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Endogenous Institutional Change and Privileged Groups

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Since the recent advances in the institutional perspective of economic development, there is considerable increase in the literature on the evolution of institutions. In this study, while employing the game theoretic approach, we explore the rent-seeking fundamentals of institutions. We model the manner in which the rent-seeking behaviour of state actors results in inefficiency of the institutional framework. The main focus is on the rents provided by the availability of natural resources wealth, foreign aid or corruption potential. By originating a framework where rulers, agents of the state, and citizens act endogenously, we show that the rents from these resources can be a significant constraint to institutional reforms. In order to come out of the bad institutions trap, the society needs to offer a substantial amount of incentives to the privileged groups. The focus is on two privileged groups, i.e. the rulers and the state agents. In most of the societies, these two groups have the highest bargaining power in the negotiations over the rules and institutions.

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1. INTRODUCTION

Institutional framework has been one of the widely discussed topics in the explanation of cross-countries development gaps. Two points are common in most of the available literature related to institutions and economic success. First, institutions are collective choices and endogenous; and thereby, emerge, persist or change from the social interactions of individuals or groups. Second, the generally agreed conclusion is that societies which encourage the protection of property rights; exercise the rule of law; and enforce contracts efficiently prosper. In contrast, societies where the policies of expropriation prevail face a severe problem of underdevelopment [North (1981, 1990); Hall and Jones (1999); Easterly (2001); Acemoglu, *et al.* (2001, 2005); Acemoglu and Johnson (2005); Knack and Keefer (1995); Mauro (1995); Dollar and Kraay (2003) and Rodrik, *et al.* (2004)].[1] Theoretically, most of these studies regard institutions as social infrastructure that provides an economic environment within which economic actors

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[1]Most of these studies assert that in order to understand long-run economic performance, it is inevitable to address the interaction between institutions, politics and markets. Institutions form the rules of the game within which both politics and markets operate and ultimately determine economic outcomes.

solve their allocation problems. Thus, institutions have a direct bearing on the incentives structure of society. Accordingly, factors accumulation and technological progress are only the proximate causes of development while institutions are the fundamental ones.

Although it is unanimously argued that economic institutions such as private property, the rule of law, and contract enforcement are of primary importance in the realisation of economic development; there has, however, been lack of sufficient agreement on what determine the institutional framework in a society. There are a variety of opinions regarding the evolution of institutions. For instance, four different approaches have been prominent in the literature. They are the Efficiency View of Institutions, the Incidental View of Institutions, the Ideological View of Institutions, and the Social Conflict View of Institutions. The first approach is based on the cost and benefit analysis of institutions from social perspective. According to this approach, institutions appear and persist when their social benefits exceed their social costs. The second approach takes institutional change as a byproduct of some other activity.[2] The ideological view takes ideology and beliefs as the basis of institutional evolution. The final approach to the selection of institutions takes institutional change as a consequence of the conflict over the sets of institutions.[3]

This paper, combining the social conflict view of institutions and the theory of rent-seeking, examines the situation where the rent-seeking behaviour of state actors is a significant constraint to institutional reforms. Based on these two theories, we present an argument that institutional framework in any society is driven by its distributive implications. Second, it is an equilibrium outcome, whether it is efficient or less efficient. The winners of the prevailing institutional framework are those who had the greatest bargaining power during its formation. In order to change the existing inefficient institutional framework, the winner of existing institutional framework should be induced to change their strategy to the new equilibrium. This may be achieved by providing them with the incentives in the new equilibrium.

In this study, we develop an original model which contributes to the existing literature on three fronts. First, it studies endogenous institutional change taking agents of the state as a separate group besides politicians and citizens.[4] Given their *de jure* power, the state agents can prevent institutional reforms if the reforms endanger or reduce their rents. Second, it presents an argument that the choices of good economic institutions are not only constrained by the non-democratic rulers (dictators); but, in lacking democracies, the group of selected politicians also places hurdles, provided that they solve their within-group problems of free riding and collective action. Third, windfall income to the society either from natural resources or from foreign aid affects the

[2] For instance, according to the approach institutions emerge as an unintended consequence of other social or economic interaction or as a consequence of historical accidents.

[3]The detailed introduction of these approaches is given in Acemoglu (2003) and Acemoglu, *et al.* (2005). Both of these studies present an argument in favour of the Social Conflict view of Institutions by giving some historical data on European Colonisation and the comparison of North Korea and South Korea.

[4]The introduction of agents as a separate interest group is based on North (1981). North (1981) writes "it is the agents of the principals who enforce contractual agreements and enact penalties and not always, are these agents perfectly constrained by their principals". The main justification that renders the agents as separate interest groups is that they are self-interested individuals with their own interests; and their behavior is guided by those interests.

behaviour of state actors. In the same way, the corruption potential or other forms of rents associated with state intervention shapes the behaviour of rulers and their agents. In this study, we want to show how these cumulative types of rents affect the uncoordinated rent-seeking behaviours of rulers and their agents; and what does it imply for institutional reforms? The rest of the paper is organised in four sections. Section 2 surveys some of the available literature that clarifies the issue discussed in this paper. In order to motivate our hypothesis, we provide some descriptive cross-country evidence in Section 3. In particular, this analysis illustrates the growth performances of selected economies, given their endogenous and exogenous characteristics. Section 4 provides a theoretical model that formalises the main argument of the paper. Section 5 concludes the paper.

2. REVIEW OF LITERATURE

The basic argument in the paper is that institutional change is driven by their distributional advantages and the state actors, in order to sustain or expand their rents, prevent institutional reforms. We survey two strands of the literature: theoretical and applied. On the theoretical side, we focus on studies related to the social conflict view of institutions, rent-seeking, and their possible relevance to state actors. On the applied side, we survey the literature related to the possible types of rents available to the state actors and their implications for formal institutions.

2.1. The Social Conflict View of Institutions, Rent-Seeking and the State Actors

The basic premise of the social conflict view of institutions is that institutions are social choices and different groups benefit from different subsets of institutions. As a result, there is conflict of interest over these choices, and the conflict is won by the group with higher bargaining or political power. In other words, at any time and in any society, institutions which are favoured by the privileged groups persist. This approach, originated from Marx's theory of class conflict, is extensively discussed in the literature on the evolution of institutions.[5] The theories of interest groups and rent-seeking become relevant to the evolution of institutions once we take into account the distributive consideration of institutions.[6]

Rent-seeking meant to describe the resource-wasting activities of individuals and groups in seeking transfers of wealth through the aegis of state; and the groups involved in rent-seeking are the corresponding interest groups [Tullock (1967); Krueger (1974); Posner (1975)].[7] According to the traditional theory, rent-seeking arises generally due to the introduction of state to economic interactions; however, this is not the only setting in which rent-seeking may occur. There is trade-off between the social losses due to private expropriation (theft, robbery, piracy, war or disorder etc.), and the social losses due to

[5]Marx's (1970); North (1981, 1990); Libecap (1989); Knight (1992); Acemoglu (2003); Acemoglu, *et al.* (2005); Ostrom (2005); North, *et al.* (2009); Acemoglu and Robinson (2012); Khan (2013) are the most notable works in the elaboration of the social conflict view of institutions.

[6]This is justified by the fact that institutions then become the ultimate determinants of political and economic rights in any society.

[7]The formation of interest groups and the issues related to their collective action problems are extensively discussed in Olson (1965).

state expropriations (corruption, rent-seeking, malfeasance etc.).[8] Alternatively, there is some level of state interference essential for the efficiency of economic activities relative to stateless mechanism or disorder. Likewise, the traditional theories attempted to explain the rent-seeking behaviour of private groups or individuals who lobby or involve in illegal activities for attaining government transfers or other favours.[9] However, recent research has shown that state intervention in economic interactions creates public interest groups besides private groups [North (1981); Acemoglu and Verdier (2000); North, *et al.* (2009); Grief and Kingston (2011); Acemoglu and Robinson (2012)].[10]

So in general, in a rent-seeking society, there are two types of interest groups, i.e. private interest groups, and public interest groups. The public interest groups are the rulers and their agents (military, bureaucracy and judiciary). The rulers constitute as a separate group. For instance, a dictator not only uses the state to maximise his current payoffs; but he often changes the rules with a rent-expropriation view for the future. His payoff does not necessarily imply simple expropriation of the private resources; rather, it comprises the overall institutional payments, including both legal income as well as illegal rents. Similarly, in democracy, the rulers use their constitutional power to maximise theirs as well as their supporters' payoffs. Again, it does not necessarily imply that they simply transfer the rents from the minority either to them or to the groups maintaining their majority; rather, they do such maximisation constitutionally. Alternatively, in order to ensure their future rents, they choose the rules that maintain their economic and political power.

Likewise, the state agents, i.e. bureaucracy, military and judiciary constitute separate interest groups. They maximise their compensation package through their influence on the political and economic systems. Overall, this package consists of the salary paid by the state, any income (legal or illegal) obtained from outside activities, and the perks of their offices. We have substantial literature that highlights such behaviours of these groups. For instance, North's (1981) theory of the neoclassical state elaborate on how the agents' behaviour affects the emergence of institutional framework in a society? Similarly, Alesina and Tabellini (2007) argue that the rise of regulatory state has made the agents key players with regard to the decisions and execution of a large amount of legislation. In a slightly different version, Greif and Kingston (2011) argue that the enforcement of rules should be taken as an integrated component of the institutional structure.[11] Thus, the theories of institutional change should embody the enforcement

[8]The details of the Institutional Possibility Frontier are given in the Djankov, *et al.* (2003). In the paper titled as "The New Comparative Economics", the authors give the possible social orderings for a society ranging from 'Private Orderings' to 'Independent Judges' to 'Regulatory State' to 'State Ownership'. The authors give a detailed description of the social losses associated with each of these institutional structures.

[9]For instance, an entrepreneur wishing to get the monopoly rights of a government regulated industry might pay the campaign contributions to politicians, or might bribe a bureaucrat or judge for this purpose.

[10]For the details of the state and its contribution in economics interaction, see the neoclassical theory of state given in North (1981). Especially, it elaborately illustrates the instances and possibilities where the interests of the state actors may lead to the emergence and persistence of inefficient institutions. Similarly, state actors are part of the North's, *et al.* (2009) 'dominant coalition' and Acemoglu and Robinson's 'privileged groups'. See also Grief and Kingston (2011) for the enforcement of institutions as equilibrium outcome.

[11]Greif and Kingston (2011) argue that the view of institutions-as-equilibria focuses on how interactions among purposeful individuals create structure that gives each of them the motivation to act in a manner perpetuating this structure.

characteristics of institutions. So, unless we take all these groups into the structure of economics and endogenise their behaviours, it would be an incomplete discussion what Landes and Posner (1975) called 'a romantic view' that the members of the agencies are the unique guardians of some mystical "public interest".[12]

Similarly, the private interest groups maximise their payoffs given the set of informal and formal institutions. In particular, the set of formal institutions reflects their interactions with the public interest groups. The basis of these groups may be land, industry, or simply religious/ethnic causes. Olson (1965) provides the mechanism that result in the emergence of such groups; and asserts that the size and the solution of the collective action problem determine the actual effectiveness of such groups. Since, in this study, we focus more on public interest groups, so the remaining population will be assumed as a single group for simplicity.

2.2. Rents in Societies, Institutions and Economic Development

There are two types of rents that state officials can seize. First, the state actors can create or seize rents from their interactions with private individuals or groups, i.e. corruption or rent-seeking. The second source comprises the windfall rents like the rents from natural resources, foreign aid, or some other form of public funds that might exclusively be at the disposal of either the rulers or their agents. Regarding corruption, there are controversial claims with regard to its implications for economic outcomes. For instance, Mauro (1995) empirically concludes that corruption negatively affect economic growth, using cross-country data from 1960 to 1985. In contrast, Leff (1964) and Lui (1996) predict that corruption enhances economic success by avoiding bureaucratic delays. To reconcile these conflicting views, the dynamic effects of corruption need to be sought. In terms of static effect, corruption involves transfers from bribe-payers to the bribe-takers; so, it does not have a net social cost to the society. However, in terms of dynamic effects, corruption inversely affects the efficacy of institutions. Accordingly, corrupt rulers or agents will resist any institutional change that endangers this type of bounty either today or in future.

In the same way, sufficient literature exists on the implications of natural resources wealth, and foreign aid for economic growth [Auty (1990); Sachs and Warner (1997, 1999, 2001); Djankov, *et al.* (2008); Knack (2001); Brautigam and Knack (2004); Kronenberg (2004); Dalgaard and Olsson (2008); Khan (2012)]. In case of natural resources wealth, the assertions are not congruent. To some it enhances investment and productivity; while to other, it is a curse as it results in rent-seeking which hampers long run development. There are many case studies across the globe that confirms the hypothesis of the natural resources curse. For instance, resources rich countries like Mexico, Nigeria, and Venezuela are struggling in terms of their economic performances.[13] However, there is little progress on 'how it affects economic growth'? Given the recent emphasis on institutions, in this study, we explore the argument that the

[12]This concern is widely discussed in a paper titled as "The Independent Judiciary in an Interest-Group Perspective" by William Landes and Richard Posner in 1975 and a subsequent comment on the paper by Buchanan (1975). Both argue that in the economic approach to politics 'the judiciary's role is one of representing the under represented groups in the political process.

[13]In contrast, the four Asian Tigers including Singapore, South Korea, Taiwan, and Hong Kong are deficient in natural resources, but are economic miracles.

availability of natural resources rents weakens formal institutions which, in turn, transforms into underdevelopment.

Foreign aid has the same intrinsic characteristics that natural resource rents have. Most of the studies have found negative impact of aid on institutions and economic growth. For instance, Knack (2001) shows that aid flows are significantly correlated with the worsening of political risks for external investors, implying deterioration of economic institutions. Djankov, *et al.* (2008) find that both foreign aid and oil revenues have significant inverse effects on democratic institutions. Brautigam and Knack (2004) reported that the end of US aid to the South Korea and Taiwan resulted in their reforms in 1960s. Thus, the rentable resources have destructive effects on the behaviour of state actors. In particular, they encourage rent-seeking activities relative to productive activities.[14]

The model that we present below is expected to highlight on how the availability of rents in the form of natural resources wealth, foreign aid, or corruption potentials restrict the motivations to improve institutional framework. It also elaborates on how incentives scheme could change institutions if properly offered and implemented. But before going to the model, we would like to see the descriptive cross-country analysis of natural resources rents, foreign aid, corruption, and their probable implications for institutional quality.

3. DESCRIPTIVE CROSS-COUNTRY EVIDENCE

This section provides some cross-country evidence relevant to the issue in the paper. The variables of focus are those that directly or indirectly affect the compensation package of state actors. We highlight some countries where state actors have a handsome amount of rentable resources; corruption and malfeasance are common; economic performance is poor; and compare those with other countries which do not have these characteristics; and have achieved economic success. For this purpose, we choose Nigeria and Pakistan and compare them with Singapore and South Korea. The former two are economic failures while the latter two are economic triumphs.

Singapore, a small country of population slightly higher than 5 million, is one of the four Asian tigers in terms of growth performance. It has a highly market-based economy which depends heavily on exports, including largely manufacturing goods.[15] Economic growth has remained consistently high—at an average annual rate of 8.25 percent from 1960 to 2000. It has surpassed Canada, Australia, and U.K. in 1994, in terms of per capita GDP. In nominal terms, its total GDP is estimated at $194.92 billion with per capita GDP of $43,867 in 2010. Like other Commonwealth states, Singapore inherited the British model of governance. However, its institutional framework is widely known for its efficiency and competence.[16] The state-led economic achievements make

[14]For instance, Murphy, Shleifer, and Vishny (1993) argue that in situations where rent-seeking provides more lucrative opportunities than productive work does, the allocation of talent would be worse: talented and highly educated individual will be more likely to engage in rent-seeking than in productive work, with the adverse consequences for their country's growth rate.

[15]For instance, the value of its international trade is higher than its GDP, making trade one of the vital components of the economy.

[16]It has been consistently ranked high in terms of business-friendly environment by the World Bank. For instance, in 2012, it is ranked as first in terms of doing business.

Singapore a good case for studying contemporary reforms in governance and institutions. Table 1, in the Appendix, shows that Singapore has no rents from natural resources; and neither has received any foreign aid. Besides, public sector salaries and private sector salaries are almost at par in Singapore. Thus, the larger incentives to state actors combined with the lower windfall rents rank Singapore to have one of the efficient institutional frameworks in the world. This fact is evinced by its higher score on the institutional quality index, and its lower score on the corruption perception index.[17]

South Korea, likewise, is another shining example of a market driven economy, ranking 14th in the world in terms of nominal GDP. In the 1960s, Korea followed the policies of export-oriented industrialisation and import substitution, leading the economy to grow at the rate of 7 percent per annum during the whole decade. Onwards, in 1970s, they transformed to heavy and chemical industrialisation; followed by significant liberalisation in the 1990s. Given the recipe of such policies, it has been one of the fastest growing economies. For instance, from 1962 to 1990, its per capita income increased from $87 to $5199; and its total GDP expanded from $2.3 billion to $220.7 billion. Export-led industrialisation has been the major proximate factor behind the economic miracle of South Korea.[18] Second, the state actively intervened in the market, and took sufficient measures for macroeconomic stabilisation.[19] Alternatively, the state-supported industrialisation transformed South Korea from poverty stricken, inward looking, and economically backward economy in the 1960s into a globally competitive economy by the beginning of 21st century. As is evident from Table 1, South Korea has been a country with limited natural resources; and, likewise, it has never been a significant receiver of foreign aid. The limited amount of rents combined with higher incentives to state actors are the most probable reasons for limited rent-seeking, and higher economic development in South Korea.

Nigeria is the most populous country in Africa and the 8th most populous in the world.[20] It is characterised by larger ethnic and religious divisions. Additionally, it has been under colonisation; and has been endowed with enormous natural resources. For instance, since independence, the economy of Nigeria has been oil-based, providing 95 percent of foreign exchange earnings, and contributing 80 percent to the budgetary revenue. After the independence, Nigeria was expected to have potential for higher development due to its larger human and natural resources. But unfortunately, after five decades, the performance has been dismal as far as social and economic indicators are concerned. With per capita GDP of $1222 in 2010, the growth performance of Nigeria has been truncated during various decades. For instance, in the 1960s, GDP grew at the rate of 3.1 percent per annum, followed by the growth rate of 6.2 percent per annum in the 1970s which was caused by the higher oil prices in the world market. In the 1980s, the growth rate was negative due to oil price slump and debt repayment; however, in the

[17]See Table 1 for the details of data and table 2 for the definition of variables.

[18]In particular, the growth of large scale enterprises ensured the economies of scale and the technology transfer.

[19]For instance, it was often viewed as mercantilist economy as in the early periods of its industrialisation. It erected tariff barriers and imposed a prohibition on manufacturing imports, hoping that the protection would give the domestic firms a chance to improve productivity through learning by doing and technology transfer.

[20]For instance, its population is 152.217 million.

1990s, the economy again reverted to the positive growth rate and grew at the rate of 4 percent per annum.

Two factors are probably shaping Nigeria's poor economic outcomes. First, Nigeria's rulers have been unable to diversify its economy away from its overdependence on highly capital-intensive oil sector. Second, in most of the history of Nigeria, the government style has been remained as autocratic, leading to authoritarian operating rules. Table 1 illustrates that its score on institutional index is 2.8 while its score on corruption perception index is 8.3, both indicating poor institutional framework. Moreover, the rents from natural resources in Nigeria are 35 percent of GDP; and these rents are further augmented by almost half a billion dollars of aid per annum. The corruption and kickbacks of state actors resulted in squandering of the massive amounts of oil revenues and foreign aid.[21] Overall, lower public sector salaries combined with lower beliefs on meritocracy, and higher windfall rents are the most probable reasons for higher corruption, poor institutional framework and poor economic performance in Nigeria.

Finally, **Pakistan**, like Nigeria, has originated its institutional structure from the British. Pakistan, though average growing country at the rate of almost 4 percent per annum since its independence, is marked by higher levels of poverty and income inequality.[22] Pakistan though has experienced both democracy and dictatorship but the operating institutional framework in both forms of government has been authoritarian. Due to weak representative institutions, the state actors like the military and civil bureaucracy have been playing a dominant role in policy making and implementation. It has, on the one side, encouraged corruption and expropriation; and on the other side, capitalist developments have actually taken place under their patronage and close control.[23] This fact is obvious from Pakistan's lower score on the index of institutional quality. In addition, Pakistan has been one of the most aid receiving countries in the world, getting almost 1 billion dollar per annum. Alternatively, foreign aid has created a handsome amount of rents to state actors.[24] The availability of these rents and the lower relative salaries in public sector provide justifications for poor institutional framework, and higher prevalence of corruption in Pakistan.

4. THE MODEL

Consider a two period economy, populated by a continuum $1+\delta_p+\delta_a$ of economic actors, each with discount factor $\beta>0$. The population of common people is normalised to be 1; and also, it is assumed that they are the majority of the society. δ_p is the fraction of

[21]For instance, the 1996 study of corruption by the Transparency International ranked Nigeria as the most corrupt nation among 54 nations listed in the study.

[22]For instance, according to United Nation's Human Development Index (HDI), 60.3 percent of Pakistan's population lives on less than $2 a day and some 22.6 percent are living under $1 a day. Also, the distribution of wealth is highly uneven, with 10 percent of the population earning 27.6 percent of the total income.

[23]According to the rankings of the Transparency International in 1996, Pakistan was the 3rd most corrupt country in the world. Similarly, business opportunities have been restricted to selected people who have established good relationships with these two interest groups.

[24]In particular, the grants associated with Afghan War and War on Terror besides the Official Development Assistance (ODA) has added to this bounty.

politicians who are also rulers. Namely, rulers and politicians are synonymously used in this study. Finally, δ_a is the fraction of agents of the rulers. As stated earlier, in this study, agents like bureaucrats, military, or judiciary etc. are used as a separate privileged group. It is the agents of the state who enforce contractual agreements, and regulate law and order in a society. But not always, are these agents perfectly constrained by their rulers [North (1981); Acemoglu and Verdier (2000); Alesina and Tabellini (2007)]. The individuals are identical within the same group; however, there is heterogeneity across groups. This assumption is sufficient to ensure that the groups act like a player. The society is decomposed in such a way that the politicians are the rulers; the agents are the functionaries of the government; and the citizens are the subjects.

This is a two period economy, i.e. today and tomorrow. The individuals are risk neutral and their preferences are summarised by the following period felicity function:

$$u_{i,t} = C_{i,t} + \gamma_i l_{i,t} \qquad i = p,a,c \qquad t = 0,1 \qquad \ldots \qquad \ldots \qquad \ldots \qquad (1)$$

$C_{i,t}$ is the consumption of player I in period t. l_i and γ_i are the leisure and the marginal utility of leisure for individual i respectively. The subscripts p, a, and c denote the politicians, the agents, and the common people respectively. Each individual is endowed with 1 unit of time, which he exhausts in work and leisure. There is a single final good y, which is produced according to the following technology:

$$Y_t = R_t L_{y,t}^{\alpha} \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (2)$$

R_t is the degree of the effective institutional framework in period t, while $L_{y,t}$ is the amount of labour used in the production, which is supplied by the common people or citizens. α is the share of labour in production sector; and as a tradition, it is assumed that $\alpha>0$. The industry is jointly owned by the rulers and some citizens. The share of rulers is $\kappa<0.5$, in order to be closed to reality.[25] Labour is paid at the rate of competitive wage rate and the net profits are distributed according to the respective shares. Accordingly, the wage rate is given as:

$$w_t = R_t \alpha L_{y,t}^{\alpha-1} \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (3)$$

Since, there is single good, so it is also assumed to be the numeraire. Alternatively, all the incomes are measured in terms of this good. The life time value of a player from consumption is measured in terms of his current income or consumption, and his expected next period income or consumption discounted at a positive discount rate β. The institutional framework is introduced through Cobb-Douglas technology and its production function is given as:

$$R_t = \bar{R} A_t^{\rho} \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (4)$$

[25]In this study, our focus is on the countries which are natural resources rich, or which depend on foreign aid. In addition, our focus is on countries where political and economic institutions are so absolutist that they create enough corruption potential in the society. If we characterise the countries of the world by these characteristics, then the elite section of the society or North, *et al.*'s 'Dominant Coalition' is the minority of society.

Equation 4 specifies the effective level of formal institutional order as a function of the effort by the agents of the state, denoted by A.[26] The justification is that once the rules are codified or written; they are ultimately implemented by the agencies like bureaucracy, military, and the judiciary. Accordingly, the effective formal institutional framework must reflect the optimality behaviour of these agents. To make things easy, we assume to measure effort in terms of the time devoted to the improvement in or the maintenance of institutional framework. There is some status-quo level of institutional framework R_0. This assumption is made in order to put restriction that A cannot be zero in any period. This assumption reflects that we avoid the state of complete anarchy deliberately. Assume that A_0 is the level of effort associated with the minimum level of the institutional framework, R_0. Similarly $\overline{R}$ is the ideal level of institutional framework. We can assume, without loss of generality, that $\overline{R}$ are the rules which are written in the constitutions; and they are optimal.[27] So if at any time, the rules are less than $\overline{R}$, we say that the rules are not efficiently implemented by the agents of society. Also, we further assume that at the ideal level of institutional framework, $\overline{R}$, there is no expropriation of the state resources or assets by either the rulers or their agents.

The agents are paid at the competitive wage rate from the government budget for the level of effort put forward in maintaining the institutional framework. Additionally, the maintenance of the institutional framework is financed through lump sum taxation, T, on citizens. The rulers exhibit their preferences for a particular set of institutions through their willingness to initiate reforms or to maintain with the status quo. Similarly, the agents display their preferences through their provision of the effort level to the maintenance of institutional framework. Finally, the citizens' preferences for institutional framework are represented by their reaction in terms of labour supply to the production sector. The reforms introduced today produce benefits tomorrow. This assumption implies that institutions have long lasting effects on development.

4.1. Descriptions of the Players

In this section, we describe the objective functions of the players, and characterise their optimal behaviour, given their control variables.

4.1.1. *The Rulers or Politicians*

The life time value function of ruler is given as:

$$V_p = \frac{S_0}{2} + P_0 + W_p + \beta\left[\frac{S_1(R_1)}{2} + P_1(R_1)\right] + l_p \qquad \ldots \quad \ldots \quad \ldots \quad (5)$$

$$S'(R) < 0 \ \textit{and} \ P'(R) > 0$$

[26]According to Grief and Kingston (2011), institutions as equilibria encompass the enforcement characteristics of formal rules. Thus, the actual prevailing institutional framework reflects the optimality behaviour of the enforcers.

[27]At this level of institutional framework, the behaviour of agents is like that of the Weberian bureaucracy. In other words, the agents are the unique guardians of some mystical public interest.

V_p is the life time value function of the ruling elite which is the sum of current period payoffs and the discounted value of the next period payoffs. *S*, *P*, and l_p denote the expropriation of rents from either foreign aid or natural resources, share in profits, and leisure respectively. Expropriation decreases with institutional improvements and profit share increases with it. Further, W_p is the share of the rulers accruing from the institutional framework sector, i.e. the difference between the government revenue and the amount paid to the agents. The payments to agents include both the wage and any other type of reward for their efforts. We make some further assumptions. First, each period, there is some fixed amount of rents, *Z*, either from foreign aid or from natural resources, coming to the country. Some of these resources are expropriated which are jointly shared by the rulers and agents in equal amount. The remaining part is equally divided among citizens. Second, reforms, once undertaken, cannot be reversed because it is costly. These costs may include either adjustment costs or the costs associated with the strikes or lobbying of the groups who are the winners in the prevailing institutional arrangements. As stated earlier, the expropriation and profit share tomorrow are the function of reforms introduce today. There is trade-off for rulers in institutional reforms, i.e. good institutions tomorrow implies lower expropriation but higher profits; while bad institutions implies higher expropriation but lower profits.

Fors and Olsson (2007) define an excellent measure for expropriation, which is used in this study. According to that definition, the amount of expropriation at any period *t* that can be made, given the level of reforms, R_t, is given as:

$$S_t = \left(\frac{\overline{R} - R_t}{\overline{R}} \right) Z \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

Similarly, in the production sector, the profits are distributed according to the respective shares after the payment of wages. The rulers' share, P_t, at any period *t* can be written as:

$$P_t = \kappa \pi_t = \kappa (R_t L_{y,t}^{\alpha} - R_t \alpha L_{y,t}^{\alpha}) = \kappa R_t \left[1 - \alpha \right] L_{y,t}^{\alpha} \qquad \ldots \quad \ldots \quad \ldots \quad (7)$$

Using the definitions, given by the Equations 4, 5, 6, and 7, we get the lifetime value function of rulers or politicians in terms of the effort of agents and labour supply supplied to the institutional and production sectors respectively.

$$V_p = (\frac{\overline{R} - R_0}{2\overline{R}}) Z + \kappa R_0 (1-\alpha) L_{y,0}^{\alpha} + T - \rho \overline{R} A^{\rho} + \beta (\frac{\overline{R} - \overline{R} A^{\rho}}{2\overline{R}} Z + \kappa \overline{R} A^{\rho} (1-\alpha) L_{y,1}^{\alpha}) + l_p \quad (8)$$

4.1.2. *Agents of the State*

As defined above, agents are the functionaries of the government that comprise organised agencies like bureaucracy, military and the judiciary. In most of the earlier literature, their role is either taken exogenous to other groups in society or taken in a limited form of principal-agent framework. In contrast to the existing literature, our model is innovative due to two aspects. First, we take all the groups as endogenous in their decision making. Second, the endogenous behaviour of state agents implies that their cooperation or effort for institutional reforms depends on the implications of these

reforms for their compensation package.[28] In other words, they choose their effort levels to maximise their payoffs. It is assumed initially that if there is any expropriation, it is jointly shared by the rulers and their agents. Second, agents have also the potential to be involved in the decentralised corruption.[29] Defining the preferences of agents of the state over corruption implies that corruption matter for the evolution of institutions.

Let X be the fixed corruption potential per period in the economy.[30] We have assumed only decentralised corruption, so corruption is taken out of the incomes of citizens or

$$0 \leq X \leq \alpha R_t L_{y,t}^{\alpha} + (1-\kappa)(1-\alpha) R_t L_{y,t}^{\alpha} + \frac{R_t Z}{\bar{R}} - T.$$

To simplify things, we assume that corruption income enters the value function of the agents in the similar way as the expropriation of the foreign aid or natural resources rents does. Then, it is obvious that the income from corruption declines with the improvements in the institutional framework. Using the given definitions, the lifetime value function of the agents is given as:

$$V_a = \underset{A}{Max}\left(\frac{(\bar{R}-R_0)Z}{2\bar{R}} + \frac{(\bar{R}-R_0)X}{\bar{R}} + \rho\bar{R}A^{\rho} + \frac{\beta(\bar{R}-\bar{R}A^{\rho})Z}{2\bar{R}} + \frac{\beta(\bar{R}-\bar{R}A^{\rho})X}{\bar{R}} + \rho(1-A)\right) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

The first order condition of agents implies that the optimal level of effort or cooperation offered to institutional reforms by the agents is given as:

$$A^{*} = \left[\bar{R}\left(\rho - \frac{\beta Z}{2\bar{R}} - \frac{\beta X}{\bar{R}}\right)\right]^{\frac{1}{1-\rho}} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

A^{*} is the level of effort that the agent would assert in the maintenance of institutional framework. The structure in this study shows that institutional framework in any society is characterised by the optimality behaviour of agents. So, the status-quo, $A^{*}=A_0$ is equilibrium outcome. For any formal institutional change, the change in A^{*} is needed. Thus, in order to induce more effort from agents of the state, incentives are needed to be provided to them.

Lemma 1: *The effort of agent is an increasing function of its share in institutional framework sector,ρ, and a decreasing function of Z and X.*

Proof: The proof is understandable by taking the first derivate of the optimal level of effort of the agent with respect to the corresponding parameters.

[28]The compensation package includes both the legal income as well as the illegal rents.

[29]Easterly (2001) defines the decentralised corruption as the type of corruption characterised by many bribe-takers with their uncoordinated bribe-taking activities. So, by the virtue of its definition, decentralised corruption is directly related to the agents of the state.

[30]The corruption potential is defined majorly by the existing set of informal and formal institutions. For instance, the informal institutions like culture, religion or ideology determine the moral sentiments of corruption like shame, informal punishments etc. Second, the formal institutions affect corruption potential by defining the role of agents in economic interactions and the accountability procedures of the agents.

This result is very useful for the institutional explanation of cross-country development gaps. The result implies that the societies with more windfall rents like natural resources rents, foreign aid or with more corruption potential are expected to persist with the bad set of institutions. For such societies, a larger set of incentives needed to be offered to the rulers and to their agents in order to change the existing set of bad institutions. For instance, the incentives should be such that the expropriation and corruption are less advantageous relative to the legal incomes such as salary to the agents or the profits shares to the rulers. On the other hand, in societies where the history has provided them with the less corruption potential or expropriation level, good institution would emerge.

