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Diversified firms on dynamical supply chain cope with financial crisis better



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ABSTRACT

To investigate whether diversification within a supply chain can help middlemen firms survive prolonged financial crises, we simulated an extension of the dynamical supply chain network model by Mizgier et al. (2012) under normal and crisis economic conditions. In these simulations, firms in the middle of the supply chain are allowed to (i) forward vertically integrate by buying over one of its customers, (ii) backward vertically integrate by buying over one of its suppliers, or (iii) horizontally merge with a competitor to pool capital and resources. We extracted from these simulations the lifetime distributions of undiversified firms, and of firms adopting the three diversification strategies described above. We then compare the average lifetimes and the rates at which the midsections and tails of the cumulative lifetime distributions decay for these four types of firms. Based on these comparisons, we found that forward vertical integration most effectively extends the lifetimes of middlemen firms during a financial crisis, but also makes them less resilient to sudden economic downturns. In contrast, backward vertically integrated firms most successfully weather such downturns.

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1. Introduction

In the recent global financial crisis, many big firms with long histories went bankrupt through exposure to toxic CDO assets. These included Bear Stearns, JP Morgan, Fannie Mae, Freddy Mac, Lehman Brothers. Others, like General Motors and Chevrolet, went the way of dinosaurs from the ensuing slowdown. While news of these giants going under occupied our consciousness, the demise of many more smaller firms went largely unreported.

According to the American Bankruptcy Institute (2010), the number of business bankruptcy filings in the US in 2009 reached 16 014 new bankruptcy filings in the second quarter, the highest since 1994. In total, bankruptcy filings increased from 43 546 in 2008 to 60 837 in 2009. Along with the increased rate of bankruptcies, the US Bureau of Labor Statistics (2010) reported that the annual unemployment rate greatly increased from 5.8% in 2008 to 9.3% in 2009 with no change for the better in 2010 (9.6%).

This loss of employment due to firms folding adds stress to society. If the number of bankruptcies can be minimized, either through government support during the crisis, or through better

management practices, it might be possible to reduce the number of job losses. Surely this would be a desirable economic and social outcome.

To achieve this goal, we must first understand that firms are not islands, but are interconnected players within ever changing supply chains regularly stressed by economic downturns (Reinhart and Rogoff, 2008). Da Cruz and Lind (2012) showed that in a network of interconnected banks (suppliers of liquidity), failure of a single bank spreads through its neighbors and leads to financial instability of the entire system. Contrary to the beliefs of regulators, the authors showed that increasing capital requirement does not necessarily lead to higher stability of a realistic financial system. In fact, a lot of research has been done on understanding complex dynamics of such networks, including those of supply chains (see Section 2.1). Within this body of work, a significant amount of effort has also been put into predicting financial crisis and detecting bubbles (Johansen and Sornette, 2001; Sornette and Anderson, 2002; Johansen, 2004). In this paper, we put one (supply chain network dynamics) and one (financial crisis) together, and ask if we can get three (means for firms on a supply chain to alleviate the impact of economic downturn).

The best way to discover supply chain management practices that would help firms weather financial crises would be to mine historical data on their long-term viability. For example, we can

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look into a complete registry of firms within a given industry, to see when they were registered and deregistered. From firms living through one or more financial crises, we then identify the anomalously long-lived ones to do careful case studies.

In particular, we suspect that some of the long-lived firms might have benefitted from diversification. To identify diversified firms, we would need data on their proprietors or boards of directors, because diversified firms frequently share the same proprietors or directors, or have these coming from the same extended families. Unfortunately, data down to these levels of details are hard to acquire, because they are captured by different agencies, and can in some countries be considered too sensitive to be released for academic research. Depending on the country, the proportion of diversified firms may also be small, making assurance of statistical significance difficult to achieve.

In the absence of real data, we settled for synthetic data generated by computer simulations, where there are no issues of data sensitivity or identification of diversified firms. We can also run large numbers of simulations to ensure that our conclusions are statistically significant. However, for simulated outcomes to be plausible, the model used must be sufficiently realistic. This is why we choose to work with the dynamical supply chain model of Mizgier et al. (2012), which is an adaptation of the dynamical supply chain model of Weisbuch and Battiston (2007).

