

**EXPLORING THE LINKAGES BETWEEN
EXPORTS, FINANCIAL CONSTRAINTS, AND
RESEARCH AND DEVELOPMENT
INVESTMENT: EVIDENCE FROM PAKISTAN**



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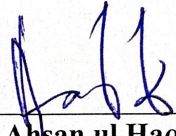


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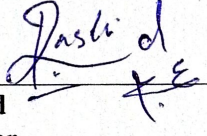
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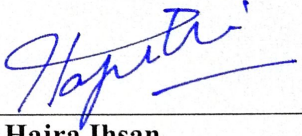
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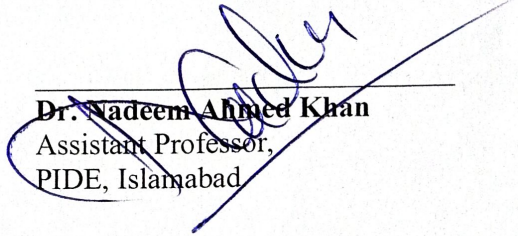
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Declaration

I Romaisa Batool hereby state that my M-Phil thesis titled “Exploring the Linkages between Exports, Financial Constraints, and Research and Development Investment: Evidence from Pakistan” is my own work and has not been submitted previously by me for taking any degree from Pakistan Institute of Development Economics, Islamabad. At any time if my statement is found to be incorrect even after my Graduation the university has the right to withdraw my M-Phil degree.

Date: _____

Romaisa Batool

To my Parents

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ABSTRACT

This study empirically investigates the relationship between exports, financial constraints, and research and development investment at firm level. The analysis is carried out using unbalanced data of 258 exporting firms listed on Pakistan Stock Exchange (PSE) over the period of 2009-2018. Empirical model is estimated using SUR techniques by considering all equations simultaneously. Results of the study show a significant and positive relationship between exports and R&D investment and vice versa. Relationship between financial constraints and exports is found to be negative. Likewise, R&D investment also had a negative effect on financial constraints. Overall, this study suggests that government and private financial institutes need to work together to provide easier access to funds at firm level. Moreover, government should increase coordination between academic institutes and firms to encourage innovate ideas and improve competitiveness at firm level as well as provide incentives and sustainable atmosphere for firms to expand their activities to increase exports and invest in research and development activities.

Keywords: Exports, Financial Constraints, WW index, R&D investment, Total factor productivity (tfp).

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1. INTRODUCTION

Export provides an interface to how much a country is competitive globally. Generally, export enables the exploitation of economies of scale, facilitates resource allocation, enhances foreign exchange reserves position, creates employment opportunities, and increases efficiency and productivity. From the literature there is a strong evidence that export is an important driver of sustainable economic growth (Weiss, 2005), specifically in Pakistan (Shirazi & Manap, 2004). Export is one of the indicators of competitiveness which is an important policy objective.

Pakistan's export performance remained weak over the past two decades despite vigorous efforts to improve exports as a percentage of GDP. According to world bank, export share of Pakistan in world declined from 0.18% to 0.13 %. Therefore, it is crucial to shift the focus from macro to micro level. There are several determining factors of exports at firm level. These include size of firm, R&D, technological capabilities, human capital, foreign ownership, and market structure (Dijk, 2002). But in this research, the relationship between, financial constraints, and research and development investment will be determined.

When firms enter international market, they must pay some significant fixed sunk cost such as for custom duty, regulatory compliance, and establishment of a foreign distribution network. Along with this, firms incur variable cost since the time span for finalizing the transaction is larger in case of international transactions. Time required for payment of upfront cost and the following cash flows is normally longer than that in national market. As these costs are to be paid up front, therefore, working capital requirement for firms that export is higher than those who do not. Hence, demand for

external finance for exporting firms is also higher. In such circumstances, firms might face financial constraints.

Financial constraints are the hindrances in accessing finance/funds. Firms can generate funds either from internal sources or external sources or both. Internal sources of funds include retained earnings. External sources of generating funds include borrowing from financial institutions i.e., banks or by issuing shares that are traded at the capital market. Financial constraints arise because of lack of knowledge, poor cash flow management, information asymmetries, and market imperfections etc.

Two possible patterns emerge in explaining the relationship of exports to financial constraint. First indicates a causal relationship moving from financial constraints to exports because of high sunk cost threshold preventing firm to export (Manova et al., 2011). Second indicates causal relationship moving from export to financial constraints because exporters can easily access international markets which widens the credit supply and their revenue is more stable hence liquidity status improves (Greenaway et al., 2007).

Firms that are able to overcome financial hindrances and enter international market face competition. At a time when many developing countries are rapidly increasing their exports share, Pakistan continues to struggle in accelerating the exports of manufactured goods. It is generally believed that exports of Pakistan are not competitive enough in international markets and therefore, it is unable to expand its market share. For firm to manufacture competitive products, they need to constantly improve new products as well as introduce innovation with the passage of time which can be achieved through investing in research and development. Research and development are the innovative activities performed by firms and governments for

development of new products and services, or for improving existing products and services. R&D is the engine driving product and process differentiation. It is an investment in innovation, technology, and future capabilities which is translated into new products and services. A lot of countries are targeting to enhance their R&D investment to gain competitive edge over the others. R&D and export affect each other (Çetin & Cincera, 2015). Therefore, for firm to perform well and survive in the international markets, it is necessary to engage in research and development activities.

Firms require finance to carry out research and development activities. Pecking order theory by (Myers and Majluf, 1984) states that information asymmetries between managers and external investor while assessing investment project of the firm. These asymmetries are more during the idea stage of project, so is the cost of external and internal financing. But as the innovative project begins, these information asymmetries decrease making investor more inclined to investment and hence decreasing the financial constraints. Information asymmetries between managers and investors may cause ambiguity affecting financial situation of firm and can hinder R&D investment. Therefore, firms depend in internal financing for R&D to a major extent (Czarnitzki & Hottenrott, 2009).

1.1 Gap Analysis

Previous studies on these variables were done in European countries and their results were inconclusive. For instance, on study found that less constrained firms are likely to be indulged in exporting activities (Greenaway et al., 2007, Manova et al., 2011), but in case of France no significant results were found in favor of hypothesis that firm that are less financially constrained self-select into exporting activates (Bellone et al., 2010). Moreover, exports are vital for economic growth, especially for developing countries.

To the best of my knowledge, there is no specific work on these variables (R&D investment, and financial constraints) in relationship to exports in Pakistan. Therefore, this study will focus on exploring the relationship between the said variables.

1.2 Problem Statement

Exports in July, 2019 amounted to be \$1.717 billion and imports were \$4.364 billion in comparison to \$2.102 billion and \$5.042 billion of exports and imports respectively in May 2019. Although exports decreased, but trade deficit was also decreased to \$2.647 billion in July, 2019 from \$2.940 billion in May, 2019 (Pakistan Bureau of Statistics). It is evident that this decrease in deficit was due to decreased imports only. For situation to improve further, exports need to be increased.

There is extensive research on exports in case of Pakistan, but majority of the study focus on macro variables. Despite various efforts to improve exports at macro level, export performance remained weak. Export share of Pakistan in world decreased from 0.18% to 0.13% in past two decades according to world bank. Therefore, to progress our economic condition and to lessen trade deficit as well, it is crucial to shift our focus to micro level.

Nowadays when a lot of developing countries are increasing their exports share in the world, Pakistan still struggles to accelerate the sales of manufactured goods in international market. It is generally believed that exports of Pakistan are not competitive enough, therefore, it is unable to expand its market share. To perform well in international markets, firms must have comparative advantage over the ones trading the same goods or services as them. As R&D activities translates into product and process differentiation as well as innovation, therefore, it might play a significant role in exports. R&D investment and exports might face financial hindrances; therefore, this

study will focus on the said issue and explore the linkage between exports, financial constraints, and R&D investment in a simultaneous framework.

