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World Financial Cycles*

Yan Bai

University of Rochester

Patrick J. Kehoe

Stanford University and Federal Reserve Bank of Minneapolis

Fabrizio Perri

Federal Reserve Bank of Minneapolis

ABSTRACT

Data shows that, in the cross section of emerging countries, sovereign spreads are highly correlated, much more so than local economic conditions. However, in standard models of sovereign default the main drivers of sovereign spreads are local conditions. This paper proposes a mechanism that can explain, at the same time, the high correlation of spreads and the low correlation of local conditions. The model features a large developed economy, which lends to a large number of developing economies, using long run bonds that can be defaulted on. The key feature of the model is the presence of long run risk (as in Bansal and Yaron, 2006). We first show that the model can account for the dynamics of several real variables and of sovereign spreads in the cross section of developing economies. We then use the model for examining how much of the fluctuations in spreads in developing economies arise from the changes in long risk in the developed economy (the price of risk), v/s changes in long run risk in the developing economies themselves (the quantity of risk). We find that 2/3 of fluctuations in spreads are explained by the quantity of risk. Our conclusion is that world financial cycle is largely driven by a world-wide, low frequency long run risk component.
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Data on various financial statistics support the idea that there is a world financial cycle. (See, among others, Longstaff et al. 2011, Rey 2013, and Tourre 2017.) For example, a prominent feature of the data on emerging economies is that sovereign spreads are highly correlated across these economies and are much more so than are local economic conditions. For example, in our data set with 23 emerging economies, the median cross-country correlation of sovereign spreads is 52% whereas the median cross-correlation of output growth rates is only 17%. Moreover, this cross-country correlation of emerging economy spreads is also higher than the cross-correlation of emerging economy stock returns. Finally, when the U.S. stock market return is low, the spreads in emerging economies tends to be high.

These patterns are at odds with the popular mechanisms in standard models of sovereign default in which the main drivers of sovereign spreads are local conditions. We propose a mechanism that can explain, at the same time, the high correlation of spreads and the low correlation of local conditions. The model features a large developed economy, called the *North* which lends to a large number of emerging economies, called the *South*, using long term bonds. As in the default literature, if an emerging economy defaults on such a bond then it is excluded from the bond market for a some period of time and during that time suffers an reduction in output.

A key difference between our model and the vast majority of the sovereign debt literature is the preferences we use and output processes we consider are those popular in finance rather than the standard ones in the sovereign debt literature. In particular, we assume that the consumers in all countries have Epstein-Zin preferences. For output processes, we assume the growth rate of output in the North is the sum of a highly serially correlated component, referred to as *North long run risk*, and an idiosyncratic i.i.d. growth shock whereas the growth rate of output in each Southern country is the sum of a highly serially correlated component that is common across these countries, and referred to as *South long run risk*, and a country-specific idiosyncratic i.i.d growth shock. The North and the South long run risk are correlated.

The key to producing patterns consistent with a world financial cycle is the presence of long run risk. In our setup most of the patterns of financial variables are driven by the presence of long run risk which generates large movements in financial variables, such as stock markets, but only small movements in country level growth rates. In turn, most of the movements in country level growth rates and other measures of local conditions on the real side of the economy are driven by country-specific idiosyncratic shocks. Interestingly, even though much of the volatility of spreads is driven by idiosyncratic shocks, they still can be highly correlated due to long run risk.

When the long run risk component of growth in the North and the South happen to both fall several things happen. Since the long run risk is highly serially correlated, the North anticipates a long period of slow growth and, hence, desires to save. In equilibrium, because the South taken as a whole is small the North cannot save in equilibrium and instead its interest rate falls. This drop in the long run risk component in the North also leads to a drop in the returns on its stocks. The drop in the South long run risk component of growth leads it to default more in the current period, and more importantly, leads Northern lenders to anticipate that it will be more likely to default in the future. Since this component is common across Southern countries their spreads tend to rise in a correlated fashion. Moreover, the positive correlation of the North and South risk means that just when the North desires consumption more the South tends to default more. This implies that the defaultable bonds are a particular risky asset and helps explain why their spreads are larger than their default frequencies.

In our model the world financial cycle is driven by common movements in the quantity of risk across Southern countries, driven by the common South long run risk component, together with a fluctuating price of risk, driven by the North long run risk component. We examine the separate implications of each type of risk by considering versions of the model with only North long run risk and only South long run risk. We think of the version with only North long run risk as modeling in a simple way the popular alternative story to ours that the high correlations of spreads across emerging economies is mainly driven by fluctuations in the price of risk in the North. We find that this version of the model can only generate about a third of the observed correlation of spreads across countries and, in this sense, by itself it cannot generate a world financial cycle. The version with Southern risk alone can generate about two thirds of the observed correlation of spreads. In this sense, we (tentatively) suggest that the quantity of risk can account for two thirds or the world financial cycle and the price of risk can account for one-third.

Relation to the Literature

Our modeling of preferences and shock structure extends to a one large country, many small country setup a version of the two country models used in a series of papers in macro-finance by Colacito and Croce 2008, 2010, 2011, and 2013, which in turn build on the closed economy long run risk literature emanating from Bansal and Yaron 2004.

Our modeling of defaultable debt builds on the work on sovereign debt including Eaton and Gersovitz 1981, Aguiar and Gopinath 2006, Arellano 2008, and the work surveyed by Aguiar et al. 2016.

1. Empirical Analysis

In this section we document facts about sovereign spreads in emerging markets, their global comovement and their connection to real economic activity and to stock markets, locally and in the United States. For this purpose we use interest spreads on dollar denominated sovereign bonds (from EMBI Global) for 23 emerging countries with at least 15 years of data, together with data on GDP and stock returns, for these countries and the United States, over the period 1994-2017. [1]

A. Spreads, Default Frequencies and GDP

Figure 1 plots the spreads for a subset of countries in our sample. The vertical scale is capped at 1500, as some of the countries experienced default and thus spreads are extremely high. There are few features that we want to highlight in the figure. The first is the very high degree of comovement. This is seen, for example, when all countries experience an increase in spread during the great recession and the Euro debt crisis, or when all countries experience a decline in spreads over the period 2004-2006. The second is the presence of episodes in which the spread in one or more countries spikes (by a very large amount). An example of this is the Argentine crisis of 2000, when the spread of Argentina, Brazil and Mexico spike, but the spreads of Poland and Malaysia are not affected much. Finally we also point out the very

[1] The countries in our sample are Argentina, Brazil, Bulgaria, Chile, China, Colombia, Dominican Republic, Ecuador, El Salvador, Hungary, Malaysia, Mexico, Nigeria, Panama, Peru, Philippines, Poland, Russia, South Africa, Turkey, Ukraine, Uruguay and Venezuela.

high volatility and high level of spreads. As an example consider Brazil, whose spread, in the first part of the sample oscillates from values above a 1000 to values below 500.

In traditional models of sovereign default the main determinant of spreads is the default probability, which in turn is affected by local economic conditions. For these reasons in Table 1 we report key statistical properties of the spreads and we contrast then with moments about default probabilities and GDP in these emerging economies. Except for default frequency, each moment in the table (i.e. average, standard deviation etc.) is computed for each country and then we report the median, and the p10 and p90 for the distribution of that moment across countries in our sample. So, for example, the number 3.5% the first column of line 1 of the table is the median (across all 23 countries in our sample) of the average spread.

The first feature we want to highlight from the table is that average spreads across countries are significantly higher than the default frequency. The median spread is 3.5%, while the default frequency is 2.1%. As noted by, among others, Meyer et al. 2019, this points toward a theory where spreads not only reflect compensation for default risk, but also a risk premium component. The second is the high volatility of spreads, as the median country has a standard deviation of spreads exceeding 200 basis points. The third is the very high correlation of spreads. The median couple of countries exhibits a correlation in spreads of 51.6%. The correlation is even higher when one looks at the change in spreads, as line 5 in the table shows that 90% of the couples of countries in our sample exhibit a correlation in spreads higher than 37.4%.

