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Moral Hazard, Monitoring and Punishment: Evidence from a Field Experiment

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The existing literature establishes that there exists inefficiency in energy consumption in Pakistan. In particular, with regard to electricity consumption, the problem of moral hazard is prevalent in the public sector. In this study, we observe this aspect by focusing on the behaviour of consumers once they are held liable to monitoring with the associated punishment mechanism. By providing evidence from a field experiment, we make three conclusions. First, individuals respond to both the monetary and non-monetary punishments. Alternatively, with the introduction of punishments, they reduce moral hazard with respect to electricity consumption. Second, the habitual violators of rules reform their behaviour after they are made accountable for their actions. Third, if appropriate monitoring systems along with the associated punishment mechanism are introduced, we can have beneficial effects in terms of resolving the energy crisis on the aggregate level.

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1. INTRODUCTION

Moral hazard refers to a situation where economic agents maximise their benefits in an inefficient way. Alternatively, in situations of moral hazard, economic agents are able to avoid the costs associated with their conduct.[1] Moral hazard usually occurs due to asymmetric information which involves both 'hidden actions' and 'hidden information' [Arrow (1985)]. For instance, workers' shirking which is costly for the employers to monitor and carelessness in precautions taken by the insured are the examples of hidden actions. Likewise, superior information of experts related to services such as those of the physicians, lawyers, masons, managers, politicians etc. are the examples of hidden information. The issue with moral hazard is that the agents' actions and the consequences of those actions cannot be separated. A feasible solution would be to either make agents liable for the outcomes of their actions or deter them from the actions which involve moral hazard.

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[1]Formally, according to Kotowitz (1989), moral hazard is defined as actions of economic agents in maximising their own utility to the detriment of others, in situations where they do not bear the full consequences or, equivalently, do not enjoy the full benefits of their actions due to uncertainty and incomplete or restricted contracts which prevent the assignment of full damages (benefits) to the agent responsible.

To our knowledge, there is no systematic study which discusses the issue of moral hazard in the context of monitoring, detection or the associated punishment mechanism. However, there are related studies which analyse the impact of monitoring or punishment in circumstances pertaining to other social dilemmas. For instance, one such dilemma is the contribution to public good which agents try to evade in the absence of monitoring or punishment. In this type of literature, the framework of public good games is used in order to observe the behaviour of individuals with regard to their contribution to the provision of non-excludable public goods.[2] The experimental evidence in this regard shows that, on average, the participants in public good games contribute between 40 percent and 60 percent of their endowment [Camerer (2003)]. However, in repeated games, the contribution declines due to the problem of free-riding. Alternatively, free-riding results in the break of cooperation in case of public goods [Ostrom (2000); and Fischbacher, *et al*. (2001)]. Thus, in order to avoid free-riding or control the disruption of cooperation, there should be some type of social sanctioning.[3] Social sanctioning can discipline the defectors which results in higher contributions to public goods. According to Fehr and Gächter (2002), if agents in a public good game are provided with the power to sanction others; then the level of cooperation would increase. In sharp contrast, Nikiforakis (2008) shows that punishment enhances cooperation; however, peer punishment in a decentralised framework declines due to the fear of counter punishment. In addition to the game-theoretic literature, there are also studies which discuss moral hazards in different situations. For example, Stevens and Thevaranjan (2010) assert that the issue of moral hazard can be resolved in the principal-agent model if the agents are sensitised morally.[4] Likewise, Itoh (2004) proclaims that the presence of other-regarding preferences is of central concern in resolving the issue of moral hazard. We also have some other suggestions for minimising moral hazards like peer pressure in team work [Corgnet, *et al*. (2015)]; the recommendation of deductible in insurance [Raaij (2016)]; prudential regulations in financial sector [Hellmann, *et al*. (2000)] etc.

In general, the concept of moral hazard comes from the insurance industry which provides a way to transfer risk to somebody else.[5] Here, we define moral hazard in a different context; i.e. we define it in terms of the misuse of electricity consumption in public sector. In Pakistan, there is inefficiency with regard to the consumption of electricity in public sector [Khan, *et al.* (2016)].[6] In this study, we discuss this type of inefficiency in the context of monitoring and the associated punishment mechanism. We conjecture that the introduction of punishment would have beneficial effects in reducing such inefficiency. For our analysis, we focus on a public sector university, i.e. Quaid-i-

[2]For instance, according to Olson (1965), in case of public goods, one has to choose contribution for the provision of those goods where free-riding is preferable.

[3]See, for instance, Fehr and Gächter (2000); Fehr and Gächter (2002); Kritikos and Bolle (2004); Gintis, *et al*. (2005); Fowler (2005); Henrich, *et al*. (2006); Rockenbach and Milinski (2006); and Sigmund, (2007); Casari and Luini (2009); Faillo, *et al*. (2013); Bortolotti, *et al*. (2015) for details.

[4]In particular, they show that adding moral sensitivity increases the descriptive, prescriptive, and pedagogical usefulness of the principal-agent model.

[5]For example, an insurance company will pay up if you damage a rental car. However, the concept has wider applications in other fields of economics. See, for instance, Nyman (1999) in case of health economics.

[6]For instance, according to Khan, *et al*. (2016), in hostels of public sector universities, the monthly consumption of electricity per student is 46.2 units as compared to 19.58 units in private hostels and an average of 20.5 units in households.

Azam University (QAU), Islamabad, which is a typical public sector organisation of Pakistan. In most of the public sector universities in Pakistan, the employees and students are not charged for the electricity that they consume during the working hours and studies, respectively.[7] This is justified by the fact that universities' fees in public sector are subsidised in Pakistan. Likewise, in hostels of the public sector universities, the consumption of electricity is exclusively made by the resident students. In case of hostels, students are charged in lump sum for their hostel rents, utilities, and other services. Alternatively, they are not charged an extra amount for the over-consumption of electricity that they might make. Due to these factors, there exists the problem of moral hazard in hostels of the public sector universities as far as the consumption of electricity is concerned. Khan, *et al*. (2016) find that students in the public sector hostels misuse electricity by free riding on the non-consumers of public sector.

Students in the hostels of QAU are allowed to use lights, fans and irons in their rooms. Other electric appliances such as heater, water heating rods, and air conditioners are not allowed. However, in the presence of organisational inefficiency with respect to monitoring, it is very difficult to restrain students from using such prohibited appliances. In order to regulate students in this regard, we have to raise the intrinsic and extrinsic costs of misuse of the electricity.[8] In this study, we focus on the extrinsic costs by introducing monitoring with a specified punishment mechanism in a field experiment. We use "keeping lights switched on in a locked room" as a proxy for the misuse of electricity. The experiment comprises six treatments with varying levels of punishments. In the Baseline Treatment (BT), we conduct survey of all boys' hostels for three consecutive days. During the survey, we count the number of locked rooms with inside lights switched on. In the second treatment, named as Soft Notice Treatment (SNT), we display an appeal on the notice boards of all boys' hostel which suggests judicious use of electricity in the hostels. After two days of the appeal, we conduct the survey again by counting the number of locked rooms with their inside lights switched on. We repeat this process for four more treatments by introducing different levels of punishments. For instance, in the third treatment, named as Harsh Notice Treatment (HNT), we introduce harsh words in the appeal. Likewise, in the fourth treatment, named as Warning Notice Treatment (WNT), we warn the students of an associated fine with the misuse of electricity. In addition to displaying the warning notices on notice boards, during this treatment, the notices of warning were also delivered in all rooms. Finally, in the fifth and sixth treatments, i.e. Fine of Five hundred rupees Treatment (FFT) and Fine of One thousands rupees Treatment (FOT), respectively, we introduce monetary punishment. As stated earlier, we conduct the survey for three consecutive days in all of the treatments in order to count the number of locked rooms with their inside lights switched on. We find

[7]In Pakistan, in most of the public sector universities, the consumption of electricity can be decomposed into three types. First is the electricity that is used in the common places like class rooms, libraries, laboratories, street lights etc. Second category is the consumption of electricity, made specifically by the employees in offices etc. Finally, there is also another category which is made exclusively by the students in their hostels. In the first two categories, the consumption is mainly paid by the universities as the university fees in the public sector are subsidised. Thus, the consumption of electricity is like a public good. In other words, the employees and students may free ride on public sector. Similarly, in the third case, there may be a probability of moral hazard with regard to the electricity consumption.

[8]For instance, for raising the intrinsic costs, we have to morally train the students. Likewise, for extrinsic costs, we have to provide efficient monitoring and punishment mechanism.

that the introduction of monitoring with punishment makes the students significantly careful about the misuse of electricity. In other words, the number of locked rooms with their inside lights switched on significantly declines with the introduction of punishment. The rest of the paper is organised in five sections. Section 2 provides a review of literature. Section 3 describes the trends in the energy crisis of Pakistan and, in addition, it briefly discusses the earlier findings in this regard. In Section 4, we describe the experimental procedure, and discuss the treatments and hypotheses of the study. Section 5 discusses the results of our analysis while Section 6 concludes the paper.

2. REVIEW OF LITERATURE

There is considerable literature which highlights the implications of punishments for economic behaviour. As is mentioned earlier, most of the existing studies are undertaken in the context of public good games.[9] However, besides controlled experiments, there are studies which test the impact of punishment in an environment of natural experiments. For instance, Elbla (2012) explores the role of punishment in reforming the behaviour of students in schools. In particular, the study finds that both the verbal and corporal punishments have negative impact on students' behaviour and personality in Khartoum, Sudan. In a similar way, Bar-Ilan and Sacerdote (2004) investigate the impact of punishment on deterring people from the violation of laws.[10] Traffic signals in Israel and San Francisco are used as testing beds for the experiment. The data on cars passed through the red lights was collected by the installed cameras.[11] The behaviour of drivers was observed before and after the increase in fine. The results show that increase in fine sharply decreases the violation of crossing the red lights. On average, the criminally convicted individuals cross red lights more than the non-convicted ones; however, in terms of elasticity, the response of both towards fine is almost similar. Also, youngsters and people with old cars have higher elasticity with respect to fine as compared to older individuals and people having new cars, respectively. In terms of ethnicity, the minority groups in Israel show lower response towards an increase in fine.

Likewise, there are studies which focus on the level of optimal punishment in deterring some crimes. Nikiforakis and Normann (2008), in this regard, provide a comparative static analysis of punishment in a public good game.[12] In particular, they focus on both the effectiveness of punishment and the amount by which the punishment can lessens the receivers' income. In each treatment of the experiment, the individuals were initially endowed with fixed amount of money and the participants decided simultaneously how much to contribute for a public good.[13] The results indicate that contributions increase monotonically with the increase in punishment. In particular,

[9]See, for example, Fehr and Fischbacher (2004) and Nikiforakis (2008).

[10]They examine the impact of punishment on deterrence across different personal characteristics such as age, criminal record, driving record and income.

[11]The experimenter chooses red light signals at 8 intersections point of San Francisco and 73 intersections points of Israel.

[12]Through experiment, they examine the usefulness of four different levels of punishment in terms of contribution to a usual public good. The experiment comprises a repetitive linear public good game with two or more players.

[13]The participants were not allowed to communicate with each other.

higher levels of punishment ensure full cooperation which results in enhancing welfare. However, punishment below a threshold level cannot prevent the deterioration of cooperation for the provision of public good.

