (1-\varphi)Q_{jt+1}\right] B_{jt+1} \\ & + \theta E_t M_{t+1} \int^{\kappa^*_{jt+1}} \left[J_{jrt+1}(K_{jt+1}, B_{jt+1}, \kappa) + B_{jt+1} + (1-\varphi)Q_{jt+1}B_{jt+1}\right] d\Psi(\kappa), \end{aligned} \tag{10}$$

where $J_{rt+1} + B_{jt+1} + (1-\varphi)Q_{jt+1}B_{jt+1}$ is the future value of the firm, namely, the sum of equity and bond value. Hence, at this bond price the value of resources the intermediary gives to firm j at t, $Q_{jt}B_{jt+1}$, is equal to the value of total future payments that firm j makes to the intermediary where these future payments are valued using the northern household's stochastic discount factor.

The first term on the right side of (10) is the value of payments on the long-term bond conditional on no default at $t+1$. The second term is the value of payments received conditional on a default at $t+1$. In this case, the debt holders become the sole owners of the firm and are entitled to collect the current value of the firm, which after a costly restructuring, leaves the holders with a fraction θ of the firm's pre-default value. We assume that these restructuring costs are paid in a lump sum to all consumers so that total resources in the economy are unchanged by default. It will turn out that this way of modeling default will imply defaulting firms carry over the leverage as non-defaulting firms. The main difference is that a defaulting firm pays a cost of $1-\theta$ of its total value in restructuring payments and that the incumbent debt holders become the new owners of all equity and debt claims in the defaulting firms.

As we show in the appendix, using familiar logic, the value function of a firm $J_t(K_{jt}, B_{jt}, \kappa_{jt})$ is homogenous of degree 1 in (K_{jt}, B_{jt}) and the price function $Q_{jt}(K_{jt+1}, B_{jt+1})$ is homogenous of degree 0 in (K_{jt+1}, B_{jt+1}) and independent of j so that

$$J_t(K_{jt}, B_{jt}, \kappa_{jt}) = J_t(\omega_{jt}, \kappa_{jt})K_{jt} \text{ and } Q_{jt}(K_{jt+1}, B_{jt+1}) = Q_t(\omega_{jt+1}) \tag{11}$$

where $\omega_{jt} = B_{jt}/K_{jt}$ is the *leverage* of a firm with debt B_{jt} and capital K_{jt}. As we discuss later these properties imply simple aggregation results for our equilibrium.

2.2 Southern Countries

The preferences of any southern country i is of the Epstein-Zin form

$$V_{it} = (1-\beta_S)\log(C_{it}) + \beta_S \log\left(EV_{it+1}^{1-\gamma}\right)^{\frac{1}{1-\gamma}}, \tag{12}$$

where β_S is the common discount factor in the South. All the southern countries and the North have a common elasticity of intertemporal substitution parameter $1/\gamma$. We assume that southern countries are more impatient than the North in that $\beta_S < \beta$, and so they borrow from the North on average.

Each southern country faces stochastic endowments Y_{it}. We assume that, as in Bansal and Yaron (2004), the growth rate of output $y_{it} = \log Y_{it}$ has a serially correlated component, x_{it}, referred to as *long-run risk* along with a short run component e_{it}. Specifically, this process is given by

$$\Delta y_{it} = \mu_S + x_{it-1} + \sigma_S e_{it}, \qquad e_{it} = u_{it} + v_S u_{St}, \tag{13}$$

where the long-run risk in country i is

$$x_{it} = \rho_{xS} x_{it-1} + \phi_{xS}\sigma_S e_{xit}, \qquad e_{xit} = u_{xit} + v_{xS} u_{xSt}. \tag{14}$$

All of the shocks (u_{it}, u_{xit}) for all i and the common southern shocks (u_{St}, u_{xSt}) as well as the North shocks $(u_{Nt}, u_{xNt}, u_{\sigma Nt})$ are mutually independent, jointly normal, mean zero, variance 1, and i.i.d. over time. Notice that the innovation for the growth of the endowment of country i, e_{it}, has an idiosyncratic part u_{it} and a common southern part u_{St}. Here v_S is the loading of each country i on the common southern short-run shock u_{St}. The long-run risk shocks, e_{xit}, have a similar structure: an idiosyncratic part u_{xit} and a common southern long-run part u_{xSt} with a common loading v_{xS}.

Importantly, we have purposely chosen the shocks in the South to be uncorrelated with those in the North. As we show later, this assumption is consistent with the data because the correlation between growth rate shocks in the South and the North is essentially zero. However, it is also useful from a modeling perspective because it implies that all correlations between spreads in the South and the North are driven by endogenous mechanisms in the model rather than by the correlation of primitive shocks. (We also experimented with allowing correlation between the shocks in the South and the North and found similar answers when we quantify our model to be consistent with the same moments we use in the baseline.)

In contrast, the correlation of endogenous variables across southern countries is the result of both the correlation of the primitive shocks across countries, driven by their common southern components, along with the equilibrium response of these southern variables to shocks in the North. Because of this feature, our model leaves open the possibility that much of the correlation in spreads in the South is driven by a common lender effect, namely, because they all borrow from the northern lender. This mechanism is driven by northern shocks that affect the price of risk on risky debt charged by northern intermediaries, and this, in turn, influences the debt choices and default decisions on southern debts. In our quantitative analysis, we parse out the role of each of these forces.

2.2.1 Debt and Default

We assume that the only asset that is traded across countries is a long-term state-uncontingent bond for which countries may default. The debt that the southern countries issue is analogous to that issued by the northern firms in that one unit of a bond in time t is a promise to pay one unit in period $t+1$, $(1-\varphi)$ in period $t+2$, $(1-\varphi)^2$ in period $t+3$,, and so on. At date t the country services the debt by paying B_{it} and issues L_{it} new units of debt, where

$$L_{it} = B_{it+1} - (1-\varphi)B_{it}. \tag{15}$$

The government can default on its long-term bond. After default, $1-\theta_s$ fraction of debt is written off, and the country goes into financial autarky for a stochastic number of periods referred to as the *default phase* and then it returns to the *normal phase*. As for reentry, in each period in the default phase, with probability λ the defaulting country regains access to the international financial market. In the period it regains access, it owes θ_s fraction of the stream of payments it owed in the period t that started this default phase. In particular, recall that absent default, a debt of B_{it} at t implies a flow of payments of B_{it} at t, $(1-\varphi)B_{it}$ at $t+1$ and so on. Here we assume that if a country defaults at t on the debt B_{it} and reenters in period $\tau > t$, then on the legacy debt B_{it} it owes $\theta_s B_{it}$ at τ , $\theta_s(1-\varphi)B_{it}$ at $\tau+1$, and so on. Of course, if the country issues new debt once it reenters, it is also obligated to pay the resulting stream of coupons on this debt as well. Here we are not explicitly charging interest on the unpaid stream of payments during the default phase.

Next, when a country is in the default phase, there are also direct costs that decrease the effective endowment of the country. As discussed by Mendoza and Yue (2012), these costs stand in for various difficulties that countries have in trading, like importing specialized inputs for production. We parameterize the default cost similarly to that in the handbook chapter in Aguiar et al. (2016), so that consumption during default is given by

$$C_{idt} = e^{\kappa_{it}} h(x_{it}) Y_{it}. \tag{16}$$

where κ_i is normally distributed with mean 0 and standard deviation of σ_κ and $h(x_{it}) = 1 - a_0 e^{a_1 x_{it}} \leq 1$.

To understand the motivation for the lost endowments in default implicit in the default cost $h(x_{it})$, recall the quantitative work on default starting from Arellano (2008) and surveyed in Aguiar et al. (2016). As Arellano (2008) noted, countries tend to default in *bad times*. In that work, when output follows a stationary process, the relevant notion of bad times is when current output is low. That work assumes a default cost function in which the cost of default is disproportionately low when output is low and shows that it leads to countries defaulting more in bad times.

In our model, it is output growth that is stationary rather than the level of output. Hence, here a country faces bad times when the current output growth is low, and therefore future growth prospects are poor. In particular, this function implies when x_{it} is low, the resources lost in default are low. In equilibrium, this function implies that a country defaults more in such bad times. Aguiar et al. (2016) consider such a setup, and we follow their work closely.

Finally, the term κ_{it} makes the cost of default fluctuate in each period and immediately implies a cutoff rule for default in κ. As Aguiar et al. (2016) noted, having such a cutoff rule makes computations tractable with long-term debt.

2.2.2 A Southern Country's Problem

Consider the problem of a southern country i in period t. At the beginning of period t, the idiosyncratic shocks of this southern country along with the aggregate shocks in the South and the North are realized. Thus, at the beginning of period t, the state of southern country i is $(B_{it}, \kappa_{it}, s_{it})$ where $s_{it} = (Y_{it}, x_{it})$.

Immediately after these shocks are realized, the country decides to default or not. It does so by comparing the value of repayment W_{irt} with that of default W_{idt}. The value V_{it} at this point is the maximum over the values of each option so that

$$V_{it}(B_{it}, \kappa_{it}, s_{it}) = \max\left\{W_{irt}(B_{it}, s_{it}), W_{idt}(B_{it}, \kappa_{it}, s_{it})\right\}. \tag{17}$$

Consider first what happens if the government chooses to repay at the beginning of the period. If so, the country can use its endowment and new borrowing to pay for both its consumption and current debt payment so that the budget constraint under repayment is given by

$$C_{irt} + B_{it} = Y_{it} + Q_{it}(B_{it+1}; s_{it})\left(B_{it+1} - (1-\varphi)B_{it}\right) - \Gamma_B\left(\frac{L_i}{Y_i}\right). \tag{18}$$

where $L_{it} = B_{it+1} - (1-\varphi)B_{it}$. Here, conditional on repayment, the government chooses B_{it+1} to maximize

$$W_{irt}(B_{it}, s_{it}) = \max_{B_{t+1}} (1-\beta_S)\log(C_{rt}) + \beta_S \log\left(G_{it}(B_{it+1}, s_{it})\right) \tag{19}$$

subject to the budget constraint (18), where the continuation value G_{it} is given by

$$G_{it}(B_{it+1}, s_{it}) = \left[E_t V_{it+1}(B_{it+1}, \kappa_{it+1}, s_{it+1})^{1-\gamma}\right]^{\frac{1}{1-\gamma}}. \tag{20}$$

Let $B_{it+1} = \bar{B}_t(B_{it}, s_{it})$ denote the policy function under repayment.

Instead, if the country defaults, it has no decisions to make, and it simply consumes its endowment net of the penalties from default. Hence, the value during the default phase is

$$W_{idt}(B_{it}, \kappa_{it}, s_{it}) = [(1-\beta_S)\log[e^{\kappa_{it}} h(x_{it}) Y_{it}] + \beta_S \log(G_{idt}(B_{it}, s_{it}))]$$

Since in any period of the default phase, the government regains access to international financial market with probability λ with a fraction θ_s of its defaulted debt, the continuation value G_{idt} is given by

$$G_{idt}(B_{it}, s_{it}) = \left[\lambda G_{it}\left(\theta_S B_{it}, s_{it}\right)^{1-\gamma} + (1-\lambda)\int E_t W_{idt+1}(B_{it}, \kappa, s_{it+1})^{1-\gamma} d\Psi(\kappa)\right]^{\frac{1}{1-\gamma}},$$

and G_{it} is the continuation value of reaccessing international financial markets with debt level of $\theta_S B_{it}$, given by equation (20).

We now turn to show that there is a cutoff level of κ_{it}^* such that the government defaults if κ_{it} is sufficiently high. We define $\kappa_{it}^* \equiv \bar{\kappa}_t(B_{it}, s_{it})$ to be the value of κ_{it} such that the government is indifferent between repaying and defaulting. That is, κ_{it}^* satisfies

$$W_{idt}(B_{it}, \kappa_{it}, s_{it}) = W_{irt}(B_{it}, s_{it}).$$

To show that the default rule has the posited form, we show that the value of default W_{idt} is increasing in κ_{it} while, obviously, the value of repayment W_{irt} does not depend on κ_{it}, so that the resulting value takes the form

$$V_{it}(B_{it}, \kappa_{it}, s_{it}) = \left\{ \begin{array}{c} W_{irt}(B_{it}, s_{it}) \text{ if } \kappa_{it} \leq \bar{\kappa}_t(B_{it}, s_{it}) \\ W_{idt}(B_{it}, \kappa_{it}, s_{it}) \text{ otherwise} \end{array} \right\}. \tag{21}$$

so that the probability of repaying is given by $\Psi(\kappa_{it}^*) = \int_{\kappa \leq \kappa_{it}^*} d\Psi(\kappa)$.[4] To see that W_{idt} is

[4]Here we simply assume that for all relevant value of the states (B_{it}, Y_{it}, x_{it}) such a cutoff level κ_{it}^* exists. In

increasing in κ_{it} note that

$$\frac{\partial W_{idt}}{\partial \kappa_{it}} = W_{idt}(1 - \beta_S) > 0.$$

2.2.3 Bond Price Schedule

Northern households invest in the debt of southern countries. Since the South as a whole is small relative to the North, the evolution of sovereign debt does not affect the amount consumed by the North. Hence, southern debt is priced by the discount factor of the North given by M_{Nt+1} in (2). To derive the bond price schedule for long-term defaultable debt, the northern lender needs to evaluate the stochastic stream of repayments it will receive from the southern country and evaluate this stream with its stochastic discount factor.

Consider the stream of payments that a northern household expects to receive when it lends $Q_t B_{it+1}$ to a southern country i at t that is currently in normal times with shocks s_{it}. In terms of $t+1$, for states s_{it+1} in which the southern country does not default, it expects that the government will repay B_{it+1} and that the value of the remaining debt will be $Q_{t+1}(B_{it+2}, s_{it+1})(1-\varphi)B_{it+1}$ where in the pricing function $B_{it+2} = \bar{B}_{t+2}(B_{it+1}, s_{it+1})$ is the borrowing of the government at $t+1$ in state s_{it+1} given that it has borrowed B_{it+1} at t.

Next, consider states s_{it+1} in which the northern lender expects the southern country to default in period $t+1$. Consider the two branches that follow such a default: one with reentry and one without reentry. With probability λ, the government reenters the normal phase and owes the recovery amount $\theta_s B_{it+1}$. Hence, this value is $Q_{t+1}(\theta_s B_{it+1}, s_{it+1})\theta_s B_{it+1}$ which is equal to the value received from a government that was in the normal phase in period $t+1$ and borrowed $\theta_S B_{it+1}$. With probability $1-\lambda$, the government remains in the default phase at $t+1$. The value of debt recovery at $t+1$ of a claim to B_{it+1} is the expected value over these two branches, and it can be recursively written as

$$\Omega_{t+1}(B_{it+1}, s_{it+1}) = \lambda Q_{t+1}(\theta_s B_{it+1}, s_{it+1})\theta_s B_{it+1} + (1-\lambda)E_t M_{Nt+2}\Omega_{t+2}(B_{it+1}, s_{it+2}). \tag{22}$$

Now moving back to period t, we can define the value of a claim to B_{it+1} at t for a country with state (B_{it+1}, s_{it}). This value is given by the right side of the following equation, and this

practice, we establish sufficient conditions on the states so that this is true.

value defines the price $Q_t(B_{it+1}, s_{it})$ on the left side of it, namely

$$Q_t(B_{it+1}, s_{it})B_{it+1} = E_t\left[M_{Nt+1}\left\{\Psi^*_{t+1}\left[1+(1-\varphi)Q_{t+1}(B_{it+2}, s_{it+1})\right]B_{it+1} + [1-\Psi^*_{t+1}]\Omega_{t+1}(B_{it+1}, s_{it+1})\right\}\right] \tag{23}$$

where $B_{it+2} = \bar{B}_{t+2}(B_{it+1}, s_{it+1})$. Notice that the right side of (23) is the value of the stream of payments from such a claim valued at the northern discount factor. As noted at $Q_t(B_{it+1}, s_{it})B_{it+1}$ the northern household is indifferent to holding such a claim.

Following Arellano, Mateos-Planas, and Ríos-Rull (2023), we define the spreads as the difference between the yields to maturity of the sovereign bonds and the risk-free bonds with the same maturity so that

$$sp_t = \left[\frac{1}{Q_{it}} + 1 - \varphi\right] - \left[\frac{1}{Q_{ft}} + 1 - \varphi\right] = \frac{1}{Q_{it}} - \frac{1}{Q_{ft}},$$

where the price of the risk-free bond is given by $Q_{ft} = E_t M_{Nt+1}[1 + (1-\varphi)Q_{ft+1}]$ and the price Q_{it} is given by (23).

2.3 Aggregation and Equilibrium

As mentioned, our model has a simple aggregation property which implies that for endogenous aggregate states, we need only record the aggregate capital stock K_t and the common leverage of each firm $\bar{\omega}_t$. Recall that an individual firm with debt B_{jt} and capital K_{jt} has leverage $\omega_{jt} = B_{jt}/K_{jt}$. We assume that all firms start with the same leverage $\omega_{j0} = \omega_0$, in that they all have the same ratio of debt to capital but possibly different levels of both.

