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## **FINANCING INNOVATION : A SYSTEMATIC REVIEW OF LITERATURE**

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Innovation has always been an extensive and an indispensable part of human existence. The discovery of fire, wheel, electricity, to name a few, were all discoveries or inventions that have pushed forward the human civilization to its current state and promises to continue. In economics however, the centrality of innovation in the process of growth today is undeniable. However, investigation into innovation as it affected economic growth and development is not very old. It was only in 1939 when Schumpeter used the word to mean a creative and useful change that the idea of innovation became widespread. Since then it has been broadly recognized that new and radical ideas and their applications to business activity resulting in more efficient solutions and new products have drastically changed societies, both economically and socially. Abundant empirical evidence exists today suggesting that innovative economies have long surpassed their non-innovative counterparts. innovation today is the driving force behind all the major economies of the world (Andergassen et. al 2009, Bae and Yoo 2015, Mansfield 1972, Nadiri 1993, Romer 1986, Santacreu 2015, Solow 1956).

This was not always so. The classical growth theorists were pessimists in this regard. Ricardo and Malthus talked about the inevitability of stagnation, the only outcome as their ideas of the economy precluded the possibility of continuous technological progress. Schumpeter (1942), however, believed in the vast opportunities that capitalism provided, particularly the power of innovation. He coined the term ‘*creative destruction*’ describing it as “*the process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one*” . This creation he believed would come through discontinuous disturbance in the form of innovation and these innovations will boost the growth of output. In the neo-classical or Solow-Swan (1956) model, assuming fixed technology, the model predicts that the economy converges to a steady state level of capital per worker and per capita economic

growth stops. However if technology grows, then it is possible to achieve a positive growth rate. In the model “technology” is a parameter that represents innovation. An increase in technology will directly cause output per capita to rise and it will also increase the marginal product of capital. Jones (2005) extended the classic Solow growth model and the Romer (1990) model to give Ideas led growth model that places innovative ideas in technology as an important factor of production. In what he describes as “The Ideas Diagram”, he shows the inter relationship between ideas, non-rivalry of goods, increasing returns and competitive equilibrium.

### **What is Innovation?**

Innovation may be described as the process of translating an idea into a good or a service that creates value. It involves a deliberate application of information, imagination and initiative in deriving greater or different values from the available resources and includes all processes by which new ideas are generated and converted into useful products. It comprises of

- Product innovation, i.e. the introduction of a new product or a significant qualitative change in the existing product.
- Process innovation, i.e. the introduction of a new improved process for making or delivering goods and services.

The distinction is of course not always as crisp in real life. For example, a process innovation to produce a good e.g. a drug may involve the discovery of a new enzyme i.e. a product innovation. Another distinction to be made is with respect to the quantum of innovation, i.e. incremental innovation as distinct from radical innovation. Incremental innovation is a systematic process that entails gradual but continuous improvements upon the existing products or processes.

The inventive process as a continuous phenomenon began with industrial revolution in the eighteenth century and continues to this day. The process that has converted innovative ideas in technology into economic growth has been the most important economic process of the last 200 years. Its main outcome has been a continuous growth of world population coupled with a growth of per capita income.

## **Financial Markets and Innovation**

The role of financial markets when it comes to innovation has not received sufficient attention in literature. While following Schumpeter (1911) a persistent debate exists emphasizing how the services of the financial sector, namely allocating capital and risk appropriately in the economy, have an important and positive impact on the economic development of a country and its per capita income level and rate of growth, mirrored by empirical evidence from Goldsmith (1969) who concluded *“that a rough parallelism can be observed between economic and financial development if periods of several decades are considered,”* these studies did not explicitly deal with the process of innovation.

In the same vein Rajan and Zingales (1998, 2001) argued that financial development substantially facilitates economic growth by reducing the cost of external finance to financially dependent industries with financial development having twice the effect on the growth of the number of establishments in an industry as it has on the growth of their average size. The undisputed role of the financial markets and institutions in the economic growth is also strengthened by the findings of Levine (1997) and later by Beck (2001). The later found strong evidence suggesting that financial infrastructure is alone significant in determining the country's competitiveness by increasing the export shares and trade balances in industries that use external finance.