To our knowledge, there are no studies which directly examine the impact of punishment on behaviour in the context of misuse of electricity. However, we do find studies which are related to this aspect. For instance, Takeuchi and Mizobuchi (2012) examine whether the behaviour regarding the misuse of electricity can be reformed through incentives. The study is based on the residents of Matsuyama, a city of Japan. In order to see the impact of incentives on the reduction of electricity consumption and, thereby, the reduction in Carbon Dioxide (CO_2), the behaviour of 53 households was tested through the effect of monetary reward on the electricity consumption.[14] The results show that 34 percent of the households successfully reduce their consumption of electricity with an average reduction rate of around 4.8 percent. However, there were some households which did not respond to the economic incentives showing that, for some people, economic reward should be sufficiently high in order to incentivise them in this regard. The results also show that as the economic reward increases, the reduction of electricity consumption also increases. There also exist some experimental studies that test the impact of intrinsic motivation in addition to economic incentive on the conservation of energy. The review of such studies has been provided by Daniel, *et al*. (2016). They discuss three streams of literature related to energy and water conservation. The first stream examines the impact of dynamic billing on the use of energy which shows that when consumers are charged high tariffs at peak time as compared to normal time, the average consumption decreases [Caves, *et al*. (1984); Jessoe and Rapson (2014); Ito, *et al*. (2015)]. The second stream shows that if people are provided information about how much do they consume relative to others; they reduce the consumption of electricity due to social comparison [Allcott (2011); Ayres, *et al*. (2012)]. An experiment related to our work is done by Delmas and Lessem (2014). They use non-financial motive for checking the behaviour of residence halls with students who do not pay electricity bills in University of California Los Angeles (UCLA). In addition to the standard private social comparison, they introduce a treatment that publicly displays which rooms on a floor are above the median consumption and find that public comparisons reduce energy use by 20 percent. The third stream of papers shows that people do not internalise the private cost due to inefficient investment in the energy sector. When they are sensitised, they start investing more and thus reduce the inefficient use of electricity [Allcott and Taubinsky (2015)].

In this study, we focus on the implications of punishment as deterrence for the misuse of electricity. Our sample includes hostels of Quaid-i-Azam University (QAU), Islamabad. We observe the behaviour of students towards electricity consumption while we introduce different types and levels of monetary and non-monetary punishments. Punishments raise extrinsic costs of the agents for misusing electricity. This study is different from the available studies in the sense that actual punishment notices are delivered to students after they were found misusing the electricity.

[14]The field experiment lasted 12 weeks from November 2010 to January 2011.

3. TRENDS AND EARLIER FINDINGS OF THE ENERGY CRISIS IN PAKISTAN

Electricity is one of the key energy sources and plays an important role in the economic activities of an economy. Almost all of the industrial as well as agricultural development is mainly based on the availability of electricity [Alter and Syed (2011)]. Pakistan is facing severe electricity shortfall since 2005.[15] In particular, the existing production is not meeting the current demand of electricity. The overall demand of electricity grew by 23.5 percent between 1980 and 2011 [Kessides (2013)]. The shortfall in May 2012 was estimated at 6,000 Mega Watt (MW) [Ebrahim (2012); The Express Tribune (2011); National Electric Power Regulatory Authority (NEPRA) (2011a, 2011b)]. It slightly declined to 4,250 in June, 2013 with demand standing at 16,400 MW and generation standing at 12,150; however, the gap is still alarming [Pakistan (2015)]. The predictions for the near future demonstrate that the gap between the demand and supply is likely to increase to 8,000 MW by 2017 and 13,000 MW by 2020 [Shahbaz (2011)].

The electricity crisis can be analysed from two perspectives, i.e. the supply side or the demand side. The supply side incorporates the production capacity as well as the issues related to the distribution and transmission of electricity from grid to the end users. As is stated earlier, production capacity of electricity is low in Pakistan with huge distributional losses. For instance, Pakistan, on average, wastes 20 to 25 percent of output of electricity through technical and non-technical losses. This wastage is significantly higher as compared to an average of 4 to 12 percent for developed countries [National Transmission and Dispatch Company Limited (NTDCL) (2011; 2014); NEPRA (2014)]. On the demand side, the inefficient use of electricity is of concern for Pakistan. According to Ullah, *et al*. (2014), 52 percent of the increase in energy intensity since 1972 is caused by the inefficiency in the use of energy. This evidence is supplemented by the fact that Pakistan is far behind the developed as well as many developing countries in terms of energy efficiency. For instance, for each dollar of GDP, Pakistan is consuming 15 percent more energy than India, and 25 percent more energy than the Philippines (Friends of Democratic Pakistan (FDP), 2010). In addition, according to FDP (2010), the energy consumption per unit of GDP for Pakistan is five times higher than the average of the developed countries; and it is two times higher than the world average. The potential saving due to the efficient use of energy in Pakistan is estimated at 18 percent which is equal to 11.16 Million Tons of Oil Equivalents (MTOE), resulting in 51 percent reduction in the net imports of oil [FDP (2010)].[16] All of these trends imply that we have the potential of saving electricity through the demand side measures; however, so far, we have not been able to do so. Given these trends, there has been commendable research conducted on energy issues in Pakistan. However, most of the studies have been conducted in the context of changes in energy prices and their impact on economic growth, inflation and other macroeconomic indicators.[17] To our knowledge, there is only

[15]Although, the gap between demand and supply of electricity is growing for the last 30 years, the severity surfaced since 2005.

[16]For instance, according to FDP (2010), the potential of energy saving just in the one fiscal year of 2008 was estimated at 6.1 MTOE which corresponds to 15.4 percent of the total energy consumed in the country.

[17]See, for instance Jamil and Ahmad (2010), Ashraf, *et al*. (2013), Shahbaz and Feridun (2012) etc.

one study, i.e. Khan, *et al*. (2016), on the micro perspective of energy crisis in Pakistan which shows that the consumption of electricity in public sector is inefficient. In this study, we contribute to this line of research by highlighting the importance of monitoring and punishment mechanisms in addressing inefficiency.

4. EXPERIMENTAL PROCEDURES, TREATMENTS AND HYPOTHESES

In this section, we describe the experimental procedure and provide details of all of the treatments. Also, we state the theoretical framework and the corresponding hypotheses of our analysis.

4.1. Experimental Procedure

The expeirment was conducted in boys' hostels of QAU. There are ten hostels and two annexes for the residence of students in QAU. Male students occupy six hostels; and the rest of the hostels are for female students. Based on convenience, the experiment was conducted in male hostels only.[18] As shown in Table 1, the six boys' hostels accommodated 1424 students. The experiment continued from October 27, 2015 to December 04, 2015. We conducted survey in all boys' hostels for three consecutive days, i.e. Friday, Saturday, and Sunday in each week. As stated earlier, our purpose was to count the number of locked rooms with inside lights switched on. Keeping this purpose in view, the survey was mostly conducted at night from 7:00 PM to 9:00 PM. In this way, we could identify the resident students who misuse electricity.

Table 1

Description of the Boys Hostel of QAU

Hostel No.	Allocation of Students	Number of Rooms	Number of Seats	Number of Seats per Room
3	M.PHIL/PHD	102	204	Bi-Seaters
4	M.PHIL/PHD	102	204	Bi-Seaters
6	MSc(1^{st} and 2^{nd})	90	360	Four-Seaters
7	BS(1^{st}, 2^{nd}, 3^{rd} and 4^{th})	52	208	Four-Seaters
8	MSc(3^{rd} and upper)	112	224	Bi-Seaters
9	BS(5^{th} and upper)	112	224	Bi-Seaters
Total		570	1424	

Source: QAU Prospectus 2015-2016.
Note: M.Sc. and M.Phil. are 4 semesters programmes while BS and PhD are 8 semesters programmes.

[18]Future research can certainly replicate the study for female hostels.

4.2. Experimental Treatments

The experiment comprised six treatments. The details of each treatment are summarised in Table 2. In the Baseline Treatment (BT), we conducted a survey of all boys' hostels and counted the number of locked rooms with inside lights switched on. In this treatment, there was no associated punishment. After the collection of data in BT, we arranged a meeting with the administration of hostels in order to ask for permission for displaying appeal on notice boards. After the approval of provost, the notice was prepared and displayed on all of the notice boards of boys' hostels with the support of hostel administration. After the display of notice on notice boards in SNT, all of the rooms were surveyed in the same way as in the BT treatment. It is worth mentioning that notices were displayed on working days. The survey was conducted after a lapse of at least one day so as to allow students some space for reading the notices. Again, the survey was conducted for three consecutive days, i.e. Friday, Saturday, and Sunday. The HNT was similar to the SNT, except the wording of the notices. Alternatively, this time the notice incorporated harsh words instead of soft request. Again, after the formal approval of hostel administration, the harsh notice was displayed on all of the notice boards of hostels. The notice in HNT advised the students to keep lights of the rooms switched off in their absence. The same notice also warned the students of the issuance of warning letter in case of any non-compliance. After the display of notice, again, the survey was conducted for three consecutive days from Friday to Sunday. In WNT, the notices were hand delivered to all rooms of Boys hostels. The notice was handed over to any of the resident students in their rooms. The wording of the notice was also relatively harsh than HNT. In FFT, each room was fined 500 rupees in case of non-compliance. The per student decomposition implies that, in bi-seater room, a student was fined 250 rupees while, in four-seater room, each of the resident was fined 125 rupees. FOT was similar to FFT, except the amounts of fine. In FOT, the fine was raised to 1000 rupees per room in case of non-compliance. Even, in this case, the fine on room implied equal distribution among the resident students. While delivering the fine notices, a copy was kept in the personal file of each student for record purpose. Like, the previous treatments, in WNT, FFT, and FOT, the survey was conducted for three consecutive days. In the survey, we noted down the number of locked rooms with their inside lights switched on for each treatment.

In this study, violation is defined as "locked room with inside light switched on" and is measured as "the percentage of locked rooms with inside lights switched on in the total locked rooms". For each treatment, we take the average for both the total number of locked rooms with inside light switched on and the total number of locked rooms across the three times survey. We are interested in the decline in intensity of the violation, in this regard. However, we do not treat one-time violator and multiple-times violators differently, when we assign them the monetary punishment. This is the limitation of this study as we could not send fine notices on weekends.[19]

[19]Treating one-time and multiple-times violators differently could trigger protest from students as students could ask that why they were not informed on the first violation, which was not possible administratively on weekends.

Table 2

Details of Treatments

Treatments	Date of Notice	Date of Survey	Relevant Wording in the Notice[20]
Baseline Treatment (BT)	No Notice	October 28 November 2 and 3, 2015	No Notice
Soft Notice Treatment (SNT)	November 5, 2015 (Displayed on Notice Boards of Hostels)	November 6, 7, 8, 2015	All the residents of the boys' hostels are advised to switch-off the lights, fans etc. as they leave their respective rooms.
Harsh Notice Treatment (HNT)	November 11, 2015 (Displayed on Notice Boards of Hostels)	November 13, 14, 15, 2015	All the residents of the boys' hostels are strictly advised to switch-off lights and other electrical appliances etc., as they leave their respective rooms. In case of non-compliance, warning notices will be issued to all resident students of a room.
Warning Notice Treatment (WNT)	November 18, 2015 (Delivered to all Students of Hostels in their Rooms. In Locked Rooms, Notices were Dropped inside)	November 20, 21, 22, 2015	It has been observed that, in spite of repeated notices issued by the office, the students do not switch off the lights of their rooms in their absence. It is sheer negligence and wastage of energy resources. Students are, therefore, finally warned to switch off all the lights and other electric appliances while leaving the room. In case of non-compliance, heavy fine will be imposed on the violators.
Fine of Five hundred rupees Treatment (FFT)	November 26, 2015 (Delivered to Violators only. The notice included Names, Department and Semester of all resident students of a room)	November 27, 28, 29, 2015	In exercise of the powers vested in Provost under the clause 17(a) of QAU Hostel Regulations, 1996, the residents of the room are therefore fined Rs 500/- collectively (i.e. Rs.125/-each in four seater room and Rs 250/-each in bi-seater room). The students are therefore, directed to deposit the above mentioned fine into the authorised university account under intimation to this office by December 07, 2015. Failing to comply with instructions or refusing to receive the notification would be considered as another act of indiscipline or cognisable offence under the law.
Fine of One thousand rupees Treatment (FOT)	December 2, 2015 (Delivered to Violators only. The notice beared Names, Department and Semester of all resident students of a room)	December 4, 5, 6, 2015	In exercise of the powers vested in Provost under clause 17(a) of QAU Hostel Regulations, 1996, the residents of the room are therefore fined Rs 1000/- collectively. All the residents of the room are, therefore, directed to deposit the above mentioned fine collectively into the authorised university account under intimation to this office by December 10, 2015. Failing to comply with instruction or refusing to receive the notification would be considered as another act of indiscipline or cognisable offence under the law.