Moving now to GDP growth the table confirms features of emerging market data that have been highlighted by previous studies. Emerging market experience much volatile growth than the US (see Neumeyer and Perri, 2015), their growth is more serially correlated over time (see Aguiar and Gopinath, 2007). More relevant for our analysis are the two facts in lines 9 and 11 of Table 1. Line 9 shows that the cross country correlation of the GDP growth (18.9%) is much lower than the cross country correlation of the spreads (51.6% or 62.1%). Line 9, however, shows that, in any given country, growth and spreads are negatively correlated. taken together these two facts suggest that GDP growth might play a role in the dynamics of spreads, but growth alone is not able to account for the presence of the high international comovement of spreads (the world financial cycle).

B. Spreads and Stock Markets

The empirical analysis so far has shown that spreads in emerging markets strongly comove internationally. This strong comovement is not present in local fundamentals (GDP growth). For this reason in this section we explore data on stock returns to assess their connection to spreads and to their global component. The upshot from this table is that the presence of a global factor, which was not very dominant in GDP growth, appears to be very strong in stock market data. Stock market returns in emerging markets are very volatile (twice as much as in the US, see line 2 of Table 2), and strongly internationally correlated (see line 3).

As we argue in the next section, the facts presented so far are hard to explain using a standard sovereign default model as in Eaton-Gersovitz (1981) or Arellano (2008).

2. A World Economy

We consider a large North country and a continuum of small Southern countries, indexed by i. We focus on the small open economy case in which the Southern countries taken as a whole are small in the world economy.

A. Preferences and Endowments

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

$$(1) \quad W_{it} = \left\{ (1-\beta_S) c_t^{1-\gamma} + \beta_S \left[E(W_{it+1}^{1-\theta}) \right]^{\frac{1-\gamma}{1-\theta}} \right\}^{\frac{1}{1-\gamma}}.$$

where β_S is the common discount factor in the South. The preferences of the North has the same form as (1) but with discount factor β. All the Southern countries and the North have common parameters γ and θ, where $1/\gamma$ is the elasticity of intertemporal substitution and θ controls risk aversion.

The process for the endowment of the North, Y_t, follows a process similar to that in Bansal and Yaron (2004), in which the growth rate of output is the sum of a serially correlated component, X_t, referred to as long run risk and a North specific component ε_t, referred to as idiosyncratic risk. Specifically, this process is given by

$$(2) \quad \log Y_t - \log Y_{t-1} = \mu + \log X_{t-1} + \varepsilon_t$$

where the process for long run risk X_t in the North is given by

$$(3) \quad \log X_t = \rho \log X_{t-1} + \varepsilon_{Xt}.$$

The shocks ε_t and ε_{Xt} have zero means and standard deviations σ_N and σ_X respectively. The constant μ determines mean growth for the process. The process for the growth rate of a Southern country i is given by

$$(4) \quad \log y_{it} - \log y_{it-1} = \mu + \alpha_S \log X_{it-1} + \varepsilon_{it}$$

$$g_{it} = \frac{y_{it}}{y_{it-1}} = \exp(\mu + \varepsilon_{it}) X_{it-1}^{\alpha_S}$$

where the process for long run risk X_{it} in Southern country i is given by

$$(5) \quad \log X_{it} = \rho_S \log X_{it-1} + \varepsilon_{Xit}.$$

The shocks ε_{it} and ε_{Xit} have zero means and standard deviations σ_S and σ_{SX} respectively. In this specification all of the Southern countries have a common loading on North long run risk component, given by the parameter α.

All of these shocks are Normally distributed and, over time, are independent and identically distributed, but we allow them to be contemporaneously correlated. The idiosyncratic shocks in the North ε_t have contemporaneous correlation ρ_{NS} with each Southern country's idiosyncratic shock ε_{it} and are independent of the long run risk shocks at all leads and lags. The idiosyncratic shocks ε_{it} and ε_{jt} of any two Southern countries have contemporaneous correlation ρ_{SS} and otherwise independent of all other shocks Likewise, the long run risk shocks in the North ε_{NXt} have contemporaneous correlation ρ_{XNS} with long run risk shocks ε_{iXt} of each Southern country i and the long run risk shocks ε_{iXt} and ε_{jXt} of any two Southern countries i and j have contemporaneous correlation ρ_{XSS} and all are otherwise independent of other shocks.

B. Financial Markets

As does Hatchondo and Martinez (2009), we assume that the only asset that is traded across countries is a long-term state-uncontingent bond for which countries may default. One unit of a bond in time t is a promise to a payment of ϕ in period $t+1$, $\phi(1-\phi)$ in period $t+1$, $\phi(1-\phi)^2$ in period $t+2$, and so on. Note that if $\phi = 1$ the bond is a standard one-period bond and if $\phi = 0$ it is a console.

If country i chooses to default on its debt in period t it faces two punishments. First, it enters financial autarky in period $t+1$ and in each period after that it is regains access to financial markets with probability λ. We let $f \in (n, d)$ denote the financial state where n denotes the country is in *normal times* with access to credit markets and d denote the country is *in default*, in that the country has defaulted but has not yet regained access to financial markets. Second, during the period in which it is in financial autarky its output is reduced by $y_{it}f(g_{it}, \kappa_{it})$ where g_{it} is the growth rate of output of country i and κ_{it} is an i.i.d. shock to the cost of default.

We also want to price stocks in each country. These stocks of any given country can be held only by consumers in that country. As in Bansal and Yaron (2004), we models stocks as claims to dividends. The process for dividends in the North are given by

$$\log D_t - \log D_{t-1} = \alpha_d \log X_{t-1} + \varepsilon_{dt}$$

and for a South country i are given by

$$\log d_{it} - \log d_{it-1} = \alpha_{dS} \log X_{it-1} + \varepsilon_{dit}$$

where we allow the innovations to be contemporaneously correlated but i.i.d. over time. Within each country consumers can buy or sell these claims which are in zero net supply. Since consumers within each country are identical, these claims are not traded in equilibrium, and so are priced so that any consumer in the country is indifferent to holding them or not. Because these claims are in zero net supply we do not explicitly include them in consumers' budget constraints.

C. Consumer Problems

At the beginning of period t, the economy inherits the long run risk X_{t-1} and the current period shocks are realized. These include the long run risk shock, ε_{Xt}, the idiosyncratic shock ε_t in the North and the idiosyncratic shocks ε_{it} for each Southern country i. Given our small open economy assumption, the aggregate state is given by $S_t = (X_{t-1}, \varepsilon_{Xt}, \varepsilon_t)$.

From our small open economy problem, the allocations in the North are those of a closed economy with consumption at t equal to output at t, namely Y_t. Hence, using recursive notation, with $Y(S)$ and $Y(S')$ denoting output in current and the next period, the world stochastic discount factor is

$$(6) \quad Q(S,S') = \pi(S'|S)\beta \left(\frac{Y(S')}{Y(S)}\right)^{-\gamma} \left\{\frac{W(S')}{[EW(S')^{1-\theta}]^{\frac{1}{1-\theta}}}\right\}^{\gamma-\theta}.$$

Consider the problem of a Southern country i in period t. At the beginning of period t the idiosyncratic endowment shock ε_{it} and the cost to default shock κ_{it} is realized, and, if that country was in default in period $t-1$, the re-entry shock is realized.