For centuries, banks alone were the pillars of the financial system. Banking had a substantial existence in Roman times, declined during the Middle Ages and revived again with Renaissance. The banking houses of Venice and Genoa are considered the precursors of modern, every day, commercial banks. Schumpeter considered banks significant in credit creation by supplying funds for investment in creative processes. His critics however undermined the role of banks. They argued that since innovations and their implementations required long term gestation and investment periods, banks loans, which are generally short term, cannot finance such investments. This was buttressed by the experience of the Hausbanks in Germany in the 19th century and the Japanese Main Bank system in Japan after World War II who caught up with the UK and USA respectively. However, the East Asian financial crises of 1997 led to some serious concerns about the functionality of banks.

Up to the early 1990's the economists credited the relatively slack performance of the U.S. economy to the market based system particularly for long-term economic growth and regarded the bank based system relatively good. The Japanese corporations were out-competing their American counterparts in every market and debt-finance was largely held responsible for it (Johnson, 1982 and Prestowitz, 1988). The Japanese like the Germans a century before seemed to be innovating continuously introducing new goods and processes while the USA before 1990 failed to be doing so.

However in the 1990s, the pendulum swung in the opposite direction as the Japanese economy stagnated while the U.S. forged ahead in this decade. The existence of an efficient equity market is largely held responsible for this (Porter, 1990). The equity market acting as a Technology/Opportunity Demonstrator enables the sale of firms(start-ups) set up by agents(innovators) to other agents(professional businessmen) hence enabling certain ventures to come into existence which otherwise would not have existed at all (Sengupta, 2002). For instance over the past 30 years or so, from semiconductors to Google to Intel to FedEx and now to Tesla, the private equity especially the venture capital industry has profoundly changed the U.S. economy. Also it contributed in generating 20% new jobs in the U.S during 1990-2002.

The radical innovative ideas of the individuals in the 19th century were financed by small groups of wealthy individuals. For example, many of the inventions that became part of the industrial revolution in U.K. were financed and/or undertaken by individual businessmen/sole proprietors and some times rich amateurs. The complexity of present day technology necessitate the involvement of teams of researchers in universities and laboratories and some times funded by the government. However the Venture Capital industry also is helping to provide the bridge between radical innovative ideas and actual production.

Venture Capital (VC) is a method of raising money via high net worth individuals who are looking for diverse investment opportunities in exchange for shares/ownership in the company that they help to bring in to existence by promoting. It is associated with firms that have high growth potential and high levels of uncertainty.

The venture capitalists select ideas depending on their growth potential, provide them with finance and management services and after initial development and commercialization transfer them to the business sector through IPO's or acquisitions.

Venture capitalism in India is an important factor with approximate \$120 billion of VC and private equity funds deployed in the country representing an average equity ownership of 40%, capturing 15% or more of the market capitalization on the National Stock Exchange (NSE). A sign of growing maturity of the industry is that some enterprises have raised as many as 8 rounds of financing (follow-on-funding) before going public (The Economic Times, 2017). Venture Capital is likely to play an important role in the Government of India, under its 'Start Up India' initiative, that strives to achieve economic growth driven by new innovations and inventions, so as to accelerate employment opportunities, especially in the areas of technology and digitization, agriculture, manufacturing, education, etc.

The literature on the role of financial markets and innovation is dispersed and not very rich. This is not so for the genesis of technological progress itself and a brief overview of the literature is outlined below. There are the models like Arrow (1962) and Solow (1957) which explicitly go into the genesis of technical progress. For Arrow, technical progress is the outcome of "Learning by doing" i.e. the result of experience gained from working with both variety and quantum of machines. For Uzawa (1965) technical progress was an endogenous variable that depended on the amount of investment in human capital. Important models that followed including Lucas (1988) and Romer (1990) all took their cue from Uzawa in this regard. Shell (1966) on the other hand made technical progress dependent on resources devoted to inventive activity.

With respect to the relationship between finance and innovation specifically, Landes (1969) describes the industrial revolution and its financial and technological propellants as a never ending story of progress. Inspired by the technological progress of the twentieth century, John Maynard Keynes (1936) predicted a future of surpluses and overproduction where Economic Problems would take a "back seat". Jacobs (1969, 1984), Landes (1969), Murphy et al (1991), Porter (1990), Romes (1986, 1994), Rosenberg and Birdzell (1986), to name a few, provide empirical and theoretical proof that innovative economies are prosperous. Similar findings prove that increased

spending on R&D by the firms is manifested in better financial performance and increased market valuation, e.g. Hall *et al* (1993), Chan *et al* (1990) and Pakes (1985). This being true, economists like Merton (1957, 1968, 1999, 1977 and 1988) support reverse causality with technological improvements resulting in reduction in transaction costs. However, when it comes to financial markets affecting innovation, Greenwood and Jovanovic (1990) report about the increase in savers' and investors' appetite for risk resulting from financial development.

