Introduction and Literature

Capital theory is a vast topic in finance and there still seems to be the argument as to what capital means and what it should truly mean. Neoclassicals define capital as a physical quantity that is independent of prices (Robinson, 1970). Historically, the definition of capital has been often shifting from either financial or physical. It started as being financial, in that it meant the sum of all money equivalent of all assets minus the sum of the money equivalent of all liabilities at a particular date to the conduct of the operations of a specific business unit (Lewin and Cachanosky, 2019). After a while economists argued that capital could not be defined as being financial only, and that birthed the physical aspect of capital referred to as physical capital. This connotes the set of physical production goods (often referred to as capital goods). In recent times, capital theorists began to take a look at how time could have an effect on capital as a whole, thus, illustrating capital in terms of having three different but inseparable dimensions: value, quantity and time. What this means is that capital can be viewed as financial, physical and yet involving time in a particular business process. Various disciplines have various definitions for capital, for example, Bourdieu’s capital theory recognizes that capital does not necessarily need to be economic but also includes other factors such as social and cultural capital (Bourdieu, 1986). Lewin and Cachanosky (2019) indicate that capital can be understood as the money value of a firm which accounts for all assets and liabilities. Stating that “*productive activities employ stocks of durable and nondurable productive resources over time to produce a flow of valuable products or services for use or for sale*”. The value of capital is based on the production process over time and the value of its finished goods or services. Interestingly, developed nations in recent years are beginning to experience a rise in the importance of intangible capital (such as information technology) in production and a decline in the reliance on physical capital (Caggese and Perez-Orive, 2022).

Interest rates as well as foreign exchange rates play a vital role in transmitting distortions to the capital structure of economies. Low interest rates do not accommodate for intangible investments due to the nature of intangible capital financing eventually resulting in consequences for aggregate capital misallocation. (McKinnon, 2010; Cachanosky, 2014; Caggese and Perez-Orive, 2022)

According to Caggese and Perez-Orive (2022), the reaction of tangible and intangible firms to interest rate changes differ, in that increases in interest rates negatively affects investment of tangible firms. This is expected as conventional theories would rightly predict. However, the investment of intangible firms reacts positively to increases in interest rates.

Capital structure

To explain the combination of security and financial sources used by a corporation, various hypotheses have surfaced. Following the foundational paper by Modigliani and Miller (1958), which raised the problem of the relationship between a firm's choice of finance and its value, the financing choice of firms is, in fact, possibly the most investigated topic area in finance in recent decades. Although there isn't a single, widely recognized explanation describing why companies choose between debt and equity, various theories have surfaced in the previous few decades. These theories have considered macroeconomic variables as well as firm level characteristics in particular.

Modigliani and Miller (1963) suggest that firms may prefer debt over equity due to tax advantages, potentially leading to high debt levels for profitable firms. However, Miller (1977) and others note the impact of personal taxation, and DeAngelo and Masulis (1980) argue that firms with other tax shields may not prioritize interest tax shields.

Myers and Majluf (1984) propose the pecking-order theory, suggesting that firms, due to information asymmetry, prefer internal funding over external sources. Thus, profitable firms may use retained earnings for investments rather than debt. Rajan and Zingales (1995) find support for this theory, showing a negative correlation between leverage and profitability.

Rajan and Zingales (1995), following Bradley et al. (1984) and Titman and Wessels (1988), find a positive relationship between tangibility (ratio of fixed to total assets) and leverage. They suggest that firms with more collateral may find it easier to secure debt, aligning with the ideas of Scott (1977), Williamson (1988), and Harris and Raviv (1990) on reducing agency problems.