Consider country i after such shocks are realized that is currently in the normal state. This country decides current consumption and new borrowing. In this nonstationary environment, all level variables will be nonstationary, so we find it convenient to divide the level variables for consumption, debt, and output by y_{it-1} and denote the resulting scaled values as c_{it}, b_{it}, and g_{it}. This country faces a bond price schedule $q(b_{it+1}|S_t, X_{it-1}, \varepsilon_{Xit})$ for issuing b_{it+1} units of (scaled) new bonds. Hence, in recursive notation its budget constraint is

$$(7) \quad c_i + \phi b_i = g_i + q(b_i'|S, X_{i-1}, \varepsilon_{Xi})\left[g_i b_i' - (1-\phi)b_i\right].$$

If such a country is in normal times its state is (S, b_i, s_i) and if it is in default its state is (S, s_i) where $s_i = (X_{i-1}, \varepsilon_{Xi}, \varepsilon_i, \kappa_i)$ records the country i shocks. A country in normal times first decides whether or not to default on inherited debt. Let

$$v(S, b_i, s_i) = \max\left\{w^R(S, b_i, s_i), w^D(S, s_i)\right\}$$

denote maximum of the value of repaying $w^R(S,b,s_i)$ and the value of defaulting $w^D(S,s_i)$. Letting $\delta \in \{0,1\}$ with $\delta = 0$ denoting default and $\delta = 1$ denoting repay, we have $\delta(S,b_i,s_i) = 1$ if $w^R(S,b_i,s_i) \geq w^D(S,s_i)$ and zero otherwise.

The value of repaying is

$$w^R(S,b_i,s_i) = \max_{c_i,b_i'} \left[(1-\beta_S)c_i^{1-\gamma} + \beta_S g(s_i)^{1-\gamma}\left[Ev(S',b_i',s_i')^{1-\theta}\right]^{\frac{1-\gamma}{1-\theta}}\right]^{\frac{1}{1-\gamma}}$$

subject to

$$c_i + \phi b_i \leq g(s_i) + q(b_i'|S,X_{i-1},\varepsilon_{Xi})\left[b_i' g(s_i) - (1-\phi)b_i\right].$$

where the growth rate of country i is $g(s_i) = \exp(\mu + \varepsilon_{it})X_{it-1}^{\alpha_S}$. Let $b_i'(S,b_i,s_i)$ denote the resulting bond choice. In default there is no choices to be made, consumption is $c_i^d = g(s_i)f(g(s_i),\kappa_{it})$ and the value is

$$w^D(S,s_i) = \left[(1-\beta_S)\left(c_i^d\right)^{1-\gamma} + \beta_S g(s_i)^{1-\gamma}\left[E\left(\lambda w^R(S',0,s_i')^{1-\theta} + (1-\lambda)w^D(S',s_i')^{1-\theta}\right)\right]^{\frac{1-\gamma}{1-\theta}}\right]^{\frac{1}{1-\gamma}}.$$

Consider next the bond price schedule. Given the default rule, $\delta(S,b_i,s_i)$, the bond price set by the North on long term debt is

$$q(b_i'|S,X_{i-1},\varepsilon_{Xi}) = E\left\{Q(S,S')\delta(S',b_i',s_i')[\phi + (1-\phi)q(b_i''(S',b_i',s_i')|S',X_i,\varepsilon_{Xi}')]|S,X_{i-1},\varepsilon_{Xi}\right\}$$

where $b_i''(S',b_i',s_i')$ denotes the debt issued by country i in the subsequent period and the expectation is conditional on $(S,X_{i-1},\varepsilon_{Xi})$.

The small open economy equilibrium is defined in the natural way.

3. Quantification and Results

We assign the risk aversion parameter of the North and each Southern country to be $\theta = 10$, the intertemporal elasticity of substitution of the North and each Southern country to be $1/\gamma = 1.5$, and the mean growth rate of output per capita to be 2%.

We parameterize the default cost similarly to that in Aguiar et al. (2016), so that consumption during default in levels is given by

$$C_i^d = \exp(\kappa_i) y_i (1 - a_0 g(s_i)^{a_1})$$

which in scaled terms becomes $c_i^d = \exp(\kappa_i) g(s_i)(1 - a_0 g(s_i)^{a_1})$ where κ_i is Normally distributed with mean 0 and standard deviation of σ_κ.

We choose the rest of the parameters listed in Table 3, the endogenously chosen parameters, so that in Table 4 the moments of the benchmark model match as well as possible the data moments listed in the first column.

A. Results

Consider now the moments of the benchmark model for involving output. The benchmark model has similar standard deviation and serial correlation of output growth as in the North and the average standard deviation and average output growth in the South. The average correlation of the output growth in the North and each of the countries in the South is low in the data (17.3%) and a bit lower in the model (6.54%). The average correlation of output across Southern countries is also low in the data and the model (16.5% and 16.9% respectively).

Consider next moments involving interest rates, default rates and spreads. The mean risk free rate and mean default rate are similar to the data.

More important is the standard deviation of spreads. Recall that the comprehensive analysis of existing debt models by Aguiar et al. (2016) argued that a major shortcoming of these models was that the generated an order of magnitude less volatility in spreads than in the data, at least when quantified to be consistent with fairly typical countries such as Mexico. Indeed, Aguiar et al. (2016) argue that the success of the earlier work by Arellano (2008) in generating the observed volatility of the spread is that it focused on Argentina which has nearly 3 times the volatility of a more typical country such as Mexico.

We quantify our model to have similar volatility to the median volatility of our sample of 23 countries. Even so our model does a reasonable job of generating the observed volatility of spreads, namely 1.46% in model and 2.06% in the data. For comparison, note that the preferred baseline model in Aguiar et al., their *SG* model, which has a stochastic trend, like our model does, generates a standard deviation of spreads of only .2% in the model versus 3% in the data. (See Table 9, p. 1724 Aguiar et al. 2016.)

A second major result of the model is that it is able to produce spreads that are much more correlated across countries than output growth. In the data the spreads have an average correlation of 51.6% whereas output growth has an average correlation of only 16.5%. Our benchmark model produces a similar pattern: spreads have a correlation of 41% whereas output growth has a correlation of only 16.9%.

Turning to moments involving stock returns, we see that the volatility, average return, and equity premium on North and South stocks are similar to those in the data. Interestingly, the correlation between local conditions in Southern country, as measured by its growth rate, and its spread is stronger than the correlation of global conditions, as measured by the North stock returns and its spread in both the data (-36.3% vs. -11%) and the model (-31.8% vs. 15.2%).

Finally, consider flows of goods as measured by current account to output. The model produces somewhat less volatility in current account flows than in the data, but similar correlation of these flows across countries. In terms of cyclicality, current account flows are more countercyclical in the data than in the model.

B. Decompositions

We now consider the effects of the North and South long run risk shocks separately. In Table 4 we consider two other economies. In the *only X_N economy* we consider an economy in with the long run risk shock in the South is constant, that is, $\sigma_{SX} = 0$ and in the *only X_S economy* we consider an economy in with the long run risk shock in the North is constant, that is, $\sigma_X = 0$.

Long run risk only in the North

Consider the only X_N economy. Notice first that, relative to the benchmark economy, the serial correlation of output growth falls from 34.8% to 22.5%. (Here it is important to understand that even though the innovations to Southern country growth rates are independent at the quarterly level when we time aggregate these growth rates to construct the annual output levels and then take the serial correlation of these constructed annual output growth they are indeed serially correlated.)

The cross correlation of these annual output growth measures across the North and the South is now essentially zero since there is no correlation between their shocks and the cross correlation across the Southern countries is now essentially zero for the same reason.

Clearly, because the South is small, the risk free rate is identical in the benchmark economy and this economy. For the same reason, so are the North stock returns and the North equity premia.

Interestingly, relative to the benchmark economy, the mean default rate essentially doubles from the benchmark economy, from 2.2% to 4%, whereas the mean spread falls by over 200 basis points, from 5.9% to 3.6% and the standard deviation of the spread falls precipitously, from 1.5% to .5 %. The intuition for these patterns is a bit subtle. Let us start with why the spread falls. In the benchmark economy the correlation of X_N and X_S means that the South tends to default at the same time the North has a particularly high desire for consumption, that is when both X_N and X_N are low. That makes the defaultable bond very undesirable for any given default rate. In the X_N only economy, a Southern country tends to default when its idiosyncratic shock is low. This makes the default rate essentially uncorrelated with the North stochastic discount factor. Hence, a defaultable bond in this case is not very risky.