With respect to risk, what makes innovation unique is the inherent risk and uncertainty associated with it that makes it extremely difficult to finance. It, being a long and expensive process, requires resources to be committed till the end and also the outcomes are uncertain and hence the returns not assured. (O'Sullivan, 2005). In the initial stages the innovator largely depends on his own savings, friends and family for the development of the idea. Larger firms rely on retained earnings while young innovator firms depend either on banks or capital markets. Banks are unlikely to fund because ideas are largely intangible assets presenting growth opportunities that cannot act as collateral.

The bank based system in Continental Europe is less capable than the market based one in US and UK according to Boot and Thakor(1997),Rajan and Zingales(2001),Carlin and Mayer(2002), Herrera and Minetti(2007). Also public funds do not provide any strategic guidance leading to any increase in absorptive capacity according to Da Rin and Penas (2007). Information asymmetry is another feature that renders financing difficult. For example, competition prevents firms from disclosing their idea to investors (Bhattacharya and Ritter, 1983). On the other hand, these problems of adverse selection and moral hazard are significantly reduced by capital markets and institutions, thereby reducing the firms' cost of outside finance (Rajan and Zingales, 2001).

Venture capital provides the "missing market" (Hall and Lerner, 2009) and are perceived better than banks in financing innovation by policymakers (European Commission, 2009). Venture investors are 'company builders' who influence innovation, professionalization and commercialization strategies equally, hence providing financial and non-financial assistance to young entrepreneurs (Da Rin and Penas, 2007). They provide equity investment and so share both the profits and losses. This makes them spend time and money on individual firms, assisting them,

which banks cannot (Amit, Brander and Zott, 1998; Kaplan and Stromberg, 2001). Earlier studies by Tybejee and Bruno (1984), Sahlman (1988, 1990) and Gorman and Sahlman (1989) plus later studies by Admati and Pfleiderer (1994), Barry (1994), Lerner (1995) and Hellman (1998), all document significant value creation by VC's.

The literature provides several reasons for this. Venture investors are good at timing conditions (Gompers et al 2007). They invest in companies at the 'right time' and then go public 'at the right moment' thus freeing their capital to re-invest in new ventures (Michelacci and Suarez, 2004). Also the certification role of venture investors (Megginson and Weiss, 1991) and their networks of relationships (Hochberg, Ljungqvist, and Lu, 2007) contributes to attract companies which already have good growth opportunities (Soreson, 2006), so that venture investors would mainly turn them into 'cash cows' (Bottazzi and Da Rin, 2002) with a successful exit.

Venture capital plays a positive role in accumulation of absorptive capacity of portfolio companies by influencing their innovation strategies, mainly 'make' and 'make and buy' R&D strategy and also a more regular R&D effort. (Cassiman and Veugelers, 2002, 2006). Kortum and Lerner (1998) also find that VC-backed firms are more likely to innovate than non VC-backed firms. A debate that closely follows is, if it is the 'innovation first' or the 'VC first'. While Hirukawa and Ueda (2008) believe it is the new technologies that increase demand for VC, Kortum and Lerner (2000) suggest the reverse order. They are supported in this by the studies conducted using firm-level data in the US (Hellman and Puri, 2000), Germany (Engel and Keilbach, 2007) and Italy (Caseli, Stefano and Perrini 2009) that show that VCs instead of fostering new innovations, invest in already innovative firms.

Regarding the strategy followed by VC's, Kaplan and Stromberg (2001b) find that VC's help overcome principal-agent contracting problem through sophisticated contracting, pre-investment screening and post-investment monitoring and advising. As against this Hellman and Puri (2000) argued that VC stimulates innovation via screening of firms than via incentives and monitoring. Engel and Keilbach (2007) also reached these conclusions. Observing German VC-backed and non VC-backed firms they found that VC's are more focused on getting existing innovations into the market and less on fostering new ones. But again Lerner et al (2008) in his study of US firms

found that instead of VC just engaging in ‘cherry-picking’, actually result in firms pursuing more influential innovations once the VC investment takes place.