1.3 Objectives of the Study

Keeping in view the economic conditions of our country and current trade deficit, it is vital to improve our exports at firm level. Firms' export behavior is said to be influenced by number of variables including investment in innovation and financial constraints being faced. Therefore, the objective of this research is:

- To find the linkages between research and development investment, financial constraints, and exports.

1.4 Research Questions

Research questions of the study are:

- What is the linkage between exports, R&D investment, and financial constraints?
- Does R&D investment influence exports or is it the other way round?
- What is the effect of external financial constraints on exports and R&D investment?
- Do exports and R&D investment cause financial constraints of a firm to decrease?

1.5 Significance of the Study

There is no previous research done on the simultaneous study of the Exports, financial constraints, and R&D investment in case of Pakistan. Therefore, this study will serve as a starting point in certain domain for Pakistan. Moreover, exports of Pakistan are believed to be not much competitive in case of manufactured goods and since this study

focuses on R&D investment i.e. a means to gain comparative advantage, therefore it can be used by exporting firms to improve their international performance.

Growth is the consequence of international efforts by firms engaging in R&D activities (Jones, 2013). Hence firms, can use the results of this study in their decision regarding the exports and innovation. Furthermore, to bring growth in economy by benefiting from exports government can encourage firms by adopting measures to minimize the financial hindrance in way of export and R&D investment. Government can promote exports by minimizing tariffs and by providing subsidies to exporting firms. Government and private financial institutions need to work together to provide easier access to finance at firm level on basis of preset conditions such as a certain level of export sales out of total sales, or certain proportion of revenue contributed towards investment in R&D.

1.6 Plan of the Study

This study is planned as: chapter 2 provides the brief overview of theoretical and empirical literature on relationship between R&D investment and exports, financial constraints and exports, and R&D investment and financial constraints. Chapter 3 provides theoretical framework, data sources and sample, empirical model, and estimation technique adopted for analysis.

2. LITERATURE REVIEW

This section provides the brief review of literature of previous theoretical and empirical studies. The literature was reviewed not only to provide the framework for study, but also for the historical perspectives on the link between research and development investment, financial constraints, and exports.

2.1 Theoretical Background

This research is based upon three different streams of literature. First one concentrates on the relationship between R&D investment and exports, second stream of literature explores the relationship between the financial constraints and exports and third stream of literature focuses on the relationship between R&D investment and Financial Constraints.

2.1.1 Exports and R&D investment

In the early theoretical literature, the relationship moves from innovation to Exports (Vernon, 1966). The argument presented to support of this product-cycle model is that innovation or product differentiation translates into comparative advantage which enables firm to compete in global markets.

In the late 1980s and early 1990s a new class of growth models emerged that incorporated the theory of Schumpeterian imperfect competition. According to Schumpeterian theory, new technology replaces the old one resulting in increased quality of goods. The imperfect models developed in 1990s, have been developed on the basis that growth is the consequence of international efforts by firm engaging in R&D activities (Jones, 2013). Theoretical argument that is mostly presented is that

innovation causes an increase in firms' productivity and consequently encourages exports (Melitz, 2003).

According to international trade theory, free trade encourages growth, wellbeing through comparative advantage. Moreover, internationalization of firm may also encourage the investment in research and development because returns from new investment are higher in a large international market (Smith et al., 2002).

R&D gives advantage to firms in terms of competitiveness which may prove to be an incentive to enter international market (Aw et al., 2011). But according to Carboni and Medda (2018), clear evidence on the effect of R&D investment is still not found due to the reason that competition in global market improves innovation of firms resulting from technological spillovers or through learning by exports. Therefore, implementing a reverse relationship from exports to R&D investment. According to Gorodnichenko and Schnitzer (2010), for financially healthier firms' innovation and exports are complementary activities, but for financially constrained firms they become substitutes.

2.1.2 Exports and Financial Constraints

From theoretical perspective there exists at least two possible patterns. First pattern indicates a causal relationship moving from financial constraints to exports because of high sunk cost threshold preventing the firms to take part in international markets (Manova et al., 2011). Second pattern moves from exports to financial constraints. Exporters can usually access international markets easier than non-exporters which widens their credit supply, and revenue from exports is believed to be more stable because of diversification in sales globally, therefore, it improves the liquidity status of firms that are involved in exports (Greenaway et al., 2007). Another analysis shows the

existence of circular link between export and financial constraints. In *ceteris paribus* condition exporting firms have lower probability of their credit applications to be denied, and firms who are not credit constrained are more likely to export (Altomonte et al., 2015).

Presence of sunk cost raises the question of financing it and these sunk costs do not correspond to their concurrent revenues. Firm that overcome financial market imperfection become exporters (Bellone et al., 2010). According to Manova et al., (2011), financial constraints interact with heterogeneity of firms and allow those firm to export which are the most productive. Theory behind this is that firms that are more efficient earn greater revenues and can offer a higher return to their creditors in case repayment. Therefore, they are more likely to get financing from external sources if need be.

Firms find it more challenging to start exporting when they need access to more financing or when the potential investors expect a lower return in case of default, therefore, credit constraints can prevent potentially profitable forms for entering international market. But in one research conducted in France, there was no evidence found in favor of hypothesis that less constrained firm self-selected into exports activities, instead a strong effect of later on the financial health (Bellone et al., 2010).

Smith et al., (2002) put forth that larger firms are expected to incur lower cost because of economies of scale. Since, entering an international market requires some sunk cost, therefore it is predictable that larger firms are more prone to be exporters or have a higher export share. In addition, firms that have high financial solvency can handle higher risk, hence, have greater likelihood of becoming exporters, whereas firms with

limited liabilities are better suited to take risk in international markets in comparison to personal ownerships.

2.1.3 Financial Constraints and R&D investment

Negative relationship between R&D investment and financial constraints is indicated by the theory. Myers and Majluf's (1984) presented a Pecking order theory of financing that highlights the significance information asymmetries that exist between managers and external investors when they evaluate the investment project of the firm. They said information asymmetries are more during the initial i.e. idea stage of the project in comparison to the later stages. As a result, higher cost is incurred in case of external as well as internal financing. When the innovative project begins, information asymmetries decreases making external investors more inclined to investment.

According to García-Quevedo et al., (2018), failure in innovation projects is often because of uncertainty arising from their intrinsic characteristics and asymmetries in information. In addition, availability of financial sources may limit the ability of a potentially innovative firm to engage in such projects.

Information asymmetries that exist between investors and managers might cause ambiguity affecting the financial situations of a firm, therefore, it may obstruct investment in R&D. Hence, external financing in such cases is expensive. As a result, firms depend on internal sources of financing to a major extent for carrying out R&D activities. This can constrain investment in R&D, specifically for firms with limited internal sources (Czarnitzki & Hottenrott, 2009).

2.2 Empirical Background

This section is further divided into three sub sections i.e. Research and development investment, Exports, Financial constraints and exports, and Research and development investment and financial constraints.

2.2.1 Exports and R&D investment

There exists a mutual correlation between R&D and exports exists (Altomonte et al., 2015). Empirical analysis done by Carboni and Medda (2018) shows that there exists a positive relationship among the R&D activities performed by firms and their decision to be involved in international markets. They concluded that firms that engage R&D activities increases tendency to export by 40% when endogeneity of R&D was accounted for.

A study conducted in Portugal based 340 firms by Neves et al., (2016) showed a strong cross-dependence in the firms' decision to export and invest in R&D activities. Engaging in export projects enhances the firms' likelihood of carrying out R&D activities and investment in R&D increases the export probability, therefore, R&D and exports emerge out as complimentary activates.