The most important result here is that with only North long run risk shocks the model cannot produce a correlation of spreads across the South similar to that in the data. In particular, the correlation of spreads in this case is only 16% whereas it is 52% in the data. This result implies that, at least in this model, the idea that most of the correlation of spreads in the South is coming from variations in the North's willingness to lend, as measured by the variations in the North's stochastic discount factor is not consistent with this set up.

There are other patterns in the data that this only X_N economy cannot deliver. Absent any Southern long run risk, the model is unable to produce any correlation between Northern and Southern stock returns (0% in X_N only model but 42% in the data) or any correlation across Southern stock returns (0% in X_N only model but 31% in the data).

Long run risk only in the South

Consider now the only X_S model in which the only long run risk is in the South. This version generates zero correlation of output growth between the North and the South.

Since the only source of risk free rate variations is the North long run risk, the world risk free rate is now constant. Interestingly, the mean default rate in the model increase a bit from the benchmark (2.8% in this version and 2.2% in the benchmark). The mean and the volatility of spreads are higher in this version than in the benchmark (here we have a 6.1% mean and a 1.7% volatility vs. a 5.9% mean and a 1.5 % volatility in the benchmark).

Interestingly the correlation of spreads across the Southern countries is only a bit smaller than in the benchmark model (36.7% in the X_S only model and 41% in the benchmark model).

This version of the model fails to produce reasonable properties for North stock returns, in that it neither captures the link between North stock returns and South spreads nor does it produce reasonable properties for the North stock returns in and of themselves. In particular, the correlation between North stock returns and South spreads is now essentially zero (1% in the model versus -11% in the data). Moreover, for North stock returns the average return and volatility are much too low and the equity premium is much too low. Of course, these patterns are to be expected since the main source of risk in North stock returns is not the idiosyncratic shocks in the North but rather the long run risk in the North.

Realization graphs

We also find it useful to graph some realizations for the only X_N model and the only X_S model in Figures 3 and 4 respectively. We choose stylized patterns for X_N and X_S to help make clear the differing role for long run risk and idiosyncratic shocks. To make these graphs comparable we choose the same innovations for the X_N and X_S in the two cases as well as the same innovations for the idiosyncratic shocks. To keep the graphs simple we plot only two Southern countries,which are carefully chosen so that the correlations and volatilities in these realizations are consistent with those for long samples with many Southern countries.

Compare first the spreads. Clearly, the spreads in the only X_S model are higher and more volatile than the corresponding ones in the only X_N model. These differences do not seem to be that related to differences in borrowing behavior. Indeed, the ups and downs of debt to output seem to be very related to the idiosyncratic shocks: when idiosyncratic growth in a country is low that country increases its debt to output and when this growth is high the country decreases its debt to output.

Clearly, in both versions, the world risk free rate and the North price dividend ratio closely tracks the long run risk in the North. Indeed, given the South is small, the closed form solutions from Bansal Yaron (2004) prove that this holds exactly. In the only X_N version, the Southern countries stock returns have lower volatility than in the only X_S version. With only Southern long run risk, the presence of this risk makes Southern countries stock returns more volatile and more correlated.

C. Impulse Responses

We now turn to examining the impulse responses to various shocks.

Responses to Long Run Risk Shocks

We begin by comparing the benchmark economy's impulse responses to a one standard deviation innovation to long run risk in the North to those for a one standard deviation innovation to long run risk in a Southern country. When making this comparison recall that output growth in the North has a loading of 1 on the North long run risk whereas output growth in the South has a loading of 3 on South long run risk. Thus, on impact a given innovation in long run risk generates three times as large of a change in a Southern country's output growth as it does to the North country's output growth.

With this in mind, consider the response to a one standard deviation negative innovation to North long run risk. This shock does change both the current growth and expected future growth of the North, in that the North's output growth falls on impact and then is expected to slowly return to its mean, leaving it at a new lower level in the long run. The North desires to move consumption from the present, with its relatively high level of output, to the future, with its relatively lower level. Hence, the risk free interest rate falls, here by 15 basis points and then slowly recovers. Faced with this slightly higher interest rate, the Southern country borrows a bit more, increasing its debt to output ratio a bit, and the spread on its debt rises a bit, about 10 basis points on impact.

Now, let's contrast this response to a one standard deviation negative innovation to South long run risk. Clearly, this shock has no effect on the world risk free rate because it has no impact on the North at all. The current growth rate of the South falls from about .9% per year to .55% in the current quarter then slowly returns to its mean leaving the South to settle down to a new lower level. Thus, the country anticipates a slow decline in its level of output and responses by lowering its debt to output ratio a bit. The spread increases about 80 basis points from 5% to 5.8%. A major reason for this increase that with our cost of default function, the cost of default falls with the country's growth rate so, all else equal, the country is more likely to default. In terms of the stock market, the price dividend ratio tracks the level of South long run risk and the return suffers a one period fall.

Responses to Idiosyncratic Shocks

In Figures 5 and 6 we show the responses to idiosyncratic shocks to a Southern country's output growth and the North country's output growth. Since these shocks are i.i.d. they do not change the forecast future growth rates. Since they are permanent shocks to the level of output they also lead to a permanent drop in consumption, and essentially no change in debt or spreads.

4. Conclusion

We have proposed a simple model of a world financial cycle. Our model is consistent with the idea in existing sovereign debt models that the volatility of spreads on sovereign debt are 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.

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. The time-varying price of risk emanating from a shock that effects the North stochastic discount factor accounts for at most a third of this correlation of spreads.

In this sense, we investigated if our model is consistent with the popular view that the high correlations of spreads across emerging economies are mainly be driven by fluctuations in the price of risk in the North. We find that they are not and that, instead, the quantity of risk in the South plays a dominant role.

Finally, we view our model as showing that, in contrast to a popular view, there may be no need for some sort of contagion to account for the comovement of spreads across countries.

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Table 1: Spreads, Default Frequency and GDP in emerging economies

Default Frequency*	2.1%				
Spreads	Median	P10	P90	# ctys/pairs	U.S.
1.Average	3.5%	1.7%	8.5%	23	-
2.Standard deviation	2.1%	1.1%	5.8%	23	-
3.Pair-wise correlation	51.6%	0.1%	84.9%	253	-
Change in Spreads					
4.Standard deviation	0.9%	0.5%	2.5%	23	-
5.Pair-wise Correlation	62.1%	37.4%	80.6%	253	-
Output Growth					
6.Average	3.3%	2.2%	5.1%	23	2.5%
7.Standard deviation	5.3%	3.5%	9.9%	23	2.4%
8.Serial Correlation**	43.1%	12.6%	61.5%	23	34.1%
9.Pair-wise Correlation	18.9%	0.1%	38.9%	253	-
10.Correlation with US	20.4%	9.1%	41.1%	23	-
11.Correlation with spread	-36.3%	-53.0%	-11.3%	23	-

**We classify a country/quarter in default when either Standard & Poor, Moodys or Fitch does so for that country/quarter. We have 1916 country quarters in our sample and of those we classify 40 in default.*

***Serial correlation of growth is computed on yearly growth rate, which allows us to use a longer sample spanning from 1960 to 2017.*

Table 2: Stock markets and spreads

Stock Market Returns*	Median	P10	P90	# ctys/pairs	U.S.
1. Average	5.5%	-1.5%	11.6%	19	7.0%
2. Standard deviation	58.7%	37.2%	95.7%	19	31.9%
3. Pair-wise correlation	41.5%	16.0%	56.9%	167	-
4. Correlation with spreads	-17.9%	-26.2%	-0.04%	19	-
5. Correlation with Δ spreads	-46.3%	-0.57%	-25.3%	19	-
5. Correlation with U.S. returns	46.8%	32.6%	0.57%	19	-
6. Correlation btw US returns and spreads	-16.3%	-29.4%	7.4%	19	-
7. Correlation btw US returns and Δ spreads	-38.2%	-53.0%	-27.2%	19	-

