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INTERNATIONAL AGGREGATE RISK: EFFECTS ON FINANCIAL STABILITY

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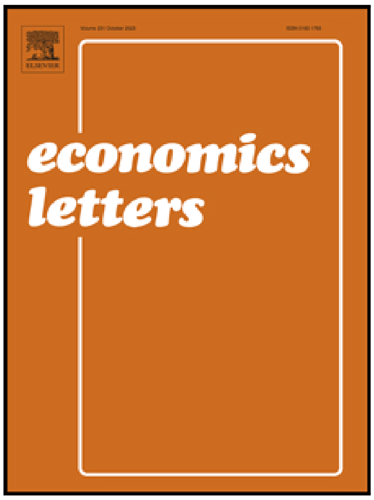

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Highlights

- Aggregate risk on a global scale can affect the stability of financial systems.
- The model considers an exogenous parameter indicating the concentration of international credit risk in both domestic and foreign banking systems.
- It shows that if multiple countries are impacted by the same shock, diversification of risk becomes impossible.
- A global economic downturn may make international lenders scarce or the real interest rate may substantially increase, leading to an economic crisis.

INTERNATIONAL AGGREGATE RISK: EFFECTS ON FINANCIAL STABILITY

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Abstract

The increasing interconnectedness of financial and economic systems has led to the emergence of global risks that can impact financial stability. In this paper, we explore how aggregate risk on a global scale can affect the stability of financial systems. We present a simple model that considers an exogenous parameter indicating the concentration of international credit risk in both domestic and foreign banking systems. When this parameter is high, the model is vulnerable to aggregate risk. Our research shows that if multiple countries are impacted by the same shock, diversification of risk becomes impossible.

In the event of a global economic downturn, international lenders may become scarce, or the real interest rate may substantially increase, perhaps leading to an economic crisis.

JEL: E44, F36, G01, G15, G21
Keywords: Aggregate Risk, Financial stability, real interest rates.

I. INTRODUCTION

Various types of risks have recently impacted the financial markets and the world economy (Clance et al, 2019, Barros et al, 2023, Ren at al, 2023, Alam et al, 2023, Boungou et al, 2023), many of which cannot be diversified.

This article abstractly examines aggregate risk. We also include literature on other risks that may impact financial risk in general for completeness. Several studies have analyzed various sources of risk, including geopolitical and investor sentiment. Deng and Li (2024) show that local economic policy could affect the international banking system. Caldara and Iacoviello (2022) have examined the geopolitical risk (GPR) index spikes and have combined the aggregate measures with industry- and firm-level indicators of geopolitical risk. Their research shows that investment drops more in industries that are exposed to aggregate geopolitical risk. The Global Financial Stability Report (IMF, April 2023) documents an increase in macro-financial stability due to rising geopolitical tensions among major economies that have intensified concerns about global economic and financial fragmentation. Gramlich et al. (2023) explore the impact of natural disasters, which is theoretically aggregate risk, and suggest measures for banking regulators to mitigate these risks. As a result, financial fragmentation reduces diversification opportunities of portfolios. The benefits of international diversification are well-known, as demonstrated in previous works by Levy and Sarnat (1970), Driessen and Laeven (2007), Bai and Green (2010), and many others. In fact, one of the defining characteristics of modern financial markets is their worldwide interconnection.

Gaies et al. (2022) have studied the potential link between investor sentiment and instability in the global financial system from a macro-financial standpoint (Harrison et al, 2024). Phan (2022) has provided a direct link in a sample of 540 US banks covering the period from 1999 to 2019 where an increase in geopolitical risk is associated with a decline in bank stability. An interesting aspect analyzed by Cecchetti (2015) is how the regulatory system can exacerbate (in)stabilities. He warns against engaging in time-varying discretionary regulatory policies.

We build a simple model can help you understand the events that have occurred in the past few decades, which have witnessed a rise in overall risk levels.

When there is an increase in concentration in credit risk in both foreign and domestic banking systems then multiple countries are affected by the same shock, and the risk cannot be diversified. If all countries experience an economic downturn, there will be no lenders in the international market, or if there is any equilibrium, the real interest rate will be significantly high.

The paper is organized as follows. Section II present the model. Section III derives the equilibria that are discussed at section IV. The conclusion in section V suggests the presence of non-diversifiable risk, which could have a significant impact on international financial stability.

II. THE MODEL

There are three periods, $t = 0{,}1{,}2$, and two countries: domestic, c , and foreign, f, where we denote $i = f, c$ and when it is not confusing, the equations eliminate the notation i for simplicity of exposition.

Foreign risky asset, R^f and a domestic risky asset, R^c yield a random return at date 2 per unit invested at date 0. They can assume two values, $R^i = R^{Hi}$, and $R^i = R^{Li}$, where $i = f, c$, with the probabilities specified below. If a portion of the investment in these assets is liquidated at $t = 1$, it yields a certain return of λ^i per unit invested. The fraction of the assets that is liquidated is denoted α. It is assumed that $R^{Hi} > R^{Li} > \lambda^i \geq 0$.