It turns out that firms that begin a period with the same leverage will choose the same leverage in both the default and the non-default states and that as noted in (11) both the value function and the price schedule only depend on debt and capital through their implied leverage ω_{jt}. Because of these properties, as long as firms start at date 0 with the same leverage, they will always have the same leverage.

Of course, even though the equilibrium will be symmetric, in that all firms choose the same leverage $\bar{\omega}_t$, when we compute an individual firm's decisions, that firm has to evaluate what happens when it chooses its own leverage ω_{jt+1} to be different than aggregate leverage $\bar{\omega}_{t+1}$. In this sense, the problem of a firm has the classic *big K little k* form. In particular, when solving an individual firm's problem, its state is $(\omega_t; \bar{\omega}_t, K_t, x_{Nt}, \sigma_t)$. Then in equilibrium, once we impose symmetry, we need only record the aggregate state $(\bar{\omega}_t, K_t, x_{Nt}, \sigma_t)$. Given this feature, rather than having to record the entire distribution of (K_{jt}, B_{jt}) in the aggregate state, we only need to $(\bar{\omega}_t, K_t)$. See appendix A for details.

Using these properties, we can write market clearing in goods markets as

$$C_t + K_{t+1} - (1-\delta)K_t + \Gamma_\omega \left(\frac{B_{t+1}}{K_{t+1}}\right) K_{t+1} + \Gamma_K \left(\frac{K_{t+1}}{K_t}\right) K_{t+1} = (A_{Nt}N_t)^{1-\alpha_k} K_t^{\alpha_k}.$$

3 Quantification

Here we use data from 12 emerging market economies' output and sovereign spreads along with U.S. data on output, corporate spreads, and the stock market to discipline our model's parameters. We begin by discussing how we deal with the severe movements in output growth during the Great Recession and Covid. We then turn to how we set the parameters, discuss how we solve the model, and then show how well our model quantitatively reproduces the moments that we target.

3.1 Dealing with Disasters in Output Growth

In Figure 4 we plot the output growth in the US and a series constructed by taking the cross-section mean of output growth in our 12 emerging market economies. Two periods stand out: the trough of the Great Recession, 2008Q4 and 2009Q1, and the Covid period, starting in 2020Q1. As we can see, during these two periods, the output growth in the US and the emerging markets moves very closely together, and these movements are very large.

Consider first the Covid period. This period has some very extreme points in its growth rates. For example, in 2020Q2, the average growth in emerging markets is -65% while in 2020Q3 it is 47%. Similarly, in 2020Q2, output growth in the US is -33%, and in 2020Q3, it was 30%. Notice that this was an extreme drop in growth rates followed by an extreme rise in growth rates. The later periods of Covid also have some very extreme behavior. This extreme behavior makes the statistics we use to calibrate the model very sensitive to exactly how we handle it. To avoid that sensitivity we calibrate the model from 1994Q1 to 2019Q4, thus ignoring the Covid period in the calibration. However, we conduct the particle filter analysis over the entire period, 1994Q1 to

2023Q2.

Next, we treat the trough of the Great Recession as a *world disaster* in which every country has a negative shock to its growth rate at the same time. To handle it, we amend our stochastic processes for the northern productivity and southern endowments to have a world disaster in this period in a simple way. Specifically, we add to the productivity process of the North given in (3) a term $-\omega_{dN}\eta_{t+1}$ and add to the endowment process of each southern country a term $-\omega_{dS}\eta_{t+1}$ where the i.i.d process for η_{t+1} is 1 with probability p and 0 with probability $1-p$. We choose p to be such that, on average, one disaster occurs in our sample, so that $p = 1/104$ and we choose ω_{dN} and ω_{dS} so that it accounts for both the decline in output growth in the North over the trough of the Great Recession and for the average decline in southern countries' growth over this same period. This leads us to set $\omega_{dN} = 4.2\%$ and $\omega_{dS} = 5.1\%$.

3.2 Parameters

We assume that the capital adjustment cost function, Γ_K, and the debt adjustment cost functions for the North, Γ_ω, and for the South, Γ_B, have the standard quadratic form,

$$\Gamma_K(g_k) = \frac{h_k}{2}(g_k - e^{\mu})^2, \ \Gamma_\omega(\omega) = \frac{h_{\omega N}}{2}(\omega - \bar{\omega})^2, \ \Gamma_B\left(\frac{L_i}{Y_i}\right) = \frac{h_{\omega S}}{2}\left(\frac{L_i}{Y_i} - \bar{\ell}\right)^2, \quad (24)$$

where g_k is the growth rate of capital, ω is the leverage of a firm, and L_i/Y_i is the debt issuance to GDP.

Table 2 presents two sets of parameters. The first set includes assigned parameters such as the risk aversion parameter γ, output growth μ, debt maturity parameter φ, North capital share α_k, North depreciation rate δ, the persistence and standard deviation of North volatility shock $(\rho_\sigma, \phi_\sigma)$, and the parameter λ that controls the exclusion periods after South defaults.

We follow Bansal and Yaron (2004) and set the risk aversion parameter γ to 12. The mean growth rate of output per capita μ is set to 1.6% to match the average output growth rate globally from 1994Q1-2019Q4. To ensure an average debt duration of 5 years, we set the debt maturity parameter φ to be $1/20$. The North capital share α_k is set to 0.3, which is consistent with the capital share in the United States. We choose δ such that the annual depreciation rate is 10%. The volatility shock parameters $(\rho_\sigma, \phi_\sigma)$ are taken from Bansal and Yaron (2004). Following the literature, we assume that after default, a South country is excluded from international financial markets for an average of three quarters, which is captured by setting $\lambda = 1/3$.

The second set of 13 parameters is chosen to target the 60 observed moments reported in Table 3-5, which include output growth, spreads, and stock returns for both North and South. For each moment, we compute it in the overall sample 1994Q1-2019Q4 and in that same sample, excluding two quarters in the trough of the Great Recession, namely 2008Q4 and 2009Q1.[5] The moments from the model we use are calculated from 1,000 draws of length 104 quarters in which we designate that a disaster occurs over 2008Q4 and 2009Q1. When comparing our model to the data, we treat the model simulated data the same way we do the actual data. In particular, when we simulate the *overall sample* we include these two quarters of disaster, and for the *normal times* sample, we exclude these two quarters. Note that this strategy is similar to that used in Wachter (2013) and Kilic and Wachter (2018).

This set comprises some parameters that have region-specific values, some unique to North, and some unique to South. The first set is those that all countries have but differ in the North and the South. These are the discount factors β, short-run volatilities σ, the persistence parameters of long-run risk ρ_x, the standard deviations of long-run shock $\phi_x\sigma$, the standard deviations of idiosyncratic shocks σ_κ, the debt recovery parameters θ, and the leverage adjustment cost parameters h_ω and with $\bar{\omega}$ and $\bar{\ell}$ in (24). The parameters that are specific to the North are the borrowing subsidy χ and the capital adjustment cost parameter h_k. The parameters that are specific to the South are the default cost parameters a_0 and a_1, the common components in southern short-run growth, ν_S, and in southern long-run growth, ν_{xS}.

Table 2's lower panel displays the parameters that are endogenously chosen to jointly target the moments in Tables 3-5. We chose these moments because they present a comprehensive summary of moments for the key variables, including output growth, North corporate spreads, South sovereign spreads, and North stocks. For southern countries, we consider the average of moments across countries. For each variable, for each country, we first compute this moment over our sample period country-by-country for the 12 countries in the South and then take the mean of these 12 time-series moments.

It is clear from our motivating evidence section that the patterns of comovements in our relatively short sample vary a good deal over the various phases. We think it is instructive to measure the range of the moments our model can generate in samples of similar length.

[5] We did not include the post Covid period when computing the moments. However, we include this period in the particle filter analysis as model validation.

In particular, we focus on the $5th$ and $95th$ percentiles of the simulated distribution for South moments for samples of the same length as the data and record these percentiles in braces below the means of the corresponding moments in the tables.

The range of these percentiles is important for our model's ability to generate the four phases of the world cycle, which have very different patterns. For example, during the EM crises phase, the correlation of North and South spreads is very small, but during the global cycle phase, they are very large. If the ranges across simulations for this correlation were tiny, say instead of ranging from $(-19.7, 67.4)$ as they do in Table 5, they instead ranged from $(26.0, 26.2)$, the model would never be able to generate the very different patterns we see across the four phases. One of the reasons the model is able to generate such a wide range is that both the long-run risk shocks and the volatility shocks are very persistent. (CHECK)

Although all parameters are essential in determining the moments, certain parameters have a more significant influence on specific moments. The annualized discount factor for all southern countries, 0.92, is lower than that of the North, 0.96, which helps in making the southern countries borrow on average and, hence, in generating the observed sovereign spreads. The short-run volatility of output growth in the South, 1.15%, is much higher than that of the North, 0.74%, which helps account for the South's greater output growth volatility. Furthermore, the South's long-run growth prospects are more volatile, with a value of 0.23% compared to North's 0.15%, consistent with the findings of Aguiar and Gopinath (2007) that the low frequency fluctuations in output in emerging market economies are larger than those in developed economies.

Next, the debt recovery, default cost, and idiosyncratic shock parameters of the North matter greatly for the mean and volatility of corporate spreads for northern firms. Likewise, the corresponding parameters for the South matter greatly for the moments of sovereign spreads. In the North, the debt recovery parameter is approximately 55%, while in the South, it is around 32%, which helps account for the lower mean spreads in the North.

Finally, the cross-country correlations of output growth and spreads among southern countries discipline the common components of short- and long-run growth. Comparing Tables 3 and 5, we see that the output growth in the South is much less correlated than are spreads in the South. For example, in normal times, these are 13.1% versus 47.8%, respectively. That the correlation of southern output growth rates is fairly low is directly related to the small loading of 0.33 on the common short-run growth shock u_{St}. As we discuss in detail later the correlation of southern spreads arises both from a common shock effect and a common lender effect. Here the fairly large loading of ν_{xS} of 1 determines the magnitude of the common shock component of southern spreads relative to the shocks to North long-run risk and North volatility, which determine the magnitude of the common lender effect.

3.3 Solution Method

The model is solved by a global solution method. The solution is projected on a basis of Chebychev polynomials collocated on Smolyak sparse grid. The model displays important nonlinearities that require polynomials of at least order 8 to achieve small residuals outside the collocation grid. Expectations over the 7-dimensional shock vector for each country are evaluated using a monomial rule that integrates polynomials of up to order 9. By the assumption that the South is small, we can solve the model in two stages. First, we solve the northern economy over the 4-dimensional space of northern states. Then, we solve the southern economy, given the northern pricing kernel, over the 6-dimensional space of northern and southern states.

3.4 Comparing Model and Data

As Tables 3 to 5 show, overall the benchmark model successfully captures the crucial aspects of the world financial fluctuations. To understand these tables note that under *Data* the statistics in the column *Overall* are computed using the full sample in the data, from 1994Q1 to 2019Q4, and the statistics in the column *Normal Times* are computed using the same data except that they exclude the two-quarter-long trough 2008Q4-2009Q1 of the Great Recession. Under *Model* the statistics in the column *Overall* use model-generated data from 1000 runs of the same length as in the data, namely 104 quarters and in the column *Normal Times* we use these same model-generated data, except that we remove the two-quarter-long trough generated by the disaster. The numbers in brackets indicate the 5*th* and 95*th* percentiles of the corresponding statistics over these 1000 runs.

First, as Table 3 shows, our model is able to replicate the output growth patterns observed in the data, including standard deviations, serial correlations, and cross-country correlations in northern and southern countries. Notably, the model accounts for the feature that individual southern countries have much greater volatilities of output growth than the North, 2.6% vs.

1.1% overall in the data and 2.8% vs. 1.3% overall in the model. Next, notice that once the two-period-long disaster is removed from both the model and the data, the average correlation of output growth between the North and each southern country is low in the model, averaging about zero, and ranging from −14.7% to 14.4%, which encompasses the low correlation in the data of 4.3%. In this sense, outside of the two-quarter-long disaster, output growth in the North and the South is effectively uncorrelated. Finally, in normal times both the data and the model exhibit a low average pairwise correlation of output growth across southern countries, at 13.1% and 16.6%, respectively.

Consider now moments of default rates and spreads in the North reported in Table 4. Our model performs well for these moments. Interestingly, our model can account for the *corporate spread puzzle*, namely that the spread on corporate bonds is higher than the expected default losses. Specifically, in both the model and the data, the average default rate on corporate debt is 0.5% whereas in both the model and the data, the average spread is double that. The reason the spread is higher than the default rate reflects both that in our model, consumers are risk averse, which generates risk premia, and that the debt is long-term, so spreads move today not only because of expectations of default in the next period but also in all periods in the future.

Next, note that the corporate spread is countercyclical in both the model and the data. In the model, in normal times, the average correlation of northern corporate spreads with northern output growth is −24.6%, and in the data, it is −34.4%, which comfortably falls within our simulated range of −68.6% to 35.1%.

As Table 4 also shows, our model reproduces well the stock volatility, average return, and equity premium in the data. We find this encouraging because our model goes beyond most of the literature following Bansal and Yaron (2004), which simply treats dividends as exogenous processes unconnected to underlying firm decisions. In contrast, our endogenous dividends are governed not only by underlying shocks but also by firms' endogenous debt and equity choices. Even so, the model and data share similar dividend growth volatility. In normal times, the standard deviation of dividend growth is 13.1% in the data and 12.1% in the model. Moreover, the model's dividend growth is procyclical and exhibits a negative serial correlation in normal times, consistent with the data.

These successful dividend dynamics generate a price-to-dividend (PD) ratio that matches that of the data. Note that in both the model and the data, a boom in stocks, in the sense that the PD ratio is high, is associated with a low spread and high output growth. In particular, in normal times, the correlation between the PD ratio and the corporate spread is negative in the model (-65.9%) and in the data (-35.9%), whereas the correlation of the PD ratio with output growth is positive, 33.3% in the model and 25.6% in the data. Finally, our model produces a sizable equity premium. It is important to notice that the data moments for all of these statistics lie comfortably within our 5% to 95% range. In this sense, our model is consistent with all of the data features.

We turn now to the patterns of sovereign default and spreads, presented in Table 5. The model performs well in generating the key moments of defaults and spreads, including mean default and spreads, standard deviations of spreads, serial correlations of spreads, and correlations of spreads with own country's output growth and with other countries' spreads. In particular, in both the model and the data, the average default rate in the South is about 2%, which is four times higher than that in the North. Similar to the patterns of corporate spreads in the North, sovereign spreads in the South are higher than their default rates. Specifically, the difference between spreads and their default rates is about 1.4% in the model and 1.2% in the data.

A crucial moment for southern spreads is their standard deviations. Our model generates the observed average volatility of spreads of 1.5%. We view this as a success for our model. In contrast, previous studies, such as the comprehensive analysis conducted by Aguiar et al. (2016), emphasized that existing models of sovereign default have a *sovereign debt volatility puzzle* in that these models tend to generate significantly less volatility in spreads than that in the data, particularly for countries like Mexico[6]. This puzzle holds not only for models with deterministic trends and stationary shocks, but also for models with stochastic trends. Indeed, the preferred baseline stochastic growth model in Aguiar et al. (2016) has this puzzle in that their model generates a standard deviation of spreads of only 0.2% which is only $1/15th$ of the corresponding standard deviation of 3% in their data, (see Aguiar et al. (2016) Table 9, p. 1724).

A second major result of the model in terms of accounting for EM spreads is that it is able to produce spreads that are much more correlated across countries than output growth. In normal times in the data, the spreads have an average correlation across southern countries of 48%, whereas output growth has an average correlation of only 13.1%. The model produces a

[6]Interestingly, Aguiar et al. (2016) noted that the earlier work by Arellano (2008), which focused on Argentina, successfully captured the observed volatility of the spread due to the country's higher volatility, but they argued that Argentina is not typical.

comparable pattern, with spreads having a correlation of about 46.8% and output growth having a correlation of about 16.6%.

Our model also captures the well-studied negative correlation between a southern country's spreads and its output growth, -27.6 in the data and -30.6 in the model in normal times. South and North spreads are not very correlated in the data in normal times, about 17.6%, and 22.2% in the model. We also see the model's wide dispersion in this number, ranging from -19.8% to 67.5%. This suggests that the model can generate both the type of strong positive comovement seen during the global cycle phase and the weak positive comovement seen during the EM crises phase. Likewise, our model produces a wide dispersion in the comovement between North stock prices and South spreads, with correlations that in normal times are about zero with a wide dispersion between -61.9% and 15.1%. Given this range, depending on the sequence of shocks, the model can be consistent with the strong negative correlation in the data during the global cycle phase but can easily turn positive, as in the EM crises phase.