Definition 1: Define θ as the rate of incentives that the rulers offer to the agents to bring about institutional change. For instance, if the rulers wish to have an effective institutional framework R_t in the society, the incentives to the agent of the state becomes θR_t.

4.1.3. *Citizens*

The citizens are endowed with 1 unit of time, which they exhaust in labour to production sector and leisure. Their maximisation problem is given as:

$$V_c = \underset{L_{y,t}}{Max}(\alpha R_t L_{y,t}^{\alpha} + (1-\kappa)(1-\alpha)R_t L_{y,t}^{\alpha} + \frac{R_t Z}{\bar{R}} - T - \frac{(\bar{R} - R_t)X}{\bar{R}} + \alpha(1-L_{y,t})) \qquad for\ t = 0,1 \quad ... \quad ... \quad ... \quad ... \quad ... \quad (11)$$

According to the optimisation of the citizens, the equilibrium supply of labour to the production sector is given as:

$$L_{y,t}^{*} = [(\alpha + (1-\kappa)(1-\alpha))R_t]^{\frac{1}{1-\alpha}} = (QR_t)^{\frac{1}{1-\alpha}} \qquad ... \quad ... \quad ... \quad (12)$$

Lemma 2: *The labour supply is increasing in institutional reforms R_t. Moreover for $\kappa \leq 1$, the supply of labour changes positively with the change in κ if the indirect institutional implications of a change in κ are larger than the direct effects of the same change that is*

$$\frac{dL_{y,t}}{d\kappa} \geq 0 \qquad iff \qquad Q\frac{dR_t}{d\theta^{*}}\frac{d\theta^{*}}{d\kappa} \geq (1-\alpha)R_t.$$

Alternatively, the indirect effect of κ on labour supply must dominate the direct effect of κ on labour supply for labour supply to respond positively to changes in κ.

Proof: The Proof of the first line is obvious from the expression of the equilibrium supply of labour. The proof of second claim is given in the appendix.

The first result follows from the fact that improvements in institutional framework imply higher wage rate and higher profit shares. In other words, improvements in institutions implies higher price of leisure which cause an increase in the supply of labour. The second result implies that for $\kappa \leq 1$, the indirect effect of κ on labour supply must dominate the direct effect of κ on labour supply for labour supply to respond

positively to changes in κ. When κ increases, there are two effects on the supply of labour. One is the direct effect which decreases the labour supply because an increase in κ implies that the share of citizens in profits decreases. The other effect is indirect, i.e. through its effect on institutions. This effect is positive because for $\kappa \leq 1$,

$$\frac{d\theta}{d\kappa} \geq 0$$

that is institutions improve with the increase in κ, where θ is the rate of incentives that the rulers offer to the agents to bring about institutional change. The net effect is the sum of these two effects, which is only positive if the above inequality is satisfied.

4.2. Institutional Change and the Associated Incentives

According to North (1990), institutional change comes about when changes in relative prices create incentives for individuals or groups to renegotiate contracts or restructure rules. There are three relevant interest groups with two of them having the *de jure* political power to bring about institutional change.[31] Accordingly, we need to clarify their associated incentives with the institutional change. As stated earlier, the maintenance of institutional framework and the associated institutional change is financed by lump sum taxation on citizens. Now in this simple economy, the rulers will initiate reforms if and only if their life-time payoffs from the new institutional framework are, at least, as much as it would be if they maintained with the status quo. In our framework, this implies the following condition which we can name as the participation constraint of the rulers;

$$V_p^1 - V_p^0 = -\theta R_1 - \rho(R_1 - R_0) - \frac{\beta(R_1 - R_0)Z}{2\bar{R}} + \beta\kappa(1-\alpha)Q^{\frac{\alpha}{1-\alpha}}\left[R_1^{\frac{1}{1-\alpha}} - R_0^{\frac{1}{1-\alpha}}\right] \geq 0 \qquad C1.$$

The details of the derivation of $C1$ are given in the appendix. The first two terms is the loss in income associated with the transfers from the rulers to the agents with the corresponding institutional change. The third term is the change in the receipts from expropriation while the last term is their corresponding change in profits. According to the setting, all the first three terms are expected to be negative while the last term should be positive. To put it in more concrete words, there is a trade-off in initiating institutional reforms, i.e. good institutions imply higher share in profits from the production sector, lower expropriation receipts, and a loss in terms of transfer from the rulers to the agents. On the other hand, the persistence of bad institutions or the status quo implies higher expropriation of rents, lower share in profits, and no additional transfer to the agents. Thus any type of institutional change will be initiated if the net benefits to the rulers are positive.

In the same way like rulers, at the status quo level, R_0, $A_0=A^*$ is the optimal level of the effort of agents. Now in order to improve institutional framework, more effort from

[31]The *de jure* political power is the power which is allocated by the political institutions in a society. For instance, it includes the power of rulers and their agents, given to them by the constitution. See, also, for the details of different components of political power and their definitions Acemoglu and Robinson (2006).

agents of the state is needed.[32] In order to induce agents to supply more effort, there must be some incentives associated with any effort level, $A>A_0=A^*$. Here we assume that for any institutional improvement, the agents is provided with some constant rate, θ, of benefits that is

$$INC_a = \theta R_1 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (13)$$

Incorporating this increment in the optimal behaviour of the agents, we would drive the best response function of the agents.[33] This is given by the following function:

$$A^{**} = \left[\overline{R}(\rho + \theta - \frac{\beta Z}{2\overline{R}} - \frac{\beta X}{\overline{R}}) \right]^{\frac{1}{1-\rho}} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (14)$$

The only difference between A^* and A^{**} is the inclusion of θ inside the bracket, i.e. with the offer of increment, A^* increases to A^{**}. Thus θ>0 implies higher level of optimal efforts by the agents in comparison with the status quo.

4.3. Equilibrium

This is sequential game with perfect information; so it can be solved by backward induction. The ruler serves as Stackelberg leader in the game. He observes two things before playing his strategy. First, he observes the optimal effort of agents of the state at all levels of incentives. Likewise, he observes the optimal supply of labour at all levels of institutional framework. After observing the behaviours of agents and labour, he decides whether to initiate institutional reforms or not?

4.3.1. *Strategies Sets*

The strategy of rulers is to either initiate reforms or maintain with the status quo; and if the reforms are to be initiated, then how much incentives are to be offered to the agents? To write it more formally, the actions of rulers are given by the function:

$$\sigma_\rho : [0,1] \times [A_0,1] \rightarrow \left\{ 0, (1, \theta \in \Re^+) \right\}$$

0 refers to status-quo and 1 refers to initiating institutional reforms. Similarly, the functional form of the actions of agents is given as:

$$\sigma_a : \left[0, \frac{(\overline{R} - R_0)Z}{2\overline{R}} \right] \times \left[0, \frac{(\overline{R} - R_0)X}{\overline{R}} \right] \times \theta \rightarrow [A_0,1].$$

Finally, the function of the citizens' actions is the following:

$$\sigma_c : [R_0, \overline{R}] \rightarrow \left[(QR_0)^{\frac{1}{1-a}}, (Q\overline{R})^{\frac{1}{1-a}} \right]$$

[32] Acemoglu and Verdier (2000) suggest when agents are difficult to monitor, they should receive higher wages. So in order to reduce corruption and improve the efficiency of agents, the incentives for corruption must be diminished that can be made possible with higher wages.

[33] The details of the derivation are given in the appendix.

Given, these sets of strategies, we define sub-game perfect equilibrium for this game.

Definition 2: *The sub-game perfect equilibrium is defined as* "*the strategy profile:*

$$\sigma^* = \left(\sigma_p^*, \sigma_a^*, \sigma_c^*\right)$$

such that the strategies of the rulers, agents and the citizens are best responses to each other".

There are various strategy profiles which can be in equilibrium depending on the values of parameters. Nevertheless, for any specification of parameters, the equilibrium is unique.

4.3.2. *Subgame Perfect Equilibrium*

Given any optimal values of A and L_y, such that the inequality $C.1$ in not satisfied, there is unique sub-game perfect equilibrium in which the players play

$$\sigma_p^* = 0, \sigma_a^* = A_0 \; and \; \sigma_c^* = (QR_0)^{\frac{1}{1-a}},$$

In the same way, for any optimal values of A and L_y such the inequality $C.1$ is satisfied, there is unique equilibrium for any specification of the parameters. In this equilibrium players play

$$\sigma_p^* = 1, \theta, \sigma_a^* = \left[\bar{R}(\rho + \theta - \frac{\beta Z}{2\bar{R}} - \frac{\beta X}{\bar{R}})\right]^{\frac{1}{1-\rho}} \; and \; \sigma_c^* = (QR_1)^{\frac{1}{1-a}}$$

The rate of incentives to the agents, θ, is determined by the maximisation problem of the rulers that is given by the following implicit equation

$$\frac{\partial V_p^1}{\partial \theta^*} = \frac{\rho}{1-\rho}\bar{R}A^{2\rho-1}\left[-(\rho + \theta + \frac{1-\rho}{\bar{R}\rho}A^{1-\rho} + \frac{\beta Z}{2\bar{R}}) + \beta\kappa(\bar{R}A^{\rho}Q)^{\frac{\alpha}{1-\alpha}}\right] = 0 \qquad \ldots \quad (15)$$

Given, the assumed functional forms, it is complex to derive the optimal level of θ^* in reduce form; however, assuming that the conditions of Implicit Function Theorem (IFT) are satisfied, we can characterise the comparative statics with respect to the parameters of the model. To do comparative statics, we assume α=2/3. In most of the empirical literature on growth, the labour share in production is estimated as α=2/3.[34] Also, we assume that the shares of rulers' and agents in the institutional framework sector are equal, i.e. ρ=1/2. These assumptions are made to make things clear for understanding. The resulting comparative statics with respect to the optimal rate of incentives that rulers would offer to the agents are summarised in the following lemma.

[34]See, for instance, Krueger and Lindahl (2001) for a detailed discussion of the most plausible world level of the labour share.

Lemma 3:*For the optimal level of θ with respect to the ruler, it is true that*

$$\frac{d\theta^*}{dZ} \leq 0 \quad if \quad \frac{\partial}{\partial Z}\left(\frac{\partial V_p^1}{\partial \theta^*}\right) \leq 0 \qquad and \qquad \frac{d\theta^*}{d\kappa} \geq 0 \; if \; \kappa \leq 1$$

Proof: Given in the appendix.

The change in the available rentable resources, *Z*, has four effects for the outcomes of rulers. One is the direct effect and the other three are indirect. For instance, when *Z* increases, the direct effect comes on expropriation which also increases. The indirect effect is through its effect on institutions. The increase in *Z* implies the worsening of institutions which, in turn, implies lower payments to agents, lower profits, and higher expropriation in future. So lemma 4.3 implies that θ^* will decrease with the increase in *Z* if the loss in profits is smaller than the benefits from higher expropriation and lower payment to agents. This result is very important in the sense that the improvements in institutions would be prompted only if the importance of profits was higher to the rulers relative to that of the expropriation. The second result is straightforward; as an increase in κ implies higher share of the rulers in profits from production sector, which induces the rulers to initiate institutional reforms and offer a positive rate of incentives to the agents. Now, we summarise the results of the equilibrium in the following proposition:

Proposition 1: *There is a unique sub-game perfect equilibrium in the game described above*

$$(\sigma^* = (\sigma_p^*, \sigma_a^*, \sigma_c^*))$$

It is such that if the inequality C.1 is not satisfied, then institutional framework is R_0 *and* $A=A_0=A^*$ *and*

$$L_{y,1} = (QR_0)^{\frac{1}{1-\alpha}}.$$

If the inequality C.1 is satisfied, then $A=A^{**}$*, and*

$$R_1 = \bar{R}(A^{**})^{\rho} \text{ and } L_{y,1} = (QR_1)^{\frac{1}{1-\alpha}}$$

It is highlighted how in economies with multiple interest groups, and having rentable resources, the incentives for institutional reforms diminish with the increase in rentable resources. Second, by taking the enforcement of institutions as endogenous and the agents of the state as a separate interest group, it is shown how the actual effectiveness of the formal institutional framework is shaped. In other sense, it is illustrated that the prevailing institutional framework in any society reflects the optimality behaviour of the various interest groups in that society. In order to bring about change, the privileged groups need to be incentivised to change their strategy to the new equilibrium.

4.3.3. *Efficiency*

What is the efficient output in this economy? The answer to this question is simple. We need to find the values of *A* that maximises the total output in the production sector. The output in the reduced form is given as:

$$Y = (\overline{R}A^{\rho})^{\frac{1}{1-\alpha}} Q^{\frac{\infty}{1-\alpha}}$$

The value of A that, for a given values of the parameters, maximises the total output is 1. When A=1, the institutional framework in the economy is at the best level, i.e. $\overline{R}$. By assumption, this implies no corruption, and no expropriation of natural resources or foreign aid. Using these facts in the expression for A^{**} implies

$$\theta^{**} = \frac{1}{\overline{R}} - \rho \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (16)$$

This is the level of θ that will induce the agents to offer its total supply of endowment to the institutional framework. θ** is decreasing with ρ. The intuition is that ρ is the share of agents in the institutional sector, and higher ρ implies higher rewards for the effort in the maintenance of institutions which serves as an alternative to θ. Similarly, θ** is also decreasing with $\overline{R}$. The justification is that relative expropriation increases at all levels of R_t with the increase in the ideal institutional framework, $\overline{R}$. Thus, the agents' opportunity cost of improvement in institutions decreases. As a result, little incentives are needed to induce agents for higher effort.

However, efficiency can only be achieved if the incentives of both the rulers and the agents are coincided with the ideal form of institutional framework. In other words, efficiency requires:

$$\theta = \theta^{**} = \frac{1}{\overline{R}} - \rho \ \textit{and} \ R_1 = \overline{R},$$

and C.1 is satisfied at the efficient level of institutions, *i.e.*

$$(\rho R_0 - 1) - \frac{\beta(\overline{R} - R_0)Z}{2\overline{R}} + \beta\kappa(1-\alpha)Q^{\frac{\alpha}{1-\alpha}}\left[\overline{R}^{\frac{1}{1-\alpha}} - R_0^{\frac{1}{1-\alpha}}\right] \geq 0 \qquad \ldots \quad \ldots \quad (C2)$$

This is equivalent to stating that the payoffs of the ruler at the efficient level are at least as much as it would be if the system continued with the status quo. The purpose of this discussion is to highlight the fact that in societies where the agencies are strong, the constraints to efficiency may not only be associated with the rulers; but also, these self-interested agents might hinder institutional reforms. In this simple model, if *C*.1 (C.2) is not satisfied, the rulers would prefer to continue with the status quo; i.e. they would never prefer the efficient level of institutional framework as there are no associated incentives. Similarly, for θ<θ**, the agents would never offer the efficient level of effort. In general, when it is in the interest of those with sufficient bargaining strength to alter the formal rules will there be major changes in the formal institutional framework [North (1981)].

5. CONCLUSION

This study is motivated by the previous literature that has emphasised the importance of institutions in the growth and development process. Especially, we have focused on the costs of incorporating state actors and their interests into the formal

sanctioning process. Additional motivation is given by the literature on the curses of natural resources, foreign aid or other types of rents that are associated with state intervention. Today there are many countries in the world characterised by lacking democracies along with powerful agencies. In order to create or sustain their rents, the selected rulers-cum-politicians avoid institutional reforms. Such reforms are usually of interest to the wide cross-section of society. In the same way, agencies, whether they are civil or military, are constraints to institutional reforms. There are various degrees of power that the agencies have in such countries. In some countries they are serving the interests of the rulers and, in return, are offered with perks and privileges. Yet in other countries, they are jointly involved in the expropriation of rents provided by the natural resources wealth or foreign aid. Their involvement in decentralised corruption is widely evidenced in many instances. In this study, we formalise these issues and provide a game theoretic framework which can explain the behaviour of rulers and their agents in the presence of such rents. Our model is innovative in showing that the availability of rents offered by the natural resources wealth, foreign aid or corruption potential instigate the rulers and their agents to persist with the bad set of institutions.

There are three main findings of this study. First, it shows that the greater the amounts of windfall rents, i.e. the rents from natural resources or foreign aid, the lesser are the incentives that the rulers and agents have for institutional reforms. This can be a possible explanation for the persistence of underdevelopment in natural resources rich economies like Nigeria, Venezuela, Mexico etc. and the most aid receiver countries like Mozambique, Congo Democratic Republic, Tanzania, Philippines, and Pakistan. Second, the incentives of state officials for institutional reforms decline with the increase in corruption potential. Alternatively, the larger the corruption potentials in a society, the smaller are the incentives of its state officials for institutional reforms. This finding supports the existence of underdevelopment in the corrupt countries like Nigeria, Bangladesh, Somalia, Haiti, Angola and some Central Asian Republics etc. Third, our model shows that, in order to improve institutions in countries with rentable resources or corruption potential, a larger set of incentives should be given to both the rulers and agents. Such incentives must be sufficient to make expropriation and corruption less advantageous relative to those incentives.

Although the model discusses the endogenous behaviours of different interest groups in a clear way, we believe that several other aspects might be fruitfully analysed within the given framework. For instance, we have focused only on the impact of institutions on labour supply or profits. It can be extended to see the dynamic effects of institutions on capital accumulation, including both physical as well as human. In addition, an econometric analysis is clearly needed in order to understand the exact channels of causation.

APPENDIX 1

A. Let

$$Q = (\alpha + (1-\kappa)(1-\alpha)) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{(A1)}$$

Then the labour supply is

$$L_{y,t} = (QR_t)^{\frac{1}{1-\alpha}}$$

B. The ruler's payoff from status-quo is given as:

$$V_P^0 = (\frac{\overline{R} - R_0}{2\overline{R}})Z + \kappa R_0(1-\alpha)(QR_0)^{\frac{\alpha}{1-\alpha}} + T - \rho R_0 + \beta\left[(\frac{\overline{R} - R_0}{2\overline{R}})Z + \kappa R_0(1-\alpha)(QR_0)^{\frac{\alpha}{1-\alpha}}\right] \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{(A2)}$$

While his payoffs, given the new set of institutions is given as

$$V_P^1 = (\frac{\overline{R} - R_0}{2\overline{R}})Z + \kappa R_0(1-\alpha)(QR_0)^{\frac{\alpha}{1-\alpha}} + T - (\rho+\theta)R_1 + \beta\left[(\frac{\overline{R} - R_1}{2\overline{R}})Z + \kappa R_1(1-\alpha)(QR_1)^{\frac{\alpha}{1-\alpha}}\right] \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{(A3)}$$

The individual rationality constraint, $V_p^1 - V_p^0 \geq 0$ implies that

$$-\theta R_1 - \rho(R_1 - R_0) - \frac{\beta(R_1 - R_0)Z}{2\overline{R}} + \beta\kappa(1-\alpha)Q^{\frac{\alpha}{1-\alpha}}\left[R_1^{\frac{1}{1-\alpha}} - R_0^{\frac{1}{1-\alpha}}\right] \geq 0 \quad \ldots \quad \text{(C1)}$$

C. With the new set of incentives, the agent's maximisation problem becomes

$$V_a = \underset{A}{Max}(\frac{(\overline{R} - R_0)Z}{2\overline{R}} + \frac{(\overline{R} - R_0)X}{\overline{R}} + (\rho+\theta)\overline{R}A^{\rho} + \frac{\beta(\overline{R} - \overline{R}A^{\rho})Z}{2\overline{R}} + \frac{\beta(\overline{R} - \overline{R}A^{\rho})X}{\overline{R}} + \rho(1-A)) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{(A4)}$$

As a result, the new level of effort after incentives is A^{**} and is given as

$$A^{**} = \left[\overline{R}(\rho + \theta - \frac{\beta Z}{2\overline{R}} - \frac{\beta X}{\overline{R}})\right]^{\frac{1}{1-\rho}} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{(A5)}$$

D. Proof of Lemma 3: The first order condition of the ruler after he decides to bring about institutional reforms is given by the equation:

$$\frac{\partial V_p^1}{\partial \theta^*} = \frac{\rho}{1-\rho}\overline{R}A^{2\rho-1}\left[-(\rho + \theta + \frac{1-\rho}{\overline{R}\rho}A^{1-\rho} + \frac{\beta Z}{2\overline{R}}) + \beta\kappa(\overline{R}A^{\rho}Q)^{\frac{\alpha}{1-\alpha}}\right] = 0 \quad \ldots \quad \text{(A6)}$$

Given the assumptions on the parameters values, equation *A6* implies that

$$\frac{d\theta^*}{dZ} = -\frac{\frac{\partial}{\partial Z}(\frac{\partial V_p^1}{\partial \theta^*})}{\frac{\partial}{\partial \theta^*}(\frac{\partial V_p^1}{\partial \theta^*})} = -\frac{-\beta^2\kappa(Q\overline{R})^2 A^{\frac{1}{2}}}{\left[2\overline{R}\beta\kappa(Q\overline{R})^2 A^{\frac{1}{2}} - 2\right]} \quad \ldots \quad \ldots \quad \ldots \quad \text{(A7)}$$

Since θ* is the maximiser, so the denominator is negative by the definition of a maximum. The numerator is negative which completes the proof of the first part of the lemma, i.e.

$$\frac{d\theta^*}{dZ} \leq 0 \;\; if \;\; \frac{\partial}{\partial Z}\left(\frac{\partial V_p^1}{\partial \theta^*}\right) \leq 0$$

This implies that the marginal effect of θ^* is decreasing with the increase in *Z*. Increase in θ^* implies improved institutional framework, which in turn, implies higher profits, higher payments to agents and lower expropriation of available rents. Similarly increase in *Z* implies lower institutional framework, which in turn, implies higher expropriation, lower profits and lower payment to agents. Equation A7 implies this joint effect must be negative for θ^* to respond negatively to changes in *Z*.

Similarly, to see the effect of a change in κ on θ^*, we again using the implicit function theorem

$$\frac{d\theta^*}{d\kappa} = -\frac{\frac{\partial}{\partial \kappa}\left(\frac{\partial V_e^1}{\partial \theta^*}\right)}{\frac{\partial}{\partial \theta^*}\left(\frac{\partial V_e^1}{\partial \theta^*}\right)} = -\frac{\beta \bar{R}^2 QA(Q - 2\kappa(1-\alpha))}{\left[2\bar{R}\beta\kappa(Q\bar{R})^2 A^{\frac{1}{2}} - 2\right]} = -\frac{\beta \bar{R}^2 QA(1-\kappa)}{\left[2\bar{R}\beta\kappa(Q\bar{R})^2 A^{\frac{1}{2}} - 2\right]} \quad \ldots \text{(A8)}$$

Again by the definition of a maximum, the denominator is negative while the numerator is obviously positive for $\kappa \leq 1$ which is the case by assumption. This completes the proof of the second part of the lemma.

E. Proof of Lemma 2:

$$L_{y,t}^* = [(\alpha + (1-\kappa)(1-\alpha))R_t]^{\frac{1}{1-\alpha}} = (QR_t)^{\frac{1}{1-\alpha}} \qquad \ldots \quad \ldots \quad \ldots \quad (12)$$

Taking the first order of derivative of the optimal level of labour supply with respect to κ, we get the result

$$\frac{dL_{y,t}}{d\kappa} = \frac{1}{1-\alpha}(QR_t)^{\frac{\alpha}{1-\alpha}}\left[-(1-\alpha)R_t + Q\left(\frac{dR_t}{d\theta^*}\right)\left(\frac{d\theta^*}{d\kappa}\right)\right] \qquad \ldots \quad \ldots \quad \ldots \quad \text{(A9)}$$

The first term inside the bracket is negative for any α<1. The second term is positive because $\frac{dR_t}{d\theta^*} \geq 0$ is implied by $\frac{dA^{**}}{d\theta^*} \geq 0$ and $\frac{d\theta^*}{d\kappa} \geq 0$ is implied by *A8* for $\kappa \leq 1$. Thus

$$\frac{dL_{y,t}}{d\kappa} \geq 0 \qquad iff \qquad Q\frac{dR_t}{d\theta^*}\frac{d\theta^*}{d\kappa} \geq (1-\alpha)R_t.$$

F.

Table 1

Comparison of Two Asian Tigers and Two Developing Countries

Country	GDP per Capita	RSP	Inst	AID (US Million $)	CPI	NR
Korea, South	20756.69	0.500	6.620	91.265	5.012	0.012
Singapore	43866.92	0.802	8.856	14.374	0.819	0
Nigeria	1222.48	0.028	2.773	547.860	8.268	33.844
Pakistan	1006.95	0.083	3.655	899.189	7.730	3.581

Source: World Development Indicators, World Bank; World Bank Governance Indicators; and Rauch and Evans (2000).

Note: Each entry is the average of the available data as otherwise indicated in Table 2.

Table 2

Description of the Variables

Variable	Description
GDP Per Capita	It is Gross Domestic Product (GDP) per capita in current US $ in 2010, taken from the World Development Indicators.
Inst.	This variable is a measure of institutional quality. It is based on the World Bank's Governance Matters VII [Kaufman, Kraay, and Mastruzzi (2009)] and is the average of their three measures that is the average of the Government Effectiveness, the Rule of Law and Regulatory Quality. The basic purpose is to capture the effects of bureaucracy, judiciary and army etc. The original indices takes values from –2.5(poor quality) to 2.5(highest quality). However, here I changed the index for simplicity, which now in this study takes the values from 0(extremely poor institutions) to 10 (perfect institutions).
CPI	This measure is based on the Corruption Perception Index of the Transparency International and again the value of the original index has been changed for simplicity. In this study, the index takes the values from 0(no corruption) to 10(highest corrupt).
NR	This is a measure of natural resources rents, which are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents, taken from World Development Indicator (WDI).
AID	Foreign aid is denoted by aid, represents Official Development Assistance (ODA) and other official aid received in current US dollars, taken from the WDI, World Bank.
RSP	RSP is a measure of the salaries in the public sector relative to private sector and is taken from Rauch and Evans (2000), which is the ration of the salaries in the public sector and those in the private sector.

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Trade Shocks and Labour Adjustment: Evidence from Pakistan's Manufacturing Industries

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The present study is an attempt to explore the impact of trade liberalisation on employment and wages of production and non-production workers in large scale manufacturing industries of Pakistan. We use a sample of 18 industrial establishments with a time series data covering a period 1970-71 to 2005-06. In order to account for endogeniety problem, this study uses the Generalised Method of Moments (GMM). The study comes up with the findings that trade liberalisation has significantly negative impact on employment of both production and non-production workers. On the other hand, trade liberalisation has a significantly positive impact on wages of production workers, but it has no significant impact on wages of non-production workers. The negative impact of trade is attributed to the high protection given to most of the inefficient industries in the post liberalisation period. On the other hand, reduction in non-production worker employment is not unexpected as in case of developing country like Pakistan, trade liberalisation is supposed to displace capital intensive industries that employ most of the non-production (skilled) workers.

Keywords: Production Worker, Non-production Workers, Trade, Employment, Wages

1. INTRODUCTION

Pakistan initiated deregulation and liberalisation of the economy in the late 1990s as a result of structural adjustment programme. In the past, the economy of Pakistan subjected to different type of trade restrictions in order to protect the economy from foreign competition and to encourage industrialisation in the country. The restricted trade regime resulted in inefficiency in the manufacturing sector and the economy lagged behind in competitiveness. Pakistan initiated restructuring the economy by moving towards free trade through gradual reduction in import duties and other non-tariff barriers. The Figure 1 indicates the trend in import duties which shows that import duties reduced gradually from 1990 to 1995, whereas after 1995, there has been as smooth decline in import duties till 2011. The government of Pakistan not only relied on reducing import duties, but in most of the cases non-tariff barriers were replaced with tariffs. Besides, the maximum tariff rate was reduced significantly. In 1986-87, the maximum

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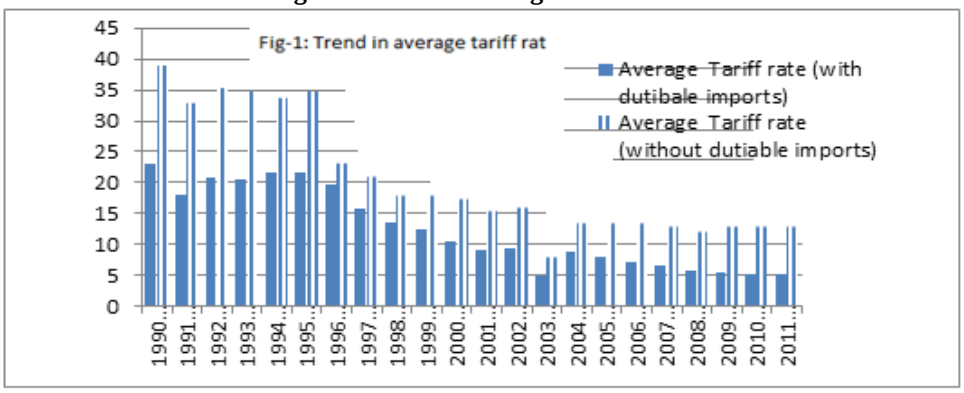
tariff rate was 225 percent, which was reduced to 45 percent during 1997-98. Furthermore, to cascade[1] the tariff structure, the earlier surcharges and taxes also known as para tariffs were merged with statutory tariff (national tariffs) regimes. Most of the items that were not importable earlier were made importable, however, there was some exception for goods prohibited because of religious, health as well as security considerations [Khan (1998)].

Fig. 1. Trend in Average Tariff Rate



Source: Based on data from Federal Board of Revenue.

Since 2008, Pakistan has taken some cautious steps of trade liberalisation. Its average applied MFN tariff is 14.3 percent in 2014-15, slightly down from 14.8 percent in 2008. All but 45 tariff lines are ad valorem. Since July 2014, Pakistan no longer has duty free tariff lines. The tariff displays a significantly positive escalation. Some 98 percent of tariff lines are bound; the average bound rate is 61.5 percent. Regulatory exemptions and concessions provided for various industries under SRO regimes remain an important source of deviation from MFN rates. Pakistan has bound other duties and charges at zero, but "regulatory import charges" of 5 percent apply on some 284 mostly agricultural products. Since Pakistan's last Review, the Government has been implementing a programme to modernise customs procedures. In addition to tariffs, imports are subject to sales tax. Despite cautious liberalisation, overall tariff levels remain high, which weakens productivity growth and constitutes an impediment to efficient resource allocation and the integration of Pakistan into global value chains. In addition, the use of ad hoc trade policy instruments under SROs remains common and severely undermines the predictability of the trade regime; it also supports a culture of rent-seeking. The elimination of tariff and tax-related SROs, planned for end-2015, will significantly increase transparency of the trade regime.

If we compare the actual tariff level in Pakistan in the context of WTO rules, Table 1 shows that Pakistan tends to have relatively moderate MFN applied tariffs while it has a relatively high bound tariffs under the WTO. Summing over tariff lines we observe a higher average MFN and higher average bound tariff rates on agricultural commodities. On the other hand, we note a relatively lower MFN on agricultural commodities when averaging the MFN applied tariffs weighted by trade value.

[1]Higer tariff for final goods and lower tariff for inputs.

Table 1

Summary of Pakistan's MFN and WTO Bound Tariffs

	Year	All Products	Agriculture	Non-agriculture
Simple Average Final Bound		59.9	95.6	54.6
Simple Average MFN Applied	2010	13.9	17.0	13.4
Trade Weighted MFN Applied Average	2009	9.8	9.1	9.9
Value of Imports in Billion US$	2009	31.7	4.2	27.5

Source: Authors elaboration based on data from the World Trade Organisation.

It is to be noted that we are referring to MFN applied tariffs rather than true paid duties, indicating that it would include exemptions and other taxes. Similarly, from Appendix A1 we also observe that there are many instances where we find that the "MFN applied tariffs is 'duty free' although the bulk of agricultural imports enters as tariff lines with duties in the range of 5 percent to 25 percent". Remarkably, we also observe that most of the non-agricultural commodity imports tends to enter as tariff lines in the range of 0 percent to 10 percent. [Valdes (2013)].

In recent years, Pakistan in line with WTO commitments has been restructuring its tariff structure. It is evidenced by the fact that by July 2014, Pakistan did not have duty free lines. However, again in recent years, a tariff escalation has been noted. For example, 98 percent of tariff lines are bound where is the average bound rate is 61.5 percent. Furthermore, different types of concessions and regulatory exemptions and SROs given industries has been a source of deviation from MFN. Despite cautious liberalisation, overall tariff levels remain high, which is not a good omen in term of productivity and efficiency of resource allocation.

Adjusting to the increasing trade liberalisation requires a considerable reallocation of resources between different sectors of the economy. In particular, increasing trade liberalisation tends to have implication for labour markets of Pakistan. The adjustment may take place in the form of changes both in employment and wages. This study therefore, is an attempt to understand how the adjustment takes place in the economy in term of employment and wages. In particular, how the employment of production[2] (presumably low skilled) workers and non-production workers[3] (skilled) workers behave in the post liberalisation period.