4.3. Theoretical Framework and Hypotheses

[20]See detailed wording in Appendix.

As discussed above, Quaid-i-Azam University charges each student fixed amount of fee per semester for hostel. The fee includes room rent, furniture, utilities, and other related services. On average, the amount of fee remains the same for each student during the entire period of study. As the students are not charged separately for utilities, therefore, at the end of each month, the university pays all utility bills. The students usually remain unaware about the exact amount of units of electricity that they consume each month. If we take electricity as a consumer good for the student; then equilibrium implies that the marginal benefit from consumption must be equal to the marginal cost. The consumption of electricity is beneficial for a student when he remains in his room; however, once he leaves his room, then the marginal benefits become zero for him.[21] In comparison, the marginal cost of electricity is independent of consumption as far as an individual student is concerned.[22] In other words, we can say that the price of each additional unit of electricity is zero for each student. This discrepancy between the marginal benefit and marginal cost leaves no incentive for the students to conserve electricity. Accordingly, we might expect that the students will not be careful about switching off lights of the rooms in their absence. Thus, the probability of leaving the lights switched on in locked rooms increases with the misperception of students regarding the payment mechanism of electricity by the university.[23] In order to motivate students for switching off lights in their absence, we have to enhance the marginal cost of switched-on lights in locked rooms. Alternatively, if the students are made liable for the cost of leaving lights switched on in locked rooms, we can reduce the misuse in electricity consumption. This is the focus of this paper where we want to see the impact in the notice treatments.

In SNT, HNT and WNT, if the students do not read notice boards; then the behaviour of students across the BT and these treatments might not be different. Also, even after reading the notices, the effect might not be different across these treatments if the students take the message like a cheap talk and consider the warning a non-credible threat. The reason is that as per the information of hostel administration, the students were never given warning notices on leaving lights switched on inside a locked room. In contrast, in FFT and FOT, the behaviour of students might be different as compared to BT because the students are monetarily punished for leaving lights switched on in locked rooms. This is due to the fact that the marginal cost of misuse increases while the marginal benefit, which is zero, remains the same. Therefore, majority of students are likely to abstain from leaving lights switched on in locked rooms in the fine treatments. Based on the above discussion, the hypotheses of the study are given below:

H1: The behaviour of students towards switching off lights in locked rooms is likely to be the same across BL and SNT, HNT and WNT.

[21]For instance, he will need light for study, fans for cooling etc. when he is inside the room.

[22]The reason is that the charges of electricity do not depend on the amount of consumed units of electricity. Rather it is fixed and collected in bulk at the time of fee submission at start of the semester.

[23]The students fail to realise that the government funds universities for meeting their expenditure. This funding, in turn, is financed by the taxes which are either directly or indirectly paid by almost all of the citizens of Pakistan. Thus, the students who misuse electricity in the university hostels also pay taxes to government in the form of sales tax, mobile phone taxes etc. So, the cost of misusing electricity is to some extent paid by the students. As on average people are not much rational to perceive the complexities of all this process as is shown from the results of centipede game where player do not play equilibrium per backward induction. Hence, higher misperception implies higher misuse of electricity.

H2: The behaviour of students towards switching off lights in locked rooms is likely to be different across BL and FFT, FOT.

Also, it is established in the literature that some people consider the imposition of fine like a price, hence it is likely that the students remain careless even after monetary punishment [Gneezy and Rustichini (2000); Siang (2012)]. For instance, according to Gneezy and Rustichini (2000), when parents are fined for picking up kids late from a day care center; the parents further delayed the arrival time instead of coming on time. Likewise, Siang (2012) shows that imposing fine on employees does not improve the attendance rate as employees consider paying fine like a price for their late coming. Based on this discussion the third hypothesis of the study is:

H3: The behaviour of students across FFT and FOT might not be different.

5. EXPERIMENTAL FINDINGS

In this section, we discuss the findings of our analysis. We divide this section into three subsections. In subsection 5.1, we provide an overview of the overall findings across all the treatments. In addition, we discuss the decomposition of findings across the degree levels of the consumers. In subsection 5.2, we discuss a comparative analysis of the impact of each treatment on the behaviour of misusers of electricity. Finally, in subsection 5.3, we explore the overall impact of experiment on the overall consumption of electricity.

5.1. Overview of Findings Across Treatments

Table 3 shows an overview of the overall findings across all treatments. As is evident from the Table, there is a continuous reduction in the percentage of locked rooms with inside lights switched on with the introduction of notices and the associated punishment. The impact of soft and harsh notices is small; however, still, it is significant in both cases as compared to the BT ($p<0.05$ and $p<0.01$ in both cases, respectively).[24] This finding is contrary to hypothesis 1 where we claim that the behaviour of students towards switching off lights in locked rooms is likely to be the same across BL, SNT and HNT. In other words, some individuals require just a reminder for reforming their behaviour which the soft and harsh notices in SNT and HNT respectively offer to them. Likewise, the comparison of SNT and HNT implies that both are almost similar in impact ($p=0.33$). This, in other words, suggests that individuals who are insensitive to notices behave in the same way in case of both the soft and harsh notices. It also shows the carelessness on part of the students towards minor changes in the wording of notices displayed on notice boards.[25] Alternatively, for such students major changes in wording such as warning matters may incentivise them to conserve electricity due to the increase in the marginal cost associated with that warning. This fact is shown by the comparison of HNT and WNT. As we can see from Table 3, there is a significant reduction in the percentage of locked rooms with the inside lights switched on in WNT as compared to HNT ($p<0.01$). Further, the introduction of monetary punishment is more effective as

[24]This p-value is the corresponding value of z-statistic of unequal variances while using the number of locked rooms with inside lights switched on as observation.

[25]It is possible that they might not have studied the displayed notices.

compared to warning. For instance, the percentage of locked rooms with inside lights switched on declines to 29.53 percent in FFT and 29.47 percent in FOT as compared to 42.32 percent in WNT ($p<0.01$ in both cases). This finding is in line with hypothesis 2 which claims that the monetary punishment is more effective. This also confirms that punishment decreases the issue of moral hazard or increases cooperation in the presence of free riding which is already established in the literature by Polinksy and Shavell (1984); Ilan and Sacerdote (2004); Visser, *et al.* (2006); and Nikiforakis and Normann (2008). Moreover, it is pertinent to mention that the comparison between FFT and FOT provides some support to the conjecture that fine is a price which is predicted by Gneezy and Rustichini (2000).

Table 3

Part I: Overview of Findings Across Treatments

Treatments	Total Number of Locked Rooms in all the three Rounds	Total Number of Locked Rooms with Inside Lights Switched On in all the three Rounds	The Percentage of Locked Rooms with Lights Switched On
BT	368	253	68.75%
SNT	637	412	61.77%
HNT	713	422	59.19%
WNT	638	270	42.32%
FFT	762	225	29.53%
FOT	638	188	29.47%
Total	3756	1770	47.12%

Part II: Inferential Comparison of Treatments

Treatments	P-Value	Treatments	P-Value
BT vs SNT	0.026	SNT vs FOT	0.000
BT vs HNT	0.002	HNT vs WNT	0.000
BT vs WNT	0.000	HNT vs FFT	0.000
BT vs FFT	0.000	HNT vs FOT	0.000
BT vs FOT	0.000	WNT vs FFT	0.000
SNT vs HNT	0.332	WNT vs FOT	0.000
SNT vs WNT	0.000	FFT vs FOT	0.984
SNT vs FFT	0.000		

Note: The survey was conducted for three consecutive days. Therefore, the number of rooms here implies that it is out of the total of 1710=570*3.

Most of these descriptive results are confirmed by the simple regression analysis which is shown in Table 4. As is evident from columns 1 to 5 in Table 4, all the dummies for all the treated rounds except SNT and HNT are significant in reducing the number of locked rooms with inside lights switched on. Column 6 confirms this finding further, once we incorporate the dummies for all of the treated rounds in the same regression. Columns 7 and 8 show an important finding that monetary punishment is more effective

as compared to non-monetary punishment.[26] Alternatively, warnings associated with SNT, HNT and WNT, respectively are less effective as compared to monetary fines associated with FFT and FOT. As shown in Table 2, we have two types of hostels i.e. in some hostels, rooms are bi-sweaters while, in others, they are four-sweaters. Consequently, the punishment per resident varies across these two types as the imposed fine is on per room basis. In order to check the robustness across this variation, in column 10, we add the dummy for hostels having four-sweater rooms. However, we find no significant difference. Our results are robust with regard to the fine burden per student.

The overall findings can be decomposed across different units, i.e. hostels, of the survey. In this way, we can analyse the behaviour of students while controlling for the type of degrees for which they are enrolled in the university. As we have shown earlier that MPhil/PhD students reside in hostels 3 and 4; MSc students reside in hostels 6 and 8; BS students reside in hostels 7 and 9, therefore, we merge the data of these hostels by the level of degrees in which the resident students are enrolled. The details of this composition are shown in Table A1 in the Appendix A. It is evident from the Table that, for each level of students, the misuse of electricity declines with each successive treatment. In other words, in each hostel, the introduction of notices and fines has beneficial effects on the misuse of electricity. Thus, our results are robust to the different levels of educations.[27]

Table 4

Simple Regression Results

Dependent Variables										
Percentage of Locked Rooms with Inside Light Switched On									Impacted Rooms	Number of Residents in a Room
	1	2	3	4	5	6	7	8	9	10
Constant	60.43***	60.31***	60.74***	56.53***	51.47***	60.43***	56.53***	60.43***	31.46***	60.55***
DSNT	–0.25					–0.25*				
DHNT		1.30				1.17				
DWNT			–16.82***			–16.52***				
DFFT				–25.30***		–29.20***				
DFOT					–21.6***	–30.57***				
DNotices								–5.20		–5.20
DFines							–25.99***	–29.89***	16.30**	–29.89***
D4R										-0.35
N	36	54	72	90	108	108	108	108	30	108
R^2	0.0001	0.0021	0.25	0.36	0.21	0.59	0.47	0.49	0.04	0.49
F	0.00	0.11	23.88***	49.99***	27.38***	29.10***	95.85***	49.55***	4.69**	32.73***

Note: 1. ***=p<0.01, ** = p<=0.05 and *=p<0.01.

2. D with each Treatment denotes dummy for that Treatment. Likewise, DNotices and DFines are dummies for all types of notices and fines, respectively. D4R shows the dummy for rooms with 4 residents.

5.2. Behavioural Impact of Notices and Fines

[26]In columns 7 and 8 we incorporated collective dummies for notices and fines.

[27]In terms of impact, the MSc students are slightly superior to the MPhil/PhD and BS students. For instance, in a sequential sense, the percentage of locked rooms with inside lights switched on is 23.53 percent for MSc students which is lower as compared to 30.10 percent for PhD students and 26.76 percent for BS students.