Our model successfully produces a wide range of moments that are usually studied in isolation in three areas of research: international business cycles, sovereign default, and corporate finance. Specifically, it is capable of reproducing the observed levels of volatility, as well as within-country and cross-country correlations, in both real and financial variables. Additionally, the model accounts for several puzzles that have arisen in these fields, such as the sovereign spread puzzle, the corporate spread puzzle, and the equity premium puzzle. Furthermore, our model can account for the world financial cycles that have been observed.

4 The Drivers of the World Financial Cycle

Here we explore the driving forces of the world financial cycle. We begin by building intuition for the impact of each shock separately by analyzing the impulse responses to the key shocks. Then we back out the underlying shocks that drive the three key asset market variables—emerging market spreads, the northern spreads, and the northern stocks—using particle filter analysis. We use this analysis to quantify the relative importance of the common shock mechanism and the common lender mechanism by phase of the cycle.

4.1 Impulse Response Functions

To gain an understanding of the model's mechanisms and to develop some intuition for how our model identifies the underlying shocks we now examine the impulse responses to North long-run risk shocks u_{xN}, North volatility shocks $u_{\sigma N}$, and the South long-run risk shocks u_{xS}. We focus on these shocks rather than the short-run growth rate shocks, u_N, u_S, or u_i because spreads are mostly driven by persistent shocks.

Figure 5a presents the impulse responses to a one standard deviation negative innovation to the long-run risk in the North's productivity u_{xN}. As the top left panel of this figure shows, this shock changes both the current growth and expected future growth of the North's output, in that the North's output growth falls on impact and then is expected to slowly return to its mean, leaving the level of output at a permanently lower level in the long run.

Given this shock, northern consumers expect to be poorer in the future than they are now. Hence, these consumers would like to save and thus move consumption from the present, with its relatively high level of output, to the future, with its relatively low level. In equilibrium, the risk-free interest rate falls to clear the market. Here it falls by 23.8 basis points and remains low for a long time. The worsened prospects for future growth lead the North price-dividend ratio to fall by about 6.7 basis points on impact and then slowly recover. These worsened prospects also imply higher expected default by firms, and North corporate spreads rise by about 9.1 basis points.

Because the shock to the long-run risk in the North is uncorrelated with the long-run risk in the South, all that happens in the South is that they face a different schedule for borrowing, including a lower risk-free interest rate. This induces southern countries to borrow more, which leads to higher and more persistent default rates in the future. North lenders charge a higher spread to compensate for their higher expected loss from sovereign default and the risk they bear. As a result, the southern sovereign spreads increase by 12.6 basis points after a lower u_{xN}.

Consider next the responses to a one standard deviation increase in the volatility shock $u_{\sigma N}$ in Figure 5b. The increased level of uncertainty raises North households' desire to hold safe assets relative to risky assets, including stocks. As a result, on impact North price-dividend ratios decrease by 1.3 basis points, and the risk-free rates decreases by 9.6 basis points. This higher volatility of productivity increases corporate spreads in two ways: it increases the likelihood of future defaults, and it decreases the northern households' willingness to hold risky corporate debt. In combination, these two forces lead northern corporate spreads to increase by 5.3 basis points on impact and to stay persistently high.

The North volatility shocks affect the South in two ways. First, it directly increases the volatility of the northern lenders' pricing kernel, thus decreasing northern lenders' willingness to hold the risky southern debt. Hence, it shifts up the southern spread schedule. Second, a lower risk-free rate implies that borrowing is cheaper for the South. As a result, the South debt-to-GDP ratio and spreads rise, as shown in the figure.

Finally, consider the responses to a one standard deviation negative innovation to the South long-run risk u_{xS} shown in Figure 5c. This shock has no effect on any northern variable. Instead, this shock worsens the growth prospects of the southern countries and lowers their default cost. Hence, the shock increases their chance of defaulting on any given level of debt. It also gives these countries an incentive to save more by reducing their debt since the present level of output is higher than it is expected to be in the future. Here the direct effect from the worsening debt schedule for any level of debt dominates, and as a result, southern spreads increase by 60 basis points and slowly revert back.

These impulse response functions provide some intuition for how the model uses data on these observable variables to uncover the underlying shocks to North long-run risk, North volatility, and South long-run risk. In what follows, we over-simplify the mechanics of how the model works to help make the intuition simpler. In the next section, we will be more formal.

Consider first how the model determines the relative sizes of the North long-run risk shock and North volatility shock, along with a realization of the observables. The impulse responses clearly show that for a given change in observed northern spreads, the stock market falls a lot more following a North long-run risk shock than it does following a North volatility shock. Indeed, on impact following a one-standard-deviation long-run risk shock, the fall in the stock market (PD) relative to the increase in the spread, both expressed in percentages is $6.7/.091 = 74$. In contrast, on impact following a one-standard-deviation volatility shock, this same ratio is only $1.3/.064 = 20$.

Note that if we asked the model to only match the path of a single series, for example, the northern corporate spreads, then there are a large number of combinations of northern long-run risk and volatility shocks that can do so. However, for nearly all of these combinations, the predicted movements for a second series, say the stock market, will be far from its observed movements. Instead, when we ask the model to simultaneously match the movements in northern spreads and the northern stock market, it can determine the relative sizes of these shocks. In particular, for a given increase in the northern spread, the larger the fall in the stock market, the greater is the fraction of the increase in spreads that emanates from the long-run risk shock and the smaller the fraction from the volatility shock.

Next, consider how we can back out the drivers of southern spreads. Both long run risk shocks and volatility shocks shift the schedule that northern lenders offer to southern borrowers and, hence, move southern spreads. However, the common lender effect from these shocks necessarily implies that when these northern shocks drive the bulk of the movements in southern spreads, the northern asset prices—corporate spreads and stock—and the south spreads must be highly correlated. In contrast, since southern shocks are independent of northern ones, when southern long-run risk shocks drive the bulk of the movements in southern spreads, northern and southern spreads are not very correlated. Hence, by simultaneously matching the comovements between the northern asset prices and the southern spread series, the model can uncover the relative size of southern shocks to northern ones.

Taken all together, when the model has to simultaneously match the comovements of northern and southern spreads along with the comovements of northern spreads and the northern stock market, it can uniquely uncover the underlying shocks. In practice, we also include data on the growth rate of output in the North and that of all southern countries. These series can intuitively be thought of as pinning down the short-run shocks.

4.2 Decomposing the Driving Forces

In this section, we decompose the driving forces underlying the world financial cycle, including the drivers in each of the four phases.

4.2.1 Particle Filter Analysis

To this end, we use a particle filter on quarterly data over 1994Q1-2023Q2 to back out the 29 underlying shocks. From the North, we back out 3 shocks, $(u_{xN}, u_{\sigma N}, u_N)$, and from the South, we back out 2 common shocks (u_{xS}, u_S) and 24 idiosyncratic shocks $\{u_{xj}, u_j\}_{j=1}^{12}$, We then conduct counterfactual analyses by considering the role of southern and northern shocks both separately and in tandem.

To understand our procedure, note that our model has a block recursive form that we exploit for computational convenience. Since the South as a whole is taken to be small in the world and the shocks in the North are independent of those in the South, the northern series does not depend on the realizations of the southern ones. Hence, we can solve the North independently of the South. In particular, we can back out the three northern shocks using three data series: North output growth Δy_{Nt}, price-dividend ratio pd_{Nt}, and corporate spreads sp_{Nt}. The long-run shocks u_{xNt} and the volatility shocks $u_{\sigma Nt}$ are identified using the intuition developed above. The output growth is mainly driven by the short-run shocks u_{Nt}. Putting the backed-out long-run shocks and volatility shocks together, we can construct the path of the North stochastic discount factor.

In the second step, given the backed-out northern shocks, we pin down the southern shocks. To do so, we first plug the northern shocks into the pricing kernel and then use the particle filter as well as the southern series on growth rates and spreads to recover two series of the reduced form i.i.d normally distributed shocks $e_{jt} = u_{jt} + \nu_S u_{St}$ and $e_{xjt} = u_{xjt} + \nu_S u_{xSt}$ for each country. A simple formula then gives the maximum likelihood estimate of the common component, u_{St} and u_{xSt} for each of the series, namely,

$$u_{St} = \frac{\nu_S}{1 + 12\nu_S^2} \sum_{j=1}^{12} e_{jt} \text{ and } u_{xSt} = \frac{\nu_{xS}}{1 + 12\nu_{xS}^2} \sum_{j=1}^{12} e_{xjt}.$$

Then, given the reduced form series e_{jt} and e_{xjt} for each country and parameters ν_s and ν_{xS}, we construct these common components and then use the reduced form shocks e_{jt} and e_{xjt} to back out the primitive shocks u_{jt} and u_{xjt}.

In practice, it is important to adapt the particle filter to reconstruct the shocks for a reasonable number of particles. We use an auxiliary particle filter in which we utilize the Cubature Kalman Filter (Arasaratnam and Haykin 2009) to construct the proposal distribution. This resulting auxiliary particle filter is able to reconstruct the time series of successfully output growth and sovereign spreads for each individual country by our recursive method with small measurement errors, with the exception of Brazil in the 2002-2003 period.

**add some details. a. the max likelihood problem in the footnote and a couple of sentences about the Cubature Kalman Filter, c. put Brazil in a footnote.

4.2.2 Intuition

Before we turn to a formal analysis, let us use the intuition we developed from the impulse response analysis to analyze this data informally. Clearly, in Figure 6 panels *a* and *b* in the emerging market crises phase, the high level of the stock market should imply good growth prospects for the North, and the low corporate spreads should imply low levels of volatility. These patterns imply that these are *good times* for northern consumers, and hence northern lenders should be willing to accept risk. Thus, given these patterns in the North, it is hard for the common lender channel to play much of a role during this phase. Hence, the only way left to explain the observed high and volatile spreads in emerging markets is that the growth prospects in the EM were poor and worsening up to about 2003, that is, through the common shock channel.

In contrast, these same panels show that during the great spread moderation phase from 2003 to 2007, the northern corporate spreads have only a modest fall followed by a modest rise, and the stock market is fairly flat. Here again, it is difficult for the model to blame the sharp decline in southern spreads on the North. Instead, the most obvious culprit driving the large drop in southern spreads is that growth prospects in the South are improving.

For the global cycle phase, we see that this phase begins with the Great Recession in which all three key financial variables fare very poorly: the stock market in the North collapses, and both northern and southern spreads increase greatly. Hence, the impulse response intuition suggests that this is a phase of worsening growth prospects in both the North and South as well as a phase of high volatility. So here, both the common lender channel and the common shock channel are likely to both be important. From the end of the Great Recession to 2016, the stock market in the North is fairly stable and corporate spreads track sovereign spreads pretty well. These patterns suggest that throughout this phase, the common lender channel may be able to account for a significant fraction of the southern spreads.

Finally, the data from the geoeconomic fragmentation phase suggest that several opposing forces are present. First, as Figure 2b shows, there is a growing dispersion in the trends of emerging market spreads. This divergence is unlikely to result from the common lender channel– which makes southern spreads tend to move together. Second, as Figure 6 shows there is a large increase in the southern spreads in 2020Q2, even though both the US stock market and corporate spreads are fairly stable. Both of these features make it hard for adverse developments in the north to account for the spike in southern spreads. These patterns suggest that during this phase as well, most of the movements in southern spreads are driven by southern long-run-risk shocks. Interestingly, the geoeconomic fragmentation phase is reminiscent of the early phase—but in reverse—suggesting that there was not a one-time permanent change to a global cycle around the Great Recession.

4.2.3 Formal Analysis

Now let us turn to the formal analysis. Figure 6 shows the data and model implications for US corporate spreads, US price-dividend ratios, and the aggregate EM spread. Note that in the data and the model, the aggregate EM spread is the average across the 12 countries in our model. This figure shows the model, using the shocks backed out using the particle filter, successfully replicates the data. Figure 7b shows the backed out states for the North, the growth prospects x_N and the volatility shock σ_N as well as the average of the growth prospects $\bar{x}_{St} = \sum_{j=1}^{12} x_{jt}/12$ for the South. In Figure A1 in the appendix, we show the model can also replicate the pattern of each country's spreads. In Figure A2, we show the backed-out states for each southern country.

The backed-out shocks are consistent with our informal analysis. During the EM crises phase, the growth prospects of the North are excellent, indeed they are much higher in this phase than in any other. The volatility in the North is moderately high but nowhere near enough to overwhelm the impact of the growth prospects on corporate spreads. In contrast, average growth prospects for the South are low and volatile. During the great spread moderation the striking pattern is the sharp and prolonged improvement of the growth prospects of the South. In terms of accounting for the large drop in South spreads, the growth prospects of the North are going the wrong way in that they are worsening throughout the phase. The volatility shocks in the North are going the right way, in that they are falling modestly, but the impact of these shocks on southern spreads is small. Next, at the beginning of the global cycle phase is the Great Recession, in which all three shocks are worsening: growth prospects are falling in the North and the South, and volatility is increasing. For the latter part of this phase, there are modest fluctuations in all three series. In the geoeconomic fragmentation phase, the northern growth prospects are increasing, the volatility shocks are modestly increasing, and the southern growth prospects are deteriorating. Figure A2 in the appendix shows the backed-out growth prospect shocks for each individual country are gradually fanning out.

Using the backed-out shocks, we can isolate the driving forces of South spreads by considering the southern and northern shocks in isolation. Figure 7c illustrates this decomposition, with the black line representing the benchmark model that matches the data. The green line shows the counterfactual spreads when we feed only the northern shocks into the model. The red line shows the counterfactual average southern spreads. To construct this line, we first construct the counterfactual spread that arises for each southern country when we feed in only that country's common and idiosyncratic growth shocks and then take averages.

As the figure shows, northern shocks contribute little to southern spreads during the emerging market crisis phase. Indeed in this early period, by themselves, the northern shocks would lead to tiny fluctuations in southern spreads, from between 2% and 4%, whereas in the data, they fluctuate much more, between 2% and 9%. In sharp contrast, southern shocks account for nearly all of the movements in the southern spreads. So, as we intuited, during this period, the common lender channel essentially has no role because the common shock channel dominates.

During the great spread moderation, this figure shows that the key force behind the large and steady decline in southern spreads is the southern shocks, specifically their improving growth prospects, whereas the northern shocks do little. Throughout the global cycle period, both northern and southern shocks play a sizable role, with both playing about equal roles during the Great Recession. For the part of the global cycle phase that follows the Great Recession to the end Covid, spreads in the South stay low because of the good growth prospects in the South. Indeed, if there were only northern shocks, the spreads in the South would have been several hundred basis points higher. Finally, during the geoeconomic fragmentation phase, the southern country's growth prospects play the dominant role in accounting for southern spreads.

In Figure 8, we plot a decomposition of each southern country's spread. Clearly, in all phases except for the global cycle phase, the southern shocks are the main drivers of southern spreads. Specifically, the components of southern spreads driven by southern shocks—the red lines—track the baseline spreads much more closely than do the components of southern spreads driven by the northern shocks—the blue lines. To help understand the underlying forces, in Figure A2, we plot the backed-out long-run risk shocks for each southern country. This figure clearly shows that, in the great spread moderation phase, the growth prospects of individual southern countries are converging, whereas, in the geoeconomic fragmentation phase, these growth prospects are fanning out.

Finally, we turn to distinguishing between the two shocks in the North. Comparing the patterns of the stock prices and the backed-out growth prospects in the North in Figure 7d, it is clear that in the model, these growth prospects drive the movements in stock prices. Comparing the corporate spreads to the volatility shocks in Figure 7e, we see, to a fairly large extent, that corporate spreads are driven by volatility shocks. The decomposition of price-dividend ratios and corporate spreads in Figure 9 echoes these conclusions. In Figure 9a we see that shutting down the volatility shock has little effect on the ability of the model to reproduce the movements in the stock market, confirming that the stock market is mainly driven by northern growth prospects. In Figure 9b, we see that the corporate spreads are mainly by the volatility shocks. Indeed, except for the Great Recession, northern growth prospects produce very modest fluctuations in corporate spreads.

So far, we have shown graphs of decompositions of series into the components due to various shocks. Here we more formally define this procedure and use it to develop some summary statistics. To understand these decompositions, consider a generic series, y_t, produced by the baseline model with all shocks. Then, given a partition of shocks into groups indexed by i, we define the *component of y_t due to shocks in group i*, denoted y_{it}, as the prediction of the model for this series given the shocks in this group backed out from the particle filter, with all other shocks set to their means. For example, in Figure 7c, we considered the series for the average southern spread, $\overline{sp}_t$, and partitioned the shocks into all the southern shocks, $i = S$, and all the northern shocks, $i = N$, and graphed the components $\overline{sp}_{St}$ and $\overline{sp}_{Nt}$ generated by feeding into model only the southern shocks or only the northern shocks. We then construct summary statistics, referred to as *ϕ statistics*, defined by

$$\phi_i(y_t) = \frac{1/var(y_t - y_{it})}{\sum_i 1/var(y_t - y_{it})}. \tag{25}$$

These statistics capture how well a component, such as the component of average southern spreads due to northern shocks tracks the underlying variable, namely the average southern country spreads generated by the benchmark model. Note that since the benchmark model essentially reproduces the data, this ϕ statistic likewise captures how much of the movements in the series in the data can be accounted for by these shocks.