2.2.2 Exports and Financial Constraints

Credit constraint severely limit firms' overall export sales, hamper their capability to enter more foreign markets, which restrict the range of goods they trade (Manova et al., 2011). It has been found by Bellone et al., (2010) those firms that are less credit constrained self-select into exports and external funds are a significant but not crucial factor in export status. Firms initiating exports exhibit better financial health in contrast to competitors who are not involved in international markets, whereas, no evidence was

found in support of internationalization resulting in better access to financial markets as well as between financial health and units of production traded in foreign markets. It supports the idea that financial constraints are relevant due to presence of sunk cost at the start. Their results supported the presences of firm heterogeneity.

There is a negative impact of financial constraints on extensive margin of exports (probability of the firm to export) as well as on the intensive margin of exports (share of exports to the total sales) (Petrovito & Pozzolo 2019). According to the empirical results of a study conducted by Altomonte et al., (2015) on firms in seven European countries (France, Italy, UK, Spain, Austria, Germany, and Hungary), show a circular relationship among exports and financial constraints. Firms involved in international markets have less probability of their credit applications being rejected and firms that are not credit constraint have greater likelihood to sell in international markets. A research conducted on Chinese firms by Egger and Kesina (2014), concluded that one standard deviation increase in financial constraints is estimated to reduce the probability to export by one or two percentage.

Size of firm positively affects the firms' decision to perform exports as well as invest in R&D, whereas age of firm has a notable effect only on the decision to export (Carboni & Medda, 2018). However, according to Smith et al., (2002), the older the firm is, greater is its probability to be export oriented as well as invest in R&D activities, though this probability increases at a decreasing rate. Positive effects linked with export status such as employment growth declines with age of firm (Grazzi & Moschella, 2017).

2.2.3 Financial Constraints and R&D investment

R&D investment does not directly correlate with firms' likelihood to be credit constrained, but this does not imply that financial constraints do not effect firms' capability to indulge in R&D activities, as indirect effects of financial friction may still exist (Altomonte et al., 2015). Indirect impacts of financial constraints have more importance in decision of whether to invest in R&D than direct effects (Caggese, 2015). In contrast, Bond et al., (2005), found that financial constraints do not have any affect in case of long turn investments like R&D.

Unavailability of external funds to finance R&D, firms' inability to utilize internal sources of funds, and build up liquidity for R&D activities during economic recession may be hindering R&D investment in emerging markets (Sasidharan et al., 2015). According to García-Quevedo et al., (2018), failure of R&D projects is a significant issue when it results due to financial market failure. They also found out that not only financial access is critical to avoid negligence of innovation project, but also the market conditions and availability of technical information are vital. The decision to carry out R&D is greater in concentrated markets and is lesser for firms in industries faced with high entry barriers (Smith et al., 2002).

According to Czarnitzki and Hottenrott (2009), internal sources of funds are more conclusive for R&D than they are for capital investment. External constraints effect smaller firms more than larger firms in case of R&D implying that for smaller firms, investment in R&D accelerates as circumstances to get external funds get better, whereas larger firms are not as sensitive. In addition, no monotonic relationship between financial constraint and age was found.

Table 2.1: Summary of Reviewed Literature

Reference	Region of Analysis	Time period	Variables	Methodology	Conclusion
Aw et al., (2011)	Taiwan	2002-2004	Capital stock vector of variable input prices, Export, R&D, Productivity	Dynamic structural model.	<ol style="list-style-type: none"> 1. Productivity improves endogenously as a result of R&D investment decision. 2. Marginal benefit from exports and R&D increase with productivity. 3. Sunk cost of initiating R&D and export is more than their fixed cost. 4. Sunk and fixed cost of R&D is greater than that of exports 5. Decreasing trade cost will have noteworthy effect on likelihoods of export and R&D investment
Neves et al., (2016)	Portugal (340 thousand non-financial companies)	2006-2012	Exports and R&D. Explanatory Variables: Size, advertising, productivity, age, foreign and capital intensity.	Bivariate Probit models	<ol style="list-style-type: none"> 1. R&D and exports are complementary activities. 2. More productive firms self-select into export activities. 3. R&D and exports positively affect sales growth, and it improves when these activities occur at the same time.
Manova et al., (2011)	China	2003-2005	External finance dependence, R&D spending, Inventories to sales ratio, Asset tangibility	Sensitivity Analysis	<ol style="list-style-type: none"> 1. Credit constraints severely limit firms' overall export sales, hinder their capability to enter more targeted markets, and limit the choices of products they trade.

					2. For financially underdeveloped economies, foreign direct investment can decrease negative effects of credit market frictions on exports, growth, and private sector development.
Melitz (2003)	Exploratory Study				
Smith et al., (2002)	Denmark (3,500 firms)	1997	R&D Dummy, Firm size (number of employees), domestic market share, wage share, Solvency ratio	FIML estimation and bivariate probit models.	<ol style="list-style-type: none"> Exports is positively affected if firm has decided to engage in R&D activities. Export orientation depends positively on financial solvency of firm.
Grazzi & Moschella, (2017)	Italy	1998-2006	Age, Size, growth rate, export (dummy)	Multivariate regression	<ol style="list-style-type: none"> Exporting firm grow more than non-exporting firms. Positive effect of export declines with age of firm. Small firms grow more than large firms even if age difference is also considered. Young exporters appear to be well equipped to face unfavorable
Carboni and Medda (2018)	France, Germany, Italy, Spain, Uk, Austria, Hungary	2007-2009	R&D dummy, Export dummy, Firms with positive tangible investment dummy Control Variables: Size, age	2SLS, 3SLS, SURE, IV estimation method	<ol style="list-style-type: none"> R&D activities relate positively with decision to export. Firms size positively affects decision to invest in R&D as well as exports.

Gorodnichenko and Schnitzer (2010)	Large number of countries, Data from BEEPS	2002-2005	Financial constraints, innovation,	IV estimates	<ol style="list-style-type: none"> 1. Domestically owned firms lag behind foreign owned firms in terms of innovation. 2. For financially healthier firms, innovation and exports are complementary activities, but for financially constrained firms they become substitutes.
García-Quevedo et al (2018)	Spain	2005-2013	Financial constraints (internal and external), abandon project at execution stage, abandon project at conception stage, R&D.	Bivariate Probit Model	<ol style="list-style-type: none"> 1. Financial constraints have greatest chances of leaving a project during conception stage. 2. Spanish firms are more affected by internal financing sources during design stage but are more sensitive to external financing sources during execution stage.
Czarnitzki & Hottenrott (2009)	Germany	1992-2002	R&D investment, size, age, empirical price cost margin, credit rating,	Cross sectional approach, Tobit panel estimator.	<ol style="list-style-type: none"> 1. Availability of internal funds is more conclusive for investment in R&D. 2. Smaller firm are affected more from external constraints than larger firms in case of R&D.
Bellone et al., (2010)	France	1993-2005	Financial constraints (liquidity ratio, leverage ratio), total factor productivity, firm size, wage per employee	Multivariate index, Probit model, dynamic GMM	<ol style="list-style-type: none"> 1. Less credit constrained firms self-select into exports. 2. External funds are significant determinant of exports. 3. No evidence in support of internationalization leading to better access to financial markets 4. No positive relation between financial health and no of sales internationally

Petrovito and Pozzolo (2019)	65 emerging and developing countries within world bank enterprise survey (WBES)	2013-2014	Export, credit rationed dummy, productivity, age, size, competition in national market, share of temporary and skilled workers, and productive capacity of firms.	Linear Probability Model, Bivariate Probit mode, 2SLS	1. Negative affect of credit constraint on intensive and extensive export margin
Altomonte et al., (2015)	France, Germany, Italy, Spain	2007-2009	Ratio of cash flow to total assets, Dividend payout dummy, ratio of long-term debt to total asset, natural log of total asset, sales growth. Control Variables: age, size, total factor productivity.	SURE	1. Financial constraints are key determinant innovation (R&D investment) and export activities of firms. 2. Positive impact of export and innovation on financial health
Egger and Kesina (2014)	China	2001-2007	Debt ratio, liquidity ratio, employment, productivity, capital intensity, state owned firms, foreign owned firms	Panel Regression, IV estimation, cross-sectional version of the two-part fractional	1. Financial constraints hinder firms to participate in international markets but are not significant in relation to intensive margin of exports i.e. export to sales ratio.