Demand Shocks

Demand shocks are typically caused by changes in consumer preferences, economic policies, or external factors such as changes in the global economy (Kilian, 2008). The most common example of a demand shock is a sudden change in consumer demand for a product or service (Kilian and Hicks, 2013; Leduc and Lui, 2016). This can lead to a decrease or increase in the level of production of the product, depending on whether the demand shock is positive or negative (Ball et al., 1995; Berument et al., 2010; Kiss et al., 2023). According to the conventional theory of growth and fluctuations, aggregate demand results in temporary deviations from a production trend that is solely influenced by supply forces (capital accumulation, labor force growth and technological progress). After a shock, the economy returns to its typical output path: In the words of the empirical research on growth and economic fluctuations, GDP is "trend steady". In the literature on real business cycles, deviations from trend can be long-lasting, but this is typically read as indicating that supply-side variables, such as technological shocks, dominate fluctuations in the economy (Kilian and Park, 2009). The topic of whether aggregate demand shocks have long-lasting, irreversible consequences on output and living standards thus appears to be answered negatively by orthodox economic theory, with few exceptions (Bachmann, et al., 2013; Dutt and Ros, 2003; Dutt and Ros, 2007). Economic growth may be permanently impacted by aggregate demand. As a result of rising returns, hysteresis impacts in labor markets, and balance of payments limitations, it is demonstrated that even if the economy converges to some "normal" route, this course could still be changed by significant demand shocks. It is also demonstrated that the economy might not follow its "normal" trend, in which case fiscal and monetary policy will affect output and growth over the long run (Dutt and Ros, 2007; Kilian, 2009)

Supply shocks

Changes in the availability or price of a crucial input in the production process are frequently what trigger supply shocks (Reifschneider et al., 2015). They are unexpected events that cause a sudden change in the availability of a key input or resource in the production process, leading to changes in the overall cost structure of firms (Ecstein and Sinai, 1986). These shocks can have a significant impact on the economy, with implications for production, employment, and inflation.

Raw material, energy, or labor price increases are the most typical types of supply shocks (Blinder et al., 2013; Bruno and Sachs, 1982). When businesses are unable to generate as much output as before, a sudden increase in the price of an input might result in a drop in the supply of the product being produced (Eckstein and Sinai, 1986; Fisher et al., 1994).

The relationship between supply shocks and pricing in the production structure has been the subject of numerous researches. For instance, a study by Blanchard and Fischer (1989) contends that positive supply shocks can boost a firm's production capacity, resulting in higher output and reduced inflation. These shocks include drops in the price of oil or advances in technology. On the other hand, negative supply shocks, such as abrupt rise in oil costs or a natural disaster, can cause output to fall and prices to rise. The impact of shocks in supply-side policies, such as tax incentives and deregulation, on productivity and efficiency can have long-term effects on production structure by influencing investment decisions, technology adoption, and competition (Jorgenson, 1991).

Models of Demand and Supply shocks on production structure

One of the most prominent theories on the impact of supply and demand shocks on production structure is the Input-Output (IO) framework (Gilmartin et al., 2008; West, 1995), which is based on the idea that different sectors of the economy are interconnected through their use of intermediate inputs. The IO framework can be used to analyze the impact of supply and demand shocks on the production structure by tracing the flow of inputs and outputs through different sectors of the economy (Li et al., 2018). IO model was used to study the impact of Chinese import competition on US manufacturing and the study found that Chinese imports led to a decline in demand for US-manufactured goods, which in turn led to a decline in the number of firms and workers in the sector (Acemoglu et al., 2016; Autor et al., 2013).

Another approach to studying the impact of supply and demand shocks on the production structure is through the use of computable general equilibrium (CGE) models. These models are used to analyze the impact of changes in supply and demand on the economy as a whole, by considering the interactions between different sectors and households (Blake et al., 2001; Diao and Thurlow, 2012; Doroodian and Boyd, 2003; Seung and Water, 2010). One study on macroeconomic and distributional consequences of energy shocks utilized this model and showed that oil supply shocks are costly and result in a decline in real GDP, higher average prices and increase balance of payment deficits (Adenikinju and Falobi, 2006).

More generally, supply and demand shocks can have significant impacts on the production structure, with the magnitude and direction of the impact depending on a range of factors, including the initial structure of the economy, the nature of the shock, and the policy response. While different models have accessed the impacts and possible directions of demand and supply shocks, there is little to no research using a directed acyclic graph to model the impact of demand and supply shocks on a production structure.

Money Supply

The importance of monetary policy measures as a means to increase firms' access to debt funding has been underlined by the recent Global Financial Crisis. In the midst of the crisis, central banks in most advanced economies have carefully examined the possibility of buying public and private debt to increase credit and money supply (Epstein1, 2007; El-Erian, 2017; Julio et al., 2020).