Note that this statistic (25) is the inverse of the mean square error for each group of shocks scaled so that the sum across these groups adds to one.[7] More generally, these ϕ statistics have

[7] See Brinca et al. (2016) for similar use of such statistics.

the desirable features that each lie in $[0, 1]$, sum to one across the components, and if a particular component tracks the benchmark series perfectly, in that $y_t - y_{it} = 0$ for all t then $\phi_i(y_t)$ reaches its maximum of 1.

Table 6 decomposes the average southern spread into the component explained by *Only North* shocks and into the component explained by *Only South* shocks, both overall and across the different phases. The decomposition over the full sample attributes 18.4% of the fluctuations in this series to northern shocks and 81.6% to southern shocks. (Note that the average southern spread series is constructed by running the filter on each of the 12 countries separately and then taking averages.) Interestingly, it is only during the global cycle phase that the northern shocks account for the majority of the fluctuations in southern spreads, namely, 68%. Indeed, for any other phase, they account for less than a quarter of the fluctuations.

The last two columns of Table 6 decompose the fluctuations in southern spreads driven by northern shocks into the component coming from the volatility shocks, σ_N, and the component coming from northern growth shocks, namely the i.i.d shocks u_N and the growth prospect shocks. Clearly, during the global cycle phase and the great spread moderation, the main driver from the North is the volatility shocks, but in the other two phases, the main driver is the growth rate shocks.

Finally, Table 7 decomposes the drivers of northern stocks and corporate spreads. In terms of stocks, overall and in each phase, the growth rate shocks are by far their largest driver. In terms of northern spreads, it is more mixed. Overall, a bit over half of the movements in spread are driven by growth rate shocks, 58.5%, and the remainder is driven by the volatility shocks, 41.5%. During the great spread moderation phase and the global cycle phase, northern spreads are mainly driven by volatility shocks—85% and 61.4%, respectively.

5 Counterfactuals and Robustness

We turn now to a combination of counterfactual and robustness exercises. First, we perform a counterfactual that highlights the discipline imposed by simultaneously having to account for the comovement among our three key asset prices. We then show that our model gives similar answers when we use junk bond spreads and a narrow measure of stocks from the financial sector rather than the measures of spreads and stocks that we use in our baseline.

5.1 Counterfactual and Intuition for Identification

The key discipline the particle filter uses to identify the most important primitive shocks, namely shocks for southern country growth prospects, northern growth prospects and volatility is that it finds the most likely shocks that simultaneously produce the observed southern spreads, northern spreads, and northern stock market series. In terms of identifying the short run i.i.d growth shocks in each country, these are mostly identified by the individual country series for output growth.

Our first experiment sheds light on the discipline imposed by forcing the filter to simultaneously account for spreads in the southern and northern asset prices. To do so, we run a counterfactual in which we restrict the series that the particle filter uses to identify shocks by *excluding* the key northern financial series, namely corporate spreads and stocks. Specifically, we suppose that the observable series is only the southern spreads in each country and the growth rates of output for all the southern countries and the North. When we do so, this gives the filter the freedom to choose shocks to explain these observables, especially the southern spreads, with no regard for the implications for the northern financial series.

In Figure 10a, we see that the model is able to produce the average southern spread very well. The main question is though, how did it accomplish this without the discipline of northern financial data? As Figure 10c and 10d make clear, the filter did so by choosing the key North shocks, growth prospects, and volatility shocks, so that northern spreads are highly correlated with southern spreads 94.9%, and northern stocks are highly negatively correlated with southern spreads, -69.4%. This pattern is intuitive: one can think of northern lenders as treating northern borrowers, firms, in a similar fashion to how it treats southern borrowers, countries. In particular, if the northern pricing kernel moves so that northern lenders become wary of lending to northern firms; they also become wary of lending to southern countries.

One part of this wariness in the North arises from elevated volatility—which, as we have seen, is largely determined by northern spreads. To dig a little deeper into this logic, in Figure 10e, we compare the backed-out volatility shock in the baseline against the backed-out volatility shock in our counterfactual. The counterfactual volatility shock is much larger than the baseline volatility shock. For example, the mean of counterfactual volatility shock σ_N^2 is twice that of its baseline value during the EM crises phase. The other part of the wariness comes from poor growth prospects in the North—which the filter infers mostly from northern stocks. For example, as Figure 10f shows, to generate this second part of wariness in EM crises years of 1995 and 1999, the counterfactual x_N shock indicates poor prospects, whereas the baseline shock indicates excellent prospects.

Thus, the model can indeed be made consistent with the view that the North drives southern spreads. It does so by making the underlying shocks very different from those in the baseline. But, of course, that means that these counterfactual shocks imply sharply different patterns for northern asset prices from those in the baseline. To drive this point home, in Figures 10g and 10h, we plot the counterfactual patterns of northern spreads and price-dividend ratios against those in the data. Clearly, these patterns are completely different from those in the data: the correlation of the counterfactual spreads with the observed spreads is essentially zero, 4.6%, and likewise for the correlation between counterfactual price-dividend ratios with the observed ones, 6.3%.

In sum, the model can indeed produce the observed southern spreads solely from northern shocks, and thus solely from the common lender effect. Critically, however, it can do so only if the implied asset prices in the North are strongly counterfactual.

5.2 Robustness to Stock and Spread Measures

In the baseline model, we focused on investment grade spreads, namely Baa yields minus Aaa yields, as our measure of corporate spreads. The reason we did so is that the vast majority of corporate bonds are investment-grade bonds, on the order of 85%. Interestingly, however, as authors such as Longstaff et al. (2011) have documented spreads on noninvestment grade bonds or *junk bonds* are more correlated with southern spreads than are investment-grade bonds. In the first robustness exercise, we explore what happens if we replace our measure of investment-grade yields with junk bond yields in the particle filter and keep our other series unchanged.

In the baseline model we also focused on the stock market series for xxx...Doing so is consistent with the view that the global intermediary is an agent representing all consumers in the North. This intermediary prices all stocks and bonds in our world economy and does so using the northern consumer's pricing kernel. In this interpretation, it seems reasonable to use the broadest measure of stocks available, that is a market-wide index.

An alternative approach, motivated in part by the literature that identifies the global intermediary with the U.S. financial sector, such as Morelli, Ottonello, and Perez (2022), is to use a measure of stocks, which only represent the financial sector (which has a value of about one-fifth that of the sum of the values of financial and non-financial stocks). In the second robustness exercise, we explore the implications of this logic by replacing our measure of the stock market with a narrower one that corresponds to the financial sector.

5.2.1 Using Junk Bond Spread Series

We first contrast the correlation of spreads between emerging market bonds and U.S. investment-grade bonds with those between emerging market bonds and junk bonds. In Table 11, we show the resulting correlations for each emerging market country by phase. Comparing this table to Table 1 we see that, over the whole period, junk bond spreads are more correlated with EM spreads than are investment grade spreads, 39.5% vs 18%. The bulk of the increased correlation comes from the EM crises phase, 29.9% vs 12.1%, and the great spread moderation phase, 72.5% vs 49.6%.

Here we perform a counterfactual experiment in which we replace our baseline investment grade spread series with a junk bond spread series, scaled to have the same mean and variance as our baseline series so that it mirrors the average risk profile of the typical U.S. firm. Note that this scaling has no effect on the correlations reported in Table 11. We do so to explore if increasing the correlation between the North corporate spread series and the EM sovereign spread series we feed into the particle filter greatly changes our results. We find that our conclusions are robust to this change.

Specifically, we run the particle filter exactly as in the baseline but we replace the spread series in the baseline with the scaled spread series on junk bonds. In Figure 11b we display the backed-out states. Clearly, relative to the baseline case in Figure 7b, the backed-out volatility shocks using junk bond spreads peak earlier and are about 50% larger than in the baseline. Comparing Figure 11e to Figure 7e, it is clear that both of these features are due to the different patterns of spreads over time of these two types of bonds.

Turning now to the decompositions, we compare Figure 11c with Figure 7c. The most striking difference is that when we use junk bond spreads, the counterfactual *Only South* series tracks the southern spreads series more closely than it does when we use our baseline spreads. This pattern is most evident during the second half of the EM crises phase and the great spread moderation phase, during which the Only South series lies essentially right on top of the baseline series.

To understand why this occurs, we need to return to the baseline results. When we used investment grade spreads, we saw that the booming stock market during the second half of the EM crises phase was accompanied by low northern spreads. These patterns led the model to back out booming growth prospects and only a modest increase in volatility. As Figure 11c shows, the combination of these two northern shocks together would have led to a sizable fall in southern spreads—from 1997 to 1999, the green *Only North* line predicts spreads less than 3%, whereas the actual spreads were over 6%. Since in this phase observed southern spreads were increasing (by nearly 5% from 2% to about 7%) rather than falling, the southern growth prospects had to fall sharply enough not only to offset the positive common lender effect but also to generate a rise in southern spreads. The need to do so led the southern shocks by themselves to overshoot the increase in southern spreads.

In contrast, as Figure 11e shows for this same phase, to justify the increase in the junk bond spreads in the presence of a booming stock market, the filter infers that the volatility shock increased sharply, as confirmed by Figure 11b. This increase in the volatility shock means that, through the common lender effect, the northern shocks can account for some of the increase in southern spreads. Hence, the southern growth prospects have to do less of the heavy lifting for the rise in southern spreads and the southern shocks by themselves no longer need to overshoot the southern spreads. Taken together, this means that the counterfactual *Only South* series fits the actual southern spreads much better than does the *Only South* series from the baseline.

This reasoning helps explain why when we back out shocks using junk bond spreads, the fraction of variance explained by southern shocks in the EM crises phase rises from about three quarters, 74.3% in Table 6 to 87.9% in Table 12—thus implying that using the junk bond spread makes the northern shocks account for *less* of the variation of southern spreads. This reasoning also explains a similar but a more modest rise of the fraction of variance accounted for by southern shocks during the great spread moderation phase. Comparing Tables 13 and 8 we see a similar but less pronounced pattern holds for the average of the individual country variance decompositions.

In summary, we have seen that even if we use a corporate spread series that is much more correlated with the EM spreads than the baseline series to back out the underlying forces driving southern spreads, our results do not change much. That is, we still conclude that, except for the global cycle phase, southern shocks account for much greater fraction of southern spreads than do northern shocks.

5.2.2 Using a Stock Market Index for the Financial Sector

Next, we redo our decompositions when we replace our stock market measure with one that is made up of financial firms, the Financial Select Sector SPDR fund (XLF).[8] We first contrast the correlations between spreads on emerging market debt and the US price-dividend ratio with those between emerging market spreads and the financial firms' price-dividend ratios. In Table 14, we show the resulting correlations for each emerging market country by phase. Comparing Table 14 to Table 1 we see that, over the whole period, on average financial stocks are more negatively correlated with EM spreads than are overall stocks, -8.7% vs 10.0. The bulk of the decrease in correlation comes from the geoeconomic fragmentation phase, -50.6% vs 9.5%.

Turning now to the decompositions, compare Figure 12c with Figure 7c. When we use financial stocks, the counterfactual *Only South* series tracks the southern spreads series more closely than it does do when we use our baseline measure of stocks. This pattern is most evident during the second half of the EM crises phase and the great spread moderation phase, during which the *Only South* series essentially lies on top of the baseline series. Comparing Table 15 to Table 6 we see that, overall, using financial stocks leads the fraction of southern spreads explained by southern shocks to *rise* from 81.6% to 88.5%, with the bulk of this increase coming from the EM crises phase and the great spread moderation phase. A similar pattern holds when comparing Table 16 and Table 8 for individual countries.

5.2.3 Summary

Finally, in Table 17, we report on some summary statistics for a counterfactual in which we replaced our baseline northern spreads and stock series with the junk bond spreads and the financial stocks and found similar results. For details, see the appendix.

In short, for all of these experiments, we robustly find two results. First, during the global cycle phase, northern shocks account for the bulk of the movements in southern spreads. Second, for all three other phases, southern shocks account for the bulk of movements in southern

[8] The XLF fund only started in 1998, and we wanted to extend this series back to 1994. To do so, we spliced it together with the S&P 500, which tracks the XLF series well post-1998. See the appendix for details.

spreads.

6 Conclusion

We have proposed a unified framework of a world financial cycle. Our model can generate the changing patterns of world financial cycles. It is consistent with the idea in existing sovereign debt models that the volatility of spreads on sovereign debt is mostly driven by local economic conditions. Importantly, however, because of the presence of long-run risk in the North and the South, it is simultaneously consistent with the high correlation of spreads across countries even though local economic conditions are not highly correlated. Our model can also match North stock and spread correlations.

Quantitatively we find that the most important driver of the correlation of spreads across countries is a common factor in the quantity of risk in the South before 2007 and post Covid. The time-varying price of risk emanating from a shock that affects the North stochastic discount factor accounts for about two-thirds of sovereign spread movements during the global cycle phase, but matters less than 30% in other phases.

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APPENDIX TO "WORLD FINANCIAL CYCLES"

BY YAN BAI, PATRICK J. KEHOE, PIERLAURO LOPEZ, AND FABRIZIO PERRI

A North Firm's Transformed Problem

Note that firms choose individual investment to achieve the target k_{t+1}, i.e., letting $i_t \equiv I_t/K_t$, we have $i_t = k_{t+1} - (1-\delta)$. Specifically, all firms that start with the same leverage face an identical problem, so they all choose identical leverage and capital growth rates after the default decision is made. As long as firms start at date 0 with the same leverage, they will therefore always have the same leverage. Similarly, as long as firms start at date 0 with the same capital stock K_{jt}, they will have the same capital at each date. We therefore drop the j notation for simplicity.

We are now looking for a Markov equilibrium in which the firm at time t takes as given the decision of its successor and we have a fixed point: taking as given the future default and leverage rules $\kappa^*_{t+1} = \kappa^*_{t+1}(\omega_{t+1})$ and $\omega_{t+2} = \omega_{t+2}(\omega_{t+1})$, the current and future price schedules $Q_t(\omega_{t+1})$ and $Q_{t+1}(\omega_{t+2})$, and the aggregate states, the firm finds it optimal to choose the same rule as its successor $\kappa^*_t = \kappa^*_t(\omega_t)$ and $\omega_{t+1} = \omega_{t+1}(\omega_t)$.

Accordingly, optimality in the choice of leverage ω_{t+1} implies the first-order condition:

$$\begin{aligned}
0 = {} & \frac{\partial Q_t}{\partial \omega_{t+1}} \left[\chi \omega_{t+1} k_{t+1} - (1-\varphi)\omega_t\right] + \chi Q_t(\omega_{t+1}) k_{t+1} - \Omega'(\omega_{t+1})\, k_{t+1} \\
& + k_{t+1} E_t M_{t+1} \Psi(\kappa^*_{t+1}(\omega_{t+1})) \left[-\varphi + \frac{\partial v_{t+1}}{\partial \omega_{t+1}}\right] \\
& + k_{t+1} E_t M_{t+1} \underbrace{\left[R_{kt+1} - \kappa^*_{t+1} - \varphi \omega_{t+1} + v_{t+1}(\omega_{t+1})\right]}_{=0} \Psi'(\kappa^*_{t+1}) \frac{\partial \kappa^*_{t+1}}{\partial \omega_{t+1}}
\end{aligned}$$

The envelope condition implies

$$\frac{\partial v_t}{\partial \omega_t} = -Q_t(1-\varphi)$$

Optimality in the choice of the capital growth k_{t+1} implies the first-order condition:

$$1 = \chi Q_t \omega_{t+1} + E_t M_{t+1} \int^{\kappa^*_{t+1}(\omega_{t+1})} \left[R_{kt+1} - \kappa - \varphi \omega_{t+1} + v_{t+1}\right] d\Psi(\kappa) - h'(k_{t+1}) - \Omega(\omega_{t+1})$$

Note that we can use this expression to simplify the one for the value v_t as

$$
\begin{aligned}
v_t &= Q_t \left[\chi \omega_{t+1} k_{t+1} - (1-\varphi)\omega_t\right] - k_{t+1} - h\left(k_{t+1}\right) - \Omega\left(\omega_{t+1}\right) k_{t+1} + k_{t+1}\left[1 - \chi Q_t \omega_{t+1} + h'\left(k_{t+1}\right) + \Omega\left(\omega\right.\right. \\
&= -(1-\varphi) Q_t \omega_t - h\left(k_{t+1}\right) + h'\left(k_{t+1}\right) k_{t+1}
\end{aligned}
$$

How to model High Yield

Key: Assume that the high yield firms are zero mass (think of them as living on some island)

1. their productivity is realization by realization identical to what we calibrated with only Baa in the baseline. (still used the Baa data

2. the face identical wages, identical pricing kernel realization etc.