In this section, we analyse the behavioural impact of notices and fines. In particular, we are interested in analysing the behaviour of those students whose rooms were locked with inside lights switched on in a particular treatment. For instance, we want to see whether the display of notices, warnings or fines in the next treatment plays any role in reforming their behaviour. In order to test this, we follow a sequential approach, i.e. we want to see the impact on behaviour in the next treatment. We capture such behaviour through the following formula:[28]

$$BI = [(CT=0 \ \& \ PT=1)/(PT=1)] \times 100$$

Where CT=0 implies that in current treatment the locked room has inside lights switched off, while PT=1 means the same locked room has inside lights switched on in the previous treatment. The results of this behavioural impact are shown in Table 5. As is evident from the Table, there were 165 rooms which were locked in both the BT and SNT with their inside lights switched on in BT; however, with the introduction of notices during SNT, the residents of 57 rooms switched off their lights. This implies that 34.55 percent of the violators reformed their behaviour with the display of notice in SNT. Likewise, the harsh notice during HNT resulted in the reformation of behaviour of 35.06 percent of the violator students during SNT. This improvement in behaviour is increasing with the severity of punishment. For instance, warning, Rs 500 fine and Rs 1000 fine ended up with the behavioural improvement of 47.16 percent, 58.95 percent, and 68.63 percent of the students, respectively. It is also shown by P-value of Z-statistic for cross-treatment comparison in Table 5. In particular, like the overall results, the monetary punishment is an effective tool in reforming the behaviour of habitual violators of rules. This is also confirmed by the simple regression in column 9 of Table 4 in which the dummy for fines is significant in reforming the behaviour of violators. Again, the decomposition of students by the level of their degrees shows a similar pattern. For instance, Table A2 in the Appendix A shows that the introduction of notices and fines reform the behaviour of violators in similar fashion across all three levels of education in hostels.

Table 5

The Impact of Each Treatment on Reforming the Behaviour of Violators[29]

Treatments	Number of Overlapped Locked Rooms with Lights Switched On in Previous Treatment	Number of Overlapped Locked Rooms with Lights Switched Off in Current Treatment	Percentage of Overlapped Locked Rooms with Lights Switched Off in Current Treatment	Statistical Significance on the basis of Z-statistic (P-value<0.05)
Impact of SNT	165	57	34.55%	---
Impact of HNT	251	88	35.06%	0.9124

[28]BI, CT and PT refer to Behavioural Impact, Current Treatment and Previous Treatment, respectively.

[29]As a limitation of our work, we could not provide such analysis on per room basis due to data record issues.

Impact of WNT	229	108	47.16%	0.0071
Impact of FFT	190	112	58.95%	0.0160
Impact of FOT	51	35	68.63%	0.2077

There is a possible limitation of our study in the sense that we are not able to precisely differentiate whether the locked rooms with lights switched off in the subsequent treatments are the outcomes of our treatment variables or random phenomena? For instance, we do not know whether the students read the notices displayed on notice boards or not? However, we run the baseline treatment three times and calculate the average behaviour of students regarding leaving the rooms locked with lights switched on. Hence, it is our observation that any change in the subsequent rounds can be assigned to the treatment variables. In addition, the information displayed on notice board is shared by students with each other. Hence, we perceive that even if a student has not read the notice board; still, he might have got the information.

5.3. Impact of the Experiment on the Conservation of Electricity

In this section, we examine the probable impact of the whole experiment on the conservation of electricity. For this purpose, we took the electricity bills of all hostels from the office of Project Director (PD) of QAU. We then compared the consumed units of electricity for the months of December, 2014, January, 2015 and February, 2015 with those of the same months in 2015-2016. This comparison is provided in Table 6 which shows that except for the month of December, the consumption declines significantly in all of the remaining months. The overall impact shows that, with the experiment, the electricity consumption declines by 23040 KWh during these three months. This, in other words, suggests that if we establish an efficient monitoring system with appropriate punishment mechanism, we can achieve efficiency in terms of energy conservation. Likewise, the comparison between different levels of students demonstrates that for all levels except MSc students the consumption of electricity declines after the experiment.[30] It is pertinent to mention that, during the experiment, the hotels' administration installed 24 electric geysers of 1000 KW. Hence, the real impact might be under estimated due to this factor. One might ask about the other factors that could lead to the conservation of energy such as the break time between the two semesters etc. However, we opine that this work compares the same months for two consecutive years, where all other factors including the break time are controlled for automatically. Hence, in this regard, we can at least perceive a correlation between the behaviour of conserving energy and the fear of being punished.

Table 6

Comparison of the Consumed Electricity before and after the Experiment (in KiloWatt-hour(KWh))

Months	Before Experiment (2014-2015) (consumed units in KWh)	After Experiment (2015-2016) (consumed units in KWh)	Difference between 2014-2015 and 2015-2016 (consumed units in KWh)

[30]See Table A3 in the Appendix A for the details.

December	52280	62200	9920
January	137320	123520	–13800
February	196880	177720	–19160
Total	386480	363440	–23040

6. CONCLUSION

This study is motivated by the previous literature that emphasises the role of punishment in situations, involving moral hazard. Additional motivation is given by the findings with regard to the recent energy crisis in Pakistan. Inefficiency in energy consumption is considered as one of the major factors responsible for this crisis. In this study, we examine how monitoring and the associated punishment mechanism resolve moral hazard as far as the electricity consumption in public sector is concerned? We use the framework of a field experiment which comprises six treatments. The experiment was conducted in boys' hostels of Quaid-i-Azam University (QAU), Islamabad. We focus on three aspects. First, we examine how monetary and non-monetary punishments incentivise individuals to abandon the misuse of electricity? Second, we focus on the behaviour of violators of rules, i.e. misusers of electricity. For instance, we investigate how their behaviour towards misuse changes with the severity of monetary and non-monetary punishments. Third, we explore the overall impact of the experiment on the overall conservation of electricity.

Based on our indicator of misuse, i.e. the number of locked rooms with inside lights switched on, our analysis shows three important findings. First, people are responsive to both monetary and non-monetary punishments. For instance, with the introduction of punishments, we observe declining trends in the ratio of locked rooms with inside lights switched on. In particular, the trend in this change gets steeper over the severity of both the non-monetary and monetary punishments. When individuals are informed about their misuse of electricity in a soft tone; they show a weak response in terms of change in their behaviour. In contrast, when they are informed in a harsh tone; their response enhances as compared to that of the soft tone. Likewise, the response level strengthens once individuals are made liable to monetary punishment. Second, the individuals who are habitual violators of rules show reformation in their behaviour with the severity of punishments. In our case, we define habitual violators of rules as those who regularly keep lights switched on in their locked rooms. This finding negates the objection which people might make that the positive response towards monetary and non-monetary punishment may be due to new residents. Instead, our findings reveal that even those who are habitual violators show response to both the monetary and nonmonetary punishment. Again, the response to the monetary punishment is higher than that of the nonmonetary punishment. Third, with regard to the overall impact of the experiment, our finding shows that people start conserving electricity once they are made liable to monetary and non-monetary punishments. This is shown by the reduction in overall consumption of electricity after the experiment. This finding negates the doubts about the possible retaliation in terms of misusing the other non-visible electric appliances such as iron-rods.

The study suggests that once individuals are informed about the external effects of their actions of moral hazard; they reform their behaviour. Consequently, if a monitoring

system with the associated punishment mechanism is introduced; we can have beneficial effects in terms of resolving the moral hazard in energy consumption. However, future research in this strand is certainly needed in order to have clear policy guidelines in this regard. For instance, this experiment is undertaken only in boys' hostels. The same experiment with the same number of treatments can be done in female hostels for having a gender-based comparison. Likewise, the experiment is focused on students. Future research can examine the behaviour of employees in a public sector institution. Similarly, future research can also examine the issue of moral hazard by observing the use of electricity in the rooms for heating and cooking purposes, which is not allowed in most of the hostels; however, this requires physical inspection of each room. A limitation of our study is that hostel administration does not allow such uses to a student. Hence, we used "locked room with lights switched on" as a proxy for the moral hazard of using electricity for heating and cooking purpose. We assume that though this proxy captures the issues of moral hazard but it is not its perfect substitute.

APPENDIX-A

Table A1

Part I: Overview of Findings by Different Levels of Education

Treatments	MPhil/PhD	M.SC	BS
BT	72.81%	66.67%	61.11%
SNT	65.37%	62.34%	58.56%
HNT	60.51%	55.19%	63.33%
WNT	41.49%	43.62%	47.13%
FFT	30.23%	23.99%	36.67%
FOT	30.10%	23.53%	26.76%

Table A1

Part II: Inferential Comparison of Treatments by Different Levels of Education (Corresponding P-Values for Each Treatment)

BT	–	–	–
Impact of SNT	0.0949	0.4413	0.4593
Impact of HNT	0.2340	0.1118	0.5028
Impact of WNT	0.0000	0.0098	0.0054
Impact of FFT	0.0060	0.0000	0.0477
Impact of FOT	0.9124	0.6672	0.0588

Table A2

Part I: Impact of Each Treatment on Reforming the Behaviour of Violators by Different Levels of Education

Treatments	MPhil/PhD	M.SC	BS
Impact of SNT	34.21%	33.96%	36.11%

Impact of HNT	33.62%	39.76%	30.91%
Impact of WNT	48.51%	43.48%	49.15%
Impact of FFT	59.49%	60.94%	55.32%
Impact of FOT	51.00%	69.23%	68.42%

Table A2

Part II: Inferential Comparison of Treatments in Terms of Reformation by Different Levels of Education (Corresponding P-Values for Each Treatment)

Treatments	MPhil/PhD	M.SC	BS
Impact of SNT	–	–	–
Impact of HNT	0.93624	0.4965	0.6030
Impact of WNT	0.0271	0.64552	0.0477
Impact of FFT	0.14156	0.04444	0.5287
Impact of FOT	0.2757	0.57548	0.2187

Table A3

Comparison of the Consumed Electricity before and after the Experiment by the Level of Degrees (in KiloWatt-hour(KWh))

	MPhil/PhD Students		MSc Students		BS Students	
Months	2014-2015	2015-2016	2014-2015	2015-2016	2014-2015	2015-2016
December	19520	21000	17240	22480	15520	18720
January	51600	48240	42120	50240	43600	25040
February	66280	64000	68600	58440	62000	55280
Total	137400	133240	127960	131160	121120	99040
Net Difference	–4160		3200		–22080	

Note: The Net Difference is total units consumed in 2015 subtracted from those in 2014.