The venture capital industry originated in the US with the formation of American Research and Development in 1946. A few other venture funds were also established in the following years. The flow of money into these funds hardly exceeded a few hundred million dollars annually. In 1979 the US Department of Labor clarified the Employee Retirement Income Security Act (ERISA), that allowed pension funds to invest in VC, famously called the ‘prudent man’ rule. In the next 8 years venture funds observed an increase from about \$481 million to \$5billion. Of this the pension funds contributed nearly half (Gompers and Lerner, 1999). This is often credited with the high tech revolution that characterized the US in the 1990s (Gilson, 2003). The venture capital funds are critically important and have contributed significantly in making US the pioneer of innovation and hotbed of innovative ideas (Kortum and Lerner, 1998 and Gompers and Lerner, 1999). Their studies also reveal that unlike venture firms, the established US corporations are much less successful and economically unimportant in funding innovation.

The VC industry in the Europe, on the other hand, has been slow in replicating this performance. Until 2006, the banks were the main source of VC funds with Pension funds replacing them thereafter. Popov and Roosenboom (2011) in their study covering 21 European countries and 15 manufacturing industries from 1991 to 2008, found that only about 3.9% of the industrial innovation could be attributed to VC. High entry barriers, stringent employment practices and Europe’s rudimentary knowledge networks were mainly behind this. Apart from these, intellectual property protection, human capital and tax and legal rules also influence the relation between VC and innovation.

Differentiating between civil and common law countries, Megginson, (2001) suggests that common law countries rely much more heavily on financial markets in general and VC’s in particular to fund research spending. Black and Gilson (1998) and Jeng and Wells (2000) find that VC is much more important in countries with large domestic capital market. Romain and De La Potterie (2003) empirically confirm the findings of Jeng and Wells (2000) and Gompers and Lerner (1998) that VC shares a positive relationship with GDP (gross domestic product),

technological opportunities, entrepreneurial culture and short run interest rate, while a negative one with corporate gains tax rate(CITR), larger long run interest rate and labor market rigidities.

The empirical literature on the determinants of innovation is also not extensive. Among those who have investigated this aspect, Furman *et al* (2002) and Kanwar and Evenson (2002) have reported that human capital, GDP and patent protection as empirically important country level determinants of innovation. Griffiths and Kickul (2008) in their empirical study of EU countries argued that government policies should be aimed at reducing corruption and increasing R&D spending to increase innovation activities. They also reported that innovation is positively related with high-tech workers, patent application and supported Timmons and Bygrave's findings (1986) and Zedar (1998) in their view of VC funding, both early as well as late stage, in being crucial for the success of innovation and entrepreneurship. In an another cross-country empirical analysis of 43 countries from 1998-2002 Ding (2006) found the rule of law environment as viewed in terms of Intellectual property protection and the level of tertiary education and not exam scores in being fundamental to the success probability of innovation.

The literature surveyed above reveals as has already been said, that it is not yet coherent. There is no study or work that attempts to classify what kind of technical progress is best financed by a certain financial structure. This is true for both the theoretical and empirical literature surveyed. The empirical literature seems to suggest that for incremental innovation be it process innovation or product innovation, bank finance is more suitable than market finance. But for “disruptive” technological change, market finance may be more suitable. This is a conclusion that can be tentatively drawn from the literature on the subject but there is currently no empirical work that firmly establishes this or a formal model that can provide a theoretical justification for this apparent bifurcation.

### **Rationale and Scope of Study**

*In line with what has been observed, there exists ample scope for studies that aim to investigate theoretical links between the type of the financial institution/ finance and innovation.*

The rationale for such a study thus becomes clear from the survey of the literature. This is a gap that deserves to be addressed. The following reasons may be advanced for this.

Theories in Trade that are dynamic in nature like those advanced by Vernon and Dollar suggest that new goods originate in the developed “North” and are later manufactured in the developing “South” taking advantage of its cheap labor. While this is historically true, the reasons for this are not stated; they are merely assumed. The study of the linkages between the financial market structures and the nature of innovation may give us a clue as to why this is so.

Secondly, the startups which are geared towards new goods and services are integral to giving economies an edge whereby they enjoy market power for some time. This is vitally important for economies seeking to be innovation driven knowledge economies instead of competing on the basis of low costs.

### **What Research Questions can be proposed?**

The Research Questions that can be proposed based on the literature review are:

1. Is there any theoretical reason to suggest that Bank Finance and Equity Finance have different impact on innovation?
2. Is there any theoretical reason to suggest that product innovation generates positive impact on the macroeconomic factors, namely employment, in the economy?
3. Is there any theoretical reason to suggest that equity finance particularly Venture capitalists support new innovative firms? If so, how?

### **Conclusion**

The record startups in job creation and their role in transforming the economy is one of the reasons for the current government in India to initiate Start Up India. Therefore the study of linkages between the type of financial institution and nature of innovation is also relevant in the Indian context.

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