The only thing different is the mean and volatility of κ

At this stage we have the following policy functions: $\Delta y_N(\epsilon_{Nt+1}, x_{Nt}, \sigma_{Nt})$, $pd(x_{Nt}, \sigma_{Nt})$, $baa(x_{Nt}, \sigma_{Nt})$, $hy(x_{Nt}, \sigma_{Nt})$. So I can filter out the 3 shocks $(\epsilon_{Nt+1}, x_{Nt}, \sigma_{Nt})$ by using 3 of these 4 series.

- Our baseline uses observations about the first three $\Delta y_N(\epsilon_{Nt+1}, x_{Nt}, \sigma_{Nt})$, $pd(x_{Nt}, \sigma_{Nt})$, $baa(x_{Nt}, \sigma_{Nt})$ to back out $(\epsilon_{Nt+1}, x_{Nt}, \sigma_{Nt})$.

- What I did alternatively uses observations about $\Delta y_N(\epsilon_{Nt+1}, x_{Nt}, \sigma_{Nt})$, $pd(x_{Nt}, \sigma_{Nt})$, $hy(x_{Nt}, \sigma_{Nt})$ to back out $(\epsilon_{Nt+1}, x_{Nt}, \sigma_{Nt})$. This is as if we did not observe Baa. This is somewhat inconsistent in the sense that I used Baa to parameterize the model, then I forget they exist to filter out. It is also inconsistent in that the implied Baa trajectory needs not coincide with the observe Baa series.

Alternative proposal, friendlier to us and without the inconsistency: the productivity of HY firms is different from the productivity of Baa. They have at least one different state σ_{hy}. Then, the policy function for HY will be $hy(x_{Nt}, \sigma_{Nt}, \sigma_{hyt})$. Then, we would do: 1) back out $(\epsilon_{Nt+1}, x_{Nt}, \sigma_{Nt})$ as in our baseline; 2) back out residually the σ_{hyt} by using observations about $hy(x_{Nt}, \sigma_{Nt}, \sigma_{hyt})$.

A.1 Mechanisms: Common Lender versus Common Shock

One promising implication of our model is that it can generate the observed high correlation across southern spreads even though output growth rates are not highly correlated. In our model, there are two mechanisms that generate this correlation across southern spreads. The first, the *common lender effect*, arises because every southern country faces the same risk-averse northern lender represented by the global intermediary. Hence, any shock in the North that affects this lender can spill over to all of the rates offered to southern borrowers. The second, the *common shock effect*, is that the common component of southern shocks to each country's output makes these rates naturally move together. Together these two features enable our model to generate the observed comovement of sovereign spreads as measured by their average pairwise correlation, which in the data is 47.8%.

To better understand the role of each mechanism, we conduct three counterfactual analyses. In the first analysis, we shut down the common lender effect by making northern consumers risk-neutral and thus set the risk aversion, γ, to zero. In the second analysis, we turn off the common shock effect by setting the loading parameter ν_s and ν_{xs} on the common components on southern shocks to zero so that southern shocks are independent across countries. The third analysis shuts down both effects by assuming both risk-neutral lenders and independent shocks. In each case, we recalibrate the model by adjusting σ_κ to match the mean default rates in the North and the South. Table 1 provides a comparison of relevant moments across these three models and our baseline.

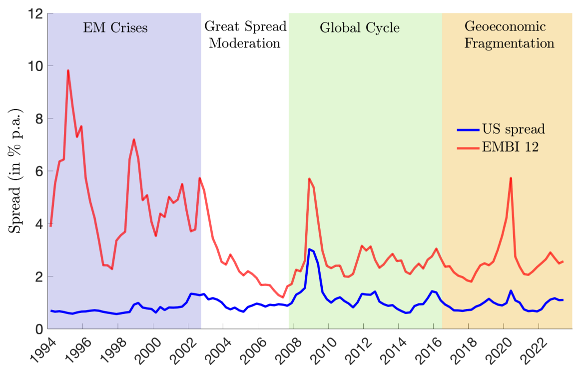
The second column shows the results with a risk-neutral lender. We see that absent the common lender effect, our model generates a lower spread than in the baseline, despite the same mean default rates: the difference in spreads and default rates fall by more than half from 1.4% to 0.6%. This is because with risk-neutral lenders, the model does not have a risk premium, which is an important channel for generating southern spreads. Moreover, the correlation across southern spreads also decreases from 46.8% in the baseline to 42.4%, demonstrating the impact of common lenders on the comovement of southern spreads. Furthermore, since the common lender effect is the only reason that South and North spreads are correlated, once that effect is turned off, their correlation is theoretically zero (but not quite because of small samples).

The third column shows the results with uncorrelated southern shocks. We see that turning off the common shocks in the South does not affect northern moments, such as the North spreads. In terms of southern spreads, the mean spread in the South is only slightly lower than in the baseline. However, the correlation of spreads across the South has a dramatic decrease to about from 46.8% to 8.4%. The correlation between the average southern spreads and North spreads barely moves, from about 22.2% in the baseline to 21.8%. The reason is that in the baseline, the average southern spread is driven both by the common lender effect and the common shock effect, whereas the northern spreads are driven by the common lender effect. Once we turn off the common southern shock then the only force driving both spreads is the common lender effect, so their correlation changes little.

The last column of Table 1 shows that when we remove both the risk-averse common lenders and common south shocks, the model is unable to generate any comovement of spreads in the South or between the South and North.

Figure 1: World Financial Cycles: Asset Prices

(a) *US corporate spread and EM sovereign spread*



(b) *US stock and EM spreads*

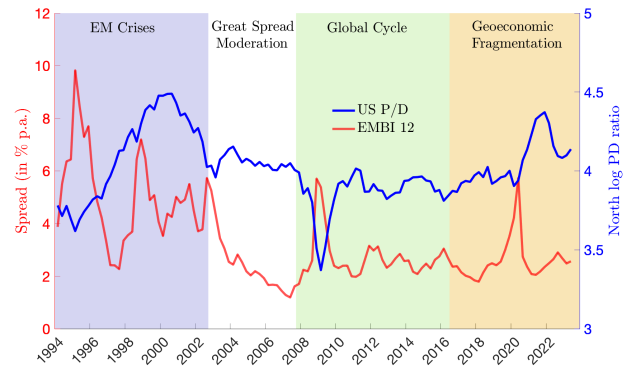
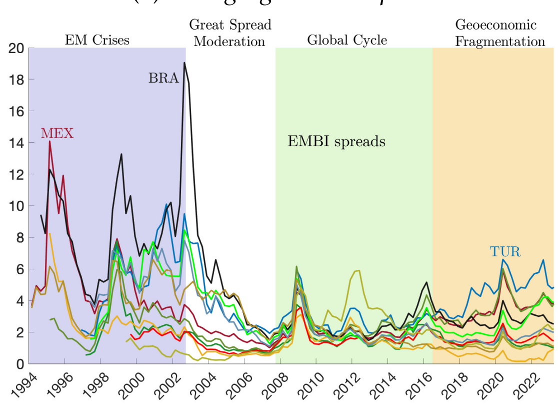


Figure 2: World Financial Cycles: Emerging Market Spreads

(a) *Emerging Market Spreads*



(b) *Interquartile Range of Emerging Market Spreads*

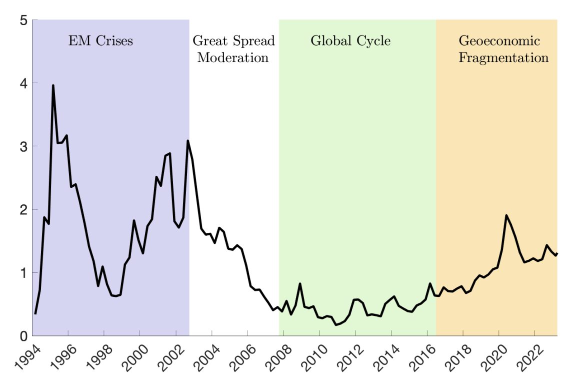


Figure 3: Emerging Markets Spreads

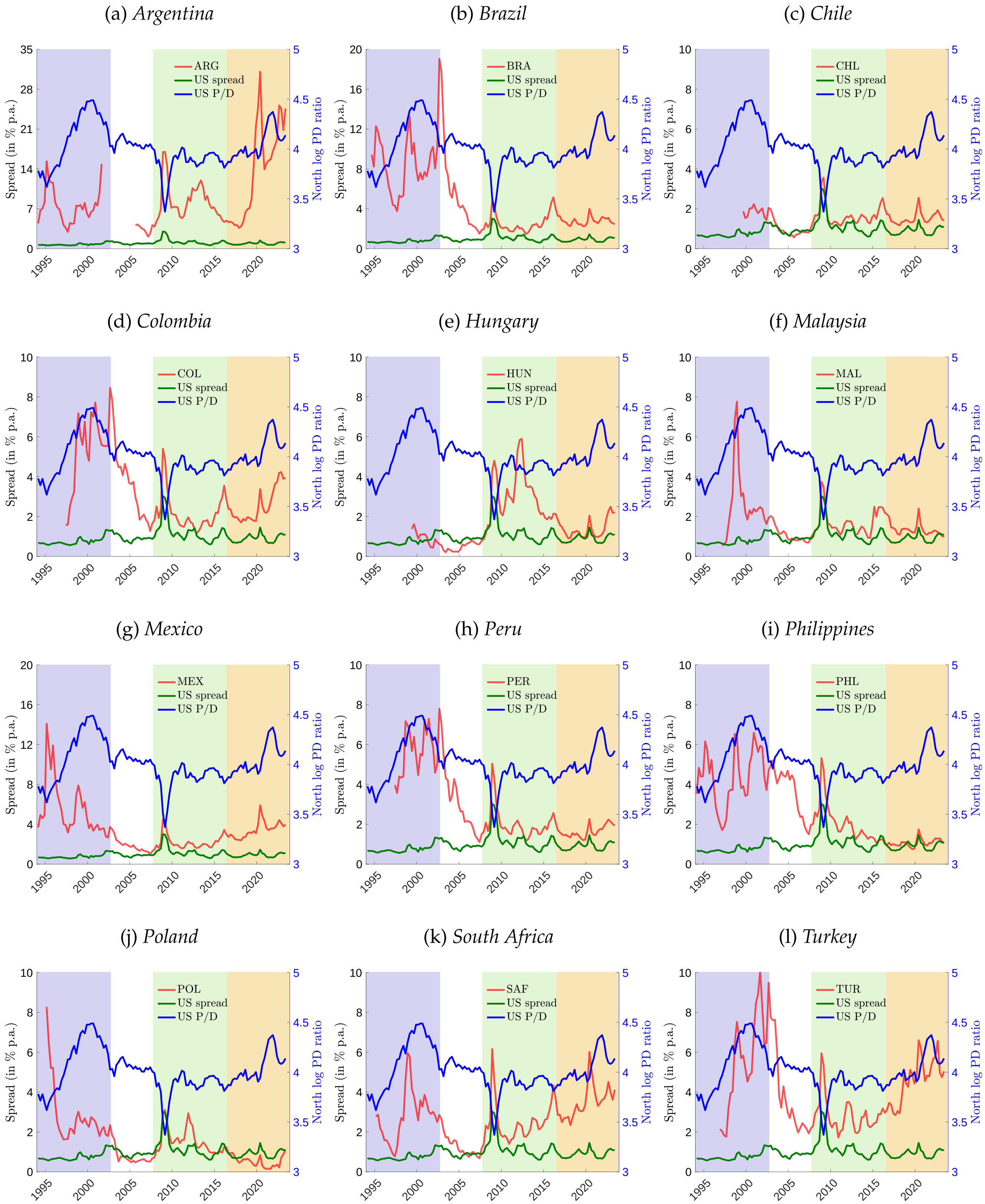


Figure 4: World Financial Cycles: US vs EM Output Growth

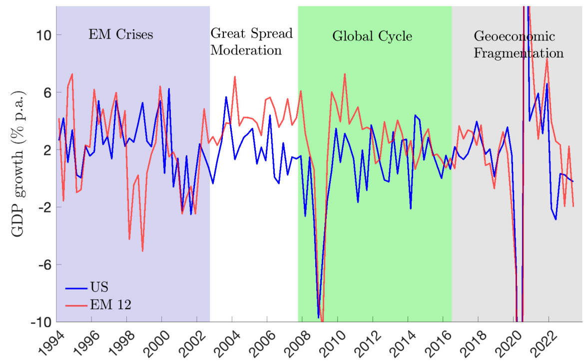
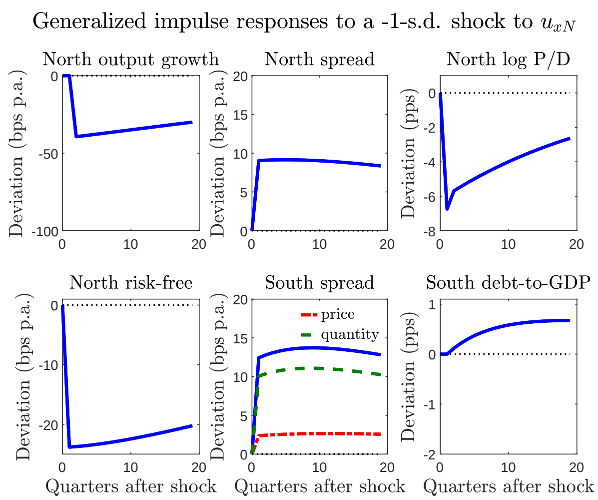
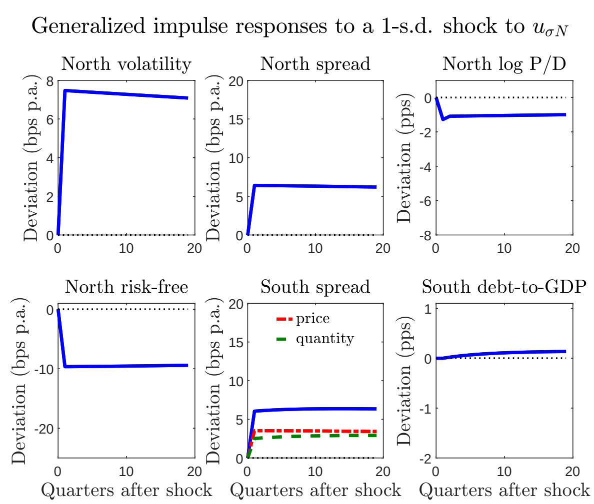


Figure 5: Impulse Response Functions

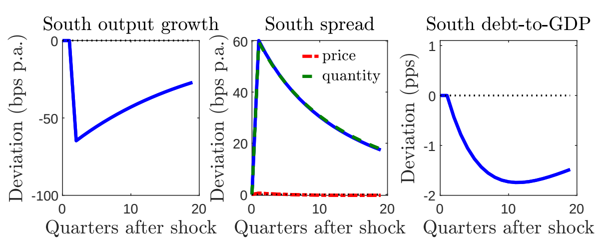
(a) *Negative shock to* u_{xN}



(b) *Positive shock to* $u_{\sigma N}$



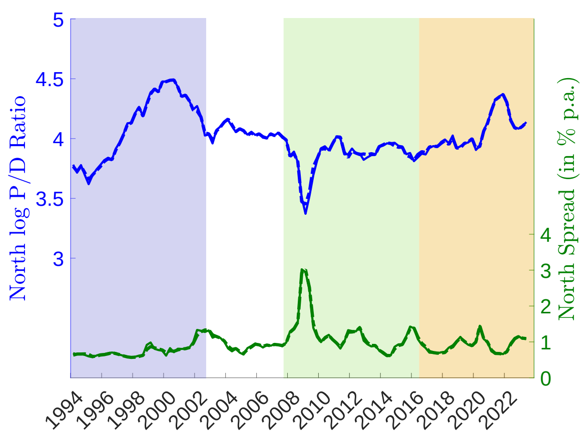
(c) *Negative shock to* u_{xS}



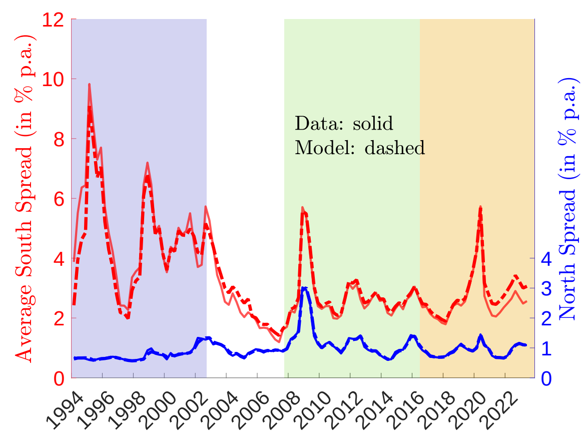
Notes: Panel (a) plots the IRFs to a one standard deviation decline in North long-run risk u_{xN}, Panel (b) is for a one standard deviation increase in North volatility shock $u_{\sigma N}$, and Panel (c) plots the IRFs to a one standard deviation decline in South volatility shock u_{xS}.