2. TREND IN EMPLOYMENT AND WAGES

Table 2 indicates a pattern of production worker's employment and wage both in the pre and post-liberalisation period. It shows that in the pre-liberalisation period, many of the import competing industries experienced an impressive growth (mostly in the double digits) in employment and wages. It included industries like electrical goods,

[2]Production workers means those who are engaged in work directly associated with production like manufacturing, assembling, packing, repairing etc. Working supervisors and persons engaged for repairs and maintenance are also included.

[3]Non-Production workers includes administrative and professional employees, white collar office employees.

industrial chemicals, other chemicals, machinery industry, glass and non-metallic products as well as rubber industry. However, in the post-liberalisation period, when most of the tariffs and other non-tariff barriers were eliminated in the 1990s, many of these industries which had recorded a significant positive growth in term of employment and wages, tumbled down and the growth rate became negative in term of employment and wages of production workers.

Table 2

Industry-wise Compound Annual Growth Rate in Employment and Wages of Production Workers (%)

	Pre-liberalisation Period[4] (1975-76 to 1990-91)		Post-liberalisation Period (1990-91 to 2005-06)	
Industry	Employment	Wages	Employment	Wages
Food	0.8	1.2	5.7	3.7
Beverages	24.6	20.8	–6.9	–9.2
Coal and Petroleum	2.0	2.5	7.8	2.6
Drugs and Medicine Industry	0.5	5.2	0.8	0.1
Electrical Goods	15.2	13.7	–3.6	–1.5
Fabricated Metal Products	8.7	7.8	–1.9	–3.2
Glass and Non-Metallic Products	15.1	16.4	–5.3	–8.4
Industrial Chemicals	4.1	3.8	8.1	–4.6
Iron Bars and Steel Industry	14.3	13.5	–6.7	–5.4
Leather and Foot Wear Industry	–1.9	–1.1	7.8	3.5
Machinery Industry	14.5	8.4	3.9	4.4
Other Chemicals	13.1	12.4	–5.9	–6.1
Paper Printing and Wood	7.2	12.0	13.8	10.2
Rubber Products	14.2	13.5	–3.5	–6.6
Textile	–0.02	–2.8	7.0	5.4
Transport Goods	–4.7	1.1	27.1	13.6

Source: Author's own calculation based on various issues of CMI.

However, this result is not very surprising. Since during the 60s, Pakistan actively pursued the strategy of import substitution. Many of these industries got protected through subsidies, tariffs and other non-tariff measures. For example, Naqvi and Kemal (1991) who conducted a comprehensive survey on the structure of protection in Pakistan came up with the findings that during the 1960, import competing industries got protected heavily while these import competing industries were the most inefficient industries. In

[4]In fact, Pakistan, in the late 80s, under the Structural Adjustmetn Programme, moved toward a more liberalised regime by reducing import duties and eliminating non-tariff barriers. Hence the period before 1990-91 is considered as pre-liberalisation, while the period after 1990-91 is post-liberalisation.

the 1990s, the liberalisation strategy pursued by Pakistan resulted in elimination of subsidies, tariff and non-tariff barriers. As a result, these import competing industries were no more able to withstand foreign competition and production worker's employment and wages experienced a decline.

On the other hand, Table 3 also shows that many of the labour intensive industries like food, leather and footwear, paper printing and wood, transport and textile industry, which experienced a very nominal growth or even a negative growth in production worker's employment and wages in the pre-liberalisation period, recorded a significant positive growth in the post-liberalisation period. This transformation pattern from import competing industries towards export oriented industries is quite interesting and is in accordance with the traditional trade theory.

Table 3

Industry-wise Compound Annual Growth Rate in Employment and Wages of Non-Production Workers (%)

	Pre-liberalisation Period (1975-76 to 1990-91)		Post-liberalisation Period (1990-91 to 2005-06)	
Industry	Employment	Wages	Employment	Wages
Food	2.7	2.0	8.4	6.0
Beverages	4.4	–5.0	–13.7	–9.3
Coal and Petroleum	–0.9	2.7	7.1	6.7
Drugs and Medicine Industry	3.3	6.9	4.2	2.6
Electrical Goods	9.0	–0.7	–3.7	–2.8
Fabricated Metal Products	0.6	0.4	2.9	–2.6
Glass and Non-metallic Products	4.7	5.4	–0.5	–2.5
Industrial Chemicals	6.2	5.7	11.2	9.9
Iron Bars and Steel Industry	3.4	2.4	–0.8	–3.3
Leather and Foot Wear Industry	7.8	–4.5	11.1	9.5
Machinery Industry	3.5	3.5	9.5	6.3
Other Chemicals	5.8	3.8	–1.1	–3.1
Paper, Printing and Wood	6.2	10.9	16.6	10.8
Rubber Products	5.3	5.7	0.8	–4.9
Textile	–2.3	–0.6	10.6	6.7
Transport Goods	2.5	–0.8	11.1	7.0

Source: Author's own calculation based on various issues of CMI.

Table 3 shows the trend in employment and wages of non-production workers. With the exception of coal and petroleum and textile industry, growth in employment and wages was positive in almost all other industries. Unlike the production workers, growth in employment and wages of non-production workers was not as high in the pre-liberalisation period. However, in the post-liberalisation period, there was a higher growth in employment and wages of non-production workers in the food industry, coal and petroleum, industrial chemicals, leather and footwear industry, machinery industry, paper printing and wood, transport and textile industry.

Many of these industries which experienced a higher growth in term of employment and wages were labour intensive industries. But this finding may not be surprising as it is more likely be the result of the increasing technological change that

takes place with the increasing globalisation and liberalisation. Industries make use of a more modern techniques and technology requiring the use of more skilled workers in order to compete in the face of increasing global competition.

There were some other industries wherein both employment and wages of non-production workers recorded a decline. It included the industries like beverages, electrical goods, glass and non-metallic products, other chemicals as well as iron bars and steel industry.

3. EMPIRICAL EVIDENCE

The main theoretical reference on the impact of trade liberalisation on employment and wage differential is the traditional Heckscher-Ohlin-Samuelson theorem. Heckscher-Ohlin theorem of international trade forms the basis for studying the link between trade and employment. According to the H-O theorem, countries allocate their resources towards the production of a commodity with which the country is abundantly endowed. Developing countries being labour abundant, will allocate their resources towards the production of labour-intensive goods, while developed countries will concentrate on the production of capital intensive goods because they use to have more capital. Trade between them will lead to a more efficient use of resources; increase the share of labour in total output in the developing countries and that of capital in the developed countries. Similarly, the Stolper-Samuelson theorem also proves that there is one to one correspondence between the product prices and the factor prices. Since trade liberalisation is likely to increase the demand for labour intensive products in developing countries, so the demand for labour in the developing countries, while for capital in developing countries is expected to increase. The main idea of HOS framework is re-distribution of employment from import substituting sector towards export sector.

The Stolper-Samuelson Theorem (SST) implies that protectionism increases the demand for the scarce factor. In developing countries the scarce factor is capital, while capital is skilled biased. Hence, the demand for skilled workers will increase. It follows that liberalisation will stimulate the demand for unskilled workers in developing countries; while in developed countries it will increase the demand for skilled workers [Beaulieu and Dehejia (2005)].

The literature on employment and wages has expanded a great deal in the last decade. Most of the studies have been accomplished in the context of both developed and developing economies. The empirical findings are mixed. Some studies, come up with the findings that trade has a positive impact while other show that trade has either no significant impact or it has no impact on labour demand. [Wood (1997); Revenga (1997); Slaughter (2001); Hasan (2001); Banga (2005)]. Rama, *et al.* (2003) presents an analytical review of literature on trade, globalisation and labour market outcomes. The study points out that empirical results on globalisation and labour demand are sharply divided, and come up with different consequences. However, one of the pattern tends to emerge from these studies, i.e. wages tend to fall with trade and rise with foreign direct investment at least in the short run. In the long run, however, both trade and foreign direct investment tends to have a positive impact on wages. Furthermore, the study indicates that social protection programmes are helpful in reducing inequality while, core labour standards seems to have no significant impact on return to labour.

Hasan, *et al.* (2007) examine the impact of trade liberalisation on labour demand elasticities using industry-level data dis-aggregated by states of India from 1980 to 1997 while decomposing labour demand elasticity into substitution effect and scale effect. The empirical findings show that in the post liberalisation period, these elasticities have increased especially in states subjected to more flexible regulations. Belman and Lee (1996) analysing a review of literature on trade and job displacement in US comes up with the findings that because of downward sticky wages, trade may reallocate and displace workers. This type of adjustment could be costly if it is involuntary as the typical displaced workers are supposed to experience a significant associated losses, including a potentially prolonged period of unemployment and reduced earnings once they get re-employed. Some studies link change in increasing wage inequality with trade , FDI and immigration. The empirical results show that production worker wages tend to rise with exports but decline with increasing FDI and immigration. As far, the employment of production workers is concerned, it tends to increase with increasing productivity and exports as well. On the other hand, FDI and immigration, both have a negative impact on production workers' employment [Yasin (2007)].

Some studies evaluating the validity of assumptions and prediction of traditional trade models show that there are other channels through which trade may affect wages. The study identifies that traditional trade theories presume that the good which is imported is also produced locally. As a result a good imported is likely to displace domestic workers, however, Edwards and Lawrence (2010) show that a country may not necessarily produce the goods imported and therefore, may not displace domestic workers. Hence the predictions of the traditional trade theories may not be held as expected.

Helpman, *et al*. (2012) shows that the role of labour market rigidity is important for labour market outcomes of trade openness. The study concludes that trade tends to result in higher unemployment in sectors where labour market frictions are low. On the other hand, in a sector where labour market frictions are higher trade tends to result in lower unemployment. Some studies show that the impact of trade on employment and wages is dependent on the type of labour market structure. For example, a study by Iqbal *et al.* (2012) examining the impact of trade liberalisation on employment and wages in Pakistan's manufacturing come up with the findings that trade tends to have a positive impact on employment and wages with flexible labour markets, however, with regulated markets are incorporated in the model, the results are still robust and don not change indicating that labour market regulations do not have any significant effect on the labour market. Similarly, Krishna, *et al.* (2012) investigates wage dispersion across heterogeneous worker groups in Brazil in response to trade liberalisation. It shows that higher education workers experience greater increases in wage dispersion relative to low education workers following trade liberalisation.

In a recent study, Iqbal, *et al.* (2014) have examined the impact of trade on employment of production and non-production workers in case of Pakistan, while using the CMI data. The study has reported a negative impact on employment of both production and non-production workers. However, the aforementioned study has not examined the impact of trade on wages of production and non-production workers. Theoretically, it is also possible that the adjustment to trade liberalisation may have taken

place through a decline in employment, but at the same time, trade may have contributed to reducing wage inequality of production and non-production workers.

An important relationship between trade liberalisation and wage inequality tends to instigate from the traditional trade theorem of Stolper Samelosn theorem which postulates that the gap between the wages of production and non-production workers should narrow down in labour abundant countries such as a developing country like Pakistan. However, this empirical evidence has not been supported by most of the studies that have focused on trade and wages related outcomes in developing countries [Robins (1996); Wood (1997) and Arbache (2001)].

The present study makes a contribution to the existing literature by investigating the Stolper Samuelson theorem in the context of Pakistan which to the best of our knowledge none of the studies have investigated so far. The present study, therefore, attempts to fill this gap by analysing the impact of trade both on employment and wages of production and non-production workers so that we can identify that how labour market adjustment takes place i.e., whether it is through adjustment in employment or wages.

4. ECONOMETRIC MODEL

To estimate the impact of trade liberalisation on wages and emloyment of production and non-production workers, we follow Milner and Wright (1998), and derive labour demand equation from a profit-maximising model of firm behavior. Now assume a Cobb-Douglas production function of the following form:[5]

$$Y_{it} = A^{\gamma} K_{it}^{\alpha} N_{it}^{\beta} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Y, A, K and *N* shows output, technological progress, capital stock and units of labour respectively. Whereas, γ is the share of efficiency of production, α is the share of capital and β shows the share of labour used in the production. The industrial sector is denoted by i varies from $i = 1, 2, \ldots N$ and the time period is shown by notation *t*, varies from $t = 1, 2, \ldots T\ldots$.

A firm is assumed to choose the level of capital and labour according to its marginal revenue product. We obtain the following expression after eliminating the capital and solving the system simultaneously:

$$Y_{it} = A^{\gamma}\left(\frac{\alpha N_{it}}{\beta} \times \frac{w_i}{c}\right)^{\alpha} N^{\beta}{}_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

To take the logarithm and rearrange the Equation (2), the derived demand of the industry can be written as follows:

$$ln N_{it} = \theta_0 + \theta_1 ln W_{it} + \theta_2 ln Y_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

where

$$\theta_0 = -(\gamma ln A + \alpha ln\alpha - \alpha ln\beta)/(\alpha+\beta), \theta_1 = -\alpha/(\alpha+\beta)$$

[5]This model is heavily based on the study of Milner and Wright (1998).

$$\text{and} \qquad \theta_2 = 1/(\alpha+\beta) \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Just like Greenaway (1995), we also assume *A* as technical efficiency, which is correlated with trade, share and evolve over time in the following manner:

$$A_{it} = e^{\delta 0 Tit} M_{it}^{\delta 1} X_{it}^{\delta 2}, \quad \delta_0, \delta_1, \delta_2 \qquad > 0 \qquad \ldots \quad \ldots \quad \ldots \quad (4)$$

Where *T* is time trend, *M* and *X* are imports and exports respectively. To allow for dynamic changes and adjustments in Equation (3), the estimated labour demand equation can be written as follows:

$$ln\, N_{it} = \theta_0 + \theta_1\, ln\, N_{it-1} + \theta_2\, ln W_{it} + \theta_3\, ln Y_{it} + \theta_4\, ln V_{it} + u_{it} \quad \ldots \quad \ldots \quad (5)$$

Where *N, W* and *Y* denote total employment, average real wages and industry *i* output in time *t*, where *t*=1, 2….*T*. *V* denote vector of variables which affect labour demand. θ_0 is intercept, while θ_1, θ_2 , θ_3 and θ_4 are other unknown parameters to be estimated.

Wage equation can be determined as an inverse labour supply function and other factors. To sum up these effects, we estimate a wage equation of the following form:

$$ln W_{it} = \beta_0 + \beta_1\, ln Y_{it} + \beta_2\, ln N_{it} + \beta_3\, ln W_{it-1} + \beta_4\, ln V_{it} + u_{it} \quad \ldots \quad \ldots \quad (6)$$

where *W, Y* and *N* are defined as above, while, β_0 is intercept and β_1 , β_2 , β_3, β_4 are unknown parameters, to be estimated. In the above model, *V* represents a vector of variables, affecting labour demand. For the purpose of our study, the key variables are openness, average tariff rate, exports, imports, and time trend used. Equations (5) and (6) paves the basis for estimation of wage and employment equation of production and non-production workers.

Production workers

$$ln\, PN_{it} = \theta_0 + \theta_1\, ln\, PW_{it} + \theta_2\, ln\, PN_{it-1} + \theta_3\, ln Y_{it} + \theta_4\, ln Z_{it} + \theta_5 V_{it} + \mu_{it} + \eta_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

$$ln\, PW_{it} = \theta_0 + \theta_1\, ln\, PN_{it} + \theta_2\, ln\, PW_{it-1} + \theta_3\, ln Y_{it} + \theta_4\, ln Z_{it} + \theta_5 V_{it} + \mu_{it} + \eta_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

Non-production workers

$$ln\, NPN_{it} = \theta_0 + \theta_1\, ln\, NPW_{it} + \theta_2\, ln\, NPN_{it-1} + \theta_3\, ln Y_{it} + \theta_4\, ln Z_{it} + \theta_5 V_{it} + \mu_{it} + \eta_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

$$ln\, NPW_{it} = \theta_0 + \theta_1\, ln\, NPN_{it} + \theta_2\, ln\, NPW_{it-1} + \theta_3\, ln Y_{it} + \theta_4\, ln Z_{it} + \theta_5\, V_{it} + \mu_{it} + \eta_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

Where *PN, PW, NPN, NPW* and *Y* represent production worker's employment, production worker's real wages, non-production worker's employment, non-production

worker's real wages and output in industry *i* and time *t*, wherever *t*=1, 2….*T*. *Z* represents liberalisation i.e. average tariff rate measured as import duties divided by volume of imports. *V* denotes vector of variables which affect labour demand such as exports, imports and time trend used as proxy for technology. θ_0 is intercept, while θ_1, θ_2, θ_3, θ_4, θ_5, θ_6 and θ_7 are other unknown parameters to be estimated whereas μ_{it} and η_{it} represent error terms which pick up random measurement errors in employment and wages respectively.

5. ESTIMATION PROCEDURE

In response to shocks such as trade shock, adjustment of employment and wages usually is not contemporary rather there is a time involved in adjustment; we therefore have to include lag of the dependent variable in the model. However, inclusion of dependent variable with lag has a problem that some of the standard estimators such OLS, fixed effects, random effects, and feasible generalised least squares (FGLS) tends to produce estimates that are biased and inconsistent. [Nickell (1981) and Kien and Yoon (2009)].

To deal with this issue, IV and GMM approaches are the most appropriate to date in order to have unbiased and consistent results. Nonetheless, we use GMM approach to deal with heteroskedasticity if it is present, whereas even if there is no heteroskedasticity present, GMM estimator is still better compared to IV approach. Unlike the IV approach, GMM estimator makes use of all available moment conditions and therefore, yields not only consistent but efficient estimates also. [Baum, Schaffer, and Stillman (2003)]. The GMM estimator consists of first-differenced GMM (DIF-GMM) and system GMM (SYS-GMM). The former is developed by Arellano and Bond (1991) and the latter is developed by Blundell and Stephen (1998), both are popular to estimate dynamic panel dataset. However, in both of the estimators, the first-difference GMM is considered to have "poor finite sample properties, in terms of bias and imprecision, when lagged levels of the series are only weakly correlated with subsequent first differences". Besides, when the number of time period available is small, the difference GMM might be subject to a large downward finite-sample bias. For this purpose, the system-GMM is the most suitable one compared to difference GMM. We, therefore, tend to use the Sys-GMM the main method for estimating the employment and wage equations. For the purpose of our study, we estimate the model with both difference GMM and Sys-GMM in order to check robustness of the model. Furthermore, to check consistency of the model, we in this study will use Hansen *J* test.

6. DATA

This study uses a panel dataset with a sample of 18 large scale manufacturing industries and time series data from 1970-71 to 2005-06.[6] Because of non-availability of time series data on annual basis, this study uses data with a 5 years gap. We use industry data according to Pakistan's Standard Industrial Classification (PSIC) at 3-digit level. The data regarding output, employment and wages of production and non-production

[6]The latest available survey data of CM is upto 2005-06 only. Whereas, the recent structure of the economy has been changed a lot by 2015, so, we must be careful in analysing the result of our study.

workers come from various issues of the Census of Manufacturing Industries (CMI) of Pakistan. Commodity-wise exports and imports data come from various issues of *Statistical Year Book*. To construct variable of trade liberalisation, we divide total import duties over the volume of imports. In order to construct variable of real output, this study deflates nominal output with wholesale manufacturing price index. Similarly, we divide the employment cost by the total number of employees to form a nominal wage variable while to convert it into real wages, we deflate nominal wage with the consumer price index (CPI).

As part of the data analysis, an examination of the correlation between variables is presented in Table 4. This is to get some preliminary view regarding the types of associations which prevail among variables. The correlation results show that production worker's employment is correlated negatively with production worker's wages, the average tariff rate, imports and real output, but it is correlated positively with non-production worker's employment and non-production worker's wages, openness and exports.

Table 4

Correlation Matrix

	PN	PW	NPN	NPW	TF	RX	RM	RY
PN	1.00							
PW	–0.71	1.00						
NPN	0.85	0.52	1.00					
NPW	0.77	0.80	–0.69	1.00				
TF	–0.04	–0.03	–0.06	–0.03	1.00			
X	0.07	–0.03	0.08	–0.01	–0.11	1.00		
M	–0.06	–0.11	–0.07	–0.13	0.05	–0.01	1.00	
RY	–0.05	–0.09	–0.03	–0.09	–0.03	0.11	0.11	1.00

Source: Calculated by author.

Note: PN=Production worker's employment, PW= Production worker's wages, NPN=Non-Production worker's employment, NPW= Non-Production worker's wages, TF= Average Tariff rate, X= Exports, M= Imports, Real output.

Production workers' wages are correlated positively with non-production worker's employment and non-production worker's wages and openness, but correlated negatively with average tariff, exports, imports and real output. Non-production worker's employment is correlated positively with openness and exports, but correlated negatively with non-production workers wages, average tariff rate, imports and real output. Finally, non-production worker's wages are correlated negatively with the average tariff rate, exports, imports and real output but correlated positively with openness.

7. RESULTS

Estimation[7] results showing the impact of trade liberalisation both on employment and wages of production and non-production workers are presented in Tables 5 and 6.

[7]For estimation purpose this study uses Eviews-5. However, it is a fact that for GMM, the most suitable software is STATA.

Estimation results are based on difference GMM and Sys-GMM. Model-1 and 2 show that trade liberalisation has significantly negative effect on production worker's employment, while it has a significantly positive impact on real wages of production workers. Similarly, the empirical results based on Sys-GMM are reported in model 3 and 4 in Table 5. The results are robust as the Sys-GMM based results show that the impact of trade liberalisation is significantly positive impact on employment while it is significantly negative impact on real wages.

Table 5

Regression Results of Production Workers

	Differenced GMM		System GMM	
	Employment	Wages	Employment	Wages
Variables	Model-1	Model-2	Model-3	Model-4
Real Wages	–2.446 (–2.145)**	–	–0.226 (–3.114)**	–
Employment Lag	0.424 (4.668)**	–	0.228 (4.568)**	–
Employment	–	–0.234 (–2.601)**	–	–0.224 (–1.894)*
Wage Lag	–	0.323 (3.440)**	–	0.353 (4.440)**
Output	0.105 (2.098)**	0.628 (1.976)*	0.257 (3.098)**	0.232 (1.886)*
Liberalisation	0.175 (2.206)**	–0.001 (–2.178)**	0.173 (2.654)**	–0.074 (–1.889)*
Exports	0.124 (2.556)*	0.062 (1.861)*	0.173 (1.994)**	0.074 (1.979)**
Imports	–0.073 (–1.754)	–0.864 (–1.691)	–0.063 (–1.654)	0.174 (1.71)
Time Trend	–0.018 (–1.182)	0.016 (1.472)	–0.048 (–1.162)	0.033 (0.472)
R-squared	0.6449	0.6284	0.7321	0.7284
No. of Observation	144	144	144	144
No. of Industries	18	18	18	18
Hansen J-Test: P-value	0.09341	0.11901	0.24438	0.23312
Wald Test (Joint Significance): p-value	0.0000	0.0000	0.0000	0.0000

Note: *Significant at 10 percent level, ** Significant at 5 percent level. (a) Robust t-statistics are given in parentheses. (b) Standard errors are HAC heterosckedasticity-and autocorrelation-consistent) or Newey-West standard errors.

In the aftermath of trade liberalisation, these inefficient industries were not able to withstand foreign competition. Other independent variables such as output and wages have signs according to theory. Both lag of employment and real wages have significantly positive effect on its current level in almost all model specifications of Table 5.

Exports have significantly positive effect on production workers' employment while it has positive but insignificant effect on production workers' wages indicating that rising export intensity increases labour demand. This can be attributed to the fact

that Pakistan's exports are more labour-intensive than imports. This result has an important implication for Pakistan's labour market. It implies that exports have generated new jobs for Pakistan's abundant labour force, thus reducing its unemployment level.

Hence, an increase in export volume will bring about employment opportunities for Pakistan's abundant labour force. As far as import penetration is concerned, it is interesting to note that its estimated coefficient is positive but statistically insignificant. Table 6 indicate estimation results regarding the impact of trade liberalisation on employment and wages of non-production workers. The empirical results are based on first difference GMM and Sys-GMM as well. Difference-GMM based results show that trade liberalisation measured as average tariff rate has significantly negative impact on employment but it has significantly positive impact on wages of non-production workers. The empirical results obtained with System-GMM show trade liberalisation have significantly negative impact on employment while it has no significant impact on wages of non-production workers.

Table 6

Regression Results of Non-Production Workers

	Differenced GMM		System GMM	
	Employment	Wages	Employment	Wages
Variables	Eq-1	Eq-2	Eq-3	Eq-4
Real Wages	–1.527 (–2.136)**	–	–1.517 (–2.146)**	–
Employment Lag	0.428 (4.568)**	–	0.328 (2.568)**	–
Employment	–	–0.024 (–2.54)**	–	–0.034 (–2.854)**
Wage Lag	–	0.313 (2.440)**	–	0.353 (4.440)**
Output	0.057 (2.098)**	0.232 (0.286)	0.422 (2.098)**	0.312 (1.896)*
Liberalisation	0.073 (1.754)*	–0.174 (–1.923)*	0.034 (1.685)**	–0.474 (1.869)
Exports	0.446 (1.145)	0.044 (2.114)	0.226 (1.114)	0.628 (1.976)*
Imports	0.024 (2.668)**	0.113 (3.440)*	0.028 (1.868)*	0.064 (1.691)
Time Trend	0.048 (1.862)*	0.161 (2.172)**	0.048 (1.182)	0.114 (0.472)
R-squared	0.6621	0.6558	0.6321	0.7484
No. of Observation	144	144	144	144
No. of Industries	18	18	18	18
Hansen J-Test: P-value	0.2003	0.319	0.2443	0.0912
Wald Test (Joint Significance): p-value	0	0	0	0

Note: *Significant at 10 percent level, ** Significant at 5 percent level. (a) Robust t-statistics are given in parentheses. (b) Standard errors are HAC heterosckedasticity-and autocorrelation-consistent) or Newey-West standard errors

Real wages as well as output have expected signs. Imports have almost positive effect both on employment and wages of non-production (relatively high-skilled) workers. Imports of developing countries are usually assumed to be skill-biased and are expected to have a positive effect on labour demand of non-production workers.

On the other hand, exports have a positive but insignificant effect on employment and wages of non-production workers. However, in case of Sys-GMM, the results show that exports have insignificantly positive impact on employment, but it has a significantly positive impact on the wages of non-production workers. Our empirical results on the impact of trade on employment and wages of production and non-production workers show that they almost confirm the empirical findings of [Revenga (1997)].[8]

8. DIAGNOSTICS TESTS

To account for endogeneity problem in estimating employment and wage equations, this paper has used difference-GMM and system-GMMG. Almost in all of the analysis, other than the independent variables we have used the first difference, lag of the first difference of dependent variable and second lag of the dependent variable as instruments. In order to check for the validity of over identifying restrictions, we have used Hansen J-test. Under null hypothesis of Hansen J-test, the validity of over-identifying restrictions is supposed to be satisfied if there is no second order correlation of the residuals. However, our results of the Hansen-J test do not allow us to reject the hypothesis of the validity of instruments used in the study. As far as hetroskedasticity and auto correlation are concerned, all estimates are based upon HAC (Hetroskedasticity-Auto-correlation Consistent) robust standard errors.

9. CONCLUSION

Trade openness and liberalisation is a key to foster economic growth and development in a developing country like Pakistan. Changes in economic structure in favour of increasing exports' share of manufactured products could be a favourable signal for this process. However, increasing trade liberalisation is also supposed to result in reshuffling of jobs across sectors. This paper aimed to investigate the labour market's response to trade liberalisation. For this purpose, the paper builds on a dynamic labour demand that incorporates average tariff rate, exports and imports. For this purpose, the study uses difference GMM as well as system GMM in order to estimate the model. The study comes up with the findings that trade liberalisation has significantly negative impact on employment of production and non-production workers whereas, trade liberalisation has significantly positive impact on wages of production workers but it has no significant impact on wages of non-production workers with both difference GMM and system-GMM. The negative impact of trade is attributed to the high protection given to most of the inefficient industries in the post liberalisation period. On the other hand, reduction in non-production worker employment is not unexpected as in case of developing country like Pakistan, trade liberalisation is supposed to displace capital intensive industries that employ most of the non-production (skilled) workers.

[8]The major limitation of this study is the use of data upto 2005-06 which is not very updataed as CMI 2010-11 is still in process.

Appendices

Appendix A1

Summary of Pakistan MFN Applied Import Duty Ranges

Frequency Distribution		Duty-free	0 ≤ 5	5 ≤ 10	10 ≤ 15	15 ≤ 25	25 ≤ 50	50 ≤ 100	> 100	Non ad valorem
		% of tariff lines or % of import value								% of lines or value
Agricultural Products										
Final Bound		0	3.3	0	0.3	0.1	0.5	90.3	1.8	0.1
MFN Applied	2010	13.9	19.6	15.7	13.8	14.5	20.1	2.4	0	5
Import Value	2009	34.8	4.1	17.4	21.6	19.6	2.2	0.2	0	32.6
Non-agricultural Products										
Final Bound		0	1.9	0	1.8	14.9	18.3	62.3	0	0
MFN Applied	2010	5	38.4	13	6.7	31.6	4.9	0.3	0	0.1
Import Value	2009	36.1	25.3	18.7	3.8	11.8	2.7	1.7	0	0.9

Source: Authors elaboration based on data from the World Trade Organisation.

Appendix A2

Average Rate of Import Duty with and without Exemption/Concessions

Year	Average Tariff rate*	Average Tariff Rate**	Year	Average Tariff Rate*	Average Tariff Rate**
1990-91	23.0	39.0	2001-02	9.1	15.1
1991-92	17.9	32.6	2002-03	9.3	15.6
1992-93	20.8	35.3	2003-04	4.8	7.5
1993-94	20.6	34.7	2004-05	8.8	13.3
1994-95	21.6	33.5	2005-06	8.1	13.1
1995-96	21.6	34.6	2006-07	7.1	13.1
1996-97	19.6	22.9	2007-08	6.5	12.7
1997-98	15.7	20.7	2008-09	5.7	11.7
1998-99	13.5	17.7	2009-10	5.7	12.5
1999-00	12.3	17.7	2010-11	5.6	12.7
2000-01	10.5	17.0			

*With dutiable imports, ** Without dutiable imports.

Appendix A3

List of Industries Used for Regression Analysis

No. of Industry	Industry	No. of Industry	Industry
1	Food	10	Other Chemicals
2	Tobacco	11	Coal and Petroleum
3	Leather and Foot Wear Industry	12	Rubber Products
4	Textile	13	Glass and Non-metallic Products
5	Wearing Apparel	14	Iron Bars and Steel Industry
6	Beverages	15	Fabricated Metal Products
7	Paper Printing and Wood	16	Machinery Industry
8	Drugs and Medicine Industry	17	Electrical Goods
9	Industrial Chemicals	18	Transport Goods

Appendix A4

Variables Codes and Definitions

Variables	Definition
Employment (N)	Average daily persons engaged in manufacturing includes employees, working propreitaries, unpaid family workers and home workers.
Wages (W)	It includes wages and salaries paid plus cash and non-cash benefits and constructed as employment cost divided by average number of employee speudr industry paid to the workers.
Production Workers (PW)	Production workers means those who are engaged in work directly associated with production like manufacturing, assembling, packing, repairing etc. Working supervisors and persons engaged for repairs and maintenance are also included.
Non-Production Workers (NPN)	Non-Production workers includes administrative and professional employees, white collar office employees, drivers watchmen, peons, sweepers etc.
Value of Production (Y)	It consists of the value of finished products and by-products, receipts for work done for others, receipts for repairs and maintenance, value of sale of semi-finished products and by-products, wastes and used goods, value of electricity sold, value of sales of goods purchased for resale, the net increase in the value of work in the process and the value of fixed assets produced by the establishment for its own use.
Average Tariff Rate (z2)	This is measured by value of import duties divided by volume of imports.

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Which Pairs of Stocks should we Trade? Selection of Pairs for Statistical Arbitrage and Pairs Trading in Karachi Stock Exchange

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Pairs Trading refers to a statistical arbitrage approach devised to take advantage from short term fluctuations simultaneously depicted by two stocks from long run equilibrium position. In this study a technique has been designed for the selection of pairs for pairs trading strategy. Engle-Granger 2-step Cointegration approach has been applied for identifying the trading pairs. The data employed in this study comprised of daily stock prices of Commercial Banks and Financial Services Sector. Restricted pairs have been formed out of highly liquid log share price series of 22 Commercial Banks and 19 Financial Services companies listed on Karachi Stock Exchange. Sample time period extended from November 2, 2009 to June 28, 2013 having total 911 observations for each share prices series incorporated in the study. Out of 231 pairs of commercial banks 25 were found cointegrated whereas 40 cointegrated pairs were identified among 156 pairs formed in Financial Services Sector. Furthermore a Cointegration relationship was estimated by regressing one stock price series on another, whereas the order of regression is accessed through Granger Causality Test. The mean reverting residual of Cointegration regression is modeled through the Vector Error Correction Model in order to assess the speed of adjustment coefficient for the statistical arbitrage opportunity. The findings of the study depict that the cointegrated stocks can be combined linearly in a long/short portfolio having stationary dynamics. Although for the given strategy profitability has not been assessed in this study yet the VECM results for residual series show significant deviations around the mean which identify the statistical arbitrage opportunity and ensure profitability of the pairs trading strategy.

JEL classifications: C32, C53, G17
Keywords: Pairs Trading, Statistical Arbitrage, Engle-Granger 2-step Cointegration Approach, VECM.

1. INTRODUCTION

The concept of statistical arbitrage emerged from the notion of predictability and long-term relationship in stock returns, which has been further support by the recent advent of the idea of mean reversion. The idea of mean reversion in stock prices supports predictability and works against the concept of efficient market hypothesis according to which stock prices exhibit a random walk and cannot be forecasted. A mean reverting

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time series, on the contrary can be forecasted using historical data [Charles and Darné (2009); Gupta and Basu (2007)]. Furthermore literature also reported the role of mean reversion for portfolio allocation and asset management. Over the past decade, the hedge funds and investment banks have capitalised on statistical arbitrage opportunities using mean reverting portfolios. Simplest of such portfolios is a two-asset portfolio in case of pairs trading [Pole (2007); Vidyamurthy (2004)].

Pairs trading strategy was initiated by Nunzio Tartaglias while working with Morgan and Stanley during the era of 1980s. It has been adopted by hedge funds as a statistical arbitrage technique. The idea emerged from the fact that certain securities depicted daily correlated returns over a long period of time. Therefore trading strategies were developed in order to capitalise upon these statistical arbitrage opportunities evolving due to the market inefficiencies [Lo and MacKinlay (1988); Khandani and Lo (2007); Lo and Mackinlay (1997); Gatev, *et al.* (2006); Guidolin, *et al.* (2009)]. In pairs trading, pairs are formed of those stocks, which had shown similar price movements historically. When the selected pair depicts divergence between the price movements, it is assumed to be temporary and is capitalised upon through opening long/short positions simultaneously. The strategy aspires that these short-term fluctuations will converge over the period of time under the effect of long run equilibrium relationship between the two stocks.

Traditionally stocks are allocated in a portfolio on the basis of correlation or other non-parametric techniques. In this study Cointegration based trading pairs have been developed. The existence of a cointegrating association provided a base for developing a certain linear combination between the cointegrated trading pairs and as a result the portfolio developed is a stationary process. Any deviation depicted by stock price series from the equilibrium is regarded as mispricing. Hence the stock price series are expected to return to zero from these short term mispricing deviations. The effect of mispricing makes one stock appear as undervalued and the other as overvalued and creates a statistical arbitrage opportunity for pair traders. Therefore in pair trading a two stock portfolio is developed through taking a long position in an undervalued stock and a short position in an overvalued stock. A portfolio maintaining a value below its equilibrium position creates a prospect for opening a long position however it is closed when the portfolio value returns back to its likely mean position. Whereas a short position is opened in the portfolio when its value is above its equilibrium value and is closed out when the portfolio value falls close to the estimated mean. Such short-term mis-pricing moments make the portfolio profitable under the pairs trading strategy.

Which pairs of stocks should we trade? This is a critical question, imperative for the traders to address, in order to avoid trading with the mismatched pairs which may make the pairs trading strategy unprofitable. Therefore the primary objective of this study is to select a trading pair based on the co-movement of two stock price series in the long run and the speed of adjustment of the disequilibrium term. Engle-Granger (EG) Test for Cointegration has been applied to identify the long run equilibrium relationship between two stocks. The EG approach to Cointegration will help in assessing whether the relationship between two stocks in a pair is spurious or not. A Cointegration relationship is estimated by regressing one stock price series on another, whereas the order of regression is accessed through Granger Causality Test. The stationary residual series of

the cointegrating regression depicts the mean reverting behaviour of a trading pair. Consequently, the Vector Error Correction Model (VECM) has been employed to model the stationary residual series. The residual series contains significant information pertaining to co-movement between the trading pairs. For instance the 'speed of adjustment' coefficients in the VECM describe how quickly the system reverts to its mean after observing a short-term deviation and also identifies which stock in a pair performs the error correction function.

In order to achieve the above mentioned objectives the rest of the study has been organised into following sections. Section 2 postulates a brief overview of academic literature pertaining to pairs trading strategy. Section 3 explains the methodology adopted in the study for describing pairs trading strategy. Section 4 specifies the empirical results and Section 5 provides discussion and conclusion of the empirical study.

2. LITERATURE REVIEW

Since long the pairs trading strategy has fascinated the practitioners as well as the academicians. Kawasaki, *et al.* (2003) analysed the profitability of taking both long and short positions simultaneously in a pair of stocks that yields a stationary spread series. The long/short investment strategies proved to be profitable. Kawasaki, *et al.* (2003) did not present the idea of pairs trading formally however the underlying concept remained same. Nath (2003) proposed a simple yet profitable pairs trading strategy based on Cointegration analysis, in the large and highly liquid secondary market of US treasury securities while accounting for finance and transaction cost. Hong and Susmel (2003) further tested the pairs trading strategy based on Cointegration analysis for 64 Asian shares listed in their local markets as well as in the US markets as American Depository Receipt (ADR). The findings of the study revealed significant pairs trading profits in the US ARD market. Elliot, *et al.* (2005) extended the concept of pairs trading and asserted that the Pairs trading strategy works through making a market neutral portfolio with zero beta and is referred to as spread. This spread is further modelled as mean reverting process using the Gaussian Markov Chain model. On the basis of the simulated data, the findings of the study revealed that the methodology proposed by Elliot, *et al.* (2005) has the ability to generate profits from the financial time series data which is found out to be out of equilibrium. Andrade, *et al.* (2005) introduced the effect of uninformed demand shocks in the pairs trading strategy in the Taiwanese stock market revealing significant excess returns.

The literature pertaining to pairs trading is pioneered by Gatev, *et al.* (2006). Under the pairs trading strategy proposed by Gatev, *et al.* (2006) pairs were selected on the basis of the distance approach and using the identified pairs long and short positions were taken on the basis of preset criteria. The strategy yielded annualised returns of 11 percent and the findings of the study also suggested that the pair trading strategy is a profitable option for those investors who are exposed to smaller transaction costs and can execute short sale activities. Do, *et al.* (2006) followed the pairs trading strategy proposed by Gatev, *et al.* (2006) and introduced the stochastic spread approach for the formation of restricted pairs. The findings of Do, *et al.* (2006) reported stable performance results and also confirmed the mean reversion behaviour observed under the stochastic residual spread approach. Lin, *et al.* (2006) also extended the work of Gatev, *et al.* (2006) through replacing the distance approach with

Cointegration analysis during the pair formation period. Papadakis and Wysocki (2007) attempted to test the impact of accounting information events (i.e. earnings announcements and analyst's earnings forecasts) on the profitability of the pairs trading strategy proposed by Gatev, *et al.* (2006) and inferred that the stock prices drift, due to the earnings announcements and the analyst's earnings forecasts, is a significant factor affecting the profitability of the pairs trading strategy. Later Bock and Mestel (2009) attempted to execute the traditional pairs trading strategy through apply the trading rules.

The idea of pairs trading further evolved with the work of Engelberg, *et al.* (2009) for whom the primary motivation was to understand and identify those factors that cause the pairs to diverge. Certain factors identified by Engelberg, *et al.* (2009), that might affect the convergence and divergence patterns in stock prices, included liquidity of the stocks in a pair, information diffusions, horizon risk and divergence risk. The results suggested that the profits from the pairs trading strategy are short lived and are directly related to the information pertaining to the constituent firms in a pair. Engelberg, *et al.* (2009), asserted that the identification of a lead lag relationship between stocks due to a common information event depicts a strong lacking in the unconditional pairs trading strategy proposed by Gatev, *et al.* (2006) which works without referring to the events leading to the changes in the prices of stocks in a pair.

Huck, *et al.* (2009) introduced combined forecast approach and Multi criteria decision methods for pair selection and depicted promising results and categorised the proposed methodology as a powerful tool for pair's selection. Perlin (2009) tested the pairs trading strategy in the Brazilian stock market with high frequency data and discovered that the pairs trading strategy is profitable and market neutral in the Brazilian market and generates best results for the high frequency daily data. The concept of high frequency pairs trading was further supported by Bowen, *et al.* (2010) confirming that higher profits from the strategy are generated during the first hour of the trading. Bianchi, *et al*. (2009) tested the pairs trading strategy in the commodity futures market and the findings of the study revealed statistically significant excess returns. Bolgün, *et al.* (2010) and Yuksel, *et al.* (2010) tested the pairs trading strategy proposed by Gatev, *et al.* (2006) in the Istanbul Stock Exchange and revealed that the profitability from pairs trading is highly sensitive to transaction restrictions and transaction commissions.

Do and Faff (2010) extended the pairs trading strategy proposed by Gatev, *et al.* (2006) and suggested that the pairs trading strategy performs well during the turbulent times in the market i.e. it is profitable in the bearish markets. Mori and Ziobrowski (2011) further asserted that only the market trends are not important for explaining divergence patterns and the profitability of pairs trading rather the market characteristics and dynamics also play a significant role. Do and Faff (2012) once again tested the pairs trading strategy proposed by Gatev, *et al.* (2006) while assessing the impact of transaction cost on the profitability of pairs trading strategy. The empirical results exhibited that the pairs trading strategy remains profitable even after controlling for the trading costs however the level of profit decreases. These findings were further supported by Pizzutilo (2013) while testing the effectiveness of the pairs trading strategy for the individual investors under the existence of the relevant constraints in the form of restriction to short selling and trading costs. Furthermore Huck (2013) also tested the sensitivity of the pairs trading strategy to the length of the formation period and signified that the large abnormal positive returns are generated when long formation periods are employed.

Hong, *et al.* (2012) revealed a positive performance of the pairs trading strategy in the Korean stock market whereas Broussard and Vaihekoski (2012) described excess positive returns from the pairs trading strategy in the Finish market. Mashele, *et al.* (2013) also affirmed that the investment strategy based on pairs trading is successful in the Johannesburg stock exchange. Caldeira and Moura (2013) claimed that the pairs trading strategy based on Cointegration remains profitable in the Brazilian market even during the times of financial crisis and thus generate consistent profits.

Several techniques have been reported in the literature for the implementation of pairs trading strategy. The four most commonly reported techniques include the non-parametric distance approach [Gatev, *et al.* (1999); Nath (2003)], the stochastic spread method [Elliot, *et al.* (2005)], the stochastic residual spread method [Do, *et al.* (2006)] and the Cointegration method [Vidyamurthy (2004)].

The significance and power of the Cointegration technique can be inferred from the fact that it allows for the application of estimation models like Ordinary Least Square and Maximum Likelihood to non-stationary time series. Regardless of its vast applicability, the use of Cointegration technique in the field of investment analysis and portfolio management is still limited. This limited use of Cointegration in investment strategies is attributable to massive use of a standardised correlation analysis for asset returns. Correlation analysis technique works for stationary variables, which in turn entails prior de-trending of stock prices and financial time series data which is normally integrated of order one or higher. As a result all inferences are based on returns [Damghani, *et al.* (2012)]. Due to the de-trending procedure valuable information is lost from the differenced time series [Johansen (2011)]. Likewise if time series included in a system are integrated of different orders then different orders of differencing are needed to make the variables stationary. Therefore inferences made on the basis of correlation analysis fail to incorporate important information pertaining to the time series understudy.

The Cointegration approach for pairs trading is significantly adopted and favoured in the literature due to its simplicity and ability to avoid the problem of model mis-specification and to identify mean reversion in price series [Broussard and Vaihekoski (2012); Gutierrez and Tse (2011); Puspaningrum, Lin, and Gulati (2010); Chiu and Wong (2012)]. In order to benefit from the positive features of Cointegration approach this study also strives to adopt the Cointegration approach in order to form and select pairs for pairs trading strategy in Karachi Stock Exchange while using Engle Granger Cointegration methodology. Literature concludes pairs trading as an efficient arbitrage opportunity emerged through statistical transformations however this arbitrage opportunity can only be materialised through the correct selection of pairs possessing long term equilibrium. The next section elaborates the methodology adopted to assess the long run equilibrium relationship between stocks included in a pair and their mean reversion behaviour imperative for a successful pairs trading strategy.

3. DATA COLLECTION AND METHODOLOGY

This study utilised daily stock prices of 22 Commercial banks and 19 Financial Services companies listed on the Karachi Stock Exchange (KSE). The daily data of stock prices has been retrieved from *Business Recorder*. Since it is imperative for pairs trading

that the stocks remain actively traded and liquid, therefore only those stocks were included in the study, which depicted high turnover and active trading. Out of the 23 listed commercial banks and 40 listed financial services companies, 22 banks and 19 financial services companies were included in the study solely on the basis of high turnover and active trading [Do and Faff (2010)]. The issue of stale prices and restricted trading became a reason for stocks exclusion from the study. See Appendix I for the list of companies included in the study.

The sample time period consists of daily stock returns collected over a period extending from November 2, 2009 to June 28, 2013 having total 911 observations for each time series incorporated in the study. This study is based upon restricted trading pairs, which refers to pair formation of stocks from the same industry or sector [Kawasaki, *et al.* (2003)]. There are several reasons attributable to opting for restricted pairs trading. Pairs trading, by virtue of its construction is largely perceived as a market neutral strategy in which portfolios are deliberately constructed to hold zero beta and inhibit the systematic risk. In such neutralised portfolios profits are generated by the long and short positions solely due to the convergence of residual spread in the form of mean reversion. Therefore stocks in a pair have been selected from the same sector with an assumption that they would be affected by similar systematic risk factors and resultantly the portfolios developed would have a zero beta. In this study 231 restricted pairs have been developed using 22 sampled Commercial Banks (see Table 3 in Appendix III) and 171 pairs have been developed using 19 financial services companies however 15 pairs were dropped due to the Stationarity issues and for the rest of the analysis 156 pairs have been considered (see Table 4 in Appendix III). The formula employed for developing stock pairs is given below,

$No. of\ Stock\ Pairs = \frac{N^2-N}{2}$, N is the number of sample Companies.

Another reason supporting the formation of restricted pairs is the theoretical justification for a cointegrating relationship existing between the two stocks of the same sector. Although Cointegration alone provides fundamental basis for the formation of a trading strategy yet in case of restricted pairs this statistical relationship is also justified by the fact that the two stocks are affected by similar fundamental factors in the long run. Therefore a cointegrating relationship found in-sample would be expected to prevail in the long run out-of-sample as well. However a cointegrating relationship between two randomly selected stocks would possess no economic and theoretical justification along with any surety to prevail in the long run. Consequently the study worked with two sectors being commercial banks and financial services sector as described above. Trading pairs made in each sector are handled separately.

As mentioned earlier, the objective of the study is to identify trading pairs on the basis of a long run equilibrium relationship between two stocks in a pair and the speed of adjustment of the disequilibrium term. On the basis of the set objective, the methodology has been divided in to four subsections. For testing long run equilibrium relationship Engle-Granger (EG) approach to Cointegration has been discussed in subsection 3.1. Later in subsection 3.2., Granger Causality test has been discussed in detail due to its ability to provide an insight into the dynamics of a cointegrating relationship for cointegrated pair of stocks. A uni-directional Granger Causality test describes which stock informationally leads another

stock in a trading pair. In subsection 3.3., a cointegrating equation and a residual spread has been established on the basis of uni-directional Granger Causality output. In subsection 3.4., for estimating the short run relationship between the cointegrated share prices series, Vector Error Correction Model has been discussed in detail.

3.1. Engle Granger (EG) 2-step Approach to Cointegration

A simple approach to Cointegration has been proposed by Engle and Granger (1987) in order to estimate a long run equilibrium relationship between two non-stationary time series. If a linear combination of two non-stationary time series is stationary then the two series exhibit a long run equilibrium relationship. For two series to be cointegrated it is imperative that they must be integrated of same order. Alexander (2008) asserted that although the OLS estimators are normally employed for stationary time series yet it can also be applied to non-stationary time series in case the cointegrating regression residual is a stationary process [Greene (2002)]. EG approach to Cointegration is a two step process illustrated below.

Step 1: Cointegrating Regression

For testing Cointegration, it is imperative for the two series to be non-stationary and integrated of same order. Hence the Augmented Dickey-Fuller test (ADF) applied to the log price series as a test of Stationarity in which appropriate lag length is determined using Aikaike's Information Criterion (AIC). If any of the log prices series is reported to be stationary i.e. I(0) by the ADF test, such a series is excluded from the analysis. This exclusion is attributable to the fact that Cointegration of a stationary and a non-stationary series results in a spurious regression with non-stationary residual series [Greene (2002)]. Hence if x_t and y_t are I(1) processes, then a long run relationship is estimated between log of x_t and log of $y_t$using the OLS estimator.

$$y_t = \beta_o + \beta_1 x_t + e_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3.1)$$

In the Equation 1, β_o is a constant and β_1 is the Cointegration coefficient. The residual series of the cointegrating regression is tested for Stationarity in step 2.

Step 2: Testing Stationarity of Residual Series

In this step ADF test is employed to verify the Stationarity of the estimated residual series $\widehat{e_t}$ retrieved from Equation 1 in step 1 of the EG approach, described through the Equation 2 below.

$$\widehat{e_t} = y_t - \beta_o - \beta_1 x_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3.2)$$

According to the EG approach, the estimated residual series has to be stationary for the x_t and $y_t$to be cointegrated.

The Equation 3.2 depicts a portfolio consisting of 1 Long unit of stock y_t for every β_1 short units of stock x_t and the portfolio has an equilibrium value of e_t. The deviations from the equilibrium value are represented by $\widehat{e_t}$, which is a stationary process ensuring mean reversion in portfolio value. In case the two variables are not cointegrated then the resulting regression provides spurious results and $\widehat{e_t}$ is not a stationary process.

3.2. Granger Causality Test

In the EG approach ordering of variables can emerge as an issue. For instance if log prices of y_t are regressed on log prices of x_t, then a different residual series is generated which is further tested for stationarity. In case of pairs trading strategy the ordering issue can be resolved through the Granger Causality test. Moreover the use of Granger Causality test also allows for assessing the lead-lag relationship between two stocks [Greene (2002)].

Granger causality test under bivariate (x, y) setting can be expressed as under,

$$y_t = \beta_o + \beta_1 y_{t-1} + \cdots + \beta_i y_{t-i} + \alpha_1 x_{t-1} + \cdots + \alpha_i x_{t-i} + e_t \quad \ldots \quad \ldots \quad (3.3)$$

$$x_t = \beta_o + \beta_1 x_{t-1} + \cdots + \beta_i x_{t-i} + \alpha_1 y_{t-1} + \cdots + \alpha_i y_{t-i} + e_t \quad \ldots \quad \ldots \quad (3.4)$$

This analysis provides two tests; first test examines a null hypothesis that the *x* does not granger causes *y* and the second tests examines that *y* does not granger causes *x*. If the first null hypothesis is rejected and the second is accepted, it can be inferred that *x* granger causes *y* indicating uni-directional causality from *x* to *y*. This also depicts that *x* informationally leads *y* [Greene (2002)]. However in case if both the hypotheses are rejected then there is a bi-directional causality between *x* and *y* but if both the hypotheses are accepted there are no evidence of causality between *x* and *y*.

3.3. Cointegrating Directional Regression and Testing Residual Spread for Stationarity

After assessing the direction of causality through the Uni-directional Granger Causality test, the issue pertaining to ordering of variables in cointegrating regression is resolved and allows the researchers to estimate a cointegrating directional regression as given in Equation 3.1 if null hypothesis of Equation 3.3 is rejected in Granger Causality test [Greene (2002)]. As mentioned under the EG approach to Cointegration, estimated residual spread series is tested for Stationarity using ADF test.

3.4. Vector Error Correction Model (VECM)

According to the Granger Representation Theorem, when the two time series are cointegrated, the Vector Autoregressive model (VAR) is mis-specified [Greene (2002)]. The mis-specification problem can be treated through incorporating the previous disequilibrium term in the VAR model as an explanatory variable and thus the model becomes well-specified and is termed as Vector Error Correction model (VECM). VECM allows for modelling the dynamics of one time series as a function of its own lags, lags of its cointegrated pair and the error correction component. The error correction component determines the speed of adjustment of time series from a short run deviation to its equilibrium position [Gujarati (2003)]. After obtaining the disequilibrium term from Equation 3.1, the VECM is applied to the two cointegrated log return series Δy_t and Δx_t.

$$\Delta y_t = \alpha_1 + \gamma_1 e_{t-1} + \varepsilon_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3.5)$$

$$\Delta x_t = \alpha_2 + \gamma_2 e_{t-1} + \varepsilon_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3.6)$$

In the Equation 3.5 and Equation 3.6, e_{t-1} is the lag of disequilibrium term obtained from Equation 3.2 above. α_1 and α_2 are constant terms whereas γ_1 and γ_2 are the speed of adjustment coefficients.

$$\Delta y_t = \alpha_1 + \sum_{i=1}^{m} \beta_{11}^{i} \Delta x_{t-i} + \sum_{i=1}^{m} \beta_{12}^{i} \Delta y_{t-i} + \gamma_1 e_{t-1} + \varepsilon_{it} \quad \ldots \quad \ldots \quad (3.7)$$

$$\Delta x_t = \alpha_2 + \sum_{i=1}^{m} \beta_{21}^{i} \Delta x_{t-i} + \sum_{i=1}^{m} \beta_{22}^{i} \Delta y_{t-i} + \gamma_2 e_{t-1} + \varepsilon_{it} \quad \ldots \quad \ldots \quad (3.8)$$

Both the Equations 3.7 and 3.8 have been estimated through OLS while including the lags of the dependent and independent variables in order to avoid autocorrelation problem. From the Equations 3.7 and 3.8, the values of γ_1 and γ_2 can be retrieved which can be termed as speed of adjustment coefficients [Gujarati (2003)]. The size and sign of the speed of adjustment coefficients are the two critical characteristics. In VECM, it is imperative that either one of the two or both coefficients must be statistically different from zero. When both the statistically significant speed of adjustment coefficients depict opposite sign, it can be inferred that the two cointegrated time series will move in opposite direction to resume equilibrium [Gujarati (2003)]. However if the two depict same sign, then both series will exhibit convergence in the same direction, with one moving faster than the other one.

The size of the speed of adjustment coefficient indicates that the larger the size of the speed of adjustment coefficient the faster will be the response of the dependent variable towards the deviation from the long run equilibrium. Large values of speed of adjustment coefficients also indicate highly stationary disequilibrium term. However in case these coefficients have small values it can be concluded that the dependent variable either does not responds or responds very slowly to the short term deviations [Gujarati (2003)].

Here the size and sign of the speed of adjustment coefficients depict the mean reversion and convergence characteristics of two cointegrated time series in a pair. Therefore for pairs trading profitability it is imperative that the speed of adjustment coefficients must be significant having the right sign and a large size.

On the basis of the methodology devised above, empirical results of the study have been illustrated in the next section.

4. EMPIRICAL RESULTS

This section pertains to the empirical testing of the trading pairs selection idea presented in the preceding sections and the interpretation of results. Table 1 (Appendix I) contains a List of companies included in the study pertaining to Commercial Banks and the Financial Services sector. For each company given in Table 1, a symbol is also given as quoted in Karachi Stock Exchange. Later in the analysis, these companies will be referred to using these symbols. Subsequent subsections depict application of the methodology devised in Section 3.

4.1. Cointegration Results

Cointegration analysis strives to work with non-stationary time series data in order to assess long run equilibrium relationship. Therefore for Cointegration analysis, the sample time series have to be non-stationary. Table 2 in Appendix II, provides the

summary of ADF test for the entire log share price series incorporated in the study related to commercial banks and financial services sector. Table 2 provides the tau-statistic for the ADF test in levels along with the relevant p-values given in parenthesis. According to the ADF test results for all the understudy log share price series, all the series are non-stationary being I(1) except for two series in Financial Services Sector. Hence overall the null hypothesis of unit root cannot be rejected, on the basis of the ADF test results all the series qualify for Cointegration analysis under the EG two step approach.

In this study, Long run relationship has been assessed through EG Cointegration approach for all the potential trading pairs in Commercial Banks and Financial Service Sector listed on the Karachi Stock Exchange. In the EG two step approach, the Stationarity of the residual series, estimated through the OLS regression, when applied to two non-stationary log share price series, has been tested. Table 5 and Table 6 in Appendix IV contains the result of EG Cointegration tests for Commercial Banks and Financial Services Sector respectively. For each trading pair EG Cointegrating regression estimated residual series has been tested for Stationarity using the ADF test and the p-values have been reported. In Commercial Banks Sector out of the 231 potential trading pairs 60 pairs were found out to be cointegrated as reported in Table 5. P-values reported in Table 5 indicate the rejection of unit root null hypothesis. Similarly Table 6 reports the EG Cointegration rest results for Financial Services Sector indicating that out of 156 potential trading pairs 77 were found out to be cointegrated as the p-values reported in Table 6 rejected the unit root null hypothesis at the significance level of 1 percent, 5 percent and 10 percent.

For all the cointegrated pairs, revealed in both Commercial Banks and Financial Services Sector, a long run equilibrium relationship can be inferred as meaningful and statistically significant. In order to assess the direction of causality or the order of cointegrating regression for all the cointegrated pairs in Commercial Banks and Financial Services Sector granger causality results have been reported in the next sub section.

4.2. Results of Granger Causality Test

For 60 cointegrated pairs in Commercial Banks sector and 77 cointegrated pairs in Financial Services Sector granger causality has been tested in this sub section. This will provide an insight into the dynamics of the cointegrated pairs through describing which share price series in a cointegrated pairs informationally leads the other series. Table 7 and Table 8 in Appendix V provide pair-wise granger causality test results for each cointegrated pairs in Commercial Banks and Financial Services Sector respectively. For every trading pair two null hypotheses have been tested and reported along with the p-values in Table 7 and Table 8. The acceptance or rejection of the null hypothesis determines the direction of causality in each trading pair.

For instance, in Commercial Bank Sector pair-wise granger causality test results for BAFL/BOK depict bi-directional causality as both the null hypotheses have been rejected. Same is found out to be true for ABL/UBL pair. However in case of HBL/HMB pair, both the null hypotheses have been accepted indicating no causal relationship between the two return series.

Analysing the granger causality results (see Table 7) for ABL/BOK pair, it can be inferred that BOK granger causes ABL whereas ABL does not granger causes BOK. Such inferences are based on the p-values of both the null hypotheses. This is an evidence

of unidirectional causality exhibiting that BOK leads ABL. Similarly in Financial Services Sector unidirectional causality has been reported in FDIBL/FCSC pair for which the null hypothesis stating that FDIBL does not granger causes FCSC is accepted as its p-value > 0.05. However null hypothesis stating FCSC does not granger causes FDIBL is rejected with the p-value < 0.05. This is again an evidence of unidirectional causality.

Out of the 60 cointegrated pairs in Commercial Bank Sector 25 pairs reported unidirectional causality. Similarly in Financial Services Sector 40 pairs reported unidirectional causality. Since in this study, the idea is to form a long/short two asset portfolio with one asset leading the other, therefore only the pairs demonstrating unidirectional causality have been considered for further analysis. 35 pairs from Commercial Bank Sector and 37 pairs from Financial Services Sector have been excluded from the analysis either due to no causality or bi-directional causality.

4.3. Estimation of Directional Regression and Residual Spread Stationarity

After identifying the direction of causality, in this section cointegrating direction regression equation has been estimated and the estimated residual series is tested for stationarity. This step of the methodology strives to confirm the long term equilibrium relationship between the trading pairs depicting unidirectional causality. Since it is a cointegrating regression, OLS estimator has been applied on two non-stationary log share price series for which the stationarity of the estimated residual series has been ensured through the ADF test. Table 9 and Table 10 contain cointegrating directional regression results for commercial banks and financial services sector respectively.

Continuing the BAHL/FABL pair from the Commercial Banks Sector, the cointegrating coefficient estimated through the cointegrating regression is 0.5812 (see Table 9 in Appendix VI). The cointegrating coefficient is significant and can be interpreted as the number of units of FABL held short for every one unit of ABL held long so that the resulting portfolio is mean reverting. The value of the portfolio is given by [C+e_t] exhibiting an equilibrium value of 23.61016 (see Table 9 in Appendix VI). Fluctuations in the portfolio value around its equilibrium value are governed by the deviations in e_t. Here it can be inferred that the behaviour of e_t dictates the behaviour of the total portfolio value. For a meaningfully cointegrated pair of share price series, it is critical for e_t to be stationary as only then the dynamic behaviour of e_t will depict strong levels of mean reversion. Stationarity of e_t ensuring mean reversion is a necessary condition for a successful pairs trading strategy. Table 9 also provides the ADF test statistics along with its p-value for residual series estimated through the cointegrating regression of BAHL/FABL pair. For BAHL/FABL pair residual series, the unit root null hypothesis has been rejected at the significance level of 5 percent hence confirming the existence of a long run equilibrium relationship between BAHL/FABL. Similarly in the Financial Services Sector, the cointegrating regression for FDIBL/FCSC pair exhibits a cointegrating coefficient of 0.1910 indicating the number of FCSC units to be held short for every one unit of FDIBL held long. The portfolio has an equilibrium value of 0.9069 and any deviations in the equilibrium value are governed by deviations in e_t as the estimated residual series is reported to be stationary and mean reverting on the basis of the ADF test results.

The strong evidences of long term equilibrium relationship and mean reversion revealed by the results of the cointegrating directional regression lead the discussion towards estimating error correction model in order to understand the short term dynamics of the cointegrated variables.

4.4. Validation Short Term Deviations through VECM

In this subsection, the error component has been modelled using Vector Error Correction Model (VECM) for which the results are given in Table 11 and Table 12 for Commercial Banks and Financial Services sector respectively. For VECM, log differences of stock prices have been employed. Table 11 and Table 12 also include Long run β Coefficient and its [t-statistic] for each cointegrated pair. Speed of Adjustment Coefficients γ1 and γ2 are also given along with their [t-statistic].

The VECM results for Commercial Banks Sector indicate that at least one of the speed of adjustment coefficients is statistically significant confirming the existence of cointegrating relationship as reported in the previous subsection. VECM results for BAHL/FABL pair, of Commercial Banks, depict a significant long run β coefficient confirming the granger causality results and indicating that FABL granger causes BAHL. Furthermore for BAHL/FABL pair, both the speed of adjustment coefficients is statistically significant having opposite signs. This indicates that both the stocks in the pair respond towards the exogenous shocks to restore the equilibrium position of the portfolio however their response is opposite to each other. Similarly for ABL/BOK, both the speed of adjustment coefficients is significant having same signs (see Table 11 in Appendix VII). According to the reported results γ1 (–0.0599) and γ2 (–0.0025) is significant at 5 percent. For ABL/BOK pair speed of adjustment coefficients depict same sign which indicates that in response to a shock, ABL and BOK move in the same direction however ABL moves faster than BOK on the basis of larger size of its γ1 coefficient in order to restore the equilibrium. Considering the case of NBP/BAHL pair, there is a significant long run β coefficient confirming the granger causality results and indicating that BAHL leads NBP and confirms the long term equilibrium relationship. For NBP/BAHL pair, one speed of adjustment coefficient is found out to be significant (γ1=-6.13575) indicating that in case of disequilibrium and short term shocks NBP responds to restore the equilibrium.

Considering KASBSL/JSIL pair from the Financial Services Sector, the VECM results in Table 12 report a significant long term β coefficient confirming the cointegrating relationship however none of the speed of adjustment coefficients are statistically different from zero. In this case it can be inferred that although KASBSL and JSIL report a long run equilibrium relationship yet there is no term in the model that responds to restore the model to some equilibrium level after experiencing short term deviations. For such pairs in pairs trading mean reversion is not possible.

Therefore on the basis of the VECM results it can be recommended that only those cointegrated pairs must be traded for which either one or both speed of adjustment coefficients are significant having correct signs and are large enough to generate faster response for restoring equilibrium after short term shocks.

5. CONCLUSION

In this study an attempt has been made to answer a primary question in pairs trading strategy being; which pairs of stocks should we trade? In order to answer this question, the study has focused on cointegration analysis for ensuring mean reversion in the selected pairs. For a successful pairs trading strategy it is imperative that a trading

pair must depict long run equilibrium relationship as well as short run relationship ensuring mean reversion. Here mean reversion is imperative due to the fact that if any divergence from equilibrium position creates an arbitrage opportunity and a trade is opened, then there must be convergence in order to restore the equilibrium and close the trade to earn arbitrage profits. This can only be achieved with pairs that depict a long run equilibrium relationship as well as also respond to the short term deviations due to exogenous shocks.

The focus of the study remained Commercial Banks and Financial Services Sector in Karachi Stock Exchange and formed 231 restricted pairs in Commercial Banks sector and 156 restricted pairs were formed in Financial Services sector. The alternate hypothesis of long run equilibrium relationship between stocks in pair is found out to be true for 60 pairs in Commercial Banks sector and for 77 pairs in Financial Services sector under the EG 2 step Cointegration approach. In order to further confirm the cointegration relationship, direction of causality has also been assessed through Granger Causality test revealing 25 trading pairs in Commercial Banks demonstrating unidirectional causality whereas 40 pairs depicted unidirectional causality in Financial Services sector. For all the cointegrating pairs, a long run directional regression has been estimated and the regression residuals have been tested for stationarity in order confirm the long run equilibrium relationship. Later for all the cointegrating pairs, the residual is modeled through employing the VECM in order to ensure that at least one of the two speed of adjustment coefficients is significant so that mean reversion can be expected in a pair. The methodology for pairs selection proposed in this study works through forming restricted pairs of highly liquid stocks and ensures the existence of long term as well as short term equilibrium relationship between stocks in a pair. In doing so this methodology responds to a major risk factor in pairs trading being absence of co movement or long run relationship between stocks in a pair. The pairs formed under this methodology depict long run relationship as well as short term corrections to the random shocks experienced and are capable of executing a profitable pairs trading strategy.

The scope of this study has remained limited to proposing and empirically testing the pairs selection technique within the context of Karachi Stock Exchange. The scope of the study did not include assessing the profitability of pairs trading in Karachi Stock Exchange which should be the next research endeavour. Future research attempts can be made through expanding the scope to other sectors of Karachi Stock Exchange. Further the proposed pair's selection technique should be employed for pairs trading in Karachi Stock Exchange.

6. PRACTICAL IMPLICATION OF THE STUDY

This study focuses upon a comprehensive application of pairs trading strategy within the context of Pakistan. The pairs trading strategy as a hedge fund strategy is new to the emerging equity market of Pakistan. Through this research the application of pairs trading investment strategy in Pakistan will help in broadening the investment horizon of the local investors. Although short selling is not allowed in Pakistan which is the primary assumption of the pairs trading strategy yet it can be based on the assumption that the stocks can be sold short. Therefore this study tends to challenge the restricted short selling policy in the equity market of Pakistan.

APPENDIX I

Table 1

List of Companies

Table 1 contains a List of companies included in the study pertaining to Commercial Banks and the Financial Services sector. For each company given in the Table 1, a symbol is also given as quoted in Karachi Stock Exchange. Later in the analysis, these companies will be referred to using these symbols

Commercial Banks		Financial Services Sector	
Symbol	Company Name	Symbol	Company Name
ABL	Allied Bank Limited	AHL	Arif Habib Limited
AKBL	Askari Bank Limited	DEL	Dawood Equities Limited
BAFL	Bank Al-Falah Limited	ESBL	Escorts Investment Bank Limited
BAHL	Bank Al-Habib Limited	FCSC	First Capital Securities Corporation Limited
BOK	Bank Of Khyber Limited	FDIBL	First Dawood Investment Bank Limited
BOP	Bank Of Punjab Limited	FNEL	First National Equities Limited
BIPL	Bankislami Pakistan Limited	GRYL	Grays Leasing Limited
FABL	Faysal Bank Limited	IGIBL	IGI Investment Bank Limited
HBL	Habib Bank Limited	JSGCL	JS Global Capital Limited
HMB	Habib Metropolitan Bank Limited	JSIL	JS Investments Limited
JSBL	JS Bank Limited	JSCL	Jahangir Siddiqui Company Limited
KASBB	KASB Bank Limited	KASBSL	KASB Securities Limited
MCB	MCB Bank Limited	MCBAH	MCB-ARIF Habib Savings & Investments Ltd
MEBL	Meezan Bank Limited	OLPL	Orix Leasing Pakistan Limited
NIB	NIB Bank Limited	PASL	Pervez Ahmed Securities Limited
NBP	National Bank of Pakistan	SPLC	Saudi Pak Leasing Company Limited
SBL	Samba Bank Limited	SIBL	Security Investment Bank Limited
SILK	Silkbank Limited	SCLL	Standard Chartered Leasing Limited
SNBL	Soneri Bank Limited	TRIBL	Trust Investment Bank Limited
SCBPL	Standard Chartered Bank Limited		
SMBL	Summit Bank Limited		
UBL	United Bank Limited		

APPENDIX II

Table 2

Augmented Dickey Fuller (ADF) Test Results for Log Price Series

Table 2 contains ADF test results of log prices in order to ensure that the price series qualifies the condition of non-Stationarity for the Cointegration analysis. Table 2 provides the tau-statistic for the ADF test along with the relevant p-values given in parenthesis

Commercial Banks		Financial Services Sector	
Symbol	tau-Statistic (p-value)	Symbol	tau-Statistic (p-value)
ABL	–0.12981 (0.22445)	AHL	–1.79456 (0.3837)
AKBL	–2.07698 (0.2542)	DEL	–1.97609 (0.2977)
BAFL	–1.11167 (0.7136)	ESBL	–1.81009 (0.376)
BAHL	–1.41394 (0.51052)	FCSC	–2.38769 (0.1452)
BOK	–1.4434 (0.5624)	FDIBL	–2.23861 (0.1926)
BOP	–1.79736 (0.3823)	FNEL	–1.7598 (0.401)
BIPL	–1.09327 (0.7208)	GRYL	–1.92371 (0.3216)
FABL	–1.68157 (0.4407)	IGIBL	–2.36111 (0.153)
HBL	–1.01707 (0.33335)	JSGCL	–2.33763 (0.1601)
HMB	–2.44617 (0.1291)	JSIL	–2.36966 (0.1505)
JSBL	–1.50221 (0.5327)	JSCL	–2.14956 (0.2253)
KASBB	–2.22589 (0.1971)	KASBSL	–2.38842 (0.145)
MCB	–2.29299 (0.1743)	MCBAH	–2.72558 (0.06965***)
MEBL	–1.36619 (0.6005)	OLPL	0.170826 (0.9708)
NIB	–1.5681 (0.499)	PASL	–1.72358 (0.4193)
NBP	–2.04519 (0.2675)	SPLC	–0.928116 (0.7799)
SBL	–2.03015 (0.2739)	SIBL	–0.750174 (0.8322)
SILK	–2.27314 (0.1808)	SCLL	–2.25135 (0.1882)
SNBL	–2.5003 (0.1153)	TRIBL	–2.72648 (0.0695***)
SCBPL	–0.0529857 (0.9526)		
SMBL	–1.92746 (0.3198)		
UBL	–0.512045 (0.8866)		

* Significant at 1 percent, **Significant at 5 percent, ***Significant at 10 percent.

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APPENDIX III

Table 3

List of Trading Pairs for Commercial Banks

Table 3 provides a list of pairs for Commercial Banks Sector. Using 22 sampled Commercial Banks, 231 pairs have been formed employing the following formula $No.of\ Stock\ Pairs = (N^2 - N)/2$, N is the number of sampled Commercial Banks. Relevant symbols have been used to represent a specific Commercial Bank in a pair.

1	BAFL/BAHL	31	BAHL/KASBB	61	AKBL/BOK	91	BOK/UBL	121	BIPL/SBL	151	HBL/SCBPL	181	KASBB/SBL	211	NIB/SBL
2	BAFL/ABL	32	BAHL/MCB	62	AKBL/BOP	92	BOK/SMBL	122	BIPL/UBL	152	HBL/SILK	182	KASBB/UBL	212	NIB/UBL
3	BAFL/AKBL	33	BAHL/MEBL	63	AKBL/BIPL	93	BOK/SCBPL	123	BIPL/SMBL	153	HBL/SNBL	183	KASBB/SMBL	213	NIB/SMBL
4	BAFL/BOK	34	BAHL/NBP	64	AKBL/FABL	94	BOK/SILK	124	BIPL/SCBPL	154	HMB/JSBL	184	KASBB/SCBPL	214	NIB/SCBPL
5	BAFL/BOP	35	BAHL/NIB	65	AKBL/HBL	95	BOK/SNBL	125	BIPL/SILK	155	HMB/KASBB	185	KASBB/SILK	215	NIB/SILK
6	BAFL/BIPL	36	BAHL/SBL	66	AKBL/HMB	96	BOP/BIPL	126	BIPL/SNBL	156	HMB/MCB	186	KASBB/SNBL	216	NIB/SNBL
7	BAFL/FABL	37	BAHL/UBL	67	AKBL/JSBL	97	BOP/FABL	127	FABL/HBL	157	HMB/MEBL	187	MCB/MEBL	217	SBL/UBL
8	BAFL/HBL	38	BAHL/SMBL	68	AKBL/KASBB	98	BOP/HBL	128	FABL/HMB	158	HMB/NBP	188	MCB/NBP	218	SBL/SMBL
9	BAFL/HMB	39	BAHL/SCBPL	69	AKBL/MCB	99	BOP/HMB	129	FABL/JSBL	159	HMB/NIB	189	MCB/NIB	219	SBL/SCBPL
10	BAFL/JSBL	40	BAHL/SILK	70	AKBL/MEBL	100	BOP/JSBL	130	FABL/KASBB	160	HMB/SBL	190	MCB/SBL	220	SBL/SILK
11	BAFL/KASBB	41	BAHL/SNBL	71	AKBL/NBP	101	BOP/KASBB	131	FABL/MCB	161	HMB/UBL	191	MCB/UBL	221	SBL/SNBL
12	BAFL/MCB	42	ABL/AKBL	72	AKBL/NIB	102	BOP/MCB	132	FABL/MEBL	162	HMB/SMBL	192	MCB/SMBL	222	UBL/SMBL
13	BAFL/MEBL	43	ABL/BOK	73	AKBL/SBL	103	BOP/MEBL	133	FABL/NBP	163	HMB/SCBPL	193	MCB/SCBPL	223	UBL/SCBPL
14	BAFL/NBP	44	ABL/BOP	74	AKBL/UBL	104	BOP/NBP	134	FABL/NIB	164	HMB/SILK	194	MCB/SILK	224	UBL/SILK
15	BAFL/NIB	45	ABL/BIPL	75	AKBL/SMBL	105	BOP/NIB	135	FABL/SBL	165	HMB/SNBL	195	MCB/SNBL	225	UBL/SNBL
16	BAFL/SBL	46	ABL/FABL	76	AKBL/SCBPL	106	BOP/SBL	136	FABL/UBL	166	JSBL/KASBB	196	MEBL/NBP	226	SMBL/SCBPL
17	BAFL/UBL	47	ABL/HBL	77	AKBL/SILK	107	BOP/UBL	137	FABL/SMBL	167	JSBL/MCB	197	MEBL/NIB	227	SMBL/SILK
18	BAFL/SMBL	48	ABL/HMB	78	AKBL/SNBL	108	BOP/SMBL	138	FABL/SCBPL	168	JSBL/MEBL	198	MEBL/SBL	228	SMBL/SNBL
19	BAFL/SCBPL	49	ABL/JSBL	79	BOK/BOP	109	BOP/SCBPL	139	FABL/SILK	169	JSBL/NBP	199	MEBL/UBL	229	SCBPL/SILK
20	BAFL/SILK	50	ABL/KASBB	80	BOK/BIPL	110	BOP/SILK	140	FABL/SNBL	170	JSBL/NIB	200	MEBL/SMBL	230	SCBPL/SNBL
21	BAFL/SNBL	51	ABL/MCB	81	BOK/FABL	111	BOP/SNBL	141	HBL/HMB	171	JSBL/SBL	201	MEBL/SCBPL	231	SILK/SNBL
22	BAHL/ABL	52	ABL/MEBL	82	BOK/HBL	112	BIPL/FABL	142	HBL/JSBL	172	JSBL/UBL	202	MEBL/SILK		
23	BAHL/AKBL	53	ABL/NBP	83	BOK/HMB	113	BIPL/HBL	143	HBL/KASBB	173	JSBL/SMBL	203	MEBL/SNBL		
24	BAHL/BOK	54	ABL/NIB	84	BOK/JSBL	114	BIPL/HMB	144	HBL/MCB	174	JSBL/SCBPL	204	NBP/NIB		
25	BAHL/BOP	55	ABL/SBL	85	BOK/KASBB	115	BIPL/JSBL	145	HBL/MEBL	175	JSBL/SILK	205	NBP/SBL		
26	BAHL/BIPL	56	ABL/UBL	86	BOK/MCB	116	BIPL/KASBB	146	HBL/NBP	176	JSBL/SNBL	206	NBP/UBL		
27	BAHL/FABL	57	ABL/SMBL	87	BOK/MEBL	117	BIPL/MCB	147	HBL/NIB	177	KASBB/MCB	207	NBP/SMBL		
28	BAHL/HBL	58	ABL/SCBPL	88	BOK/NBP	118	BIPL/MEBL	148	HBL/SBL	178	KASBB/MEBL	208	NBP/SCBPL		
29	BAHL/HMB	59	ABL/SILK	89	BOK/NIB	119	BIPL/NBP	149	HBL/UBL	179	KASBB/NBP	209	NBP/SILK		
30	BAHL/JSBL	60	ABL/SNBL	90	BOK/SBL	120	BIPL/NIB	150	HBL/SMBL	180	KASBB/NIB	210	NBP/SNBL		

Table 4

List of Trading Pairs for Financial Services Sector

Table 4 provides a list of pairs for Financial Sector. Using 19 sampled Financial Services companies, 156 pairs have been formed employing the following formula,

$No.of\ Stock\ Pairs = \frac{N^2-N}{2}$, N is the number of sampled Financial Services Companies. Relevant symbols have been used to represent a specific Financial Services Company in a pair.

1	FDIBL/AHL	31	DEL/ESBL	61	GRYL/FCSC	91	JSCL/SPLC	121	JSIL/SPLC		
2	FDIBL/DEL	32	DEL/GRYL	62	GRYL/JSIL	92	JSCL/SIBL	122	JSIL/SIBL		
3	FDIBL/IGIBL	33	DEL/IGIBL	63	GRYL/JSGCL	93	JSCL/TRIBL	123	JSIL/TRIBL		
4	FDIBL/JSCL	34	DEL/JSCL	64	GRYL/KASBSL	94	FNEL/FCSC	124	JSGCL/KASBSL		
5	FDIBL/FNEL	35	DEL/FNEL	65	GRYL/OLPL	95	FNEL/JSIL	125	JSGCL/MCBAH		
6	FDIBL/FCSC	36	DEL/FCSC	66	GRYL/PASL	96	FNEL/JSGCL	126	JSGCL/OLPL		
7	FDIBL/JSIL	37	DEL/JSIL	67	GRYL/SCLL	97	FNEL/KASBSL	127	JSGCL/PASL		
8	FDIBL/JSGCL	38	DEL/JSGCL	68	GRYL/SPLC	98	FNEL/MCBAH	128	JSGCL/SCLL		
9	FDIBL/KASBSL	39	DEL/KASBSL	69	IGIBL/JSCL	99	FNEL/OLPL	129	JSGCL/SPLC		
10	FDIBL/OLPL	40	DEL/MCBAH	70	IGIBL/FNEL	100	FNEL/PASL	130	JSGCL/SIBL	151	PASL/TRIBL
11	FDIBL/PASL	41	DEL/OLPL	71	IGIBL/FCSC	101	FNEL/SCLL	131	JSGCL/TRIBL	152	SCLL/SPLC
12	FDIBL/SCLL	42	DEL/PASL	72	IGIBL/JSIL	102	FNEL/SPLC	132	KASBSL/MCBAH	153	SCLL/SIBL
13	FDIBL/SPLC	43	DEL/SCLL	73	IGIBL/JSGCL	103	FNEL/SIBL	133	KASBSL/OLPL	154	SCLL/TRIBL
14	AHL/DEL	44	DEL/SPLC	74	IGIBL/KASBSL	104	FNEL/TRIBL	134	KASBSL/PASL	155	SPLC/SIBL
15	AHL/ESBL	45	DEL/SIBL	75	IGIBL/MCBAH	105	FCSC/JSIL	135	KASBSL/SCLL	156	SPLC/TRIBL
16	AHL/GRYL	46	DEL/TRIBL	76	IGIBL/OLPL	106	FCSC/JSGCL	136	KASBSL/SPLC		
17	AHL/IGIBL	47	ESBL/IGIBL	77	IGIBL/PASL	107	FCSC/KASBSL	137	KASBSL/SIBL		
18	AHL/JSCL	48	ESBL/JSCL	78	IGIBL/SCLL	108	FCSC/MCBAH	138	KASBSL/TRIBL		
19	AHL/FNEL	49	ESBL/FNEL	79	IGIBL/SPLC	109	FCSC/OLPL	139	MCBAH/OLPL		
20	AHL/FCSC	50	ESBL/FCSC	80	IGIBL/SIBL	110	FCSC/PASL	140	MCBAH/PASL		
21	AHL/JSIL	51	ESBL/JSIL	81	IGIBL/TRIBL	111	FCSC/SCLL	141	MCBAH/SCLL		
22	AHL/JSGCL	52	ESBL/JSGCL	82	JSCL/FNEL	112	FCSC/SPLC	142	MCBAH/SPLC		
23	AHL/KASBSL	53	ESBL/KASBSL	83	JSCL/FCSC	113	FCSC/SIBL	143	OLPL/PASL		
24	AHL/MCBAH	54	ESBL/OLPL	84	JSCL/JSIL	114	FCSC/TRIBL	144	OLPL/SCLL		
25	AHL/OLPL	55	ESBL/PASL	85	JSCL/JSGCL	115	JSIL/JSGCL	145	OLPL/SPLC		
26	AHL/PASL	56	ESBL/SCLL	86	JSCL/KASBSL	116	JSIL/KASBSL	146	OLPL/SIBL		
27	AHL/SCLL	57	ESBL/SPLC	87	JSCL/MCBAH	117	JSIL/MCBAH	147	OLPL/TRIBL		
28	AHL/SPLC	58	GRYL/IGIBL	88	JSCL/OLPL	118	JSIL/OLPL	148	PASL/SCLL		
29	AHL/SIBL	59	GRYL/JSCL	89	JSCL/PASL	119	JSIL/PASL	149	PASL/SPLC		
30	AHL/TRIBL	60	GRYL/FNEL	90	JSCL/SCLL	120	JSIL/SCLL	150	PASL/SIBL		

APPENDIX IV

Table 5

Cointegration Results for Commercial Banks

Table 5 contains the Engle-Granger (EG) Cointegration test results for Commercial Banks. For each trading pairs, Engle-Granger Cointegrating Regression error has been tested for Stationarity using the ADF test and the p-values have been reported in the table below

	Trading Pairs	EG (p-value)		Trading Pairs	EG (p-value)		Trading Pairs	EG (p-value)		Trading Pairs	EG (p-value)
1	BAFL/BOK	0.008789*	19	ABL/MEBL	0.02807**	39	FABL/SMBL	0.09897***	57	MEBL/UBL	0.0918***
2	BAFL/MEBL	0.02299**	20	ABL/SBL	0.9959***	40	FABL/SILK	0.01807*	56	NBP/SILK	0.09046***
3	BAHL/AKBL	0.04425**	21	ABL/UBL	0.08923***	41	HBL/HMB	0.05596**	57	NIB/SNBL	0.0697***
4	BAHL/BOP	0.06455***	22	ABL/SCBPL	0.04085**	42	HBL/JSBL	0.06623***	58	SBL/SNBL	0.01072**
5	BAHL/BIPL	0.0918***	23	AKBL/KASBB	0.08669***	43	HBL/KASBB	0.06546***	59	UBL/SCBPL	0.000009841*
6	BAHL/FABL	0.002668*	24	AKBL/NIB	0.02887**	44	HBL/MCB	0.09504***	60	SMBL/SILK	0.003712*
7	BAHL/HMB	0.0003476*	25	AKBL/SBL	0.05104***	45	HBL/MEBL	0.06476***			
8	BAHL/KASBB	0.0411**	26	AKBL/SNBL	0.08551***	46	HBL/NBP	0.08939***			
9	BAHL/MEBL	0.0358**	27	BOK/BIPL	0.02936**	47	HBL/NIB	0.06438***			
10	BAHL/NBP	0.001183*	28	BOK/MEBL	0.001175*	48	HBL/SMBL	0.07491***			
11	BAHL/NIB	0.02914**	29	BOK/SCBPL	0.01992*	49	HMB/NBP	0.01724**			
12	BAHL/SMBL	0.04305**	30	BOP/KASBB	0.004174*	50	HMB/SILK	0.05437***			
13	BAHL/SCBPL	0.04955**	31	BOP/NIB	0.009164*	51	KASBB/NIB	0.001719*			
14	BAHL/SILK	0.02161**	32	BOP/SBL	0.02544**	52	KASBB/SBL	0.0724***			
15	BAHL/SNBL	0.0681***	33	BOP/SNBL	0.07581***	53	KASBB/SILK	0.08409***			
16	ABL/BOK	0.02138**	34	BIPL/JSBL	0.01882*	54	KASBB/SNBL	0.04456**			
17	ABL/BIPL	0.0274**	35	BIPL/MEBL	0.05611**						
18	ABL/JSBL	0.03491**	36	FABL/HMB	0.00924*						
			37	FABL/NBP	0.0007933*						
			38	FABL/NIB	0.04268**						

* Significant at 1 percent, **Significant at 5 percent, ***Significant at 10 percent.

Table 6

Cointegration Results for Financial Services Sector

Table 6 contains the Engle-Granger (EG) Cointegration test results for Financial Services Sector. For each trading pairs, Engle-Granger Cointegrating Regression error has been tested for Stationarity using the ADF test and the p-values have been reported in the table below.

	Trading Pairs	EG p-value		Trading Pairs	EG p-value		Trading Pairs	EG p-value		Trading Pairs	EG p-value		Trading Pairs	EG p-value
1	FDIBL/AHL	0.0056*	19	DEL/JSCL	0.00001903*	35	GRYL/IGIBL	0.00064*	53	IGIBL/TRIBL	0.09656***	71	MCBAH/SPLC	0.08559***
2	FDIBL/DEL	0.0000*	20	DEL/FNEL	0.03626**	36	GRYL/JSCL	0.00080*	54	JSCL/JSIL	0.0026*	72	OLPL/SCLL	0.00000*
3	FDIBL/IGIBL	9.147e-05*	21	DEL/FCSC	0.00000*	37	GRYL/FNEL	0.0001*	55	JSCL/JSGCL	0.0384**	73	PASL/SPLC	0.03601**
4	FDIBL/JSCL	0.001359*	22	DEL/JSIL	0.0001*	38	GRYL/FCSC	0.00066*	56	JSCL/KASBSL	0.03866**	74	PASL/SIBL	0.02605**
5	FDIBL/FNEL	0.02285**	23	DEL/JSGCL	0.00000*	39	GRYL/JSIL	0.00076*	57	FCSC/JSGCL	0.006474*	75	PASL/TRIBL	0.0587***
6	FDIBL/FCSC	0.0001264*	24	DEL/KASBSL	0.00000*	40	GRYL/JSGCL	0.00082*	58	FCSC/KASBSL	0.01155*	76	SCLL/SIBL	0.07853***
7	FDIBL/JSIL	0.001275*	25	DEL/PASL	0.00000*	41	GRYL/KASBSL	0.00044*	59	FCSC/PASL	0.06795***	77	SPLC/SIBL	0.00051*
8	FDIBL/JSGCL	0.001362*	26	DEL/SIBL	0.02753**	42	GRYL/OLPL	0.00038*	60	FCSC/SIBL	0.09751***			
9	FDIBL/KASBSL	0.00007*	27	DEL/TRIBL	0.0009031*	43	GRYL/PASL	0.00048*	61	FCSC/TRIBL	0.0001118*			
10	FDIBL/PASL	0.00011*	28	ESBL/JSCL	0.00248*	44	GRYL/SCLL	0.00064*	62	JSIL/JSGCL	0.04554**			
11	FDIBL/SCLL	0.06495***	29	ESBL/FNEL	0.03565**	45	GRYL/SPLC	0.00000*	63	JSIL/KASBSL	0.02953**			
12	FDIBL/SPLC	0.00976*	30	ESBL/FCSC	0.0001*	46	IGIBL/JSCL	0.00163*	64	JSGCL/KASBSL	0.03947**			
13	AHL/DEL	0.00074*	31	ESBL/JSGCL	0.00053*	47	IGIBL/FNEL	0.08451***	65	JSGCL/PASL	0.07957***			
14	AHL/ESBL	0.05041***	32	ESBL/KASBSL	0.00006*	48	IGIBL/FCSC	0.02687**	66	JSGCL/TRIBL	0.03619**			
15	AHL/FCSC	0.05804***	33	ESBL/OLPL	0.07936***	49	IGIBL/JSIL	0.0005128*	67	KASBSL/SPLC	0.04196**			
16	AHL/KASBSL	0.08265*	34	ESBL/PASL	0.00001*	50	IGIBL/JSGCL	0.02714**	68	KASBSL/SIBL	0.03391**			
17	DEL/ESBL	0.00002*				51	IGIBL/KASBSL	0.009774*	69	KASBSL/TRIBL	0.007249*			
18	DEL/IGIBL	0.00005*				52	IGIBL/SIBL	0.05003***	70	MCBAH/SCLL	0.04695**			

* Significant at 1 percent, **Significant at 5 percent, ***Significant at 10 percent.

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Appendix V

Table 7

Pair-wise Granger Causality Test Results for Commercial Banks

Table 7 provides pair-wise Granger Causality Test Results, for each cointegrated trading pair of Commercial Banks identified in Table 5. For every trading pair two null hypotheses have been given along with their p-values. The acceptance or rejection of the null hypothesis determines the direction of causality in each trading pair.

	Trading Pairs	Direction of Causality (Null Hypothesis)	p-value	Direction of Causality (Null Hypothesis)	p-value
1	BAFL/BOK	BAFL does not Granger Cause BOK	0.045**	BOK does not Granger Cause BAFL	0.005*
2	BAFL/MEBL	MEBL does not Granger Cause BAFL	0.007*	BAFL does not Granger Cause MEBL	0.049**
3	BAHL/AKBL	AKBL does not Granger Cause BAHL	0.392	BAHL does not Granger Cause AKBL	0.643
4	BAHL/BOP	BOP does not Granger Cause BAHL	0.159	BAHL does not Granger Cause BOP	0.509
5	BAHL/BIPL	BIPL does not Granger Cause BAHL	0.738	BAHL does not Granger Cause BIPL	0.551
6	BAHL/FABL	FABL does not Granger Cause BAHL	0.005*	BAHL does not Granger Cause FABL	0.933
7	BAHL/HMB	BAHL does not Granger Cause HMB	0.369	HMB does not Granger Cause BAHL	0.001*
8	BAHL/KASBB	KASBB does not Granger Cause BAHL	0.017**	BAHL does not Granger Cause KASBB	0.259
9	BAHL/MEBL	MEBL does not Granger Cause BAHL	0.118	BAHL does not Granger Cause MEBL	0.218
10	BAHL/NBP	BAHL does not Granger Cause NBP	0.000*	NBP does not Granger Cause BAHL	0.562
11	BAHL/NIB	NIB does not Granger Cause BAHL	0.033**	BAHL does not Granger Cause NIB	0.957
12	BAHL/SMBL	SMBL does not Granger Cause BAHL	0.026**	BAHL does not Granger Cause SMBL	0.692
13	BAHL/SCBPL	SCBPL does not Granger Cause BAHL	0.266	BAHL does not Granger Cause SCBPL	0.18
14	BAHL/SILK	BAHL does not Granger Cause SILK	0.355	SILK does not Granger Cause BAHL	0.076***
15	BAHL/SNBL	BAHL does not Granger Cause SNBL	0.191	SNBL does not Granger Cause BAHL	0.037**
16	ABL/BOK	ABL does not Granger Cause BOK	0.475	BOK does not Granger Cause ABL	0.001*
17	ABL/BIPL	ABL does not Granger Cause BIPL	0.892	BIPL does not Granger Cause ABL	0.027**
18	ABL/JSBL	JSBL does not Granger Cause ABL	0.003*	ABL does not Granger Cause JSBL	0.757
19	ABL/MEBL	MEBL does not Granger Cause ABL	0.010**	ABL does not Granger Cause MEBL	0.735
20	ABL/SBL	SBL does not Granger Cause ABL	0.883	ABL does not Granger Cause SBL	0.522
21	ABL/UBL	ABL does not Granger Cause UBL	0.020**	UBL does not Granger Cause ABL	0.010**
22	ABL/SCBPL	ABL does not Granger Cause SCBPL	0.061***	SCBPL does not Granger Cause ABL	0.038**
23	AKBL/KASBB	KASBB does not Granger Cause AKBL	0.012**	AKBL does not Granger Cause KASBB	0.031**
24	AKBL/NIB	NIB does not Granger Cause AKBL	0.252	AKBL does not Granger Cause NIB	0.033**
25	AKBL/SBL	SBL does not Granger Cause AKBL	0.647	AKBL does not Granger Cause SBL	0.018**
26	AKBL/SNBL	SNBL does not Granger Cause AKBL	0.106	AKBL does not Granger Cause SNBL	0.359
27	BOK/BIPL	BOK does not Granger Cause BIPL	0.000*	BIPL does not Granger Cause BOK	0.213
28	BOK/MEBL	MEBL does not Granger Cause BOK	0.038**	BOK does not Granger Cause MEBL	0.004*
29	BOK/SCBPL	SCBPL does not Granger Cause BOK	0.055***	BOK does not Granger Cause SCBPL	0.068*
30	BOP/KASBB	KASBB does not Granger Cause BOP	0.000*	BOP does not Granger Cause KASBB	0.037**
31	BOP/NIB	NIB does not Granger Cause BOP	0.019**	BOP does not Granger Cause NIB	0.017**
32	BOP/SBL	SBL does not Granger Cause BOP	0.049**	BOP does not Granger Cause SBL	0.005*
33	BOP/SNBL	SNBL does not Granger Cause BOP	0.020**	BOP does not Granger Cause SNBL	0.12
34	BIPL/JSBL	JSBL does not Granger Cause BIPL	0.008*	BIPL does not Granger Cause JSBL	0.028**
35	BIPL/MEBL	MEBL does not Granger Cause BIPL	0.016**	BIPL does not Granger Cause MEBL	0.131
36	FABL/HMB	HMB does not Granger Cause FABL	0.002*	FABL does not Granger Cause HMB	0.226
37	FABL/NBP	FABL does not Granger Cause NBP	0.033**	NBP does not Granger Cause FABL	0.002*
38	FABL/NIB	NIB does not Granger Cause FABL	0.000*	FABL does not Granger Cause NIB	0.390
39	FABL/SMBL	SMBL does not Granger Cause FABL	0.002*	FABL does not Granger Cause SMBL	0.773
40	FABL/SILK	SILK does not Granger Cause FABL	0.006*	FABL does not Granger Cause SILK	0.291
41	HBL/HMB	HMB does not Granger Cause HBL	0.56	HBL does not Granger Cause HMB	0.31
42	HBL/JSBL	JSBL does not Granger Cause HBL	0.263	HBL does not Granger Cause JSBL	0.351
43	HBL/KASBB	KASBB does not Granger Cause HBL	0.816	HBL does not Granger Cause KASBB	0.039**
44	HBL/MCB	MCB does not Granger Cause HBL	0.004*	HBL does not Granger Cause MCB	0.000*
45	HBL/MEBL	MEBL does not Granger Cause HBL	0.571	HBL does not Granger Cause MEBL	0.467
46	HBL/NBP	NBP does not Granger Cause HBL	0.375	HBL does not Granger Cause NBP	0.349
47	HBL/NIB	NIB does not Granger Cause HBL	0.9	HBL does not Granger Cause NIB	0.397
48	HBL/SMBL	SMBL does not Granger Cause HBL	0.981	HBL does not Granger Cause SMBL	0.384
49	HMB/NBP	NBP does not Granger Cause HMB	0.000*	HMB does not Granger Cause NBP	0.000*
50	HMB/SILK	HMB does not Granger Cause SILK	0.087***	SILK does not Granger Cause HMB	0.007*
51	KASBB/NIB	NIB does not Granger Cause KASBB	0.000*	KASBB does not Granger Cause NIB	0.001*
52	KASBB/SBL	SBL does not Granger Cause KASBB	0.001*	KASBB does not Granger Cause SBL	0.000*
53	KASBB/SILK	SILK does not Granger Cause KASBB	0.004*	KASBB does not Granger Cause SILK	0.001*
54	KASBB/SNBL	SNBL does not Granger Cause KASBB	0.195	KASBB does not Granger Cause SNBL	0.000*
55	MEBL/UBL	UBL does not Granger Cause MEBL	0.029**	MEBL does not Granger Cause UBL	0.057**
56	NBP/SILK	SILK does not Granger Cause NBP	0.034**	NBP does not Granger Cause SILK	0.591
57	NIB/SNBL	SNBL does not Granger Cause NIB	0.293	NIB does not Granger Cause SNBL	0.221
58	SBL/SNBL	SNBL does not Granger Cause SBL	0.000*	SBL does not Granger Cause SNBL	0.196
59	UBL/SCBPL	SCBPL does not Granger Cause UBL	0.000*	UBL does not Granger Cause SCBPL	0.000*

60	SMBL/SILK	SILK does not Granger Cause SMBL	0.001*	SMBL does not Granger Cause SILK	0.081**

* Significant at 1 percent, **Significant at 5 percent, ***Significant at 10 percent.

Table 8

Pair-wise Granger Causality Test Results for Financial Services Sector

Table 8 provides pair-wise Granger Causality Test Results, for each cointegrated trading pair of Financial Services Sector identified in Table 6. For every trading pair two null hypotheses have been given along with their p-values. The acceptance or rejection of the null hypothesis determines the direction of causality in each trading pair.

	Trading Pairs	Direction of Causality	p-value	Direction of Causality	p-value
1	FDIBL/AHL	FDIBL does not Granger Cause AHL	0.624	AHL does not Granger Cause FDIBL	0.00954*
2	FDIBL/DEL	FDIBL does not Granger Cause DEL	0.245	DEL does not Granger Cause FDIBL	0.00000043*
3	FDIBL/IGIBL	FDIBL does not Granger Cause IGIBL	0.023**	IGIBL does not Granger Cause FDIBL	0.01046**
4	FDIBL/JSCL	FDIBL does not Granger Cause JSCL	0.319	JSCL does not Granger Cause FDIBL	1.6E-05*
5	FDIBL/FNEL	FDIBL does not Granger Cause FNEL	0.576	FNEL does not Granger Cause FDIBL	0.02073**
6	FDIBL/FCSC	FDIBL does not Granger Cause FCSC	0.393	FCSC does not Granger Cause FDIBL	6.5E-06*
7	FDIBL/JSIL	FDIBL does not Granger Cause JSIL	0.591	JSIL does not Granger Cause FDIBL	0.0000014*
8	FDIBL/JSGCL	FDIBL does not Granger Cause JSGCL	0.091***	JSGCL does not Granger Cause FDIBL	0.00045*
9	FDIBL/KASBSL	FDIBL does not Granger Cause KASBSL	0.053***	KASBSL does not Granger Cause FDIBL	4.7E-10*
10	FDIBL/PASL	FDIBL does not Granger Cause PASL	0.001*	PASL does not Granger Cause FDIBL	1.0E-05*
11	FDIBL/SCLL	FDIBL does not Granger Cause SCLL	0.723	SCLL does not Granger Cause FDIBL	0.50789
12	FDIBL/SPLC	FDIBL does not Granger Cause SPLC	0.183	SPLC does not Granger Cause FDIBL	0.11682
13	AHL/DEL	AHL does not Granger Cause DEL	0.001*	DEL does not Granger Cause AHL	0.04378**
14	AHL/ESBL	AHL does not Granger Cause ESBL	0.016**	ESBL does not Granger Cause AHL	0.31485
15	AHL/FCSC	AHL does not Granger Cause FCSC	0.081***	FCSC does not Granger Cause AHL	0.21266
16	AHL/KASBSL	AHL does not Granger Cause KASBSL	0.202	KASBSL does not Granger Cause AHL	0.00017*
17	DEL/ESBL	ESBL does not Granger Cause DEL	0.647	DEL does not Granger Cause ESBL	0.00229*
18	DEL/IGIBL	DEL does not Granger Cause IGIBL	0.012**	IGIBL does not Granger Cause DEL	0.18355
19	DEL/JSCL	DEL does not Granger Cause JSCL	0.186	JSCL does not Granger Cause DEL	0.00000077*
20	DEL/FNEL	DEL does not Granger Cause FNEL	0.107	FNEL does not Granger Cause DEL	0.18414
21	DEL/FCSC	DEL does not Granger Cause FCSC	0.088***	FCSC does not Granger Cause DEL	2.2E-06*
22	DEL/JSIL	DEL does not Granger Cause JSIL	0.072***	JSIL does not Granger Cause DEL	0.00418*
23	DEL/JSGCL	DEL does not Granger Cause JSGCL	0.000*	JSGCL does not Granger Cause DEL	0.0000001*
24	DEL/KASBSL	DEL does not Granger Cause KASBSL	0.074***	KASBSL does not Granger Cause DEL	0.00000000014*
25	DEL/PASL	DEL does not Granger Cause PASL	0.000*	PASL does not Granger Cause DEL	0.00049*
26	DEL/SIBL	DEL does not Granger Cause SIBL	0.005*	SIBL does not Granger Cause DEL	0.10931
27	DEL/TRIBL	DEL does not Granger Cause TRIBL	0.001*	TRIBL does not Granger Cause DEL	0.00491*
28	ESBL/JSCL	ESBL does not Granger Cause JSCL	0.464	JSCL does not Granger Cause ESBL	0.00611*
29	ESBL/FNEL	ESBL does not Granger Cause FNEL	0.363	FNEL does not Granger Cause ESBL	0.47728
30	ESBL/FCSC	ESBL does not Granger Cause FCSC	0.405	FCSC does not Granger Cause ESBL	0.01547**
31	ESBL/JSGCL	ESBL does not Granger Cause JSGCL	0.953	JSGCL does not Granger Cause ESBL	0.01357**
32	ESBL/KASBSL	ESBL does not Granger Cause KASBSL	0.359	KASBSL does not Granger Cause ESBL	0.00093*
32	ESBL/OLPL	ESBL does not Granger Cause OLPL	0.333	OLPL does not Granger Cause ESBL	0.18549
34	ESBL/PASL	ESBL does not Granger Cause PASL	0.292	PASL does not Granger Cause ESBL	6.4E-05*
35	GRYL/IGIBL	GRYL does not Granger Cause IGIBL	0.76877	IGIBL does not Granger Cause GRYL	0.86253
36	GRYL/JSCL	GRYL does not Granger Cause JSCL	0.17222	JSCL does not Granger Cause GRYL	0.05647***
37	GRYL/FNEL	GRYL does not Granger Cause FNEL	0.96619	FNEL does not Granger Cause GRYL	0.50531
38	GRYL/FCSC	GRYL does not Granger Cause FCSC	0.53427	FCSC does not Granger Cause GRYL	0.32847
39	GRYL/JSIL	GRYL does not Granger Cause JSIL	0.10984	JSIL does not Granger Cause GRYL	0.64746

Continued—

Table 8—(*Continued*)

40	GRYL/JSGCL	GRYL does not Granger Cause JSGCL	0.98607	JSGCL does not Granger Cause GRYL	0.23617
41	GRYL/KASBSL	GRYL does not Granger Cause KASBSL	0.33830	KASBSL does not Granger Cause GRYL	0.31856
42	GRYL/OLPL	GRYL does not Granger Cause OLPL	0.12011	OLPL does not Granger Cause GRYL	0.04313**
43	GRYL/PASL	GRYL does not Granger Cause PASL	0.3759	PASL does not Granger Cause GRYL	0.29695
44	GRYL/SCLL	GRYL does not Granger Cause SCLL	0.25314	SCLL does not Granger Cause GRYL	0.3681
45	GRYL/SPLC	GRYL does not Granger Cause SPLC	0.05378***	SPLC does not Granger Cause GRYL	0.00405*
46	IGIBL/JSCL	IGIBL does not Granger Cause JSCL	0.57933	JSCL does not Granger Cause IGIBL	0.000000056*
47	IGIBL/FNEL	IGIBL does not Granger Cause FNEL	0.81196	FNEL does not Granger Cause IGIBL	0.02041**
48	IGIBL/FCSC	IGIBL does not Granger Cause FCSC	0.79704	FCSC does not Granger Cause IGIBL	0.00338*
49	IGIBL/JSIL	IGIBL does not Granger Cause JSIL	0.64385	JSIL does not Granger Cause IGIBL	0.00000000019*
50	IGIBL/JSGCL	IGIBL does not Granger Cause JSGCL	0.22881	JSGCL does not Granger Cause IGIBL	0.000093*
51	IGIBL/KASBSL	IGIBL does not Granger Cause KASBSL	0.42880	KASBSL does not Granger Cause IGIBL	0.00000066*
52	IGIBL/SIBL	IGIBL does not Granger Cause SIBL	0.31957	SIBL does not Granger Cause IGIBL	0.58752
53	IGIBL/TRIBL	IGIBL does not Granger Cause TRIBL	0.07367***	TRIBL does not Granger Cause IGIBL	0.13207
54	JSCL/JSIL	JSCL does not Granger Cause JSIL	0.02360**	JSIL does not Granger Cause JSCL	0.18699
55	JSCL/JSGCL	JSCL does not Granger Cause JSGCL	0.00013*	JSGCL does not Granger Cause JSCL	0.2979
56	JSCL/KASBSL	JSCL does not Granger Cause KASBSL	0.00023*	KASBSL does not Granger Cause JSCL	0.55267
57	FCSC/JSGCL	FCSC does not Granger Cause JSGCL	0.000034*	JSGCL does not Granger Cause FCSC	0.00191*
58	FCSC/KASBSL	FCSC does not Granger Cause KASBSL	0.24617	KASBSL does not Granger Cause FCSC	0.00012*
59	FCSC/PASL	FCSC does not Granger Cause PASL	0.00055*	PASL does not Granger Cause FCSC	0.70983
60	FCSC/SIBL	FCSC does not Granger Cause SIBL	0.76366	SIBL does not Granger Cause FCSC	0.48351
61	FCSC/TRIBL	FCSC does not Granger Cause TRIBL	0.00012*	TRIBL does not Granger Cause FCSC	0.08037***
62	JSIL/JSGCL	JSIL does not Granger Cause JSGCL	0.00116*	JSGCL does not Granger Cause JSIL	0.16529
63	JSIL/KASBSL	JSIL does not Granger Cause KASBSL	0.00027*	KASBSL does not Granger Cause JSIL	0.25675
64	JSGCL/KASBSL	JSGCL does not Granger Cause KASBSL	0.03094**	KASBSL does not Granger Cause JSGCL	0.06883***
65	JSGCL/PASL	JSGCL does not Granger Cause PASL	0.08093***	PASL does not Granger Cause JSGCL	0.00157*
66	JSGCL/TRIBL	JSGCL does not Granger Cause TRIBL	0.01116**	TRIBL does not Granger Cause JSGCL	0.07006***
67	KASBSL/SPLC	KASBSL does not Granger Cause SPLC	0.87545	SPLC does not Granger Cause KASBSL	0.05085***
68	KASBSL/SIBL	KASBSL does not Granger Cause SIBL	0.51602	SIBL does not Granger Cause KASBSL	0.14843
69	KASBSL/TRIBL	KASBSL does not Granger Cause TRIBL	0.000068*	TRIBL does not Granger Cause KASBSL	0.59387
70	MCBAH/SCLL	MCBAH does not Granger Cause SCLL	0.21970	SCLL does not Granger Cause MCBAH	0.06382***
71	MCBAH/SPLC	MCBAH does not Granger Cause SPLC	0.73239	SPLC does not Granger Cause MCBAH	0.75992
72	OLPL/SCLL	OLPL does not Granger Cause SCLL	0.00039*	SCLL does not Granger Cause OLPL	0.00421*
73	PASL/SPLC	PASL does not Granger Cause SPLC	0.6873	SPLC does not Granger Cause PASL	0.1347
74	PASL/SIBL	PASL does not Granger Cause SIBL	0.00974*	SIBL does not Granger Cause PASL	0.77292
75	PASL/TRIBL	PASL does not Granger Cause TRIBL	0.00312*	TRIBL does not Granger Cause PASL	0.20855
76	SCLL/SIBL	SCLL does not Granger Cause SIBL	0.0073*	SIBL does not Granger Cause SCLL	0.19709
77	SPLC/SIBL	SPLC does not Granger Cause SIBL	0.00442*	SIBL does not Granger Cause SPLC	0.03593**

* Significant at 1 percent, **Significant at 5 percent, ***Significant at 10 percent.

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APPENDIX VI

Table 9

Cointegration (Directional) Regression Results for Commercial Banks

On the basis of the direction of causality (Uni-directional Causality) identified in Table 7 for trading pairs of Commercial Banks, Table 9 presents the results of Cointegration directional regression. Results presented in Table 9 include indentified dependent variable and an independent variable in a pair, coefficient of the independent variable along with a p-value given in (), regression constant. Table 9 also contains the ADF Test results for testing Stationarity of the Cointegration regression residual along with the p-value given in ().

	Dependent Vari.	Independent Vari.	Coeff. (p-value)		Residual ADF (t-statistic)			Dependent Vari.	Independent Vari.	Coeff. (p-value)		Residual ADF (t-statistic)	
				cont		p-value					cont		p-value
1	BAHL	FABL	0.5812 (0.000)*	23.61016	-3.8999	0.0124**	15	BIPL	BOK	1.3391 (0.000)*	-1.56108	-4.0016	0.0015*
2	BAHL	HMB	0.4781 (0.000)*	20.9131	-4.7210	0.0007*	16	BOP	SNBL	1.8304 (0.000)*	-3.24987	-3.1873	0.0211**
3	BAHL	KASBB	1.0195 (0.000)*	28.18701	-3.7632	0.0189**	17	BIPL	MEBL	0.3592 (0.000)*	-2.03251	-3.3139	0.0146**
4	NBP	BAHL	3.3711 (0.000)*	-47.1737	-5.0585	0.0002*	18	FABL	HMB	0.5624 (0.000)*	0.717819	-4.0477	0.0012*
5	BAHL	NIB	1.6054 (0.000)*	26.55518	-3.8510	0.0145**	19	FABL	NIB	2.6246 (0.000)*	5.427415	-4.1568	0.0008*
6	BAHL	SMBL	1.2250 (0.000)*	26.52914	-3.7731	0.0183**	20	FABL	SMBL	2.0361 (0.000)*	5.26936	-3.3659	0.0125**
7	BAHL	SILK	1.7729 (0.000)*	26.15899	-3.7202	0.0215**	21	FABL	SILK	3.2383 (0.000)*	3.897978	-3.9692	0.0017*
8	BAHL	SNBL	0.6498 (0.000)*	26.20657	-3.8015	0.0168**	22	KASBB	HBL	0.0206 (0.000)*	0.198711	-2.8660	0.0498**
9	ABL	BOK	2.3337 (0.000)*	50.81223	-3.8655	0.0138**	23	SNBL	KASBB	1.2111 (0.000)*	3.949449	-3.2217	0.0191**
10	ABL	BIPL	1.5024 (0.000)*	54.87699	-3.7509	0.0196**	24	NBP	SILK	13.4228 (0.000)*	21.7032	-3.0897	0.0277**
11	ABL	JSBL	2.0844 (0.000)*	55.34554	-3.8163	0.0161**	25	SBL	SNBL	0.2733 (0.000)*	0.370128	-3.9730	0.0016*
12	ABL	MEBL	0.6842 (0.000)*	48.75288	-3.9042	0.0123**							
13	NIB	AKBL	0.1922 (0.000)*	-0.44271	-3.5417	0.0072*							
14	SBL	AKBL	0.1002 (0.000)*	0.688091	-4.1347	0.0009*							

* Significant at 1 percent, **Significant at 5 percent, ***Significant at 10 percent.

Table 10

Cointegration (Directional) Regression Results for Financial Services Sector

On the basis of the direction of causality (Uni-directional Causality) identified in Table 8 for trading pairs of Financial Services Sector, Table 10 presents the results of Cointegration directional regression. Results presented in Table 10 include indentified dependent variable and an independent variable in a pair, coefficient of the independent variable along with a p-value given in (), regression constant. Table 10 also contains the ADF Test results for testing Stationarity of the Cointegration regression residual along with the p-value given in ().

	Dependent Vari.	Independent Vari.	Coeff. (p-value)	cont	Residual ADF (t-statistic)	p-value		Dependent Vari.	Independent Vari.	Coeff. (p-value)	cont	Residual ADF (t-statistic)	p-value
1	FDIBL	AHL	0.022 (0.000)*	0.9391	–3.6719	0.0047*	19	GRYL	JSCL	0.0459 (0.000)*	2.1951	–4.8257	0.0001*
2	FDIBL	DEL	0.4413 (0.000)*	0.7483	–5.3018	0.0000*	20	GRYL	OLPL	0.0925 (0.000)*	2.0081	–5.2584	0.0000*
3	FDIBL	JSCL	0.0593 (0.000)*	0.8801	–3.9091	0.0021*	21	IGIBL	JSCL	0.0803 (0.000)*	1.0600	–4.0200	0.0014*
4	FDIBL	FNEL	0.0882 (0.000)*	1.1233	–3.3445	0.0133*	22	IGIBL	FNEL	0.1260 (0.000)*	1.3466	–3.4668	0.0091*
5	FDIBL	FCSC	0.1910 (0.000)*	0.9069	–4.0146	0.0014*	23	IGIBL	FCSC	0.2292 (0.000)*	1.2156	–3.6535	0.0050*
6	FDIBL	JSIL	0.1276 (0.000)*	0.7231	–3.6734	0.0047*	24	IGIBL	JSIL	0.1836 (0.000)*	0.7650	–4.4445	0.0003*
7	ESBL	AHL	0.0353 (0.000)*	1.4183	–2.7528	0.0657***	25	IGIBL	JSGCL	0.0336 (0.000)*	0.9958	–3.7915	0.0031*
8	FCSC	AHL	0.1197 (0.000)*	0.0303	–4.3509	0.0004*	26	IGIBL	KASBSL	0.2804 (0.000)*	0.7851	–3.8290	0.0027*
9	AHL	KASBSL	7.3470 (0.000)*	–1.9622	–2.7436	0.0671***	27	TRIBL	IGIBL	1.4681 (0.000)*	–1.1119	–4.1332	0.0009*
10	ESBL	DEL	0.6531 (0.000)*	1.2258	–3.0762	0.0287**	28	JSIL	JSCL	0.4202 (0.000)*	1.8400	–3.7587	0.0035*
11	IGIBL	DEL	0.5484 (0.000)*	0.9852	–3.2389	0.0182**	29	JSGCL	JSCL	2.1842 (0.000)*	4.6630	–3.4752	0.0089*
12	DEL	JSCL	0.1343 (0.000)*	0.3012	–4.3547	0.0004*	30	KASBSL	JSCL	0.2498 (0.000)*	1.4770	–3.5062	0.0081*
13	SIBL	DEL	0.2696 (0.000)*	1.9144	–3.1713	0.0221**	31	FCSC	KASBSL	1.0593 (0.000)*	–1.0784	–3.5066	0.0080*
14	ESBL	JSCL	0.0853 (0.000)*	1.4554	–2.7354	0.0685***	32	PASL	FCSC	0.4627 (0.000)*	0.5522	–3.0213	0.0333**
							33	JSGCL	JSIL	4.7029 (0.000)*	–1.1674	–2.7882	0.0603***
							34	KASBSL	JSIL	0.5513 (0.000)*	0.7092	–3.2210	0.0191**
							35	KASBSL	SPLC	0.9838 (0.000)*	3.7645	–3.5790	0.0064*
15	ESBL	FCSC	0.2678 (0.000)*	1.5210	–3.3724	0.0122**	36	TRIBL	KASBSL	0.6692 (0.000)*	–1.2134	–4.0567	0.0012*
16	ESBL	JSGCL	0.0384 (0.000)*	1.2938	–2.8211	0.0557***	37	MCBAH	SCLL	–1.2208 (0.000)*	22.6492	–4.0032	0.0015*
17	ESBL	KASBSL	0.3271 (0.000)*	1.0211	–3.0346	0.0322**	38	SIBL	PASL	0.2894 (0.000)*	1.7810	–3.3519	0.0130**
18	ESBL	PASL	0.5847 (0.000)*	1.1869	–4.3860	0.0003*	39	TRIBL	PASL	0.9436 (0.000)*	–0.2571	–3.7394	0.0037*
							40	SIBL	SCLL	0.2410 (0.000)*	1.6021	–3.3991	0.0113**

* Significant at 1 percent, **Significant at 5 percent, ***Significant at 10 percent.

Appendix VII

Table 11

Vector Error Correction Model for Commercial Banks

For all the cointegrated trading pairs in Table 9 depicting stationary residual series, the error component has been modeled using Vector Error Correction Model (VECM) for which the results are given in Table 11. For VECM, log differences of stock prices have been employed. Table 11 includes Long run β Coefficient and its [t-statistic] for each cointegrated pair. Speed of Adjustment Coefficients γ1 and γ2 are also given along with their [t-statistic].

	Cointegrated Pairs	Stock Returns	Long run β Coefficient and [t-statistic]	Speed of Adjustment Coefficient [t-statistic] γ1	γ2
1	BAHL/FABL	D(BAHL(–1))	2.1968 [14.4977]	–0.0586 [–6.69236]	0.0112 [2.24338]
		D(FABL(–1))			
2	BAHL/HMB	D(BAHL(–1))	–5.1874 [–18.6267]	–0.0831 [–7.36522]	–0.0005 [–0.07867]
		D(HMB(–1))			
3	BAHL/KASBB	D(BAHL(–1))	109.2040 [18.9841]	–0.0513 [–6.10595]	–0.0020 [–1.35322]
		D(KASBB(–1))			
4	NBP/BAHL	D(NBP(–1))	6.2869 [14.3942]	–0.0362 [–6.13575]	0.0023 [1.08320]
		D(BAHL(–1))			
5	BAHL/NIB	D(BAHL(–1))	–26.608 [–21.3260]	–0.0525 [–5.86007]	–0.0014 [–1.23619]
		D(NIB(–1))			
6	BAHL/SMBL	D(BAHL(–1))	–12.255 [–18.8430]	–0.0476 [–5.57379]	–0.0008 [–0.49040]
		D(SMBL(–1))			
7	BAHL/SNBL	D(BAHL(–1))	123.4980 [18.2288]	–0.0481 [–5.85832]	–0.0033 [–1.45229]
		D(SNBL(–1))			
14	SBL/AKBL	D(SBL(–1))	0.008576 [0.83123]	–0.029508 [–3.18985]	0.114769 [2.55400]
		D(AKBL(–1))			
15	BIPL/BOK	D(BIPL(–1))	–2.804577 [–18.2003]	–0.021053 [–2.83659]	0.002953 [0.54793]
		D(BOK(–1))			
16	BOP/SNBL	D(BOP(–1))	–3.184867 [–18.8377]	–0.015118 [–2.41349]	0.001631 [0.48197]
		D(SNBL(–1))			
17	BIPL/MEBL	D(BIPL(–1))	–0.484138 [–15.0934]	–0.015176 [–2.39326]	0.008355 [0.66998]
		D(MEBL (–1))			
18	FABL/HMB	D(FABL (–1))	3.041034 [16.2935]	–0.043057 [–5.73502]	0.018313 [2.06832]
		D(HMB (–1))			
19	FABL/NIB	D(FABL (–1))	–23.49303 [–20.9658]	–0.041225 [–5.10291]	–0.002011 [–1.08006]
		D(NIB(–1))			
20	FABL/SMBL	D(FABL(–1))	–19.06986 [–19.0906]	–0.029402 [–4.34719]	0.000169 [0.07275]
		D(SMBL(–1))			

Continued—

Table 11—(*Continued*)

8	BAHL/SILK	D(BAHL(–1))		–0.051 [–6.26651]		21	FABL/SILK	D(FABL(–1))		–0.03419 [–5.02514]	
			16.0746		0.0011				146.8413		0.002288
		D(SILK(–1))	[18.2065]		[0.79015]			D(SILK(–1))	[18.9168]		[1.16274]
9	ABL/BOK	D(ABL(–1))		–0.0599 [–6.47245]		22	KASBB/HBL	D(KASBB(–1))		–0.008937 [–2.77087]	
			–53.3772		–0.0025				–0.014373		0.009231
		D(BOK(–1))	[–20.6643]		[–1.98667]			D(HBL(–1))	[–4.96063]		[0.16207]
10	ABL/BIPL	D(ABL(–1))		–0.0563 [–6.19890]		23	SNBL/KASBB	D(SNBL(–1))		–0.025673 [–3.06487]	
			–16.0092		–0.0018				–2.350703		0.001515
		D(BIPL(–1))	[–20.4628]		[–1.12564]			D(KASBB(–1))	[–18.8064]		[0.29131]
11	ABL/JSBL	D(ABL(–1))		–0.0486 [–5.79719]		24	NBP/SILK	D(NBP(–1))		–0.027807 [–4.79866]	
			–19.0039		–0.0006				190.4803		0.000358
		D(JSBL(–1))	[–19.8613]		[–0.62591]			D(SILK(–1))	[18.7952]		[0.91714]
12	ABL/MEBL	D(ABL(–1))		–0.0591 [–6.20863]		25	SBL/SNBL	D(SBL(–1))		–0.033859 [–3.12691]	
			–6.4267		–0.0078				–0.325853		0.011061
		D(MEBL(–1))	[–20.1588]		[–2.36566]			D(SNBL(–1))	[–14.1252]		[0.44216]
13	NIB/AKBL	D(NIB(–1))		–0.0108 [–1.61586]							
			-0.07675		0.0955						
		D(AKBL(-1))	[-8.21175]		[2.95370]						

Table 12

Vector Error Correction Model for Financial Services Sector

For all the cointegrated trading pairs in Table 10 depicting stationary residual series, the error component has been modeled using Vector Error Correction Model (VECM) for which the results are given in Table 12. For VECM, log differences of stock prices have been employed. Table 12 includes Long run β Coefficient and its [t-statistic] for each cointegrated pair. Speed of Adjustment Coefficients γ1 and γ2 are also given along with their [t-statistic].

	Cointegrated Pairs	Stock Returns	Long run β Coefficient and [t-statistic]	Speed of Adjustment Coefficient [t-statistic] γ1	γ2
1	FDIBL/AHL	D(FDIBL(–1))		–0.031812 [–3.30189]	
			–0.019315		0.054080
		D(AHL(–1))	[–5.24008]		[0.47173]
2	FDIBL/DEL	D(FDIBL(–1))		–0.137529 [–7.98745]	
			–2.588218		–0.002591
		D(DEL(–1))	[–22.7248]		[–0.11908]
3	FDIBL/JSCL	D(FDIBL(–1))		–0.043342 [–3.64555]	
			–0.038733		0.082940
		D(JSCL(–1))	[–5.68741]		[1.15780]
4	FDIBL/FNEL	D(FDIBL(–1))		–0.059747 [–5.94349]	
			0.370759		0.059412
		D(FNEL(–1))	[16.6720]		[1.62395]
5	FDIBL/FCSC	D(FDIBL(–1))		–0.045059 [–3.68319]	
			–0.083461		0.054825
		D(FCSC(–1))	[–4.29110]		[1.83737]
6	FDIBL/JSIL	D(FDIBL(–1))		–0.032884 [–3.09409]	
			–0.099844		0.056210
		D(JSIL(–1))	[–9.15115]		[1.32916]
7	ESBL/AHL	D(ESBL(–1))		–0.027807 [–2.64295]	
			–0.030834		0.025670
		D(AHL(–1))	[–4.63482]		[0.42555]
8	FCSC/AHL	D(FCSC(–1))		–0.024423 [–3.21811]	
			–0.173071		0.028153
		D(AHL(–1))	[–16.2000]		[0.75230]
22	IGIBL/FNEL	D(IGIBL(–1))		–0.04956 [–5.50098]	
			0.231905		0.087592
		D(FNEL(–1))	[14.6064]		[2.74258]
23	IGIBL/FCSC	D(IGIBL(–1))		–0.024715 [–2.80272]	
			–0.068855		0.035045
		D(FCSC(–1))	[–3.27266]		[1.82772]
24	IGIBL/JSIL	D(IGIBL(–1))		–0.054083 [–5.01955]	
			–0.021308		0.135760
		D(JSIL(–1))	[–1.76307]		[3.51931]
25	IGIBL/JSGCL	D(IGIBL(–1))		–0.03288 [–3.36403]	
			–0.014201		0.153874
		D(JSGCL(–1))	[–3.74714]		[1.48559]
26	IGIBL/KASBSL	D(IGIBL(–1))		–0.033948 [–3.55983]	
			–0.032959		0.058937
		D(KASBSL(–1))	[–1.53782]		[2.67901]
27	TRIBL/IGIBL	D(TRIBL(–1))		–0.03069 [–3.58503]	
			–2.049311		0.003966
		D(IGIBL(–1))	[–16.0130]		[1.09014]
28	JSIL/JSCL	D(JSIL(–1))		–0.0243 [–1.84488]	
			–0.219192		0.012750
		D(JSCL(–1))	[–8.70638]		[0.58442]
29	JSGCL/JSCL	D(JSGCL(–1))		–0.010112 [–1.21334]	
			–2.31639		0.005645
		D(JSCL(–1))	[–23.7371]		[1.37420]

Continued—

Table 12—(*Continued*)

				–0.003615					–0.02026	
9	AHL/KASBSL	D(AHL(–1))		[–0.86544]		30	KASBSL/JSCL	D(KASBSL(–1))		[–2.03111]	
			–6.970244		0.001527				–0.177445		0.047565
		D(KASBSL(–1))	[–18.5089]		[1.78128]			D(JSCL(–1))	[–11.2157]		[1.76590]
				–0.069215						–0.014724	
10	ESBL/DEL	D(ESBL(–1))		[–5.52993]		31	FCSC/KASBSL	D(FCSC(–1))		[–1.76841]	
			0.876937		0.034502				–1.303408		0.010302
		D(DEL(–1))	[10.9883]		[3.71409]			D(KASBSL(–1))	[–19.5045]		[1.20194]
				–0.079991						–0.012411	
11	IGIBL/DEL	D(IGIBL(–1))		[–6.58810]		32	PASL/FCSC	D(PASL(–1))		[–1.35292]	
			2.414926		0.034104				–0.234482		0.022040
		D(DEL(–1))	[18.5549]		[2.45157]			D(FCSC(–1))	[–6.62978]		[1.67156]
				–0.05546						–0.003932	
12	DEL/JSCL	D(DEL(–1))		[–4.12513]		33	JSGCL/JSIL	D(JSGCL(–1))		[–0.71101]	
			–0.034454		0.174838				–5.941587		0.002702
		D(JSCL(–1))	[–3.43876]		[3.18455]			D(JSIL(–1))	[–23.9589]		[1.61516]
				–0.03771						–0.013585	
13	SIBL/DEL	D(SIBL(–1))		[–3.24110]		34	KASBSL/JSIL	D(KASBSL(–1))		[–1.48783]	
			0.267976		0.011506				–0.511235		0.022783
		D(DEL(–1))	[3.45499]		[1.49624]			D(JSIL(–1))	[–18.7492]		[1.55469]
				–0.029934						–0.01167	
14	ESBL/JSCL	D(ESBL(–1))		[–2.77626]		35	KASBSL/SPLC	D(KASBSL(–1))		[–2.48194]	
			–0.051042		0.021119				–4.155565		0.001923
		D(JSCL(–1))	[–4.00034]		[0.67898]			D(SPLC(–1))	[–21.5997]		[0.73082]
				–0.029534						–0.045089	
15	ESBL/FCSC	D(ESBL(–1))		[–2.76647]		36	TRIBL/KASBSL	D(TRIBL(–1))		[–3.93622]	
			–0.035455		0.021081				–0.143323		0.036783
		D(FCSC(–1))	[–0.97287]		[1.68788]			D(KASBSL(–1))	[–2.80295]		[3.40445]
				–0.030514						–0.030546	
16	ESBL/JSGCL	D(ESBL(–1))		[–2.74668]		37	MACBAH/SCLL	D(MCBAH(–1))		[–4.60142]	
			–0.031231		0.028929				36.49555		–0.002715
		D(JSGCL(–1))	[–4.81474]		[0.46042]			D(SCLL(–1))	[21.7511]		[–1.13404]
				–0.033806						–0.043652	
17	ESBL/KASBSL	D(ESBL(–1))		[–3.01345]		38	SIBL/PASL	D(SIBL(–1))		[–3.53746]	
			–0.201769		0.017342				–0.508298		–0.004458
		D(KASBSL(–1))	[–5.52764]		[1.24966]			D(PASL(–1))	[–8.98474]		[–0.49363]
				–0.080183						–0.037536	
18	ESBL/PASL	D(ESBL(–1))		[–6.07900]		39	TRIBL/PASL	D(TRIBL(–1))		[–4.17065]	
			0.517249		0.049464				–0.043496		0.023109
		D(PASL(–1))	[9.29244]		[4.30419]			D(PASL(–1))	[–0.70553]		[3.46128]
				–0.049979						–0.05772	
19	GRYL/JSCL	D(GRYL(–1))		[–4.55651]		40	SIBL/SCLL	D(SIBL(–1))		[–4.64782]	
			0.165826		0.022418				0.369581		0.033901
		D(JSCL(–1))	[5.13007]		[1.32287]			D(SCLL(–1))	[6.63143]		[2.75978]
				–0.095607							
20	GRYL/OLPL	D(GRYL(–1))		[–7.96700]							
			2.177157		0.003701						
		D(OLPL(–1))	[16.5884]		[0.41263]						
				–0.047519							
21	IGIBL/JSCL	D(IGIBL(–1))		[–4.34022]							
			–0.023225		0.118659						
		D(JSCL(–1))	[–3.15714]		[2.00433]						

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Shocks as a Source of Vulnerability: An Empirical Investigation from Pakistan

RASHIDA HAQ

The objective of this paper is to investigate the incidence of different types of shocks in rural Pakistan and identify the household characteristics that are associated with this phenomenon. It is observed that one-third of households experience an adverse shock, be it natural/agricultural, economic, social or relating to health. The natural/agricultural shocks have major share in the total burden of shocks while the households' coping mechanism is overwhelmingly informal and largely asset-based. The poorest of the households adopt behaviour-based strategies like reducing food consumption, employ child labour, work more hours etc. Overall, households of with less educated heads, high dependency ratio, large household size, low welfare ratio, farm household, ownership of land and residing in south Punjab or Sindh are more vulnerable to suffer shocks, particularly of income. Vulnerability in terms of a decline in consumption is observed for households who are hit by natural/agricultural or health shocks. For all these reasons, a gradual shift from traditional emergency relief measures towards ex-ante actions to reduce and mitigate hazard impacts should be encouraged along with non- exploitative credit and more effective safety nets.