Fig. A1. Overview of Findings Across Treatments

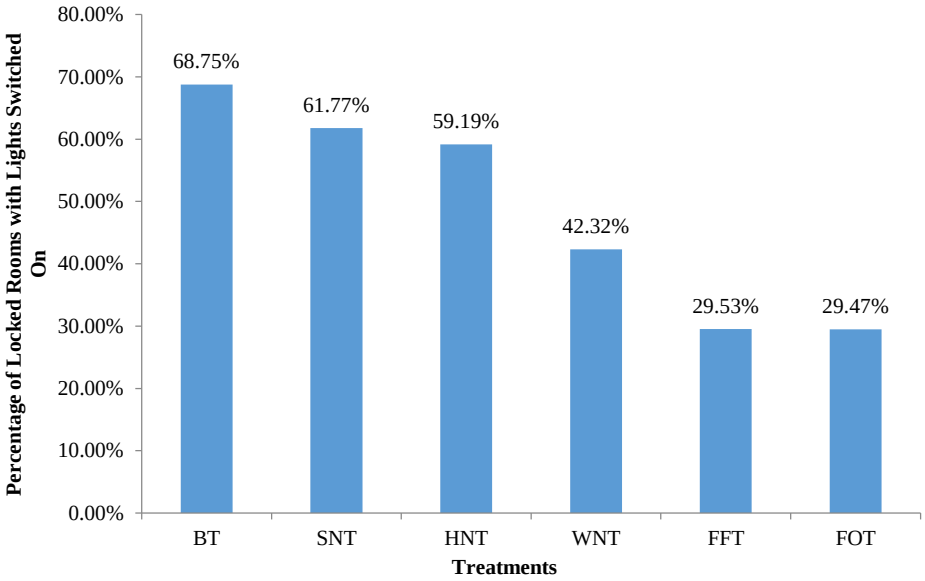


Fig. A2. Decomposition of Students by the Level of Degrees

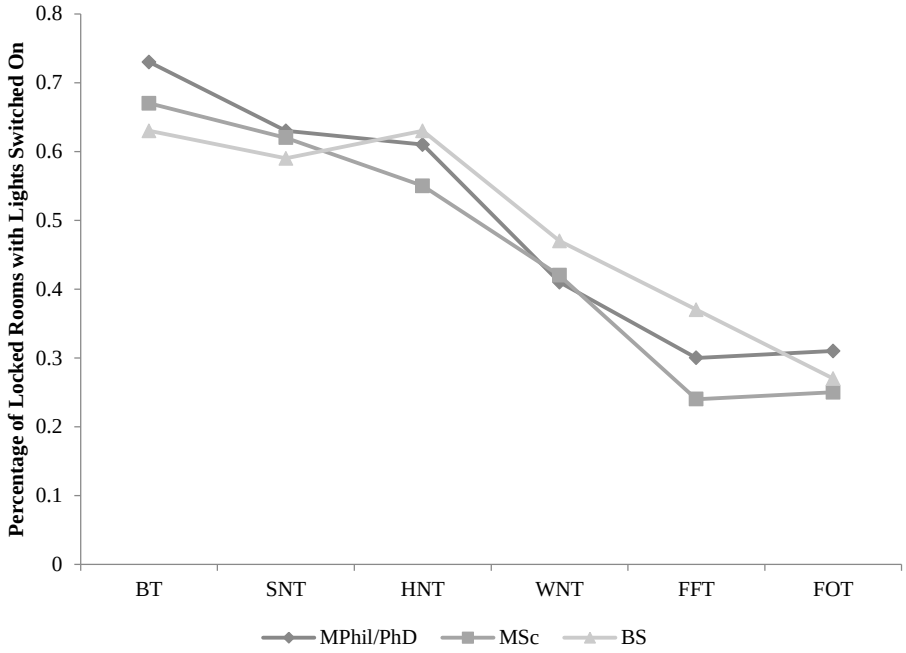


Fig. A3. The Impact of Each Treatment in Reforming the Behaviour of Violators

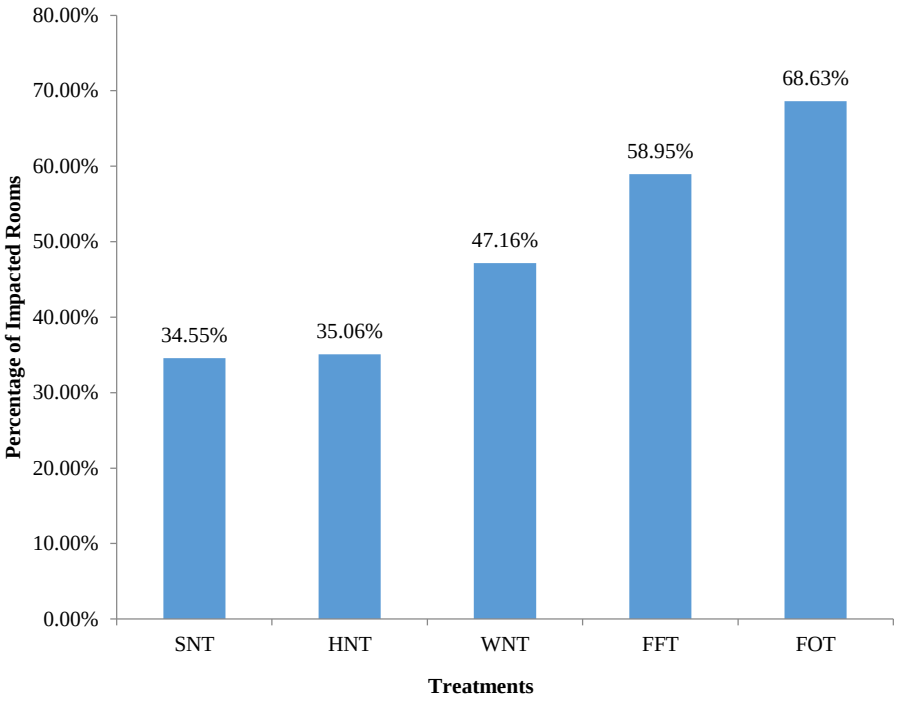
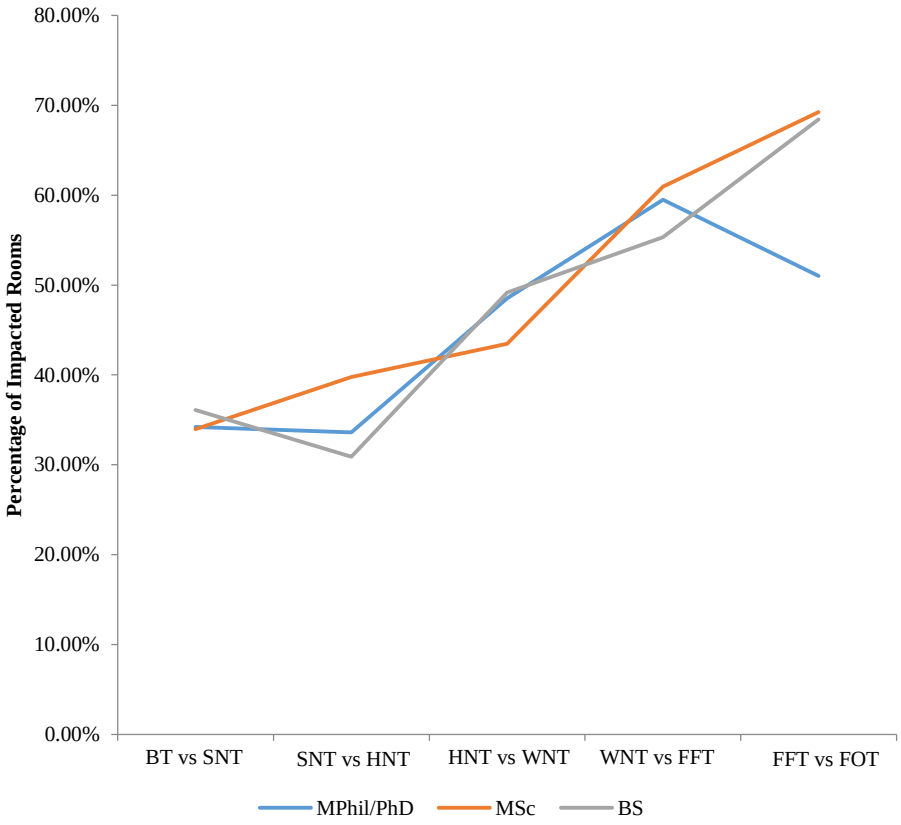


Fig. A4. The Impact of Each Treatment in Reforming the Behaviour of Violators by the Level of Degrees



APPENDIX-B

In this appendix we provide the copies of the notices that we used for different treatments.

B1 Copy of the Notice for SNT

Notice for the Economical use of Electricity in Hostels

It has been observed that some of the boarders do not switch-off lights/other electrical appliances while leaving their rooms. As we all know the current critical situation of a wider gap between supply and demand of electricity culminating into ever-worst situation of load-shedding, hence we utterly need to adopt a habit of judicious use of electricity.

Therefore, all the residents of the boys hostels are advised to ensure switch-off the bulbs, fans etc. as and when they leave their respective rooms.

Senior Warden (Boys hostels)

B2: Copy of the Notice for HNT

Second Notice for the Economical use of Electricity in Hostels

It has been observed that in spite of the first notice dated 06/11/2105 for the economical use of electricity in hostels, most of the boarders do not switch-off lights/ other electrical appliances while leaving rooms locked. The current situation of wider gap between the supply and demand of electricity at national level is known to all. Hence, we need to adopt a habit of judicious use of electricity in hostels.

Thus, all the residents of the boy's hostels are strictly advised to ensure switch-off lights/ other electrical appliances etc., as and when they leave their respective rooms locked. In case of non-compliance warning notice will be issued to all dwelling students of a room.

Senior Warden (Boys Hostels)

B3:Copy of the Notice for WNT

QUAID-I-AZAM UNIVERSITY

(Office of the resident Warden)

No.QAU/BH/2015- Dated:------

Subject: **Warning**

It has been observed that in spite of repeated notices issued by this office, you do not switch off the lights of your room while leaving it. It is sheer negligence and wastage of energy resources. You are, therefore, finally warned to switch off all the lights and electric appliances while leaving the room. Failing to comply with the instructions, heavy fine will be imposed on you.

Resident Warden

Unit A/B/C

Room No------- Hostel No------

Copy:-

Provost/ Senior Warden for information please.

B4: Copy of the Letter FFT

QUAID-I-AZAM UNIVERSITY

(Office of the Provost)

No.QAU/P(BH)/2015-1916

Dated: 25.11.2015

Fine Notice

With reference to this office Warning letter No.QAU/BH/2015-1875 dated 17.11.2015 regarding misusing of lights and other electric appliances, it has been once again noted during physical checking. That you did not follow the instructions of this office and also noted that lights of your room were still switched on while the room was locked.

In exercise of the powers vested in Provost under clause: 17(a) of QAU, Hostel Regulation, 1996 the allottees of the room are therefore fined Rs 500/- collectively (i.e.

Rs 125/-each in four seater room and Rs 250/-each in bi-seater room) The student (s) is/are therefore, directed to deposit the above mentioned fine into the authorised university account under intimation to this office by 07.12.2015. Failing to comply with instruction or refusing to receive the notification would be considered as another act of indiscipline/cognisable offence under the law.

Senior Warden

Room No._____ Hostel No___
Name of the allottees

1. Name _____ Deptt __ Sem __
2. Name _____ Deptt. __ Sem. __
3. Name _____ Deptt. __ Sem. ___
4. Name _____ Deptt. __ Sem. __

Distribution:

- Chairperson Concerned Department
- Provost (Boys Hostels)
- Controller of Examinations
- Treasurer
- Resident Warden with the direction to facilitate delivery of above notification to the concerned student at the earliest. In case of non-compliance please report back.

B5: Copy of the Letter for FOT

QUAID-I-AZAM UNIVERSITY

(Office of the Provost)

No.QAU/P(BH)/2015- Dated:- 02.12.2015

Fine Notice

With reference to this office Warning letter No.QAU/BH/2015-1875 dated 17.11.2015 and subsequent fine of Rs 500/- collectively vide notification No.QAU/P(BH)/2015-1916 dated 25.11.2015 regarding the misuse of lights and other electric appliances, it has been found that you once again did not follow the instructions of this office and left the lights of your room switched on while the room was locked. The date of the survey of your room is dd/mm/yy at xy pm

In exercise of the powers vested in Provost under clause: 17(a) of QAU, Hostel Regulation, 1996 the allottees of the room no ---xy---are therefore fined Rs 500/- each.

All the allottee of the room is therefore, directed to deposit the above mentioned fine into the authorised university account under intimation to this office by 10.12.2015. Failing to comply with instruction or refusing to receive the notification would be considered as another act of indiscipline/cognisable offence under the law.

Senior Warden

Room No._____ Hostel No.___
Name of the allottees:

1. Name _____ Deptt __ Sem __

2. Name _____ Deptt. __ Sem. __
3. Name _____ Deptt. __ Sem. ___
4. Name _____ Deptt. __ Sem. __

Distribution:

- Chairperson Concerned Department
- Provost (Boys Hostels)
- Controller of Examinations
- Treasurer
- Resident Warden with the direction to facilitate delivery of above notification to the concerned student at the earliest. In case of non-compliance please report back.