At equilibrium, the Mizgier, Wagner and Hołyst (MWH) model has few large bottom level suppliers and few large top level customers, but many small and medium sized firms in the middle of the supply chain. This proliferation of middlemen has been observed in many supply chains, in particular by Popp (2000) in the apparels industry. From an ecological perspective, middlemen firms evolve naturally during good times in a sophisticated economy, filling the niche of specialized firms producing a small number of products highly efficiently. However, because of their specialization, these middlemen firms are also most susceptible to sudden changes in the economic climate and conditions.

In this paper, we will provide a short overview of the agent-based supply chain modeling literature in Section 2. In Section 3, we will describe how we extend the MWH model by allowing middlemen firms to diversify, either by (i) buying over one of their suppliers, or (ii) buying over one of their customers, or (iii) merging with a competitor. We then report our findings in Section 4, and discuss their implications in Section 5. Finally, we conclude in Section 6.

2. Literature

2.1. Supply chain modeling

A supply chain is a network organized according to production relationships. By buying goods from and selling goods to each other, firms bring products or services from raw material-supplier to end-customers (Committee on Supply Chain Integration, 2000). In today's competitive and ever changing markets, effective management of the supply chain is essential for minimizing inventory and logistic costs (Julka et al., 2002a,b).

Beside using stochastic processes, discrete events, linear and nonlinear programming and game theory (Ambrosino and Scutella, 2005; Wang et al., 2014; Larsen and Thorstenson, 2014; Feng et al., 2014; Chen and Grewal, 2013), there are empirical studies on identifying key variables of successful supply chain strategies (Roh et al., 2014). Also agent-based modeling (ABM) found its way into supporting and analyzing business decisions in recent years (Swaminathan et al., 1998; Julka et al., 2002a,b; Chatfield et al., 2009).

In the growing literature on supply chain modeling and simulations, we also find papers dealing with uncertainties (Yu and Li, 2000; Santoso et al., 2005) and dynamic changes (Ahn and Lee, 2004; Akanle and Zhang, 2008; Anosike and Zhang, 2009; Almeder et al., 2009).

Our study is based on the recent paper by Mizgier et al. (2012). Incorporating supply chain features defined by Melo and Nickel (2009), Mizgier, Wagner and Hołyst worked with a multi-stage supply chain network with single commodity and multi-period observations. Their model is an extension of the static supply chain network model of Weisbuch and Battiston (2007), whereby the network structure is allowed to continuously evolve under economically realistic rules. They are interested in how stochastic fluctuations in local processes can impact the global economic behavior of the supply chain, and observed that collective bankruptcies lead to emergent network structures.

2.2. Merger and acquisitions

The exact term for merger is merger by horizontal integration or horizontal merger. We speak of horizontal integration if a firm is taken over by, or merged with a competitor at the same level of the supply chain (Hill and Jones, 2009).

The usual corporate motives for merger and acquisitions are two-fold. The first, economic motivation is to improve internal efficiencies through the economy of scale. The second, strategic motivation is to enhance external relations by product growth or geographical expansion. Through mergers, competing firms pool their capitals and market shares, to leap frog over leading competitors (Chapman, 2002; Bodolica and Spraggon, 2009; DeYoung et al., 2009).

The diversification we model in this paper is more commonly referred to as vertical integration. Vertical integration means the expansion of the production program to products of the previous, next, both or all levels of the supply chain. The expansion of products to the next level is called forward vertical integration. A firm can achieve this by setting up the capabilities to make products at the next level, or by buying over its own customers. In contrast, backward vertical integration means that production capabilities are extended to the previous level.

In spite of the successes of many of the world's largest and highly diversified conglomerates, which include IBM, Hewlett-Packard, General Electric, Wesfarmers, Bidvest, or ITC Limited and Mitsubishi, management experts now consider diversification 'old-fashioned' and 'no-go'. Instead, they champion outsourcing peripheral functions, so that modern firms can focus on their core businesses (Hill and Jones, 2009). Why is diversification perceived as poor management practice in the modern business world? One reason might be the lack of positive evidences that diversification improves profits, growth, and market shares, which are what managers are interested in Mueller (2003). Another reason might be the need for a diversifying firm to acquire foreign managerial and technical practices, which may impede the business from being run efficiently (Stahl and Voigt, 2005).

3. Model

3.1. The model scheme

In the MWH model (Fig. 1) we assume five stages in the network from stage 0 (the consumers) to stage 4 (the raw material suppliers). We further assume that there are 50 firms in each stage, so that there are a total of $N=250$ firms. A firm in stage s and a firm in stage $s+1$ are connected by a link, if the former places orders to, and receives goods from the latter. So, a firm in

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