Corporate capital structure is likely to depend on decisions made by monetary authorities given the role of monetary policy in achieving financial stability (Ashcraft et al., 2011; Stein, 2012) and the idea that a more stable environment should support company operations. To the degree that borrowing restrictions affect business cycles and collateral values, it is widely recognized that monetary policy can impact bank lending and real activity (Lacoviello, 2005; Gilchrist and Zakrajsek, 2011; Stein, 2012).

According to Pindado et al., (2020), there exists a nonlinear relation between money growth and corporate debt stating that the relation exhibits an inverted U-shape. An increase in the money supply facilitates firms’ indebtedness because of the higher liquidity in the market (Holmstrom and Tirole, 1998; Schnabl, 2012; Dewally and Shao, 2014; Pindado et al., 2020). However, there is an optimal level beyond which additional growth of the monetary aggregate has the opposite effect. From this level onwards, further expansionary measures discourage firms from borrowing because of the risk of inflation, which would in turn lead to increases in interest rates, making debt more expensive (White, 2009; Bordo and Landon-Lane, 2013; Pindado et al., 2020). Nevertheless, the characteristics of the banking system influence the intensity of the effect of money supply on firm debt and determine the level of growth of the monetary aggregate that is necessary to maximize firms’ access to debt financing (Becker and Ivashina, 2014). If there is higher liquidity in the hands of banks, the impact of expansionary measures on debt is mitigated and the inflection point at which the relation between both factors turns from positive to negative is reached at a higher level (Eichengreen, 2004; White, 2009). By contrast, in countries where banks allocate a higher fraction of their resources to private credit, the effect of the monetary aggregate on debt is more pronounced, reducing the amount of money supply that is necessary to maximize corporate leverage (Bolton and Freixas, 2006; Kashyap et al., 2008; Crouzet, 2018).

According to Chung and Ariff (2016) and Urbanovský (2016), there is not yet a consensus in empirical research supporting Friedman's proposition that "increases in money supply should lead to liquidity surges and credit expansion." Friedman (1968) argued that a gradual increase in the money supply is essential for a healthy economy as it stimulates economic growth. Therefore, since various sector of an economy’s growth is often indicative of aggregate economic growth, it is possible that the money supply directly influences these sectors or acts as a moderator for the impact of microeconomic variables on the global market (Otambo, 2016; Egbunike and Okerekeoti, 2018). Additionally, Singh, Mehta, and Varsha (2011) suggested that including macroeconomic variables in investment decision-making could enhance investors' ability to develop profitable investment strategies thus, creating a growth in the economy.

In recent years, researchers have increasingly focused on how the external macroeconomic environment influences a firms' capital structure (Bokpin, 2009; Kumar et al., 2017; Dong, 2023). Korajczyk and Levy (2003) investigated this relationship and discovered that firms without financing constraints tend to prefer equity financing during economic expansions, whereas they favor debt financing during contractions. Conversely, firms facing financing constraints exhibit the opposite pattern. This highlights the significant impact of the macroeconomy on firms' capital structure. Hackbarth et al., (2006) further emphasized the importance of capital supply shocks, whether from the credit or capital markets, in shaping firms' capital structure. Kashyap et al., (1993) observed that tight monetary policy leads to changes in firms' external financing behavior, resulting in a significant decrease in the amount of bank loans obtained by firms. The influence of macroeconomic conditions on capital structure exhibits distinct patterns: firms without financing constraints demonstrate counter-cyclical changes in their target leverage, whereas constrained firms show cyclical changes (Leary, 2009).

There is little empirical data examining the impact of money supply and demand shocks on firms’ capital structure. The majority of research considers macroeconomic factors as relatively stable external conditions influencing corporate financing decisions. These studies either aim to manage macroeconomic disturbances or seek to explain variations in capital structure from a microeconomic perspective. For instance, Dongwei and Haihua (2009) analyzed China's capital structure using macroeconomic factors and discovered an inverse relationship between China's capital structure and economic cycles. A more recent study carried out by Dong (2023) which examined the correlation between money supply and corporate capital structure through the lens of financial constraints discovered that there is a significant and positive relationship between money supply and corporate capital structure when financing constraints are not considered. Dong also found that the impact of money supply on capital structure differs among firms with varying degrees of financing constraints, with firms facing higher financial constraints experiencing a significantly stronger effect compared to those with lower constraints. However, there still remains a gap in the literature regarding the effects of a demand and/or supply shock of money supply to the capital structure of a firm.