The international banking sector is composed of a continuum of banks that invest consumer's endowments at date 0. The banking sector is perfectly competitive, so that banks' objective is to maximize social welfare.

Each country is exposed to credit risk shocks and to Y^i production shock causing current liquidity problems. When the economy is in downturn the production is lower than the optimal level, denoted $\bar{Y}$. When the economy is in upturn the production is higher that $\bar{Y}$.

Therefore, each country experiences at the intermediate period $Y^{Li} < \bar{Y}$ or $Y^{Hi} > \bar{Y}$. The realization of both shocks is observed by a bank at date 1. When production is lower than the desired amount, the state sells a fraction, denoted α^i of bonds. However, the probabilities (and hence the distribution) of these banks at date 0 depends on an exogenous parameter $\omega \in (0,1)$ that indexes the degree of *concentration of international credit risk* in the banking systems of foreign and domestic countries.

Specifically, the fraction of banks that experience a given pair of realizations of credit risks is given by the following table, with $p \in (0,1)$ and $q \in (0,1)$, where p is the joint probability of the banking system to have a high foreign return and a low domestic return, and q is the joint probability of a bank system to have a high domestic return and a high foreign return.

These probabilities, p and q , are asymmetrically dependent.

R^c / R^f	HIGH R^{Hc}	LOW R^{Lc}
HIGH R^{Hf}	$(1-\omega)q$	ωp
LOW R^{Lf}	$\omega(1-p)$	$(1-\omega)(1-q)$

Thereafter we refer to parameter ω as an index of "*international financial risk concentration*".

If $\omega = 0$, then the banking system is made of banks that *diversify* their credit, when country f has high assets return given a high economic activity, country c has a low return or an economic downturn so that there is a lender and a borrower. In contrast, if $\omega = 1$, banks *concentrate* their credit risks since all the world is facing an aggregate shock. As ω increases, the banking system exhibits a higher concentration of risks for any given values of (p, q).

III. EQUILIBRIUM

Here we examine how well an *international* market works for any level of risk concentration (i.e. any ω).

There is an international financial market where liquidity can be traded at the intermediate date. The amount of funds that each country trade in the international market is denoted b^i and the gross international real rate is denoted by r.

At date 0, competitive bank system of each country maximizes the expected utility of consumers according to the level of output that could be high or low $R^i(Y^{Hi}, Y^{Li})$. They choose the amount of borrowing $b^i, i = f, c$ (if positive, borrowing, if negative, lending) and the amount of asset to liquidate, α^i, to solve:

$$\max_{\alpha,b} \Pi_1 = \mu U(c_1) + (1-\mu)U(c_2) \quad (1)$$

Subject to

$$\mu c_1 = \alpha\lambda + b \quad (2)$$

$$(1-\mu)c_2 = R(1-\alpha) - rb \quad (3),$$

where r is he "international" real interest rate, to be determined in the $t = 1$ credit equilibrium and μ is the consumers consumption at period 1 or the aggregate liquidity needs.[1]

Assume an equilibrium exists (we will find that there may not be an international equilibrium). Substituting (3) in (2) through b,

[1] The framework is derived from by Diamond and Dybvig (1983).

$$\mu c_1 + (1-\mu)\frac{c_2}{r} = \alpha\lambda + \frac{R}{r}(1-\alpha) \qquad (4).$$

The solution α^*satisfies the constrain is binding. Hence, the solution is given by:

$$\alpha^* = 0 \text{ if } \frac{R}{r} \geq \lambda \text{ and } \alpha^* = 1 \text{ if } \frac{R}{r} < \lambda \qquad (5).$$

Equation (5) states that if the long asset value at period 1 is lower that λ, it is always optimal to liquidate it.

A necessary condition for the existence of an international financial market equilibrium that provides macro-finance stability is:

Proposition 1. *The international equilibrium exists when the real interest rate falls within a given set of assets return parameters.*

$$r \in \left(\frac{R^L(Y^{Li})}{\lambda}, \frac{R^H(Y^{Hi})}{\lambda}\right) \text{ for each country } i = f, c \qquad (6).$$

This is because if $r \leq \frac{R}{\lambda}$ by (4) banks in country f or c will not liquidate the investment in the risky technology, and by (2) they will wish to finance all date 1 consumption by borrowing. Thus, there would be no country lenders, hence no international equilibrium. Likewise, if $r > \frac{R}{\lambda}$, by (5) all countries will liquidate the investment in the risky technology, and by (3) they will wish to finance all date 2 consumption by the repayments on lending at date 2. But at date 1 there would be no borrowers, hence no international finance equilibrium.