				response model.	
Caggese (2015)	Italy	1989-2000	Productivity, age, R&D expenditure/profits, TFP	Panel Regression	1. Indirect effects of financial constraints are more decisive of whether or not to invest in R&D than direct effects.
Bond et al., (2005)	Germany, Uk	1985-1994	Flow of fixed investment, R&D investment, Gross operating profit, sales, cash flow.	Error correction models, GMM estimator	1. Cash flow show significant results for British firms, but not significant results for German firms. 2. Significant correlation between cash flow and R&D investment decision.
Sasidharan et al., (2015)	India	1991-2011	R&D dummy, cash flow, debt issues, sales, cash holdings, stock issues	GMM estimator	1. Relation between R&D investment and internal cash flow in positive. 2. Business group affiliation has no significant benefit for financial factors and R&D investment.

2.3 Concluding remarks

To sum up the literature review, it is concluded that relationship between exports, R&D investment and financial constraints is ambiguous. Theoretical literature suggests that innovation leads to better performance which proves to be an incentive to indulge in exports. Another argument given in this case is that technological spillovers from exports translates into innovation in firms. Empirical analysis indicates the cross dependence and a circular link between both variables.

When relationship between exports and financial constraints is studied, two patterns emerge from theory. One of them indicates the causality moving from financial constraints to exports while other suggests the opposite. Empirical results suggest a negative relationship between financial constraints and exports. But one study concluded that in case of France there was no evidence found in which less financially constrained firm self-selected into exports.

R&D investment and financial constraints exhibit a negative relationship, but studies also suggest that R&D is more sensitive to indirect effects of financial constraints. Whereas one study suggests that R&D investment may not be sensitive to financial constraints at all. Literature also indicated a dependence of R&D investment on information asymmetries and agency problem between managers and investor.

Results of the reviewed literature are suggesting different relationships and there are very limited number of studies focusing on the combined effect of all these variables (exports, financial constraints, and R&D investment) in a simultaneous framework. These limited studies had their focus on developed countries namely France, Germany, Italy and Spain, Austria, Hungary, and UK. Since exports are vital for economic growth

of a country, especially for emerging economies, so there should be a study focusing such countries. Therefore, this study will try to bridge this gap by exploring the linkages between exports, financial constraints, and R&D investment of firms operating in Pakistan.

3. DATA AND METHODOLOGY

This section includes theoretical framework, empirical model, variable construction, data and sample, and estimation model used in the research.

3.1 Theoretical Framework

From review of previous literature, we can build out theoretical framework as:

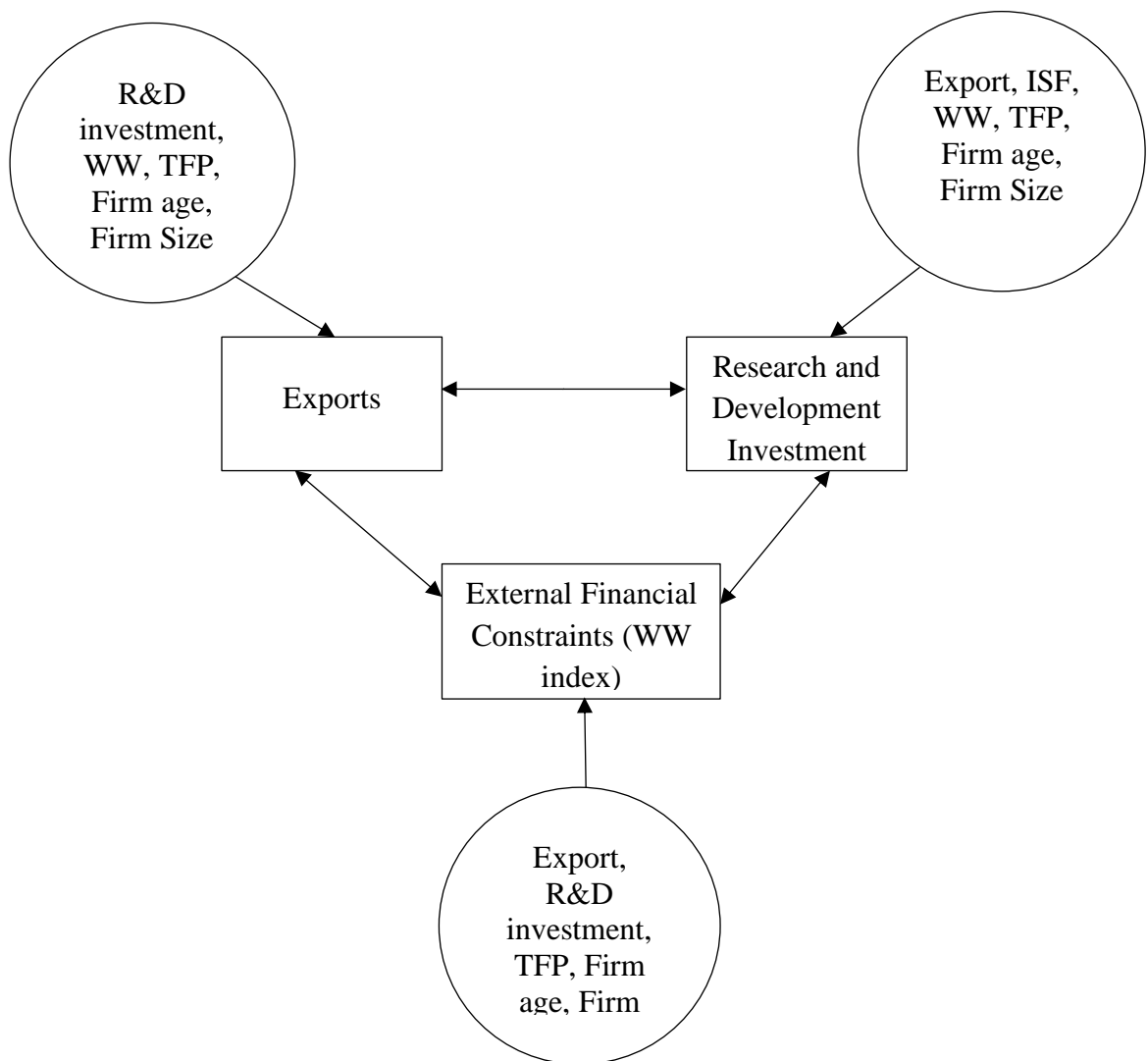


Figure 3.1 Theoretical Framework

The above diagram shows that main variables i.e. exports, R&D investment, and WW index are interdependent on each other. When export is considered as dependent variable then R&D investment, WW index, are independent variables. When R&D investment is taken as dependent variable then export, internal sources of funds are independent variables. In case of WW index as dependent variable, R&D investment, and export are independent variables. Whereas total factor productivity, firm age, and firm size are control variables common for all the dependent variables.