Research Hypothesis

Data and Methodology

Data

This research consists of a panel time series data ranging from 2001 to 2020 for counties in the US. The sample data comes from the Bureau of Economic Analysis database while the money supply data is sourced from the center for financial stability database. In order to satisfy the requirements of panel data analysis, counties with incomplete data were excluded.

Methodology

According to literature, it can be observed that the capital structure of an entity is influenced by macroeconomic variables. Therefore, we first examine the correlations between the structure of an economy and money supply. We also include another macro variable (unemployment rates) to examine its impact on the shocks to money supply and whether there is a direct effect on capital structure or an indirect effect, or perhaps to effect at all. In order to test the impact of shocks to the macroeconomic variables on the economic growth of a firm, we employed the use of directed acyclic graphs (DAGs), which would give us the directions of effect and their respective correlations.

Directed acyclic graphs (DAGs) serve as visual depictions illustrating causal relationships within a set of variables, devoid of cycles. Originating from the realms of artificial intelligence and computer science, these graphical models elucidate the causal flows between and among variables (Pearl, 2000). DAGs offer a distinct method from Granger causality tests, focusing on asymmetries in causal interactions that are not based on the time sequence, unlike the Granger test which relies on such temporal asymmetries. While relatively novel in economic analysis, there is an increasing body of precedent supporting the utilization of DAGs in this field. (Examples include, Wang and Bessler, 2006; Li et al., 2013; Imbens, 2020; Miljkovic and Goetz, 2020; Barrera and Miljkovic, 2022). A simple definition of a DAG is a graphical representation of a comprising directed edges (or arrows) that connect nodes (or variables) and delineate their paths. In a DAG, nodes (variables) like A, B, and C are connected by edges, showing causal relationships. Paths in a DAG are sequences of connected nodes. Directed paths follow the arrows, while undirected paths do not. Kinship terms describe relationships along a path. For example, in a directed path from A to C, A is C's ancestor and C is A's descendant. In a path like A→B→C, A is a direct cause of B, and B is a result of A and the cause of C. Nodes on directed paths, like B in A→B→C, are intermediary variables. They lie on the causal path between the start and end nodes, in this example A and C respectively.

DAGs employ computer-programmed algorithms to visually represent causal relationships derived from observational data (Lauritzen and Richardson, 2002). Mathematically, these graphs depict conditional independence, as demonstrated by the recursive product decomposition (Miljkovic et al., 2016):

, (1)

where Pr represents the probability of variables (), the symbol П represents the product operator and is the realization of some subset of variables that have causal effect on with i = 1,2,…,n.

Pearl (2000) introduced D-separation as a method to visually represent independencies and causes. It determines if one set of variables (A) is independent of another set (B), given a third set (C), within a specific causal network. D-separation associates "dependency" with "connectedness" and "independence" with "unconnectedness" or "separation." This approach graphically represents conditional independence, allowing us to identify these relations within a directed acyclic graph. By constructing such a graph where variables () are represented as direct causes (), we can interpret the independencies indicated by the equation using D-separation (Pearl, 2000).

This research focuses on the original PC algorithm. In the original PC-algorithm, the partial correlation between two variables X and Y is computed while controlling for all other variables in the regression. This is done by regressing one error term on the other, without a constant term, across all possible combinations of the remaining variables. The highest p-value from these regressions indicates the statistical significance of the causal link between X and Y. If the partial correlation is not statistically significant, it suggests that the link between X and Y should be eliminated (Caton and Gupta, 2021).

We further explored a machine learning technique to partition the counties based on similar characteristics, and create the graphs to test the effects. We explored the kml3d clustering, which is used for clustering longitudinal data types. We identify four sectors of the economy as a proxy for the structure of these entities (counties), and they include; (1) Agriculture, forestry, fishing and hunting; (2) Mining, quarrying, and oil and gas extraction, and (3) Utilities. The description of each variable is shown in Table 1.

Table 1. Description of variables

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