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Dispersion in macroeconomic volatility between the core and periphery of the international trade network

Anindya S. Chakrabarti[1]

Economics Area, Indian Institute of Management, Ahmedabad, Vastrapur 380015, India

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ABSTRACT

At the country level, macroeconomic volatility tends to correlate with trade openness although the direction of correlation is not stable across samples. Higher openness allows for greater diversification opportunities, but provides lesser immunity from outside shocks. Here I consider trade network as a composite of all pairwise trade linkages to emphasize that different linkages contribute differently to the transmission or mitigation of shocks, and show that volatility is inversely related to centrality, a summary measure of strength of the linkages specific to a country. I study a dynamic multi-country, multi-sector model subject to idiosyncratic liquidity shocks, and characterize volatility as an explicit function of centrality, diversification and the Herfindahl of the trade network in equilibrium. With sufficient skewness in the trade linkages across countries, similar shocks generate substantially different levels of repercussions across the network. The conventional effect of diversification holds true that countries with better diversified trade portfolio fluctuate less. Centrality directly contributes to higher resilience to exogenous shocks, thus reducing volatility. Combined effect of these two mechanisms dominates the opposite effect that a more central country is also more exposed to shocks, which increases volatility. The model calibrated to the EU generates and closely replicates the negative relationship between centrality and volatility. The theoretical model is then extended to capture preference shocks and sparseness of the trade networks.

1. Introduction

How does the number and identity of trading partners affect a country's macroeconomic volatility? In this paper, I argue that the architecture of the trade network embedding the countries, is an important factor determining country-level fluctuations. Volatility is a net outcome of two effects: how a country dissipates idiosyncratic shocks to its neighbors in the network, and how the spill-over effects of shocks emanating from neighbors propagated through the network affect the domestic economy. I show that the dispersion in trade linkages in the network contributes to the dispersion of cross-country volatility, where countries in the core of the trade network shows lesser volatility than those in the periphery.

Structurally, this paper is related to the literature on volatility of granular economic entities. Whereas the literature has typically considered the effect of linkages across granular entities on aggregate volatility, this paper considers the effect of

E-mail address: anindyac@iima.ac.in

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linkages on volatility of individual granular entities. For example, Acemoglu et al. (2012) argued in the context of an input-output model that in an economy comprising many sectors with sufficient dispersion in intersectoral linkages, idiosyncratic shocks of different sectors explain a substantial portion of aggregate volatility. Thus in a sufficiently granular economy, the 'diversification' argument fails for the aggregate volatility in the sense that idiosyncratic shocks do not cancel each other. An immediate precursor of this idea can be found in the 'granular hypothesis' forwarded by Gabaix (2011) who showed that in an economy comprising firms with sufficient dispersion in size, idiosyncratic shocks do have a sizeable effect on aggregate volatility. On the other hand, Kelly et al. (2013) considered the effects of linkages on volatility. They showed that in an economy with granular firms, linkages between firms and customers drive the firm-size distribution which in turn affects the firm-level volatility.

The present approach is complementary to the above literature and explains economy-level volatility through demand shock spill-overs via trade linkages. The idea that the mode of economic integration is better understood though the network structure of trade rather than the aggregate volume, has already been proposed by Kali and Reyes (2007). Schiavo et al. (2010) analyzed the mapping between international trade network and the international financial network and argued that the spread of financial distress depends on the topology of the corresponding networks[2] An interesting analogy is provided by Hübler (2016) who showed that the complexity of the trade network and its related dynamics can be related to the electric networks. Lee et al. (2011) analyzed a simple model of crisis spreading on the global macroeconomic network. Here we take a theoretical approach to tackle the problem of shock propagation through a trade network from a macroeconomic point of view by explicitly modeling the network topology in terms of trade flows across countries, each having a standard new-Keynesian dynamical structure. This allows us to solve the model explicitly and simulate the model to study the dynamics of shock propagation across the network. Finally, I conduct moment comparison between the model and the data. I show that the data indeed exhibits an inverse relationship between macroeconomic volatilities of countries and the network centrality, as generated by the model.

In the model, I consider a set of islands endowed with differentiated tradable goods which are traded competitively, and the islands produce non-tradable goods. They also hold a non-consumable liquid asset, the supply of which is fixed from outside. For simplicity, let us call it money. As an example, imagine that island A gets an endowment of apples, island B gets an endowment of bananas and the endowment processes are *i.i.d.* across islands. Each island is inhabited by unit mass of households who supplies labor and capital to produce housing service which is non-tradable. The preferences of households are defined over a bundle of tradables and the non-tradable goods. Thus tradables are differentiated according to their origin (Armington, 1969). Finally, the households are liquidity constrained, the total amount of liquidity being the amount of liquid asset the households have and the revenue generated from selling their products (Apples and Bananas) in the international market. Suppose both islands are in equilibrium. Now, if island A receives a positive liquidity shock, then the households' liquidity constraint will be relaxed and the demand for consumption of both domestic and foreign goods will increase in A. While importing tradables from B, there will be net liquidity flow from A to B to settle the trade deficit. This relaxes the liquidity constraint for island B increasing domestic demand. In presence of nominal frictions in prices of non-tradables i.e. housing, there will be real effects in both A and B. The assumption of competitive trading mechanism and sticky prices (Calvo, 1983) in non-tradables highlight the difference in market power of sellers in the international market vis-a-vis the domestic market. Similarly, the assumption of endowment of tradables and endogenous production of non-tradables emphasize the differential role of domestic demand for consumption of domestic goods (Lane, 1999).

I extend this basic framework in several steps. First, the whole setting is made dynamic along with capital formation in the domestic economy allowing the usual consumption-smoothing mechanism to work. Second, the model incorporates $N \geq 2$ islands allowing us to consider the effects of the whole network. Third, the model generates a network based on the demand-side parameters. This is a big difference from the existing literature, which typically considers a supply-side input-output network (see e.g. Acemoglu et al. (2012); Carvalho (2014)). In the general framework, the volatility of macro variable v of the i-th country can be expressed as a function of the centrality a_i^*, volatility of exogenous shock σ_a, network size N, variance of the export portfolio $\sigma_{\mathcal{T}_i}^2$, share in the total supply s_i and the network concentration index (Herfindahl) H:

$$\sigma_{v_i} = f\left(\sqrt{N}\left(\frac{\sigma_a}{a_i^*}\right)\sqrt{\sigma_{\mathcal{T}_i}^2 + s_i.H}\right). \tag{1}$$

The model endogenously generates an inverse relationship between centrality[3] of countries in a trade network and their corresponding income volatility. This result hinges on a mechanism that the more central islands accumulate a larger stock of assets. Intuitively, a large fraction of fiscal stimulus in Greece will eventually end up in Germany as the latter is more central than the former (we are of course, ignoring other considerations like debt obligations here). To see why this is the case, let us assume that all countries are maintaining zero trade surplus and there is a non-degenerate distribution of liquidity across countries. An exogenous stimulus creates an increase in demand for the receiving country. When trading with its neighbors, part of the stimulus is redistributed, which in turn boosts demand in those countries. Then shock will spread from these countries to their neighbors in the next round of trading and so on. Eventually more central countries, by virtue of being important suppliers to other countries, will receive the biggest share of the pie. Thus due to trade, countries

[2] See Fagiolo (2017) for a review of the complex network study of international trade network from an empirical and theoretical point of view.

[3] To be defined formally in Section 2. Centrality is a measure of connectedness of nodes within a network.