3.2 Empirical Model

As stated in the literature review there are different relations suggested between R&D investment, financial constraints, and exports. For instance, some theories suggest a causal relationship moving from financial constraints to exports (Manova et al., 2011), while others suggest the opposite (Greenaway et al., 2007). Furthermore, literature suggested a circular link between the said variables (Altomonte et al., 2015). Based on these studies, our econometric model consists of following equations:

$$Exp_{it} = \beta_0 + \beta_1 RD_{it} + \beta_2 WW_{it} + \beta_3 TFP_{it} + \beta_4 FA_{it} + \beta_5 FS_{it} + \varepsilon_{it} \quad (3.1)$$

$$RD_{it} = \beta_0 + \beta_1 Exp_{it} + \beta_2 ISF_{it} + \beta_3 WW_{it} + \beta_4 TFP_{it} + \beta_5 FA_{it} + \beta_6 FS_{it} + \varepsilon_{it} \quad (3.2)$$

$$WW_{it} = \beta_0 + \beta_1 RD_{it} + \beta_2 Exp_{it} + \beta_3 TFP_{it} + \beta_4 FA_{it} + \beta_5 FS_{it} + \varepsilon_{it} \quad (3.3)$$

Where,

Exp = firm exports

WW = Index proposed by Whited and Wu (2006)

RD = Intangible assets as proxy for R&D investment

TFP = Total factor productivity

ISF = Internal sources of fund

FA = Firm age

FS = Firm size

3.3 Variable Construction

This section comprises of firstly, the main variables of the study, and secondly, the definition of explanatory or control variables involved in the research.

3.3.1 Main Variables

Three main variables used in the model are exports, R&D investment, and financial constraints.

3.3.1.a Exports:

Export is a form of international trade in which goods and services that are produced in one country are bought by residents of another country. In this study, export data for non-financial manufacturing firms is used. Exports are calculated as:

$$\text{Exports} = \text{Ln} \left(1 + \frac{\text{Export Sales}}{\text{Sales}} \right) \quad (3.4)$$

For instance, if a firm only exports than the ratio of export sales to sales will be one and the natural log of one gives zero as the result. Therefore, researchers add one in in above calculation to keep the value of this variables as positive.

3.3.1.b R&D investment

Investment in research and development refers to investment in innovation and technology and translates into development of new product and processes as well as

differentiation of existing products and processes. Firms engages in R&D to gain competitive advantage which proves to be an incentive to enter foreign market (Aw et al., 2011). Due to lack of availability of data in case of Pakistani firms, we will use intangible assets as a proxy for R&D investment. According to Johnson and Pazdekra (1993), R&D expenditure create intangible capital for firms. Genuine R&D activity is an investment in accumulation of knowledge and their corresponding assets are intangible assets i.e. the stock of knowledge and technologies (Parham, 2009).

3.3.1.c Financial Constraints:

Financial constraints are defined as hindrances in accessing finance. They can be measured by several factors such as leverage and liquidity ratios. But here we will use WW index proposed by Whited and Wu (2006) as our main variable to measure external finance constraints. Firms considered as constrained by using this index exhibit attributes associated with exposure to external financial constraints. WW index was constructed by them using generalized method of moments (GMM) estimation of an investment Euler equation.

Whited and Wu (2006) estimated their equation by taking quarterly firm level data of 2002 Standard and Poor's (S&P) COMPUSTAT industrial files. After screening their data, they were left an unbalanced panel between 131 and 1390 firms per quarter for time period of January 1975 to April 2001. After estimation of Euler equation an index known as WW index with following coefficients was obtained:

$$\begin{aligned}
 WW\ index = & -0.91CF_{it} - 0.062\ DIVPOS_{it} + 0.021\ TLTD_{it} - 0.04LNTA_{it} + \\
 & 0.102\ ISG_{it} - 0.035SG_{it}
 \end{aligned}
 \tag{3.5}$$

Where,

i = Firm, & t = time

CF= ratio of cash flow to total assets

DIVPOS = dummy variable that takes the value of 1 if firm pays out cash dividends

TLTD = ratio of long-term debt to total assets

LNTA = natural log of total assets

ISG = 3-digit SIC industry growth of the firm

SG = firm sales growth

For estimating WW index for Pakistani firms need data for financial variables at firm level as well as three market variables associated to stochastic discount factor in Euler equation. Therefore, this data is difficult to acquire and may not be reliable since Pakistani stock market is not fully developed yet. Therefore, we are using the same coefficients as constructed by Whited and Wu (2006). Various Pakistani researchers also adopted the same practice such as Rashid and Ashfaq (2017) and Qasim et al., (2020). Additionally, research scholars all around the world use WW index for firms' financial constraints as it is based specifically considering the firms' characteristics. For instance, Lin et al., (2011) and Altomonte et al., (2016).

3.3.2 Control Variables

Control variables used in this research are firm age, firm size, total factor productivity, and internal sources of funds.

3.3.2.a Firm Size

From literature it was found that firm size influences both exports and R&D investment (Carboni & Medda, 2018). Furthermore, Czarnitzki and Hottenrot (2009) indicated that effect of external constraints differs according to size of firms in case of R&D investment. Size of firm can be measured by using different proxies such as total assets, total sales, market value of equity, and number of employees. In this research we are using log of total assets as a proxy for estimating firm size.

3.3.2.b Firm Age

Age of firm is the length of time during which a firm has existed. It can be calculated by considering the date firm was listed. For this purpose, Hansen (1992) used date of founding, incorporation, or acquisition (in case of mergers) of firms depending upon the availability of data. In this study listing age of firm is used to determine firm age.

3.3.2.c Total Factor Productivity

Total factor productivity measures the economic efficiency and is defined as the ratio of total output to total inputs produced. Olley and Pakes (1996) and Levinson and Petrin (2003) used Cobb Douglas production function and estimated total factor productivity in a residual form.

$$Y_{it} = A_{it} \cdot K_{it}^{\alpha k} \cdot L_{it}^{\alpha l} \cdot M_{it}^{\alpha m} \cdot e_{it}^{\mu} \quad (3.6)$$

Where, Y_{it} is output (state output to market) of firm i in time period t is function of K_{it} ; stock of capital, L_{it} ; labor, and M_{it} ; intermediate material. A_{it} is efficiency parameter or Hicksian neutral efficiency level.

Taking natural log of equation 3.6 results in a linear function. $\ln(A_{it}) = \alpha_0 + \epsilon_{it}$. A_{it} is unobservable to researcher and is measure of ignorance due to variation in output level.

Hence, it cannot be explained on observable inputs. The log form of above equation can now be written as:

$$Y_{it} = \alpha_0 + \alpha_k k_{it} + \alpha_l L_{it} + \alpha_m M_{it} + \varepsilon_{it} \quad (3.7)$$

α_0 is the measure of efficiency level of firms over the time period. ε_{it} consists of constant and residual of error term which can be further decomposed into least predictable and unobserved components i.e. μ_{it} and μ_{it}^q (Sahu et al., 2011). Therefore, equation 3.7 can now be written as:

$$Y_{it} = \alpha_0 + \alpha_k k_{it} + \alpha_l L_{it} + \alpha_m M_{it} + \mu_{it}^q + \mu_{it} \quad (3.8)$$

Firm level productivity ($\hat{\omega}_{it}$) equals $\alpha_0 + \mu_{it}$, whereas, μ_{it}^q is unexpected deviation from mean resulting from measurement error (Olley & Pakes, 1996). Researcher use following equation to estimate firm level productivity.

$$\hat{\omega}_{it} = Y_{it} - \hat{\alpha}_k k_{it} - \hat{\alpha}_l L_{it} - \hat{\alpha}_m M_{it} \quad (3.9)$$

According to Levinsohn et al., (2004) all inputs used are in log form to adjust $\hat{\omega}_{it}$. Levison and Petrin (2003) estimation technique is used to estimate TFP where labor is a free variable and capital is a quasi fixed variable. LP-estimator identifies endogeneity in its function. Furthermore, in case of this estimator intermediate materials are used to avoid any biasness. While estimating total factor productivity in STATA `levpet` command is used (Levison et al., 2004).