Using (2), (3) and (5) in (1), country's i bank (R, μ) solves:

$$\max_b \Pi_1 = \mu U\left(\frac{\alpha^*\lambda + b}{\mu}\right) + (1-\mu)U\left(\frac{R(1-\alpha^*) - rb}{1-\mu}\right) \qquad (1a),$$

the first order condition with respect to b is

$$U'\left(\frac{\alpha^*\lambda + b}{\mu}\right) = rU'\left(\frac{R(1-\alpha^*) - rb}{1-\mu}\right) \qquad (7).$$

Thus, the solution of each country bank problem is given by (5) and (7). Note that banks' optimal choice is the decision to liquidate, $\alpha^*(R)$, which does not depend on μ, and $b(R,\mu)$. The liquidation decision in response to the credit risk realization does not depend on the single country liquidity shock (in (5) nothing depends on μ), but the borrowing decision depends on both shocks (by (7)). In today's integrated financial markets, stability relies on the exogenous indicator ω of "*international financial risk concentration*". This is because financial crises tend to spread from one country to another when there is no effective distribution of liquidity shocks. Such situations arise when there is *global aggregate risk*.

We characterize equilibria for log utility preferences, $U(c) = \ln(c)$. The computation of the utility function allows to find the welfare implications.

Equation (7) yields:

$$\frac{\mu}{\alpha^*\lambda + b} = \frac{r(1-\mu)}{R(1-\alpha^*) - rb} \qquad (8).$$

Solving (8)

$$b(R,\mu) = \frac{1}{r}(\mu R(1-\alpha^*) - r(1-\mu)\alpha^*\lambda) \qquad (9).$$

Since $r \in \left(\frac{R^l}{\lambda}, \frac{R^h}{\lambda}\right)$, by (5), optimal asset's liquidation is $\alpha^*(R^l) = 1$ and $\alpha^*(R^h) = 1$.

Following there are two international borrowing/lending positions:

$$b(R^l,\mu) = -(1-\mu)\lambda \qquad (9a)$$

$$b(R^h,\mu) = \frac{1}{r}(\mu R^h) \qquad (9b)$$

and international financial equilibrium requires:

$$\omega p \frac{1}{r}\mu R^h + (1-\omega) q \frac{1}{r}\mu R^h = (1-\omega)(1-q)(1-\mu)\lambda + \omega(1-\mu)\lambda \quad (10).$$

The above equation (10) is linear with respect to r and has the unique solution:

$$r^* = \frac{R^h\mu(\omega p + (1-\omega)q)}{\lambda(1-\mu)(\omega(1-p) + (1-\omega)(1-q))} \qquad (11).$$

The solution international interest rate in (11) raises as the liquidity needs and the opportunity cost of holding the asset, R^h, increase.

Proposition 2. *The international real interest rate increases when the opportunity cost of holding risky assets goes up.*

IV. COMPARISONS OF EQUILIBRIA

This section identifies conditions ensuring existence of equilibria for the extreme values of ω, and analyses the set of parameters for which equilibria exists for such values.

Using (11) and $r^* \in \left(\frac{R^L(Y^{Li})}{\lambda}, \frac{R^H(Y^{Hi})}{\lambda}\right)$, the stability of the international financial markets belongs in the set:

$$1 \geq \frac{\mu(\omega p+(1-\omega)q)}{(1-\mu)[(1-\omega)(1-q)+\omega(1-p)]} \geq \frac{R^L(Y^{Li})}{R^H(Y^{Hi})} \qquad (12).$$

We use equation (12) to determine the existence of international equilibria, which leads to systemic financial stability. The cases are *diversification of international credit risk* ($\omega = 0$) that is absence of aggregate risk, and that of *concentration of international credit risk* ($\omega = 1$). The main result is summarized in the following proposition.

We to compare the *size* of the set of economies, indexed by the diversifiable country's risks *p* and q, for which equilibria exist for $\omega = 0$ and for $\omega = 1$.

Using the right and the left hand side of (12), the equilibrium domains for $\omega = 0$, $[v_0(\omega = 0), v_1(\omega = 0)]$, and for $\omega = 1$, $[v_0(\omega = 1), v_1(\omega = 1)]$, , are respectively

$$\left[v_0(\omega = 0) = \frac{\frac{R^L}{R^H}(1-\mu)}{\mu+\frac{R^L}{R^H}(1-\mu)}, v_1(\omega = 1) = 1-\mu\right] \qquad (13)$$

and

$$\left[v_0(\omega = 1) = \frac{\frac{R^L}{R^H}(1-\mu)}{\mu + \frac{R^L}{R^H}(1-\mu)}, v_1(\omega = 1) = \frac{1-\mu}{1-2\mu}\right] \quad (14).$$

The larger is the interval for which equilibria exists under diversification or concentration, the larger is the set of economies that may benefit from the risk sharing opportunities offered by the market.

Consider the difference between the equilibria interval (13 and (14). Suppose that there is not liquidity need at period 1, the two set are equal. The problem arises when there is a need for constant consumption, rather than just in a specific instance. When the level of consumption reaches high values, to the extreme of $\mu = 1$, it becomes difficult to maintain financial balance and can lead to a liquidity crisis, causing financial instability as shown in equation (14).

Proposition 3. *Global financial instability is caused by high aggregate risk for any level of liquidity other than zero.*

V. CONCLUSION

Our model shows that aggregate risk concentration seems of first order importance for the smooth international financial markets functioning. This work has shown that an increasing aggregate risk undermines global financial stability, making portfolio diversification more challenging.

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