Figure 6: Data and Model Implications for Key Financial Data

(a) *Northern spread and stock prices*

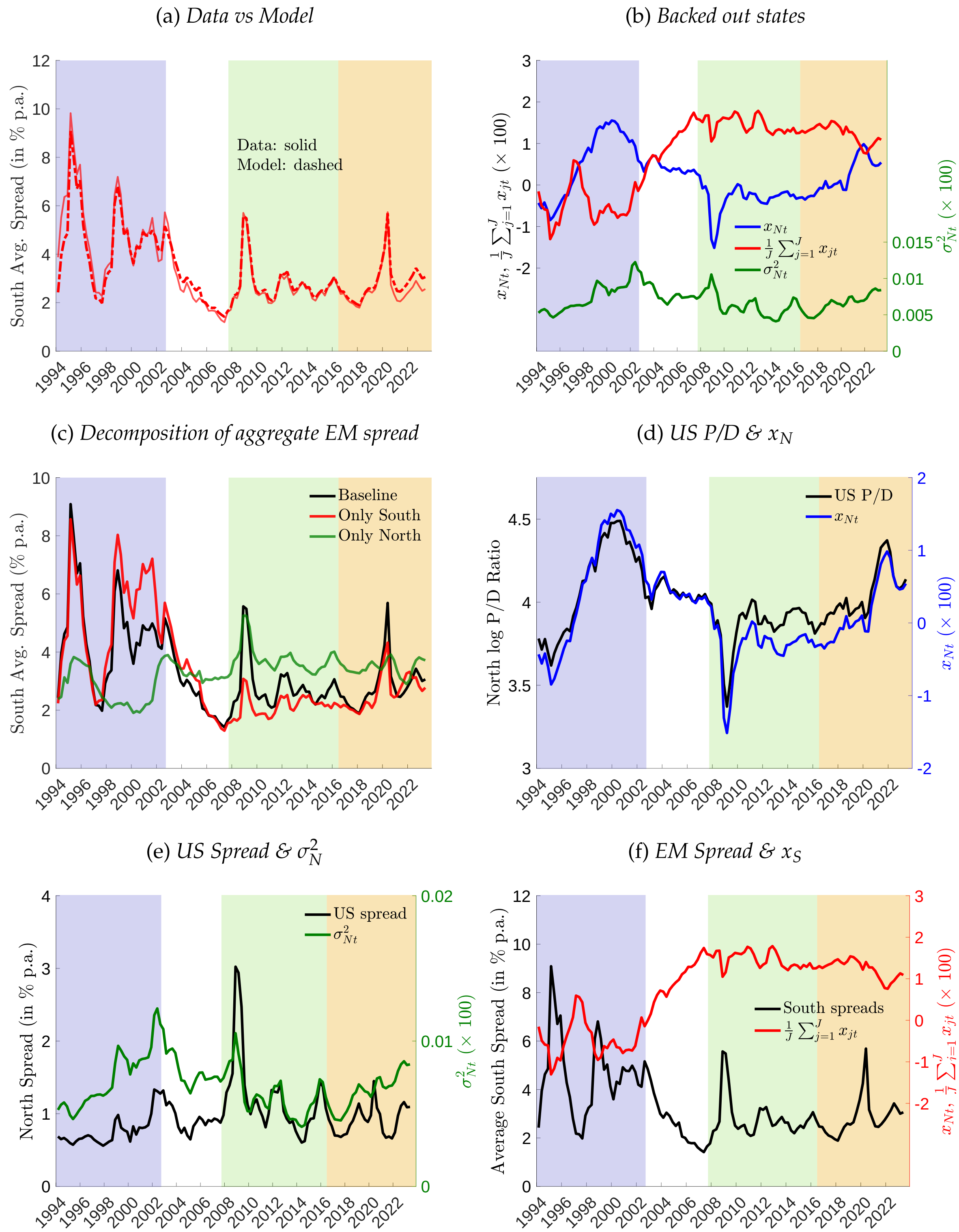


(b) *Northern and southern spreads*



Notes: Panel (a) plots North spreads and price-dividend ratio in the model and the data. Panel (b) plots North corporate spreads and South sovereign spreads in the model and the data. The dashed lines are the model generates series, and the solid lines are the data series.

Figure 7: Decomposition of aggregate EM spreads and backed out states



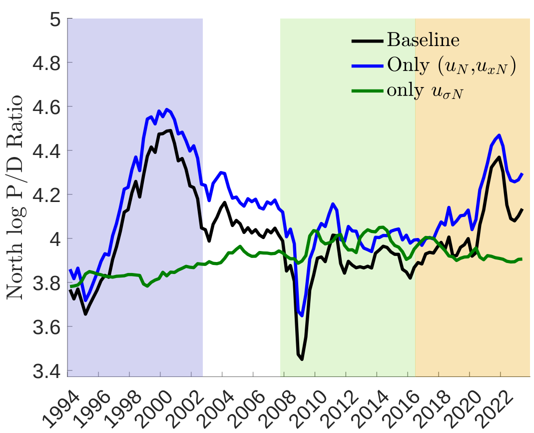
Notes: Panel (a) plots the backed-out states of North long-run risk u_{xN} and volatility shock σ_N and the average of South long-run risk. Panel (b) plots the South average spread in the benchmark, with only South shocks, and with only North shocks.

Figure 8: Decomposition of individual EM spreads

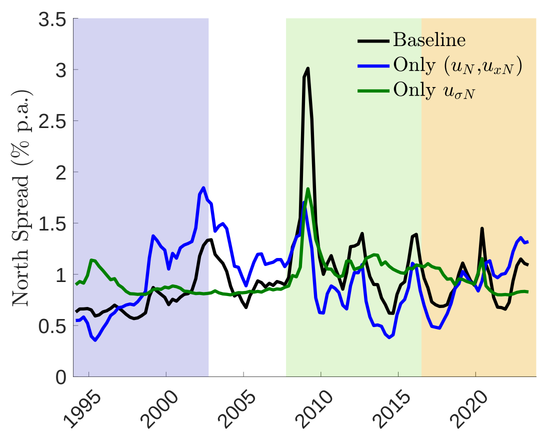
Notes: Each panel plots 12 countries' sovereign spreads in the baseline and counterfactuals with only South shocks and with only North shocks.

Figure 9: Decomposition of Northern Financial Variables

(a) *Decomposition of US price-dividend ratios*

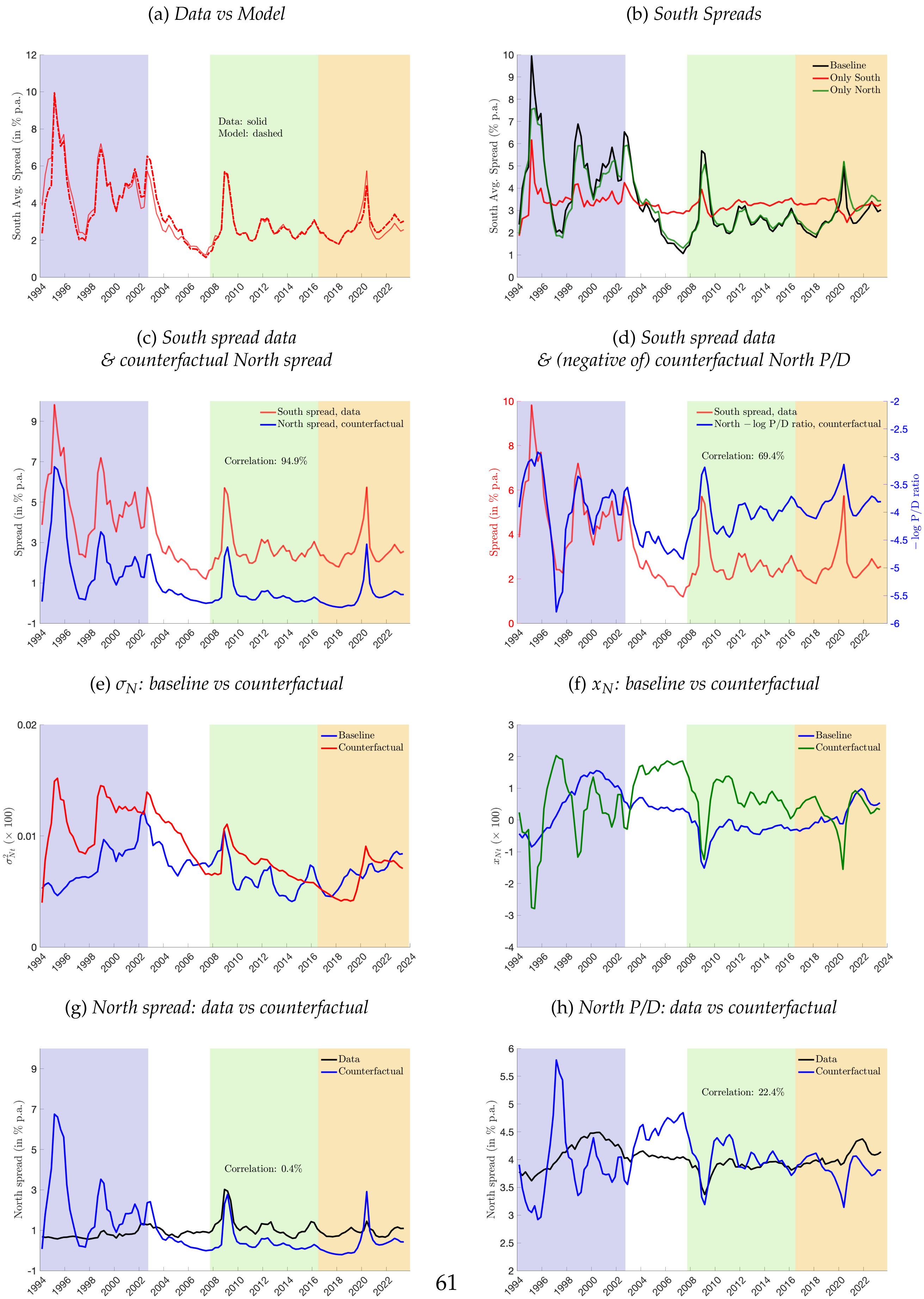


(b) *Decomposition of US corporate spread*



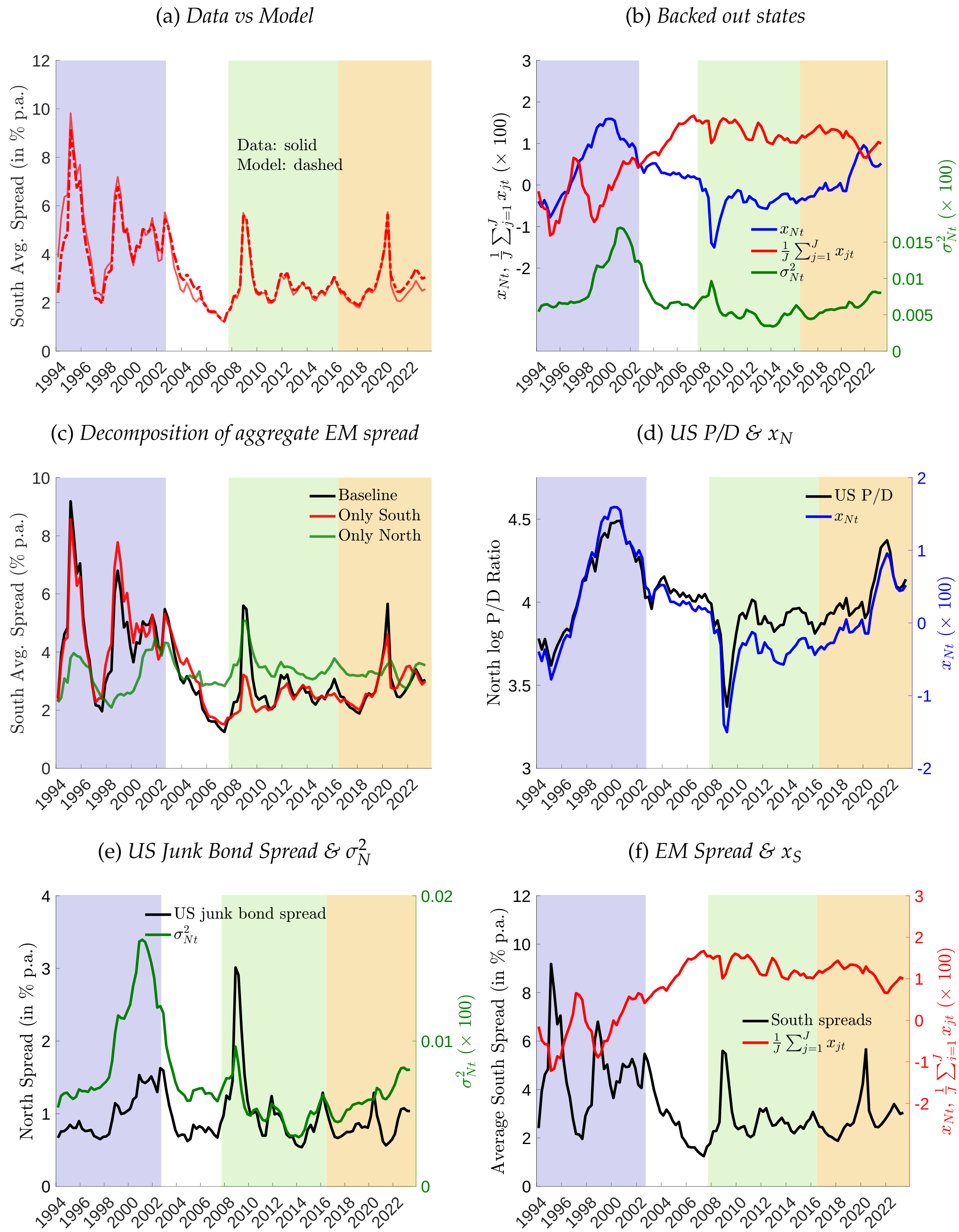
Notes: Panel (a) plots the North price-dividend ratio in the benchmark, only short and long-run risk (u_N, u_{xN}), and only volatility shock $u_{\sigma N}$. Panel (b) plots the North corporate spreads in the benchmark, only short and long-run risk (u_N, u_{xN}), and only volatility shock $u_{\sigma N}$.

Figure 10: Counterfactual: Omitting North Spreads and Stocks from Particle Filter



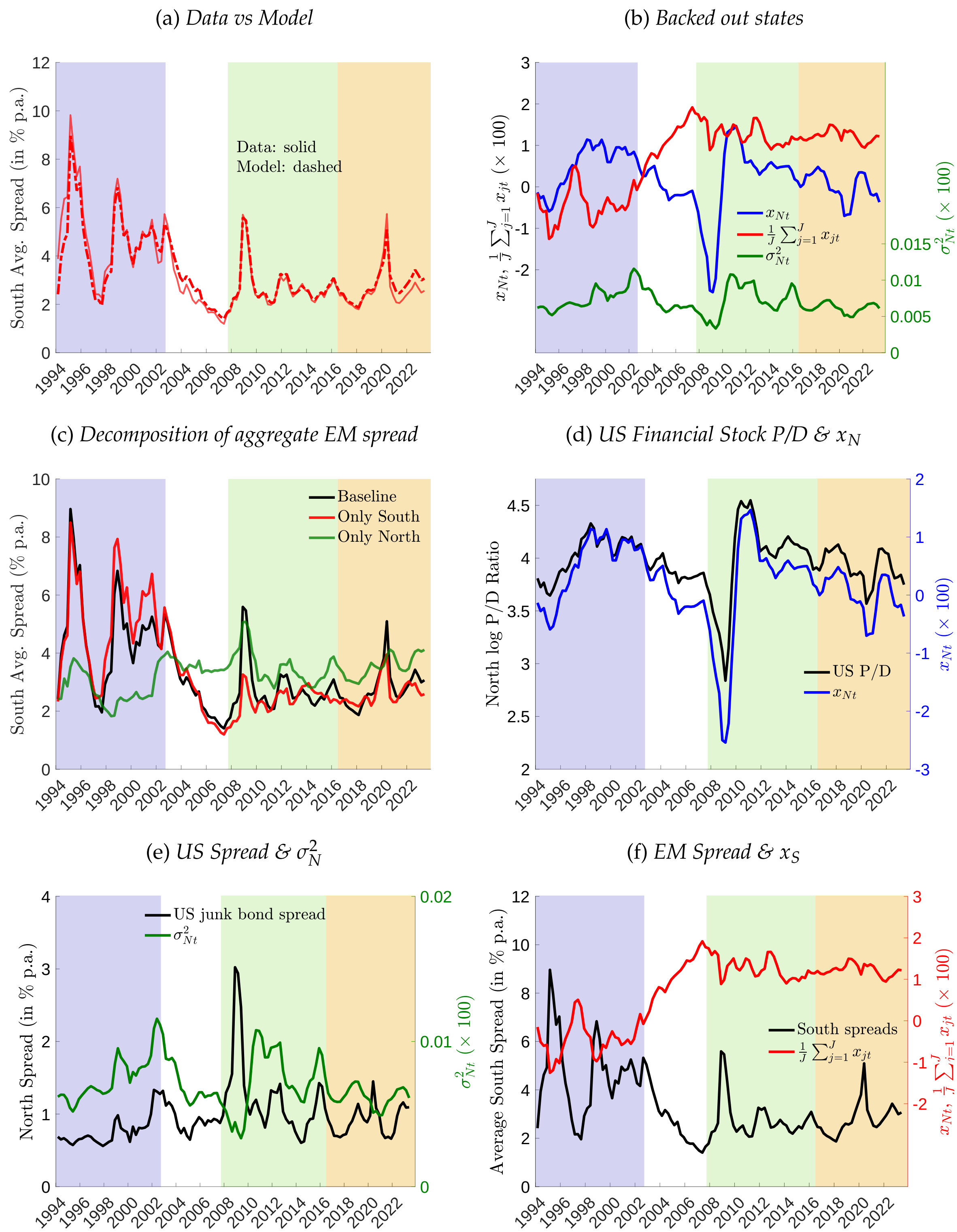
Notes:

Figure 11: Robustness: Using US Junk Bond Spreads



Notes: Panel (a) plots the backed-out states of North long-run risk u_{xN} and volatility shock σ_N and the average of South long-run risk. Panel (b) plots the South average spread in the benchmark, with only South shocks, and with only North shocks.

Figure 12: Robustness: Using Financial Stocks



Notes: Panel (a) plots the backed-out states of North long-run risk u_{xN} and volatility shock σ_N and the average of South long-run risk. Panel (b) plots the South average spread in the benchmark, with only South shocks, and with only North shocks. Financial stocks are Financial Select Sector SPDR Fund (XLF)

Table 1: Correlation of EM Sovereign Spreads with US Corporate Spread and Stock

	Overall	EM crises	Great spread moderation	Global cycle	Geoeconomic fragmentation
Correlation of EM spreads with US corporate spread					
ARG	28.2	16.0	-15.7	65.7	58.0
BRA	-7.8	51.1	67.5	57.1	31.3
CHL	65.1	-23.6	81.6	85.3	65.9
COL	13.2	54.0	50.6	85.6	43.7
HUN	49.4	-44.2	5.2	38.5	64.3
MAL	23.4	5.1	69.9	80.1	35.5
MEX	-15.7	-33.6	61.2	82.4	70.8
PER	5.3	35.1	55.0	89.3	48.9
PHL	3.5	20.2	15.1	87.0	62.0
POL	3.1	-29.0	69.4	69.3	29.0
SAF	33.5	32.8	63.3	71.9	70.3
TUR	15.5	60.7	72.5	87.4	58.9
Mean	18.0	12.1	49.6	75.0	53.2
St. Dev.	23.4	36.8	30.8	15.3	15.1
Correlation of EM spreads with US P/D					
ARG	-2.2	-35.1	-8.8	-76.9	39.8
BRA	25.7	-12.0	-1.8	-54.5	6.5
CHL	-22.2	2.7	-20.7	-82.0	-5.3
COL	51.0	45.8	16.4	-81.8	45.4
HUN	-54.8	59.6	-58.2	-37.8	-6.0
MAL	14.1	23.5	-3.5	-74.0	-50.2
MEX	-5.6	-69.1	3.6	-82.0	29.5
PER	50.0	19.1	12.0	-84.0	32.7
PHL	22.8	19.8	34.3	-80.2	8.5
POL	-20.4	-59.4	-24.5	-64.1	-58.6
SAF	16.0	55.8	8.6	-70.5	24.8
TUR	45.7	37.5	1.4	-81.0	46.8
Mean	10.0	7.3	-3.4	-72.4	9.5
St. Dev.	32.4	43.2	23.4	14.0	35.0

Notes: This table reports the correlation of each country's sovereign spread with US corporate spread and stock. US corporate spread is measured with Baa−Aaa, and US stock is measured with stock price-dividend ratio. *Overall* covers the period 94Q1-23Q2, *EM crises* for 94Q1-02Q3, great spread moderation for 02Q4-07Q3, global cycle for 07Q4-16Q2, geoeconomic fragmentation for 16Q3-23Q2.

Table 2: Parameterization

Assigned parameters		North	South
γ	North and South risk aversion	12	12
μ	North and South mean growth rate (annualized)	.016	.016
$1/\varphi$	average debt duration (quarters)	20	20
α_k	North capital share	.3	–
δ	North depreciation rate (annualized)	.10	–
ρ_σ	persistence of volatility shock (annualized)	.999	–
$\phi_\sigma\sigma$	s.d. volatility shock (%)	0.00036	–
$1/\lambda$	average exclusion after default (quarters)	–	3
p	probability of disaster (%)	.96	.96
ω_d	output growth decline in disaster (%)	4.2	5.1
Endogenously chosen		North	South
β	discount factor (annualized)	.96	.92
σ	short-run volatility (%)	.74	1.15
ρ_x	persistence of long-run shock	.97	.95
$\phi_x\sigma$	s.d. long-run shock (%)	.15	.23
θ	recovery rate parameter	.55	.32
σ_κ	s.d of idiosyncratic shock κ (%)	9.50	13.0
h_ω	leverage adjustment cost parameter	.80	.20
χ	borrowing subsidy	1.01	–
h_k	capital adjustment cost parameter	8	–
a_0	default cost mean	–	.26
a_1	default cost elasticity	–	28
ν_S	common component in short-run growth	–	.33
ν_{xS}	common component in long-run growth	–	1.0

Table 3: Moments: Output Growth, North and South

	Data		Model	
	Overall	Normal Times	Overall	Normal Times
North output growth				
Standard deviation, N (% p.a.)	1.1	0.9	1.3	1.1
			(0.8, 2.0)	(0.6, 1.9)
Serial corr of output growth, N	35.2	4.3	20.6	16.4
			(-2.9, 47.0)	(0.5, 54.7)
South output growth				
Standard deviation, S (% p.a.)	2.6	2.3	2.8	2.5
			(2.6, 3.0)	(2.4, 2.8)
Serial corr of output growth, S	26.8	20.0	16.2	12.7
			(8.0, 26.5)	(10.5, 28.9)
Corr of output growth N and S	23.2	4.3	16.8	-0.0
			(1.2, 31.1)	(-14.7, 14.4)
Corr of output growth across S	23.0	13.1	28.9	16.6
			(21.7, 37.6)	(10.8, 28.7)

Notes: The numbers in brackets indicate the 5th and 95th percentiles of the simulated distribution. The moments in the *Overall* column are calculated for the entire period 1994Q1-2019Q4, and those in the *Normal Times* column are calculated for the entire period but 2008Q4 and 2009Q1.

Table 4: Moments: Default, Spreads, and Stock in North

	Data		Model	
	Overall	Normal Times	Overall	Normal Times
Default and Spreads				
Mean real Aaa yield	3.6	3.6	3.2	3.2
			(-0.2, 5.2)	(-0.1, 5.2)
Standard deviation, real Aaa yield	1.3	0.7	0.9	0.7
			(0.3, 1.8)	(0.3, 1.8)
Mean default rate	0.5	0.5	0.5	0.5
			(0.0, 2.1)	(0.0, 2.1)
Mean spread	1.0	0.9	1.2	1.2
			(0.2, 3.5)	(0.2, 3.5)
Standard deviation, spread	0.4	0.3	0.4	0.3
			(0.1, 1.2)	(0.1, 1.3)
Serial correlation of spreads	84.5	82.3	94.3	89.6
			(86.5, 98.7)	(86.3, 98.7)
Corr(corporate spread, output growth)	-60.3	-34.4	-28.3	-24.6
			(-64.2, 28.7)	(-68.6, 35.1)
Stock Market				
Standard deviation, dividend growth	13.6	13.1	12.3	12.1
			(7.8, 17.6)	(7.7, 17.6)
Serial correlation, dividend growth	-0.8	-10.1	-14.7	-15.4
			(-31.0, 2.4)	(-31.1, 2.4)
Corr(dividend growth, output growth)	42.2	31.8	24.0	22.9
			(7.3, 39.2)	(7.1, 37.6)
Mean P/D	4.0	4.0	3.0	3.0
			(2.7, 3.2)	(2.7, 3.2)
Standard deviation, P/D	21.0	16.1	16.7	13.7
			(8.1, 29.3)	(8.1, 29.4)
Serial correlation, P/D	94.8	88.2	89.6	83.6
			(78.7, 96.6)	(78.4, 96.7)
Corr(P/D, output growth)	38.0	25.6	36.8	33.3
			(10.1, 63.5)	(14.5, 68.4)
Corr (P/D, corporate spreads)	-48.1	-35.9	-67.3	-65.9
			(-96.2, 29.6)	(-96.2, 30.6)
Equity premium using Aaa yield	3.7	5.2	3.4	3.5
			(1.1, 7.0)	(1.2, 7.1)

Notes: The numbers in brackets indicate the 5th and 95th percentiles of the simulated distribution. The moments in the *Overall* column are calculated for the entire period 1994Q1-2019Q4, and those in the *Normal Times* column are calculated for the entire period but 2008Q4 and 2009Q1.

Table 5: Moments: Default and Spreads in South

	Data		Model	
	Overall	Normal Times	Overall	Normal Times
Mean default rate	2.0	2.0	2.3	2.3
			(0.6, 4.9)	(0.6, 4.9)
Mean spread	3.2	3.2	3.7	3.7
			(1.9, 6.2)	(1.9, 6.2)
Standard deviation, spread	1.9	1.5	1.8	1.5
			(1.2, 2.5)	(1.2, 2.5)
Serial correlation, spreads	88.2	86.2	87.1	82.1
			(81.8, 92.3)	(81.5, 92.2)
Corr of spreads across S	47.7	47.8	48.3	46.8
			(27.0, 70.8)	(26.9, 70.8)
Corr(S spreads, S growth)	-32.9	-27.6	-33.3	-30.6
			(-44.3, -22.0)	(-46.3, -23.6)
Corr(S spreads, N spreads)	18.7	17.6	26.1	22.2
			(-19.7, 67.4)	(-19.8, 67.5)
Corr(S spreads, N P/D)	10.5	-1.1	-25.0	-22.1
			(-61.8, 14.7)	(-61.9, 15.1)

Notes: The numbers in brackets indicate the 5th and 95th percentiles of the simulated distribution. The moments in the *Overall* column are calculated for the entire period 1994Q1-2019Q4, and those in the *Normal Times* column are calculated for the entire period but 2008Q4 and 2009Q1.

Table 6: Decomposition of South Sovereign Spreads

	North vs South		Decomposing North	
	Only North	Only South	Only (u_N, u_{xN})	Only $u_{\sigma N}$
Overall (94q1-23q2)	18.4	81.6	14.9	3.5
EM crises (94q1-02q3)	25.7	74.3	20.8	4.9
Great spread moderation (02q4-07q3)	12.4	87.6	4.5	7.9
Global cycle (07q4-16q2)	68.0	32.0	26.4	41.6
Geoeconomic fragmentation (16q3-23q2)	22.5	77.5	18.1	4.4

Notes: y_{bench} are the benchmark series without disaster shock. The variance decomposition uses ϕ-statistics $\phi_i = \frac{1/\operatorname{var}(y_{\text{bench}} - y_{i,\text{counter}})}{\sum_i 1/\operatorname{var}(y_{\text{bench}} - y_{i,\text{counter}})}$. Numbers are in percent.

Table 7: Decomposition North Stock and Spreads

	Only (u_N, u_{xN})	Only $u_{\sigma N}$
Overall (94q1-23q2)		
N stocks	97.7	2.3
N spread	58.5	41.5
EM crises (94q1-02q3)		
N stocks	98.5	1.5
N spread	57.6	42.4
Great spread moderation (02q4-07q3)		
N stocks	79.4	20.6
N spread	15.0	85.0
Global cycle (07q4-16q2)		
N stocks	88.0	12.0
N spread	38.6	61.4
Geoeconomic fragmentation (16q3-23q2)		
N stocks	96.1	3.9
N spread	56.9	43.1

Notes: y_{bench} are the benchmark series without disaster shock. The variance decomposition uses ϕ-statistics $\phi_i = \frac{1/\operatorname{var}(y_{\text{bench}} - y_{i,\text{counter}})}{\sum_i 1/\operatorname{var}(y_{\text{bench}} - y_{i,\text{counter}})}$. Numbers are in percent.

Table 8: Decomposition of Emerging Markets Spreads

	Overall *(94q1-23q2)*		*EM crises* *(94q1-02q3)*		*Great spread moderation* *(02q4-07q3)*		*Global cycle* *(07q4-16q2)*		*Geoeconomic fragmentation* *(16q3-23q2)*	
	North	South	North	South	North	South	North	South	North	South
ARG	12.1	87.9	40.6	59.4	12.3	87.7	0.7	99.3	0.1	99.9
BRA	34.3	65.7	43.9	56.1	64.3	35.7	38.7	61.3	53.8	46.2
CHL	42.1	57.9	58.5	41.5	46.0	54.0	74.6	25.4	46.6	53.4
COL	12.6	87.4	13.1	86.9	7.1	92.9	52.7	47.3	13.8	86.2
MAL	13.1	86.9	8.9	91.1	20.6	79.4	71.6	28.4	54.0	46.0
MEX	13.6	86.4	17.5	82.5	14.6	85.4	71.7	28.3	20.3	79.7
PER	12.8	87.2	19.5	80.5	3.9	96.1	74.9	25.1	36.1	63.9
PHL	11.0	89.0	18.3	81.7	4.2	95.8	53.2	46.8	53.1	46.9
POL	25.7	74.3	12.4	87.6	37.5	62.5	64.1	35.9	66.6	33.4
SAF	19.3	80.7	14.7	85.3	16.7	83.3	41.5	58.5	20.6	79.4
TUR	13.7	86.3	12.3	87.7	7.1	92.9	55.2	44.8	11.5	88.5
Average	19.5	80.5	24.3	75.7	25.5	74.5	53.2	46.8	32.9	67.1

Notes: The variance decomposition uses ϕ-statistics $\phi_i = \frac{1/\operatorname{var}(y_{\text{bench}} - y_{i,\text{counter}})}{\sum_i 1/\operatorname{var}(y_{\text{bench}} - y_{i,\text{counter}})}$. All numbers are in percent.

Table 9: Decomposition of South Sovereign Spreads: No North Asset Prices

	North vs South		Decomposing North	
	Only North	Only South	Only (u_N, u_{xN})	Only $u_{\sigma N}$
Overall (94q1-23q2)	90.6	9.4	54.1	36.4
EM crises (94q1-02q3)	89.9	10.1	70.9	18.9
Great spread moderation (02q4-07q3)	97.6	2.4	57.4	40.2
Global cycle (07q4-16q2)	92.9	7.1	67.9	25.1
Geoeconomic fragmentation (16q3-23q2)	80.0	20.0	52.3	27.7

Table 10: Model Decomposition of Emerging Markets Spreads: No North Asset Prices

	Overall (94q1-23q2)		*EM crises (94q1-02q3)*		*Great spread moderation (02q4-07q3)*		*Global cycle (07q4-16q2)*		*Geoeconomic fragmentation (16q3-23q2)*	
	North	South	North	South	North	South	North	South	North	South
ARG	24.9	75.1	41.2	58.8	24.4	75.6	9.0	91.0	5.8	94.2
BRA	29.7	70.3	37.2	62.8	13.1	86.9	50.4	49.6	64.1	35.9
CHL	80.7	19.3	75.2	24.8	84.1	15.9	73.8	26.2	66.4	33.6
COL	52.8	47.2	57.1	42.9	76.6	23.4	64.7	35.3	46.1	53.9
MAL	62.9	37.1	39.5	60.5	82.5	17.5	72.3	27.7	56.1	43.9
MEX	46.5	53.5	27.7	72.3	82.7	17.3	78.9	21.1	85.6	14.4
PER	58.6	41.4	82.0	18.0	88.0	12.0	80.5	19.5	64.7	35.3
PHL	60.2	39.8	59.5	40.5	71.7	28.3	63.7	36.3	66.3	33.7
POL	79.3	20.7	73.7	26.3	87.7	12.3	73.6	26.4	61.0	39.0
SAF	72.7	27.3	78.4	21.6	82.4	17.6	60.5	39.5	86.5	13.5
TUR	48.7	51.3	49.0	51.0	58.2	41.8	71.0	29.0	48.9	51.1
Average	58.4	41.6	62.1	37.9	71.9	28.1	63.8	36.2	60.5	39.5

Notes: The variance decomposition uses ϕ-statistics $\phi_i = \frac{1/\operatorname{var}(y_{\text{bench}} - y_{i,\text{counter}})}{\sum_i 1/\operatorname{var}(y_{\text{bench}} - y_{i,\text{counter}})}$. All numbers are in percent.