Gross manufacturing output or the total sales of firm are considered as state of output (Y) (Sahu et al., 2011). In case of capital (K), researchers use firm size as a proxy (Dang et al., 2018). Firm size can be indicated by total assets owned by a firm as well as their logarithm (Setiadharmas & Machali, 2017). Labor (L) is measured through wage bill of a

firm which in turn is measured using wage/salaries (product of number of hours employees and wage rate per hour) given to employees of a firm (Lopes & Teixeira, 2012). Finally, Material (M) can be calculated using cost of raw materials as well as processing materials that are used in the production of finished products (Sharma & Mishra, 2011). Therefore, equation 3.9 can be estimated using:

Y (sate of output) = natural logarithm of total sales of firm

K (Capital) = natural logarithm of total assets

L (Labor) = natural logarithm of salaries (number of hours employees work × wage rate)

M (intermediate material) = natural logarithm of cost of material

Total factor productivity (TFP) is calculate using omega function in STATA. Following table shows the results of LP- production function:

Table 3.1: Results of LP - Estimation

Output(Y)	Coef	Std.Err.	z	P>z	[95% Conf. Interval]
Labor(L)	0.189***	0.042	4.480	0.000	0.106 0.271
Capital(K)	0.979***	0.144	6.780	0.000	0.696 1.262

Wald test of constant returns to scale: Chi2 = 1.18 (p = 0.2770).

3.3.2.d Internal Sources of Funds

Internal sources of funds are taken as a control variable for R&D investment in this study. Companies retain a portion of their earnings for this purpose. Three proxies are

used for internal sources of fund viz: profit margin, net income over total interest payment, and liquidity ratio. In this study we use liquidity ratio as a proxy for internal sources of funds.

$$\text{Liquidity Ratio} = \frac{\text{Current Assets} - \text{Current liabilities}}{\text{Total Assets}} \quad (3.9)$$

Table 3.2: Description of Variable

Variables	Symbol	Description
Export	Exp	Export is log of one plus foreign sales in total sales
Research and development	RD	Intangible assets used a proxy.
Whited and Wu Index	WW	An index proposed by Whited and Whu (2006), used to measure external financial constraints.
Firm Age	FA	Number of years of listing of a firm.
Firm Size	FS	Log of total assets used as proxy for firm size.
Total Factor Productivity	TFP	Total factor productivity measure economic efficiency
Internal Sources of Funds	ISF	Funds available from internal sources calculated by dividing the difference of current assets and current liabilities over total assets

3.4 Data and Sample

To carry out the investigation, panel data set for non-financial manufacturing firm of Pakistan are taken from Pakistan Stock Exchange Ltd, published by State Bank of Pakistan for a 10 years' window i.e. 2009-2019. For calculating export share to total sales, firm with no or zero export sales were excluded. Also, the firm with missing values for the variables used in this research are also dropped out.

Total number of non-financial manufacturing firms are estimated to be 411 from year 2001- 2018. After only considering the manufacturing firms that were exporting as well come out to be 258 firms. So, data of these 258 firms from year 2009 -2018 is taken from state bank of Pakistan's website for empirical analysis.

3.5 Estimation Method

Though there are many methods to estimate results such as Ordinary least square (OLS), 2SLS, 3SLS, IV estimation, GMM estimator, and Bivariate probit models etc. However, we start with an estimation method that incorporates all the variables i.e. R&D investment, financial constraints, and exports in a simultaneous framework. Since our equations have some common dependent variables such as total factor productivity, age, and size etc. Hence, we will use seemingly unrelated regression (SUR) or seemingly unrelated regression equations (SURE) proposed by Arnold Zellner (1962) for estimating our model

3.5.1 Seemingly Unrelated Regression (SUR) or Seemingly Unrelated Regression Equations (SURE)

Arnold Zellner (1962) proposed seemingly unrelated regression (SUR) or seemingly unrelated regression equations model consisting of several regression equations, each

having its own dependent variable. Such models can be estimated separately by means of ordinary least square (OLS), but these estimates are not as efficient as SURE. Therefore, we used SURE/SUR to estimate our empirical model.

Motivation behind using SURE was to gain efficiency in estimation by combining information on different equations and to impose and/or test restrictions that involve parameters in different equations. It considers all the separate relationships collectively to draw the statistical inferences about the model parameters, errors are assumed to be homoscedastic and linearly independent within each equation and each equation is correlated with the others in the same time period.

4. RESULTS AND DISCUSSIONS

This chapter investigates the effect of Exports, Financial Constraints (measured by WW index), and Research and Development Investment (intangible assets as a proxy) on each other along with control variables including total factor productivity, firm size, firm age, and internal sources of funds (in case of intangible assets only).

4.1. Descriptive Statistics

Descriptive statistics of all the variables used in this research are given in Table 4.1. This table summarizes and measures quantitative data. The mean value shows central tendency, whereas standard deviation is a measure of dispersion. Minimum and maximum values are also given from which range can be calculated.

Table 4.1: Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
Export _{i,t}	1736	.2483946	.2195403	.0000109	.6931472
WW _{i,t}	1736	-.7934103	.5362423	-1.18578	-.5790648
IA _{i,t}	1736	.0041494	.0287742	0	.4171378
ISF _{i,t}	1736	.040706	.3289725	-6.029805	.8136919
Size _{i,t}	1736	15.37691	1.399296	10.63499	19.49226
Age _{i,t}	1736	36.58698	16.23067	2	132
Tfp _{i,t}	1736	.3542298	.2342987	.0024756	5.301293

Note: Export is log of one plus foreign sales in total sales. *Firm Size* is the logarithm of firm's total assets; *WW* is index for measurement of external financial constraints; *IA* is the ratio of firm's intangible assets to total assets; *ISF* (internal sources of funds) is calculated by taking ratio of difference of firm's current assets and current liabilities to total assets; *Size* is the logarithm of firm's total assets; *tfp* is calculated using production function by LPMethodology-Levisohn and Petrin (2003).

Export variable is calculated using natural log of one plus export sales to total sales.

Researchers usually add one while constructing this variable to keep these calculations

positive. For instance, if all the firm's sales are to foreign countries, then taking the natural log will provide us with zero as maximum value. The location of distribution show by mean value for exports is 0.249 whereas 0.219 shows dispersion. The minimum value of Exports (i.e. is in logarithmic form) is .0000109 showing firm with smallest exporting share. Whereas the maximum value (in logarithmic form) is .6931 indicating the firm with all sales as export sales.

WW index is formed by Whited and WU in 2006 for measuring external financial constraints. Greater the value of the index, the more constrained a firm is. A lot of researchers get strictly negative values for WW index such as Mancusi and Vezzulli (2014) and Qasim et al., (2020). The location of distribution show by mean value for WW index is -.793 whereas .536 shows dispersion. The greater the value, more constrained a firm is and lesser the value, less financially constrained a firm is. The minimum value of WW index is -1.186 showing the firm that is least constrained externally. Whereas the maximum value is -.579 indicating the firm that is most constrained in case of Pakistan. As mean value of -.793 shows the location of distribution indicating that average of Pakistani firms is financially constrained.

Intangible assets are the ratio of firms' intangible assets to total assets. It has a mean value of 0.0041 and a standard deviation of 0.0288. The minimum value is zero indicating the firms that have no investment in intangible assets, while the maximum value is 0.417.

Internal sources of funds indicate the financial resources available to firm for investment. It is calculated by using a liquidity ratio i.e. taking difference of current assets and liabilities and then dividing it to total assets. Internal sources of funds have

a mean value of 0.0407, dispersion of 0.329, minimum value of -6.0298, and a maximum value of 0.8137.

Size of a firm is log of its total assets and has a mean value of 15.377 and standard deviation of 1.3992. Minimum value of size of firm came out to be 10.635 showing the firm with smallest size and the maximum value came out to be 19.492 showing the firm with largest size.

Age of firm is calculated by using listing age of firm. It has a mid-value of 36.59 and a dispersion of 16.23. Minimum age that a firm had in this data set was 2 and the maximum age was 132.

Total factor productivity (tfp) is calculated using Levison and Pterin estimator and it gives out values in log form. Mean value is case of tfp is 0.354 and the standard deviation is 0.234. Lowest value for variable tfp in this data set is 0.0025 and highest value is 5.301.

4.2. Correlation Matrix

Correlation matrix is used to analyze the association between variable by examining the correlation coefficients. Correlation coefficients indicate the strength of relationship between the two variables. Multicollinearity exists when an independent variable is highly correlated with other independent variables in the regression equation. Presence of multicollinearity is a problem as it undermines the statistical significance of independent variable. Therefore, it can have serious impact on accuracy of beta and standard errors. Due to this our analysis might not work. Following table shows correlation coefficients of the variables used in this study:

Table 4.2: Correlation Matrix

Variables	Exports i,t	Intangible assets i,t	WW i,t	Firm size i,t	age i,t	tfp i,t	ISF i,t
Exports i,t	1.000						
Intangible assets i,t	0.046 (0.057)	1.000					
WW i,t	0.0361 (0.133)	-0.018 (0.447)	1.000				
Firm size i,t	-0.091 (0.000)	0.097 (0.001)	-0.339 (0.000)	1.000			
age i,t	-0.0415 (0.000)	0.032 (0.175)	-0.010 (0.071)	0.1583 (0.000)	1.000		
tfp i,t	0.0006 (0.981)	-0.081 (0.001)	-0.077 (0.001)	-0.2564 (0.000)	-0.102 (0.000)	1.000	
ISF i,t	-0.110 (0.000)	0.0246 (0.306)	-0.025 (0.289)	0.073 (0.002)	0.004 (0.635)	0.137 (0.000)	1.000

P-values in parentheses

The relationship between exports and Intangible assets (used as a proxy for R&D investment), exports and WW index (measure of financial constraints), and exports and total factor productivity (tfp) is insignificant implying that these variables do not correlate with each other. Relationship between exports and firm size as well as firm age is significant and negatively correlated. But correlation coefficients in each case shows that this relationship is weak.

Correlation matrix shows that between intangible assets and WW index, intangible assets and firm age, and intangible assets and internal sources of funds (ISF) is insignificant inferring that these variables do not correlate with each other. However, by examining the correlation coefficients in case of intangible assets and firm size, and intangible assets and firm age it can be said that these relationships are positive but again very weak.

WW index and firm size have a negative association at a coefficient of -0.339 which is not so strong. WW index and total factor productivity also show a negative association at a coefficient of -0.077 which implies a very weak correlation. Whereas, WW index and firm size, WW index and firm age, and WW index and internal sources of funds do not correlate at all. Furthermore, total factor productivity and firm age show a weak negative association and while total factor productivity and internal sources of funds show a weak positive association. There is no significance found between correlation coefficient of firm age and internal sources of funds.

Results of correlation matrix are either insignificant or correlation coefficients show a weak association among the variable. Therefore, it can be said that there is no noticeable possibility of multicollinearity in the variables that can have an adverse effect of our regression analysis.

4.3. SURE Model

In order to analyze the relationship of dependent variables i.e., exports, intangible assets, WW, we estimate our econometric model based on equation 3.1, 3.2, and 3.3 through SURE technique. SURE (seemingly unrelated regression equation) technique was presented by Zeller in 1962 and it assumes an unstructured variance-covariance matrix of error terms (u). This model is estimated by using firm size, age, total factor productivity, internal sources of funds (in case of intangible assets only) as control variables. Also, industry fixed effects were included in the estimation. Estimation results are shown in Table 4.3.

Table 4.3: Simultaneous Equations Model, SURE.

Variables	Exports _{i,t}	Intangible Assets _{i,t}	WW _{i,t}
Exports _{i,t}		1.310*** (0.004)	-0.770*** (0.008)
Intangible Assets _{i,t}	1.165*** (0.021)		-0.149*** (0.036)
WW _{i,t}	-0.640*** (0.002)	-0.981*** (0.001)	
Tfp _{i,t}	0.479*** (0.027)	-0.307*** (0.040)	-0.121*** (0.040)
Age _{i,t}	-0.0024*** (0.0003)	0.0002 (0.0004)	0.006*** (0.0004)
Firm_size _{i,t}	0.0423*** (0.004)	0.069*** (0.006)	-0.135*** (0.006)
ISF _{i,t}		0.098*** (0.001)	
<i>Observations</i>	1736	1736	1736

Industry Dummies Included

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: *Export* is log of one plus foreign sales in total sales. *Firm Size* is the logarithm of firm's total assets; *WW* is index for measurement of external financial constraints; *IA* is the ratio of firm's intangible assets to total assets; *ISF* (internal sources of funds) is calculated by taking ratio of difference of firm's current assets and current liabilities to total assets; *Size* is the logarithm of firm's total assets; *tfp* is calculated using production function by LPMethodology-Levisohn and Petrin (2003).

In case of exports intangible assets have a coefficient of 1.165 at is statistically significant at 1% level and has an error term of 0.021. WW index, total factor productivity, age of firm, and firm size is also statistically significant at 1% for exports. WW index has a coefficient of -0.640 and an error term of 0.027, total factor productivity has a coefficient of 0.479 and an error term of 0.027, age of firm has a coefficient of -0.0024 and an error term of 0.0003, and firm size has a coefficient of 0.0423 and an error term od 0.004 in case of exports.

For intangible assets exports, financial constraints (WW), total factor productivity, firm size, and internal sources of funds have a coefficient of 1.130, -0.981, -0.307, 0.069, and 0.098, respectively. All these variables are statistically significant at 1% level of significance. Whereas age of firm is found to be insignificant in case of intangible assets.

When WW index is analyzed, it is found that, exports have a coefficient of -0.770 and an error term of 0.008, intangible assets have a coefficient of -0.149 and an error term of 0.036, total factor productivity has a coefficient of -0.121 and an error term of 0.040, age of firm has a coefficient of 0.006 and an error term of 0.0004, and firm size has a coefficient of -0.135 and an error term of 0.006. All these variables are statistically significant for financial constraint at 1% significance level.

4.4. Results and Discussion

The first equation in our estimations had firms' exports as dependent variable and intangible assets (as a proxy for R&D investment), WW index (used to measure financial constraints) total factor productivity firm age, and firm size as independent variables. Results of SUR estimates show that intangible assets are positively significant for exports indicating that as investment in R&D increases, export sales also increases. As investment in research and development activities increase, the competitive advantage also increases which proves to be an incentive to enter international markets (Aw et al., 2011). As competitiveness of firm increases, so does their sales in international market. This result is also consistent with the finding of Smith et al., (2002).

WW index is negativity significant in case of Exports implying that less financially constrained a firm is greater its export sales are. Cashflow in case of sales in

international market take longer time in comparison to domestic market. Moreover, a significant sunk cost like custom duties is also required in case of exports. Therefore, firm that are involved in exports, require funds from external sourced to finance exporting activities. Hence as the financial constraints increases, exports sales decreases. This matches the findings of Monova et al., (2011) i.e. credit constraints severely hinder firms' overall export sales.

Total factor productivity is positively significant in case of exports. As firm become more productive, their exports also increase. This is consistent with the findings of Melitz (2003) that exporting firms are more productive in efficiency. Firm size has a positive significance whereas firm age is negatively significant for exports. Firms with greater size are able to exploit economies of scale and benefit from it whereas as they grow older, they become less flexible to be outperformed by younger firms (Pervan et al., 2017).

The second equation in our model had firms' intangible assets (proxy for R&D investment) as dependent variable and exports WW index (used to measure financial constraints) total factor productivity firm age, firm size, and internal sources of funds as independent variables. Estimation results show some contradictory results in this case. Total factor productivity has opposite signs from most of the literature. But since R&D investment is not yet fully explored in developing countries especially in Pakistan, therefore, we cannot be too certain about the results here.