**Data for country stock market returns are computed using MSCI country index returns are deflated using local CPI index*

Table 3: Parametrization and results of the baseline model

Assigned	
$1/\gamma$, North and South IES	1.5
θ, North and South risk aversion	10.0
μ, North and South mean growth rate	0.5%
Endogenously chosen	
North Country Parameters	
β, discount factor	0.997
σ_X, s.d. long-run risk innovation	0.03%
ρ, persistence of long-run risk	98.2%
σ, s.d. idiosyncratic growth innovation	1.1%
α_D, loading of dividend on long-run risk	12
σ_D, s.d. of dividend idiosyncratic innovation	3%
ρ_D, corr. of dividend innovation and idiosyncratic growth innovation	85.5%
South Country Parameters	
β_S, discount factor	0.97
σ_{SX}, s.d. long-run risk innovation	0.03%
ρ_S, persistence of long-run risk	98.2%
σ_S, s.d. idiosyncratic innovation	2.5%
α_S, loading of growth on long-run risk	3.0
α_{DS}, loading of dividend on long-run risk	20
σ_{DS}, s.d. of dividend idiosyncratic innovation	20%
ρ_{DS}, corr. of dividend innovation and idiosyncratic growth innovation	22%
Debt and default parameters	
ϕ, decay of long-term debt	0.05
a_0, default cost parameter	0.075
a_1, default cost parameter	23
σ_κ, s.d of default cost shock κ	1.5%
Cross-Correlations, North and South	
ρ_{XNS}, Corr. of long-run risk innovations	0.4

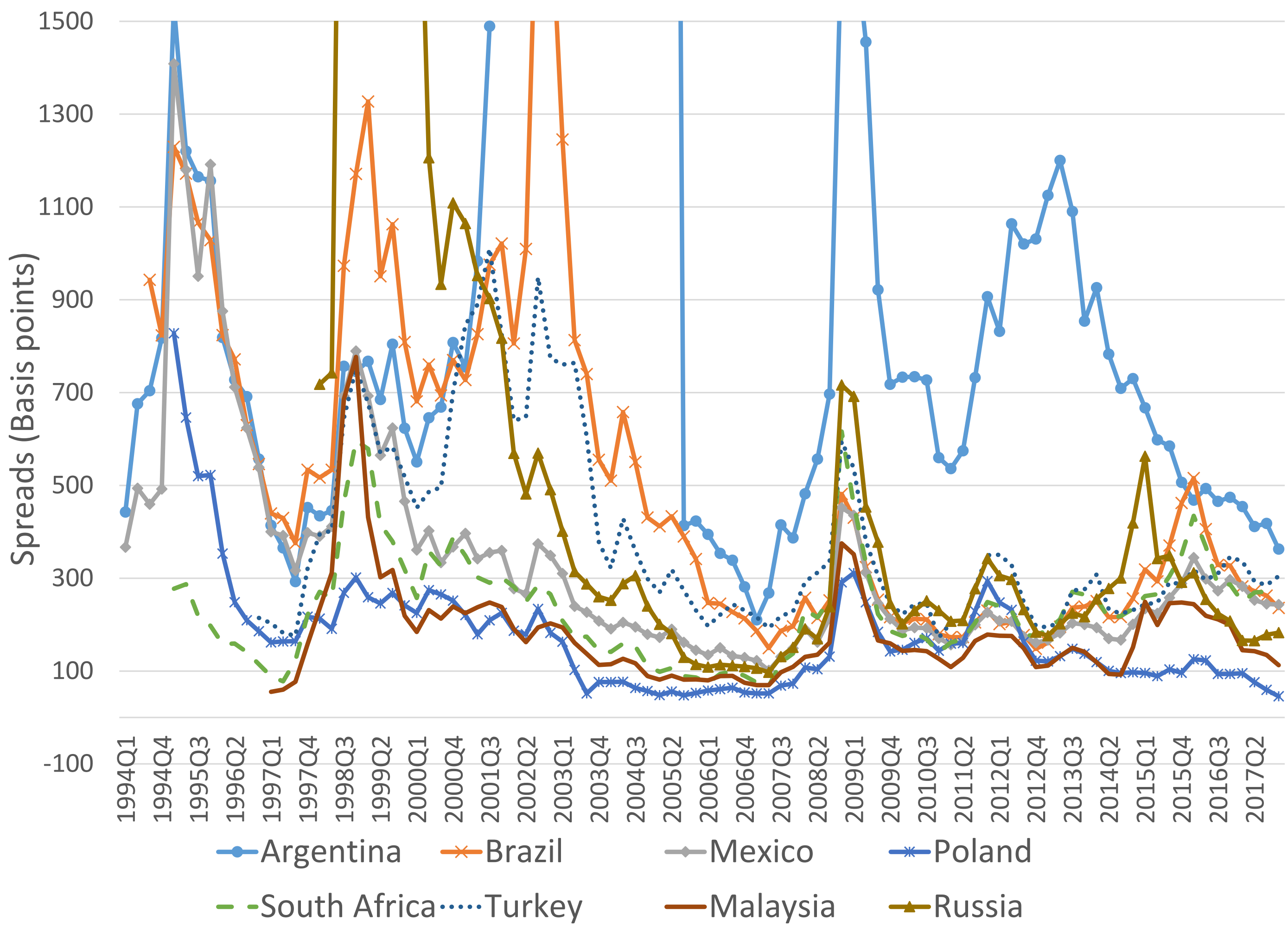
Notes:

Table 4: Benchmark Results and Decomposition

	Data	Benchmark	Only X_N	Only X_S
Annual output growth				
Standard deviation, North	2.4	2.0	2.0	1.9
S.d. output growth, South	4.2	4.5	4.1	4.5
Serial correlation of output growth, North	34.0	29.9	29.9	21.9
Serial correlation of output growth, South	43.1	34.8	22.5	34.8
Correlation of output growth, North and South	17.3	6.5	-0.5	-0.5
Correlation of output growth across South	16.5	16.9	-0.1	16.9
Interest rate, default rate, and spreads				
Mean risk free rate	1.3	1.4	1.4	1.4
S.d. risk free rate	1.0	0.2	0.2	0.0
Mean default rate	2.1	2.2	4.0	2.8
Mean spread	4.4	5.9	3.6	6.1
S.d. spread	2.1	1.5	0.5	1.7
Correlations with spread				
Corr of spreads across South	51.6	41.0	16.4	36.6
Corr (own growth, spreads), South	-36.3	-31.8	-49.8	-28.6
Corr (stock returns, spreads), South	-9.2	-24.8	-10.6	-23.1
Corr (North stock returns, South Spreads)	-11.0	-15.2	-8.5	0.5
Stock returns				
Volatility of stock returns North	32.1	26.8	26.8	11.6
Volatility of stock returns South	67.0	50.3	41.0	50.3
Average stock return North	5.5	5.5	5.5	3.3
Average stock returns South	9.0	10.0	7.1	10.1
Corr of stock returns across South	30.9	33.6	-0.0	33.6
Corr of stock returns, South and North	41.7	19.8	0.0	-0.7
Corr (stock returns, output growth), South	11.6	17.8	22.5	17.6
Corr (stock returns, output growth), North	40.2	36.1	35.1	85.5
Equity premium, North	4.2	4.2	4.2	2.0
Equity premium, South	8.0	8.6	5.7	8.6
Current accounts				
Volatility of CA/GDP, South	2.1	1.3	1.8	1.4
Corr of CA/GDP across South	11.0	12.6	-0.0	10.3
Corr(CA/GDP, GDP) (both HP filtered)	-52.0	-29.7	-69.4	-27.0