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Policy Failure in Achieving Universal Basic Education: A Theoretical Analysis

ZAHID SIDDIQUE, FAISAL JAMIL, AYESHA NAZUK, and EATZAZ AHMAD

Universal attainment of basic education is recognised as a key development goal; whereas early-age work is considered as a barrier to achieving this goal. The literature suggests that returns to education are larger than those of early-age work, and that child-labour results in long term social loss that reduces human capital. This study evaluates the argument that early-age work can itself lead to accumulation of human capital when it takes the form of apprenticeship career path. The paper develops a model that allows a rational agent (parent) to compare the early-age work as apprenticeship career path with the formal education career and shows that the parents' career choice for their child will depend on the lifetime earnings of both careers. The theoretical model is further extended and empirically tested to check whether benefits of education are higher for all levels of education. The simulation analysis suggests that for lower level of education up to Grade-12, the benefits of apprenticeship exceed the net benefits of education whereas, at Grade-12 and beyond, the net benefits of education in terms of earnings outstrip the apprenticeship career. The study implies that early-age work may not necessarily be inefficient when compared with low levels of schooling and that any intervention should ensure universal education for all without compromising skill development of resource poor children. This can be achieved through making skill development complementary to education.

JEL Classifications: H44, H52, I26, J24
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1. INTRODUCTION

The prevalence of early age work in less developed countries is generally attributed to mass poverty. In this backdrop, the policy either incentivises parents by offering conditional cash transfers to ensure that they send children to school, or takes coercive action to control child-labour. The economic theory views child-labour as a source of inefficiency because returns to education are large and early-age work results in reduced stock of human capital thus lowering lifetime earnings of the child [Basu and Van (1998); Basu and Ray (2001)]. Resultantly, policy-makers attempt to address all forms of child-labour through same regulatory measures such as banning the child-labour and incentive mechanisms. The incentive mechanism, in the prevailing policy framework is designed to compensate the direct and indirect costs of education with the presumption that these measures would essentially motivate parents to send their children to school.

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Another dominant concept of early-age work views it as an outcome of parents' selfishness. The parents have two options, either to invest in future of their children by equipping them with marketable skills mainly through education or to borrow from the future by choosing early age work for their children. The early-age work can be distinguished between the two kinds of work that a child can take up. First is the type of work that results in skill development over time such as working with motor mechanic, electrician, plumber, or tailor. There is generally no arrangement to impart useful indigenous skills in the formal educational or vocational institutions. We term apprenticeship career path for this kind of skill developing work in the informal sector. Second is the unskilled work that does not develop any specific marketable skills for instance, dish washing in hotels, household servants. It is a fairly justifiable assumption that the choice of parents to employ their children into this kind of non-skill developing work is the household strategy for subsistence and survival whereas the choice of an apprenticeship career path represents a futuristic career building strategy.

The literature suggests that human capital development depends on the level of education acquired by an agent. Empirical studies generally rely on the presumption that a relatively higher level of education always produces higher future earnings. Such studies use years of schooling as a proxy for education where each additional year of schooling raises the income level. This treatment of years of schooling seems less suitable to study the schooling choice of parents in the less developed countries. At lower levels of education, job and income prospects are usually lower as compared to the higher levels. If a household has a perception that the child is likely to attain a certain higher level of education where returns to education would exceed those of apprenticeship career path, the agent would be likely to send children to school. However, if the agent believes that the child would not be able to complete a higher level of education primarily due to his circumstances, then he may contemplate a choice between formal education and apprenticeship career path. This implies that the agents perceive education and skill-oriented work as competing career paths and they take into account of the relative gain from the two while making their rational choices. Most of the past studies conclude that early-age labour is necessarily inefficient and ignore the fact that some parents consider early-age work as a source of human capital development.

This paper develops a cost-benefit model that incorporates apprenticeship as an alternative career path to analyse its implications for the rational choice of an economic agent. In this context, the policy framework aiming at universal basic education cannot fully take into account the incentives required by the agent who chooses apprenticeship career path instead of formal education. The model shows that the prevailing policy instruments are unlikely to alter the choices of the agent and hence economies will fail to materialise the goal of universal education through these policy interventions. The model demonstrates that early-age work may not necessarily be inefficient as compared to different levels of education. The model suggests that in order to achieve the goal of universal education an overarching policy intervention is required that may educate the children by not compromising the skill and earnings development. Using the theoretical framework of the study, we conduct a simulation analysis to determine the level of education where benefits of education equal the benefits of apprenticeship. The analysis shows that at a lower level of education, the lifetime benefits of apprenticeship are higher

than that of formal education. For higher levels of education, the simulation analysis suggests that the net income earnings of education career path outstrip the earnings of early age work career. The simulation results are in agreement with the theoretical cost benefit analysis. The results imply that the goal of universal education can be achieved by improving quality of education as well as by banning the early age-work through regulatory measures.

The rest of the paper is organised as follows. Section 2 briefly reviews the theoretical frameworks within which the supply side determinants of early-age work are analysed. The section also discusses how the issue of early-age work is placed within human capital formation framework and identifies the missing link in the literature. Section 3 highlights evidence of early-age work in less developed countries and regions. The proposed cost-benefit model of early-age work-education choice is presented in Section 4. The section also discusses the failure of existing policy of universal attainment of basic education. Section 5 presents the results of the simulation analysis conducted using available data. Finally, Section 6 concludes the paper and highlights the modifications required in the existing policy regime.

2. EARLY-AGE WORK AND EDUCATION: EVIDENCE FROM LITERATURE

Economics and development literature considers education as the main source of human capital. In his seminal work, Schultz (1961) viewed human capital as capacity to adapt and respond to dis-equilibrium situations. Becker (1962) asserted that human capital is embedded in the stock of knowledge and skills that contribute directly to worker's productivity. Human capital not only affects productivity through direct effect on output and income but also has indirect effect on labour allocation. That is why the provision of basic education to children is considered a major public sector activity around the world. Earlier studies such as, Brown, *et al.* (2002) and Amin, *et al.* (2004) view the incidence of child-labour as households' struggle to survive and to make livelihood. Some other studies develop models taking insights from household production model [see, Rosenzweig and Evanson (1977); Becker (1981); Pörtner (2001a)]. In these models, the household maximises utility from different factors including, number of children, schooling, leisure and composite consumption good that are produced using time endowment of family members. Households earn money either by selling goods they produce or by working for wages.

Some recent studies influenced by Mincer (1974) focus on education and its impact on determination of wages. In these models, the household head allocates his time between leisure and paid work. The mother allocates her time among child-rearing and home production while children allocate their time endowment in leisure, education, paid work and household production. These models suggest that if income of husband increases, child education would increase and a rise in mother's income would reduce size of the family since opportunity cost of child rearing activity would increase. Also, it may result in more investment in the child. An increase in expected wage of the child increases the opportunity cost of schooling and hence may decrease attainment of education. An increase in asset holding increases the household income and hence educational attainment of the child also increases.

The demand for education in these models is a function of household income—the lower is parent's income, the higher will be the child-labour. The literature also considers income inequality as a source of child-labour [Ranjan (2001)]. Rogers and Swinnerton (2001) assume an economy that cannot support its entire population without child-labour. In this case, if everyone in the family enjoys equal share in family income then child-labour will prevail. However, the high-income families would not send children to work. Patrinos and Psacharopoulos (1997) highlight the role of family size on the incidence of child-labour and show that the age structure of children in their school going age in a household is important such that more siblings imply less schooling and more child-labour.

Economic shocks may affect parents' choice between work and education for their children. Some studies have viewed child-labour as a strategy to minimise the risk of unpredictable changes in family income due to job loss or bad harvest [Cain and Mozumder (1980)]. Pörtner (2001b) suggests that parents' motivation to see children as insurance increases in an economy where actuarially fair price insurance is not available. The child-labour as a form of risk minimising insurance implies that child-labour can prevail even during times when household may not require income of child for subsistence in normal time periods. Ejrnæ and Pörtner (2002) argue that children are perceived by the household as a tool of insurance to reduce future uncertainty. Parents invest in the number and quality of their children to maximise the 'value of family'. Land holding is the most attractive alternative source of earning in economies having less developed financial markets. Thus, if the return on education is low as compared to that of land, then the maximisation of family value takes the form of a large number of child farm workers. Such models highlight the importance of parents' education in determining the supply of child-labour. Parents with higher education are expected to have higher future income and hence have less need to insure themselves through child-labour. Mother's education is even more important in determining the educational attainments of children. These models also provide insights into the determinants of optimal family size which in turn determines the human capital development. Families lacking access to credit are more likely to withdraw children from school when faced with downturn in economic activity [see, Duryea (1998); Behrman, *et al.* (1999); Skoufias and Parker (2001)].

Theoretical models generally assume perfect land and labour markets which in reality is not the case. Skoufias (1995) highlights several types of land and labour market imperfections that may affect the optimising decision of the household. One of such imperfections relates to the difficulties in employing labour or leasing out land primarily due to principal-agent issues. This market imperfection implies that as land ownership increases, the tendency to employ family children increases. This relationship may be reversed in the case of competitive markets due to the income effect of large landholdings. Laitner (1997), Parsons and Goldin (1989), and Jacoby and Skoufias (1997) analyse how capital market inefficiencies can lead to inefficient decisions by parents regarding child-labour. When parents do not have access to capital markets, they cannot borrow against their expected future earnings when children are young in the current time period. In this scenario, they rely on internal resources of the family. Child-labour today, instead of investment in human capital formation through education, is then a kind of borrowing from future. Because returns to extra hour of schooling are expected

to be higher than that of work, the decision to send child to work is inefficient in dynamic setting but the agent finds it optimal in the constrained situation. These studies highlight the importance of parents' access to financial markets.

Basu and Van (1998) model another structural issue of labour market to analyse the phenomenon of child-labour. The study proposes that the supply of child-labour is positive when wage of parents is less than a critical level such that once their wage reaches that critical level, they withdraw their children from labour force. This implies that the aggregate labour supply both from parents and children has a backward bending curve. When child-labour reaches the zero level, the supply curve becomes positively sloped. The above formulation implies two stable equilibriums in labour market. The market clearing wage would be low in the presence of child-labour. Once child-labour is banned, the market wage rate will rise and in effect, parents do not need to send children to work. Hence, the study suggests that the economy may be stuck in low-wage trap and recommends a complete ban on child-labour. Basu (2000) shows that labour market with adult unemployment can lead to child-labour. The study analyses the effect on child-labour of minimum-wage law that is expected to create unemployed adults and these parents may use the child's earning to minimise the effects of loss in their earning.

Becker (1974) explains child-labour in terms of parents' selfishness and assumes that parents will have children only when they expect to earn positive return from them. Cigno and Rosati (2000) also developed a model of non-altruistic parents where each family is supposed to pay an amount to the parents when they become adult. The size of the payment by itself is a function of child's human capital formation activities and consumption. In this setting, parents maximise the value of their children because it maximises their old-age returns. Basu and Ray (2001) asserted that child-labour phenomenon is also affected by the balance of power between parents such that the more the decision making power is equally distributed among the father and mother, the less likely is the child-labour.

The past studies while explaining the phenomenon of child-labour, ignore the altruistic role of parents who choose apprenticeship career path for their children because the literature on human capital usually views early-age work as a source of deterioration of human capital. Labour can be reallocated from farming and other low skilled works to those nonfarm sectors where more skills are required [Fafchamps and Quisumbing (1999)]. Mincer (1974) proposed a methodology to estimate the returns to human capital, where human capital is measured through the level of education and work experience. The process of accumulation of human capital is used by economists to understand the choice between early-age work and education. The relationship between human capital and child-labour is usually viewed as of substitutes where child-labour decreases human capital by forcing the child away from education. Since returns to education are greater than returns to child labour, hence child-labour is dynamically inefficient.

Baland and Robison (2000) use maximisation of family value type model to analyse human capital formation through education. The model has an intertemporal aspect in decision making where, altruistic parents, having ability to leave bequest and having access to capital markets invest efficiently in education to their children. The optimal investment decision regarding child-labour and child education in this setup is based on comparing the value of a child's labour earning with the present value of earnings to the family due to child's human capital acquisition in school.

Emerson and Shawn (2007) model the role of parents' expectations for child-labour, fertility and education decisions and show that there is a range of income where the child is expected to receive incomplete education if parents have the belief that the return to education is low. Because child participation in labour market reduces his ability to accumulate human capital, the act of sending the child to labour market fulfils the pessimistic expectations of the child. Contrarily, if parents expect that the return to education is high, then the child completes his education, hence there is no child-labour. The paper has the implication that onetime regulatory measures, such as banning of child-labour and compulsory education, can take an economy out of child-labour equilibrium to no child-labour equilibrium because this would remove child-labour from the choice set of the agent. However, the model shows that the welfare effects of such a policy intervention depend upon the stage of development process.

The above models make a questionable implicit assumption that returns to education are always greater than returns to early-age training at workplace. This is so because these models see education as the primary source of human capital formation without realising that early-age apprenticeship can also be a source of acquiring valuable productive skills. Also these models ignore the role of parent's perception about the likelihood of their child completing some appropriate level of education (termed *critical level* in this paper). Emerson and Shawn (2007) incorporated parent's expectations about returns to education for explaining the choice between education and child-labour, but it misses the point that expected returns to education depend upon the expected level of education that a child would attain. The proposed model captures this missing link of the literature and investigates its implications for policies aimed at universal basic education.

3. EVIDENCE FROM LESS DEVELOPED REGIONS

Universal attainment of basic education is recognised as a desirable development goal included in the Millennium Development Goals (MDGs). It essentially requires that all children should be attending school in their school going age. Therefore, the issue of out-of-school children has been a primary concern for policy-makers. Although, there has been an impressive progress towards this goal, yet fully achieving this goal in some developing countries remains a challenge. It requires that all the school going age children are enrolled in school, and schools have the capacity to retain them and their successful completion of primary education. In less developed countries, the enrolment is low due to insufficient public provision of education and quality of education is low in the schools that result in dropouts. Resultantly, the primary completion rates are well below 100 percent as almost 60 million children are out of school in their school going age worldwide as of 2012 (Table 1).

Table 1

Gender-wise Differences in Educational Attainments in 2012

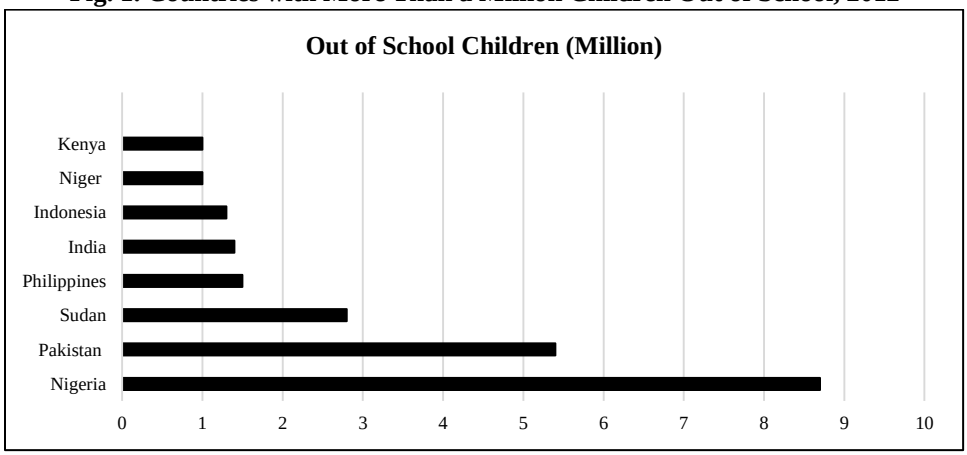
	Children Out of School (Million)		Survival Rate to the Last Primary Grade (%)	
Region	Male	Female	Male	Female
South Asia	5.5	4.8	60.0	65.0
East Asia (Developing)	3.4	3.1	91.2	93.5
Latin America	2.1	1.8	78.0	82.0
World	28.4	30.9	73.5	76.1

Source: http://data.worldbank.org/indicator

The data revealed another aspect in attainment of education in these countries that the boys underperform as compared to the girls. It is surprising since a typical perception prevails that in the less developed countries, gender discrimination in educational opportunities favours the boys. The girl's education is presumably undervalued due to various socioeconomic factors. Paradoxically, the evidence suggests that the extent of education deprivation is sufficiently high among boys as compared to girls in most of the developing regions. The primary completion rate is higher for girls than boys and more boys are out of school in their school going age. In most of the developing countries, a part of population or certain groups experience some sort of disadvantage in education.

The conditions have shown slight improvement as the number of children out of school slashed from over a hundred million in 2000 to less than 60 million in 2015. The situation has improved in almost all the countries except the countries affected by conflicts or social upheavals, where the number of children out-of-school have increased over the last decade for example, Pakistan, Iraq, Haiti, Nepal etc. The UNESCO finds that in the developing regions, children in the poorest households are four times as likely to be out-of-school as those in the richest households.[1] It is also alarming since it reflects social deprivation of the group as a disadvantage in education causes marginalisation and this deprivation effect is transmitted across generations.

Fig. 1. Countries with More Than a Million Children Out of School, 2012



Source: UNESCO Institute of Statistics (2012).

The extent of educational attainment among boys lower than girls can partly be explained by parents' opportunity to engage the boys in skill developing works during their school going age. This skill developing work choice of the parents emanates out of rationality depending on their circumstance set. The global efforts based on the existing view towards the early age work cover the cost of education either through public provision and/or cash transfer. The segment of target population that does not choose formal education a source of skill development can be persuaded through improving the quality of education and skill development through it especially for those households that cannot afford to educate their children to higher levels due to constraints imposed by the

[1]http://www.un.org/millenniumgoals/education.shtml.

circumstance set. Kazi (2006) spells out the historical evolution of laws preventing child-labour in India since 1938 and identifies the defects in the legislation and enforcement system, which fail to prevent child-labour especially in family-owned industries. However, the study does not recognise the role of apprenticeship career path in this failure.

4. THE MODEL OF EDUCATION-APPRENTICESHIP CHOICE

Our model assumes that parents have two choices regarding the career path of their children. They can either send their child to school or to workplace for apprenticeship. This study follows Basu and Van (1998) with some modifications. The parents are assumed to be rational and altruistic and choose the best option in favour of the child. Therefore, it can be assumed that career path choice for the child are made by parents in the earlier years. Basu and Van (1998) argue that child-labour is a result of poverty that forces parents to send children to the work place for subsistence and survival. The framework of our analysis is somewhat different from Basu and Van (1998) as we presume that early age apprenticeship may lead to the development of human capital and the relevant choice facing this agent is between the early-age apprenticeship and education. The agent makes his choice among the two alternatives comparing their expected benefits and costs.

4.1. Modelling Education as Career Path

Most of the monetary rewards of education are realised after the completion of a certain level of education while, the cost of the child's education is borne by the agent before joining the job market. Both the cost and benefits of education depend upon the level of education. Higher and more professional education is usually costly with high earning prospects corresponding to that level of education. Suppose education starts paying wage w_j at time period $T^* = t_j$ where j is the number of years of schooling to complete that level of education. But this optimal level of education of the child is not certain to the parents. The educational expenditures are sort of negative wage during the study period as shown in Figure 2. We assume for simplicity that the cost of education is a constant function of the level of education. The cost of education increases as the level of education j increases. Let 'j' be the maximum level of formal education that the child can attain.

Given this description, the agent forms expectations regarding the likelihood of his child continuing from a lower level to the higher level of education. The higher is the probability that the child moves to the higher education level, the higher will be the expected net benefit of education. The probability in turn is determined by socio-economic vector O that captures the circumstances of the household including elements related to demographic features, asset holding and opportunities available to the household. Given that T^* is the time when the child enters the job market after completing certain education level, then $P_j = P(T^* = t_j)$ is the probability of completing j years of schooling. The better are the circumstances of the household (vector O), the higher is the probability of T^* implying that the child continues to higher education level. With this formulation, $P_j(T^* = t_j)$ is conditional upon O; that is $P_j = P\left(T^* = j \middle| O\right)$.

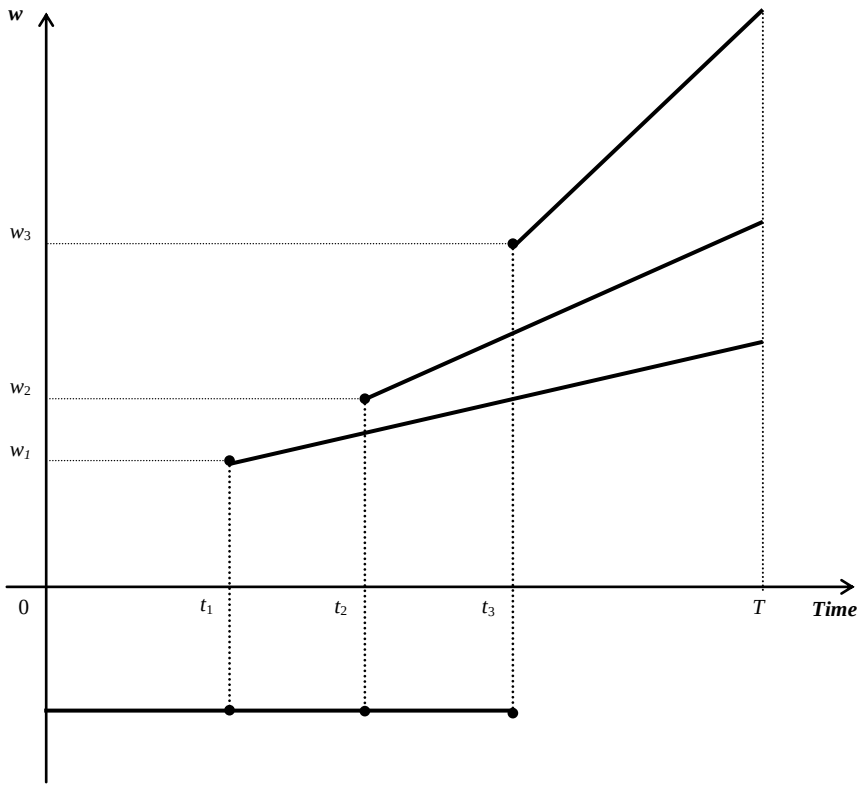
Let *C* be the annual cost of education, Δ_c be constant annual increase in this annual cost and *j* be the number of years of education. A constant annual increment in cost is assumed to specify a linear model. The present value of expected cost of education is then given by the sum of the arithmetic gradient series:

$$PV_E^C = \frac{P_1 C}{(1+r)} + \frac{P_2(C+\Delta_c)}{(1+r)^2} + \frac{P_3(C+2\Delta_c)}{(1+r)^3} + \cdots + \frac{P_{j'}(C+(j-1)\Delta_c)}{(1+r)^{j'}}$$

$$PV_E^C = \sum_{k=1}^{j'} \frac{P_k(C+(k-1)\Delta_c)}{(1+r)^k} \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad (1)$$

The benefits of education can take two forms, direct monetary rewards and indirect non pecuniary benefits.