JEL Classification: C21, C25, I32
Keywords: Shocks, Vulnerability, Poverty

1. INTRODUCTION

Households in developing countries are frequently hit by severe idiosyncratic shocks and covariate shocks which result in welfare loss not only directly but also as a consequence of the costly measures used by households to protect consumption from such shocks including less risky but also less profitable agricultural investment [Fafchamps (2009)]. The emphasis on the impact of shocks to consumption leads to the concept of vulnerability analysis. The inability to avoid welfare declines when hit by exogenous shocks can be called vulnerability. The extent of vulnerability depends on the level of underlying shock, the ability to cope with shock management strategies, and long-term income generating capacity [Chaudhuri (2003)]. Some of these shocks can have long-lasting effects in terms of perpetuating and increasing poverty and in adverse human development outcomes [Foster (1995) and Jacoby and Skoufias (1997)]. In developing countries where financial and insurance markets are incomplete or even

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absent, poor households are exposed to a variety of risks resulting in high income volatility [Baulch and Hoddinott (2000); Dercon (2002); Paxson (1992)]. In this context, such households may attempt to smooth income exante in the expectation of natural disasters. For instance, farmers can choose crop portfolios to reduce exposure to risk [Kurosaki and Fafchamps (2002)] or allocate more of their labour to non-agricultural activities when weather risk in agricultural production is high [Ito and Takashii (2009)].

Shocks emanating from different sources may result in economic or non-economic loss spread across space and time, and may differ in frequency, duration, intensity and scope. The typology of shocks typically classified and based on scope are idiosyncratic and covariate. Households' idiosyncrasy shocks comprise household-specific shocks such as illness, injury, death, job loss, crop failure and loss of transfers which are compounded by lack of financial intermediation and formal insurance, credit market imperfections and weak infrastructure, while covariate shocks such as weather adversity and market fluctuation tend to have an impact on a larger group of population in the same area at the same time [Dercon (2006)]. All these shocks can potentially contribute to high income volatility of the households. Proper conceptualisation and characterisation of the underlying dynamic process is thus imperative from both theoretical and policy perspectives.

To generate well-being in response to negative affect of shocks, households have tangible (natural, human, physical and financial capital) and intangible social capital in the form of proximity to markets, health and education facilities and empowerment at their disposal. More specifically, human capital refers to the household members' education and their health status while physical capital is related to productive assets such as land, tools, equipment and work animal, and household assets like housing and household services, livestock, food and jewellery. Finally, financial capital refers to cash, savings, and access to credit. Intangible assets consist of social capital, the proximity to market, health and education facilities and empowerment. Both types of assets are important in the context of risk management [Siegel and Alwang (1999)].

Shocks can also be divided into following categories: natural/agriculture; economic; political/social/legal; crime; health; and life-cycle shocks. Natural/agriculture shocks include earthquake, flooding, erosion, pestilence affecting crops or livestock. Economic shocks include business closures, mass layoffs, job loss, wage cuts, loss of remittances. Political/social/legal shocks include court cases and bribery, long duration general strikes, violence, crime and political unrest while health shocks include death, injury and illness. The presence of these risk and shocks can distort household's inter-temporal resource allocation behaviour which can be economically costly and may propel households into chronic poverty.

Households can smooth consumption not only across space but also over time by saving and borrowing or by accumulating and selling non-financial assets. In developing countries poor households may have difficulties in adopting these strategies because they have limited or no access to formal credit markets and they may find it hard to save or be cautious in running down assets to smooth consumption. Moreover, households may choose inputs and production techniques that reduce variability or may diversify income sources. These strategies may have long term consequences when risk leads poor households to choose safe but less profitable choices or to reduce investment in human

capital, thereby increasing the gap between the rich and the poor and pushing poor households into the poverty trap [Alderman and Paxson (1994)].

The number of natural disasters reported appears to be increasing globally—it was less than 100 per year in the mid-1970s while it was approximately 400 per year during the 2000 (EM-DAT).[2] Pakistan is classified as being extremely vulnerable to natural disasters due to its geographical location, the frequency of their occurrence, and the number of affected people. The top 10 natural disasters occurred during the period 1900 to 2013 out of which, fifth, seventh, and eighth disasters in the top10 category occurred during the 1990s and 2010s, respectively, of which floods and earthquakes were major disasters.

Recently, in Pakistan earthquake, flood and drought have caused tremendous damage to livelihoods and infrastructure, with severe implications for food security; earthquake 2005, 2010 flood and 2014 drought/famine resulted in the great losses to human life, agriculture and livestock. In this background, the role of risks, shocks and vulnerability in perpetuating poverty is important because poor households are relatively more negatively affected by uninsured shocks, as they are likely to lack the necessary human and physical capital to recover from them. In Pakistan incidence of poverty in 2010 was 20.7 percent: 22.4 percent in rural areas and 16.6 percent in urban areas [Arif and Shujaat (2014)]. They are not only suffering from average low consumption but also are subject to high fluctuations in consumption due to income risk and the lack of safety net measures. In rural areas, permanent non-farm employment is associated with the exit from poverty while education is key to such employment. Livestock is more pro-poor than crop agriculture but its role in economic growth may be limited. Social safety nets are weak; especially those provided by formal institutions, while private networks based on personal relations are more important safety nets [Kurosaki and Khan (2001)]. Since the majority of households in Pakistan depend on agriculture for their livelihoods, frequent droughts, floods, and other unexpected adverse events such as illness, loss of job, and conflicts, can lead to loss of their income and assets. While doing nothing is an option in the wake of a shock, many also tend to use several coping strategies including informal insurance, savings, loans, receiving aid and remittances, reducing consumption, and liquidating assets to at least sustain their welfare levels maintained prior to the shocks.

Improving the understanding of shocks at household level is an issue of increasing importance for Pakistan. This is particularly true for natural disaster related covariate shocks. There is limited knowledge of their incidence and the coping mechanisms adopted by households to deal with them [Heltberg and Niels (2009); Alderman (1996)]. Given the significance of risk and uncertainty associated with, policy-makers are required to incorporate shocks into their economic development strategies for quick reduction of poverty in Pakistan. In this scenario this study attempts to fill these gaps in the literature by investigating the following questions: What types of shocks most frequently affect households? Which households are more vulnerable to natural disasters such as floods and droughts? Which region is more affected by these types of shocks? What are the socio economic characteristic of the households hit by (self-reported) shocks? Finally, what are risk management strategies adopted by these households?

[2]http://www.emdat.be/natural-disasters-trends (accessed on April 17, 2015).

In this scenario the study has four main objectives related to shocks, vulnerability and coping mechanism: (i) to highlight frequency and severity of different types of shocks that affected the households in 2006-2010; (ii) to examine the correlation structure of shocks at village level; (iii) to assess the probability of occurrence a shock by a multivariate analysis; and (iv) to analyse which type of households in rural Pakistan are more vulnerable to shocks in terms of a decline in their consumption during such disaster.

The rest of the paper is structured as follows: the next section will provide review of the literature on shocks in developing countries. Section 3 lays out details of the data and methodology used for the paper and Section 4 discusses results in detail. Section 5 concludes the study.

2. REVIEW OF LITERATURES

In developing countries increased focus on risk and vulnerability motivated a series of studies aimed at theoretically conceptualising and empirically measuring household vulnerability to shocks. This section begins with a brief review of available literature on risk, shocks and vulnerability in Pakistan.

As one of the dimensions of vulnerability, Kurosaki (2006) investigates the inability of rural dwellers to cope with negative income shocks in KP province of Pakistan. Estimated results show that the ability to cope with negative income shocks is lower for households that are aged, landless and do not receive remittances regularly. While illustrating various measures of vulnerability proposed in the literature Kurosaki (2009) applies it to a panel dataset collected in rural Pakistan. The empirical results show that different vulnerability rankings can be obtained depending on the choice of the measure. By utilising these measures, it can be identified who and which region is more vulnerable to a particular type of risk. This kind of information is useful in targeting poverty reduction policies. Kurosaki (2010) also investigates the measurement of transient poverty when each person's welfare level fluctuates due to exogenous risk. Theoretical results show that poverty measures associated with prudent risk preferences perform better than other measures in assuring that the value of transient poverty increases with the depth of chronic poverty.

Using a cross-section survey Heltberg and Niels (2009) mapped and quantified shocks from all sources, ex-post responses and outcomes for a sub sample of relatively poor Pakistani households. They found high incidence and the cost of shocks, with health-related shocks being the worst. Two-thirds of the sample experienced at least one major shock in the three years prior to the survey while more than half of the reported shocks were related to health and 75 percent of the most important shocks were idiosyncratic. These findings add to the evidence that health shocks often dominate and impose severe coping costs in terms of medical expenses while relying mostly on informal and ad hoc responses: informal borrowing, spending savings, and working more were the most frequently used responses.

The relationship between health and death risk and income decisions in rural Pakistan was explored by Jacobsen (2009). He showed how insurance against hospitalisation and accidental death influenced the purpose of micro credit loans. He found that individuals were more likely to maintain the same loan purpose as their previous loan if they were insured. Their results suggest that households that are insured

against hospitalisation and accidental death pursue less diversified income portfolios. Hidayat and Takashi (2007) attempted to quantify the ill-effects of covariate shocks such as natural disasters on the sustainability of microfinance in Pakistan. Based on the difference-in-difference approach, contrasting regions that were hit by the 2005 earthquake, and regions that were not, it was found that the delay in repayment in the affected areas was 52 percent higher than that in the unaffected areas. The observed difference in the repayment delay was decomposed into changes in borrowers' composition and borrowers' behaviour. The decomposition result showed that the changes in borrowers' behaviour accounted for a large portion of the difference, suggesting a serious difficulty faced by borrowers and microfinance institutions in the earthquake-hit regions.

The literature on natural hazards typically perceives disasters to be acts of God while restricting the examination of their causes to biophysical and geographical explanations. Yasir (2009) takes a different approach; first, he argues that disasters are socially constructed and, second, he situates the interactions of large-scale natural forces with local political-economic conditions within the context of vulnerability to contend that disasters are consequences of unresolved development challenges. Using the Pressure and Release (PAR) Model his paper suggests the usefulness of the concept of vulnerability that shapes local geographies of risk and weak institutions which transform and enhance the negative impact of 'natural' hazards into 'man-made' disasters.

An empirical model of profit variability at the individual farm level was proposed by Kurosaki (1995) and was applied to Pakistan's agriculture. Results show that adding idiosyncratic yield shocks and adjusting for input costs makes the variability of net profits much larger than implied by the variability of average gross revenues. It is also demonstrated that the correlation between green fodder profit and milk profit at the farm level is substantially negative. This negative correlation implies an advantage, in terms of risk diversification, of combining fodder and milk production in one enterprise, which is commonly observed in the mixed farming system in Punjab province.

Based on fieldwork, theoretical modeling and empirical testing of agricultural households in Punjab, Kurosaki (1997) found households' characteristics affecting their production choices and the relationship between the individual decisions and the incompleteness of the rural market structure. He also observed that with substantial income uncertainties, the sample farmers were unable to share the risk efficiently with the outside world and they therefore had to diversify the risk through individual means such as crop choice and livestock management. He also sheds new light on the positive role of livestock in enhancing the welfare of households, especially of small land holders.

Using three-year household data on production and consumption from the Punjab province, Kurosaki (1996), explored that the household's livestock holding contributed to a reduction in income variability through the negative correlation of livestock income with crop income and through ex-post decumulation of livestock assets contingent on realised income in the crop sector. His results suggested that the rises in the livestock share in agricultural value-added in Pakistan during the 1980s should have improved the welfare position of smaller farm households with substantial livestock holding through reduced income variability.

Substantial evidence of consumption smoothing as well as differences in savings propensities between the rich and poor households was explored by Alderman (1996), using a three year panel data from Pakistan indicating that even poor households, use credit markets to maintain consumption in the presence of negative income shocks.

Displacement gives rise to particular vulnerability for those affected by shocks, necessitating special measures for assistance and protection that correspond to those vulnerabilities. The factors that have caused internal displacement in Pakistan in the recent past are a complex bunch and cannot be addressed by a one-size-fits-all approach. However, the official response has been largely reactive and characterised by a failure to formulate a comprehensive approach that focuses on preventing internal displacement, by avoiding conditions that may lead to displacement [Din (2010)].

This review of literatures on risk, shocks and vulnerability relating to Pakistan indicates direct implications for welfare loss due to health shock, agricultural shock and natural disaster that ultimately, translate into income shock.

3. MATERIALS AND METHODS

3.1. Data

Households in developing countries are frequently hit by severe idiosyncratic and covariate shocks, resulting in high income volatility. Pakistan being a low human development country, is frequently hit by major natural disasters, including earthquake of 2005 and flood of 2010 which resulted in huge human and economic losses. To study this scenario, panel household's survey is an important source of information but it is rarely available in developing countries. In Pakistan a three waves panel data set named 'Pakistan Rural Household Survey' is available. The first round, of Pakistan Rural Household Survey was done in 2001. The second round done in 2004 was restricted to two provinces Punjab and Sindh and the third round, renamed as Pakistan Panel Household Survey (PPHS)-2010, marked the addition of urban sample of four provinces. These longitudinal surveys were conducted by the Pakistan Institute of Development Economics with the financial assistance of the World Bank. This study is based on 'PPHS-2010' which covers all four provinces (Punjab, Sindh, Khyber Pakhtoonkhawa (KP) and Balochistan) with their urban and rural counterparts. The survey covered 16 districts[3] from all four provinces of Pakistan. The household survey questionnaire consists of two parts; a male questionnaire and a female questionnaire. The male questionnaire constitutes thirteen modules while female questionnaire has twelve modules. The total sample size of PPHS-2010 was 4142 households; 2800 in rural and 1342 in urban while Punjab 1878, Sindh 1211, KP 601 and Balochistan 452.

The data used in this paper are based on a household-level 'Risk response module' included in PPHS-2010 and similar to that developed in Hoddinott and Quisumbing (2003), but modified for the Pakistan context. The module administered only in PPHS-2010 round, asks households to report any unexpected events that were outside of their control and caused a drastic reduction in income during the last five years prior to the

[3]Punjab: Faisalabad, Attock, Hafizabad, Vahari, Mazaffargarh; Sindh: Badin, Nawab Shah, Mirpur Khas, Larkana, KP: Dir, Mardan, Lakki Marwat, Balochistan: Loralai, Khuzdar and Gwadar.

survey i.e. 2006-2010. The survey provides information on data by year and type of disaster to provide a check for the consistency between the self-reported shocks and on the actual occurrence of such shocks. These reported shocks are divided into a four broad categories: natural/agricultural; economic; social (political/social/legal); and health/life-cycle shocks that inflict welfare loss. Natural/agricultural shocks include flooding, drought, fire, earthquake and crop failure. Economic shocks include business closures, mass layoffs, job loss, wage cuts, loss of remittances and other reasons. Social shocks in Pakistan include court cases and bribery, long duration general strikes, violence, crime and political unrest. Health/life-cycle shocks include death, injury and illness. The survey distinguishes between death or illness of the primary income earner and other household members. The respondents were also asked whether the household was affected by idiosyncratic (household-specific) shocks or covariate shocks that affected larger group of population in the same area at the same time and to report the monetary value of the cost of shock. The frequency and intensity of major disasters is also of great relevance to the recovery of households. Finally, households were also asked about the four important coping strategies to manage the reduction in income such as sale of assets including land, livestock and stored crop, decrease food consumption, increase labour supply particularly of women and children, saving, borrowing and assistances from friends and relatives, etc. The present analysis has used this information on the shocks and coping strategies together with socio-economic characteristics (i.e., individual characteristics such as sex (if male=1), age in years and formal years of education) and household characteristics, like household size in numbers (taken as adult equivalent), dependency ratio,[4] per capita consumption expenditure (to be precise, 'per capita' implies "per adult equivalence unit), poverty status,[5] the ratio of female in the household size[6] (working age 15-55 years), agricultural land ownership in acres, livestock ownership in numbers, access to formal credit (yes=1) , household member abroad (yes=1), welfare ratio,[7] sector of employment of household head (agriculture=1), changes in agriculture landownership in acres and livestock ownership used as proxy of assets and welfare ratio (between 2004 and 2010). In addition to individual and household level characteristics, place of residence like Punjab and Sindh (yes=1) provinces also included. Since there is a socioeconomic gap and a difference in historical legacies between the northern and southern parts of Punjab, the analysis divided Punjab into two portions, north and south (yes=1) regions.

As reported earlier the self-reported shocks occurred between 2006 and 2010. To assess the relationship between socio-economic characterise and exposure to specific type of shocks, the data on such characteristics is used from a prior wave of the panel survey, PRHS-2004. Since the PRHS-2004 was restricted to only rural areas of two provinces, Punjab (48 villages) and Sindh (46 villages), this paper has used a sub-sample of the PPHS-2010 consisting of two provinces, Punjab and Sindh. However, the frequency of

[4]The dependency ratio takes the sum of the population under the years of 15 and over 64 and divided by the population in the intermediate range of 15-64.

[5]The poor are defined as a household with per adult equivalent consumption expenditure below the poverty line Rs 878.64 and Rs 1671.89 per month for the year 2004 and 2010, respectively [Arif and Shaujaat (2014)].

[6]Women make essential contributions to the agricultural and rural economies in all developing world.

[7]Welfare ratio is defined as consumption expenditure per adult equivalent divided by poverty line in the respected year.

shocks and their spread are reported for the whole sample of PPHS-2010 as well as the sub-sample of rural Punjab and Sindh.

3.2. Method of Analysis

This section will discuss methodologies to analyse the occurrence of shocks that lead to loss of household income, reduction in consumption, loss of productive assets, and serious concern/anxiety about household welfare:

(i) Bivariate analysis; (ii) Correlation structure of shocks; (iii) Multivariate analysis; and (iv) Fixed effect model.

In bivariate analysis simple cross tabulation with row or column percentage is presented to analyse the different types of shocks against socio-economic characteristics.

To understand the correlation structure of different shocks, factor analysis is applied which is a standard technique used to find the latent shocks that account for patterns of variation among observed shocks. Factor analysis is a method used to reduce the number of variables to a smaller number of underlying dimensions, with highly covariant variables loading on the same factor; a loading is the correlation between the variable and the component

In order to determine the characteristics of households which are likely to be affected by the occurrence of an adverse shock, a dichotomous dependent variable was constructed in this study which would be equal to one if occurring, five years preceding the survey would lead to loss of household welfare and would be equal to zero otherwise. Because the indicator is dichotomous, a logistic regression model was estimated. This model makes it possible to estimate the probability of a shock conditional on independent variables. In the same way a probability of natural/agricultural shock is also estimated.

To construct the broad group of shocks, households were classified into three groups- those that had not suffered any type of shock, those who face an income shock (natural/agriculture and economic shocks) and those who had an event of societal shock (health and social shocks). Because the variable is trichotomous, the multinomial logistic regression model is estimated. The independent variables are classified into three groups: individual, household and community-level factors for the estimation of this model.

Finally, for rural households, vulnerability in terms of a decline in their consumption is investigated when their village is hit by shocks such as floods and droughts, etc. Fixed effect (FE) model is used to explore the relationship between predictor and outcome variables within an entity (village). Each entity has its own individual characteristics that may or may not influence the predictor variables. When using FE it is assumed that something within the individual may impact or bias the predictor or outcome variables and which need to control for this. This is the rationale behind the assumption of the correlation between entity's error term and predictor variables. FE remove the effect of those time-invariant characteristics so we can assess the net effect of the predictors on the outcome variable. The standard Fixed Effect model is estimated as:

$$y_{it} = x'_{it}\beta + z'_i\alpha + \varepsilon_{it}$$

There are *K* regressors in x_{it}, not including constant term. The heterogeneity, or individual effect is $z_i'\alpha$ where z_i contains a constant term and a set of individual or group specific variables, which may or may not be observed. If z_i is observed for all individuals, then the entire model can be treated as an ordinary linear model and fit by least squares. If z_i is unobserved, but correlated with x_{it}, then the least squares estimators of β is biased and inconsistent as a consequences of omitted variables. However, in this instant, the model:

$$y_{it} = x_{it}'\beta + \alpha_i + \varepsilon_{it}$$

Where $\alpha_i = z_i'\alpha$, takes all the observable effects and specifies an estimable conditional mean. This fixed effects approach takes α_i to be group specific constant term in the regression model. The term 'fixed' effect as used here, indicates that the term does not vary over time [Greene (2003)].

The present analysis takes the specification of fixed effect model as:

$$dlnc_{2010-2004} = \propto_i + \beta.H_{iv,2004} + \gamma.S_{iv,2010} + \varepsilon_{iv}$$

where

$dlnc$ is the outcome variable (namely, change in log real per capita consumption of household *i* in village *v* between 2004 and 2010), $\propto_i$ the group specific constant term for each village, $\gamma.H_{iv,}$ is a vector of variables of household and socio-economic characteristics in 2004, $\beta.S_{iv}$ shocks to households experienced between 2004 and 2010, and $\varepsilon_{iv}$is an error term.

4. EMPIRICAL RESULTS

4.1. Shocks and Coping Mechanisms: A Descriptive Analysis

In this section the data on the distribution of shocks in the sample are illustrated. The objective is to present a description of what kinds of shocks occurred, who was affected by them and what kind of coping mechanisms were adopted.

The section defines the frequency, category, costliness and impact of shocks as reported by the sample households occurred during five years (2006-2010) preceding the survey. The sample households also identified the main coping strategies and several other details of the shocks including whether the event affected only the individual household (idiosyncratic) or the entire community (covariate shocks).

As reported in Table 1, almost one-third (33.4 percent) of the sample households experienced one most severe shock over the five-year recall period. The most common types of shocks are natural/agriculture related (55.9 percent of total) and health shocks (33.7 percent) which have resulted in major fall in income. The natural/agriculture events include loss of personal and business assets due to natural disaster, crop failure, loss of livestock and drop in crop income while health shocks comprise illness or disability and death of an income earner or other family members. Far less frequent are economic (2.0 percent) and social shocks (8.4 percent). The economic shocks consist of loss of personal or business assets due to violence or conflicts, business failure due to low sale/demand, unsuccessful investment and job loss while social shocks comprise internally displaced person and other social shocks including land or family dispute, etc.

Table 1

Extent of Shocks by Selected Shocks in Rural Pakistan (%)

		How Widespread was this Shock?				
Type of Shock	Reported Shocks	Only Affected this Household	Affected few Households	Affected many Households	Affected Almost every Households	All
		Idiosyncratic			Covariate	
Natural/Agriculture	55.9 (18.8)	21.7	8.1	19.4	50.7	100
Economic	2.0 (0.8)	74.2	25.8	0	0	100
Social	8.4 (2.5)	79.3	16.2	4.4	0	100
Health	33.7 (11.3)	91.4	4.0	1.6	3.1	100
Overall	100 (33.4)	51.1	7.7	11.7	29.4	100

Source: Computations are based on the micro data of PPHS-2010.

While analysing the spread of shocks, it is observed that the risk of shock may emanate from two broad sources: idiosyncratic shocks; or covariate shocks. Covariate shocks i.e., community level shocks, are typically natural disasters like floods, draughts and pest attack which affect agriculture production severely and potentially contribute to high income volatility of households. It is indicated that natural and agriculture shocks contribute a major share in covariate shocks. Household's idiosyncratic shocks that are household specific are shocks such as death of principal income earner, chronic illness or unemployment/underemployment etc. Health shock added 91.4 percent share in this category. Health shocks may be having more importance because they affect the household's ability to produce and generate income. These types of shocks are fairly common in developing countries including Pakistan, mainly due to the absence of easy access to medical care, drinking water, unhygienic living conditions, and limited opportunities for diversifying income sources. These difficulties are compounded by lack of financial intermediation and formal insurance, credit market imperfections and weak physical infrastructure.

The effects of shocks are multi-dimensional and affect a variety of aspects of household welfare. Table 2 reports that all types of shocks invariably affect both poor and non-poor households while rural households are disproportionately exposed to natural and agricultural shocks and are less exposed to economic shocks, specific to a formal economy. As far as family headship is concerned, female headed households are more vulnerable to overall shocks and its impact varies from shock to shock indicating a high share of health shock that is 51.1 percent of total shock while male headed households get major welfare loss due to natural/agriculture shocks that is 51.6 percent of the overall impact of shock. The impact of different types of shocks classified by assets ownership shows that households which had ownership of land and livestock suffer a major welfare loss due to natural and agriculture shocks; 70.6 percent and 65.4 percent respectively.

Table 2

Incidence of Shocks by Household Characteristics: Rural Pakistan

Household Characteristics	Type of Shock (%)				Incidence of Shock (%)
	Natural/Agricultural	Economic	Social	Health	
Poor	47.4	3.9	10.9	38.1	31.7
Non Poor	58.2	1.6	7.7	32.6	35.6
Agri Household	65.5	15.9	53.9	45.9	55.8
Credit Access	56.2	2.0	7.7	34.2	42.0
Male Head HH	57.4	2.0	2.5	33.0	32.3
Female Head HH	32.8	0	8.0	59.1	47.9
Land Ownership	62.5	1.9	5.4	29.8	60.1
Livestock Ownership	84.2	34.8	73.8	74.6	79.1
Punjab	52.7	1.6	7.3	38.3	33.6
Sindh	61.8	2.4	8.0	27.9	41.3
Total	56.1	2.1	8.1	33.7	33.4

Source: Computations are based on the micro data of PPHS-2010.

The PPHS-2010 also provides information on data by year and type of disaster to make consistent with the self-reported shocks and with the information on the occurrence of such shocks as presented in Table 3. It is reported that 67.8 percent of all shocks are occurred in 2009-10 in which a major natural disaster in the form of flood was witnessed. It was the one of the largest floods in the history of Pakistan causing unprecedented damage and killing more than 1,700 people, affected over 20 million people; in undated almost one-fifth of the country's land. The estimated cost of the flood to the economy was $9.7 billion in losses through damages to infrastructure, housing, agriculture and livestock, and other family assets.

Table 3

Major Shocks Occurred during the Last Five Years (%)

Year of Shock	Type of Shocks				
	Nat/Agriculture	Economic	Social	Health	Overall
2009-10	64.6	33.3	50.2	61.4	61.9
20008-09	22.3	46.4	21.8	19.3	21.9
2007-08	7.4	20.3	10.1	8.4	8.2
2006-07	2.5	0	12.8	11.0	5.9
2005-06	2.5	0	5.1	0.6	2.0

Source: Computations are based on the micro data of PPHS-2010.

The severity of shocks is elaborated in Table 4. The mean total cost of the most severe shock as reported by sample households, is Rs 10894.9 (or $1230). This is equivalent to 40 percent of average per adult annual household expenditures in Pakistan. In respect of average cost of shock, social shocks (Rs 233456.9 per event) are the most expensive followed by natural/agricultural shocks (Rs 113093.9 per event), economic shocks (Rs 99217.4 per event) and health shocks (74900 per event). Because of their high frequency and high costs, natural/agricultural shocks caused by far the largest share in total cost of shocks comprising 58 percent of the total burden while health shocks took 23 percent of the total burden.

Table 4

Costs and Scope of Shock, by Type of Shocks

	Cost of Shocks			Scope of Shocks	
Type of Shocks	Mean Rupees per Shock	Standard Deviation	% of Total Burden*	Covariate % of Shocks in Category	Idiosyncratic % of Shocks in Category
Natural/Agri	113093.9	169925.6	58.6	78.3 (88.9)	21.7 (24.4)
Economic	99217.4	91088.9	1.8	20.3 (0.8)	79.7 (3.1)
Social	233456.9	380357.2	16.2	26.6 (4.1)	73.4 (11.1)
Health	74900.6	127709.1	23.4	9.1(6.2)	90.9 (61.4)
Overall	10894.9	185783.5	100	49.7	50.3

Source: Computations are based on the micro data of PPHS-2010.

*% burden of shock is computed by taking % share of reported shocks out of total cost.

In parenthesis percentage distribution of type of shocks are given.

Table 4 also highlights shocks according to scope indicating that the major share of idiosyncratic shocks originates from health shocks (90.9 percent) while a larger part of covariant shocks originates from natural/agricultural shocks (78.3 percent). Health insurance is also rare in Pakistan where out of pocket expenditures accounted for 71 percent of total medical expenses, compared to 13.2 percent in the United States. When a risk materialises and becomes a shock it causes a significant major income loss to these households. These shocks can be large and may trigger substantial consumption fluctuation which can have important consequences for household welfare in the short and long run.

The coping responses practised by households to deal with shocks are illustrated in Table 5. Survey respondents were asked how they managed the reduction in income caused by the most severe shock and about their use of saving, credit and assistance in general. It is observed that coping mechanisms are overwhelmingly informal and largely asset-based using savings, sale of livestock or borrowing. The ex-post coping strategies can be divided into four main categories: (i) asset-based strategies; (ii) assistance-based strategies; (iii) borrowing-based strategies; and (iv) behaviour-based strategies. These strategies can depend on formal or informal coping mechanisms.

Asset-based coping strategies are adopted by 54 percent households experiencing shocks. This coping mechanism includes use of saving and sale of assets such as agricultural land, livestock or stored crop. Saving is likely to be held in cash that constitutes 37 percent of assets-based strategy while sale of livestock and other assets (land or stored crop) contributes 52 percent and 11 percent respectively of all asset-based responses as reported in PPHS-2010. These assets are used primarily to cope with natural/agricultural and health shocks. Assistance-based strategies were reported to have been used for 10 percent of shocks; assistance is used largely to cope with health shocks (60.6 percent) and rarely to cope with economic shocks (2.1 percent). All types of assistance received by respondents come from relatives and friends while formal coping instruments (government/NGOs) are lacking. These findings are quite comparable with Heltberg and Niels (2009) who had reported the results of a novel survey of shocks, coping, and safety nets in Pakistan. They found high incidence and cost of shocks borne by these households and in the absence of formal and effective coping options they use mostly self-insurance and informal credit. Borrowing-based strategies are used by 18.7

Table 5

Ex-Post Coping Strategies by Type of Shocks: Rural Pakistan

	Type of Shocks				
Strategy	Natural / Agricultural	Economic	Social	Health	Total
Asset-based Strategies	58.9	1.5	7.3	32.3	100
	(57.3)	(39.4)	(49.6)	(51.8)	(54.5)
Assistance-based Strategies	44.2	5.3	8.1	42.4	100
	(7.9)	(25.8)	(10.1)	(12.5)	(10.0)
Borrowing-based Strategies	41.2	1.5	9.7	47.7	100
	(13.8)	(13.6)	(22.5)	(26.3)	(18.7)
Behaviour-based Strategies	69.8	2.6	8.6	19.0	100
	(20.9)	(21.2)	(17.8)	(9.4)	(16.8)
Total	56.1	2.1	8.1	33.7	100

Source: Computations are based on the micro data of PPHS-2010.
In parenthesis percentage distribution of types of strategies are given.

percent shock affected households. Credit is almost entirely informal, offered by friends (28 percent of all loans and credit), family (40 percent) and moneylenders (22 percent); formal credit sources such as banks or microfinance (10 percent) are of marginal importance for this analysis. Informal instruments of coping mechanism dominate across all strategies. Behaviour-based strategies such as consuming less, increasing labour supply or taking children out of school for work, were used as the primary coping response in 16.8 percent of the households when hit by the worst shocks. These type of coping strategies were practised more often for natural/agricultural shocks than for economic shocks. In addition, many households reduced food consumption, non-food consumption and increased labour supply of children or women in response to shocks as a secondary coping strategy.

Dynamics of poverty and type of shocks in rural Pakistan are presented in Table 6. It is observed that non-poor households are more affected by natural/agriculture shocks as they have productive assets like land and livestock which are at risk when any hazard occurred. Serious adverse natural/agricultural shocks affect households in a variety of ways, but typically the key consequences work through assets. Assets themselves may be

Table 6

Dynamics of Poverty and Type of Shocks: Rural Pakistan

	Type of Shocks				
Poverty Status	Natural/Agricultural	Economic	Social	Health	Total
Chronic Poor	51.1	6.8	9.7	32.4	8.8
	(7.9)	(30.4)	(11.2)	(8.4)	
Transient Poor	51.0	3.5	7.5	18.1	18.0
	(16.3)	(31.9)	(18.0)	(18.1)	
Transient Non-poor	46.6	1.6	8.9	42.9	13.1
	(11.6)	(11.6)	(16.5)	(17.7)	
Never Poor	61.3	0.9	7.0	30.9	60.1
	(64.1)	(26.1)	(54.3)	(53.7)	
Total	56.1	2.1	8.1	33.7	100

Source: Computations are based on the micro data of PPHS-2010. Figures in parenthesis are column percentages.

lost directly due to the adverse shocks—such as crop failure, loss of livestock, soil erosion, while assets also play a central role in attempts to buffer income fluctuations, and may therefore be used or sold, affecting the ability to generate income in the future. Likewise, chronic poor and transient non-poor households are relatively more suffered from health shocks which affect the possibility of income earning opportunities for households and a rise in health expenditure.