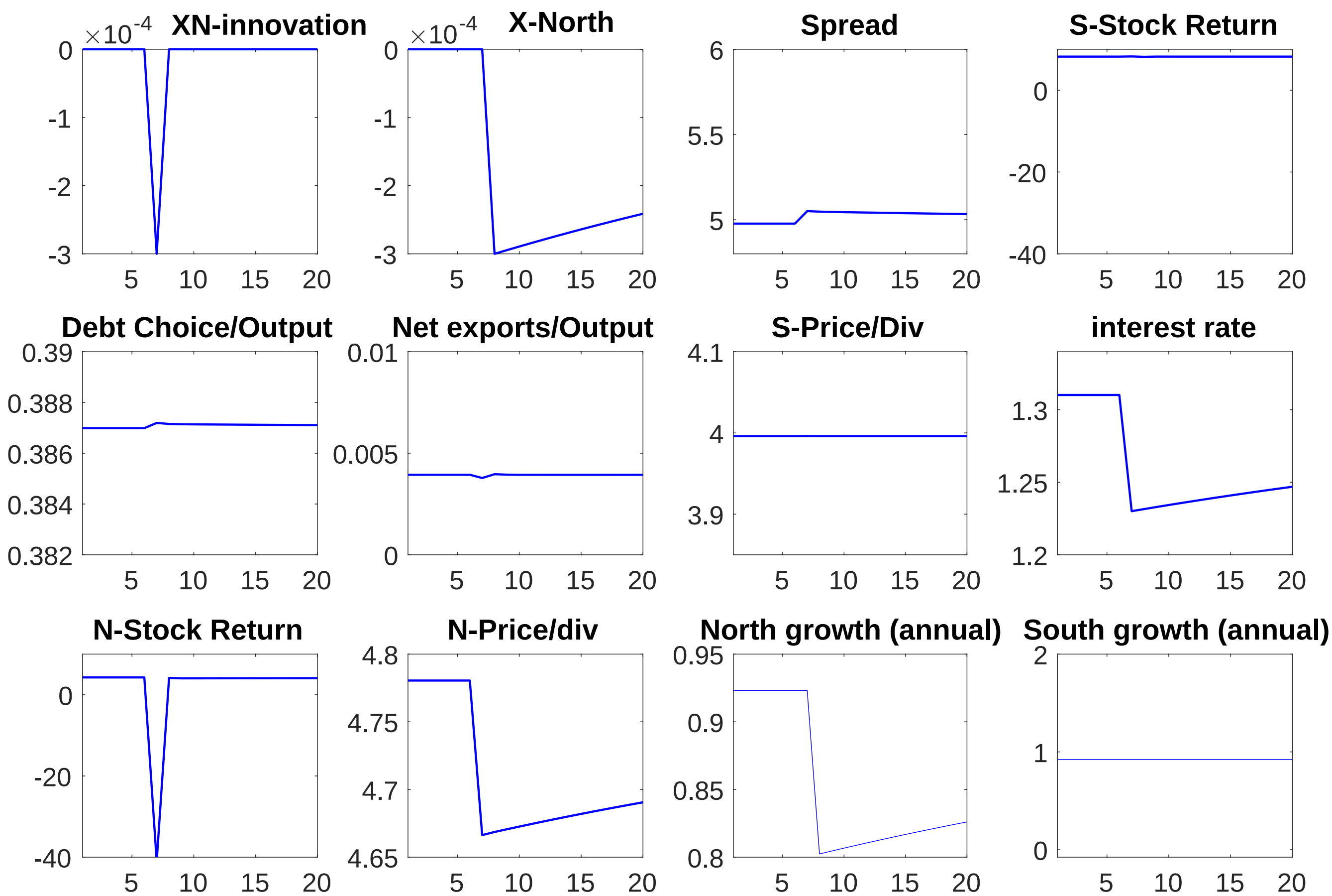
Notes:

Figure 1: Spreads in a sample of emerging markets



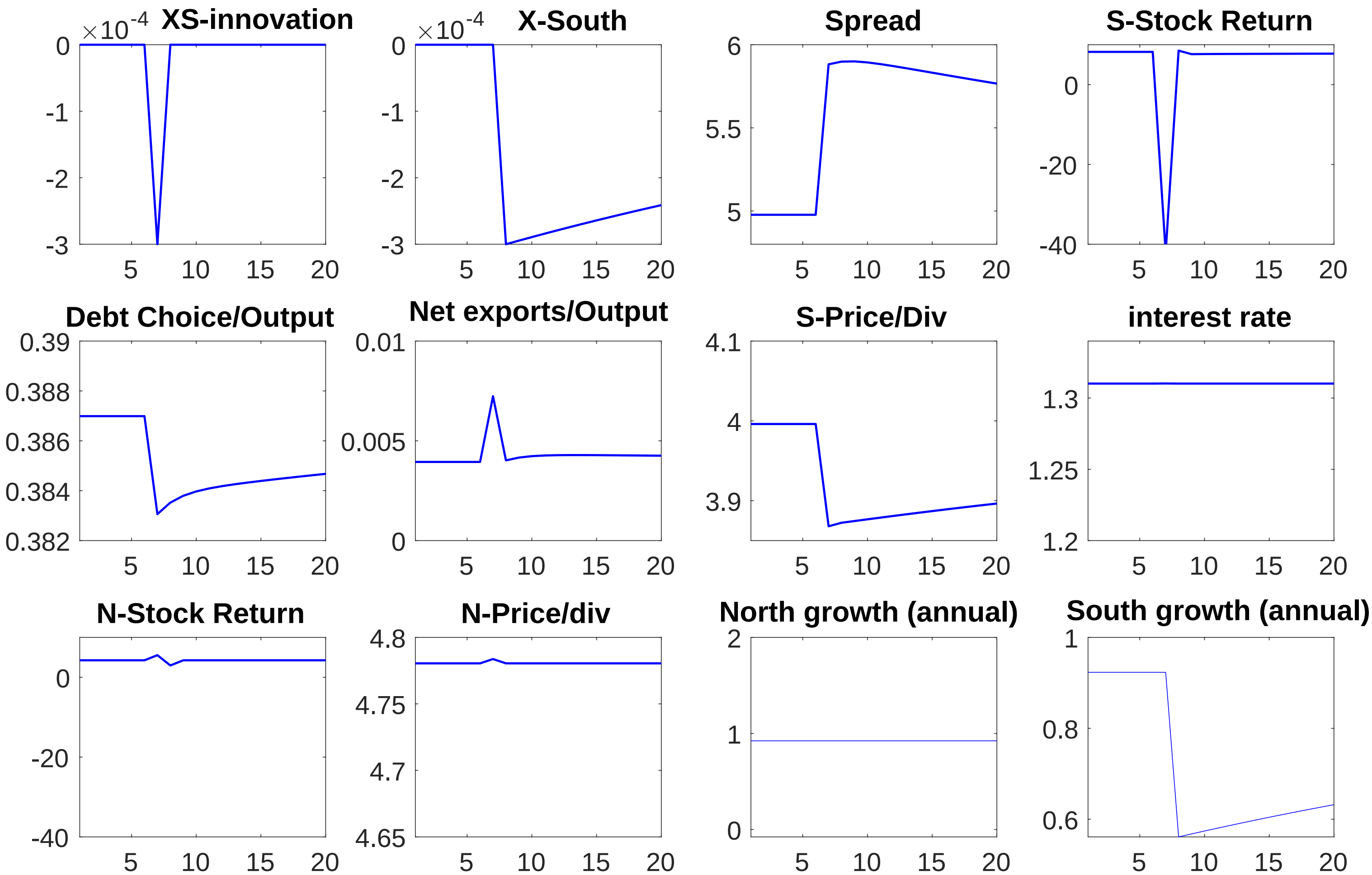
Notes:

Figure 2: Impulse Responses to North Long-run Risk Shock



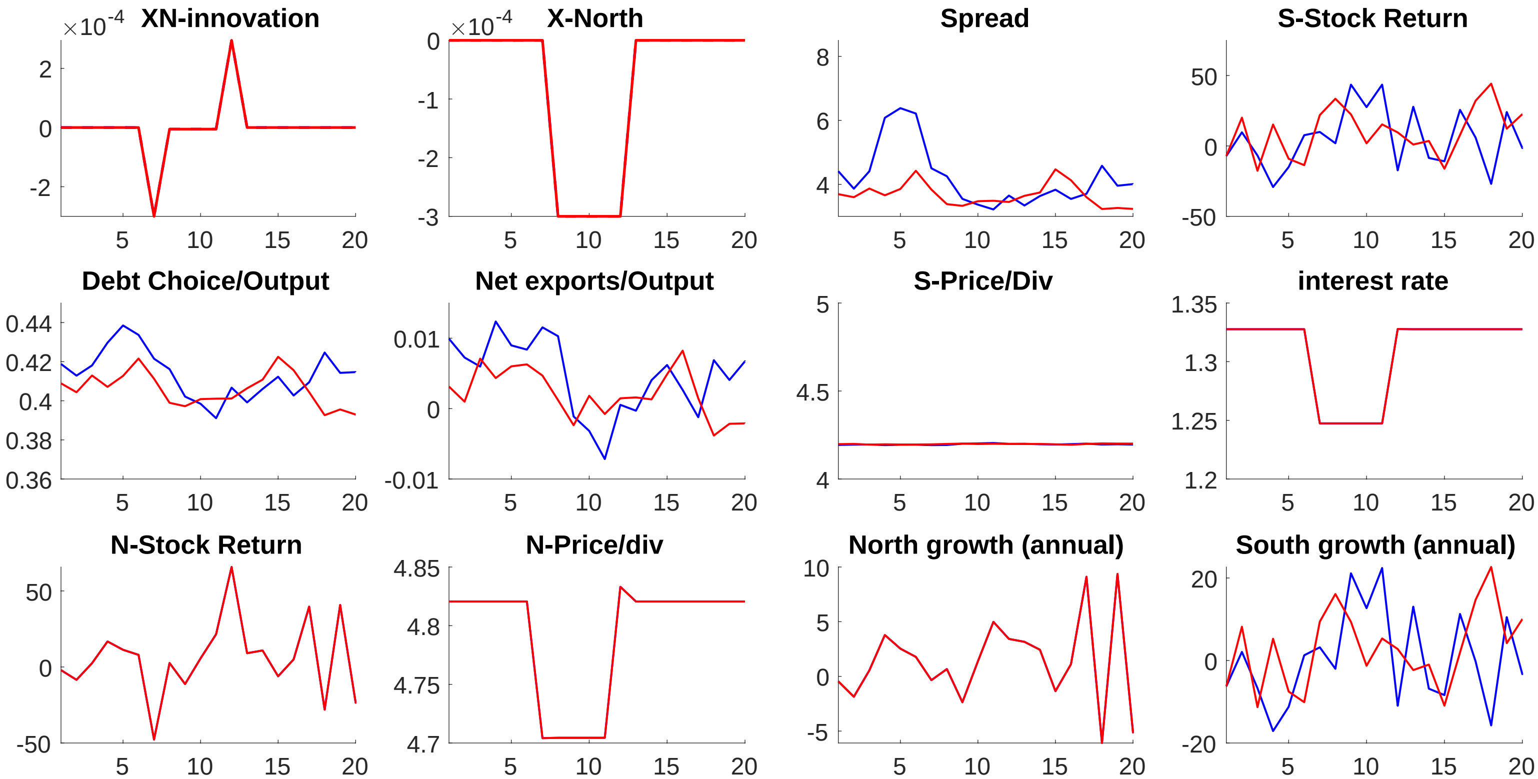
Notes:

Figure 3: Impulse Responses to South Long-run Risk Shock



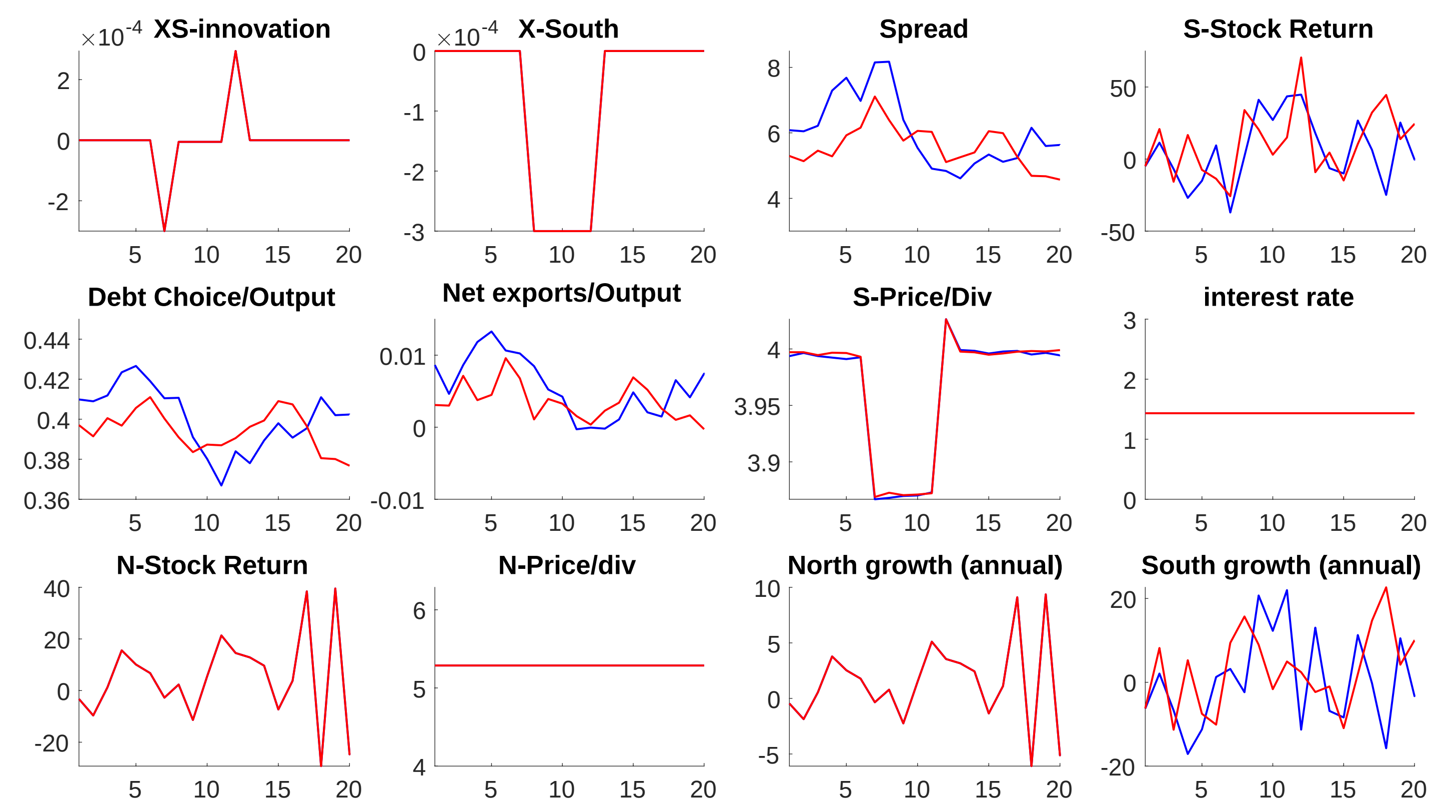
Notes:

Figure 4: Only X-North



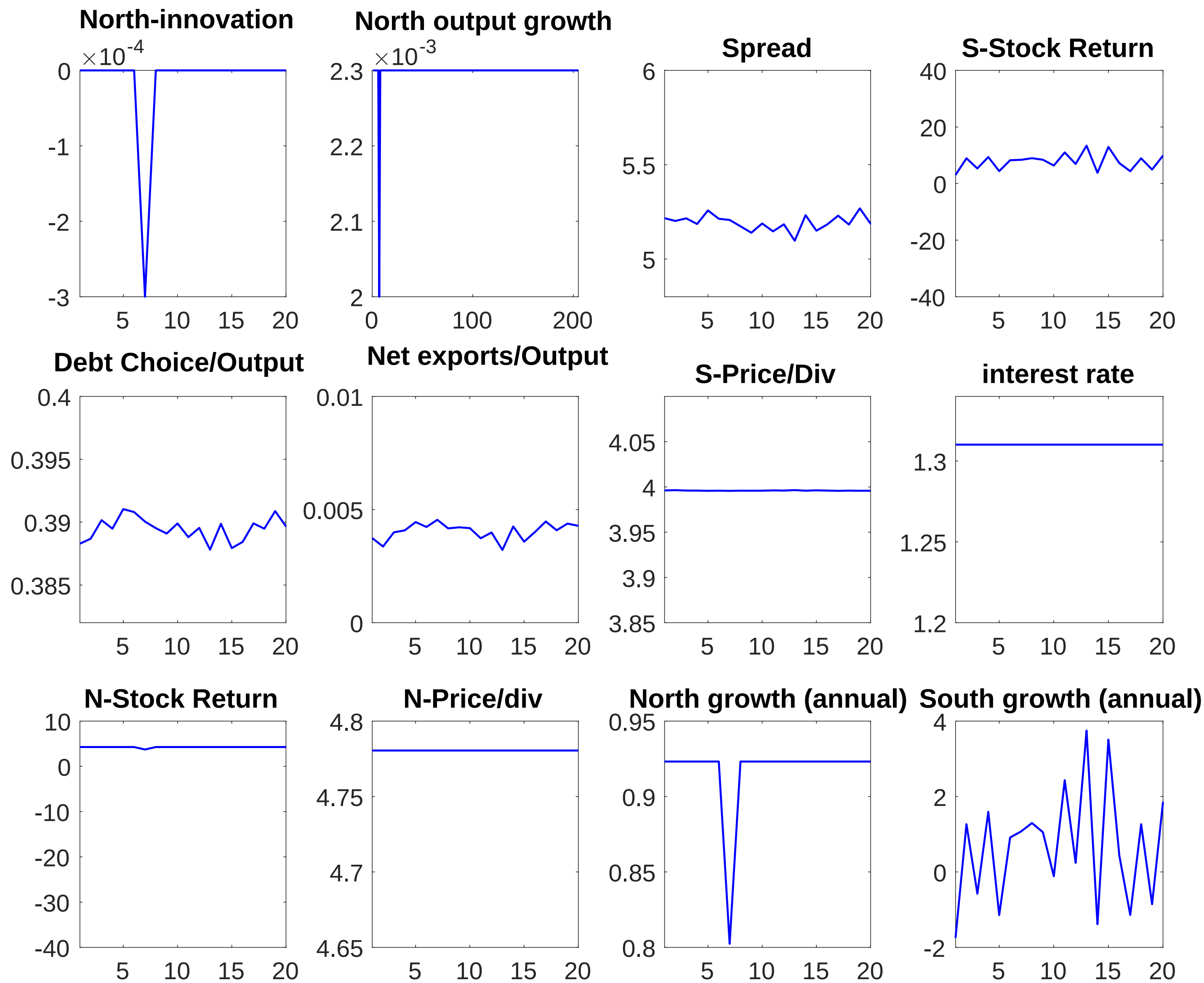
Notes:

Figure 5: Only X-South



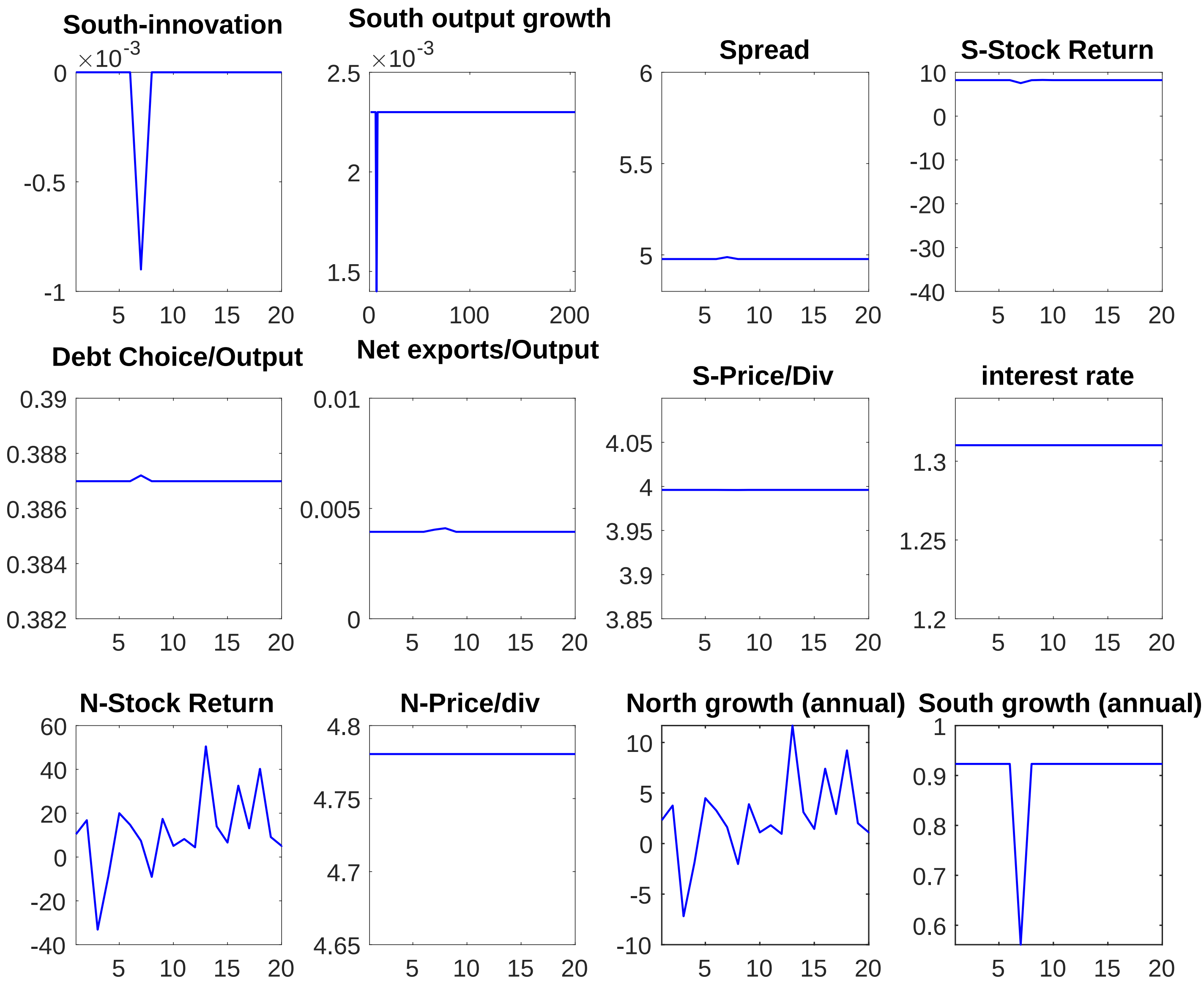
Notes:

Figure 6: Impulse Responses to North Idiosyncratic Shock



Notes:

Figure 7: Impulse Responses to South Idiosyncratic Shock



Notes: