PDR

The Pakistan Development Review

ISSN 0030 - 9729

Volume 60 - Number 1 - 2021

thepdr.pk

PAKISTAN INSTITUTE OF DEVELOPMENT ECONOMICS

PDR The PAKISTAN DEVELOPMENT REVIEW

Volume 60 Number 1
2021

C O N T E N T S

© *The Pakistan Development Review*
60:1 (2021) pp. 1–16
DOI: https://doi.org/10.30541/v60i1pp.1-16

Monetary Paradoxes of Baby-Sitting Cooperatives

ASAD ZAMAN

Many authors have described and modelled Keynesian effects in a Baby-sitting Cooperative (BSC), which has the underlying structure of a single good barter economy. We construct a simple model of the BSC economy to explore this issue, and find very surprising results. Outcomes depend on agents beliefs about the decision making process of others, as in the Keynesian beauty contest. For some structures of beliefs, money is neutral, while for others, money can have short and long run effects. The value of money can be high, low, or zero, depending purely upon expectational effects. Also, despite the fact that this is a single good economy, partial equilibrium supply and demand analysis do not work as expected. Some equilibria have excess supply, others have excess demand, and none have a match between supply and demand. Furthermore, flexible prices cannot fix this problem. An additional paradoxical property is that excessive trading can take place. Even though all trades are done with mutual consent, some of them decrease welfare, and banning certain types of trade can lead to Pareto improvements. Thus the superficially simple single good barter economy of BSC displays some subtle, complex and counter-intuitive properties.

JEL Classifications: D71, E52
Keywords: Monetary Policy, Keynesian Economics, Sunspot Equilibria, Neutrality of Money

1. INTRODUCTION

Classical economic theory of the time could not explain the Great Depression, nor the prolonged high unemployment which followed. Keynes argued that this was the result of insufficient aggregate demand, which could be fixed by expansionary monetary policy. These ideas became widely accepted, and constituted the basis for monetary policy until the 1970's. Keynesian theories conflict with the neutrality of money, and suggest that expansion of money leads to inflation only under full employment. Keynesian theories gradually fell out of favour following stagflation resulting from oil price shock in the 70's. This led to emergence of alternative macroeconomic theories, as well as a search for micro-foundations for Keynesian economics. This paper provides some micro-foundations for certain Keynesian phenomena in a specialised economy. The model provides surprising insights into the nature of these phenomena.

The Global Financial Crisis of 2007 has led to a renewed interest in Keynesian theories. In particular, Krugman in "The Return of Depression Economics" argued that

Asad Zaman <asad.zaman@alumni.stanford.edu> is formerly Vice Chancellor, Pakistan Institute of Development Economics, Islamabad.

Keynesian ideas remain relevant to understanding contemporary recessions. To motivate this, he has used a real world example of the Capitol Hill Baby-Sitting Cooperative (BSC). According to an analysis by economists who were members of the Cooperative, the BSC suffered from a recession due to a shortage of "scrip", the currency used to exchange baby-sitting services.

Krugman's analysis is based on an intuitive and heuristic analysis by Sweeney and Sweeney (1977). However, the BSC is a very simple single good economy, where the sole function of money is to allow for inter-temporal trade. This simplicity allows for a rigorous analytic treatment. Our research was motivated by the idea of analytically validating the intuitive insights of the Sweeneys and Krugman. Is the BSC a Keynesian economy? Can a shortfall of money create a recession in this economy? A simple model which displays Keynesian effects should be useful in building understanding of these phenomenon in more complex situations. Previous analyses of the BSC have come to the following conclusions.

1. In a purely heuristic analysis, Sweeney and Sweeney (1971) argued that the BSC is a Keynesian economy—insufficient money leads to recession, while excess leads to inflation. Krugman uses the Sweeney arguments without further analysis.
2. With motivation similar to ours, Hens, et al. create a mathematical model for the BSC economy. They show that the BSC economy displays Keynesian properties. There is an optimum quantity of money, and too little money leads to recession. They also conduct an experiment which validates their theory, in that the experimental results conform to the theoretical predictions. They suggest that the existence of the optimum quantity of money is due to fixed prices – one unit of scrip can be exchanged only for one unit of baby-sitting.
3. With a somewhat different model and motives, the analytical analysis of Kash, et al. reaches similar results for the BSC economy. They find that increased money supply leads to increased exchange up to a critical limit which is the optimal quantity of money. They find a new phenomenon of a "crash". Increasing money supply beyond the optimal quantity leads to zero trade as the value of money collapses to zero. Kash, et al. also suggest that the optimal quantity is due to fixed price of scrip.

All authors mention as significant the "fixed price" feature of the BSC economy. But in presence of fixed prices, the existence of an optimal quantity of money, and recession for low money is a triviality. The Keynesian rejection of neutrality of money is not based solely on sticky prices. In this paper, we create a simple model of the BSC economy to investigate the presence of Keynesian phenomena. The model leads to strange and paradoxical results, not available in earlier analyses. We list these results below.

1. The BSC Economy has the Keynesian *Beauty Contest* property. That is, equilibria depend heavily on the beliefs of agents about how other agents will behave. For the sake of definiteness, let us call this "second order expectation": agents' expectations about the decision making procedures being followed by other agents. Different types of 2nd order expectations are possible, and lead to

different types of phenomenon. All of the expectation mechanisms explored are "rational" in the sense of being self-fulfilling, creating a justification for believing in their validity.

2. The central question being investigated is: is money neutral in the BSC economy? This has a subtle, complex and perhaps paradoxical answer. In all models, money is "technically" neutral—that is, all levels of money are compatible with the same sets of equilibria. This is true *even though prices are fixed*. At the same time, money is not "expectationally" neutral. At any given level of money stock, coherent expectations about the value of money will be self-fulfilling. In our model, there are three possible coherent and self-fulfilling expectations about money: money is of high value, low value, or zero value. The quantity of money will fail to be neutral if changes in the stock of money affect the expectations about the value of money. If expectations are not affected, then changes in quantity of money have no effect on the equilibria and money is neutral in short and long run.
3. A paradoxical violation of Say's Law: The BSC economy display several other phenomena which run counter to standard intuitions. Supply creates its own demand in two strong senses. In a single period, supply of baby-sitting is jointly produced with demand, and hence supply creates demand. In addition, all agents balance budgets across time, so that for any single agent, an act of supply is exactly matched by a demand for baby-sitting services at some other point of time. Despite this dual guaranteed match between supply and demand, some equilibria have excess supply, others have excess demand, and none have a match between supply and demand.
4. Breakdown of Partial Equilibrium Supply and Demand Analysis. This phenomenon of mismatch between supply and demand has been noted by many authors, and attributed to the fixity of price—one scrip is worth one half-hour of babysitting. We show that flexible prices cannot resolve this problem. One might expect that the partial equilibrium (PE) Marshallian theory would work in a single good economy. However, we will see that supply and demand cannot be separated as required by PE analysis, and thus the intuitions generated by supply and demand analysis do not hold up.
5. Excessive Trading is Possible. Intuition suggests that trade by mutual consent is always welfare improving, since both parties agree to the trade only under this circumstance. Thus, Kash, et al. argue that the volume of trade is a good indicator of welfare in the BSC economy. In our model, despite mutual consent, trades can be welfare decreasing, and banning certain trades can lead to welfare improvements. Equilibria with lower total trading volume can be superior to situations with higher trading volumes.

All of these paradoxical properties suggest that the surface simplicity of the BSC Economy is deceptive, and hides deep and murky complexities. Although it would be premature to jump to policy implications on the basis of such a simple model, these implications are valid for the BSC economy itself, and are radically different from those suggested by standard economic intuitions. Two of these implications are highlighted below:

1. The value of money can change from high to low and to zero depending purely upon expectations in the BSC economy. It seems likely that this phenomenon will generalise far beyond the simple BSC economy, since multiple equilibria driven by expectations are ubiquitous in monetary models; see for example Evans and McGough (2005). Central Bank responses to speculative attacks on currencies are guided by the intuition that the value of currencies are determined by fundamentals. Thus, speculators cannot win if the fundamentals are sound. Many Central Banks have bet heavily and lost heavily against speculators on the basis of these intuitions. In the BSC economy, the value of money does not depend upon fundamentals, but purely on expectations about the value of money. Thus a speculative attack can succeed just by changing expectations, without any change in the fundamentals. A subtle and complex interaction between fundamentals and the value of money occurs because of the nature of expectations. If everyone believes that fundamentals are relevant to the value of money, then this becomes a self-fulfilling prophecy. Speculative attacks will then take the shape of news about change in fundamentals, regardless of whether or not such change has occurred or whether the changes being described in the news actually matter in the determination of the value of the currency. As long as the news convinces the public, and changes their expectations about the value, the attack will succeed, regardless of Central Bank interventions. This matches empirically the way speculative attacks are conducted and has radical implications for policy in face of such attacks.
2. The Sweeneys and Krugman suggests that low money supply leads to a recession in the BSC economy. In our model, this can happen but has radically different implications from the ones drawn by these authors. First, the expansion of money works through the expectations effect, and so monetary problems are not purely technical. They have a social dimension and work through consensus about the value of money. Second, even though increased money supply may increase the volume of trade, this may actually decrease social welfare. Thus, the so-called recession state, with low volume of trade and high value of money, may actually be superior in terms of welfare to a high volume of trade with low value of money. Again this is in strong conflict with standard economic intuitions.

An important lesson from our model is that choice of a particular equilibrium among a multiplicity of Nash Equilibria requires agents to coordinate plans. The central message of Bicchieri (1997) is that we must go beyond individual rationality, and study how agents actually learn to resolve the coordination problem. Behavioural economics provides us with the possibility of studying such problems, involving how a particular Nash equilibrium is chosen. Duffy (2008) has provided an extensive survey of this literature. Our research suggests that we need to move beyond individual decision making to study collective decision making in problems with multiple Nash equilibria.

2. A MODEL OF A BSC ECONOMY

The BSC is a single good economy. In each period, agents (families) can either produce the good (offer baby-sitting services) or consume it (receive baby-sitting

services). Unlike Hens, et al. (2007) and Kash, et al. (2007), we consider a finite horizon economy which terminates at a fixed and known endpoint in time. We also assume zero discount rate. These simplifying assumptions bring out clearly a core feature of the BSC economy which is obscured in the infinite horizon treatments. If prices are fixed in monetary terms, then the budget constraint means that the number of goods produced must exactly equal the number of goods consumed. This is valid both cross-sectionally and across time. That is, at every point in time, agents who produces services must exactly match in number the agents who consume. Also, every family must balance its lifetime budget by consuming services exactly equal to its production.

Assume that all families start out with an initial allocation of M0 units of money. Money—also called scrip in this context—must be used to buy services, and is earned by offering services. However, on the terminal date T, every family must return the full amount of the initial allocation. This means that families must maintain a balanced budget over the lifetime of the BSC economy. The initial allocation is only a device to allow them to borrow from future earnings. The initial money stock M0 can be made arbitrarily large, to prevent any artificial upper limit to this borrowing. Borrowing from future is automatically constrained by the maximum lifetime earnings remaining to terminal date, which declines to zero as we approach terminal date.

The basic problem is similar to that of inter-temporal consumption smoothing. The utility from consuming and producing babysitting services vary at random with time. Families would like to consume when the need is High, and produce when the cost is Low. For simplicity, we consider three states of need for babysitting service: Z(ero), L(ow), and H(igh). Families have three actions available: {P(roduce), C(onsume), I(dle)}. As a benchmark, we suppose that $U(P|Z)=U(C|Z)=U(I|Z)=0$; the utilities from idling, producing or consuming in state Z are all equal to 0. Also, $U(C|H) > U(C|L) > 0=U(C|Z)$ while $U(P|H) < U(P|L) < 0=U(P|Z)$; utilities of consuming baby-sitting services are ranked High, Low and 0 in states H, L and Z, while costs of providing baby-sitting services are in reverse order in these three states. Key assumptions regarding intertemporal swaps for any single agent are as follows:

- $U(C|H)+U(P|H) < U(I|H)+U(I|H) << 0$. Agents do not want to buy services in state H if they have to pay for them in state H. They would rather stay idle in both states. However, idling in state H, or not having baby-sitting services in a situation of high need, is a very poor outcome.
- $U(C|L)+U(P|L) < U(I|L)+U(I|L) < 0$. The same is true for state L. Idling in both periods is preferable to producing and consuming.
- $U(C|H)+U(P|L) > 0$. Consuming services in state H and paying for them in L is preferable to staying idle in both states.
- $U(C|H) > U(C|L) > 0$ guarantees that agents are happy to buy services in states H and L if they can pay for them by selling in state Z.

To understand the results to follow, it is useful to bring out certain implications of our assumptions about the utilities. We will assume that individuals maximise the sum of undiscounted expected utilities, to preserve the underlying one-for-one barter structure of the trading. Note that expected utilities are cardinal; the actual numbers matter. Nonetheless, our results will be valid for a large range of numbers satisfying the

following qualitative considerations. First, it is very important to be able to get baby-sitting in the high need state: U(C|H) >> 0. We will refer to failure to get service in state H as a "crisis": U(I|H) << 0. Having to provide services in state H is even worse: U(P|H) < U(I|H). What happens in state L is of lower order of magnitude in comparison. That is, if the utility numbers are in the thousands for state H, they are in tens for state L. It is pleasant to get services in state L and an annoyance to provide services in state L. Not getting service in state L is a minor nuisance. To a first approximation, the efficiency of any system for the baby sitting economy can be gauged in terms of its ability to prevent crises. If all high need demands for baby-sitting are fulfilled, then the system is functioning efficiently. All agents like to consume in state H, and to produce in state Z to pay for this consumption. Dynamics are driven by what happens in state L. If agents do not get enough income from sales in state Z to satisfy their H(igh) need demands, then they will produce in state L to finance consumption in state H. However, if they have sufficient income to cover their H demands, they will use the excess income to purchase baby-sitting services in state L. Thus in state L, agents can be either producers or consumers depending on market conditions.

Demand and supply depend on randomly generates states of need (H,L,Z) and hence need not be equal in any period of time. We assume that market will be cleared via randomised rationing, as in Hens, et al. (2007). That is, if there is excess supply, the demand will be distributed randomly over the suppliers; some will be chosen to supply, while some will remain idle, with identical probabilities for all agents. Excess demand is also handled similarly by randomised rationing of available supply. Crucial parameters are the probabilities p(B) and p(S) of being able to Buy or Sell baby-sitting services. If there is excess supply, then p(B)=1 while p(S) is the ratio of the number of agents who are demanding baby-sitting services to the number of agents who are offering baby-sitting services. In cases of excess demand, this is reversed: p(S)=1 while p(B) is the reverse ratio. Hens, et al. (2007) and Kash, et al. (2007) both assume that the agents know these probabilities. However, neither discusses how the agents might learn these probabilities.

How agents calculate these probabilities (p(B) and p(S)), which are required for rational decision making, is central to the operations of the BSC economy. Future probabilities cannot be calculated solely on the basis of observable variables of aggregate demand and supply. Every agent must know how other agents are making these calculations in order to arrive at an accurate estimate. This is why second order expectations are crucial to rational decision making and equilibria in the BSC economy. To demonstrate this, we work with two different models for second order expectations. One is an oracular model, while the other is a threshold model. We first describe the Oracular expectations model, which is simpler of the two.

3. ORACULAR EXPECTATIONS

To demonstrate the existence of sunspot equilibria, we assume the existence of a Fama-Oracle which forecasts the probabilities p(S) and p(B). As long as all agents believe in the Fama-Oracle, these forecasts always turn out to be accurate and therefore create rational expectations.

We assume that the Fama-oracle announces the probabilities p(B) and p(S), and that it is common knowledge that everyone believes in the Fama-oracle. Note that this is

an assumption about a particular structure of second order expectations. In addition, decisions require knowledge of the probabilities p(Z), p(L) and p(H) of the states Z, L and H. We assume that these three probabilities are known to all and the same for all agents, as well as across time. We also assume that nature generates these states in such a way that the actual proportion of the states Z,L,H across agents is exactly equal to the these three probabilities. Furthermore, over the lifetime of an agent, the actual frequency of occurrence of the three states is also matched to the theoretical probabilities of each of the three states Z, L and H. This assumption simplifies calculations and avoids peripheral complications, without affecting the central results.

Knowledge of these five probabilities (p(B),p(S),P(H),p(L),p(Z)) allows us to compute the agents' maximising strategies. We assume that $p(H) < ½$ and also $p(Z) < ½$. These inequalities imply that $p(H) < p(Z)+p(L)$ and also $p(H)+p(L) > p(Z)$.

3.1. Three Rational Expectations Equilibria

We will now show that the Fama-oracle can create three rational expectations equilibria.

Excess Supply Equilibrium (High Value of Money): Assume the oracle announces that for the foreseeable future there will be excess supply so that probability of being able to buy baby-sitting is unity: p(B)=1. Sellers will be rationed, with p(S) = p(H) / [p(L)+p(Z)]. This will be a self-fulfilling prophecy. Scrip has high value in this equilibrium in the sense that owners of scrip are guaranteed to be able to buy baby-sitting services

Excess Demand Equilibrium (Low Value of Money): Assume the oracle announces that for the foreseeable future there will be excess demand, so that p(S)=1. Demanders will be rationed, and will succeed in buying with probability p(B)=p(Z)/ [p(H)+p(L)]. This will be a self-fulfilling prophecy. Scrip has lower value in this scenario since owners of scrip can buy baby-sitting services only with probability p(B)<1.

Zero-Trade Equilibrium (Zero Value of Money): If the Fama-Oracle announces that the Gods are angry, and the value of money will be zero from now on, this too will be a self-fulfilling prophecy. In this case p(B)=p(S)=0, and no one can buy or sell baby-sitting services.

Proofs: The Zero-Trade Equilibrium is trivial. The other two cases can be proven as follows:

Excess Supply Equilibrium. Suppose the oracle announces that p(B)=1, and p(S)= p(H)/[p(L)+p(Z)] < 1. Then all agents maximise lifetime utility by always buying services in state H, and by always offering to sell in states L and Z.

Proof: To a first order approximation, agents maximise lifetime utility by avoiding crises. So we start by assuming that all agents always demand baby-sitting services in state H. To finance these purchases requires an income of p(H)xT; the proportion of time agents are in state H, times the total time horizon T. Agents maximise lifetime income by always offering to sell in states L and Z. This generates income equal to p(S) × [p(L) + p(Z)] x T because offers to sell are completed with probability p(S). This is exactly equal to p(H) x T, the income needed to purchase services in state H. Agents generate maximum possible income, which is exactly enough to meet their high priority demands for baby sitting—no crises. Any change in any decision (offers to buy or sell) will result

in crises, either because of failure to request services in state H, or insufficient budget to buy services.

Excess Demand Equilibrium: Suppose p(S)=1, and p(B)=p(Z)/[p(H)+p(L)] < 1. Then all agents maximise lifetime utility by always offering services in state Z, and always requesting services in states H and L.

Proof: Agents always succeed in selling in state Z, so their lifetime income is p(Z). Income needed to purchase their lifetime demand of services in states L and H is p(B) x [p(H)+p(L)] = p(Z). Offering services in state Z is always optimal. Since this creates exactly enough income to allow them to request services in all states L and H, this is necessarily an optimal sequence of decisions. Failure to request services will result in surplus, unutilised income.

Technical Note: We take a large finite T, and ignore complications that would arise near the terminal date. Our treatment can be made rigorous by using a limit process as both the number of agents N, and the time period T approaches infinity. This would be a formalisation of the Ramsey-Weizsacker overtaking criterion. There are many other ways to resolve the problem, but our main results are robust to minor changes in how we handle the complications near the terminal date. Our treatment provides conceptual clarity with a minimum of mathematics.

Discussion: Note that the quantity of money is irrelevant in these equilibria, as long as M0 is sufficiently large to prevent constraints on borrowing from the future. Another option is to allow agents to borrow from each other, or from the central authority. In either case, the quantity of money will be irrelevant to short run and long run equilibrium. Thus, contrary to the analyses of earlier authors, there is no optimum quantity of money in the BSC model under Oracular Expectations. However, we can create monetary effects if we link oracular forecasts to the money supply. First, we give an example to illustrate how rational expectations can create an illusion of causality between money and economic outcomes.

Suppose that the Fama oracle announces that there will be excess supply on days when the Air Quality Index (AQI) is above 50, and excess demand when AQI is less than 50—it appears perfectly plausible that people would want to go out when the pollution index is low, and to stay home otherwise. Under our model assumptions, this would also create a self-fulfilling prophecy. Thus, people could come to believe, based on solid empirical evidence, that the AQI has a causal effect on demand and supply of baby-sitting when in fact it has zero effect. To be more precise, the causal effect is created by the belief in the existence of the effect (via the Fama-Oracle intervention).

Similarly, if the Fama-Oracle announces that there will be excess supply if aggregate money stock (known to all) is greater than some threshold M*, and excess demand when it is less, this too will be a self-fulfilling prophecy. Thus monetary effects can be created if the Fama-Oracle chooses to create them.

4. THRESHOLD EXPECTATIONS

Both Hens, et al. (2007) and Kash, et al. (2007) study equilibria in threshold strategies, which is a different assumption about how agents behave in response to changes in money stock. To show that the BSC economy has the Beauty Contest property, we now study this alternative assumption about second order expectations. To

get the desired equilibria, it must be common knowledge that all agents behave using the strategies described below.

4.1. Threshold Strategies

Kash, et al. (2007) and Hens, et al. (2007) find Nash equilibria such that agents play threshold strategies. In our model, we can characterise such strategies as follows. Agents in state H always offer to buy, while agents in state Z always offer to sell. Suppose an agent holds a stock of money M. In state L, there exists threshold values M** and M* such that agents buy if M > M** and sell if M< M*. Between the two value, agents stay idle. If it is common knowledge that all agents play the same threshold strategy, then the agents can co-ordinate their beliefs about what will happen.

Let m(a,t) be the money endowment of agent a at time t. In going from time period t to t+1, the sellers' stocks will increase by 1, buyers' stocks will decrease by 1, and those who stay out of the market will remain at the same level. These transition probabilities create a Markov chain which has a limiting stationary distribution, exactly as demonstrated by both Hens, et al. (2007) and Kash, et al. (2007). Thus, for sufficiently large values of t, there exist probabilities p*(j) for j=0,1,2,... such that agents have money stock m(a,t)=j with probability p*(j). These lead to three stable probabilities p(BS), p(BB) and p(BD) of budget surplus (m(a,t) > M**), budget balance (M** ≥ m(a,t) ≥ M*), and budget deficit (m(a,t) < M*):

$$p(BS) = \sum_{j>M^{**}}^{\infty} p^*(j), p(BB) = \sum_{M^{**}\geq j\geq M^*}^{\infty} p^*(j), p(BD) = \sum_{j<M^*}^{\infty} p^*(j),$$

Once the Markov chain reaches stationarity, the proportion of buyers is p(H)+p(BS) p(L), while the proportion of sellers is p(Z) + p(BD) p(L). We ignore the initial period required for the Markov chain to reach stationarity, and calculate equilibria under the assumption of stationarity—this corresponds to the analysis of Hens and Kash, et al. who assume that the game starts in an equilibrium position. There is no harm in this assumption, since we are just illustrating some phenomena which would occur near the middle of the game. We will now show that the Nash equilibria of the threshold economy are the same as those of the oracular economy.

Proposition 1: In equilibrium, all agents in state L must play the same strategy – either buy or sell. Both of these possibilities form Nash equilibria, which are the same as the excess supply and excess demand equilibria of the Oracular economy.

Proof: First consider a case where every agent can be in Surplus or in Deficit with positive probability: p(BS)>0 and p(BD)>0. With these values for M* and M**, all agents will find themselves on both sides of the market in state L during their lifetime. This is because the Markov chain is irreducible, and all states can be reached from all other states. Thus any agent can gain by adjusting the thresholds M* and M** in such a way that one of these two probabilities is reduced to zero. This will eliminate intertemporal swaps of buying and selling in state L, leading to improved welfare. This means that values of M* and M** which lead to p(BS)>0 and p(BD)>0 cannot represent an equilibrium.

Next suppose the thresholds M* and M** are such that probability of budget surplus or balance are positive (p(BS)>0 and p(BB)>0) but there is no probability of a deficit: p(BD)=0. If a single agent shifts thresholds to make p(BB) smaller and p(BS)

larger, she will benefit from this adjustment. The actions of a single agent do not affect the aggregate probabilities p(B) and P(S) of purchase and sale, so she will be able to buy additional services in state L, improving her payoff. If all agents make these adjustments, the stable point of this adjustment process will be p(BS)=1 and p(BB)=p(BD)=0, which is the excess supply equilibrium. A similar arguments shows that p(BS)=p(BB)=0 while p(BD)=1 also leads to equilibrium.

4.2. Interpretation of Rational Expectations Equilibria

Many authors interpret threshold strategies as follows. Agents seek to have a minimal level of reserves, to provide them with a cushion against a sequence of unanticipated high priority needs. This interpretation is also supported by the actual experiences of the baby sitting cooperative as well as experimental evidence provided by Hens et. al. However, this interpretation is not fully satisfactory. This is because the economy as a whole has a fixed amount of money, and savings of one is dissavings of another. So as a group, members of the BSC cooperative cannot achieve the goal of higher savings. Also, all members play balanced budget strategies. So their money holdings form a random walk centred on initial holdings—savings cannot increase systematically. The goal of increasing reserves is an illusion, both individually and collectively. How can we expect high levels of rationality and maximisation from our agents, if they fail to realise something as simple as this?

The sunspot interpretations provide an explanation. If one agent is a skeptic, but thinks that others will believe the oracle, then it is still optimal for her to follow the Nash strategy. As discussed, the equilibrium has properties of the "beauty-contest". Even if all agents are skeptics, but consider that other agents will compute strategies under the assumption that all others are believers, the same Nash equilibrium will result. In exactly the same way, agents can co-ordinate on threshold strategies without believing that these are good strategies, if they think that everyone else will be reasoning in this way. Hens, et al. (2007) provide experimental evidence to suggest that subject do in fact follow threshold strategies, which would partly explain the experiences of the original baby-sitting cooperative.

5. LESSONS FROM THE BSC ECONOMY

Despite the surface simplicity of a single good, one-for-one barter economy, analysis of the BSC economy leads to deep, subtle, and counter-intuitive results. We summarise these results, and discuss their implications.

5.1. The Neutrality of Money

What comes out very clearly from the analysis of the BSC economy is that money is at least partly a "social construct". It derives value from our mutual agreement about its value. Thinking about the Fama-oracle as a mechanism to arrive at consensus, money have can have high, low or zero value according to our mutual agreement on one of these values. At the same time, money is not purely a social construct. The underlying structures of supply and demand determine the value of money in the two non-trivial equilibria. Thus the value of money emerges by the interaction of social norms with the economic environment. This seems to be well understood by central bankers and

treasuries who use a combination of confidence building measures such as transparency together with technical measures such as setting interest rates and open market operations to control the value of money.

Is the BSC a Keynesian economy in the sense that money is not neutral? Our analysis shows clearly that the answer is yes and no. If the agents coordinate second order expectations on the assumption that money will have high value, then the excess supply equilibrium will result. This will not change regardless of how much money there is in the system, as long as borrowing is allowed. Thus money will be neutral in short and long run. However, if agents believe that increases in money will be interpreted by other agents to imply a decrease in the value of money, then money will fail to be neutral. An increase in money supply will lower the value of money, but only because everyone believes it will do so.

5.2. Supply, Demand, and Flexible Prices

A key lesson from all previous analyses of the BSC economy is that there exists an optimal quantity of money in the BSC economy. As we have seen, this result is tied to unstated implicit assumptions about second order expectations of the agents. Under certain types of second order expectations, money is neutral, while under others it is not. In fact, failure of neutrality is surprising in standard models which are homogenous in money and prices. If a certain set of prices and money stocks (p^*, m^*) leads to efficient outcomes, then (λp^*, λm^*) will also lead to the same efficient outcomes, for any positive scale factor λ. As long as prices are flexible, there can be no optimum quantity of money. This is why Sweeney & Sweeney (1977) and other authors have argued that it is fixed prices which lead to shortages and rationing. A system of flexible prices would lead to clearing of markets, and to non-existence of an optimal quantity of money.

Unfortunately, in our BSC model, this does not work as expected. For the sake of clarity, consider a specific case where $p(Z)=p(L)=p(H) = 1/3$. All three states are equally likely. Consider the excess demand equilibrium in which all agents in states Z are sellers and all agents in states L and H are buyers. In principle, we should be able to fix the problem by raising the price of baby-sitting to reduce excess demand. Consider therefore doubling the price—the cost of baby-sitting is two units of scrip. Those who are buying must pay two units, while those who are selling will receive two units of scrip. Now note that every agent is on both sides of the market at different points in time. Today as buyers, they have to pay double, but tomorrow as sellers, they will receive double price. So the budget constraint does not change. An agent will pay two units in when he is a successful buyer in states H and L, and receive 2 x 1/3 in the state Z. Agents still have balanced budgets and therefore the excess demand will persist at any scrip price.

Our intuition for the idea that price flexibility would resolve mismatch of supply and demand is generated by the Marshallian partial equilibrium analysis. One would expect that the partial equilibrium analysis would work in a single good economy. However, the analysis fails because supply and demand are entangled. Since agents are both suppliers and demanders, a price rise affects both sides simultaneously. Lower demand due to increased prices is exactly offset by the rise in demand due to higher income.

Instead of nominal prices in scrip, we could consider changing the real price of baby-sitting. Now those who buy one unit of baby-sitting services must pay for it by offering two units. Now the agents will plan to buy in state H and sell in states L and Z. If there is no rationing, then these plans would go through. That is, agents can finance the purchases in 1/3 cases of H, by paying in 2/3 cases of L and Z. However, there is now excess supply and the probability of sale will be only ½, so agents will actually foresee a budget deficit. This is a general feature of the BSC economy. The technology is such that in any period of time, sales and purchases occur in pairs, one for one, and must match exactly. Also, across time, every agent must match every sale with a purchase on a 1:1 basis. Thus real prices are technologically fixed and cannot be varied.

5.3. A Paradoxical Violation of Say's Law

Krugman (2011) argues that the BSC economy demonstrates a violation of Say's Law. We note here how surprising and paradoxical this is. This is because this is one model in which we could attach strong expectations to the validity of Say's Law. The technology of baby-sitting is such that every good produced is automatically matched with a consumer – baby-sitting is a two sided transaction. Supply cannot be produced without demand. Furthermore all agents balance their budgets, paying for every unit consumed by one unit produced. Thus every act of supplying babysitting is exactly offset by a demand for babysitting at some other point in time. The logic of Say's law, that production creates its own demand, holds within every time period, and for every agent across time periods. If there ever was a model in which Say's Law holds, then this would be it. However, as we have seen, one of the oracular equilibria of this economy has excess supply, in violation of Say's Law. The other one has excess demand, and there are no equilibria where the two are balanced.

5.4. Efficiency Considerations

The no-trade equilibrium is, of course, highly inefficient. It can easily be seen that both of the non-trivial sunspot equilibria are also inefficient. Of the two, excess supply is usually better because all high priority demands are fulfilled; there are no crises. The inefficiency arises because the supply is proportionally split between low cost and zero cost producers, L and Z. It would be more efficient to have all production done by zero cost producers, with L producers only producing as much as minimally required to fulfil High Priority demands. Here an intervention which bans L producers from selling services could lead to greater efficiency. This is worth examining in detail because of its paradoxical implication that banning a trade done by mutual consent leads to improved welfare for all participants. We will show below that either of the two equilibria – excess demand or excess supply—may be more efficient than the other.

First, consider a situation where p(H)= 20% p(L)= 50% p(Z)= 30%. In the excess supply equilibrium, agents in states L and Z offer babysitting services and their offers are accepted with probability 25 percent. In order to pay for their demands in the H state, agents must offer services in both L and Z states to generate sufficient income. Money has value 1, and all high priority demands are fulfilled, so there are no crises. For simplicity, assume there are 100 traders. Then there are 20 trades of baby sitting services in each period. Next consider the excess demand equilibrium. Agents in state Z offer

services and are guaranteed to find a buyer. Agents in states H and L demand services and find a seller with probability 3/7. There are 30 trades each period, but less than 50 percent of high priority needs for baby sitting are fulfilled and there are large numbers of crises. Thus, we have a high volume of trade (30 trades instead of 20) but lower efficiency. Total cost free supply of baby sitting is 30, and an ideal solution would involve providing 20 to those in state H, and distributing the 10 remaining at random over the 50 agents in state L. Implementing such a solution via an anonymous market mechanism is impossible when the states are not observable. However, social mechanisms involving self-assessment and honest revelations of needs might work. In this example, excess supply is better than excess demand in terms of welfare. However the opposite may be true for other configurations.

For example, suppose that p(H)=20%, p(L)=30% and p(Z)=50%. In the excess supply equilibrium, 80 percent of the agents in states L and Z will offer baby sitting. These offers will be accepted with probability 25 percent so that one unit of credit will be earned every four periods. This will be just enough to pay for babysitting needs in the High Demand state which occurs once every five periods. There will be no crises, but all Low priority demands will remain unfulfilled while there will remain many zero cost suppliers who are unable to find buyers. The excess demand equilibrium is much better. In this case, the 50 percent of agents in states H and L will demand services, which will be exactly met by the zero cost supply from agents in state Z. By coincidence, the demand and supply are perfectly matched and there is no excess demand, as there would be if p(H)+p(L) was slightly greater than 50 percent.

6. EXPLAINING THE EXPERIENCES OF THE BABY SITTING COOPERATIVE

Understanding an implicit coordination process requires explicit modelling of the learning process followed by agents to arrive at an equilibrium. We suggest one such model which could explain the experiences of the baby sitting cooperative, as described by Sweeney and Sweeney (1971). Assume the p(H)=25%, p(L)=50% and p(Z)=25%, for the sake of concreteness. All agents start out with initial scrip endowment of 10 units. They all arbitrarily choose thresholds M** and M* which lead to certain overall probabilities p(BS),p(BB) and P(BD) for the group as a whole. These probabilities determine the supply and demand of babysitting services at arbitrary initial levels. Suppose that these arbitrary initial choices lead to 20 percent of agents in state L being sellers, 20 percent being buyers and 10 percent remaining idle. Then overall demand is 45 percent which is balanced by overall supply of 45 percent, while 10 percent of the families remain idle. Inefficiency is caused by the fact that agents in state L are both buyers and sellers – all utilities would improve if they would just stay out of the market.

What are the signals that agents receive that they can do better, and cause them to adjust strategies towards equilibrium? The buyers are buying in state L because they perceive themselves as rich relative to an arbitrarily chosen threshold M** – they think they have enough credit to be able to buy services in both states H and L. The sellers have set a high threshold M*, and perceive themselves as poor: they don't having enough credit to pay for potential crises, and are accumulating money. Attitudes towards risk would have a strong impact on these initial choices of thresholds. Since states Z and H

cancel in terms of monetary change, the buyers will decumulate money once every 5 periods (20 percent probability) and sellers will accumulate money with the same frequency. Assume M**=M* for simplicity. Then some buyers will transition to poverty and will become sellers. At the same time some sellers will transition to richness will become buyers. This state of affairs could persist for quite some time.

Assume that a psychological shock is generated by a crisis. As the random walk in money holdings takes some proportion of agents close to 0, they realise that they should hold more money in reserve to prevent crises and switch to a higher threshold M*. These agents will now become sellers in state L. As this process continues, the proportion of sellers will rise and the proportion of buyers will decline. Starting from a balanced supply and demand, it will move to a position of excess supply. To determine suitable threshold levels, an agent could calculate as follows. My high priority needs in the next 100 periods are 25 percent of 100 = 25. My maximum revenues in the next 100 periods will be p(S) x [p(L)+p(Z)] x 100 = p(S) x 75. In initial periods of the economy when demand and supply were balanced, agents were quite safe. When p(S)=1, they have earning capacities of 75, and high priority demand for only 25. However, as some agents experience crises and become sellers only in state L, the probability p(S) will start declining, leading to loss of potential income—when p(S) is 50 percent then the maximum potential earnings is reduced to 37.5 from 75. This will again induce agents to increase thresholds to a higher safe level. This adjustment process will terminate when all agents become sellers with 100 percent probability in state L. In this case p(S)=1/3 which leads to an exactly balanced budget from 75 offers to sell and 25 offers to buy. Now we have a steady state equilibrium in which the supply is three times that of demand. Economists consider that the economy has fallen into recession. In fact, as we have seen, this is a good equilibrium in that there are no crises. Nearly all high priority needs are being met. A small proportion of agents will run out of money and will experience crises, but this problem can be solved by extending them credit.

What happens when money is injected into this economy? To answer the question, we must posit a model for how agents form expectations about the behaviour of others. If for example agents believe that nothing has changed, then nothing will change, because everyone is at a stable Nash equilibrium, maximising utility subject to a budget constraint. However, change can happen if agents reason as follows. Now I have enough money reserves that I need not fear a crisis. I no longer need to sell services in state L, I can choose to buy instead, raising my welfare. As this type of thinking diffuses through the agents, demand will increase, supply will fall and p(S) will start rising. At some point, it will reach back to p(S)=1, when half of the agent in L are rich and the other half are poor. Note that richness and poverty is a state of the mind in this story, not an objective reality. Also note that as p(S) rises, agents can observe and calculate that their maximum potential earnings are increasing and therefore they are becoming richer. This will accelerate the process of change. Somewhere in the middle of the transition from excess supply to excess demand, there will occur a “golden age” where demand and supply are perfectly balanced, and the volume of trade is at a maximum. However the process will inexorably continue on past this point and go on to the excess demand equilibrium. How long the transition takes depends on details about how agents adjust expectation in changing circumstances. Economists will interpret the excess demand as being due to over-supply of money. This story corresponds closely to the one narrated by the Sweeneys of the actual experience of the baby sitting economy.

7. IMPLICIT VERSUS EXPLICIT COORDINATION

Economists who have analysed the recession in the BSC economy have poked fun at lawyers who attempted to motivate families to go out more often. The lawyers were trying to find a social solution to what was apparently a purely technical monetary problem. Our analysis shows that the failure of lawyers was their lack of persuasiveness (Capitol Hill credibility gap?), and not a wrong approach. The standard approach used in theoretical and experimental economics relies on implicit co-ordination. Making iterative adjustments to optimal responses mimics a natural learning process of implicit coordination. In presence of multiple equilibria, the outcome depends on arbitrarily chosen initial values. As in the "continental divide" game (see Camerer, 2011), Section 1.2.2), small changes in initial conditions can lead to large differences in outcomes. However, once the equilibrium is reached, it will be "sticky"—it will require group effort to change it, since no individual can benefit from shifting from the Nash equilibrium strategy.

An explicit coordination process would involve all the members of the group sitting together to achieve consensus on a common desired outcome. When this is possible, it is clearly more rational to make a conscious choice of a particular equilibrium, rather than letting it be determined by some arbitrary initial choices, coupled with default assumptions about decision making strategies of members of the group. In this context, it is important to note that groups can often achieve consensus on outcomes which are not Nash Equilibria—for instance on the strategy of 100 percent cooperation in the prisoners dilemma. The standard analysis of games is based on Savage's small world assumption, which studies each problem in isolation. In a community where there is substantial interaction outside of any particular game, this assumption does not hold. A reputation for honesty, and for fulfilling commitments is extremely valuable, and lack of it is extremely harmful in many social interactions. Thus human beings routinely fulfil commitments, even at personal cost, contrary to game theoretic assumptions based on studying the game in isolation as the sole venue of interaction. Once these habits of character are acquired, they are adhered to even in situations of interactions with complete strangers, not belonging to the original community. This means that "cheap talk" can achieve cooperative outcomes even when these are not based on individually maximising strategies. A summary of literature on cooperation by Dawes and Thaler (1988) states that "... the analytically uncomfortable (though humanly gratifying) fact remains: from the most primitive to the most advanced societies, a higher degree of cooperation takes place than can be explained … (by selfishness)".

8. CONCLUSIONS

We have already discussed how lessons derived from our model of the BSC model conflict with many of those drawn by other authors. Our model sets up the BSC economy as a single good economy which is bartered across time. Money does not play any real role except as an accounting device. As long as agents can borrow against future earnings, the quantity of money and monetary policy are irrelevant. Also, because of the 1:1 nature of the barter, price flexibility makes no difference to the outcomes.

A deeper lesson is the following. In models involving trades over time, it is crucial to model expectations regarding the future. Failure to model expectations means leaving an essential element of the model unspecified. Our BSC model illustrate what Bicchieri (2012) has argued at book length; that rationality assumptions are not enough to achieve co-ordination. Rather, we must consider how agents learn about each other, and how they arrive at a co-ordinated equilibrium. The invisible hand paradigm, taken as a fundamental organising principle, suggests that a suitable system of prices will efficiently de-centralise decisions. Agents need only consider their own separate optimisation problem, and this will produce optimal social results. However, in cases of multiple equilibria, this insight is not valid. Rather, the agents must cooperate and agree upon a solution which is beneficial to all. This can be done implicitly, via the iterative choices of best response Nash strategies. However the resulting equilibria can be highly inefficient, and can vary dramatically depending on arbitrary initial points. It will be better to co-ordinate strategies and beliefs explicitly, after considering the relative efficiency of different choices. Efforts at explicit coordination may involve designing institutions and invoking or creating appropriate social norms, which is a different paradigm from the standard individual utility maximisation in isolation.

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© *The Pakistan Development Review*
60:1 (2021) pp. 17–26
DOI: https://doi.org/10.30541/v60i1pp.17-26

Testing the Threshold Asymmetric Co-integration Interest Rate Pass-Through in the Presence of Stylised Properties: Evidence from Pakistan

FARRUKH MAHMOOD and MUHAMMAD ZAKARIA

The study examines the existence of interest rate pass-through between retail interest rates and policy rates in Pakistan using monthly data from January 2004 to March 2017. Both retail interest rates and policy rates follow stylised properties of financial time series. Therefore, the EC-E-GARCH-M model is used to estimate the interest rate pass-through between retail and policy rates as suggested by Wang and Lee (2009). Empirically, there is an incomplete pass-through from policy rates to retail interest rates, which is 73 percent basic points. This rate of pass-through is higher compared to previous studies for Pakistan. The results also highlight that there is an upward rigidity in the deposit rate model.

JEL Classifications: C22, C58,
Keywords: EC-E-GARCH-M Model, Interest Rate Pass-Through, Stylised Properties, Threshold Asymmetric Cointegration, Rigidities

1. INTRODUCTION

The interest rate pass-through mechanism is one of the crucial gateways for the central bank to achieve the goals of monetary policy. The central bank can manage the retail interest rate by regulating the policy rate. Therefore, monetary policy affects the outcome of financial institutions. The margin, markup, markdown, and the speed of pass-through are the different estimates of interest rate pass-through (Bredin et al. 2002 and Bondt, 2002). In industrialised countries, the central bank uses several channels to implement the monetary policy (Fuertes and Heffernan, 2009). However, this option is not available in the case of developing countries. One of the essential tools that the central bank can use to change the policy rate is to achieve inflation targets. This tool of the monetary policy successfully controls future expenditure and the inflation rate.

During the different stages of business cycles, when the central bank changes its monetary policy, the policy rate is also affected. As a result, financial institutions change profit margins. In this process, the central bank transfers costs to commercial banks, and commercial banks further transfer this cost to their consumers. This process of transferring cost from the central bank to consumers is called the interest rate pass-

Farrukh Mahmood <farrukhmahmood1206@gmail.com> is affiliated with the Department of Econometrics, Pakistan Institute of Development Economics (PIDE), Islamabad. Muhammad Zakaria is Associate Professor, Department of Economics, COMSATS University, Islamabad.

through effect. There is a possibility of over, under, or no interest rate pass-through. In general, no matter what kind of pass-through it is, there is a long-run relationship between different types of interest rates, and this relationship ensures the efficiency of the monetary policy.

The main objective of the monetary policy is to increase economic growth, which can only be achieved by understanding the mechanism of interest rate pass-through. For example, if the level of pass-through is low, the monetary policy will be wholly ineffective, and vice versa. Empirically, some studies have been conducted to find interest rate pass-through in Pakistan (Qayyum et al. 2005, Khawaja et al. 2008, Mohsin 2011, Hanif and Khan 2012, Hassan et al. 2012, Fazal et al. 2013, Mahmood 2018). All these studies have used the symmetric cointegration model to estimate interest rate pass-through except Mahmood (2018). The symmetric cointegration models are biased due to the presence of asymmetric information and asymmetric adjustment in the error correction model. Mainly, there are two hypotheses for the asymmetric effect, i.e., the consumer behaviour hypothesis and the bank concentration hypothesis (Karagiannis et al. 2010). Symmetric cointegration and error-correction models do not consider the asymmetric adjustment of interest rates, so the estimation results tend to reject the pass-through mechanism.

Further, the traditional error correction model ignores the effect of interest rate volatility. Therefore, the model may not be able to correctly explain the adjustment process of the interest rate in the short-term. Some studies have used KIBOR as a proxy for the policy rate, which is not an appropriate measure because KIBOR is itself dependent upon the policy rate which is set by the State Bank of Pakistan (Hassan et al. 2012, Mahmood, 2018). The present study used the T-Bill rate as a proxy for the policy rate.

Qayyum et al. (2005) have estimated the interest rate pass-through by using 6-month deposit and lending rates, while the 6-month T-bill rate was taken as policy rate. The study has found a very low degree of pass-through in the impact period and significant pass-through after 4-5 lags. It implies that the pass-through will affect after 2 to 2.5 years, which does seem appropriate economically. Later, Hassan et al. (2012) have discussed the same issue using monthly data. The study has used KIBOR as a policy rate instead of the T-bill rate. The estimated results have shown a low rate of pass-through. Khawaja et al. (2008) have also evaluated the pass-through and have concluded that there is an immediate pass-through to the deposit rate, while in the case of the lending rate, it takes about 1 to 1.5 years.

Hanif and Khan (2012) have used ARDL estimation method to estimate interest rate pass-through and have confirmed the existence of asymmetry. Fazal et al. (2013) have improved upon the Qayyum et al. (2005) model by using monthly data and have found a low degree of pass-through. The study has also confirmed that there is a low rate of pass-through both in lending and deposit rates (Mohsin, 2011). Mahmood (2018) using threshold co-integration has concluded that an asymmetric relation exists between wholesale and retail interest rates and that the rate of pass-through is incomplete. Likewise, in the long-run, retail interest rates are rigid towards the downwards adjustment while there is an upward adjustment in the error correction mechanism.

The present study uses the methodology of Wang and Lee (2009) and Mahmood (2018), to estimate interest rate pass-through. The main difference between our research and Mahmood (2018) is the choice of the policy rate, i.e. T-Bill

rate and KIBOR, respectively. Based on this difference, the primary objective of the present study is to compare the empirical result of these two studies, and additionally, to find the difference in empirical findings and policy implications due to change in policy rate variable.

An understanding of the interest rate pass-through hypothesis is essential as it directly relates to consumer behaviour, which ultimately determines future economic growth through the investment channel, and the success of the monetary policy. However, the estimation of the interest rate pass-through via improper estimation methods will lead to false conclusions and misleading implications. Furthermore, the financial time series exhibits stylised properties. Therefore, the symmetric error correction model cannot be an appropriate choice of an econometric model for the estimation of interest rate pass-through as previously done by Qayyum et al. (2005), Hassan et al. (2012), and Fazal et al. (2013).

The rest of the paper is organised as follows:

Section 2: data and methodology.
Section 3: empirical results.
Section 4: conclusion.

2. DATA AND METHODOLOGY

For empirical analysis, monthly data is used to examine the asymmetric cointegration for the interest rate pass-through mechanism. The variables used are deposit rate, lending rate, and T-Bill rate. Deposit and lending rates are weighted averages for a whole month, while the T-Bill rate is the 3-month Treasury bill rate. The data is taken from the State Bank of Pakistan (SBP). Data is selected for the period 2004M1 to 2017M3.

The methodology is in three steps. In the first step, the long-run relationship between policy rates and retail rates is examined by using the Engle and Granger (1987) test. In the second step, asymmetries in interest rate pass-through are investigated by using the Chan (1993) methodology.

2.1. Threshold Cointegration Test

Before applying the cointegration test, the first stationarity of the variables is examined. If variables are stationary at first difference, then there is a possibility of a cointegrating relationship between variables. The Engel and Granger (1987) test is used for cointegration analysis. The financial time series exhibits volatility; therefore, the cointegration relationship may not be symmetric. To find asymmetric cointegration among variables, TAR, and MTAR models will be used (Enders and Siklos, 2001).

If all variables are stationary at first difference, then the Engle and Granger (1987) cointegration test can be applied to estimate the following linear model:

$$Y_{1t} = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} \ \ldots + \beta_n X_{nt} + e_t, \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where β_i's are the parameters to be estimated, e_t represents error term. If the error term is stationary at the level, it implies the existence of a long-run cointegration relationship. For this purpose, unit root test will be applied on error term:

$$\Delta e_t = \rho e_{t-1} + \varepsilon_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

where ε_t is a white noise process. In the symmetric model, it doesn't matter if e_{t-1} is positive or negative, the changes in the value of e_t equals ρ times e_{t-1}. However, there will be a misspecification problem if there is asymmetry in the long-run equilibrium relationship in Equation (1). Enders and Granger (1998) and Enders and Siklos (2001) presume that in long-run positive and negative shocks in error cause asymmetric adjustments. These asymmetric adjustments can be tested through the TAR model in a long-run equilibrium relationship. Now the model can be written as:

$$\Delta e_t = I_t \rho_1 e_{t-1} + (1 - I_t)\rho_2 e_{t-1} + \varepsilon_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

where I_t represents an indicator variable, specified of the form

$$I_t = \{1 \text{ if } e_{t-1} \geq \tau \quad \text{or} \quad I_t = \{0 \text{ if } e_{t-1} < \tau \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

Equation (4) stipulates that τ is a threshold when e_{t-1} is greater or equal to τ (threshold value), ρ_1 is the adjustment parameter and $\rho_1 e_{t-1}$ represents the adjustment margin. When τ is higher than e_{t-1}, the adjustment parameter and the adjustment margin are ρ_2 and $\rho_2 e_{t-1}$, respectively.

True characteristics of the nonlinear model are still unknown. Therefore, Enders and Siklos (2001) assumed that Δe_{t-1} could represent the momentum of interest rate adjustment and reveal the asymmetric change of the interest rate. This asymmetric TAR model is called momentum TAR (MTAR) model and is specified as follows:

$$\Delta e_t = M_t \rho_1 e_{t-1} + (1 - M_t)\rho_2 e_{t-1} + \varepsilon_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

Where M_t is the indicator variable, which is as

$$M_t = \{1 \text{ if } \Delta e_{t-1} \geq \tau \quad \text{or} \quad M_t = \{0 \text{ if } \Delta e_{t-1} < \tau \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

where M is greater or equal to τ (threshold value), the ρ_1 is the adjustment parameter and $\rho_1 e_{t-1}$ is the adjustment margin. In turn, when τ is higher than e_{t-1}, the adjustment parameter and adjustment margin are ρ_2 and $\rho_2 e_{t-1}$, respectively. If autocorrelation also exists in Equations (3) and (5), then the revised form of TAR and MATR models can be written as follows:

$$\Delta e_t = I_t \rho_1 e_{t-1} + (1 - I_t)\rho_2 e_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta e_{t-1} + \varepsilon_t \quad \ldots \quad \ldots \quad (7)$$

$$\Delta e_t = M_t \rho_1 e_{t-1} + (1 - M_t)\rho_2 e_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta e_{t-1} + \varepsilon_t \quad \ldots \quad \ldots \quad (8)$$

where $-2<(\rho_1, \rho_2)<0$ is the sufficient condition for the error term series (e_t) to be stationary, and then it does not depend on which model Equation (7) or Equation (8) is chosen. The OLS estimators of ρ_1 and ρ_2 are consistent estimators according to F distribution only when e_t is stationary and has a known value of the threshold.

Enders and Siklos (2001) have used the F statistics for the examination of the asymmetric co-integration. If the null hypothesis is $\rho_1 = \rho_2 = 0$ is rejected, then it confirms the existence of co-integration. However, the symmetric adjustment process can be tested with the null hypothesis of $\rho_1 = \rho_2$. Rejection of the null hypothesis implies that the asymmetric adjustment of long-run relationship.

2.2. Introduction of Error Correction Term in the EGARCH-M Model

The present study applies the Engle and Granger (1987) test to the following model, which shows the long-run relation of the retail interest rate with the policy rate:

$$R_t = d_0 + d_1 M_t + e_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

where R_t the retail interest rates, M_t stands for the policy rate and e_t is the error term for the long-run. Parameter d_0 captures the fixed margin upon retail interest rate, while parameter d_1 captures the speed of pass-through. If $d_1 < 1$, it indicates incomplete pass-through. If d_1=1, it shows the complete pass-through and if d_1> 1 it means pass-through is more significant. Based on Equation (9), the asymmetric EC-E-GARCH(1, 1)-M model can be written as follow:

$$\Delta R_t = d_0 + d_1 \Delta MI_t + \sum_{i=1}^{m} a_i \Delta R_{t-i} + \sum_{i=1}^{n} b_i \epsilon_{t-i} + c\sigma_t^{\delta} + +\eta_1 M_t \hat{e}_{t-1} + \eta_2 (1 - M_t)\hat{e}_{t-1} + \varepsilon_t$$

$$\varepsilon_t = z_t \sigma_t$$

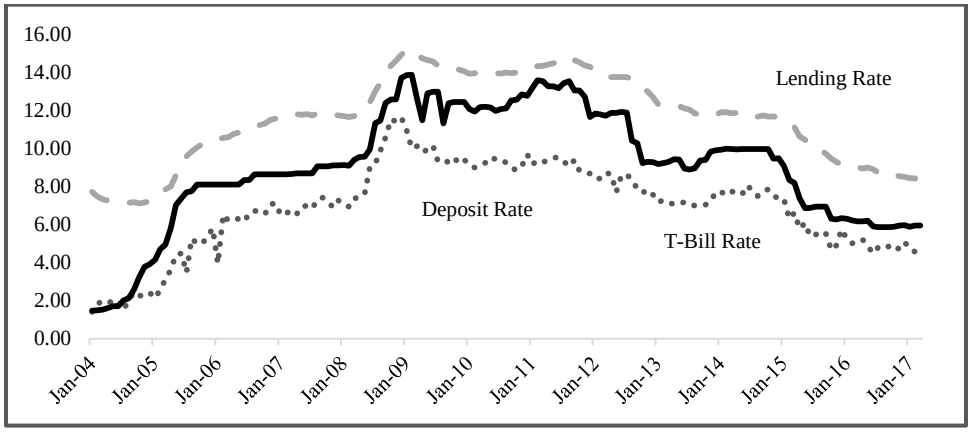
$$\sigma_t^{\delta} = \alpha_0 + \sum_{i=1}^{q} \alpha_i y_{t-i}^2 + \sum_{i=1}^{p} \beta_j h_{t-i} + \theta_1 (abs(\varepsilon_{t-i}) - \gamma_i \varepsilon_{t-i})^{\delta} + \theta_2 \sigma_{t-j}^{\delta} \quad (10)$$

Equation (10) represents the general model for EC-ARMA-EGARCH-M, in the presence of asymmetric adjustment in the short-run along with the error correction. It is also used to capture the rigidities in retail interest rates, by testing different restrictions on parameters of MTAR model's parameter (for detail see Wang and Lee 2009, Mahmood 2018).

3. EMPIRICAL RESULTS

3.1. Data Description

Visualisation is essential to study the different time series properties of data sets. Otherwise, empirical results and inference could be misleading. Variables are plotted in Figure 1. The figure reveals that all rates, i.e., lending rate, deposit rate, and T-bill rate, have the same pattern. All rates first increase, after reaching the maximum level they start decreasing. The T-Bill rate has more volatility which is also followed by the deposit rate



but with lesser volatility. The lending rate has less volatility. It implies that due to change of the T-Bill rate, there is a high rate of pass-through to the deposit rate and lower rate of pass-through to lending rate. It also indicates the possibility of cointegration among these variables, i.e. when the value of the T-Bill rate increases, then lending and deposit rates also increase and vice versa.

Table 1 provides the ADF and Phillips and Perron (PP) unit root results. The empirical results imply that all the series are not stationary at levels but are stationary at first differences.

Table 1

Unit Root Test Results

	Level		1st difference	
	ADF	PP	ADF	PP
Deposit Rate	–1.4983	–1.6456	–16.8815***	–16.7594***
Lending Rate	–1.7488	–0.6546	–4.2520***	–5.9521***
T-Bill Rate	–1.8919	–1.7841	–11.4791***	–11.4977***

Note: The critical values refer to Mackinnon (1996). ***indicate that the value is significant at 1 percent level.

3.2. Co-integration Test

Table 2 provides the long-run parameters for the deposit and lending rate models. It is estimated that there is a fixed markup for both models. However, the level of markup is higher in the case of the lending rate as compared to the deposit rate from the T-Bill rate. Furthermore, the pass-through is the same in both models, and this pass-through is higher than the previous literature. However, there is an incomplete pass-through as whenever the State Bank of Pakistan changes monetary policy, the commercial banks do not have enough power to transfer their total cost to consumers by improving the retail interest rates because there are already insufficient consumers dealing with banks. In this scenario, if the pass-through ratio increases, then the variability in the business cycle of banks will also increase (Khan et al. 2012).

Table 2

Estimation of Long-run Parameters

	Long-run Model	
	Deposit Rate	Lending Rate
d_0	0.2808*	4.9342***
d_1	0.7322***	0.7337***
H_0: $d_1 = 1$	273.23***	334.14***

Note: *** and *indicate that the value is statistically significant at 1 percent and 10 percent levels, respectively.

3.3. Error Correction Results

To confirm the existence of co-integration between the policy rate and the retail rates, TAR and MTAR models are employed. Empirical results of TAR and MTAR models are presented in Table 3. The null hypothesis of $H_0: \rho 1 = \rho 2 = 0$ is rejected in both models. It confirms the existence of cointegration among the retail rates. Similarly,

the null hypothesis of $H_0: \rho_1 = \rho_2$ is rejected in both models which confirms the existence of the asymmetric relationship. It indicates that asymmetric cointegration exists among policy rates and retail rates.

Table 3

TAR and MTAR Cointegration Results

	Co-integration			
	TAR		MTAR	
	F-value		F-value	
Deposit Rate	104.09***	Co-integration	40.97***	Co-integration
Lending Rate	287.23***	Co-integration	113.45***	Co-integration
	Symmetric/Asymmetric			
Deposit Rate	46.19***	Asymmetric	41.99***	Asymmetric
Lending Rate	3.44**	Asymmetric	13.29***	Asymmetric

Note: *** and ** indicate that the value is statistically significant at 1 percent and 5 percent levels, respectively.

Table 4 provides the estimated results of error correction in EGARCH-M model for the deposit and lending rates. The results of the deposit rate model imply that there is a low rate of pass-through due to policy rate change. Furthermore, positive values have higher error correction estimates than negative values. The null hypothesis $\eta_1 = \eta_2$ is rejected which implies that there is asymmetric error correction. Moreover, it is found that there is an upward rigidity ($\eta_1 > \eta_2$) in deposit rate model. Finally, there exists an asymmetric effect of bad news, which is exponential in the deposit rate behaviour. The results of the lending rate model show that there is quite a low rate of pass-through from the policy rate as compared to the deposit rate model. Furthermore, the positive and negative indicators have a similar error correction mechanism and also implies symmetric error correction.

Table 4

Results of the Error Correction in EGARCH-M Model

	Deposit Rate Model	Lending Rate Model
Interest Model	EC-E-GARCH (1,1) – M	EC-E-GARCH (1,1) – M
d_0	0.1883***	–0.0079
d_1	0.2199**	0.0968***
η_1	–0.4047***	–0.0753***
η_2	–0.0207	–0.0718***
w	–2.0074***	–4.3461***
α_1	–0.4198***	0.8616
β_1	0.6758***	0.5322***
θ_1	0.8436***	0.0022
θ_2	–0.2698**	0.6394**
c	–1.1558***	–0.0276

Note: *** (**) indicate that the value is statistically significant at 1 percent (5 percent) level.

The results reveal that there is an incomplete rate of pass-through i.e., 73 percent basic points between the retail interest rate due to a change in the policy rate. The results imply that borrowing from the domestic banks for investment is more efficient as banks have low power to transfer the cost to their consumer. The deposit rate is rigid upward, which implies that commercial banks will always try to give a low rate of profit to their consumers while borrowers from the bank have a higher power to reduce to the level of margin. Hence based on the empirical results of the study it is concluded that the profit margin of commercial banks depends on the power of rigidity of the borrower, i.e., if the power of rigidity is weak, then it will increase the profit margin, and vice versa.

Furthermore, one objective of the present study is to compare the empirical result of the present study with Mahmood (2018). Empirically it is found that the rate of the PT in the present study is higher as compared to Mahmood (2018). This difference is because of the appropriate choice of proxy for the policy rate, i.e., T-Bill rate instead of KIBOR.

3.4. The Economic Significance of Empirical Results

Table 5 provides a summary of the empirical results. First, there is asymmetric cointegration between retail interest rates and the policy rate. Second, mark-up exists for both models. Third, it indicates that there is an incomplete pass-through in Pakistan's case. Thus, when policy rate changes, some cost is transferred to commercial banks. To cover this cost, commercial banks adjust the markup ratio in the direction of the central bank.

Table 5

Comparison of Empirical Results

Model	Symmetric/Asymmetric Co-integration	Mark(up/down) (d_0)	Pass-Through Type (d_1)	Adjustment Rigidity (η_1 , η_2)
Deposit Rate	Asymmetric Co-integration	Mark-up	Incomplete	Upward
Lending Rate	Asymmetric Co-integration	Mark-up	Incomplete	No Rigidity

The possible justification for low-interest rates pass-through in Pakistan is mostly because of low consumer sensitivity towards the change in interest rate cost and revenues. In this situation, commercial banks will not maximise their profit; and hence, the government's economic policies might be ineffective. Consequently, the efficiency of the monetary policy associated with interest rate pass-through would decrease the possibility of achieving its objectives. Therefore, the government of Pakistan must pay close attention to market information and market structure to achieve the objective of the monetary policy.

4. CONCLUSION

The study examines the existence of interest rate pass-through between retail interest rates and the policy rate in Pakistan using monthly data from January 2004 to

March 2017. Retail interest rate and the policy rate follow the stylised properties of the financial time series. Therefore, error correction EGARCH-M model is used to estimate the interest rate pass-through between retail and policy rate, as suggested by Wang and Lee (2009) and Mahmood (2018).

The primary objective of interest rate pass-through is to increase growth through the investment channel, which can only be achieved if the rate of the pass-through is complete. However, in Pakistan, the speed of the pass-through is incomplete. One possible reason is the Islamic culture of the country as people are not attracted by the interest rates. Second, bank deposits are not a significant amount for investment. Hence, the depositors do not have much power to fight against rigidities imposed by the banks. Lastly, due to the insignificant amount of investment, minute changes occur in revenue as compared to the cost. Therefore, the State Bank of Pakistan has to give more attention to the behaviour of the market to achieve the objective of the monetary policy effectively.

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© *The Pakistan Development Review*
60:1 (2021) pp. 27–48
DOI: https://doi.org/10.30541/v60i1pp.27-48

Catastrophic Health Expenditure and Poverty in Pakistan

SHUJAAT FAROOQ and FAHAM MASUD

The current study has estimated the incidences, intensity and impacts of catastrophic health expenditures for Pakistan. For the analysis, two thresholds are used to define catastrophic health payments (1) if health expenditures are 10 percent or above of household consumption, and (2) if they are 40 percent or above of household non-food consumption expenditures. The Pakistan Panel Household Survey (PPHS) 2010/11 is used for the analysis. The findings reveal that a significant proportion of the population in Pakistan has been facing catastrophic health payment issues. The presence of children, the elderly and sick/disabled persons in the home raises the risks of catastrophic health payments. The availability of improved drinking water sources and toilet facilities reduces the risk of catastrophic health payments. Households with female heads incur more catastrophic payments as compared to households headed by males. Across the provinces, Khyber Pakhtunkhwa and Balochistan have faced a higher incidence of catastrophic payments. Catastrophic health payments have an impoverishing impact on headcount poverty, measured under various methods of propensity score matching.

JEL Classifications: I13, I14, I32
Keywords: Out-of-pocket Payments, Health, Consumption, Poverty, Health Policy

1. INTRODUCTION

The prime function of a country's health system is to provide preventive and curative services, and protect the population from the catastrophic impacts of illness, accidents, and chronic diseases by providing equitable health facilities (Rahman, Gilmour et al. 2013). Less developed countries, including Pakistan, lack well-structured health facilities and universal health coverage, especially for the poorer segments of the population. As a result, the population has to deal with a high prevalence of illness, which creates a financial burden and undermines their future earnings. Out-of-pocket (OOP) payments are the main source of health financing in the majority of underdeveloped countries, and this can be considered a barrier to establishing an equitable health system (Palmer, Mueller et al. 2004). In addition, high out-of-pocket (OOP) payments cause households to reduce their spending on other basic needs and sometimes even prevent them from seeking health care due to non-affordability (Cavagnero, Carrin et al. 2006).

Developed countries protect their population from catastrophic spending by providing adequate health facilities, health insurance, and tax-based health systems.

Shujaat Farooq <shujaat@pide.org.pk> is Assistant Professor, Pakistan Institute of Development Economics, Islamabad. Faham Masud is Research Fellow, Pakistan Institute of Development Economics, Islamabad.

However, the majority of the developing countries lack systematic risk pooling mechanisms, especially for the poor who pay from their own pockets. It may not only raise their current vulnerability, but also push them into chronic poverty and force them to compromise and forgo treatment (Bredenkamp, Mendola et al. 2010). Evidence from various countries suggests that heavy health payments compel the poor and lower middle classes to take loans, go into debt, cut down on food and non-food expenditures, and curtail schooling for their children as a coping mechanism (Krishna 2004).

The welfare losses due to catastrophic health payments have now received attention from policy-makers and many countries have started to subsidise health facilities for the poor masses through social safety nets and health insurance programmes (Honorati, Gentilini et al. 2015). The rising interest is also due to the recent trends of privatisation and liberalisation in developing countries, which cause a serious problem for those who struggle to afford health services. Rising economic and natural shocks could be another reason to protect people from catastrophic expenses (O'Donnell, Van Doorslaer et al. 2007).

Pakistan, with a population of 210 million, is responsible for providing basic necessities to all its citizens (Article 38d of the Constitution). Despite health care being a fundamental human right, the state lacks sufficient resources to provide equitable health facilities to all members of the population. The country has been facing a twofold burden where, on the one hand budgetary allocations for health services are insufficient (only 0.6 percent of GDP) and, on the other hand, around two-thirds of the population finances their health expenses themselves (GoP, 2013). Most of the health insurance and subsidised health facilities are limited to formal sector jobholders, excluding the poor due to the lack of adequate health services. The 2005 National Social Protection Strategy (2005) was alarmed that more than 70 percent of poor households faced shocks and two thirds of them reported catastrophic health expenditures as one type of shock.

Various studies in Pakistan have observed out-of-pocket health expenditures (Malik and Syed 2012), but the analysis is quite limited on the impacts of out-of-pocket health expenditures on poverty. The present study is unique, as it has undertaken an in-depth analysis on out-of-pocket health expenditures and their impact on poverty. The findings will help policy-makers to establish an equitable health policy and to target the vulnerable segments of society who suffer the most from catastrophic health expenditures.

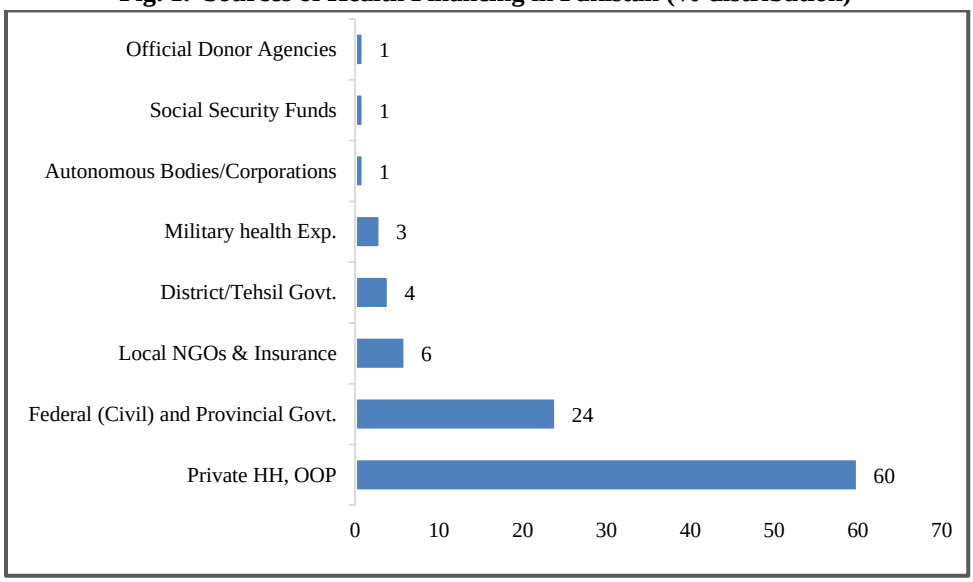
The present study comprises of seven sections.

Section 2: Health financing facts in Pakistan.
Section 3: Literature review.
Section 4: Conceptual framework.
Section 5: Data and methodology.
Section 6: Findings over the incidences and intensity of catastrophic health expenditures by socio-demographic and economic profile of households.
Section 7: A brief analysis on welfare impact of catastrophic health expenditures on headcount poverty.
Section 8: Conclusion.

2. HEALTH FINANCING FACTS IN PAKISTAN

Pakistan is a welfare state and the government is responsible for providing the necessities of life to all citizens irrespective of their sex, caste, creed or race (Article 38 of Pakistan). Despite being a fundamental right, health is treated as a commodity in Pakistan and the majority of the population finances health services from their own pockets (Malik and Syed 2012). The formal employed population may avail themselves of health insurance, subsidies and other forms of health protection, but the poor and informal workers mostly lack such incentives. As a result, 60 percent of health expenditures are private, only 33 percent come from the government, and a minor percentage falls under social safety nets and corporate sectors (Figure 1).

Fig. 1. Sources of Health Financing in Pakistan (% distribution)



Source: Pakistan National Health Accounts, Government of Pakistan, 2013.

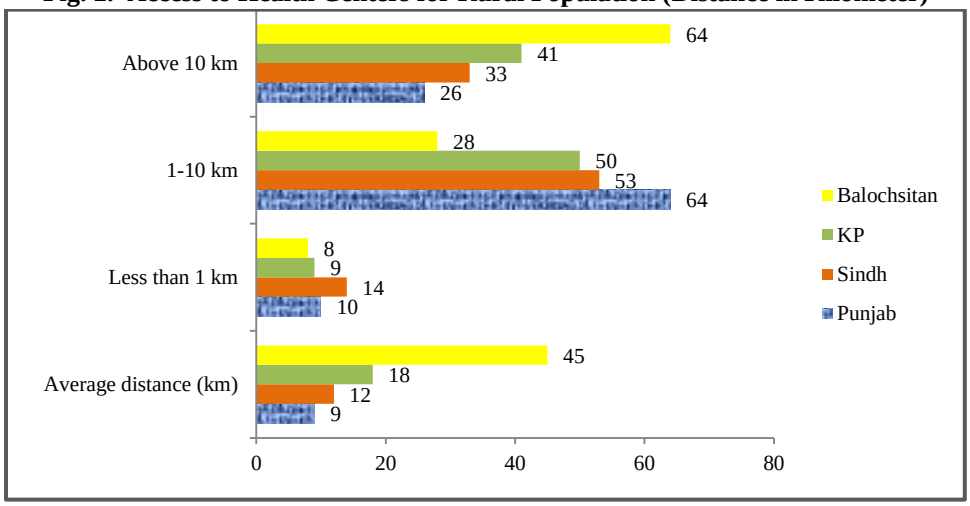
The question arises, then: *why does the majority of the population finance health expenditures from their own pockets*? The reasons are manifold, including both the demand and supply factors. The factors on the demand side include affordability, willingness to pay, socio-economic status, etc., whereas on the supply side, factors include the availability and quality of health services. There is a mixed and multi-tiered health care delivery system in Pakistan, including public, private and non-profit organisations. Although public spending has increased in nominal terms, the range and ratio of health expenditure to gross domestic product has varied between 0.4–0.9 percent since 1972 (Siddiqui et al. 1995 and Appendix Table 1). The ratio has declined over time (Khalid and Sattar 2016). Lower health spending is common among all the South Asian countries and requires drastic improvement (Appendix Table 2).

Providing better quality health services depends on conditions and the availability of a basic health infrastructure. The data shows that health facilities have increased over time in Pakistan. However, rapid population growth has negated the benefits of this increase (Appendix Table 3). Due to limited capacity, Basic Health Units (the primary

tier) are not fully functional and outreach capacity remains low. As a result, tertiary hospitals are unable to manage the patient load and some of them (i.e., Tehsil-level hospitals) lack better quality health services. The National Health Policy of 2010 has not materialised after the 18th Constitutional Amendment. Overall, poor public performance in the health sector may be attributed to the sub-optimal allocation of budgets, internal and external economic and non-economic challenges (including natural catastrophes), institutional, administrative and political changes, and a lack of capacity or willingness to carry out health reforms (Khaliq and Ahmad, 2016).

In spite of rapid growth in health infrastructure, access to health facilities is constrained by the rising cost of medical services and medicines, unequal distribution of health facilities between urban and rural areas, and inefficient utilisation of available health resources. When a person goes to a government hospital, he has to pay for the various costs, including user fees, medicine, etc., besides unofficial payments (Malik and Syed, 2012). In many cases, the infrastructure was available but could not be fully utilised because of the shortage of funds i.e., negligence, staff shortages in public hospitals and rapid growth in the number of private practitioners (Siddiqui et al. 1995). Across the provinces, access to hospitals is fair in Punjab and Sindh, but challenges remain in Khyber Pakhtunkhwa and Balochistan (Figure 2).

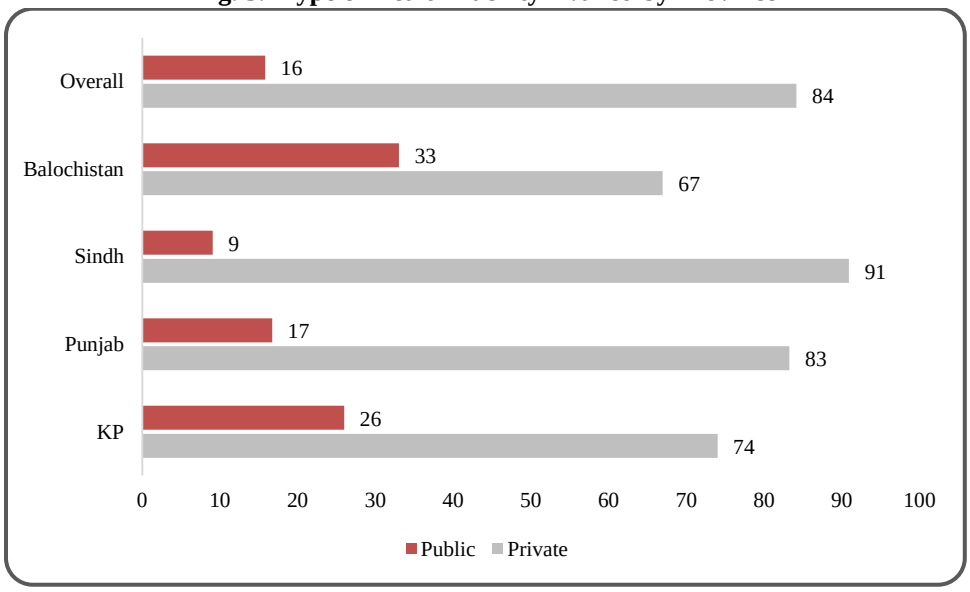
Fig. 2. Access to Health Centers for Rural Population (Distance in Kilometer)



Source: Mouza Statistics, Pakistan Bureau of Statistics (PBS), GoP (2008).

Currently, 84 percent of the population in Pakistan uses private health facilities. The access to, and quality of government hospitals may induce the public to avail health facilities from the private sector. Affordability, income, awareness and age structure could be the other factors that determine health expenditures (Toor and Butt, 2005). Possibly this is why the population of Punjab and Khyber Pakhtunkhwa has availed itself of private health facilities, as both these provinces are comparatively better off than Sindh and Balochistan. The greater utilisation of public health facilities in Balochistan province could be due to its limited private health infrastructure as well as poverty in the province (Figure 3).

Fig. 3. Type of Health Facility Availed by Province



Source: National Health Account Survey 2013/14, GOP (2013).

Pakistan has been facing an unacceptably high infant and maternal mortality rate, a double burden of diseases, and inadequate facilities given the pace of population growth. As shown in the Pakistan Demographic and Health Survey (2017), the country has been facing alarming high rates of malnutrition (37.6 percent stunting rates), poor health and well-being (skilled birth attendants attended only 69.3 percent women). As more than one quarter of the population is below the poverty line, the poor masses may further fall into chronic and intergenerational poverty if adequate health coverage is not provided. There is an immediate need for reforms at the provincial level in order to modify the health care system according to modern needs and requirements, focusing mainly on primary health care as well as investing in advanced health care. There should be a focus on building existing staff capacity, as well as ensuring their skill development in clinical practice, leadership, planning, and monitoring (Ather and Sherin, 2014).

3. LITERATURE REVIEW

Many underdeveloped countries lack equitable financing systems for health services, i.e. easy access and outreach, and lack of pre-payment mechanisms, such as tax and health insurance. As a result, a majority of the population, especially the poor, finances health expenditures from their own pocket and hence face risks of incurring heavy medical expenditures. This uninsured risk ultimately reduces their current and future wellbeing i.e. heavy out-of-pocket health payments disrupts the material living of the household including consumption, investments, and assets. If health expenses are high relative to available resources, the disruption to living standards may be considered catastrophic (O'donnell, Van Doorslaer et al. 2007).

Catastrophic health expenditure (CHE) refers to any expenditure for medical treatment that can pose a threat to a household's financial ability to maintain its

subsistence needs (Xu, Evans et al. 2005). Various studies use different thresholds for catastrophic spending, ranging from 5 to 20 percent of income and expenditures (O'donnell, Van Doorslaer et al. 2007) and sometimes up to 40 percent of the non-food expenditures (Xu, Evans et al. 2007). However, all levels suggest that a household must reduce its expenditure on basic necessities when it spends a large amount of its budget on health care and will have adverse effects on its livelihood (Chuma and Maina, 2012).

A substantial amount of literature suggests that incidences of catastrophic health payments in developing countries have been pushing millions of people into poverty annually (Rahman, Gilmour et al. 2013). Not all high health care costs can be regarded as catastrophic. A heavy bill for cardiac surgery may not cause economic burden for an affluent family who can afford the procedure, or has some health insurance. On the other hand, a low cost procedure can be financially disastrous for a poor family having no insurance coverage (Xu, Evans et al. 2003). Wagstaff, Flores et al. (2018) analysed 133 countries and found that incidences of catastrophic payments varied across countries and increased over time. At the 10 percent threshold, incidences ranged from 0.3 percent in Zambia to 44.9 percent in Lebanon with a mean value of 9.2 percent for the entire sample. The incidences of catastrophic payments are positively associated with income inequality and negatively with social security and public health infrastructure.

At a micro level, determinants could be the presence of an elderly, handicapped or chronically ill person in the home (Choi, Kim et al. 2016). Household size and age composition, i.e. presence of a higher number of children and elderly in the household, increases the probability of spending more on health care (Lee and Yoon, 2019). In addition, education brings awareness and may lead to either a decrease, or an increase, in catastrophic health expenditures (O'donnell, Van Doorslaer et al. 2007). Chronic diseases (Kashyap, Singh et al. 2018) and hospitalisation duration have a positive impact on catastrophic payments (Haakenstad, Coates et al. 2019). The probability of catastrophic payments is high among households with no health insurance and lower among those who receive medical care benefits (Lee and Yoon, 2019).

High OOP payments have three negative consequences. First, untreated illness may cause the issue of financial affordability among the lower income groups. Second, it may cause reduction in access to health care (Segall, Tipping et al. 2000). Third, households may fall into chronic poverty as people buy health services for their future welfare, and heavy health expenditures can make them take on debt and reduce their assets, including productive assets (Hao, Suhua et al. 1997).

The structure of health financing affeccts socio-economic wellbeing. Using multiple thresholds of share of health expenditures to consumption, various studies have found negative impacts on consumption (Chuma and Maina, 2012). Taking the data of 11 Asian countries, Van Doorslaer, O'Donnell et al. (2007) found that an increase in health payments caused a commensurately large increase in poverty. Findings from rural India suggest that illness and health care expenses are one of three main factors responsible for 85 percent of poverty (Krishna, 2004). Similar findings were found for Bangladesh (Rahman, Gilmour et al. 2013) and for many other countries e.g. (Wagstaff and Doorslaer, 2003) for Vietnam and (Xu, Evans et al. 2003) for 59 other countries.

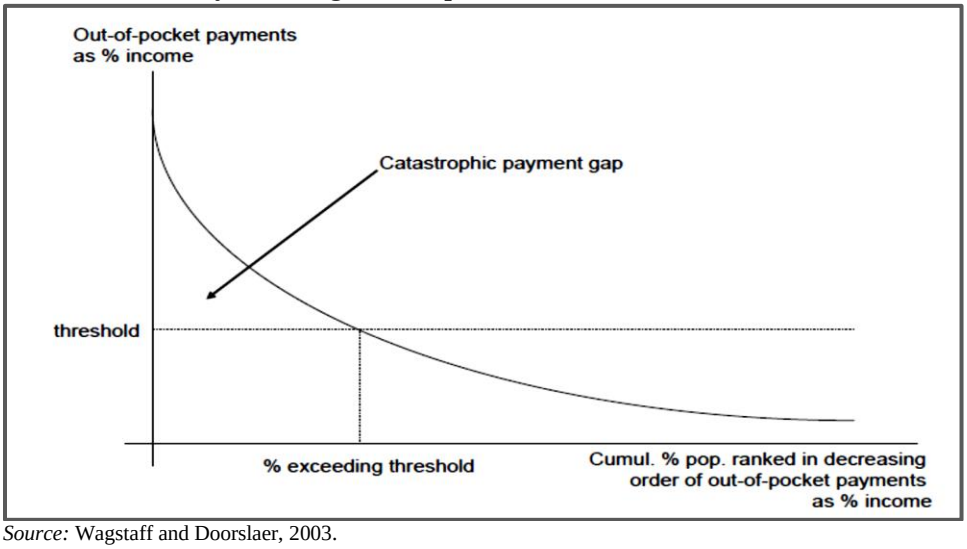
4. CONCEPTUAL UNDERPINNINGS

The concept of catastrophic health payments rests on the theoretical foundations of insurance and the economic value of uncertainty or financial risk of being exposed to large healthcare costs (Berki, 1986). An equitable public health system reduces the risks of healthcare costs. Alternatively, health insurance, whether run by governments or commercial companies, seeks to reduce this risk when a country's health financing arrangements fail to provide this coverage. The concerns of catastrophic health payments are their negative affect on economic wellbeing in the case of high OOP payments, as for example when an individual forgoes consumption of other necessities (e.g. food) to pay for health (Wagstaff, Flores et al. 2018).

There are two methodological choices in measuring catastrophic health payments. The first is to define household resources available to pay for health services. The second is the threshold used to identify health expenditures as catastrophic. In the 'budget share approach', household resources are defined in relation to a household's total budget. However, the approach fails to distinguish between populations that barely manage to meet subsistence needs with little or nothing left for discretionary expenditures (Hsu, Flores et al. 2018). In other words, dealing with both the rich and the poor at the same threshold level is not rational as rich households are more likely to exceed the threshold of minimum resources (Wagstaff and Doorslaer, 2003).

The 'capacity-to-pay (CTP) approach' addresses this limitation, recognising that poorer households spend a higher proportion of available resources on essential items than richer households do. Therefore, the method defines it by using total expenditures. To avoid this puzzle, it has been argued that OOP expenditures can be defined in terms of a household's capacity to pay (Xu, Evans et al. 2003). It is worth mentioning that all approaches consider OOP health payments as involuntary with a negative impact on the welfare of the household (Wagstaff, Flores et al. 2018).

Fig. 4. Share of Health Payments beside Cumulative Percentage of Households Ranked by Reducing Consumption Share

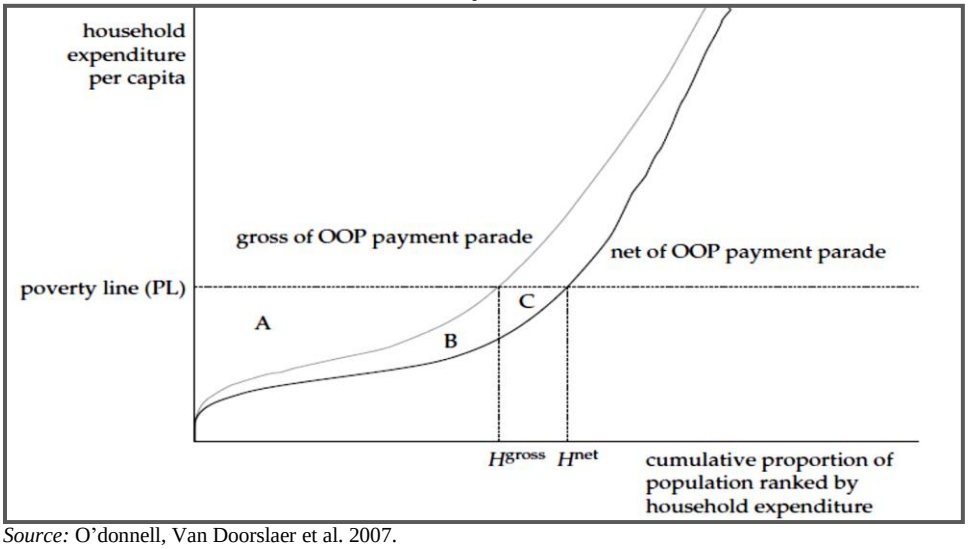


Source: Wagstaff and Doorslaer, 2003.

The prevalence and intensity of catastrophic health expenses and the headcount poverty and poverty gaps are measured in similar methodology. The incidence of catastrophic health expenses are calculated from the fraction or percentage of a sampled household with health care costs as a share of total consumption or non-food consumption, exceeding the selected threshold. As shown in Figure 4, the cumulative fraction of households ordered by the ratio of OOP expenditures to total household expenditures is on the horizontal axis in descending order. After defining the threshold i.e. 10 percent of OOP of total consumption, one can estimate the incidences of catastrophic health payments, or the percentage of households with health care expenditure whose share goes above the threshold. The indicator is 1 if the share of health expenditure exceeds the threshold which is otherwise 0.

Figure 5 provides a simple framework for examining the impact of out-of-pocket payments on the two basic measures of poverty—the headcount and the poverty gap. The figure is a variant on Pen's Parade. The two parades plot household expenditure gross and net of OOP payments on the y-axis against the cumulative proportion of individuals ranked by expenditure on the x-axis. The point on the x-axis at which a curve crosses the poverty line gives the fraction of people living in poverty. This is the poverty head count ratio. This measure does not capture the "depth" of poverty, i.e. the amount by which the poor households fall short of reaching the poverty line. A measure that does consider those is the poverty gap, defined as the area below the poverty line but above the parade.

Fig. 5. Pen's Parade for Household Expenditure Gross and Net of OOP Health Payments



Source: O'donnell, Van Doorslaer et al. 2007.

5. DATA DESCRIPTION AND METHODOLOGY

5.1. Data Description

To analyse the incidences, determinants, and impacts of catastrophic health payments on poverty, we have used the Pakistan Panel Household Survey (PPHS)

2010/11, conducted by the Pakistan Institute of Development Economics (PIDE). The 2010 round covers 4142 households in total, 2800 from rural areas and 1342 from urban areas. The PPHS 2010 has collected detailed information on each household's socio-demographic and economic profile, including detailed modules on education, health, employment, shocks, subjective well-being, food security, migration and many others. The survey has captured information on food and non-food consumption, sufficient to calculate headcount poverty (consumption based) by following official methodology (Nayab and Arif, 2012).

The female questionnaire has captured detailed health information, including access to and outreach from health services, illness and injuries, women's reproductive health, immunisation and children's health status. The health module of illness and injury has gathered information on episodes of illness, the nature of each sickness, who was consulted, hospitalisation and out-of-pocket (OOP) health expenditures made by households for all those family members who faced any illness or injury during the last 12 months. The expenditures include consultation fees for doctors, treatment costs or expenditures on medicines, and hospitalisation, diagnostic tests, and other charges, etc. It is worth mentioning that despite 755 households reporting that they had not made any health expenditures during the last year, we still included them in the analysis. The final analysis was carried out for 4023 households (2756 rural and 1267 urban households). Only 119 households were dropped because they lacked information on headcount poverty.

It is worth mentioning that the PPHS non-food module has also captured overall medicine expenditures made by households during the last twelve months. We found that medicine expenditures reported in non-food items were under-reported, as they were not linked with any individual members' illnesses and lacked detailed segregated information as captured in the health module (detailed above). To improve accuracy, we have refined the total household consumption expenditures by subtracting medicine expenditures (mentioned in non-food module) and adding health expenditures detailed in the health module.

5.2. Definition and Measurement of Catastrophic Health Expenditures

Health expenditures are *'catastrophic'* if they constitute a large share of the household budget and affect the household's ability to maintain its standard of living. The share of out-of-pocket health expenditures can be defined as:

$$OOP = T / TE * 100 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

OOP = percentage share of health expenditure in total household income/expenditures
T = household expenditure on health
TE = total income/expenditures of a household

Various researchers have used different thresholds of income or consumption to define catastrophic health expenditures. The present study has defined catastrophic expenditures by both approaches. Catastrophe-1: OOP payments over 10 percent of total household expenditure; and Catastrophe-2: OOP payments over 40 percent of non-food consumption expenditures. It is worth mentioning that we have measured headcount poverty under the Food Energy Intake (FEI) method and PKR1671.89 per adult

equivalent per month is used as the poverty line. The household is the unit of analysis; however, the data have been weighted by household size for poverty estimation (Arif and Farooq, 2014).

Following Wagstaff and Doorslaer (2003) and O'Donnell, Van Doorslaer et al. (2007), suppose T is expenditures on health care, TE is total household expenditure and/or Y is nonfood or non-discretionary expenditure. A household would incur catastrophic expenditures if T/TE or T/[TE-Y] would exceed the defined threshold (z_{cat}), i.e., 10+ percent of household expenditures, etc. The value of the threshold represents the point at which further expenses on health care force a household to sacrifice its other necessities, borrow money, sell assets or descend into poverty. The catastrophic headcount can be calculated as:

$$H= 1/N\sum_{i=1}^{N} Ei \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

An indicator, E equals1 if $T_i/TE_i > z_{cat}$ and zero otherwise, where N is the sample size. However, catastrophic headcount does not capture the degree to which households actually exceed the threshold. For this purpose, the *catastrophic payment gap* (CPG) is calculated, which shows the average amount by which OOP payments (as a proportion of total expenditures) exceed the threshold. It is measured as:

$$CPG= 1/N\sum_{i=1}^{N} Oi \text{ Where } O_i=E_i[(T_i/TE_i)-z_{cat}] \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

However, both incidence (H) and intensity (O) are related through the mean positive overshoot, which is defined as follows:

$$MPO= O/H \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

As mentioned earlier, the PPHS 2010 round covers detailed food and non-food consumption expenditures, as well as health expenditures sufficient to calculate incidence and intensity. Regarding the determinants, catastrophic health expenditures are influenced by many socio-economic and demographic factors. To find the determinants, we have undertaken both bi-variate and multivariate analyses to examine the relationship between a set of covariates of catastrophic health expenditures. The following equation has been used for multi-variate analysis to estimate the determinants of catastrophic health payments:

$$CHE\ 1_i = \alpha_0 + \alpha_1 Ch_i + \alpha_2\, Ed_i + \alpha_3\, El_i + \alpha_4\, X_i + \mu_I$$

The dependent variable is the incidence of catastrophic health payments, having two outcomes: 1 if a household is facing a catastrophe health payment issue and 0 otherwise. On the right-hand side, Ch_i represents the presence of a child in a household, Ed_i denotes the education status of the household's head and El_i is the presence of an elderly person in the household. X_i represents the vector of other control variables, including the household head's working status, household size, presence of a disabled person in home, water and sanitation, and provincial and regional dummies.

In order to analyse the impact of catastrophic health expenditures on headcount poverty, we have developed Pen's Parade Graph (Wagstaff and Doorslaer, 2003) by plotting pre and post health payments after adjusting for total consumption expenditures, along with the poverty line, against the cumulative distribution of households by per capita consumption (ranked in ascending order).

To quantify impacts, the present study has used the propensity score matching (PSM) technique. The PSM technique is applied to avoid selection biases, as characteristics of catastrophe and non-catastrophe households vary (Rosenbaum and Rubin 1983).

To overcome the issue of selective biases, PSM is ideal because it compares catastrophe households with non-catastrophe households, who possess similar socio-demographic and economic characteristics. The basic idea is to find a comparison group having a similar profile (socio-demographic) to the catastrophe-incurring group in all aspects except one, that being that the comparison group does not incur catastrophic health expenditures. The method actually balances the observed covariates between the incurring (catastrophic) group and non-incurring catastrophic group based on the similarity of their predicted probabilities that they will experience catastrophic health expenditures, named as their propensity scores (Ravallion 2003).

$$P(Xi) = \text{prob}\,(Di = 1 \mid Xi) = E(D \mid Xi)$$

where

$$P\,(Xi) = F(h\,(Xi))$$

F(h (Xi)) can have a normal or logistic cumulative distribution.
Di = 1 if the household is facing catastrophic expenditures and 0 otherwise.
Xi is a vector of pre-treatment characteristics.

Catastrophe households are matched to non-catastrophe households based on propensity score. Using Equation 6, the propensity scores are calculated first through the logistic regression and then the *Average Treatment on the Treated* (ATT) effect is estimated as:

$$\begin{aligned} ATT &= E\,(Y_{1i} - Y_{0i}) \\ &= E\,(ATE \mid D_i = 1) \\ &= E[Y_{1i} \mid D_i = 1] - E[Y_{0i} \mid D_i = 1] \end{aligned}$$

Where:

Y_{1i} is the potential outcome if the household is facing a catastrophe and
Y_{0i} is the potential outcome if the household is not facing a catastrophe.
ATE is the Average Treatment Effect

In order to make the sample comparable, it has been restricted to only those units (households) with probabilities that lie within the region known as the common support; that is, the area where there are enough of both control and treatment observations for comparison. After calculating propensity scores, the welfare impact of *Average Treatment on the Treated* (ATT) effect is estimated by the four PSM methods: Kernel method, Nearest Neighbour method, Radius method and Stratification Matching method.

- The Kernel method matches all the treated households with the weighted average of all the non-treated households where weights are inversely proportional to the distance between the propensity scores of treated and non-treated households.

- In Nearest Neighbour matching, each treated household is matched with the non-treated households having the closest propensity score with replacement.
- The Radius method imposes a limit on maximum propensity score distance, called radius.
- The Stratification matching method, which consists of dividing the range of propensity score variations in a set of intervals such that, within each interval, the treated and non-treated households have, on average, the same propensity score.

For details on the PSM methodology, see Nayab and Farooq, 2014.

6. RESULTS

6.1. Out-of-Pocket Health Payments

The respondents of the 2010 PPHS survey reported that only 3 percent of the surveyed households had ever financed their health expenses from insurance and social assistance, and the rest took care of these expenses from their own pockets. Within health expenditures, medicine was the main source of health expenses with a 74 percent share, followed by doctors' consultations (17 percent) and diagnostic tests (9 percent). As shown in Table 1, per capita OOP health expenses are strongly linked with household socio-demographic and economic characteristics. Rural households, on average, incurred less per capita health expenses than their urban counterparts. That could be due to both demand and supply factors, including limited access, outreach and awareness, as well as a lack of private health facilities in rural areas.

Female headed households are associated with higher OOP health expenses in both the rural and urban areas, as a female householder may be more cautious about her family, or it could be due to comparatively affluent households being headed by females due to overseas migration. In case of widows running female-headed households, they might be financed by someone else, as in charitable donations or under social safety net transfers, either formal or informal. Household size has a negative association with OOP per capita health expenses, suggesting that per capita health expenditures decline as household sizes increase. The negative association could be due to the poverty factor and the larger households' inability to incur more health expenditures. Affluent households, on average, have 2.5 times more health expenses than poor households (Table 1).

Table 1

Average Per Capita Annual Health Expenditures by Household Characteristics (in PKR)

Characteristics	Rural	Urban	Overall
Overall	2275	2940	2485
Sex of Head of Household			
Female	2835	2775	2815
Male	2252	2947	2470
Household Size (category)			
Upto 4 members	3039	4931	3583
5–7 members	2222	2699	2402
8–9 members	2038	2422	2164
10+members	1891	1966	1908
Headcount Poverty			
Poor	1067	1163	1091
Non-poor	2565	3216	2780

Source: Estimated from PPHS 2010 micro dataset.

The analysis reveals that average health expenditures are 6.2 percent of total monthly consumption expenditures, lower in rural areas (6.1 percent) than urban areas (6.3 percent). In both regions, on average, the bottom quintile (20 percent of the population) has endured more health expenditures as a share of household consumption, thus reflecting that they are facing more burdens and catastrophic risks (Table 2).

Table 2

Share of Health Expenditures in Total Monthly Consumption (in %)

Quintile	Overall	Rural	Urban
Bottom Quintile	6.7	6.5	7.2
2nd Quintile	6.1	6.1	6.1
3rd Quintile	6.0	6.2	5.6
4th Quintile	6.4	6.2	7.0
5th Quintile	5.7	5.5	6.2
Overall	6.2	6.1	6.3

Source: Estimated from PPHS 2010 micro dataset.

Note: Quintiles are established by using monthly household consumption.

6.2. Incidences and Intensity of Catastrophic Payments

Before explaining the results, it is worth mentioning that we have defined catastrophic health payments by two thresholds: OOP health payments are 10+ percent of the total household consumption expenditures, or 40+ percent of the total non-food expenditures. Table 3 shows that 22 percent and 16 percent of the households have catastrophic health payments when OOP health expenditures have a 10 percent and higher share in total consumption, and a 40 percent and higher share in total non-food consumption, respectively. Rural households are facing slightly higher catastrophic health payment issues than their urban counterparts, and that could be due to more poverty in rural areas with higher travel costs due to the lack of health facilities in rural regions. The lower percentage of intensity/overshoot in rural areas suggests that, overall both health expenditures and consumption expenditures (both food and non-food) are comparatively less variable than urban households (see details in Appendix Table 4 at various thresholds).

Table 3

Incidences and Intensity of Catastrophic Health Expenditures (%)

Catastrophic Payment Measures	Overall	Rural	Urban
OOP 10+% share in total consumption			
Headcount (H %)	22.4	20.7	19.4
Overshoot (O %)	3.4	2.7	4.8
Mean Positive Overshoot (MPO %)	16.5	13.1	24.9
OOP 40+ % share in non-food consumption			
Headcount (H %)	15.9	17.5	15.7
Overshoot (O %)	9.1	7.4	12.5
Mean Positive Overshoot (MPO %)	63.8	53.3	85.0

Source: Estimated from PPHS 2010 micro dataset.

Various household characteristics are likely having an impact on catastrophic health expenditures. Table 4 shows that households with female heads have incurred more catastrophic payments, which could be due to more cautious behaviour. Therefore, financial support from someone else due to poverty (in case of the former), and affordability (for overseas migrants) may support these results. Demographic variables such as the presence of children, senior citizens, and household size, have shown a health burden on households. Although there is less of a variation due to the presence of children and various categories of household size, a larger difference can be observed due to the presence of senior citizens in the home. It suggests that a household has to bear double the burden in case of seniors since there is (1) high dependency with no earning and (2) repetitive medical treatments for them.

Table 4

Incidence of Catastrophic Health Expenditures (%) by Household Characteristics

Characteristics	OOP 10 and above % Share in Total Consumption	OOP 40 and above % Share in Non-food Consumption
Sex of Head of Household		
Female	25.9	22.9
Male	20.1	13.3
Presence of child under age 5		
No	21.0	14.9
Yes	23.2	16.2
Household Size (in categories)		
Upto 4 members	18.4	12.1
5–7 members	19.7	13.8
8–9 members	20.1	12.6
10 and above members	21.8	14.1
*Presence of chronic sick or disable at home**		
No	15.1	10.4
Yes	31.0	21.4
Presence of elder (65 and above age) at home		
No	22.5	16.0
Yes	28.5	17.3
*Distance to the health facility (in Kilometers)**		
Upto 2km	21.5	14.3
>2–10km	22.6	15.4
Above 10 km	24.8	18.2
Safe Drinking Water		
No	25.2	16.9
Yes	21.5	15.2
Toilet Facility		
No	24.4	16.7
Yes	20.8	14.9
Status of hospitalised of any household member		
No	15.4	10.6
Yes	52.0	36.3
Headcount Poverty		
No	19.4	12.6
Yes	22.4	16.3
Provinces		
Punjab	17.7	9.5
Sindh	20.9	16.4
Khyber Pakhtunkhwa	27.3	18.9
Balochistan	29.6	20.2

Source: Estimated from PPHS 2010 micro dataset.

* chronic illness includes respiratory issues, heart problem, mental illness, diabetes and disability.

** it includes government hospital, rural health centre, basic health unit, private hospital and private doctor.

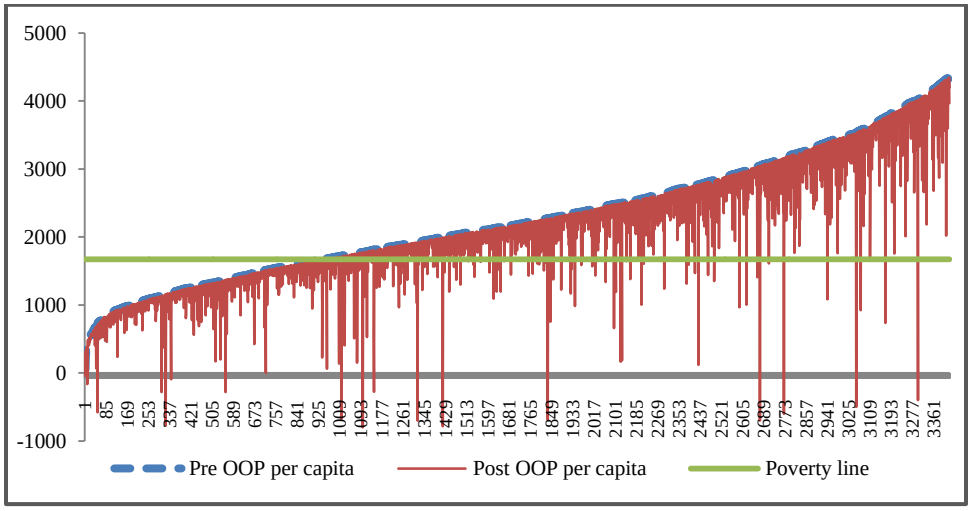
The presence of chronic sickness or permanent disability in the home also raises household vulnerability. Catastrophic health payment issues are almost double among such households as they usually face permanent health shocks, and require consistent medical treatment and permanent extra care of other adult members. Increase in distance to medical facilities also raises catastrophic payment issues as the majority of the population resides in rural areas while medical facilities are located in urban areas, making transportation cost one of the factors that raises health payments for the rural population (Table 4).

The impact of catastrophic health payments is higher for poor households, which could be due to overall lower household consumption and allocation of a higher share of income for health expenses. Although most health expenses raise the risk of poverty and vulnerability, hospitalisation is one of the leading factors of catastrophic payments. The catastrophic health payment impacts for these vulnerable households are more than triple where hospitalisations occurred in the previous 12 months.

Regional characteristics have an influence on catastrophic payments. High catastrophic payments affected Khyber Pakhtunkhwa (KP) and Balochistan provinces the most and were the lowest in Punjab. The low expenditures in Punjab could be due to low rates of headcount poverty, better affordability to pay for health services, and better health facilities that are easier to access since they are located closer to homes. Balochistan is the most vulnerable and least developed province of Pakistan in terms of education and access to basic health facilities (Table 4).

Figure 6 shows the effect of OOP health payments on household consumption. The figure can be called Pen's Parade graph or a "paint drop chart" (Wagstaff and Doorslaer, 2003). The per capita consumption expenditures, including per capita health expenditures (pre OOP per capita), and per capita consumption expenditures, excluding per capita health expenditures (post OOP per capita), along with the poverty line, are plotted by ranking per capita consumption expenditures in ascending order. The vertical bar shows

Fig. 6. Impact of OOP Health Expenditures on Household Consumption Distribution



Source: Estimated from PPHS 2010 micro dataset.

that some households are pushed into poverty due to health payments. A few households' post per capita consumption (after deducting health expenditures) even went into the negative. It is also evident from the graph that health expenditures are greater at higher values of consumption expenditures, but it is mostly households at the middle and lower end of the graph that are dragged into poverty due to health expenses.

7. CATASTROPHIC PAYMENTS: A PSM ANALYSIS

As detailed in the methodology section, the propensity score matching (PSM) method is applied to estimate the effect of catastrophic health payments on headcount poverty. Following the first step of the technique, we have estimated the propensity scores through logistic regression, for which two conditions must be met: the balancing property and the unconfoundedness property. After calculating propensity scores, the *Average Treatment on the Treated* (ATT) effect is estimated using four different methods: Nearest Neighbour; Kernel, Radius and Stratification Matching.

Following the first step of the PSM technique, Table 4 presents results over the determinants of catastrophic health payments by incorporating the correlates on which both the balancing and unconfoundedness properties conditions are satisfied. The dependent variable is binary in nature, even if the household faces catastrophic health payments, based on 10+ percent of total consumption expenditures, and 40+ percent of non-food consumption expenditure. Odds ratios are reported in Table 5.

Table 5

The Determinants of Catastrophic Health Expenditures—Logistic Regression Model

	OOP 10+ % Share in Total Consumption		OOP 40+ % Share in Non-food Consumption	
Correlates	Odds Ratio	Std. Error	Odds Ratio	Std. Error
Sex of household head (male=1)	0.893	0.196	0.516***	0.117
Presence of a child (yes=1)	1.022	0.102	1.102	0.127
Presence of an elderly person (yes=1)	1.265***	0.127	1.135**	0.132
Household size (up to 4 members as reference)				
5-7 members	1.063	0.143	1.018	0.158
8-9 members	1.046	0.165	0.871	0.159
10+ members	1.778**	0.131	0.599***	0.117
Presence of chronically sick and/or disabled person (yes=1)	1.411***	0.038	1.409***	0.044
HH member is hospitalised (yes=1)	6.717***	0.683	5.460***	0.611
Distance to health facility (in km)	1.004*	0.002	1.006**	0.003
Literacy of HH head (literate=1)	0.827**	0.079	0.759**	0.084
Number of persons per room	1.597**	0.368	1.209*	0.332
Improved water (yes=1)	0.818	0.116	0.880	0.141
Toilet facility (yes=1)	0.577***	0.063	0.643***	0.079
Region (urban=1)	0.896**	0.128	0.821***	0.173
Province (Punjab as reference)				
Sindh (yes=1)	1.246**	0.140	2.050***	0.268
Khyber Pakhtunkhwa (yes=1)	2.246***	0.299	2.733***	0.430
Balochistan (yes=1)	1.260**	0.229	2.297***	0.458
Constant	0.321***	0.098	0.253***	0.085
Pseudo-R^2	0.150		0.139	
Number of Observations (N)	3949		3949	

Source: Estimated from PPHS 2010 micro dataset.

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

The demographic variables show that the household head's sex is significant only in model 2 (OOP as a percentage of non-food consumption) where households with male heads are less likely to incur catastrophic payments compared to households with female heads. The presence of a child does not make a statistical difference; however, the presence of an old person in the home raises the likelihood of catastrophic health expenditures. Similarly, the presence of a chronically ill or disabled person in the home also raises the probability that the home will end up liable for catastrophic health payments. Various dummies of household size show that only large households (having 10 or more members) face issues surrounding catastrophic health payments as compared to smaller households (up to 4 members).

The household head's education level, as measured by literacy rate, is also found to be negatively correlated with the likelihood of incurring catastrophic expenditures. It may be because education can be used as a proxy for future income and imparts its negative influence on health spending through good health. The two health-related indicators show that hospitalisation of a household member raises the probability of catastrophic payments by 5.5 to 6.7 times as measured through both models. Distance to the nearest health facility is another factor that raises catastrophic health expenditures.

Three proxies of hygienic conditions in the home are added in the model, which shows that crowding, as measured through number of persons per room, leads to more catastrophic health payments for the home. Similarly, having a toilet facility also reduces the chances of catastrophic health payments. The impact of improved water is not significant. These hygiene variables mostly act through preventive measures of health care, as households that are more hygienic are less likely to face disease.

Households in urban areas are significantly less likely to incur catastrophic health expenditures. This is because rural areas face difficulties in access and outreach from health facilities, which are widely available in urban areas. Households in Sindh, KP and Balochistan have higher probabilities of incurring catastrophic payments compared to those in Punjab. The lower incidence in Punjab could be due to relatively fewer demand and supply gaps than the rest of the provinces, because people may have more affordable options along with better health services.

This brings us to the final stage of the PSM impact analysis results, presented in Table 6. The table shows the estimated impact of catastrophic payments by displaying the *Average Treatment Effect on the Treated* (ATT) against headcount poverty. The bootstrapped standard error, as well as the number of matching cases treated, and the size of the control group, are also given in Table 6. The impact of catastrophic health expenditures on poverty is statistically significant for all three measures (Table 5). The results show that households incurring catastrophic expenditures have a higher probability of being poor. However, this impact varies across the three measures, ranging from 4.4 to 6.7 percent under the first measure of catastrophic health payments (health expenditures as a fraction of total consumption). The trend is the same but estimates vary under the second measure (health expenditures as a fraction of total non-food consumption), with its range spanning from 7.1 to 9.5 percent, with the lowest value for the Kernel method and the highest for the Radius matching method. Thus, catastrophic payment-incurring households are more likely to be poor than catastrophic non-incurring households with similar characteristics.

Table 6

ATT Effects of Catastrophic Health Payments on Poverty

Measures/ATT	OOP 10+ % Share in Total Consumption	OOP 40+ % Share in Non-food Consumption
Nearest neighbour method		
ATT	0.044**	0.071***
N.Treated	765	509
N.Control	550	422
St. error bootstrap	0.022	0.028
t-stat	2.01	2.509
Kernel method		
ATT	0.053***	0.068***
N.Treated	765	509
N.Control	2983	3232
St.error bootstrap	0.016	0.017
t-stat	3.350	4.074
Stratification method		
ATT	0.055***	0.072***
N.Treated	765	509
N.Control	2983	3232
St.error bootstrap	0.018	0.023
t-stat	3.144	3.180
Radius Matching method		
ATT	0.067**	0.095**
N.Treated	368	267
N.Control	759	756
St.error bootstrap	0.038	0.018
t-stat	1.960	2.323

Source: Estimated from PPHS 2010 micro dataset.
***significant at 1 percent, ** significant at 5 percent, * significant at 10 percent.

8. CONCLUSIONS AND POLICY RECOMMENDATIONS

Health expenditures may become a burden when people have to sacrifice their other basic needs, as they are involuntary payments. The present study has estimated the incidences of catastrophic health expenditures and their impacts on headcount poverty. Two thresholds are used to define catastrophic payments: if health expenditures are 10+ percent of total household consumption, and if health expenditures are 40+ percent of household non-food consumption. The findings reveal that at the former threshold, 22 percent of the households in Pakistan have faced catastrophic health payment issues and 16 percent qualify under the latter cut-off. Rural areas have been facing more issues surrounding catastrophic health payments. The presence of elderly and sick or disabled

persons in the home can raise a household's vulnerability and risks of facing catastrophic health expenditures. Likewise, improved hygienic environments, meaning less crowding and consistent access to a toilet facility, can lower the risk of facing catastrophic payments. While taking the 10+ percent OOP share in consumption expenditures, catastrophic payments lead to increases in headcount poverty by 4.4 to 6.7 percent. The impact on headcount poverty worsens when a 40+ percent OOP share in non-food consumption expenditures is taken. The study, thus, proposes the following recommendations:

- The high share of OOP health expenditures along with the rising demand for private hospitals necessitates that the government enhance the access to, and outreach from, public health services and facilities, both in terms of affordable care and equitable access, and especially to vulnerable households. The public health system requires fundamental reforms to reshape the health care system and make it more efficient and effective. The structural bottlenecks in the health system may not be overcome unless fundamental changes are introduced to improve the system's technical and allocative efficiency, enhance the quality of services, and make the system more equitable.
- Pakistan lacks sufficient spending on health facilities. Communicable and non-communicable diseases and other health issues have over-stretched health facilities. The lack of universal immunisation, alarming levels of malnutrition and rising population pressures are areas of concern. The recent outbreak of dengue fever is one example. There should be much more focus on preventive measures to inform the population about universal immunisation, communicable diseases, nutritional diets, etc. Hygienic and WASH awareness could be key factors the government could use to improve health and nutrition.
- Currently, Pakistan lacks health insurance for poor households. The Prime Minister Health Insurance is a good initiative that aims to target poor households by providing reasonable health insurance (PKR 720,000 to a family per annum). The insurance can be productive for the poor by focusing on availability of medical facilities. Beneficiaries of the scheme must be made aware of it to avoid the likelihood that they will underutilise health services, as had happened earlier in BISP's Waseela-e-Sehat pilot project. Other stakeholders, i.e., NADRA and local governments, must be involved in completing the documents needed to avail the health insurance, including the B-form and CNIC for family members.

Appendix Table 1

Public Sector Health Expenditure in Pakistan (in Rs. Billion)

Years	Current Expenditures	Development Expenditures	Total Health Expenditures	Health Expenditure as % of GDP
2000-01	18	6	24	0.7
2002-03	22	7	29	0.6
2004-05	27	11	38	0.6
2006-07	30	20	50	0.6
2008-09	41	33	74	0.6
2009-10	41	38	79	0.5
2010-11	23	19	42	0.2
2011-12	29	26	55	0.3
2012-13	92	33	125	0.6
2013-14	115	59	174	0.7
2014-15	130	69	199	0.7
2015-16	147	78	225	0.7
2016-17	190	102	292	0.7

Source: Economic Survey of Pakistan, various additions.

Appendix Table 2

Health Expenditure in Selected Countries 2014

Countries	% of all Govt. Resources going to Health	Govt. Expenditures on Health (% of GDP)	Per Capita Total Health Expenditures (in US $)	Share Allocated by Households on Health Exp. (%)
Bangladesh	6	1	31	67
India	5	1	62	62
Malaysia	6	4	210	35
Nepal	11	2	40	48
Pakistan	5	1	36	56
Sri Lanka	11	2	127	42
Thailand	14	3	216	12

Source: World Health Statistics (WHO) 2014.

Appendix Table 3

Health Facilities over Time in Pakistan

Year	Population per Hospital (000)	Population per BHUs (000)	Population Per Maternity and Child Health Centers (000)	Population per Rural Health Centers (000)	Population per Bed
2001	157	27	162	264	1458
2003	165	28	165	271	1513
2005	170	29	172	281	1537
2007	172	30	180	290	1577
2009	176	32	188	297	1639
2011	181	33	208	306	1647
2013	166	33	268	276	1557
2015	164	35	262	280	1604
2016	183	37	265	284	1592
2017	184	38	267	283	1580

Source: Pakistan Economic Survey, various rounds.

Appendix Table 4

Incidences and Intensity of Catastrophic Health Expenditures (%)

	OOP Health Expenses as Share of Total Expenditure (in %)			OOP Health Expenses as Share of Non-food Expenditure (in %)		
Thresholds	Headcount (H)	Mean Gap	Mean Positive Gap	Headcount (H)	Mean Gap	Mean Positive Gap
5%	39.3	4.8	12.4	–	–	–
10%	22.4	3.4	16.5	–	–	–
15%	14.8	2.6	20.8	–	–	–
20%	10.6	2.2	26.2	30.4	13.0	43.5
25%	8.9	1.8	29.2	25.2	11.7	48.2
30%	–	–	–	21.6	10.6	52.2
35%	–	–	–	18.5	9.8	57.2
40%	–	–	–	15.9	9.1	63.8

Source: Estimated from PPHS 2010 micro dataset.

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© *The Pakistan Development Review*
60:1 (2021) pp. 49–64
DOI: https://doi.org/10.30541/v60i1pp.49-64

Mechanism of Volatility Spillover Between Stock, Currency, and Commodity Markets of Pakistan

MUHAMMAD JAMIL and HIFSA MOBEEN

This research aims to examine the mechanism of volatility transmission between stock, currency, and commodity markets of Pakistan. For this purpose, daily data covering the period August 4, 1997 to August 31, 2016 is analysed. Empirical investigation is conducted by using EGARCH model. The strength of the study is analysis of the commodity market together with stock and currency markets of Pakistan. Results of the EGARCH model suggests that bidirectional volatility spillover exists between all the bivariate cases of the three markets except in the case of volatility spillover from the currency market to the commodity market.

JEL Classifications: Q43, G10, C13, F31, F36
Keywords: Stock, Currency and Commodity Markets, Volatility Spillover, EGARCH Model

1. INTRODUCTION

Over the last few decades, financial market volatility has been the subject of study for many researchers globally. Increasing integration among major financial markets has focused the attention of academics, researchers, and policy-makers in volatility modelling and analysing the volatility transmission mechanism among major international financial markets. Volatility, in the literature is defined as *instability*, *fickleness*, or *uncertainty*, whether appearing in asset pricing, risk management, or portfolio optimisation (Jamil, 2011). Due to financial liberalisation and globalisation of the world markets, volatility of a certain market may lead to instability or uncertainty in other related markets called volatility spillover (Mishra et al. 2010). True facts and figures of volatility and volatility spillover among financial markets provide huge help for making economic and financial decisions.

In the 1990s, after financial sector reforms, the financial markets of Pakistan have become interdependent. Zapatero (1995) argued that in perfectly integrated and interdependent financial markets, explicit linkages always exist between the volatility of markets. Due to these explicit inter-market linkages, the exchange rate has become more responsive to innovations in the stock market and uncertainty in commodity markets

Muhammad Jamil <mjamil@qau.edu.pk> is Assistant Professor, School of Economics, Quaid-i-Azam University, Islamabad. Hifsa Mobeen <hifsa_mobeen2020@hotmail.com> is MPhil Economics, School of Economics, Quaid-i-Azam University, Islamabad.

(Yang & Doong, 2004). Economists and investors consider gold a safe haven industrial commodity and investment asset (Shahzadi & Chohan, 2011). Likewise, as oil and gold are international commodities and their prices are determined in international markets, volatility of oil and gold prices due to any national or international shock directly affect the exchange rate and its volatility. This may have an indirect impact on stock market volatility as well. Because of uncertainty in financial markets and frequent portfolio switching by investors, volatility in one market can travel to other related markets very easily. Keeping in mind the implications of inter-market linkages, the present study intends to analyse the research hypothesis that bidirectional volatility spillover exists between stock, currency and commodity markets.

Information available through this study can be of great importance for policy makers, investors, market players, and managers. Policy-makers can benefit from this study by understanding the behaviour of the three markets in order to efficiently formulate and implement policies for economic and financial stability. Investors and other market players can use the information available through this study to manage their local and international portfolio risk policies. By managing their exposure to foreign contracts and the exchange rate risk, results of this study can help managers to stabilise their earnings. The intended study is a unique work in the context of Pakistan, jointly analysing the mechanism of volatility transmission between three major markets. In this aspect the presented study is a novel contribution in literature with reference to Pakistan. The next four sections are as follows: Section 2 provides literature review. Section 3 comprises methodology and data. Results, and their detailed discussion are in Section 4 and Section 5 provides the conclusion.

2. LITERATURE REVIEW

Theoretical links between stock prices and the exchange rate can be explained through *Flow Oriented model* and *Stock Oriented model*. The Flow Oriented model provided by Dornbusch and Fischer (1980) suggests that causality runs from exchange rate to stock prices and the exchange rate has a positive impact on stock prices. In the Stock Oriented model provided by Branson (1983), causality runs from stock prices to the exchange rate. This model also suggests a positive relationship between stock prices and exchange rates. According to Dornbusch and Fischer (1980), appreciation (depreciation) of a local currency will decrease (increase) indebtedness of a particular country in terms of foreign currency denominated debts. In other words, the outstanding debts of local companies will be worth less (more) and thus they will have to pay less (more) in terms of the domestic currency. It results in increasing (decrease) a company's net worth and hence stock prices. Stock prices rise when the net worth of a company increases and demand for the company's shares goes up. This in turn pushes up stock prices.[1]

On the other hand, Branson (1983) proposed that a booming stock market of a country attracts domestic as well as foreign investors. Consequently, demand for local currency rises resulting in appreciation of the currency.

[1]Local currency appreciates when foreign investors seeking high returns sell foreign currency for local currency, to buy local stock, which pushes up capital inflows. Thus capital inflow will lead to an appreciation of the local currency.

According to the flow and stock oriented models, a positive relationship exists between stock prices and the exchange rate, which shows that the stock market and currency markets are interlinked. Due to interlinkage of both markets, if the returns volatility of stock (currency) market increases due to any external or internal shock, it will induce volatility in currency (stock) market returns as well.

Gold serves as a safe haven against inflation. Investors become reluctant to invest in the stock market because in periods of uncertainty, returns[2] on stocks fall. When there is instability and uncertainty in an economy, investors withdraw their investments from the stock market and prefer to park their funds in more stable commodities like gold. This pushes demand for gold giving rise to high prices of gold and ultimately high gold returns. High prices of gold will add to inflation in the economy. To reduce inflation, the central bank will set a relatively high interest rate. As interest rates and stock prices have a negative relationship, stock prices and stock returns fall. Negative linkage between gold price returns and stock price returns indicate that the rising volatility in the stock market will lead to volatility of gold price returns to some extent. However, being a safe haven, gold price returns show relatively less volatility.

An increase in oil prices due to any internal or external shock will lead to an increase in oil price returns, making room for the volatility of oil price returns to rise. Demand for other stocks will increase and hence, it will positively affect the volatility of stock returns (Park & Ratti, 2008). Prices of international commodities are determined in international currencies, most usually in US dollars. Therefore, any change in the dollar rate will most likely be transmitted to the prices of international commodities. Therefore, if appreciation in foreign exchange rates takes place, it will result in a rise in prices of imported commodities, including gold and oil in the domestic market. This suggests that a positive relationship exists between the exchange rate and commodity prices for countries importing commodities (Sjaastad & Scacciallani, 1996). The existence of strong positive linkages between currency and commodity markets signals that volatility of exchange rate returns can travel to the commodity market, making commodity price returns also volatile.

Volatility transmission has been examined in different perspectives by researchers in literature. Kanas (2000) examined the long run relationship and volatility spillover among stock returns and exchange rate in six developed countries. Analysis of the study based on Exponential Generalised Autoregressive Conditional Heteroskedasticity (EGARCH) model suggests that a significant long run relationship and volatility spillover exists among stock returns and exchange rate for all the countries. Kalu (2014) reported the bidirectional volatility spillover among stock and currency markets of selected Asian countries using the multivariate Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model. Similar results are postulated by Jebran and Iqbal (2016) for selected Asian countries by using EGARCH model.

In Pakistan, Qayyum and Kemal (2006) conducted the very first study on volatility transmission between stock market and foreign exchange market. The focus of the study was stock and flow oriented models. The Engle-Granger 2-step procedure and bivariate EGARCH model was employed for the analysis of the issue. The same results are postulated by this study; however, no long run relationship among stock market and currency market is reported. Yang and Doong (2004) postulate the same results for developed countries.

[2]Return on prices of a stock can be defined as logarithmic difference between two period prices (Fama, 1965).

However, Khan et al. (2016) have investigated the same subject matter for gold prices and the Karachi stock exchange by using the same data analysis techniques. The conclusion is that gold prices have no relationship with the KSE 100 index. Chen and Rogoff (2003) examine the impact of commodity prices on the exchange rate for Australia, New Zealand and Canada. Results of the OLS technique suggest that the exchange rate is driven by commodity prices. In Pakistan's context, the impact of crude oil prices and gold prices on the exchange rate are also analysed by Jan et al. (2014). Results of OLS and Vector Autoregressive (VAR) models suggest that oil prices affect the exchange rate positively and significantly, whereas the impact of gold prices is negative and significant. Moreover, Park and Ratti (2008) determine the issue of financial contagion and volatility spillover in India. The Dynamic Conditional Correlation (DCC)-GARCH model has been employed to analyse the daily data. It reports volatility spillover from gold, stock and foreign exchange market to the Indian commodity market.

Using Generalise Impulse Response Function (IRF), Generalised Forecast Error Variance Decompositions (FEVD) and VAR models, Masih et al. (2011) suggested that the stock market is significantly affected by oil price volatility in emerging economies. However, Aktham (2004) suggested that there is no significant relationship between oil price shocks and stock market indices of emerging economies. For Gulf Cooperation Council (GCC) countries, volatility spillover across equity markets and the two dominant commodities, gold and oil prices, has been studied by Thuraisamy et al. (2013) using multivariate GARCH model. Results of the study suggested volatility spillover from stock markets to commodity markets in mature markets, whereas in immature markets volatility is transmitted from commodity markets to stock markets. In addition, bidirectional volatility transmission increases during a period of financial crisis. Arouri et al. (2011) report the same results for Asian and GCC countries.

Another study for Pakistan determined the relationship between stock market volatility and macroeconomic variables (Hussain et al. 2015). The macroeconomic variables of inflation, exchange rate, money supply, industrial sector output, and oil prices have been studied in relation to stock market volatility. Monthly time series data has been estimated by employing EGARCH and Autoregressive Distributed Lag (ARDL) models. Analysis of the study revealed that the exchange rate has a positive and significant impact on stock returns volatility (Aliyu, 2012). However, the impact of oil prices is positive but insignificant on the stock returns volatility. Najaf and Najaf (2016) have studied the relationship between gold and oil prices and the Karachi stock exchange. Results of the study suggest that oil prices have an insignificant negative impact on stock returns, whereas gold prices have a positive but insignificant relationship with stock returns. Analysis of the study is carried out by developing a correlation matrix. Opposite results are suggested by Basher and Sadorsky (2006) for emerging economies. International multi-factor is used for data analysis.

This type of analysis, comprising of local market interlinkages can be very interesting and informative through many perspectives. Therefore, deep understanding and a strong analysis of volatility and volatility spillover between local markets is the need of the day for asset price determination, portfolio optimisation, effective policy formulation, and portfolio management in developing countries like Pakistan.

3. METHODOLOGY

In past studies, for the sake of measuring volatility of financial variables, simple measures of volatility i.e. rolling variance of the series have been used. Engle (1982) provided a family of models based on the concept that the time variant nature of a variance follows an autoregressive process. Engle (1982) and Bollerslev (1986) suggested that it would be better to simultaneously model the mean and variance of a series. Bollerslev (1986) argues that the conditional variance of an error term not only depends on past squared values of the error term but also on the variance of the error term. In pure econometric terms, if the ARCH (p, q) model follows the ARMA (p, q) process then it is called a GARCH (p, q) model. The GARCH (p, q) model allows both autoregressive and moving average components in the conditional variance of error term. Autoregressive Conditional Heteroskedasticity Models (ARCH) developed by Engle (1982) are based on the assumption that positive and negative error terms (shocks) have a symmetric effect on volatility because error terms have been taken in square form in the model. However, generally, this assumption is frequently violated in practice and it is often observed as well as reported in literature, that bad news has more impact on volatility relative to good news. In literature this phenomenon has been introduced as the leverage effect by Black (1976). In GARCH type models, it is necessary to show that all estimated coefficients should be non-negative. This means the effect of positive and negative news will be the same on the volatility series of a variable. As a solution, Nelson (1991) has introduced an extension of the GARCH model called EGARCH model. It captures the leverage effect while calculating volatility. A GARCH family model that does not require non-negativity constraints and accounts for the asymmetric effect of news is called EGARCH model. Hamilton (1989) reported that, for quantifying volatility, the EGARCH model is more advantageous than other members of ARCH/GARCH family models are.

Formally, *AR(k)-EGARCH(p, q)* model for calculating returns' volatility of KSE-100 index ($RKSE$), bilateral nominal exchange rate returns' volatility ($REXR$), oil prices returns' volatility (ROP) and gold prices returns' volatility (RGP) variables' data series can be expressed as follows:

$$R_t^x = \alpha_0 + \alpha_1 \sum_{i=1}^{n} R_{t-i}^x + e_t \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (1)$$

$$log(h_t^x) = \omega + \sum_{i=1}^{p} \gamma_j \, log h_{t-j}^x + \sum_{j=1}^{q} \rho_j \left| \frac{\mu_{t-j}}{\sqrt{h_{t-j}}} \right| + \sum_{m=1}^{r} \theta_m \frac{\mu_{t-m}}{\sqrt{h_{t-m}}} \quad \dots \quad (2)$$

The above two equations represents the *AR(k)-EGARCH(p, q)* model. In equation (1) R_t^x represent returns of variable x at time t and $t = 1,2, \dots, T$. R_{t-i}^x is the previous period returns of variable x where, $i = 1,2, \dots, n$. Variable x represents the data series of $RKSE$, $REXR$, ROP and RGP. In Equation (2) $log(h_t^x)$ is the log of variance of variable x which automatically restricts the volatility to be positive. ω is the constant level of volatility. Logarithm of the conditional variance (h_{t-j}^x) on the right hand side imply that the leverage effect is exponential, rather than quadratic, and that forecasts of the conditional variance are guaranteed to be nonnegative without imposing any restriction on the coefficients. The coefficient ρ_j measures reaction of volatility to change in news. We take the residual modulus that measures the relation with respect to positive news.

The coefficient θ_m explains the relationship of volatility to both positive and negative news, because we are not taking modulus. In this paper we employ Schwarz Bayesian Information Criteria (SBIC) for the selection of the orders k, n, p and q in Equation (1) and Equation (2) respectively.

After calculating the volatility of returns, the phenomenon of volatility spillover between stock, currency and commodity markets is captured by using bivariate *AR(k)-EGARCH(p, q)* model. Following Enders (2006), corresponding mean and variance equations used for estimating the volatility spillover are as follows:

$$R_t^x = \alpha_0 + \alpha_1 R_{t-1}^x + \beta_1 R_{t-1}^y + e_t \quad \dots \quad \dots \quad \dots \quad \dots \quad (3)$$

$$log(h_t^x) = \omega + \sum_{i=1}^{p} \gamma_j \, log h_{t-j}^x + \sum_{j=1}^{q} \rho_j \left| \frac{\mu_{t-j}}{\sqrt{h_{t-j}}} \right| + \sum_{m=1}^{r} \theta_m \frac{\mu_{t-m}}{\sqrt{h_{t-m}}} + \pi_y log\left(h_t^y\right) \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (4)$$

Equation (3) is mean equation. In mean equation R_{t-1}^y is representing autoregressive term of returns of variable *y*, where *y* is the second variable from $RKSE$, $REXR$, ROP and RGP variables, for bivariate analysis. For example in mean equation, if *x* is representing returns on oil prices (ROP) then *y* will be KSE-100 index returns ($RKSE$). Equation (4) is representing variance equation. $\pi_y log\left(h_t^y\right)$ is the returns' volatility of variable *y* and π_y is volatility spillover parameter for volatility spillover from variable *y* to variable *x* i.e. from KSE-100 index returns' volatility ($RKSE$) to oil prices returns' volatility (ROP). Explanations of the remaining parameters of the Equations (3) and (4) are same as discussed for the Equations (1) and (2).

4. DATA

In order to investigate the mechanism of volatility transmission across the stock, currency, and commodity markets of Pakistan, daily data comprising five trading days has been analysed. KSE-100 index (KSE) representing the Karachi Stock Exchange market and bilateral nominal exchange rate PKR in terms of USD (EXR) representing the currency market has been analysed. Whereas, gold prices (GP) and oil prices (OP) as a representative of commodity market are being selected.[3] The Time series data sample from August 4, 1997 to August 31, 2016 is used. The reason behind the selection of daily data set is to capture more information than we would be able to with the weekly and monthly data set. A brief summary of all variables is presented in the Table 1.

Returns on stock prices, bilateral nominal exchange rate, oil prices and gold prices is calculated as the first difference of logarithmic values of $LKSE$, $LEXR$, LOP and LGP, respectively. Calculation of returns is being done according to following formula;

$$R_t^x = log(x_t) - log(x_{t-1}) \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (5)$$

Where, R_t^x is returns at time period t of variable x, where x represent the data series of variables $LKSE$, $LEXR$, LOP and LGP. x_t is the value of variable x at time period t

[3]As gold and oil, as a commodity, represent a major portion of commodity market, therefore both are selected as a representative of commodity market (Shahzadi & Chohan, 2011).

Table 1

List and Description of the Variables

Indicator	Notations	Data Source	Description
KSE-100 Index	KSE	www.brecorder.com	KSE-100 index is a capital weighted index, composed of 100 representative companies in terms of market capitalisation. Daily closing stock prices in term of Pak-rupees are taken to represent KSE-100 index.
Exchange Rate	EXR	www.sbp.gov.pk	EXR is a bilateral nominal exchange rate between USD and PKR. It is taken in PKR.
Oil prices	OP	www.eia.gov	OP is Crushing Oklahoma Crude Oil prices per barrel taken in PKR.
Gold prices	GP	www.forex.pk	GP is 24 Karat gold prices taken in Troy Ounce in term of PKR.

Source: Author's own work.

(current time period) and x_{t-1} is value of variable x at time period $t-1$ (previous time period). After computing the returns for all variables data series, volatility of all variables is being calculated by using the *AR(k)-EGARCH(p, q)* methodology.[4]

5. RESULTS

Descriptive statistics of all the variables are presented in Table 2. Panel A of table shows descriptive statistics of logarithmic values of KSE-100 index ($LKSE$), bilateral nominal exchange rate ($LEXR$), oil prices (LOP) and gold prices (LGP). The mean of logarithmic values of all the variables is positive and is significantly different from zero. Panel B shows descriptive statistics of growth rate of KSE-100 index ($RKSE$), bilateral nominal exchange rate ($REXR$), oil prices (ROP) and gold prices (RGP). Mean of growth rate of all variables is positive and is not significantly different from zero. Median, range and standard deviation in both panels reveals that there is no outlier in the data.

Table 2

Descriptive Statistics

	Variable							
	Panel A				Panel B			
Statistics	LKSE	LEXR	LOP	LGP	RKSE	REXR	ROP	RGP
Mean	11197.89	72.35	4491.26	65413.26	0.0006	0.0002	0.0004	0.0005
Median	9429.37	60.81	3831.67	39556.32	0.0010	0.0000	0.0008	0.0004
Max.	40057.52	108.57	11580.65	170950.2	0.128	0.083	0.172	0.965
Min.	765.73	40.47	519.65	12265.97	-0.099	-0.083	-0.171	-0.989
S.D.	10235.47	19.40	3059.22	51863.47	0.014	0.004	0.024	0.023
Skew.	1.137	0.418	0.516	0.523	-0.389	1.004	-0.089	-1.099
Kurt.	3.320	1.727	1.985	1.646	8.632	169.258	7.768	1233.443
J.B.	1026	481	434	607	6702	5733069	4720	31300000

Source: Author's own work.

[4]To support the use of EGARCH model for volatility calculation, significant evidences provided by a number of researchers have been summarised by Hamilton and Susmel (1994).

J.B. test of normality is a test of the joint hypothesis that implies skewness and kurtosis are zero and 3 respectively. Therefore, J.B. statistics are expected to be zero for variable to be normally distributed. To test whether, series of variables are normally distributed or not, null hypothesis is formulated as; H_0: Variable x is normally distributed. Values of J.B. statistics presented in the Table 2 imply that variables are not normally distributed. This is due to the reason that J.B. statistics are significantly greater than zero, which is against the requirement for normality.[5] So H_0 is rejected in case of all variables' J.B. statistics presented in Table 2. It corresponds to the fact highlighted by Mandelbrot (1963), suggesting that all data series have more extreme values and have greater volatility.

The stock market is affected by countless factors. These factors might be internal or external. Among external factors, the exchange rate, and gold and oil prices have remained dominant throughout history. The Karachi stock exchange came into being soon after Independence in 1947, to facilitate the trade of ordinary shares, redeemable certificates, and corporate bonds in the country (Alam & Muzafar, 2014). In 2002, the international magazine 'Business Week' pronounced KSE as the best performing market in the world because of high liquidity and improved administration and management. During the period of global financial crisis 2008 KSE-100 index had declined slightly, however overall performance of KSE remained the least affected relative to the other Asian stock exchange markets.

In Figure 1, KSE is exhibiting increasing trend overall while the series is not showing mean reversion behaviour. Graph of $RKSE$ in Figure 2 revealed mean reversion behaviour indicating that the series is stationary. Graph of volatility of $RKSE$ series in Figure 3 is characterised by random changes and is volatile till the start of 2010. The volatility seems to change over time as well. However, the series has experienced a somewhat calm period from 2010 to onward. According to an edition of Quartz,[6] KSE is declared as 5th best performing market in the world in July 20, 2016 (Karnik, 2016). Plot of $RKSE$ and volatility of $RKSE$ is showing volatility clustering[7] during 1998 only. In 1998, due to the nuclear test and economic sanctions, market capitalisation fell.

The plot of *EXR* against time in Figure 7 is displaying a constant increasing trend and the series is not showing mean reversion behaviours. However, *REXR* graph in Figure 8 has displayed a mean reversion behaviour indicating that the series is stationary. In Figure 9, the plot of volatility of *REXR* series displays random changes and is volatile overall. However, *REXR* has experienced a somewhat tranquil period from mid-2001 to 2007(Musharraf's rule, 1999 to 2007). This was due to heavy remittance inflow and foreign direct investment during this period. Volatility clustering has been experienced by *REXR* and volatility of *REXR* in the period of nuclear explosion (1998) and financial crisis (2008).

[5]If the J. B. statistics are very low i.e. significantly different from zero we reject the null hypothesis. However, if the J.B. statistics are close to zero we cannot reject (accept) the null hypothesis **(**Gujarati and Porter, 2009)**.**

[6]Quartz is an Indian, digital magazine of global business news publication.

[7]Period of high volatility followed by period of high volatility and period of low volatility followed by period of low volatility, of either sign (Mandelbrot, 1963).

Fig. 1. Distribution of KSE-100 Index

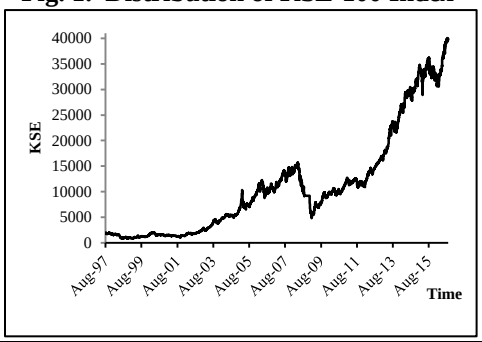


Fig. 2. Distribution of RKSE

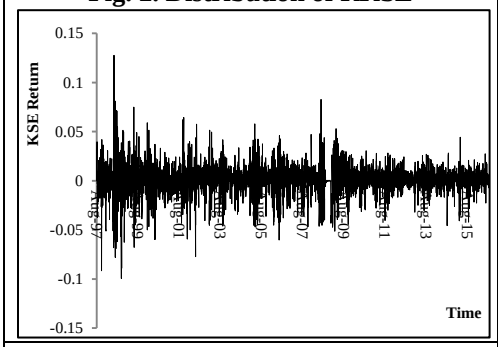


Fig. 3. Distribution of Volatility of RKSE

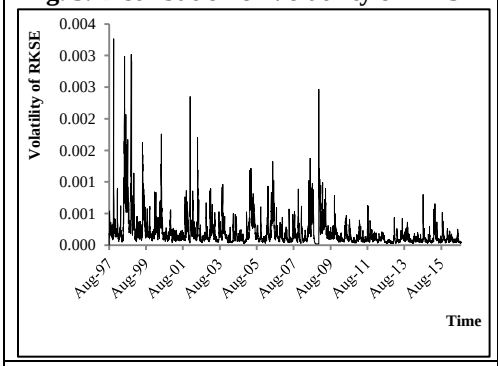


Fig. 4. Distribution of OP

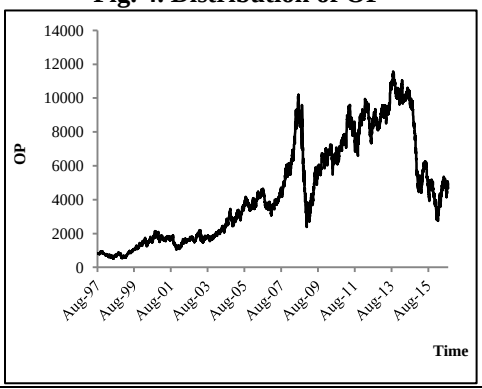


Fig. 7. Distribution of EXR

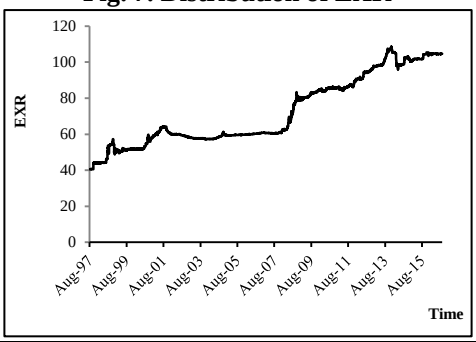


Fig. 8. Distribution of REXR

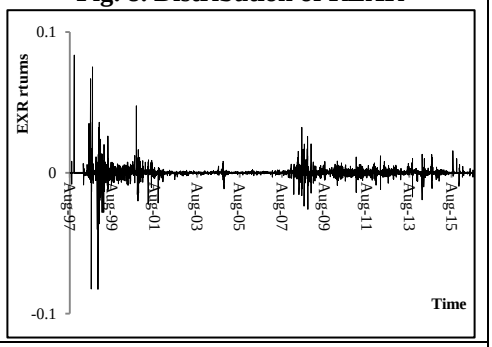


Fig. 9. Distribution of Volatility REXR

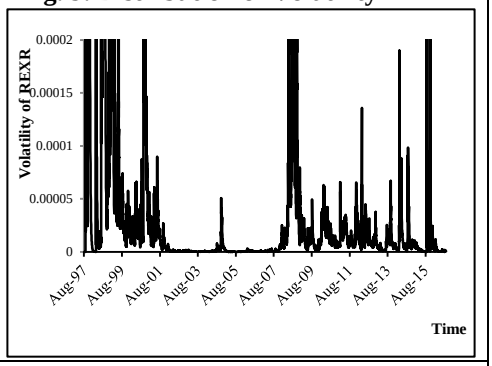


Fig. 10. Distribution of GP

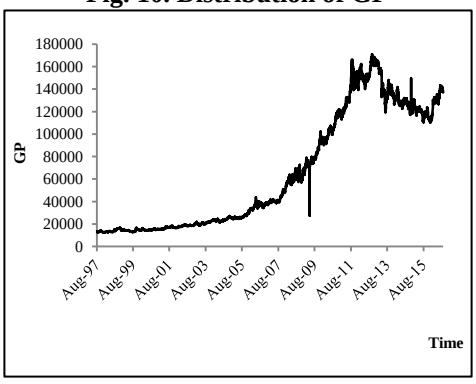


Fig. 5. Distribution of ROP

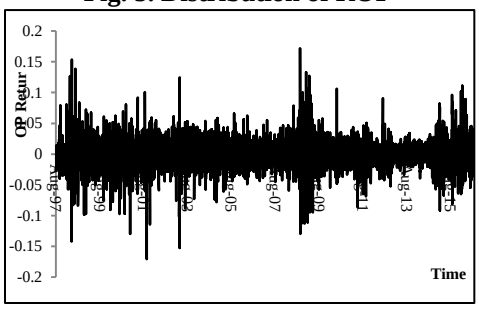


Fig. 11. Distribution of RGP

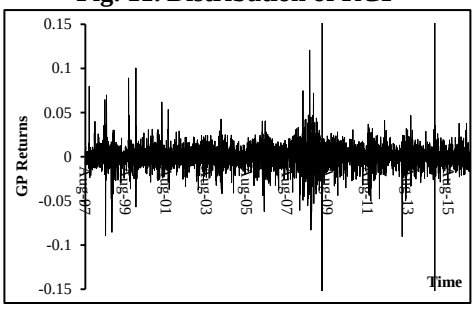


Fig. 6. Distribution of Volatility of ROP

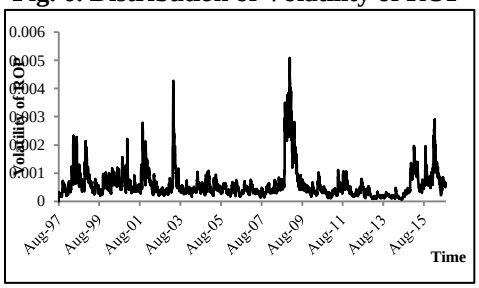
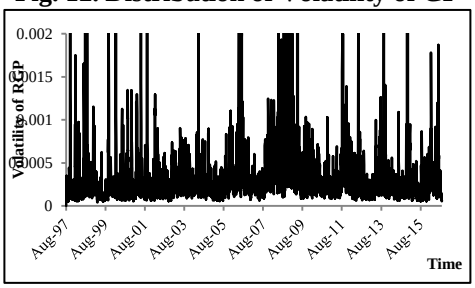


Fig. 12. Distribution of Volatility of GP



Historically, huge volatility has been observed in oil prices. However, *OP* series in Figure 4 is displaying a steady rising trend from start of the sample period till the end of 2007. The main reasons for rising oil prices were tension in the Middle East, high demand for oil from the Chinese economy, and declining oil reserves. A sudden upward surge is observed in 2008, due to the global financial crisis. *OP* series is not showing mean reversion behaviours whereas the plot of *ROP* is revealing mean reversion behaviour in Figure 5. The plot of volatility of *ROP* series in Figure 6 displays random changes and is observed as volatile overall. However, volatility of *ROP* series has exhibited a somewhat tranquil period from 2003 to 2007 and from 2010 to 2014. Aktham (2004) said that this was due to the declining value of the US dollar from 2001 to 2003. During the global financial crisis a significant jump is depicted in the *ROP* volatility series. Volatility clustering is observed in the period of nuclear explosion and financial crisis in the graph of *ROP* as well as in the graph of volatility of *ROP*.

Gold serves as a commodity as well as an investment tool (Johnson & Soenen, 1997). In Figure 10, graph of *GP* presents a smooth upward trend till the third quarter of 2008. In the fourth quarter of 2008 a sudden downward jump is observed (due to the financial crisis). After that the *GP* series again depicted an upward trend till 2012, and then a very slight down trend till 2014. In October 2012, gold prices peaked and then again revealed a gradual declining trend due to a rise in the supply of gold. From the end of 2014 onward *GP* revealed a rising trend, overall. Mean reversion behaviour has not been shown by *GP*. However, *RGP* exhibited mean reversion behaviour in figure 11. Graph of volatility of *RGP* presented in Figure 12 is characterised by random changes and is observed as volatile throughout the sample period. The main driving forces behind volatile gold prices are bouncing oil prices and the rising value of the US dollar. Volatility clustering is observed in the period of financial crisis (2008) in the graph of *RGP* as well as in volatility of *RGP*.

Before checking stationarity of the data, lag order for all the variables is checked according to the Schwarz Bayesian Information Criterion (SBIC). According to SBIC, lag order of *LKSE* is significant until the second lag, and lag length of *LEXR* and *LGP* are significant till the third lag. However, the lag order of *LOP* is significant at level. In the next step, in order to examine the stationarity of the data, Augmented Dickey and Fuller and Philips and Perron unit root tests are applied on each variable's data series included in the analysis.

Table 3

Results of Unit Root Tests

	ADF-test		PP-test		
Variables	Level	First Difference	Level	First Difference	Order of Integration
LKSE	0.131	–44.437***	–0.039	–64.242***	I(1)
LEXR	–1.449	–43.478***	–1.422	–68.275***	I(1)
LOP	–1.687	–70.102***	–1.671	–70.174***	I(1)
LGP	–0.652	–53.774***	–0.605	–125.615***	I(1)

Source: Author's own calculations.

Note: –3.431482, –2.861925 and –2.567018 are critical values at 1 percent, 5 percent and 10 percent level of significance, respectively. Whereas, ***, ** and * indicate significance at 1 percent, 5 percent and 10 percent level of significance, respectively.

According to ADF and PP test null hypothesis that series have unit root is accepted at level, indicating that *LKSE, LEXR, LOP* and *LGP* have non-stationary at level. However, null hypothesis at first difference is rejected for all data series by the both tests, demonstrating that all variables' data series have no unit root at first difference. Stationarity of all data series at first difference implies that series are integrated of order one I(1).

The mechanism of volatility transmission between stock, currency and commodity market is captured by employing the bivariate *AR(k)-EGARCH(p, q)* model. Before applying the bivariate *AR(k)-EGARCH(p, q)* model, the underlying variables that are returns on KSE-100 index ($RKSE$), returns on bilateral nominal exchange rate ($REXR$), returns on oil prices (ROP) and returns on gold prices (RGP), have been examined for possible existence of the ARCH effect. The ARCH effect is applied to check for the presence of issues of autocorrelation and heteroskedasticity in the data set of all variables series. For this purpose, ARCH effect for the returns of all variables series has been checked by applying Breusch and Pagan test. The possible existence of ARCH effect, in all the underlying variables, is confirmed by resultant significant chi-square value. Hence, EGARCH model can be applied successfully. A suitable lag order for each bivariate *AR(k)-EGARCH(p, q)* model is determined on the basis of SBIC. Results of volatility spillover are reported in Table 4.

In Table 4 variance equation results are presented regarding volatility transmission between stock, currency and commodity markets of Pakistan. Estimated results of volatility transmission from $RKSE \rightarrow REXR$ and $REXR \rightarrow RKSE$ suggests that the volatility spillover parameter (π) is positive and significant at 1 percent level of

significance. The magnitude of volatility transmission from $RKSE \rightarrow REXR$ is 0.065, which is greater than the magnitude of volatility transmission from $REXR \rightarrow RKSE$ which is 0.009. The magnitude of volatility transmission between both the markets is significant and positive. However, if magnitude of both pairs of markets are compared it can be inferred that the stock market has a dominant role in transmitting volatility to the currency market relative to the opposite case. It implies that increase in volatility of KSE-100 index returns (stock market) leads to increase in volatility of bilateral nominal exchange rate returns (currency market). From the above reported results, it can be concluded that a positive and significant bidirectional volatility spillover exists between the stock market and the currency market. The same results are confirmed by Qayyum and Kemal (2006) for Pakistan and selected Asian countries, respectively.

In panel B of Table 4, estimated results of volatility transmission from $RKSE \rightarrow ROP$, from $RKSE \rightarrow ROP$, from $RKSE \rightarrow RGP$ and from $RGP \rightarrow RKSE$ are reported. It suggests, that the volatility spillover parameter ($\boldsymbol{\pi}$) is positive and significant at 1 percent level of significance however, for $RGP \rightarrow RKSE$ volatility spillover parameter ($\boldsymbol{\pi}$) is significant at 5 percent level of significance. It depicts that bidirectional volatility spillovers exist between KSE-100 index returns' volatility (stock market) and oil prices returns' volatility (commodity market), and between KSE-100 index returns' volatility (stock market) and gold prices returns' volatility (commodity market). Kang and Yoon (2014) reported the same results for Asian countries, and Arouri et al. (2011) for GCC countries.

The magnitude of volatility transmission from $RKSE \rightarrow ROP$ is 0.009, which is less than the magnitude of volatility transmission from $ROP \rightarrow RKSE$, which is 0.036. However, as the magnitude of volatility transmission from $ROP \rightarrow RKSE$ is greater than that of the magnitude of volatility transmission from $RKSE \rightarrow ROP$, a statement can be made that volatility of the commodity market has a dominant role in volatility transmission to stock market. The magnitude of volatility transmission from $RKSE \rightarrow RGP$ is 0.943 which is greater than the magnitude of volatility transmission from $RGP \rightarrow RKSE$ which is 0.009. However, as the magnitude of volatility transmission from $RKSE \rightarrow RGP$ is greater than magnitude of volatility transmission from $RGP \rightarrow RKSE$, it can be inferred that volatility of stock market has a dominant role in transmitting volatility to the commodity market. Jaiswal and Varonina (2011) supported the same results.

In panel C of Table 4, results of volatility transmission from $REXR \rightarrow ROP$, from $ROP \rightarrow REXR$, from $REXR \rightarrow RGP$ and from $RGP \rightarrow REXR$ are presented. It suggests, that volatility spillover parameter (π) is insignificant for $REXR \rightarrow ROP$. This result is also reported by Arezki et al. (2012) for South Africa. It implies that volatility spillover does not exist from volatility of $REXR$ (currency market) to ROP volatility (commodity market). Whereas, volatility spillover parameter (π) for the volatility transmission from $ROP \rightarrow REXR$, from $REXR \rightarrow RGP$ and from $RGP \rightarrow REXR$ is significant at 1 percent level of significance. It depicts that there exists bidirectional volatility transmission between all the pairs of two markets except for the case of volatility spillover from $REXR \rightarrow ROP$ where unidirectional volatility spillover exists. However, volatility spillover parameter (π) for $RGP \rightarrow REXR$ is negative implying that increase in volatility of RGP causes volatility of $REXR$ to decrease.

Table 4

Volatility Spillover between Stock, Currency and Commodity Markets

$$log(h_t^x) = \omega + \sum_{i=1}^{p} \gamma_j \, log h_{t-j}^x + \sum_{m=1}^{r} \theta_m \frac{\mu_{t-m}}{\sqrt{h_{t-m}}} + \sum_{j=1}^{q} \rho_j \left| \frac{\mu_{t-j}}{\sqrt{h_{t-j}}} \right| + \pi_y log h_t^y$$

Panel A: Volatility Spillover between stock market and currency market		
Coefficients	RKSE → REXR	REXR → RKSE
ω	–0.029***	–0.752***
	(–2.81)	(–6.94)
γ_1	0.955***	0.913***
	(689.55)	(7.44)
γ_2		0.017
		(0.15)
ρ_1	0.640***	0.430***
	(53.75)	(23.70)
ρ_2	–0.474***	–0.107***
	(–43.01)	(–2.83)
θ	0.013**	–0.078***
	(3.77)	(–6.62)
π	0.065***	0.009***
	(39.99)	(3.62)
SBIC	–9.005	–6.051
AR(k)-EGARCH(p,q)	*AR(1)-EGARCH(1,2)*	*AR(1)-EGARCH(2,2)*

Panel B: Volatility Spillover between stock market and commodity market				
Coefficients	RKSE → ROP	ROP → RKSE	RKSE → RGP	RGP → RKSE
ω	–0.193***	–0.649***	–7.226***	–0.751***
	(–8.09)	(–7.50)	(–88.81)	(–6.55)
γ_1	0.981***	0.827***	–0.853***	0.923***
	(377.45)	(6.44)	(–375.94)	(7.39)
γ_2		0.099		0.012
		(0.83)		(0.10)
ρ_1	0.167***	0.423***	0.157***	0.441***
	(18.21)	(20.99)	(79.18)	(24.46)
ρ_2		–0.061		–0.114***
		(–1.41)		(–2.89)
θ	–0.056***	–0.085***	–0.0002	–0.077***
	(–10.25)	(–7.18)	(–0.096)	(–6.79)
π	0.009***	0.036***	0.943***	0.009**
	(4.19)	(5.11)	(120.03)	(2.26)
SBIC	–4.829	–6.061	–5.532	–6.051
AR(k)-EGARCH(p, q)	*AR(1)-EGARCH(1,1)*	*AR(1)-EGARCH(2,2)*	*AR(1)-EGARCH(1,1)*	*AR(1)-EGARCH(2,2)*

Panel C: Volatility Spillover between currency market and commodity market				
Coefficients	REXR → ROP	ROP → REXR	REXR → RGP	RGP → REXR
ω	–0.225***	–0.022***	0.079***	–0.658***
	(–8.42)	(–3.75)	(23.48)	(–78.97)
γ_1	0.983***	1.005***	1.005***	1.006***
	(391.22)	(2270.09)	(9537.44)	(2686.82)
ρ_1	0.168***	2.199***	0.071***	0.955***
	(18.72)	(136.19)	(79.23)	(93.13)
ρ_2		–1.832***		–0.589***
		(–121.23)		(–63.26)
θ	–0.054***	–0.084***	0.005***	0.137***
	(–9.99)	(–34.16)	(5.91)	(53.01)
π	0.002	0.015***	0.006***	–0.060***
	(1.31)	(16.01)	(20.04)	(–67.02)
SBIC	–4.827	–9.268	–5.629	–9.707
AR(k)-EGARCH(p, q)	*AR(1)-EGARCH (1, 1)*	*AR(1)-EGARCH (1, 2)*	*AR(1)-EGARCH (1, 1)*	*AR(1)-EGARCH (1, 2)*

Source: Author's own calculations. Note: Values in parenthesis are z-Statistics. Whereas, ***, ** and * indicate level of significance at 1 percent, 5 percent and 10 percent, respectively.

Nair, et al. (2015) reported similar results for India. The magnitude of volatility transmission from $REXR \rightarrow ROP$ is 0.002 which is insignificant and less than the magnitude of volatility transmission from $ROP \rightarrow REXR$ which is 0.015 and significant. The magnitude of volatility transmission from $REXR \rightarrow RGP$ is 0.006 that is less than the magnitude of volatility transmission from $RGP \rightarrow REXR$ which is 0.060. Between both pairs of markets, magnitude of volatility transmission is significant. But in case of $RGP \rightarrow REXR$ magnitude of volatility transmission is negative. It means that increase in volatility of currency market causes increase in volatility of commodity market. However, a rise in volatility of commodity market induces low volatility in currency market. As magnitude of volatility transmission from $RGP \rightarrow REXR$ is greater than magnitude of volatility transmission from $REXR \rightarrow RGP$, it can be inferred that volatility of RGP (commodity market) has a dominant role in transmitting volatility to returns' volatility of bilateral nominal exchange rate $REXR$ (currency market). Hegerty (2016) for Indonesia, Chile and Philippines also suggests similar results.

6. CONCLUSION

Over the last few decades, financial markets volatility is the subject matter of many researchers in the world. In the 1990s, after financial sector reforms in Pakistan, major markets of the country have become more interdependent. Zapatero (1995) argued that in perfectly integrated and interdependent financial markets, explicit linkages always exist among the volatility of markets.

Keeping in view the importance of these issues, the objective of this study is to investigate the magnitude and mechanism of volatility transmission between stock, currency, and commodity markets of Pakistan. Hypothesis of the study is tested by applying bivariate EGARCH model on daily data of KSE-100 index, bilateral nominal exchange rate, oil prices and gold prices. According to the results provided by the EGARCH model, bidirectional positive volatility spillover exists between all the possible pairs of the three markets except in the case of volatility spillover from bilateral nominal exchange rate returns' volatility to oil prices returns' volatility. Whereas, in the case of volatility spillover from gold prices returns' volatility to bilateral nominal exchange rate returns' volatility, spillover parameter is negative.

For further research it is recommended that analysis of volatility transmission should be done by using more comprehensive models. Regime switching models (like MCMS model, SWARCH model, SWGARCH model etc.) are more comprehensive models in which a variety of mechanisms of volatility transmission can be studied in detail. Moreover, the same research can be extended for panel data analysis, as less body of literature is available in this regard.

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© *The Pakistan Development Review*
60:1 (2021) pp. 65–84
DOI: https://doi.org/10.30541/v60i1pp.65-84

Modelling Foreign Exchange Risk in a Managed Float Regime: Evidence from Pakistan

JAMSHED Y. UPPAL and SYEDA RABAB MUDAKKAR

We study the implications of the exchange rate regimes (managed vs. floating) for implementing risk assessment models using Pakistan data; the country seems to manage its currency mainly against the US dollar, but to a lesser extent against other hard currencies. We test five variations of the Value-at-Risk (VaR) model, including models based on the Extreme Value Theory (EVT). Our results indicate that these models do not perform as well for the currency pairs with the managed float (USD/PKR and JPY/PKR). It implies that the managed float regime imposes additional risk and cost on economic agents. The findings of this paper provide additional support for following a free float policy, and underscore the importance of the role the exchange rate regime plays in facilitating management of risk by economic agents.

Keywords: Value at Risk, Risk Management, Managed Float, Extreme Value Theory.

1. INTRODUCTION

Since the abandonment of fixed rate regimes with the Smithsonian Agreement in 1973, the dominant view among economists is that floating exchange rates, wherein a currency's value is allowed to fluctuate according to the foreign exchange market, are preferable to fixed exchange (FX) rates (see Appendix A for definitions). However, economic policy makers may prefer fixed exchange rates as they may bring in greater short-term stability, while free-floating exchange rates increase foreign exchange volatility. This is an important consideration especially for emerging economies, which typically face three conditions: (i) their liabilities are denominated in foreign currencies while their assets are in the local currency, (ii) their financial systems are fragile, and (iii) bank and corporate balance sheets are vulnerable to exchange rate deterioration. For these reasons, emerging countries exhibit a *fear of floating* (Calvo and Reinhart, 2002). Therefore, even though officially following the free-float regime, a central bank will occasionally intervene in the currency market to stabilise its value, and thus manage the float. Consequently, the number of countries that manage the float increased significantly during the 1990s, and currently a majority of the world's currencies are on managed float, aka *dirty float*.

However, the environment of managed float regimes has rendered the management of foreign exchange risk, using models such as the Value at Risk (VaR), more

Jamshed Y. Uppal <uppal@cua.edu> is Associate Professor, The Catholic University of America, USA. Syeda Rabab Mudakkar <r.mudakkar@gmail.com> is Assistant Professor, Lahore School of Economics, Lahore.

challenging for a number of reasons.[1] Firstly, "… there are substantial and systematic differences in the behaviour of real exchange rates under these two nominal exchange rate regimes;" Mussa (1986). Genberg and Swoboda (2004) document that the "properties of the frequency distribution of changes in exchange rates are different in countries that announce that they are following a fixed exchange rate regime compared to countries that are officially floating." More importantly, the authors note that the properties of the tails of the distributions are different for the two foreign exchange regimes, i.e., the *de jure* fixed category contains a higher frequency of large exchange rate changes (of either sign) compared to the *de jure* float category. There is also a growing divergence between the *de facto* and *de jure* exchange rate regimes followed by the central banks; most countries follow a *dirty float*, which makes it more difficult to implement risk models.

Second, as Engel and Hakkio (1993) explain, the system of fixed but adjustable rates introduces a new kind of volatility: volatility caused by the expectations of exchange rate realignments. By eliminating the market's uncertainty about the future exchange rate, a system of absolutely fixed exchange rates reduces *normal* volatility. However, when the rates are fixed but adjustable and the market knows that realignment may occur, the speculation around the magnitude and timing of the realignment will exacerbate exchange rate volatility. Therefore, between realignments, exchange rate volatility will tend to be within normal limits, but around the time of realignments, it can be extreme. If the equilibrium rate continues to trend upward or downward, then the incidence of realignment increases, and with it the incidence of extreme volatility also increases.

Third, at a more fundamental level, the empirical return distributions of financial assets are found to be fat tailed and skewed in contrast to the Normal Distribution as assumed in the theoretical models. An extensive literature in finance (e.g., Nassim Taleb's *The Black Swan*) underscores the importance of rare events in risk management, which materialise as large positive or negative investment returns, a stock market crash, major defaults, or the collapse of risky asset prices. Therefore, in order to model foreign exchange risk we need to address the issue of extreme observations or heavy tails of distributions. In response, VaR risk measures based on the *Extreme Value Theory* (EVT) have been developed which allow us to model the tails of distributions and to estimate the probabilities of extreme movements in the financial markets. The basic idea behind EVT is that in applications where one is concerned about the risk of extreme loss, it is more appropriate to model the tails of the return distribution separately.

Our objective in this paper is to examine the question of whether the empirical exchange rate distributions in the managed float regime (i.e., against US Dollar in Pakistan, or the Yen in Japan) would be more or less amenable to risk modelling, than for the currencies (i.e., Pound, Euro, and Euro) not so managed. Our research addresses this question by comparing various Value-at-Risk models applied to the four exchange rates, employing back-testing techniques and examining the incidence of actual losses exceeding those predicted by the risk models. Although a number of research papers address the merits and demerits of the two exchange rate regimes, the choice of the

[1]Value at Risk (VaR) is the most widely used measure of market risk, which is defined as the maximum possible loss to the value of financial assets with a given probability over a certain time horizon.

regime also affects risk management practices. This aspect has not received as much attention in prior research.

Pakistan offers an instructive case study in two aspects. First, because of the particular foreign exchange regime followed by the country where the US Dollar (USD) is the main currency being managed, while other currencies are not, and the exchange rates are being dictated by the cross-rates. Pakistan has pursued different exchange rate regimes in its history spanning the last 70 years.[2] Following the worldwide trend of deregulation and liberalisation, Pakistan opted out of the fixed exchange rate regime and floated the rupee against a basket of sixteen currencies under a managed exchange rate regime in 1982. After a short period (1998-2000) of experimentation with the two tier system and dirty float, in July 2000 the SBP officially moved away from the managed exchange rate to a floating exchange rate regime. However, Pakistan is categorised as a managed floater per its official pronouncements. IMF's *de facto* classification of exchange rate regimes, as of July 31, 2006, notes that, "the regime operating *de facto* in the country is different from its *de jure* regime," and categorises Pakistan as following "other conventional fixed peg arrangements". A study by Rajan (2012) examining the exchange rate regimes in Asian countries over 1999-2009 period finds that, "Pakistan seems to operate rather *ad hoc* adjustable pegs." It, however, finds insufficient evidence for the existence of any systematic exchange rate fixity, but notes a high degree of influence of the US dollar and negligible influence of other currencies for Pakistan, suggesting that the country manages its currencies against the US dollar. Since the country seems to manage float primarily against the dollar as compared to other currencies, we may compare the performance of the risk models against different exchange rates.

Second, the country has suffered a series of economic shocks ranging from ongoing incidents of terrorism to natural floods in recent years. Worsening economic conditions in the country, deteriorating law and order situation, energy crisis and terrorism, have led to steady depreciation in the value of the rupee. Unsettled political issues, uncertainties surrounding the flow of foreign aid, combined with weak macro-economic management have not provided ideal circumstances for the execution of a managed float regime. During the last decade, the financial markets have experienced high volatility and incidence of extreme returns. For example, following the global financial crisis of 2007-09 (GFC), the Pakistani Rupee depreciated by 23 percent against US Dollar. Thus, the country provides us with a large number of extreme observations, which need evaluation using risk models based on the Extreme Value Theory.

2. EXCHANGE RATE RISK MODELS

The use of the VaR model has become standard practice with the introduction of J.P. Morgan's RiskMetrics™ in 1994 and the Basle II agreement in 2004, which is based on the empirical distributions of short-term asset returns. Boothe and Classman (1987) provide a comprehensive survey of the theoretical and empirical work on the unconditional distribution of foreign exchange rate returns. There is extensive evidence that the empirical distributions of foreign currency returns are fat-tailed. Koedijk et al. (1990) suggested using Extreme Value Theory to model exchange rate return based on

[2] See Janjua (2007) for details on the history of exchange rate regimes in Pakistan.

their analysis of EMS rates. Therefore, an integration of the EVT with the VaR models is a logical extension. Yet, in practice EVT based risk models have not been widely adopted.

With respect to emerging markets, various academic studies establish the applicability of the VaR models. For example, Al-Janabi (2006) demonstrates the management of trading risk exposure of foreign-exchange securities in the Moroccan market. Hooy, Tan, and Nassir (2004) document the significant impact of exchange-rate exposure on the Malaysian banks; they find that the severity of exchange-rate risk remained constant before and after financial crisis. Nath and Reddy (2003) apply three different VaR models to the FOREX market in India including a tail-index model based on EVT. They, however, find that most of the models are failing in a rolling window framework; while the full sample data overestimates the VaR. Ajili (2008) assesses the exchange risk associated with the Tunisian public debt portfolio using delta-normal VaR application, and demonstrates that the VaR approach can be used for a small developing economy. Mapa, et al. (2010) propose a method of formulating VaR using the Generalised Pareto Distribution (GPD) with time-varying parameters. They test the proposed model for the Philippine Peso-US Dollar exchange rate over 1997-2009 and show that the models were better-performing in predicting losses from exchange rate risk, and have potential as part of the VaR modelling. Wang, et al. (2010) apply EVT to estimate the tails of the Chinese Yuan (CNY) exchange rates against major currencies and measured risk using VaR and Expected Shortfall techniques. Similarly, de Jesus (2013) measured Value-at-Risk of peso/dollar exchange rates using EVT. Purevsuren (2010) illustrates how EVT can be used to model tail-related risk measures and tests the methods using out-of-sample analysis for a portfolio consisting of four Mongolian foreign exchange rates. Akbar and Chauveau (2009) did a study related to measuring risk of the FOREX market in Pakistan. The authors apply historical simulation, Monte Carlo simulation and delta-normal VaR technique to assess exchange rate risk exposure of the public debt portfolio of Pakistan.

The above mentioned studies have examined how far the VaR models can be efficacious in managing foreign exchange risk. We focus on whether these models perform better or worse for the Pakistan Rupee against foreign currencies when either of the currencies in the pair are under managed float (USD or JPY), versus other currencies (GBP or EUR) which are not being so managed.

3. MODELS, DATA AND METHODOLOGY

The study evaluates exchange rate risk of Pakistani Rupee (PKR) based on the Value-at-Risk (VAR) models against four major trading currencies, i.e. US Dollar (USD), European Euro (EUR), British Pound (GBP) and Japanese Yen (JPY) for the period January 1999 to August 2017. Data is obtained from Datastream ©Thomson Reuters database. The four currencies are selected based on their predominance in foreign exchange transactions (accounting for almost 95 percent of both payments and receipts). The sample period of about 19 years consists of 4822 to 4841 daily observations for the four exchange rates. The time span starts after the Asian currency crisis of the late 1990's and just before the country moved to adopt the current foreign exchange regime. The "returns" are measured as the first log differences of the exchange rate series i.e.:

$R_{t,EUR} = \ln((EUR/PKR)_t / (EUR/PKR)_{t-1})$
$R_{t,USD} = \ln((USD/PKR)_t / (USD/PKR)_{t-1})$
$R_{t,GBP} = \ln((GBP/PKR)_t / (GBP/PKR)_{t-1})$
$R_{t,JPY} = \ln((JPY/PKR)_t / (JPY/PKR)_{t-1})$

The purpose of converting exchange rates into geometric returns is to achieve stationarity, which is confirmed by the results of the Ducky Fuller tests as reported in Table 1. It should be noted that US Dollar and the British Pound are classified as *free-float* currencies while the Japanese Yen is considered a managed float currency.

Table 1

Augmented Ducky Fuller Unit Root Test

R_t	EUR	USD	GBP	JPY
t-Statistic	–68.687	–61.057	–70.952	–53.547
Probability	0.0001***	0.0001***	0.0001***	0.0001***

The null hypothesis assumes that the series has a unit root and *** indicates rejection of null hypothesis at 1 percent level of significance.

3.1. Value at Risk and Conditional Volatility

Value at Risk (VaR) is a high quantile (typically the 95th or 99th percentile) of the distribution of returns and provides an upper bound on tails of returns distribution with a specified probability. However, classical VaR measures based on the assumption of normal distribution of the financial asset underestimate risk as the actual return distributions exhibit heavier tails. One alternative to deal with the non-normality of the financial asset distributions has been to employ historical simulation methodology that does not make any distributional assumptions and the risk measures are calculated directly from past-observed returns. However, the historical approach still assumes that the distribution of past returns will be stable in the future. Another approach is to use Extreme Value Theory (EVT) to construct models which account for such thick tails as are empirically observed.

Although EVT is an appropriate approach for modelling the tail behaviour of stock returns, the assumption of constant volatility is contradicted by the well documented phenomenon of volatility clustering i.e., large changes in asset values are followed by large changes in either direction. Hence, a VaR calculated in a period of relative calm may seriously underestimate risk in a period of higher volatility.[3] The time varying volatility was first modelled as the ARCH (q) process (Bollerslev, et al. 1992) which relates time t volatility to past squared returns up to q lags. The ARCH (q) model was expanded to include dependencies up to p lags of the past volatility. The expanded models, GARCH (p,q) have become the standard methodology to incorporate dynamic volatility in financial time series; see Poon & Granger (2003). Similarly the auto-correlation of returns is significant in many situations and there is also a need to incorporate the ARMA (m,n) structure in the model.

[3]See Hull & White (1998). Acknowledging the need to incorporate time varying volatility VaR models employ various dynamic risk measures such as the Random Walk model, the GARCH, and the Exponentially Weighted Moving Average (EWMA).The Riskmetrics model uses the EWMA.

Our preliminary checks on the data lead us to identify different dynamic processes for the four currencies (see next section for details). The choice of the models is based on the principle of parsimony, and is supported by an examination of the standardised residuals extracted from the models.

Currency	*Model Specification*
EUR	AR(1)-GARCH (1,1)
USD	AR(2)-GARCH (1,1)
GBP	AR(1)-GARCH(1,2)
JPY	AR(1)-GARCH(2,1)

3.2. Applying Extreme Value Theory

After applying the appropriate GARCH(*p*,*q*) models to the four series, the residuals from each model are extracted. The next step is to model the tails of the innovation distribution Z_t of these residuals, using the Extreme Value Theory, as explained in the Appendix B. The estimation of the GPD parameters, ξ and β is made using the method of maximum likelihood. Finally the estimated dynamic or conditional VaR equation (see Appendix B) is: $\hat{x}_q^t = \widehat{\mu_{t+1}} + \hat{z}_q \widehat{\sigma_{t+1}}$. We run five different VaR models as have been suggested in the literature, as follows:

(i) Conditional EVT, a VaR model based on EVT and incorporating GARCH) effects;
(ii) Conditional Normal, a VaR model based on Normal Distribution, and incorporating GARCH effects;
(iii) Conditional-t, a VaR model in which in which GARCH effects are incorporated and innovations are assumed to have a Student's-t Distribution;
(iv) Unconditional EVT method, a VaR model based on Extreme Value Theory but GARCH effects are not incorporated;
(v) Unconditional Normal, a VaR model in which data are assumed to be normally distributed and GARCH effects are not incorporated.

The first three models incorporate the dynamics of volatility, the GARCH effect. Models (i) and (iv) make use of the Extreme Value Theory. Model (iii) offers an alternative to the EVT approach by employing the t-distribution when innovations may have a leptokurtic distribution. Thus, the five models allow us to draw comparisons as to the efficacy of different models for risk assessment and management.

3.3. Back-testing

After applying the five VaR models, we back-test the models on a historical series of log-returns $\{x_1, x_2, \ldots\ldots, x_n\}$. We calculate $\hat{x}_q^t$ on day *t* in the set *T={m,m+1,.....,n-1}* using a time window of *m* days each time. Similar to McNeil and Frey (2000), we set *m*=1000, but we consider 50 extreme observations from the upper tail of the innovation distribution i.e., we fix *k*=50 each time. On each day $t \in T$, we fit a new GARCH(*p*,*q*) model for the four foreign exchange returns series and determine a new set of GPD parameter estimates. We compare $\hat{x}_q^t$ with x_{t+1} for three quantile levels, $\in \{0.95, 0.975, 0.99\}$, for the four exchange rate series. A violation is said to occur whenever $x_{t+1} > \hat{x}_q^t$. We then apply a one-sided binomial test based on the number of violations for assessing the model's adequacy.

4. EMPIRICAL RESULTS AND DISCUSSION

Table 2, panel (a) provides the descriptive statistics of the four exchanges rates series, which may help to understand the extent of depreciation of the rupee against other currencies. Note that, since we are stating the exchange rate as rupees per unit of foreign currency, a positive change represents a loss in the value of rupee. However, since the series are not stationary the statistics have limited usefulness. The PKR's relative value over time is better conveyed by Figure 1, which plots the exchange rates relative to their value at the beginning of the study period. It can be seen that the PKR value showed a long-term decline against the dollar, but is marked by periods where its value was rather stable or was 'managed.' Other currencies, show mixed periods of appreciation or depreciation but the general long-term trend is that of a depreciating rupee. Panel (b) of Table 2 shows descriptive statistics of the return series. The mean for all series is positive, which reflects over the period devaluation of PKR with respect to the hard currencies. PKR's devalued relatively more against the Yen, and to a lesser degree against the British Pound. The mean and the maximum appreciation and depreciation of the Pakistani Rupee on a day-to-day basis are almost similar against all four currencies. The maximum one-day fall of Rupee against the Euro, Pound and Dollar is around 4 percent whereas against the Yen the maximum one-day depreciation is 8 percent.

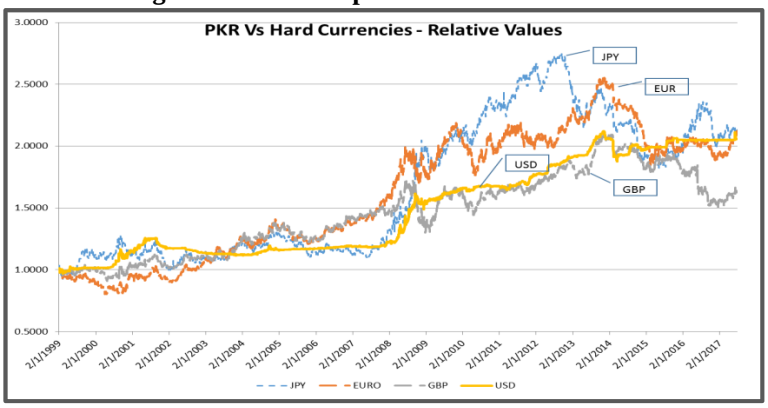
Table 2

Summary Statistics

Series	NOB	Mean	Max	Min	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
(a) Original FX Rate Series – PKR per Currency Unit								
EUR	4841	92.7432	148.6875	46.3045	28.8696	–0.0551	1.5580	421.8***
USD	4823	76.0276	108.5000	49.4750	19.2607	0.3098	1.4730	545.7***
GBP	4841	121.8037	177.6990	76.3338	26.7451	0.0524	1.8768	256.7***
JPY	4841	0.7372	1.2200	0.4030	0.2460	0.3202	1.5152	527.5***
(b) FX Return Series – First Log Differences of FX Rates								
$R_{t,EUR}$	4840	0.00015	0.0447	–0.0369	0.0071	0.1398	5.5139	1,290.3***
$R_{t,USD}$	4822	0.00015	0.0371	–0.0354	0.0033	0.3718	30.9164	155,690.8***
$R_{t,GBP}$	4840	0.00010	0.0369	–0.0835	0.0067	-0.5541	11.5040	14,832.0***
$R_{t,JPY)}$	4841	0.00016	0.0826	–0.0829	0.0081	0.1300	12.4221	17,920.6***

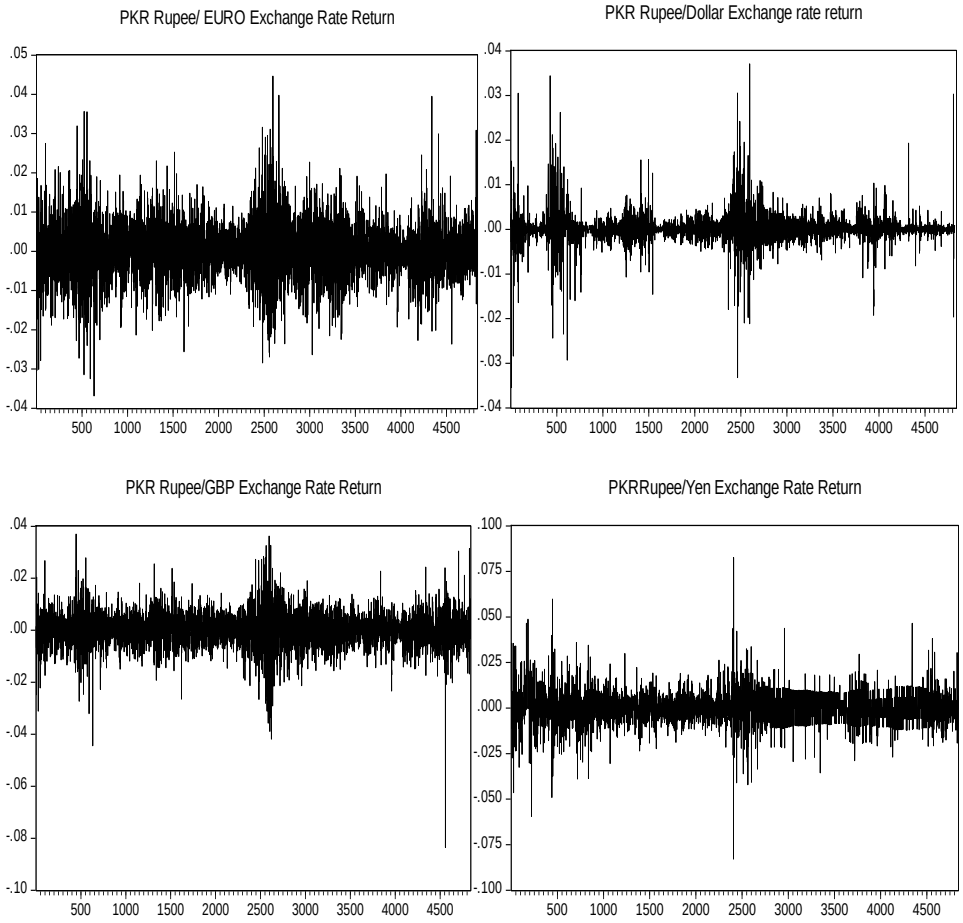
Note: The null hypothesis of Jarque-Bera test statistic assumes that series follows a normal distribution. *** indicates the rejection of null hypothesis at 1 percent level of significance. We use EVIEWS 5.0 and R 2.15.1 for the analysis.

Fig. 1. Pakistan Rupee vs. Hard Currencies.



It is notable that daily variation measured by the standard deviation of the daily exchange rate returns is the least against the Dollar; it is less than half of the standard deviations for the other currencies. The returns series in all cases have excess kurtosis (measure greater than 3) which implies the presence of outliers in daily exchange rate returns. As noted, the minimum and maximum values are very large relative to the mean, which also indicate a heavy incidence of extreme returns. There is also a considerable difference in the skewness measures. In particular, comparing the kurtosis statistics, we notice that the tails of USD/PKR return distribution are remarkably heavier than the tails of the other currency return distribution. The highest value of kurtosis in case of Dollar against Rupee indicates the frequent presence of abnormal daily exchange rate returns. The exchange rate returns in all four cases do not follow the Normal Distribution evident by the significant value of Jarque-Bera statistic; it is remarkably so in the case of the Dollar. These results support our argument that the USD is the main object of a managed float policy, and strengthen our case for separately modeling the tails of the distribution for risk assessment using EVT.

Fig. 2. The Plots a-D Show Exchange Rate Return Series for EUR, USD, GBP and JPY Respectively.



The next step is to estimate the dynamics of conditional mean and volatility of both series, as per models laid out in the previous section. Figure 1 shows the daily returns for the four exchange rate return series. The graph indicates that large changes tend to be followed by large changes of either sign and small changes tend to be followed by small changes. It implies that returns are not independent and identically distributed, and that the volatility clustering phenomenon is present in the data, which is also verfied by the correlogram of squared returns (not shown here). This suggests that GARCH models need to be employed to incorporate dynamic volitality.

As noted above, our preliminary checks on the data lead us to employ AR(1)-GARCH (1,1) model for EUR and AR(2)-GARCH (1,1) for USD, but AR(1)-GARCH(2,1) for JPY, and AR(1)-GARCH(1,2) models for GBP exchange rate series. The models are fitted using maximum likelihood method. The estimates of the models are given in the following Table 3.

Table 3

GARCH Estimation Results

Dependent Variable		$R_{t,EUR}$	$R_{t,USD}$	$R_{t,GBP}$	$R_{t,JPY}$
		Mean Equation			
Average Return	μ	0.00017	6.03E-05**	0.00013	6.70E-05
		(0.0617)	(0.0333)	(0.0819)	(0.4690)
lag 1	φ_1	–0.05996	–0.2052	–0.0499	–0.0840
		(0.0000)	(0.0000)	(0.0007)	(0.0000)
lag 2	φ_2		0.0249		
			(0.000)		
		Variance Equation			
Constant	ω	2.21E-07***	3.13E-07***	7.15E-07***	4.89E-07***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)
ARCH effect	a_1	0.0298***	0.1538***	0.0714***	0.1079***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)
	a_2				–0.07586***
					(0.0000)
GARCH Effect	b_1	0.9655***	0.8184***	0.4574***	0.9605***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)
	b_2			0.4551***	
				(0.0000)	
Durbin-Watson Stat		1.9878	1.8172	1.9577	2.0074

The p-values are given in parenthesis; ** indicates the significance at 5 percent level of significance and *** indicates the significance at 1 percent level of significance respectively.

From Table 3, comparing the volatility dynamics of four exchange rate returns, the results imply that the ambient volatility is the highest in case of Pound against the Pakistani Rupee, and the least in case of Euro, as indicated by the estimated constant. The dependence of average returns on its immediate past is highly significant in all cases indicated by p-value <0.001. However, the dependence of average daily exchange rate on last day return is negative in all cases. The significant coefficient of AR(2) in the case of the Dollar indicates that the mean dependence is highest (also justified by the magnitude of AR(1) coefficient) and least in case of the GBP exchange rate return series. The significant value of ARCH effect indicates that the impact of previous shocks on current volatility of exchange rate returns for all four currencies is prominent. In all cases,

the (combined) large values of estimated GARCH coefficients (>0.80) indicate the persistence of volatility or in other words a change in volatility affects future volatilities for a long period. The effect is the highest in case of EUR/PKR return and the least for USD/PKR. In the conditional variance equation, GARCH effect estimated by (b_1+b_2) is greater than the sum of ARCH coefficients (a_1 + a_2) which explains that the volatility in exchange rate returns depends on its past longer than one period. We next run ARCH-LM test for standardised residuals (Res_t) extracted from the fitted models. The results imply that the extracted residuals are independent identically distributed (*iid*), as indicated by the insignificant p-values in all cases. The results are reported in Table 4.

Table 4

ARCH LM Residual Test

	$R_{t,EUR}$	$R_{t,USD}$	$R_{t,GBP}$	$R_{t,JPY}$
F-Statistic	2.9295	0.6792	2.7509	0.0713
p-value	0.0870	0.4099	0.0973	0.7895

The test assumes the null hypothesis that the residuals extracted from the fitted models are independent identically distributed.

The Q-Q plots against normal distribution of the residuals series for EUR, USD, GBP and JPY respectively are placed in Appendix C, which indicate the departure from normality and heavy tails for the residual series extracted from fitted model in all four cases.

Following the approach suggested by McNeil and Frey (2000), we apply Extreme Value Theory to model right tail of the standardised residuals extracted from a GARCH model. We consider Peak-Over-Threshold method using the Generalised Pareto Distribution for tail estimation. We consider 95th percentile as the threshold for right tail of standardised residual series in each case. The choice is based on the mean excess (ME) plots placed in Appendix D. The estimates of shape and scale parameters are provided in Table-5. The positive values of estimated shape parameter (ξ) indicate that all the residual series possess heavy tails. The Excess distribution plot (given in the Appendix D) indicates that the fitted model is tenable in all cases.

Table 5

Parameter Estimates

	$\boldsymbol{Res_{t,EUR}}$	$\boldsymbol{Res_{t,USD}}$	$\boldsymbol{Res_{t,GBP}}$	$\boldsymbol{Res_{t,JPY}}$
Threshold	1.9714	1.9441	1.9266	2.2833
$\boldsymbol{N_u}$	122	115	124	104
ξ	0.0917	0.4226	0.2458	0.2132
β	0.5765	0.6630	0.4596	0.62931

Next, we consider the performance of our suggested model for well-known risk measure known as value-at-risk. We back-test the value-at-risk statistic at 95 percent, 97.5 percent and 99 percent confidence level on historical log-returns, $\{x_1, x_2, \ldots\ldots, x_n\}$, for the four series.

Table 6 reports the back testing results and provides theoretically expected number of violations and the observed number of violations using the five different VaR models as explained in the previous section. Whether the observed number of violations is significantly different from expected is measured by the binomial test and the p-values are reported in parenthesis. We consider any outcome where the observed number is different from the expected at a 5 percent or lower level of significance as a failure of the risk model.

Table 6

Back Testing Results for Number of Violations

	$R_{t,EUR}$	$R_{t,USD}$	$R_{t,GBP}$	$R_{t,JPY}$
Length of Test	3840	3822	3840	3840
0.95 Quantile				
# Expected Violations	192	191	192	192
I. Conditional EVT	201 (0.26)	167 (0.04)**	194 (0.45)	183 (0.26)
II. Conditional Normal	172 (0.07)	148 (0.00)**	197 (0.37)	115 (0.00)***
III. Conditional t	179 (0.18)	265 (0.00)***	221 (0.02)**	140 (0.00)***
IV. Unconditional EVT	181 (0.22)	176 (0.14)	220 (0.02)**	241 (0.00)***
V. Unconditional Normal	165 (0.03)**	127 (0.00)***	174 (0.09)	168 (0.04)**
0.975 Quantile				
# Expected Violations	96	95	96	96
I. Conditional EVT	99 (0.39)	89 (0.27)	105 (0.19)	96 (1.00)
II. Conditional Normal	100 (0.35)	99 (0.37)	108 (0.12)	79 (0.04)**
III. Conditional t	88 (0.22)	132 (0.00)***	100 (0.35)	49 (0.00)***
IV. Unconditional EVT	78 (0.03)**	80 (0.06)	100 (0.35)	97 (0.47)
V. Unconditional Normal	93 (0.40)	95 (1.00)	100 (0.35)	105 (0.19)
0.99 Quantile				
# Expected Violations	38	38	38	38
I. Conditional EVT	36 (0.40)	34 (0.28)	35 (0.33)	33 (0.22)
II. Conditional Normal	48 (0.07)	64 (0.00)***	52 (0.02)***	35 (0.33)
III. Conditional t	29 (0.07)	50 (0.04)**	36 (0.39)	10 (0.00)***
IV. Unconditional EVT	36 (0.40)	40 (0.41)	42 (0.30)	41 (0.36)
V. Unconditional Normal	57 (0.00)***	69 (0.00)***	52 (0.02)***	70 (0.00)***

and * indicates the significance of a binomial test at 5 percent and 1 percent level of significance respectively. The one-sided binomial test the null hypothesis with alternative that method systematically underestimates/overestimates the conditional quantile.

We find that the Conditional EVT, or the dynamic GARCH-EVT model, correctly estimate the conditional quantiles in all cases except one. Since the p-value is insignificant at all levels, the method fails only in case of USD/PKR exchange rate return at 95 percent confidence level but still provides accurate results at higher levels of confidence, which indicates that the validity of method holds. Unconditional Normal fails in seven out of the twelve total cases. It fails especially at 99 percent confidence level. The performance of the unconditional (static) EVT model at higher quantile levels seems satisfactory, since it fails in only three cases out of twelve. Surprisingly, the Conditional–t (or the Dynamic) model does not perform appropriately in most of the cases; it fails in seven out of twelve cases. Conditional-Normal performs well in five out of the twelve cases. Overall, the EVT-based VaR models, conditional and unconditional, seem to perform the better than other models.

When we compare the performance of the models across the four currencies, we observe that overall the models do not perform very well in the case of US Dollar and the

Japanese Yen, both failing in seven out of the total fifteen cases. In particular, we find that the best performing model, the Conditional EVT based VaR fails only in the case of USD. It is notable that the VaR models perform poorly against the two managed float currencies, USD and JPY, while performing adequately against the Euro and the Pound. The incidence of failure is twice as high for the managed float currencies as compared to the free float currencies.

5. SUMMARY AND CONCLUSIONS

In the debate over the merits of managed vs floating exchange rates, a key issue that has remained under-examined is the relative efficacy of the risk management tools under the two regimes. This paper attempts to address this question with respect to the Pakistani rupee, which seems to be actively managed mainly against the US dollar, but to a lesser extent against other hard currencies. This practice of differentially managing exchange rates provides us with an opportunity to study the implications of the exchange regime for implementing risk assessment models.

Our focus is on the Value-at-Risk (VaR) model, which has been widely adopted as a way of monitoring and managing market risk. In particular, the Bank has specified it for International Settlement (BIS) as well as by many central banks as a basis for setting regulatory minimum capital standards. We use five variations of the VaR model, including models based on the Extreme Value Theory (EVT). We find that the exchange rate returns distributions are fat tailed and well suited for the application of EVT based models. However, we also find that the distributional characteristics are quite different for the four currencies; the USD rate, which is an actively managed float, in particular exhibits fat tails indicating low normal volatility but higher extreme volatility. This finding conforms to the earlier cross-countries research, for example, by Genberg and Swoboda (2004). In addition, we also find that the dynamic processes are remarkably different for the four exchange rates; the principal object of managed float, USD, exhibits notable serial autocorrelation, as opposed to the other currencies.

In assessing the efficacy of the risk models, we find that the models do not perform very well in case of exchange rates within managed float regimes, i.e., US dollar or Japanese Yen. In the first case, the dollar itself is considered a free-float currency, but the USD/PKR rate seems to be a managed float. The Yen on the other hand is considered a managed float currency, but the JPY/PKR rate may not be so managed from the Pakistani side. Either way, when either of the currencies in the exchange pair is in the managed float regime, it seems to be harder to assess foreign exchange risk, relative to when both of the paired currencies are in market or free float regime. Since the managed float regime would make it more challenging to model and manage exchange rate risk, there are implications for the exchange rate policy-makers. The managed float regime increases the foreign exchange risk for all economic agents, including, for example, the foreign portfolio and direct investors, as well as the importers and exporters. The additional risk and the associated economic cost may substantially inhibit economic transaction involving foreign exchange to the detriment of the country's growth.

The implementation of the risk models in a developing country like Pakistan pose special challenges. First, the incidence of extreme events and volatility is much higher, since the economic processes may not be stable due to the evolving institutional and

regulatory environment. Therefore, the emerging countries exhibit much smaller variations of the nominal exchange rate, yet occasionally experience extreme movement in the exchange rates. As noted in the introductory section, Pakistan has been buffeted by a series of economic shocks. Second, structural economic weaknesses have led to a steady depreciation in the value of the rupee. The dilemma for the country is whether to let the currency slide gradually in small increments or to try to maintain a stable exchange rate until realignment becomes inevitable. Under a managed float the risk arising out of short-term volatility is reduced, but at the expense of increasing risk originating from extreme rate movements.

Our analysis provides a framework for jointly considering the two sources of risk. Our results indicate that a market based exchange rates regime will reduce the overall foreign exchange risk. Pakistan has historically followed different exchange rate regimes. Currently, though the country is categorised as managed floaters, its *de facto* operating regime is different from its *de jure* regime which is described as managing *ad hoc* adjustable pegs; Rajan (2012). The findings of this paper provide additional support for following a free float policy in practice as well as officially stated.

Our findings also have direct implications for the operationalisation of risk models, and underscore the importance of correctly specifying the return distributions as well as the dynamic process. Our back-testing exercise shows that the VaR measures with dynamic adjustment for volatility clustering perform better than measures that are based on normal distribution assumption, or which do not take the dynamics of volatility into account, and indicates that the exchange rate risk is better modeled using the Extreme Value Theory. However, we find that the distributional characteristics and volatility structure of exchange rates are different in case of different currencies. The study suggests that the static extreme loss estimates based on one period may not be a reliable guide to the risk of actual losses during subsequent periods, and need to be updated using a dynamic framework. This finding underscores the fundamental problem of dealing with uncertainty, i.e., dealing with the model risk arising from incorrect model specification. Moreover, the parameters of the empirical distribution may also unexpectedly shift in times of financial turbulence and may render models of risk assessment unhelpful. A dynamic VaR based system can be more adaptive to the changing market conditions and the losses are likely to be less severe than in static risk measurement system.

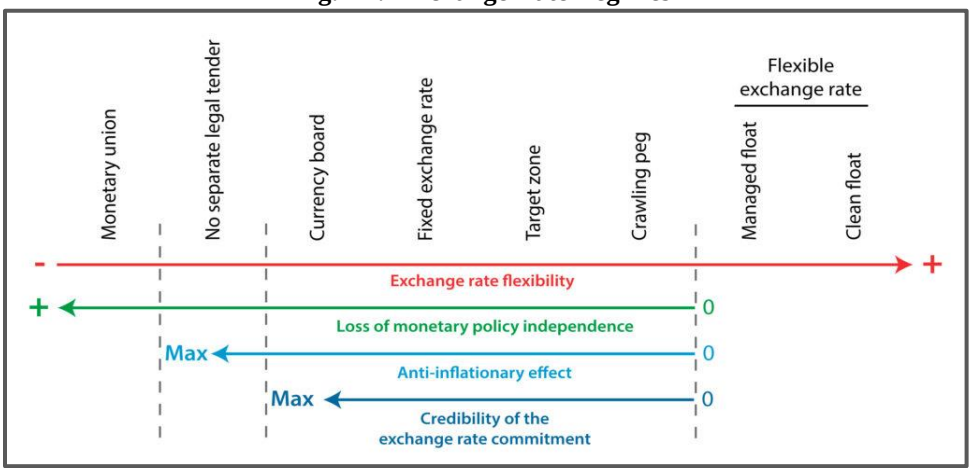
APPENDIX – A

A Note of Exchange Rate Regimes

An exchange rate regime is the system that a country's monetary authority adopts to manage the value of its currency in relation to other currencies.

There are two major regime types: (i) fixed (or pegged) exchange rate regimes, where the currency is tied to another currency or a basket of currencies; (ii) floating (or flexible) exchange rate regimes, where the foreign exchange market determines movements in the exchange rate. However, between fixed and floating exchange rate regimes there are also intermediate exchange rate regimes. The figure below illustrates various exchange rates regimes, and how these are related to the four major macroeconomic variables: exchange rate flexibility, loss of monetary policy independence, anti-inflation effect and credibility of the exchange rate commitment:

Fig. A1. Exchange Rate Regimes



Source: https://policonomics.com/lp-exchange-rate-regimes-exchange-rate-regime/

- Monetary Union, with a shared currency, such as the Eurozone;
- No separate legal tender, where the use of the currency of another country takes place;
- Currency Board, an explicit agreement on a fixed exchange rate between two or more currencies;
- Target zone arrangement, where the exchange rate is allowed to fluctuate within certain bands;
- Crawling Peg, with a periodically adjusted exchange rate;
- Managed (dirty) float, a flexible exchange rate regime with some government intervention;
- Free (clean) float, the exchange rate is market determined.

APPENDIX – B

Value at Risk and the Extreme Value Theory

1. Dynamic Value-at-Risk

Following the methodology suggested by McNeil and Frey (2000), we incorporate the conditional volatility, the GARCH effects, as follows. Let ($X_t \; t \in \mathbb{Z}$) be a stationary time series representing the daily observations of a log-return of financial asset price. We assume that dynamics of *X* are given by:

$$X_t = \mu_t + \sigma_t Z_t, \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Where μ_t and σ_t measures the mean return and volatility of the process respectively, Z_t are the innovations, which is strict white noise process with zero mean, unit variance, and marginal distribution function $F_Z(z)$. We assume that μ_t and σ_t are measurable with respect to $\mathcal{G}_{t-1}$. Let $F_X(x)$ denote the marginal distribution of stationary time series (X_t) and let $F_{(X_{t+1} \mid \mathcal{G}_t)}(x)$ denote the 1-step predictive distribution of the returns over the next day, given knowledge of returns up to and including day *t*.

The mean returns and the volatility of the GARCH (1,1) model with normal innovations has the following specification:

$\mu_t = \mu$ and $\sigma^2_t = w + \alpha(X_{t-1} - \mu)^2 + \beta\,\sigma^2_{t-1}$

with w, α, $\beta > 0$, and $\alpha + \beta < 1$. Similarly the mean returns and the volatility of AR(2)-GARCH(1,1) model is:

$\mu_t = \varphi_1 X_{t-1} + \varphi_2 X_{t-2}$ and $\sigma^2_t = w + \alpha(X_{t-1} - \mu_{t-1})^2 + \beta\,\sigma^2_{t-1}$,

The stochastic variable Z_t may be assumed to follows the Normal distribution, or alternatively a *t*-distribution where $Z_t = \epsilon_t\sqrt{\frac{\vartheta-2}{\vartheta}}$ and ϵ_t follows a Student-*t* distribution with $\vartheta > 2$ degrees of freedom.

We're then interested in estimating quantiles in the tails of these distributions. For $0 < q < 1$, a conditional quantile is a quantile of the predictive distribution for the return over the next day denoted by:

$x_q^t = \inf\{x \in \mathbb{R}: F_{(X_{t+1}\,|\,\mathcal{G}_t)}(x) \geq q\}$, where

$$F_{(X_{t+1}\,|\,\mathcal{G}_t)}(x) = P\{\sigma_{t+1}Z_{t+1} + \mu_{t+1} \leq x\,|\,\mathcal{G}_t\} = F_z((x - \mu_{t+1})/\sigma_{t+1})$$

which implies,

$$x_q^t = \mu_{t+1} + \sigma_{t+1} z_q \,, \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

where z_q is the upper qth quantile of the marginal distribution of innovation distribution which does not depend on *t*. The next step is to model the tails of the innovation distribution Z_t using Extreme Value Theory.

2. Extreme Value Theory (EVT) Models of Distribution Tails

According to EVT, the form of the distribution of extreme returns is precisely known and independent of the process generating returns; see for example, Longin (1996), Longin and Solnik (2001) and Chou (2005), and, Diebold, et al. (2000) for a note of caution. The family of extreme value distributions can be presented under a single parameterisation, known as the Generalised Extreme Value (GEV) distribution. There are two ways of modelling extremes of a variable. One approach is to subdivide the sample into *m* blocks and then obtain the maximum from each block, the *block maxima method*. The distribution of block maxima can be modelled by fitting the GEV to the set of block maxima. An alternative approach takes large values of the sample that exceed a certain threshold *u,* the peak-over-threshold (POT) approach. The distribution function of these *exceedances* is then obtained employing fat-tailed distributions models such as the Generalised Pareto Distribution (GPD). However, the POT approach is the preferred approach in modelling financial time series.

Fisher and Tippett (1928) developed the theory describing the limiting distribution of sample maxima and the distribution of *exceedances* above a threshold. Building on their work, Pickands (1975), Balkema and de Haan (1974) state the following theorem regarding the conditional excess distribution function.

Theorem: For a large class of underlying distribution functions the conditional excess distribution function $F_u(y)$, for a large value of μ, is well approximated by:

$$F_\mu(y) \cong G_{\beta,\xi}(y) \; ; \; \mu \to \infty$$

$$G_{\beta,\xi}(y) = 1 - (1 + \xi y/\beta)^{-1/\xi} \; , \; \xi \neq 0$$

$$= 1 - e^{-y/\beta}, \; \xi = 0$$

for $y \in [0, x_F - \mu]$ if $\xi > 0$, and $y \in [0, -\beta/\xi]$ if $\xi < 0$. $y = (x - \mu)$ and μ is the threshold; $x_F \leq \infty$ is the right endpoint of F. $G_{\beta,\xi}(y)$ is known as the Generalised Pareto Distribution (GPD). $F_\mu(y)$ can also be reformulated in terms of F(x) describing the entire time series X_t to construct a tail estimator for the underlying distribution. The important step in this procedure is to determine the threshold for identifying the tail region. It involves a trade-off: a very high threshold level may provide too few points for estimation, while a low threshold level may render a poor approximation. Several researchers, (e.g., McNeil, 1997, 1999) suggest employing a high enough percentile as the threshold. However, we consider Mean excess function plot in this regard.

Using as an estimator of F(u) the ratio $(n - N_u)/n$, where n is the total number of observations and N_u is the number of observations above the threshold, the tail estimator is defined as:

$$F(x) = 1 - N_u/n(1 + \xi(x-\mu)/\beta)^{-1/\xi}$$

for $x > u$. For a given probability, $q > F(u)$, the VaR estimate is obtained by inverting the tail estimation formula above to get (see Embrechts, et al. 1997).

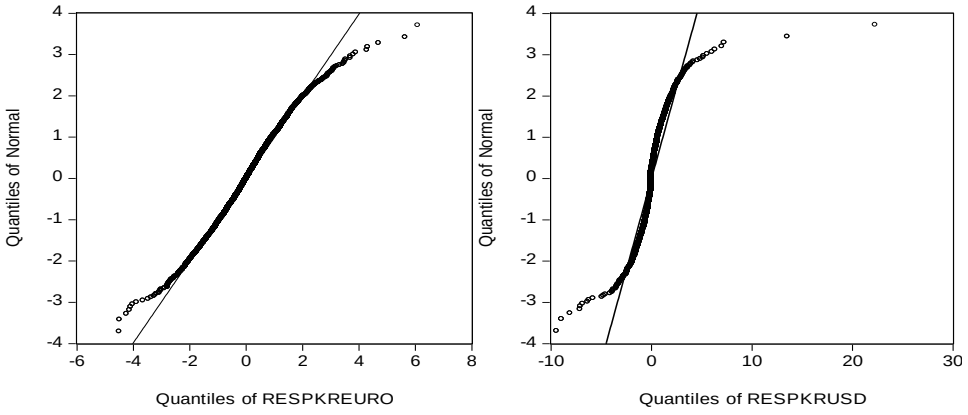
$$z_q = \text{VaR}_q = \mu + \beta/\xi \; ((n/N_u(1 - q))^{-\xi} - 1).$$

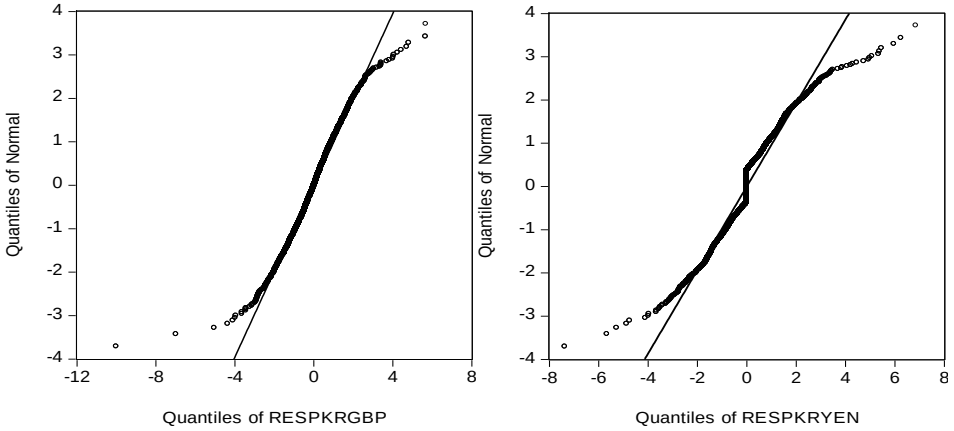
The estimation of the GPD parameters, ξ and β is made using the method of maximum likelihood. Finally the estimated dynamic or conditional VaR using eq. (1) is:

$$\hat{x}_q^t = \widehat{\mu_{t+1}} + \hat{z}_q \widehat{\sigma_{t+1}}. \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

APPENDIX - C

Q-Q PLOTS

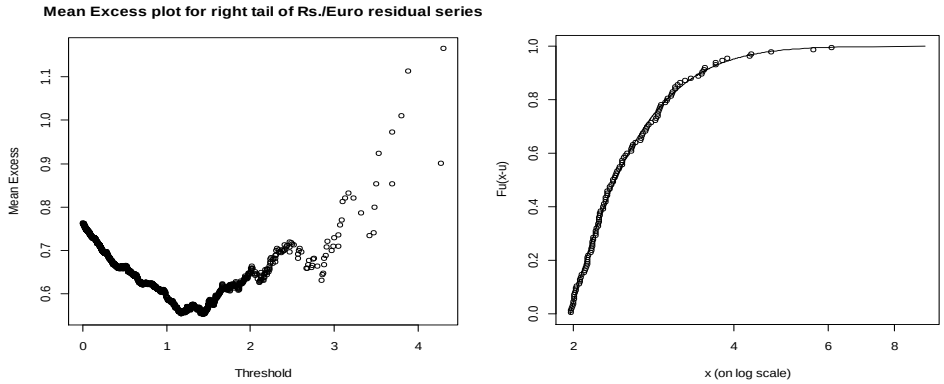


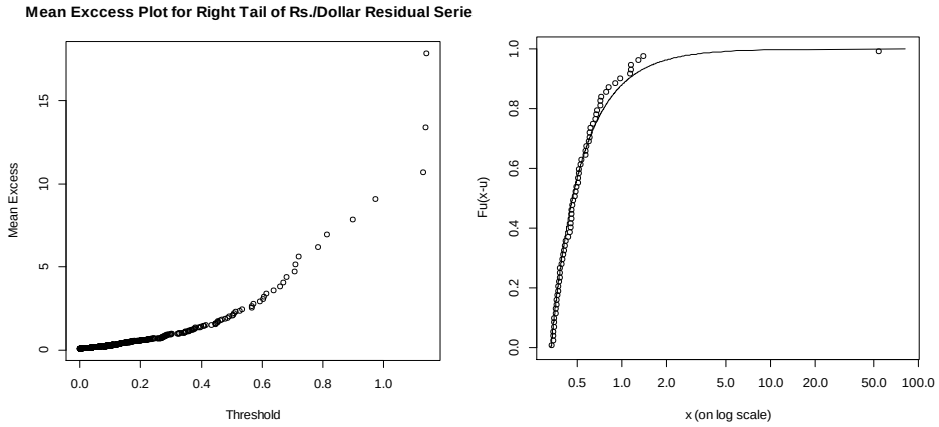


The figure shows Q-Q plot against normal distribution of the residuals series for EUR, USD, GBP and JPY respectively.

APPENDIX D

Mean Excess and Excess Distribution Plots





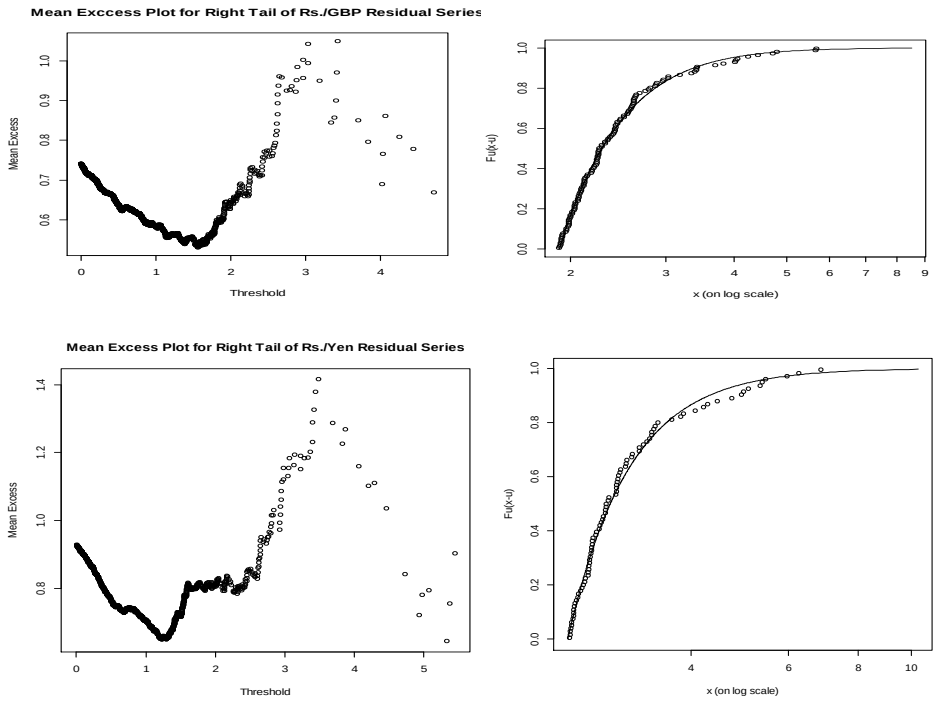


Figure 4. The left figure shows Mean excess function (ME) plotted against the threshold for right tail, whereas the right figure shows excess distribution plot for the goodness-of-fit of each residual series.

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60:1 (2021) pp. 85–91

Commentary

Exchange Rate Policy Must Seek Undervaluation!

ABDUL JALIL

In Pakistan, the exchange rate policy has always tended towards overvaluation (see Box 1). This policy has led to five major currency crises, an attack on foreign exchange reserves, and an eventual IMF programme, over the last 30 years (Haque and Hina, 2020).

Box 1: Currency Misalignment

Misaligned currency means exchange rate that is inconsistent with satisfactory macroeconomic fundamentals of a country. If the currency is misaligned, then it may be overvalued or undervalued.

Overvaluation: If the currency of a country is overvalued, then it makes the imports attractive and exports hard to sell. Currency overvaluation leads to an unsustainable current account deficit.

Undervaluation: On the other hand, if the currency of a country is undervalued, it results in current account surplus. Undervaluation of currency can stimulate the economy to a higher economic growth level.

The present knowledge brief reviews literature on the relationship between exchange rate policy stance and economic growth. Besides, an attempt is also made to estimate the misalignment of the exchange rate for Pakistan using an econometric model. The evidence provides overwhelming support for an exchange rate policy that seeks undervaluation to stimulate growth. In Pakistan, however, the State Bank of Pakistan (SBP) continues to adopt the policy of exchange rate overvaluation.

THE IMPACT OF MISALIGNMENT ON ECONOMIC GROWTH AROUND THE WORLD

As mentioned earlier, there is an extensive literature that tests the impact of exchange rate misalignment on economic growth. Three essential points can be inferred from the literature.

- There are different concepts of real exchange rate misalignment (see Box 2).
- Researchers use different sets of explanatory variables to calculate the equilibrium exchange rate.
- The calculation of the equilibrium exchange rate is sensitive to econometric models and econometric techniques.

Abdul Jalil <abdul.jalil@pide.org.pk> is Professor of Economics, Pakistan Institute of Development Economics, Islamabad.

Box 2: Methodologies for Measuring the Misalignment of Exchange Rate

The difference between the prevailing exchange rate and the 'equilibrium' exchange rate is called the misalignment of the exchange rate. The measurement of the equilibrium exchange rate is not a straightforward task. The researchers provide various measures depending on the objective, focus, the conceptual framework, empirical methodology, and assumptions (Isard, 2007). Therefore, the literature suggests several empirical methodologies to measure the equilibrium exchange rate. These may be model-independent or model-dependent. In a nutshell, there is not an 'equilibrium' exchange rate. All measures provide different numbers for the equilibrium exchange rate depending on the period, methodology, and underlying assumptions about the macroeconomic variables.

Despite all the technical issues, there is almost a consensus that the real exchange rate undervaluation positively impacts economic growth. More specifically, Bhalla (2008) notes that each 1 percent sustained undervaluation may lead to 0.3 percent to 0.4 percent increase in economic growth. On the other hand, the overvaluation of the real exchange rate negatively impacts economic activities (see Table 1).

Table 1

The Impact of Undervaluation and Overvaluation on the Economic Growth

Study	Sample Country	Sample Period	Impact of Misalignment
Impact of Undervaluation on Economic Growth			
Gala and Lucinda (2006)	58 countries	1960-1999	Positive
Bhalla (2008)	56 countries	1997-2007	Positive
Cheung et al. (2007)	111 countries	1975-2004	Positive
Dubas (2009)	102 countries	1973-2002	Positive
Coudert and Couharde (2009)	128 countries	1974-2004	Positive
Zakaria (2010)	Pakistan	1983-2005	Positive
Mejía-Reyes et al. (2010)	06 countries	1951-2000	Positive
Mbaye (2012)	72 countries	1970-2008	Positive
Bereau et al. (2012)	33 countries	1980-2007	Positive
Elbadawi et al. (2012)	83 countries	1980-2004	Positive
Ozyurt (2013)	66 countries	1983-2007	Positive
Naseem and Hamizah (2013)	Malaysia	1991-2009	Positive
Schroder (2013)	63 countries	1970-2007	Positive
Holtemoller and Mallick (2013)	69 countries	1970-2006	Positive
Couharde and Sallenave (2013)	26 countries	1980-2009	Positive
Oreiro and Araujo (2013)	Brazil	1994-2008	Positive
Grekou (2015)	CFA Zone*	1985-2011	Positive
Hajek (2016)	12 countries	1980-2014	Positive
Zou and Wang (2017)	cross-economy	1980–2011	Positive
Razzaque et al. (2017)	Bangladesh	1980-2012	Positive
Goncalves and Rodrigues (2017)	Emerging countries	1950-2014	Positive
Bhattia et al. (2018)	Pakistan	1980-2013	Positive
Iyke (2018)	100 countries	1994-2010	Positive
Chavez (2020)	11 Countries	1980-2018	Positive
An et al. (2020)	ASEAN countries	1989-2018	Positive
Baxa and Paulus (2020)	Developing countries	1996-2014	Positive
Ribeiro et al. (2020)	54 countries	1990-2010	Negative
Impact of Overvaluation on Economic Growth			
Razin and Collins (1997)	86 countries	1975-1992	Negative
Kemme and Roy (2006)	Russia and Poland	1995-2001	Negative
Abida (2011)	Tunisia, Algeria, and Morocco	1980-2008	Negative
Nouira and Sekkat (2012)	52 countries	1980-2005	Negative
Hall et al. (2013)	China, Japan, UK	2001-2009	Negative
Wong (2013)	Malaysia	1971-2008	Negative
Debowicz and Saeed (2014)	Pakistan	1982-2010	Negative
Rafindadi (2015)	Nigeria	1980-2011	Negative
Akram and Rath (2017)	India	1980-2014	Negative
Chen (2017)	49 countries	1996-2011	Negative
Morvillier (2020)	62 countries	1985-2015	Negative
Karahan (2020)	Turkey	2002-2019	Negative
Jehan and Irshad (2020)	Pakistan	1980-2016	Negative

Note: CFA-Franc: The CFA Franc is the common currency for the Franc Zone of 15 Central and West African countries, plus Comoros.

THE CHANNELS THROUGH WHICH (MIS)ALIGNMENT EFFECT ECONOMIC GROWTH

- The literature cites the example of East Asian countries' outward-oriented policies when discussing the positive impact of the undervaluation of currency on economic growth. On the other hand, the overvalued currency hurt the Latin American and African countries' economic growth following inward-oriented policies.
- Rodrik (2008) notes that market failures and bad institutions affect the tradable sector in developing countries. Therefore, currency undervaluation might work to correct market distortions and positively impact economic growth.
- The currency undervaluation may boost the industrial sector through incentives for capital accumulation, technological capabilities, and information spillover. The improved industrial sector will add to the economic growth of the country.
- Theoretically, Gala (2007) suggests that the real exchange rate's undervaluation may increase profit margins. These profit margins will induce higher savings, investments, and ultimately increase economic growth.
- A stable and competitive (undervalued) real exchange rate may boost economic diversification in developing countries.

THE CASE OF PAKISTAN

As mentioned earlier, the SBP continuously pursuing the policy of keeping the exchange rate parity overvalued by supporting the foreign exchange market through central bank interventions (see Box 3). Therefore, the prevailing nominal exchange rate in Pakistan does not reflect the equilibrium exchange rate. The difference between the prevailing and the equilibrium exchange rate is called the exchange rate misalignment. As mentioned earlier, there are several methods to calculate the misalignment of the exchange rate (see Box 2). However, we follow the IMF's suggestions[1] and use an econometric model by taking several variables into account, keeping the dynamics of Pakistan's economy in view. In this regard, we take Rao's (2019) guidelines to construct a macro model for Pakistan's case (Box 4). Since the SBP manages the exchange rate parity through interventions, we simulate the nominal exchange rate with and without foreign exchange interventions (see Figure 1).

Box 3. Central Bank Interventions

The central banks intervene in the foreign exchange market through buying and selling of the foreign/local currency to support the nominal exchange rate parity. The support could be to reach a specific desired level of exchange rate parity or to reduce the exchange rate volatility in the currency exchange market.

Selling of Foreign Currency: When the local currency is under pressure in the foreign exchange market due to weak macroeconomic fundamentals, the market signals to depreciate the exchange rate. In this scenario, the central bank sells foreign currency and buys local currency to manage the pressure. The exchange rate will be overvalued. Resultantly, the central banks lose foreign exchange reserves. The reserve deficient countries, such as Pakistan, cannot afford this policy for a long time. Whenever the central bank stops the support due to the lack of foreign exchange reserves, the local currency depreciates rapidly to adjusts to its market value. Sometimes, rapid depreciation may lead to currency crises.

Buying of Foreign Currency: On the other hand, the central bank buys the foreign currency when the market forces signal the appreciation of the local currency. The central bank builds the international reserves in this process.

[1]Almost all the IMF methodologies are based on econometric estimations.

Box 4 Currency Misalignment in the Case of Pakistan

Rao (2019) postulates that the State Bank of Pakistan (SBP) kept Pak Rupee overvalued, over several years, through central bank interventions in the foreign exchange market. Keeping the argument of Rao (2019) in view, we simulate a counterfactual exchange rate in the absence of the central bank intervention.

For this purpose, we propose a six variable structural vector autoregressive (SVAR) macroeconomic model keeping the dynamics of Pakistan's economy in view (see Rao, 2019 for details). These variables are output (denoted by *y*), interest rate (denoted by *i*), exchange rate (denoted by *e*), inflation (denoted by π), private sector credit (denoted by *psc*), and central bank interventions (denoted by *int*). The resultant SVAR model, after applying the theoretical restrictions, is as follows:

$$y_t = \beta_{10} + \beta_{14} i_t + \beta_{16} e_t + \varepsilon_t^y \quad \text{Dynamic IS equation} \quad (1)$$

$$\pi_t = \beta_{20} + \beta_{21} y_t + \beta_{24} i_t + \beta_{26} e_t + \beta_{27} E_t[\pi_{t+1}] + \varepsilon_t^\pi \quad \text{Dynamic Philips Curve} \quad (2)$$

$$psc_t = \beta_{30} + \beta_{31} y_t + \beta_{34} i_t + \varepsilon_t^{psc} \quad \text{Credit Dynamics} \quad (3)$$

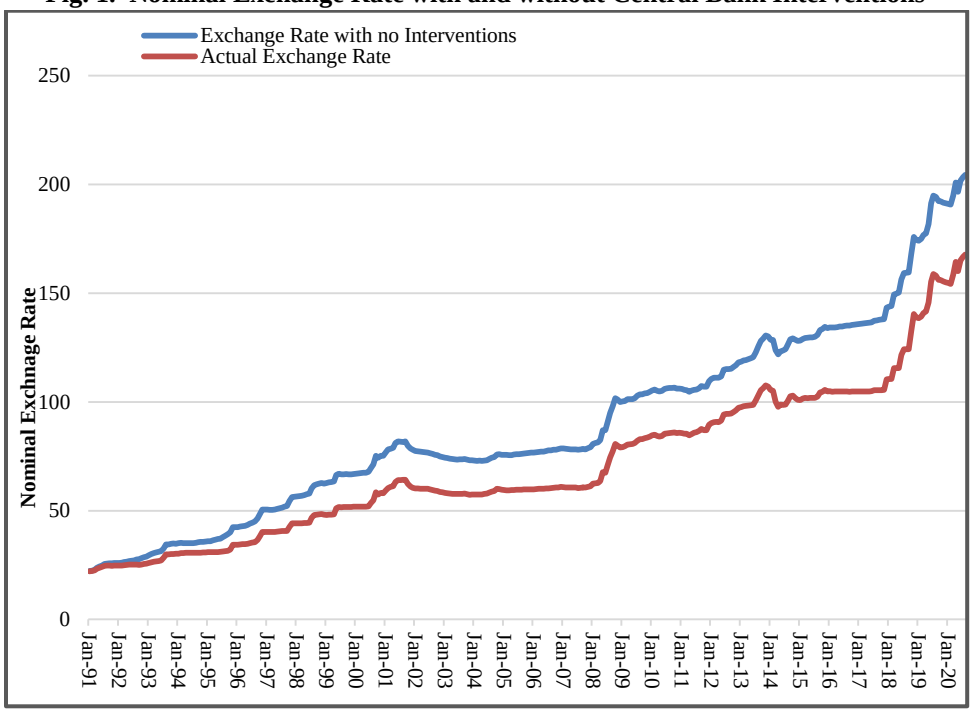
$$i_t = \beta_{40} + \beta_{41} y_t + \beta_{42} \pi_t + \beta_{46} e_t + \varepsilon_t^i \quad \text{Monetary Policy Function} \quad (4)$$

$$INT_t = \beta_{50} + \beta_{54} i_t + \beta_{56} e_t + \varepsilon_t^{INT} \quad \text{Intervention Equation} \quad (5)$$

$$e_t = \beta_{60} + \beta_{62} \pi_t + \beta_{64} i_t + \beta_{65} INT_t + \varepsilon_t^e \quad \text{Exchange Rate Equation} \quad (6)$$

Figure 1 provides a historical evaluation of SBP's intervention effectiveness in controlling the exchange rate parity.

Fig. 1. Nominal Exchange Rate with and without Central Bank Interventions



Our analysis comes up with three main messages, namely:

- First, if the SBP does not intervene to support the foreign exchange market, the exchange rate would have been around 205 per USD at the end of August of 2020. The support of SBP kept the exchange rate overvalued for a long time.
- Second, following Rao's (2019) methodology, our estimates show that the SBP has provided cumulative direct market support of USD 119 billion from January 1991 to August 2020. However, the support of USD 119 billion has yielded management of the exchange rate by only Rs. 36.
- Third, the overvalued exchange rate largely subsidised imported consumption and distorted the competitiveness of exportable items. This led to a higher trade deficit, balance of payment (BOP) crises, and ultimately the IMF bailout packages. This also suggests that if the SBP adopts a less protective exchange rate regime, we may avoid severe economic outcomes such as the depletion of foreign exchange reserves, BOP crises, and currency crises (Haque and Hina, 2020).

CONCLUSION

This note provides overwhelming evidence that currency undervaluation is beneficial for economic growth. A macro-econometric model shows that the SBP continually used our scarce foreign exchange reserves to keep the exchange rate arbitrarily overvalued throughout history. This is one important factor that has contributed to our repeated BOP crises and IMF programmes. We hope that this note will inform the exchange rate policy to keep an undervalued target exchange rate and not use reserves to fight overvaluation (see also Jalil, 2020).

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60:1 (2021) pp. 93–97

Policy

Policy-making by Understanding the Generational Economy[1]

DURR-E-NAYAB and OMER SIDDIQUE

The current population age structure of Pakistan provides the country an opportunity to reap the demographic dividend but there is no concrete evidence on its magnitude. The National Transfer Accounts (NTA) can fill this gap by quantifying the wealth flows taking place in a population through an improved understanding of the generational economy.[2] The NTA provides estimates of people's income and their consumption at every age. What is more important, however, is that the NTA helps to understand how do people, especially the young and the old who consume more than they produce, support themselves. It sheds light on whether it is through the private or public sources that the existing deficit—the difference between income and consumption—if any is filled. The estimation of the NTA for Pakistan, therefore, would strengthen our understanding of the linkages between population dynamics and development. The NTA for Pakistan provides the opportunity to look at the economic indicators through the perspective of age. It can help design public policies ranging from healthcare, education, gender equality, reproductive health and social protection to economic, social and political implications of population ageing and generational equity.

The Economic Life-Cycle[3] and Life-Cycle Deficit in Pakistan

Life-cycle accounts incorporate consumption and labour income, where consumption is subdivided into public and private consumption. The NTA is helpful in investigating the age pattern of income and consumption by quantifying the economic life-cycle. Generally, young and old age groups consume more than what they produce, hence, their economic life-cycle is in deficit.[4] Contrariwise, the working-age group produces more than their consumption and have a life-cycle surplus. The youth not only require resources for their basic needs but also for investment in their human capital, while older, apart from basic needs, require significant resources for their declining health. The consumption not only varies by age but also according to the population structure of a country. Developed economies' elderly population is increasing and thus have different age-specific consumption patterns from developing countries, which have a high proportion of the young population. Besides, in developing economies like

[1]This brief is based on a detailed study, Nayab, D., and Siddique, O. (2019) "National Transfer Accounts for Pakistan: Understanding the Generational Economy". Islamabad: PIDE and UNFPA.

[2]The social institutions and economic mechanisms used by each generation or age group to produce, consume, share and save resources (UN, 2013).

[3]The economic life-cycle is age pattern of consumption and labour income.

[4]The life-cycle deficit is calculated as consumption minus labour income.

Pakistan, consumption decisions are not individual but also depend on the collective decision within the family.

Life-cycle deficit profiles are at the core of the NTA estimates and form the bases for other NTA profiles. Since life-cycle deficit is calculated as consumption minus income, Figures 1 and 2 present the per capita and aggregate life-cycle deficits in terms of consumption and income. Consumption is the sum of private and public consumptions on education, health, and other consumption. Labour income is composed of labour earnings and self-employed income.

Fig. 1. The Life-Cycle Deficit: Per Capita Labour Income and Consumption
(thousand rupees)

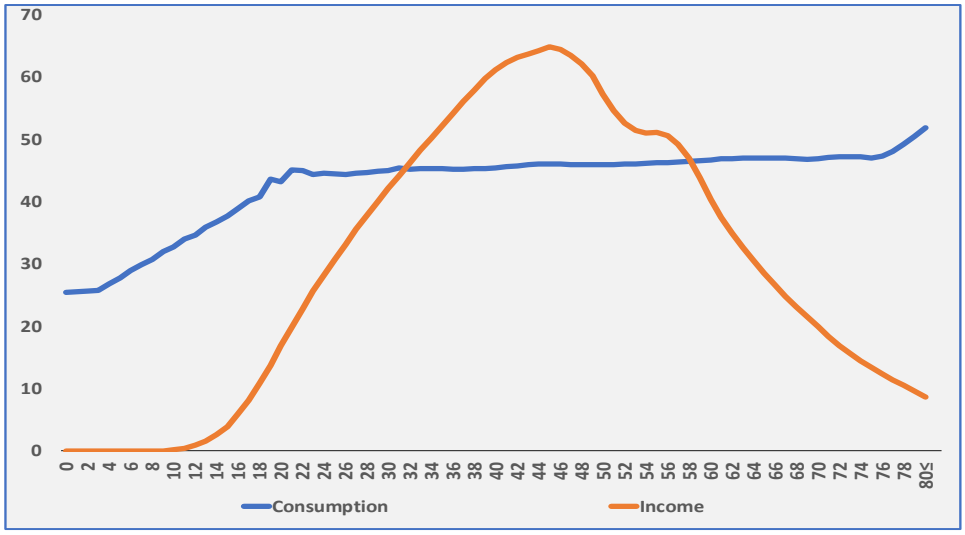
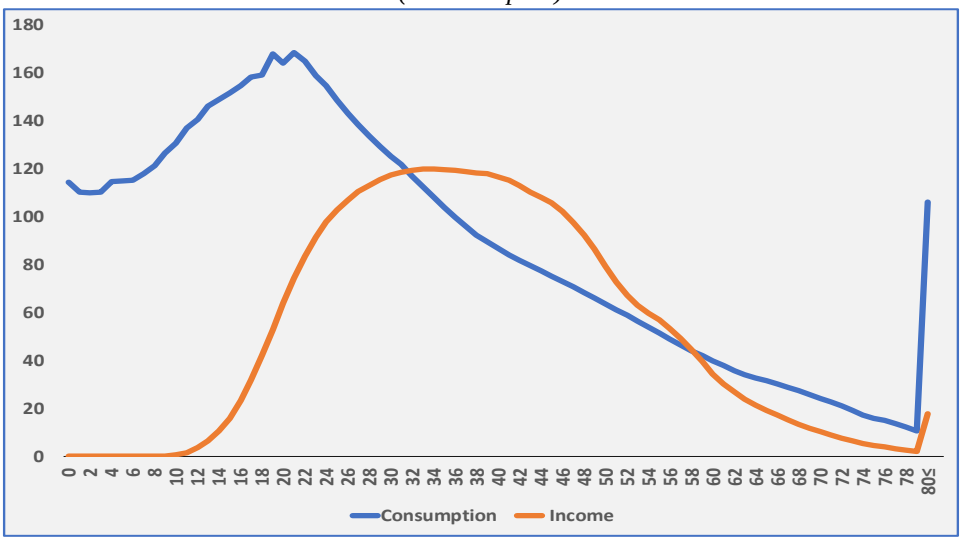


Fig. 2. The Life-Cycle Deficit: Aggregate Labour Income and Consumpstion
(billion rupees)



As Figure 1 shows, the younger population consumes more than they produce but this gap is even wider for the older population. For the young, the consumption-income gap is due to the education consumption while for the old, the gap is driven mainly by expenditures on health. Figure 2 shows the impact of Pakistan's age structure on the life-cycle deficit. Since the proportion of the population in younger cohorts is higher in Pakistan, the aggregate consumption is also higher for this age group. Consumption shows a declining trend for the older population. The figure further reveals that 25-45 is the most productive age group, in terms of generating income.

Generational Economy in Pakistan

Box 1 provides a snapshot of the magnitude of the life cycle deficit in Pakistan and the sources of its funding. The NTA estimates show that a large life-cycle deficit exists in Pakistan. A detailed look at the NTA profiles reveals that the life-cycle deficit exists for the young and an even bigger one for the elderly, on per capita basis (Figure 1). There are two mechanisms to fund the life-cycle deficit, which are private and public age reallocations (discussed below). However, for Pakistan, as summarised in Box 1, the life-cycle deficit is mainly funded through private asset-based reallocations and private transfers. Although public sources also contribute to bridging the life-cycle deficit, the role of the private sector is greater. It can be seen that private asset reallocation is the primary source of fulfilling the life-cycle deficit. Transfers, public or private, play a smaller role.

Private Age Reallocations

Private age reallocations are made through two mechanisms, namely, transfers and asset income. Transfers are cash and in-kind flows to (transfer inflows) and from (transfer outflows) individuals or age groups that do not require any explicit return. Transfers are further subdivided into inter- and intra-household transfers. Similarly, private asset income is composed of capital and property income. The private age reallocations are mediated by households, families, and other private institutions. As shown in Box 1, private transfers are a significant source of funding the life-cycle deficit and asset-based reallocation also play a major part in funding the life-cycle deficit.

Box 1: Summary of Pakistan NTA

$$\underbrace{\underbrace{C - y^l}_{7,114,713.62-4,258,371.02}}_{2,856,342.60} = \underbrace{\underbrace{y^A - S}_{4,153,992.63-1,599,033.63}}_{2,554,958.99} + \underbrace{\underbrace{\tau_g^+ - \tau_g^-}_{4,020,705.35-4,200,849.87} + \underbrace{\tau_f^+ - \tau_f^-}_{622,901.00-141,372.87}}_{301,383.6}$$

$$2,856,342.60$$

C (total consumption) = 7,114,713.62
y^l (labour income) = 4,258,371.02
$C - y^l$ (life-cycle deficit) = 2,856,342,60
y^A (total asset income) = 4,153,922.63
S (total savings) = 1,599,033.63
$y^A - S$ (asset reallocations) = 2,554,958.99

τ^+_g (public transfer inflows) = 4,020,705.35
τ^-_g (public transfer outflows) = 4,200,849.87
$\tau^+_g - \tau^-_g$ (net public transfers) = -180,144.53
τ^+_f (private transfer inflows) = 622,901.00
τ^-_f (private transfer outflows) = 141,372.87
$\tau^+_f - \tau^-_f$ (net private transfers) = 481,528.13

$(\tau^+_g - \tau^-_g) + (\tau^+_f - \tau^-_f)$ (net transfers) = 301, 383.6

Note: The figures are in million rupees.

Public Age Reallocations

Public age reallocations are the flow of current resources across age that is mediated by the government. Public age reallocations are composed of two economic mechanisms—public transfers and public asset-based reallocations—that can be used to shift resources across age. Public transfers are ones between the public and the private sector, or transfers between the public sector and the rest of the world. These are the transfers that flow from working-age adults, who pay taxes, to the ages in which beneficiaries are concentrated, often children and the elderly, to fund the life-cycle deficit. Public asset-based reallocations arise because the government owns assets and debt. Inflows occur when government earns public asset income or borrow. Outflows occur when the government have property income outflows, paying interest on public debt, or when governments save. As Box 1 shows, estimates of net public transfers[5] are small, especially when compared to private transfers. The detailed account reveals that the public transfers flow from the population in their early 30s onward to the younger population. The public asset-based reallocations are positive or zero, for all the ages.

Salient Findings of the Pakistan NTA Estimate

- The prime productive ages are the 40s in Pakistan as their income is substantially more than their consumption. The trend is in line with the idea of the demographic dividend.
- As suggested by the demographic dividend thesis, the aggregate estimates (Figure 2) show that the younger ages consume the most resources, both private and public, because of the age structure effect.
- The life-cycle deficit is funded primarily by asset-based reallocations, instead of transfers, and these reallocations are more in the private domain than public.
- Education consumption relies more on private sources than public ones. This is true for all educational levels.
- Health consumption is highest for the elderly and, irrespective of age, private financing of healthcare exceeds public.

Policy Implications

NTA estimates for Pakistan has serious policy implications for various key areas. Some of the more important ones are given below.

- *Employment of the Young:* The estimates clearly show that outflows from the working ages are meeting the life-cycle deficit faced by the young and the elderly. To reap the potential benefits of the demographic dividend, it is imperative that the young are provided gainful employment opportunities. As these young workers progress they not only provide for their own living but also for those who are dependent upon them.
- *Education Spending:* The NTA estimates show that the expenditure on education, especially public expenditure, is quite low to produce the quality needed to compete in the modern global economy. The analysis, therefore,

[5]Net public transfers are estimated as public transfer inflows minus public transfer outflows.

reinforces the need to increase investment in education, with emphasis on the quality.

- *Public health consumption*: Since according to the NTA estimates private health consumption far exceeds public health consumption, there is a dire need to increase public spending on health. Literature suggests that health expenditures are a major source of pushing households into poverty.
- *Fertility decline*: The idea of demographic dividend stems from fertility decline and dividend cannot be reaped if the fertility rates are not brought down. Unfortunately, in Pakistan fertility rates have been stagnant for some time now. The experience of East Asian countries clearly shows that they realised the demographic dividend because of rapid fertility decline. Large-scale holistically designed programmes are needed that encourage the idea of small family size and lower fertility rates on a voluntary basis.
- *Caring for the elderly:* Although the proportion of the elderly is not high in Pakistan, nor is projected to be so in the coming few decades, the numbers are fast increasing. It, therefore, is about time we start planning for the elderly because, according to the NTA estimates, the elderly have the largest life-cycle deficit and the highest health expenditure. The absence of universal public social security system makes the elderly extra-vulnerable due to changes in the family living arrangements, such as the trend towards the nuclear family system

Book Review

Amita Baviskar. *Uncivil City: Ecology, Equity and the Commons in Delhi*. 2020, Sage and Yodapress.

Amita Baviskar's latest book titled **Uncivil City: Ecology, Equity and the Commons in Delhi** provides an in-depth analysis of exclusion of the Commons from the socio-economic and political spaces of inarguably India's most powerful city; Delhi. The book is divided into three sections with eights chapters encompassing book's themes. It starts with setting the context by explaining the reasons for titling the book as '*Uncivil City'*. Conceptualising Delhi as *Uncivil* expounds the City's changing spatial dynamics which the author has detailed by analysing City's social history by doing socio-historical analysis. She also reminisces her early-life experiences with the City; what the City was for the Commons in the past; how infrastructural development has excluded the Commons; what the City's formal politics and politicised environment is doing to the Commons and what does future entail for them.

The book's first section "**Remaking Landscapes and Lives**" includes three chapters in which the author articulates City's socio-cultural and economic spaces for the Commons with the City's urban planning and development agendas. The second section "**Contesting the Commons**" argues the ecological component of the book, explaining how and why the spaces of transportation which were once operable for public consumption are being over-regulated by the State. In addition, this section also highlights that the Commons are being deprived of the opportunities of economic survivability because of urban body polity's controlling of physical environment; the River and the Ridge. The last section, "**Conclusion and Coda**" talks the readers through the burgeoning capitalist intervention in the City and the uncertainties pertaining to the rampant climate change causing unforeseen contingencies for the Commons.

In the introductory note, the author calls the three C's, **Construction, Commerce and Cars** as monstrous. Construction of physical infrastructure is swelling government's partnerships with the private sector and the continuous commercialisation of public lands in South Delhi over the last one decade is the subject of political, discursive and media criticism. She also takes a critical position on the vertical development in the City which she propounds by exemplifying high-rise buildings packing multifarious businesses and people. This predilection towards vertical over horizontal development is risky for the ecological footprints as the City's water, energy, sewage and traffic will be under severity and depravity for the Commons. For the author, Commerce and Cars are not inherently evil but the ways these have been institutionalised at the disadvantage of certain social groups such as street vendors, *thelawala*, *sabziwala*, or shops selling fresh fruit juice and hot *jalebis*, or shops offering services for repairing pressure cooker or a puncture, depict exclusion of the poor. In an attempt to gentrify the city, many small-scale traders have

left or have been forced to leave their businesses because they cannot afford the rents of industries and markets which have expanded under the westernised notion of *Commerce and Trade*. This lack of discourse on ecology and justice while focusing on debates of metropolitan urbanisation, intellectualisation and modernisation is the major critique of the author and the importance of articulating this discourse in the policy domains is the central argument of the book.

In the first chapter, "**Making Plans and Lives"** Baviskar starts by taking a theoretical route and details about the process of state-making in Delhi. In addition to practicing functionalities of formal politics, urban planning and development is also considered a marker of what ruling government and hence the State is doing and performing. To Baviskar, whatever it entails to inflate urban development and planning in Delhi has created passive and voiceless subjects and world-class and highly technocratic places, in absolute subservience of the powerful; bourgeois environmentalists, politicians and urban elites. Delhi's changing urban landscape is also indicative of coercive State apparatuses in the form of displacement of the Commons by encroachment operations. Baviskar is not only critical of this high-handedness of the powerful but also of the incessant urge and desires of City's social groups for higher living standards. The powerful capitalises on these desires and institutionalises practices of development and displacement. Baviskar also brings in metamorphosis of the Commons from being passive subjects to being agentic and retaliatory. She illustrates it by highlighting spaces of friction and contestations between *basti*-dwellers (informal settlements) and policemen during encroachment operations.

Second chapter "**Sealing Factories and Fates**", makes a point that despite the fact that 64 per cent of Delhi's air pollution in 1993-94 came from motor vehicles and 12 per cent from industrial sources, the courts decided to close down factories in the public interest. Media, environmental activists and middle-class citizens co-opted with the courts and as a result thousands of industries were shut down. Resultantly, significant financial losses were incurred by the factory owners and thousands of poor workers also lost their only source of livelihood. Over the last two decades, Delhi's industrial base has been confined in ghettos, a few of the industrial sites have been re-developed as commercial real estate and some locked in lawsuits. In chapter three "**Playing Games**", Baviskar crystalises similar apathy of State intervention in 2010 in what she calls a *spectacular event*; the Commonwealth Games. In the pursuit of creating an extravagant imagery of India as a super-power country and Delhi as a 'world-class' city, Delhi's sports infrastructure was decided to be refurbished in line with the standard of the Commonwealth Games. This refurbishment of city's landscape included building four new air-conditioned stadiums, revamping eight existing ones, and creating a new Games Village Complex for the incoming 8,500 athletes and officials visiting Delhi for a period of two weeks of the Games. Baviskar questions about the rationality behind the political economy of such spectacular events while questioning, who is there to care for the Commons? The Commons need *circus* (constituting such events) but also livelihoods which these mega-projects disrobe.

In chapter titled "**Cows, Cars, and Cycle-rickshaws**" Baviskar dissects the role of bourgeoisie environmentalists in excluding the poorer sections of Delhi. Courts, traders' associations, citizens' groups and environmental activists co-opt to put in efforts to

compel State to regulate the mobility of cows, cars and cycle-rickshaws on the open spaces of the City's landscape. The author views such stringent regulatory frameworks as systematic and structural attempts of depriving the poor and an extension of economic liberalisation of the 1990s which resulted in displacement, despair, closing down of manufacturing firms and removal of squatter settlements. While critiquing State intervention, Baviskar also criticises the narrative of 'public interest' created by middle-classes which propels exclusion of the Commons from household livability, economic survivability, and occupational operability. The next two chapters titled **The River** and **The Ridge** further elaborate State and non-State intervention in regulating the spaces of Yamuna and Mangarbani and the Delhi Ridge, becoming the reasons for enclosure of the Commons. Narrating modes of locomotion of the poor and the systematic over-regulation, Baviskar borrows from Mir Taqi Mir (1723-1810):

دلی جو ایک شہر تھا عالم میں انتخاب
رہتے تھے منتخب ہی جہاں روز گار کے

اس کو فلک نے لوٹ کر ویران کردیا
ہم رہنے والے ہیں اسی اجڑے دیار کے

There was a city, famed throughout the world/ Where dwelt the chosen spirits of the age/ Delhi its name, fairest among the fair/ Fate looted it and laid it desolate/ And to that ravaged city I belong.

The above excerpt not only captures the essence of the book but also of many experiential realities of the Commons residing across South Asian cities. In the book, Baviskar's literal, illustrative and metaphoric exactitude of Delhi's open spaces is palpable and her enduring association with *thelewala* and *sabziwala* enriches episodic accounts of urban poverty. Her reflexive positionality as a researcher and constructivist orientation as a philosopher facilitates in strengthening book's interpretivist stance. The use of sketches after every chapter gives a visual illustration of the textual accounts. The intersection of three constructs, i.e. Ecology, Equity and Commons, is explored in the broader geographical context of Delhi using qualitative research strategy and interviews, participant observation and textual deconstruction as research methods. Qualitative analysis of experiences of poverty is grounded on theoretical and pragmatic fronts. In one of her earlier writings, Baviskar writes at-length about difference between development which starts with a small *'d'* and another with a capital *'D'* with former connoting bottom-up approach and the later as the capitalist one. The pragmatic exposition of the difference between the two is very clear in the current book. The book, although critical of State and non-State intervention could have prescribed 'Alternative to Development' paradigm. The book's reticent stance towards taking a position in favour of this paradigm leaves even more discursive space for furthering research on this domain.

Fahd Zulfiqar

Pakistan Institute of Development Economics,
Islamabad.

RESEARCH FOR SOCIAL TRANSFORMATION AND ADVANCEMENT

2021 RASTA Competitive Grants Programme for Policy-oriented Research

The Pakistan Institute of Development Economics (PIDE) has launched a multi-year competitive grants programme for policy-oriented research in Pakistan titled **'*Research for Social Transformation and Advancement*'** (RASTA) under the Public Sector Development Programme (PSDP) of the Ministry of Planning, Development and Special Initiatives, the Government of Pakistan. RASTA's mission is to develop a research network of academia, think tanks, policymakers, practitioners and other stakeholders across Pakistan producing high-quality, evidence-based policy research to inform Pakistan's public policy process.

There will be six rounds of the Call for Research Proposals. The first call was in October, 2020, and the second one would be announced in the first quarter of 2021. All updates will be published on PIDE/RASTA website from time to time. In pre-submission engagements webinars and workshops are scheduled to guide potential applicants. For more details and guidelines related to RASTA programme, eligibility, application process and updates, please visit PIDE/RASTA website and follow us on Twitter.

Call for the second round coming soon.

RASTA Project Management Unit
Pakistan Institute of Development Economics,
Adjacent Quaid i Azam University Campus, P.O. Box 1091,
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PAKISTAN SOCIETY OF DEVELOPMENT ECONOMISTS

Registered Office:
Pakistan Institute of
Development Economics,
P.O. Box 1091 ,
ISLAMABAD – 44000

MEMBERSHIP FORM

Dated

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Membership No.

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EXPERIENCE IN YEARS

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REMARKS

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For conditions of eligibility for Membe rship, see reverse.

EXTRACTS FROM THE CONSTITUTION OF THE PAKISTAN SOCIETY OF DEVELOPMENT ECONOMISTS

ARTICLE 5

5.3 *Membership:* There shall be a select category of Members of the Society. The minimum criteria of eligibility for election as Member of the PSDE are:

(a) Previous *ex-officio* membership of the society;

or

(b) Master's degree in Economics, Business Administration, Public Administration, Agricultural Economics, Statistics Econometrics or Economic Demography and/or an evidence of proven scholarship in these areas of specialisation.

5.4 *Election of Member:* All persons satisfying the minimum eligibility criteria as specified in Article 5.3 may apply for Membership on the prescribed form after having their nominations duly proposed and seconded by any two *Ex-officio* Members/Members of the Society, provided that no such application shall be required of a former *Ex-officio* Member of the Society who may enrol as Member on payment of the prescribed fee at the invitation of the Council. Election to Membership shall be decided by a simple majority of the Executive Council at a constitutionally valid meeting.

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Editor: **Nadeem Ul Haque**

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