From table 4.3, exports are positively significant in case in intangible assets. Increase in exports causes and increase in intangible assets. This can be explained through learning by exports or the spillover effects of exports. As firm enter international market

they learn through experience and implement this knowledge in their activities. This result is also consistent with the findings of Carboni and Medda (2017).

Age of firm is found to be insignificant, whereas size of firm is positively related with investment in intangible assets. This indicates that in case of Pakistan R&D investment is independent of the age of firm. But as its size increases, it is more likely to benefit from economies of scale and as greater resources as well, so it is likely to invest more in R&D activities.

Estimation results show that total factor productivity is negatively significant in case of intangible assets (proxy for R&D investment). This result contradicts majority of studies like Altomonte et al., (2015) and Sasidharan et al., (2015). But majority of the researches are carried out in developed countries however for developing countries results are always uncertain. In case of Pakistan, results imply that as firms become more efficient their R&D investment decreases. Argument in this case could be that more productive firm in Pakistan do not find the need to actively innovate or constantly invest in R&D activities as they are already performing well. According to Englander et al., (1988) both R&D and total factor productivity are variables with strong time trend, therefore, it is likely that lower R&D coefficients spuriously indicate the slowing of total factor productivity growth.

Financial constraints are negatively significant for intangible assets. Firm that face financial constraints i.e., hindrances in accessing finance are less likely to invest in research and development activities. So, as financial constraints increase, investment in research and development decrease. According to Li (2011), research and development projects are more inflexible, and a financially constrained firm is likely to suspend or discontinue research and development projects.

Moreover, Internal sources of funds are positively significant with investment in intangible assets. Firm usually rely on internal sources of funds to finance research and development projects. Literature also suggested a relationship between internal sources of funds and R&D investment. Researchers also argued that internal sources of funds are more conclusive for investment in R&D in comparison to capital investment (Czarnitzki & Hottenrot, 2009). Sasidhran et al., (2015) also said that inability to utilize internal sources of finance may hinder investment in R&D.

The third equation in our model had WW index (measure of financial constraints) as dependent variable and exports, intangible assets (proxy for R&D investment), and total factor productivity firm age, and firm size as independent variables. All these results are consistent with the theory and previous researches.

Export are negatively significant for financial constraints implying that as exports of firm increases, the financial constraints they face decrease. Reason behind this relationship is that exporters have easier access to international market that widens their credit supply therefore improves the liquidity status. In addition, revenue from exports is believed to be more stable (Greenaway et al., 2007).

Investment in intangible assets is negatively significant in case of financial constraints indicating that as firms participate more in research and development activities, financial constraints they face decrease. With increase in innovative activities, firm become more competitive and hence their productivity increase causing a decreased requirement of external finance. This result is also consistent with the findings of Altomonte et al., (2013).

Total factor productivity is negatively significant in case of financial constraints. As firm become more productive their revenue increases, hence more productive firms are

better able to pay back to their creditors. Therefore, firm with greater total factor productivity have higher probability of getting finance from external sources (Bellone et al., 2010).

Firm size is negatively significant for financial constraints whereas firm age is positively significant for financial constraints. As firms grow bigger, their assets increase, and they are more likely to benefit from economies of scale. In our estimations we have used log of total asset for measuring firm size. Greater assets a firm has, more likely it is to get finance from external sources, and hence fewer financial constraints they face. Therefore, credit availability increases as size of firm increases (Yang et al., 2014).

These results suggest the existences of a two-way relationship between exports, research and development investment, and financial constraints.

5. CONCLUSION AND POLICY RECOMMENDATION

5.1. Summary of the study

This study explores the relationship between exports, financial constraints, and research and development investment at firm level. In addition to these main variables, some control variables such as firm's total factor productivity, size, age, and internal sources of funds are used to understand the relationship between exports, financial constraints, and research and development investment.

Firm level unbalanced panel data set of non-financial manufacturing from period 2009 – 2018 is used in this study. For calculating exports share firms with no exports were excluded from the data set. Additionally, firms with missing values of the variables used in this research were also dropped out. For financial constraints WW index is used and for research and development investment, intangible assets are used as a proxy.

Estimation techniques used for analysis is seemingly unrelated regression equations (SURE) presented by Arnold Zellner (1962). This technique incorporates all the regression equations simultaneously and is more efficient in estimation as compared to OLS.

Results of the study shows a significant and positive relationship between exports and R&D investment and vice versa. Two-way relationship between financial constraints and exports is found to be negative. Also, R&D investment had a negative effect on financial constraints.

5.2. Key findings

The empirical analysis shows that the main variables i.e. exports, financial constraints, and R&D investment are all significant for each other. This result is concurrent with the findings of Atonomonte et al., (2015).

Estimation results of SUR technique shows that for export sales of firms, intangible assets (proxy for R&D), WW index (measure of financial constraints), firm size, total factor productivity, and firm age are all significant. Intangible assets are stock of knowledge and technologies. Therefore, investment in these assets may increase firm's competitiveness. For firms to survive in international markets they need comparative advantage. Therefore, intangible assets are significant for exports. Also, time required for payment of upfront costs and the flow of cashflows is normally greater in international market. Hence, demand for external finance is increases in such circumstances. Therefore, WW have a negative relationship with exports. As firm age, size, and total factor productivity increases, exports sales also increase.

For intangible assets, exports, WW, tfp, firm size, and internal sources of funds are significant. As exports increase, investment in intangible assets (proxy for R&D investment) also increase. This is explained through spillover effect of exports (Carboni & Medda, 2018). Some researcher argued the internal sources of funds are more conclusive for R&D investment (Czarnitzki & Hottenrot, 2009), which was confirmed in our analysis. Age was found to be insignificant for R&D investment whereas as firm size and productivity were positively significant.

Third estimation equation had WW as the dependent variables. SUR estimates for this equation of the model show that, exports and intangible assets have a negative impact on financial constraints (measured through WW index). As firms' exports increases

financial constraints decreases. Exporters usually have easier access to international markets than non-exporters which widens their credit supply, therefore, improving their liquidity status (Greenaway et al., 2007). Financial constraints also have a negative relationship with intangible asset (proxy for R&D investment). This is consistent with the findings of García-Quevedo et al., (2018).

5.3. Limitations of the study

The main limitation of this study is the use of various proxies of estimating results. Data for R&D investment data is not available for majority of firms in case of Pakistan even though some of the firms mentioned in their annual reports that they have active R&D teams, they value R&D activities, or they invest in R&D activities. Therefore, intangible assets i.e. stock of knowledge and technologies were used instead.

5.4. Policy implications and future directions

From the results, it can be said that exports are negatively affected by external financial constraints. For the situation to improve both government and private financial institutions should work together to provide easier access to funds at firm level. They can set some conditions such as a certain level of exports sales or a certain amount of revenue contributed towards R&D investment. This would improve export sales, R&D investment, as well as provide an easier access to funds i.e. minimize financial constraints. Government should regulate exports by relaxing tariffs and by providing subsidies to exporting firms.

Government should increase coordination between universities and firms by providing grants to students or researchers with relevant or applicable innovative ideas. This will not only encourage researcher to work on something that is practical, but also help Pakistani firms becoming more competitive, benefiting overall economy.

As R&D investment also depends on internal sources of funds that a firm has. Hence, firms that show the proof carrying out increased innovative activities can be given tax credit by government. Tax credits are more favorable in a sense that they actually reduce the tax due, leaving more finance for firms to invest in R&D activities.

In this era of intense competition, it is impossible for firms to survive without innovation specially in the international markets where there are a lot more options available and therefore competition is even more intense. Hence, there should be more research in this domain in Pakistan. Forthcoming researchers can use primary methods of collecting R&D investment data directly from firms by using surveys or questionnaires etc. If the accurate data is still not available, a binary variable can be used for R&D investment to indicate whether or not firms engage in R&D activities.

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