Table 11: Data Correlation of EM Sovereign Spreads with US Junk Bond Spread

	Overall	EM crises	Great spread moderation	Global cycle	Geoeconomic fragmentation
Correlation of EM spreads with US junk bond spread					
ARG	26.7	38.1	81.8	62.3	62.3
BRA	29.2	47.4	87.5	58.6	36.4
CHL	76.3	48.5	92.8	84.3	73.1
COL	52.4	79.9	72.5	89.5	56.2
HUN	27.5	-73.3	-2.3	29.8	77.4
MAL	43.1	8.0	86.1	79.4	38.1
MEX	8.6	-31.3	82.3	84.3	68.1
PER	47.8	67.1	75.9	93.0	60.9
PHL	41.1	58.3	39.1	91.1	66.1
POL	28.9	-19.1	90.3	67.6	39.7
SAF	44.4	47.1	80.4	72.9	68.7
TUR	48.1	87.9	82.9	88.4	50.7
Mean	39.5	29.9	72.5	75.1	58.1
St. Dev.	17.0	48.9	27.3	18.3	14.0

Notes: This table reports the correlation of each country's sovereign spread with US junk bond spread. *Overall* covers the period 94Q1-23Q2, *EM crises* for 94Q1-02Q3, great spread moderation for 02Q4-07Q3, global cycle for 07Q4-16Q2, geoeconomic fragmentation for 16Q3-23Q2. Note that these correlations are invariant any linear scaling of the junk bond series.

Table 12: Decomposition of South Sovereign Spreads: Using Junk Bond Spread

	North vs South		Decomposing North	
	Only North	Only South	Only (u_N, u_{xN})	Only $u_{\sigma N}$
Overall (94q1-23q2)	11.2	88.8	6.8	4.4
EM crises (94q1-02q3)	12.1	87.9	6.2	5.9
Great spread moderation (02q4-07q3)	7.4	92.6	1.7	5.7
Global cycle (07q4-16q2)	67.0	33.0	25.0	42.0
Geoeconomic fragmentation (16q3-23q2)	20.7	79.3	16.8	3.9

Table 13: Model Decomposition of Emerging Markets Spreads: Using Junk Bond

	Overall (94q1-23q2)		*EM crises (94q1-02q3)*		*Great spread moderation (02q4-07q3)*		*Global cycle (07q4-16q2)*		*Geoeconomic fragmentation (16q3-23q2)*	
	North	South	North	South	North	South	North	South	North	South
ARG	6.4	93.6	26.7	73.3	2.4	97.6	1.7	98.3	0.1	99.9
BRA	24.4	75.6	32.3	67.7	38.3	61.7	36.3	63.7	53.0	47.0
CHL	65.4	34.6	41.6	58.4	84.6	15.4	73.1	26.9	46.1	53.9
COL	6.6	93.4	11.1	88.9	1.6	98.4	57.6	42.4	12.6	87.4
MAL	16.4	83.6	16.3	83.7	61.7	38.3	71.7	28.3	54.6	45.4
MEX	8.4	91.6	9.9	90.1	40.1	59.9	70.5	29.5	17.7	82.3
PER	7.1	92.9	16.4	83.6	2.0	98.0	79.0	21.0	36.9	63.1
PHL	8.1	91.9	15.1	84.9	5.6	94.4	58.5	41.5	51.3	48.7
POL	30.5	69.5	20.7	79.3	83.5	16.5	61.5	38.5	61.4	38.6
SAF	18.9	81.1	22.1	77.9	47.9	52.1	40.6	59.4	18.1	81.9
TUR	6.2	93.8	3.6	96.4	1.4	98.6	56.1	43.9	10.1	89.9
Average	18.2	81.8	20.4	79.6	36.5	63.5	53.4	46.6	31.5	68.5

Notes: The variance decomposition uses ϕ-statistics $\phi_i = \frac{1/\operatorname{var}\left(y_{\text{bench}} - y_{i,\text{counter}}\right)}{\sum_i 1/\operatorname{var}\left(y_{\text{bench}} - y_{i,\text{counter}}\right)}$. All numbers are in percent.

Table 14: Data Correlation of EM Sovereign Spreads with US Financial Stock P/D

	Overall	EM crises	Great spread moderation	Global cycle	Geoeconomic fragmentation
Correlation of EM spreads with US financial stock P/D					
ARG	-31.5	-36.4	-71.5	-48.7	-65.3
BRA	2.0	-23.3	47.5	-49.8	-33.0
CHL	-33.2	10.3	37.2	-74.3	-65.7
COL	-1.9	-16.6	57.0	-70.5	-37.1
HUN	-0.6	39.4	-68.2	-5.3	-48.4
MAL	3.6	35.0	50.0	-57.3	-34.2
MEX	-16.5	-53.6	50.6	-62.8	-80.4
PER	11.7	5.0	55.5	-68.9	-35.0
PHL	-9.3	1.8	49.9	-68.5	-53.5
POL	-4.1	-75.5	31.7	-32.0	-9.3
SAF	-18.4	36.9	55.3	-62.3	-80.6
TUR	-6.7	15.9	51.4	-75.0	-64.7
Average	-8.7	-5.1	28.9	-56.3	-50.6
Std	13.8	36.8	46.7	20.3	21.6

Notes: This table reports the correlation of each country's sovereign spread with US junk bond spread. *Overall* covers the period 94Q1-23Q2, *EM crises* for 94Q1-02Q3, great spread moderation for 02Q4-07Q3, global cycle for 07Q4-16Q2, geoeconomic fragmentation for 16Q3-23Q2.

Table 15: Decomposition of South Sovereign Spreads: Using Financial Stocks

	North vs South		Decomposing North	
	Only North	Only South	Only (u_N, u_{xN})	Only $u_{\sigma N}$
Overall (94q1-23q2)	11.5	88.5	8.6	2.9
EM crises (94q1-02q3)	15.2	84.8	11.1	4.1
Great spread moderation (02q4-07q3)	4.7	95.3	2.5	2.2
Global cycle (07q4-16q2)	65.1	34.9	49.2	15.9
Geoeconomic fragmentation (16q3-23q2)	26.1	73.9	21.5	4.6

Table 16: Model Decomposition of Emerging Markets Spreads: Using Financial Stocks

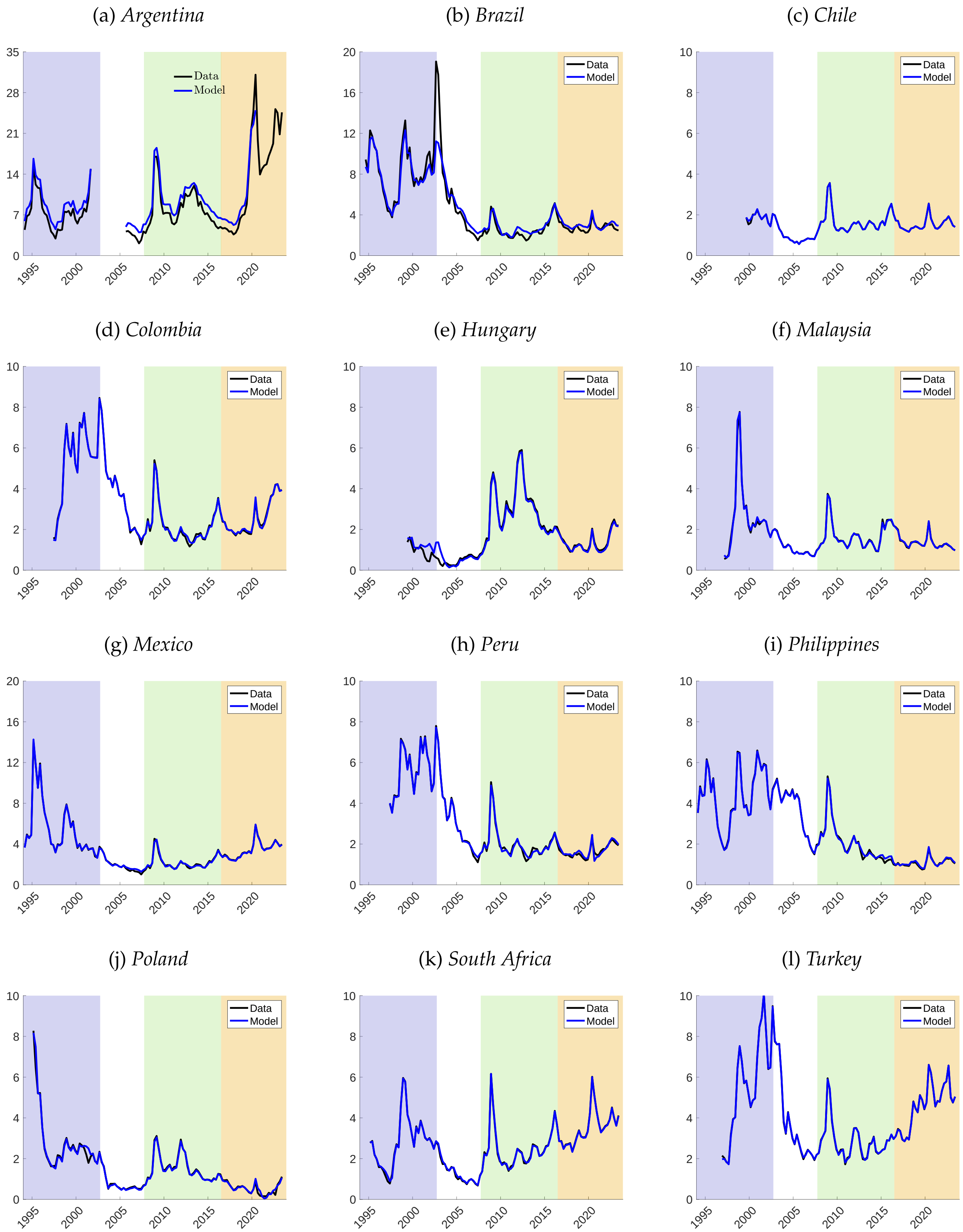
	Overall (94q1-23q2)		*EM crises (94q1-02q3)*		*Great spread moderation (02q4-07q3)*		*Global cycle (07q4-16q2)*		*Geoeconomic fragmentation (16q3-23q2)*	
	North	South	North	South	North	South	North	South	North	South
ARG	11.8	88.2	20.5	79.5	0.2	99.8	23.4	76.6	0.7	99.3
BRA	15.0	85.0	23.8	76.2	29.4	70.6	41.7	58.3	36.5	63.5
CHL	30.8	69.2	45.0	55.0	30.9	69.1	56.2	43.8	51.8	48.2
COL	7.6	92.4	4.2	95.8	2.0	98.0	58.1	41.9	13.9	86.1
MAL	9.9	90.1	8.2	91.8	13.2	86.8	56.2	43.8	31.7	68.3
MEX	10.1	89.9	11.8	88.2	8.1	91.9	57.2	42.8	26.5	73.5
PER	8.0	92.0	9.1	90.9	1.4	98.6	68.0	32.0	38.2	61.8
PHL	8.1	91.9	11.6	88.4	2.0	98.0	59.2	40.8	51.7	48.3
POL	16.9	83.1	10.7	89.3	21.1	78.9	38.2	61.8	47.2	52.8
SAF	15.0	85.0	11.2	88.8	9.1	90.9	37.0	63.0	25.6	74.4
TUR	8.6	91.4	4.4	95.6	2.0	98.0	65.0	35.0	10.0	90.0
Average	12.7	87.3	15.2	84.8	16.1	83.9	49.4	50.6	30.0	70.0

Notes: The variance decomposition uses ϕ-statistics $\phi_i = \frac{1/\operatorname{var}(y_{\text{bench}} - y_{i,\text{counter}})}{\sum_i 1/\operatorname{var}(y_{\text{bench}} - y_{i,\text{counter}})}$. All numbers are in percent.

Table 17: Decomposition of South Sovereign Spreads: Using Financial Stocks & Junk Bond

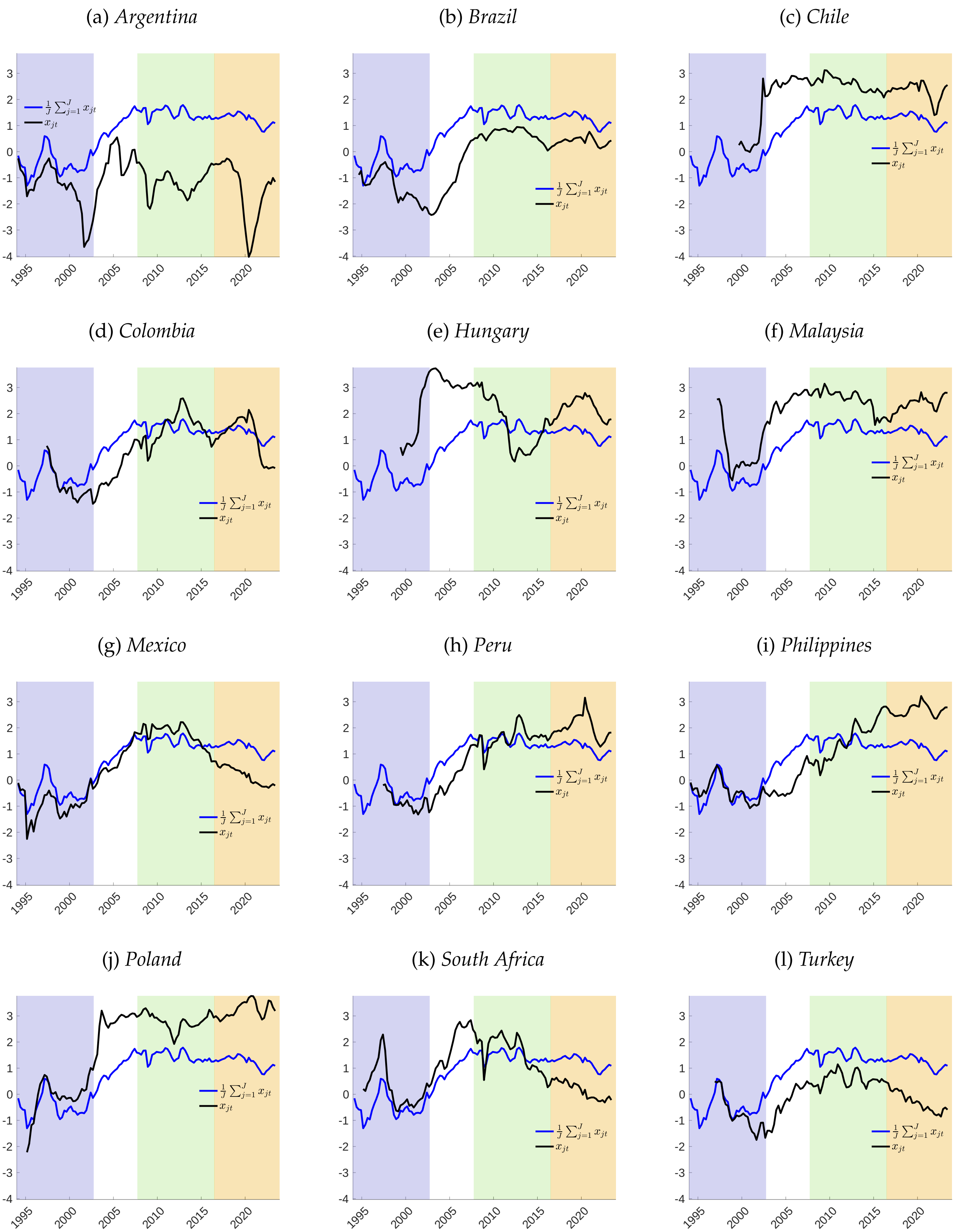
	North vs South		Decomposing North	
	Only North	Only South	Only (u_N, u_{xN})	Only $u_{\sigma N}$
Overall (94q1-23q2)	10.5	89.5	6.5	4.1
EM crises (94q1-02q3)	12.6	87.4	5.7	7.0
Great spread moderation (02q4-07q3)	4.7	95.3	1.8	2.9
Global cycle (07q4-16q2)	65.5	34.5	49.3	16.2
Geoeconomic fragmentation (16q3-23q2)	20.2	79.8	14.7	5.5

Figure A1: Data and Model Implications for the Spreads of Individual Countries



Notes: Each panel plots 12 countries' sovereign spreads in the data and highlights one specific country's spread in the data and the model.

Figure A2: Decomposition of individual EM states



Notes: Each panel plots 12 countries' backed out long-run risk shocks and the mean of them.

Figure A3: Decomposition of individual EM spreads

Notes: Each panel plots 12 countries' sovereign spreads in the baseline and counterfactuals with only South shocks and with only North shocks.