Shocks for the rich and poor against expenditure quintiles are presented in Table 7. Natural/agriculture shocks hit the upper two quintiles more than the bottom quintiles as the rich have land or livestock that are more vulnerable to natural disaster. Social shock makes the poor more vulnerable due to conflict/disputes, or funeral expenditure. Health shock affects the second quintile as compared to the richest households due to uninsured risk.

Table 7

Shocks for the Rich and Poor: Rural Pakistan

	Expenditure Quintiles 2004				
Type of Shock	Q 1 Poorest	Q 2	Q3	Q4	Q5 Richest
Natural and Agriculture	46.7	55.1	54.5	63.3	64.0
Economic	2.8	3.8	1.4	1.4	0.9
Social	10.0	8.5	6.8	9.3	3.3
Health	40.4	32.6	37.3	26.1	31.8
Main Coping Strategies					
Asset-based Strategies	50.2	43.8	54.1	63.5	61.1
Assistance-based Strategies	8.1	13.1	10.1	4.8	13.0
Borrowing- based Strategies	27.3	18.1	18.5	19.9	12.8
Behaviour-based Strategies	14.5	25.1	17.2	11.8	14.8

Source: Computations are based on the micro data of PPHS-2010.

Different types of coping mechanisms are also given against household's economic status indicating that the poorest bottom quintiles adopted behaviour-based strategies which include reducing food consumption, employing child labour, working more hours, etc. It is also observed that when a shock hits, the main strategy adopted by households is to use their assets in some way rather than to ask for help from friends and relatives, while private and public social safety nets exist but offer little effective protection. The poor are less resilient than the rich and the coping strategies used by the poor damage their prospects to escape poverty. Recent study shows that there are considerable poverty related movements depending on the type of shocks and degree of risk and uncertainty that households are faced with. Even if aggregate poverty levels remain constant over time, the share of the population which is vulnerable to poverty might be much higher [Azam and Katsushi (2012)].

4.2. Correlation Structure of Shocks

To measure the degree of covariance of the occurrence of a shock at a particular location all primary sampling units (PSUs) in which no one reported experiencing a shock in last five years were excluded from this exercise. First, the information on the incidence of the shocks at the level of the primary sampling unit was aggregated, and

then the proportion of households reporting the shock was estimated in each PSU. The present survey records information on 15 specific shocks, plus two catch-all categories; idiosyncratic or covariate.

The standard variance-covariance matrix can be used to find the pairs of shocks with the strongest association, i.e., 'business failure—drop in income' pair. The standard technique used to find the latent shocks that account for patterns of variation among observed shocks is factor analysis which is a method used to reduce the number of variables to a smaller number of underlying dimensions, with highly covariant variables loading on the same factor.

Table 8 presents the component loadings (i.e. a loading is the correlation between the variable and the factors) on the first five factors (whose eigenvalues are greater than one). The higher is the loading, the higher is the association between a variable and a factor. The present study employed factor analysis in which five components considered as 'bunched-shocks' are extracted. Factor one includes three health shocks illness/disability of household member, death of income earner and household member and loss of personal and business assets due to conflicts are positively correlated at village level. Factor two includes natural/agricultural shocks which contain, crop failure, loss of livestock due to disease or other causes and loss of personal assets due to natural disaster are moving in same direction while factor three consists of economic shocks including drop in crop income, unsuccessful investment and business failure due to low sale/demand. The three social shocks such as internally displaced persons, illness/disability of income earner and other social shocks are in fourth factor while in fifth factor two shocks related to loss of business assets due to natural disaster and job loss are correlated.

Table 8

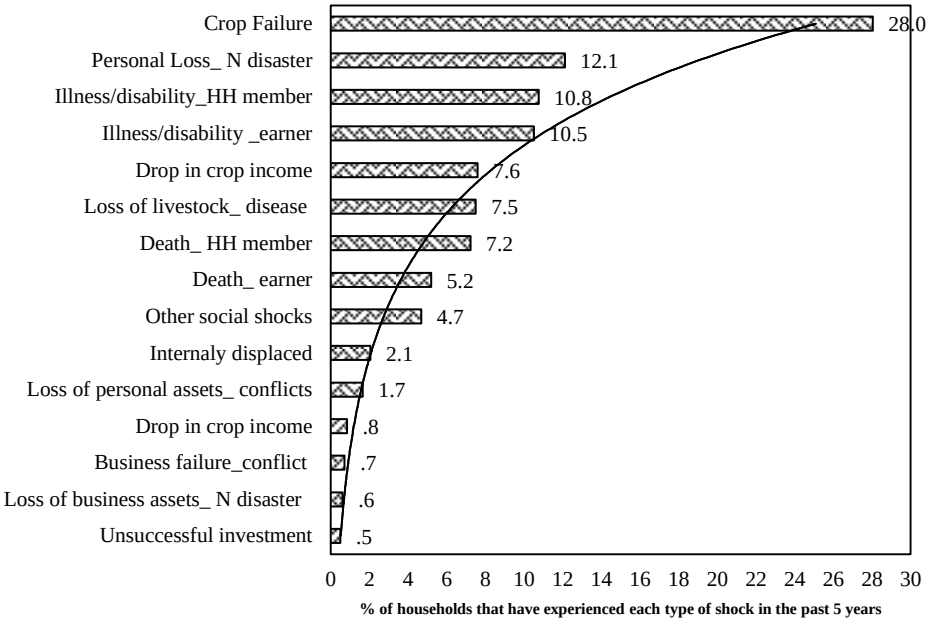
Bunched Shocks: Understanding the Correlation Structure using Factor Analysis

Shocks	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Illness/Disability of HH Member	.759	.006	-.080	.178	-.117
Death of other Household Member	.659	–.275	.336	.182	–.231
Death of an Income Earner	.600	.086	–.142	–.215	.319
Loss of Personal Assets _ Conflict	.548	.436	.012	–.215	.024
Loss of Business Assets _ Conflict	.494	.049	–.038	–.091	–.045
Crop Failure	.037	.766	–.034	–.091	–.043
Loss of Personal Assets _Natural Disaster	–.050	.701	.233	.037	–.134
Loss of Livestock _ Disease/ Causes	.251	.467	–.276	.168	.386
Drop in Crop Income	–.036	.030	.757	.128	–.048
Unsuccessful Investment	–.157	.055	.733	–.122	.215
Business Failure _ Low Sale/Demand	–.230	–.164	.340	.141	–118
Illness/Disability of Income Earner	.066	.114	–.122	.643	–.107
Internally Displaced Persons	–.014	.557	.107	.562	.025
Other Social Shocks	.218	.478	.090	.553	–.056
Job Loss	.065	–.108	.061	.046	.833
Loss of Business Assets _ Natural Disaster	–.182	.014	.155	.034	.394

Source: Computations are based on the micro data of PPHS-2010.
Note: Only principal components with eigenvalues > 1 are shown.
Reported statistic: Factor loadings after oblique rotation.

The frequency distribution of these reported shocks are also given in Figure 1. It is observed that highest reported shocks are crop failure (28 percent) and personal loss due to natural disaster (12.1 percent) while third and fourth shocks are related to health shocks; disability/illness of household member (10.8 percent) and earner (10.5 percent). A significant number of households also reported death of earner (5.2 percent) and member (7.2 percent) of households. Economic shocks including job loss, low sale, loss in investment and loss in business have small share in total shocks.

Fig. 1. Sources of Shocks in Rural Pakistan (%)



4.3. Multivariate Analysis

The result of the shocks estimated through logistic regression models to determine factors influencing the incidence and occurrence of shocks are reported in Table 9. Models in this table represent an event of shock versus no shock which resulted in welfare loss due to decrease in income. The data on shocks have been taken from the risk response module of PPHS-2010. The shocks include natural/agricultural, social, economic and health which were faced by households during 2006 to 2010. It is important to highlight that most of the determinants of the occurrence of shock are however, themselves affected by shocks. For instance, while acquisitions of such assets as ownership of land and livestock have been taken as determinant of shock, they themselves could be influenced by shocks. Another vicious circle may exist between the poverty status of the household and different types of shocks. To overcome this issue a restricted sample of panel households of rural Punjab and Sindh provinces is used to observe the impact of 'pre-shock' socioeconomic characteristics in year 2004 on the probability of experiencing an adverse shock between years 2006 to 2010.

Three types of explanatory variables have been used: individual characteristics of the head of household i.e. sex, age and years of education; household characteristics including household size (as adult equivalents), female ratio in the household, dependency ratio, welfare ratio, productive assets such as agriculture land and livestock, poverty status (poor/non-poor), household member abroad, formal credit, sector of employment (agriculture/non-agriculture) and community level variable i.e., province (South Punjab/North Punjab and overall Sindh/North Punjab). In addition to these characteristics, the analysis also adds difference in assets (ownership of land and livestock) and welfare ratio between the 2004 and 2010 period.

Table 9

Effects of 2004 Socioeconomic Characteristics on the Probability of Experiencing a Shock between 2006 and 2010

	Model-1 Shock/No Shock		Model-2 Shock/No Shock	
Correlates (2004)	Coefficient	S.E	Coefficient	S.E
Male Headed Households	0.450**	0.190	0.430**	0.190
Age of HH Head	–0.002	0.002	–0.002	0.002
Head Education(Years)	–.015**	0.006	–0.013**	0.006
Household Size	0.048*	.006	0.043*	0.006
Dependency Ratio	0.007	0.030	0.007	0.030
Poverty Status	– 0.032	0.059	0.032	0.059
Female Ratio	0.158	0.196	0.165	0.196
Welfare Ratio	–0.073*	0.024	–0.073*	0.024
Land Ownership (Acres)	0.012*	0.002	0.012*	0.002
Livestock Ownership (no)	0.014*	0.004	0.002	0.004
Credit Access	–0.253*	0.055	–0.251*	0.051
Member Abroad	–0.110	0.175	–0.110	0.248
Sector of Employment	0.317*	0.048	0.335*	0.066
South Punjab/North Punjab	0.718*	0.066	0.734*	0.066
Sindh/North Punjab	1.114*	.062	1.175*	0.062
Constant	–1.89	0.239	–1.746	0.241
Difference in Landholding	—	—	0.007*	0.003
Difference in Livestock	—	—	–0.025*	0.004
Difference in Welfare Ratio	—	—	–0.082*	0.022
LR Chi-square	511.77		662.29	
-2 Log likelihood	8946.7		7881.7	
Pseudo R^2	0.097		0.113	
Observations	1335			

Source: Computations are based on the micro data of PRHS-2004-05 and PPHS-2010.

*Significant at 1 percent, and ** Significant at 5 percent.

A glance at Model 1 reveals that a number of patterns emerge while using the panel households of rural Punjab and Sindh provinces. With respect to individual level characteristics, male headed households are more likely to experience a shock as compared to female headed households. The years of formal education achieved by household head is included in explanatory variables to capture the household ability to adopt risk management strategy. It is indicated that as the years of schooling increases,

the probability of occurrence of a shock decreases. This could be because the welfare level of educated households is higher than uneducated households in general, implying that educated households have larger room for consumption curtailment when hit by an adverse shock [Kurosaki (2009)]. Household size is positively correlated with shocks reporting rates across the board, as larger households are exposed to more shocks from multiple dimensions. With regards to the variables poverty status and female ratio in household became insignificant while welfare ratio had negative and significant relation indicating that as the welfare level of households increases, the probability of suffering a shock decreases. Access to credit plays an important role in smoothing consumption. In this analysis those household who had obtained formal credit have negative and significant relation in explaining the probability of shock because formal credit is usually taken for investment in agriculture purposes which generate stable consumption paths, even when shocks occur. Households with productive assets such as ownership of agricultural land and livestock have greater probability of reporting a shock than those which do not own these assets because assets themselves may be lost directly due to the adverse shocks—such as crop failure and loss of livestock. It is commonly believed that households whose heads are employed in agriculture sector report more shocks on average as agrarian households are often exposed to a larger sets of shocks than non-farm counterparts particularly, crop failure, loss of livestock, and natural hazards like, flood/drought. This analysis confirms this belief. Those households which are employed in agriculture sector (52 percent in Punjab and 60 percent in Sindh) are more likely to report different type of shocks. The analysis has also included those household who had member abroad and receive remittances showing less likely to hit by any type of shock but turns out to insignificant in explaining this phenomenon. Geographical location also plays an important role in determining risk and shocks. This analysis indicates that rural South Punjab and Sindh provinces are more vulnerable in term of experiencing shocks as compare to north Punjab because districts located in these regions like Muzafargarh, Bahawalpur, Nawabshah, Mirpurkhas and Badin were the worst hit in 2010 flood.

In model 2, differences in the values of three correlates (landholding, livestock and welfare ratio) between the 2004 and 2010 are added in the model. There is no major change in results when compared to model 1 except that the livestock which was significant in model 1 turned out to be insignificant in model 2. However, all the three variables—difference in two periods have significant relation with probability of occurrence a shock. The difference in livestock and welfare ratio has a negative and significant relationship with probability of a shock while landholding has positive relation to experience a shock. This analysis indicates that not only the initial socio-economic conditions of households but also a change in these conditions overtime has correlation with the probability of a shock. Thus, it can be concluded that households with positive changes in livestock and welfare ratio can lead to less likelihood of experiencing a shock as livestock can be used as buffer stock when households exposed to risk. However, difference in landholding which is included to proxy households' productive capacity and permanent income generating potential has positive and significant relation with an occurrence of shock.

Natural disasters such as floods, droughts, earthquakes, and other weather-related phenomena can affect household welfare through the destruction of physical and human

capital stock. These shocks are more frequent in developing countries, and the poor are more likely to suffer damages from natural hazards as usually they can only afford to live in marginal areas and have a limited ability to manage these risks [UNDP (2007-08)].

In Table 10, model 3 explores the factors that make households more likely to experience from natural/agriculture shock that had also resulted in loss of income and assets. It is worth mentioning that the findings of these models are not different from the outcome of model 1 and 2, with a few exceptions. Ceteris paribus, if the household head is older, the household faces a lower risk of shocks. Similarly; more educated household heads are less likely to experience a shock than those with less education level. Large households' size, high dependency ratio and sector of employment are more at risk to suffer a shock. The poverty status of the household head which was insignificant earlier came out to be significant indicating more likelihood to suffer from natural/agriculture shocks while female ratio and welfare ratio turned out to be insignificant. Household productive assets, like land and livestock have positive and significant relation with experiencing a shock. In terms of

Table 10

Effects of 2004 Socioeconomic Characteristics on the Probability of Experiencing an Agriculture Shock between 2006 and 2010

	Model-3 Agri Shock/No Shock		Model-4 Agri Shock/No Shock	
Correlates (2004)	Coefficient	S.E	Coefficient	S.E
Male Headed Households	0.563*	0.251	0.589**	0.252
Age of HH Head	–0.004**	0.002	–0.005**	0.002
Head Education(Years)	–0.036*	0.007	–0.036*	0.008
Household Size	0.038*	0.007	0.034*	0.007
Dependency Ratio	0.089**	0.035	0.093*	0.036
Poverty Status	0.319*	0.075	0.310*	0.075
Female Ratio	0.129	0.206	0.120	0.206
Welfare Ratio	–0.002	0.018	–0.021	0.027
Land Ownership (Acres)	0.017*	0.002	0.022*	0.002
Livestock Ownership (no)	0.004**	0.002	0.004	0.005
Credit Access	–0.291*	0.061	–0.297*	0.061
Member Abroad	0.083	0.219	0.034	0.218
Sector of Employment	0.693*	0.059	0.659*	0.060
South Punjab/North Punjab	1.034*	0.81	1.031*	0.082
Sindh/North Punjab	1.006*	0.070	1.031*	0.072
Constant	–2.927	0.299	–2.795	0.300
Difference in Landholding	—	—	0.012*	0.003
Difference in Livestock	—	—	–0.003	0.004
Difference in Welfare Ratio	—	–	–0.016	0.025
LR Chi-square	609.81		630.7	
-2 Log Likelihood	8560.97		8624.1	
Pseudo R^2	0.062		0.064	
Observations	1335			

Source: Computations are based on the micro data of PRHS-2004-05 and PPHS-2010.

*Significant at 1 percent, and ** Significant at 5 percent.

economic well-being Punjab province is better off as compare to Sindh province while within Punjab, Southern region is worse off in terms of human and social development as compare to Northern region [Haq and Azher (2013)]. Finally, as expected households residing in south Punjab and Sindh regions are more exposed to natural disaster as witnessed frequent floods and droughts in this regions.

In model 4, differences in the values of three predictors (landholding, livestock and welfare ratio) between the 2004 and 2010 are added in this analysis to explore the probability of occurrence an agriculture shocks. There is no major change in results as compared to model 3 except livestock ownership turn out to be insignificant while difference in landholding between these periods is significant and households turned out to be more vulnerable to ill effect of shocks.

The shocks are multi-dimensional and affect a variety of aspects of household welfare. For this multivariate analysis, all shocks are decomposed into income shock and societal shock. Income shock is computed by aggregating natural/agricultural shocks and economic shocks while societal shock includes health shocks and social shocks. The results of multinomial logistic regression model presented in Table 11 show the effects of the independent variables on the probability of an income shock vs. no shock and societal shock vs. no shock. Income shock constitute the highest burden of shock with 58.8 percent while societal shock takes 41.2 percent in total welfare loss as reported in descriptive analysis. With respect to the individual level characteristics, a male headed household is found to be more likely to suffer income shock while it is insignificant for societal shock. Age of household head is insignificant in both models while household size has positive and significant relation with the probability of occurrence of an income and societal shocks indicating that as household size increases households are more vulnerable to shocks. Education level of household head reduces probability of income shock but insignificant for probability of societal shocks. The dependency ratio which is used to measure the pressure on productive population is positive and significant showing that as this ratio increases, a household is more likely to suffer an income shock. Women make essential contributions to the agricultural and rural economies in all developing countries including Pakistan. They often manage complex households and pursue multiple livelihood strategies but many of these activities are not defined as "economically active employment" in national accounts but they are essential to the well-being of rural households. To analyse the impact of working age female population in household size, female ratio is included in the model, but this variable turn out to insignificant in explaining the probability of experiencing a shock in both models. Poverty status indicates deprivation of a household, had negative and significant relationship with reference to income shock while it increases the probability of societal shock. Welfare ratio which is a measure of overall well-being of household turns out to be significant indicating that as economic status of the household increases probability of suffering an income shock reduces. When the effect of ownership of productive assets is examined, it was found that a household with land and livestock ownership significantly increases the probability of income shock while it reduces the likelihood of occurrence of societal shocks.

Table 11

Multinomial Logistic Regression: The Probability of Experiencing a Shock

	Model 5			
	Income Shock / No Shock		Societal Shock/ No Shock	
Correlates (2004)	Coefficient	S.E	Coefficient	S.E
Intercept	–2.245	0.336	–1.567	0.293
Male headed Households	0.719**	0.277	0.194	0.225
Age HH Head	–0.003	0.002	0.001	0.002
Head Education (Years)	–0.028*	0.008	0.002	0.008
Household Size	0.053*	0.007	0.043*	0.009
Dependency Ratio	0.0985**	0.037	–0.080**	0.040
Poverty Status	–0.197**	0.078	0.153**	0.074
Female Ratio	0.200	0.221	0.110	0.215
Welfare Ratio	–0.015**	0.020	–0.069	0.033
Land Ownership (Acres)	0.016*	0.002	–0.018*	0.003
Livestock Ownership (no)	0.007***	0.004	– 0.022*	0.004
Credit Access	– 0.447*	0.064	0.047	0.067
Member Abroad	–0.288	0.253	0.334***	0.203
Sector of Employment	0.631*	0.063	0.053	0.063
South Punjab/North Punjab	1.098*	0.086	–0.397*	0080
Sindh/North Punjab	1.249*	0.076	–0.967*	0.078
Chi-square		853.977		
-2 Log Likelihood		15730.0		
Pseudo R^2		0.104		
Observations		1335		

Source: Author's computation is from the micro data of PRHS 2004-05 and PPHS-2010.

*Significant at 1 percent, and ** Significant at 5 percent. a. The reference category is: No shock.

Access to formal credit is used to capture the household's capacity to mitigate the effect of shock. It was observed that a household with access to credit is less likely to report an income shock while it is insignificant for probability of societal shocks. Sector of employment demonstrates positive and significant relation with probability of economic shock while it is insignificant for societal shock. Significant regional variations exist in determining the likelihood of shocks. In model 5, southern Punjab and Sindh provinces are more vulnerable to hit an income shock while it is negative for societal shock. When a shock hits a household, it affects household assets. To capture this effect, the study had taken change in landholding, livestock and welfare ratio between the two periods as reported in Table 12. There is no major change in correlates of this model except a couple of exceptions, i.e., ownership of livestock turn out to be insignificant in both type of shocks. The sensitivities of shock responses to differences in landownership and welfare ratio lower the probability of societal shock while it is positively related to income shock in case of land ownership. The changes in livestock ownerships is negatively associated with probability of income shocks indicating that positives changes in this productive assets is used as ex ante coping mechanism to avoid an income shock.

Table 12

Multinomial Logit Model: The Probability of Experiencing a Shock

	Model 6			
	Income Shock / No Shock		Societal Shock/ No Shock	
Correlates (2004)	Coefficient	S.E	Coefficient	S.E
Intercept	–2.114	0.341	–1.259	0.299
Male Headed Households	0.736**	0.277	0.167	0.226
Age HH Head	–0.004	0.002	0.001	0.002
Head Education (Years)	–0.028*	0.008	0.003	0.008
Household Size	0.049*	0.008	0.037*	0.009
Dependency Ratio	0.09**	0.038	–0.081**	0.040
Poverty Status	–0.185**	0.079	0.099	0.075
Female Ratio	0.195	0.221	0.115	0.216
Welfare Ratio	–0.053**	0.029	–0.069**	0.033
Land Ownership (Acres)	0.021*	0.002	–0.015*	0.004
Livestock Ownership (no)	0.005	0.005	–0.004	0.006
Credit Access	– 0.451*	0.064	0.062	0.067
Member Abroad	–0.218	0.252	0.371***	0.205
Sector of Employment	0.602*	0.063	0.0129*	0.062
South Punjab/North Punjab	1.098*	0.088	–0.444*	0.082
Sindh/North Punjab	1.27*	0.078	–1.073	0.081
Difference in Landholding	0.012*	0.003	–0.013**	0.006
Difference in Livestock	–0.009*	0.004	0.048*	0.006
Difference in Welfare	–0.035	0.026	–0.107*	0.031
Chi-square	985.622			
–2 Log Likelihood	15587.0			
Pseudo R^2	0.119			
Observations	1335			

Source: Author's computation is from the micro data of PRHS 2004-05 and PPHS-2010.

*Significant at 1 percent, and ** Significant at 5 percent a. The reference category is: No shock.

These shocks can affect assets in many ways, first, through the impact on their amount, value and productivity. This could be the direct result from the shock or a ramification of its impact through the absence or inadequate application of coping mechanisms. Poor households tend to pay a higher cost for mitigating and coping with risk due to their reduced asset base. Next section discusses vulnerability measured in terms of sensitivity of consumption changes due to shocks.

4.4. Vulnerability: Sensitivity of Consumption Changes Due to Shocks

In developing economies poor households are likely to suffer not only from low level of welfare on average but also from fluctuations in their welfare to their limited coping abilities [Fafchamps (2009); Dercon, *et al.* (2005)]. The inability to avoid welfare declines when hit by exogenous shocks can also be called vulnerability [Ligon and

Schechter (2003); Kurosaki (2006)]. Idiosyncratic and village-level negative shocks may have been responsible for the consumption decline of certain households when the country experienced a consumption increase on average. Aggregate shocks such as droughts and floods cannot be perfectly insured by risk sharing.

Given this inability, Kurosaki (2013) explored households which are more vulnerable in terms of a decline in consumption when a village is hit by shocks like flood, drought and health and what kind of microeconomic mechanism underlies the household heterogeneity in vulnerability, using two-period panel data collected in rural Pakistan in 2001 and 2004. This study also investigates households in rural Pakistan who are vulnerable to shocks in terms of a decline in their consumption expenditure when their village is hit by covariate or idiosyncratic shocks which is based on risk response module of panel data of 2010 with base year 2004. To measure vulnerability change in real per capita log consumption expenditure (*dlnc*) for the years 2004 and 2010 is taken as welfare measure. The average real consumption expenditure increased between the two periods as presented in Table 13. The increase is larger in Punjab province than in Sindh province while within Punjab it is higher for northern Punjab as compare to southern Punjab, indicating spatial disparity across the two provinces which accounts for approximately 80 percent of Pakistan's total population. This increase in the average consumption is not shared equally among all households. Among the full sample of panel households, the average of *dlnc* was 0.21, indicating an increase of 11.5 percent in real consumption over the two survey periods. However, 35.4 percent of individuals suffered from a decline in their welfare levels (i.e., *dlnc* was negative). Thus, the aggregate figure hides the fact that certain households suffered from a severe decline in their welfare during the two survey period. The welfare changes can also be analysed by taking households with different groups of shocks which was reported in PPHS-2010 indicated that those households who are experienced by shocks had less positive changes in consumption as compared to no shocks. In addition, households who suffered health shocks due to injure/sickness/death had the least positive growth in consumption per capita as compared to other groups.

Table 13

Household level Welfare Changes in Rural Pakistan from 2004 to 2010

	Distribution of $dlnc_i$ *(changes in log consumption per capita)*		
	Mean	Standard Deviation	*% dlnc>0*
Shock	0.18	0.71	62.5
No Shock	0.22	0.69	65.7
Agricultural Shock	0.18	0.67	62.9
Economic Shock	0.17	0.41	68.3
Social	0.27	0.62	73.0
Health	0.17	0.78	59.1
Overall	**0.21**	**0.70**	**64.6**
Punjab	0.23	0.65	67.2
North Punjab	0.30	0.60	70.0
South Punjab	0.16	0.70	64.5
Sindh	0.18	0.74	62.0

Source: Author's computation is from the micro data of PRHS 2004-05 and PPHS-2010.

As controls for household characteristics that determine consumption growth, the paper follow the standard literature on the determinants of welfare in developing countries [Glewwe (1991)] and include variables such as agricultural production assets owned by the household, farmland and household assets like milk animals, bullock, sheep and goats, etc., with other households characteristics in 2004. The household level covariate/idiosyncratic shocks that occurred after the first round of survey may have affected the consumption level due to income loss. For this reason, four groups of shocks reported in the last five years in PPHS-2010 that are exogenous to initial consumption are included in the model.

The estimated results of village level fixed effect model[8] is presented in Table 14. Among household characteristics, seven variables have statistically significant coefficients: household head's age (positive), household head's years of schooling (positive), household size (negative), sector of employment (positive), welfare ratio (positive), the size of owned land (positive) and number of livestock (positive). The analysis shows that aged household heads with more year of schooling and high welfare ratio had experienced higher growth in consumption between the two periods. The coefficient of household size is negative and statistically significant indicating that as household size increases, require larger amount of consumption thus growth in consumption decreases between the two periods. The finding that households with land and livestock ownership are ahead forward in consumption growth suggests that growth from 2004 to 2010 was based on agricultural sectors in rural Pakistan.

Table 14

Vulnerability: Sensitivity of Consumption Changes and Household Characteristics

	Dependent Variable: *dlnc* (Change in log Consumption)	
Explanatory Variables	Coefficients	Standard Errors
Intercept	0.27	0.04
Male Headed Households	–0.15	0.144
Age HH Head (Years)	0.0035***	0.0014
Head Education (Years)	0.011*	0.005
Household Size	–0.08*	0.019
Dependency Ratio	0.003	0.24
Female Ratio	0.26	0.13
Welfare Ratio	0.16*	0.01
Land Ownership (Acres)	0.003***	0.001
Livestock Ownership (No)	0.035*	0.014
Credit Access	0.010	0.006
Sector of Employment	0.024*	0.009
Natural and Agriculture Shocks	–0.17**	0.023
Economic Shocks	–0.035	0.05
Social Shocks	–0.0047	0.01
Health Shocks	–0.036**	0.121
R-sq: Within Village = 0.27		
Between = 0.16		
Overall =0.24		
F(15,852) = 13.15		
Prob > F = 0.0000		

[8]With village fixed effects, a Hausman test comparing the fixed effects (within) regression and the random effects regression gives a p-value of .0005. The result of the test provides evidence in favour of the village fixed effect being uncorrelated with the other regressors and helps confirm this specification.

With regard to coefficients on shocks, all are negative but only natural/agriculture shocks and health shocks are significantly related to welfare. The absolute value of the coefficient on natural/agricultural shock is especially large, indicating that households had to reduce consumption by 15 percent[9] when their households located in particular village is hit by floods/drought/ earthquake. This implies a substantial decline in welfare capturing a major disaster of 2010 flood especially in Punjab and Sindh province. Analysis from Arif and Shujaat (2014) using the same panel data suggest that those household who are suffered from agriculture shocks are more likely to fall into poverty. On the other hand, the coefficient on economic shocks and social shocks are statistically insignificant. In addition to these shocks, health shock is significantly negative specifying a decline of 8 percent in consumption when a household member or earner get sick/injured indicting income loss due work days lost. The decline in consumption can also captured due to death of earner which suspended income flow in the family.

5. CONCLUSIONS

In developing countries, shocks from many sources strike frequently and hit hard, causing loss of life, assets, and livelihoods which has also established the fact that the cost of risk exceeds the impact of shocks. The objective of this study is to investigate sources of vulnerability defined as households' exposure to shocks and their limited ability to mitigate the impact of shocks. It has used household survey data from PRHS-2004 and PPHS-2010 focusing on the risk response module to explore the probability of shocks and sensitivity of consumption changes due to shocks.

The findings of this study elaborate that approximately one third of the rural households experience an adverse shock during the last five years 2006-2010, including natural/agricultural shocks 55.9 percent, economic shocks 2.0 percent, social shocks 8.4 percent and health shocks 33.7 percent. The incidence of shock is greater from natural/agricultural events and health related shock. Households with agriculture land and livestock ownership are more vulnerable to face shocks. As far as the scope of shock is concerned, 53.7 percent households suffer from idiosyncratic shocks, particularly health related while 46.3 percent had covariate shocks focusing on natural disasters. The natural/ agricultural shocks contribute the major share of loss due to shocks. It is observed that coping mechanisms are overwhelmingly informal and largely asset-based using savings or sale of livestock whereas the poorest bottom quintiles adopted behaviour-based strategies which include reducing food and non-food consumption, employment of child labour and increased working hours, etc. The analysis also sheds new light on the positive role of livestock in mitigating adverse impact of shocks as 29 percent households' sale livestock as coping measures.

To determine factors influencing the incidence of shock, the available panel households from rural Punjab and Sindh are taken to determine the pre shock characteristic of households. A number of patterns emerge while using all type of shocks and natural/agricultural shock: male headed households, large household size, land and livestock ownership, employment in agriculture sector and resident of south Punjab and Sindh are more vulnerable to suffer from shocks whereas educated household head, high

[9](1 – exp (–0.1708) =(1– 0.84366) = 0.157.

welfare ratio and access to formal credit reduces probability of a shock. In addition to it, high dependency ratio and poverty status of the households are more likely to increase the probability of natural/agricultural shocks. However, positive changes in ownership of livestock and welfare ratio between two time period, lower the probability for occurrence of shocks. .

When the sample is categorised into income and societal shocks, it is observed that male headed households, large household size, dependency ratio, land ownership, livestock ownership, sector of employment, south Punjab and Sindh increase the probability of income shock while welfare ratio and access to formal credit lower it. However, land and livestock ownership, member abroad, south Punjab and Sindh lower the probability of societal shocks.

This paper also elucidated which households in rural Pakistan are vulnerable in terms of a decline in their consumption when their village was hit by a shock. It is found that those households who experienced a shock had less positive change in their consumption levels as compared to those households who have experienced no shocks. The empirical analysis of consumption vulnerability also found that households with agricultural and health shocks are more vulnerable as compare to other households.

Shocks will continue to occur, however to mitigate their impact in the future requires a reduction in the socio-economic vulnerability and increased resilience that can be achieved through policies geared towards improving social conditions and living standards. In this regard, access to micro credit to build up productive assets such as livestock, as it smooth consumption, enables to do saving and productive assets. Lastly, health insurance is imperative especially for the poor segment of the society because in case of health shock they had not only to bear health expenditure but also loss market hours of work.

Finally, to strength the 'National Disaster Management Authority' which will be the focal point for coordinating and facilitating the implementation of strategies and programmes on disaster risk reduction, response and recovery, particularly in case of flood which is a common phenomenon in case of Pakistan.

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