Fig. 2. Earning Path in Case of Education Career Choice



(a) Direct Expected Monetary Returns are based on human capital earning function of Mincer (1974), where monetary returns to education occur due to productivity enhancement, skill development, and knowledge. Higher education and professional skills are associated with higher wages. Earnings associated with any education level can be viewed as consisting of two components: a base amount (w_j) and a constant increment (Δ_{wj}). Figure 2 shows that if the level of education completed happens to be j_1, then starting wage is w_1 and this wage grows every year at some constant amount Δ_{w1} till

retirement denoted by *T*. On the other hand, if the child completes j_2 years of schooling where $j_2 > j_1$, then his starting wage is w_2 that grows at Δ_{w2}, with $w_2 > w_1$ and $\Delta_{w2} > \Delta_{w1}$. The starting point of wage (w_j) and its growth path (Δ_{wj}) depends upon the level of education when the agent enters the job market. The present value of the expected life time earnings of education, PV_E^D, turns out to be the present value of an arithmetic gradient series consisting of a base amount and a constant increment.

$$PV_E^D = P_1\left[w_1\left(\frac{1}{(1+r)^1}+\frac{1}{(1+r)^2}+\cdots+\frac{1}{(1+r)^T}\right)+\Delta_{w1}\left(\frac{1}{(1+r)^2}+\frac{2}{(1+r)^3}+\cdots+\frac{T-1}{(1+r)^T}\right)\right]$$
$$+P_2\left[w_2\left(\frac{1}{(1+r)^2}+\frac{1}{(1+r)^3}+\cdots+\frac{1}{(1+r)^T}\right)+\Delta_{w2}\left(\frac{1}{(1+r)^3}+\frac{2}{(1+r)^4}+\cdots+\frac{T-2}{(1+r)^T}\right)\right]$$
$$+P_{j'}\left[w_j\left(\frac{1}{(1+r)^{j'}}+\frac{1}{(1+r)^{j'+1}}+\cdots+\frac{1}{(1+r)^{j'+m}}\right)+\Delta_{wj}\left(\frac{1}{(1+r)^{j'+1}}+\frac{2}{(1+r)^{j'+2}}+\cdots+\frac{T-j'}{(1+r)^{j'+m}}\right)\right]$$

Where $j' + m = T$. This reduces to:

$$PV_E^D = \left[P_1 w_1\left(\frac{(1+r)^{T-1}-1}{r(1+r)^T}\right)+P_2 w_2\left(\frac{(1+r)^{T-2}-1}{r(1+r)^T}\right)+\cdots+P_{j'}w_{j'}\left(\frac{(1+r)^{T-j'}-1}{r(1+r)^T}\right)\right]$$
$$+\left[P_1\Delta_{w1}\left(\frac{(1+r)^{T-1}-r(1)-1}{r^2(1+r)^T}\right)+P_1\Delta_{w1}\left(\frac{(1+r)^{T-2}-r(2)-1}{r^2(1+r)^T}\right)+\cdots+P_{j'}\Delta_{wj'}\left(\frac{(1+r)^{T-j'}-r(j')-1}{r^2(1+r)^T}\right)\right] \quad (2)$$

This equation gives the present value of direct benefits of education.

(b) Indirect External Benefits: Indirect benefits of education can be divided into two components: positive social externalities and non-pecuniary personal benefits. Several past studies assess the direct external impact of education and find that education results in increased political awareness and likelihood of participation in political process [Milligan, Moretti, and Oreopoulos (2004); Dee (2004)], lower level of criminal activity [Lochner and Moretti (2004)], improved health of household [Currie and Moretti (2004); Chou, *et al.* (2007)], increased probability of higher education of the next generation [Oreopoulos, Page, and Stevens (2003)] and higher rates of productivity of workers [Moretti (2004)]. Suppose *b* measures the indirect benefits of one year of education which accrue to the society in the lifetime of the child assumed to be *T* years. It includes psychological benefit associated with the tag of being 'literate' in society whereas carrying the stigma of illiterate in society gives disutility to uneducated people. This can also be viewed through screening argument of Stiglitz (1975), where education works as a signaling device for discriminating between high and low ability people. Let it be represented by *S* (a function of factors such as overall awareness about the importance of education in the society captured by the literacy rate). As this awareness increases in society, the stigma associated with illiteracy increases which leads to the higher magnitude of *S*. In this formulation, *v* can represent the vector of variables that affect *S* positively (for example, an increase in the literacy rate in an area where the child lives increases the level of stigma if there is a high tendency in the family of child to do work) Adding this psychological benefit with the above ones gives indirect benefits:

$$PV_E^{ID} = (b + S)T = B \quad [2] \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Adding Equations (2) and (3) gives total benefits of education career path. Subtracting cost (1) from total benefits of education gives net gains of education career path.

[2]Present value of these indirect benefits may be discounted at some subjective rate.

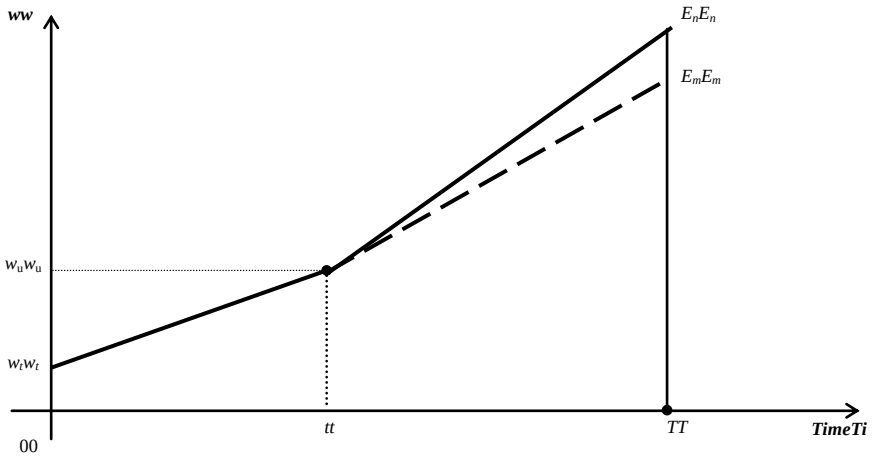
4.2. Modelling Apprenticeship Career Path

The benefit and cost corresponding to the choice of apprenticeship career path are given as follows.

(a) Apprenticeship career path enables the agent to earn wage w_o during training time which starts at time $t_o = 0$, and this w_o is also expected to increase overtime, say, at an amount Δ_t until the child becomes expert in his work after t years.

(b) The on-the-job training imparts valuable skills that eventually set his career path and earn him higher wage (w_u) in future when the training is complete and he turns into an expert (expert). The earning path after becoming an expert depends on whether he turns into an entrepreneur by setting his own enterprise and earns E_n or remains employee and earns E_m till time T. Let p be the probability that he would become an entrepreneur and earn Δ_{en} growth rate in w_u and $(1 - p)$ be the probability that he remains employee and obtains Δ_{em} growth rate in wage w_u till time T. Intuitively, Δ_{en} would be greater than Δ_{em}. For simplicity, we assume that w_t, w_u and their increments Δ_t, Δ_{en} and Δ_{em} are applicable to all apprenticeship professions that impart valuable skills. The probability of becoming an entrepreneur is dependent upon socio-economic opportunities (q) available to the agent. This earning schedule of apprenticeship career path is shown in Figure 3. The earning path in the case of establishing an enterprise is higher than in the case where an expert remains employee in the informal sector.

Fig. 3. Earning Path in Case of Apprenticeship Choice



The present value of expected lifetime earning in apprenticeship career path is given as follows:

PV_A = PV of earning during training time
+ p(PV of earning as entrepreneur after training)
+ $(1 - p)$ (PV of earning as employee after training)

This is given by the sum of present values of arithmetic gradient series:

$$PV_A^B = \left[w_t\left(\frac{(1+r)^t-1}{r(1+r)^t}\right) + \Delta_t\left(\frac{(1+r)^t-rt-1}{r^2(1+r)^t}\right)\right] + p\left[w_u\left(\frac{(1+r)^{T-t}-1}{r(1+r)^T}\right) + \Delta_{en}\left(\frac{(1+r)^{T-t}-r(T-t)-1}{r^2(1+r)^T}\right)\right] + (1-p)\left[w_u\left(\frac{(1+r)^{T-t}-1}{r(1+r)^T}\right) + \Delta_{em}\left(\frac{(1+r)^{T-t}-r(T-t)-1}{r^2(1+r)^T}\right)\right] \quad \ldots \quad \ldots \quad (4)$$

4.3. The Decision Criterion

The choice to send the child to school depends upon the above two *PV* expressions given in Equations (2) and (4). The objective is to examine how the factors that determine the choice of education career path play a role in schooling decision of the child. We analyse net benefits of both career paths for that critical education level (j^*) that equates the present values of the two career paths. Note that j^* is expected to lie between 0 and the highest level of education, i.e. $0 < j^* < j'$. Writing the direct benefits of education for j^* level of education and solving the total benefits of education with those of apprenticeship career we obtain,

$$PV_E^{NB(j^*)} = PV_A^B \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

$$j^* = \frac{ln\left(\frac{\alpha}{\gamma}\right)}{ln(1+r)-\left(\frac{\beta}{\alpha}\right)-\left(\frac{\gamma}{\tau}\right)} = \frac{\alpha\tau\ \ln\left(\frac{\alpha}{\gamma}\right)}{r\alpha-\beta\tau-\gamma\alpha}\ ^{3} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

Equation (6) gives the critical level of education (j^*) which equates the present values of the expected net benefits of education and informal apprenticeship career paths. The critical level of education (j^*) can also be interpreted as perceived pay-back period of the agent, that is how long will it take for return on education to become equal to the return yielded by apprenticeship career path. In other words, it is the number of years of education that the agent believes should leave him indifferent about the two career paths such that j^* is the breakeven point that would equate the net benefits of education with those of apprenticeship. Therefore, j^* can be seen as appropriate wait-time of the agent to enter the job market. This interpretation of j^* has two implications for rational decision making.

(1) It is evident from the solution that higher is the j^* required to equate PVs of both career paths, the more is the number of years a child must continue to study to out-perform the expected earnings of apprenticeship career. Also, the higher is the j^*, the higher is the initial wealth/income an agent must be endowed with to finance the cost of education. As the pay-back period of the agent increases, his willingness to go for education career would decline.

(2) Choosing the education career path is not necessarily superior for all levels of educational attainments. It depends upon the level of education (j) for which we are comparing the two choices. For all $j<j^*$, expected returns on education are less than those in apprenticeship career, hence choosing education would be inefficient for such an agent at these lower education levels. This important

[3]See Appendix for solution.

result shows why education policies that seek to 'ensure minimum education for all children' may fail under certain conditions (such as adverse poverty and family education background etc.). If education policies target a minimum education level j_t that is less than j^*, then agent would not be motivated. This is shown in detail in Section 4.5 below.

4.4. Some Comparative Statics of the Model

Equation (6) can be used to analyse the response of j^* to a set of exogenous and policy variables. We examine some of these here.

(1) Cost of Education (C): Differentiating (6) with respect to *C* gives:

$$\frac{\partial j^*}{\partial C} = \frac{\left(\frac{1}{\alpha}(ln(1+r)) - \frac{\beta}{\alpha} - \frac{\gamma}{\tau}\right) + ln\frac{\gamma}{\alpha}\left(\frac{\beta}{\alpha^2} + \frac{\gamma}{\tau^2}\right) r(1+r)^T}{\left(ln(1+r) - \frac{\beta}{\alpha} - \frac{\gamma}{\tau}\right)^2} < 0 \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

The above sign holds because $\gamma < \alpha$ (therefore $\frac{\gamma}{\alpha} < 1$) and $ln(1+r) < \beta + \frac{\alpha\gamma}{\tau}$. When the annual price of education increases, it decreases the net benefits of education and j^* would decrease in the mind of agent. This means that parents' willingness to spare the child for schooling would decrease. Thus, (7) says that the critical level of education (j^*) in the economy is required to decrease for motivating the agent to choose education career path after a rise in the cost of education. But if j^* does not change in the economy or the agent believes that it has not changed; then he would be discouraged to send the child to school after increase in *C*. Because j^* is determined by the interaction of several factors and market forces in the economy, it can't be altered (say by government intervention) in response to an increase in price of education. Hence, we have the proposition:

Proposition 1: Everything held constant, an increase in the price of education would decrease the number of years spent on education by the child.

It is interesting to note that the rate at which this perceived j^* changes due to a change in *C* depends not merely on the growth rate of the cost of education (Δ_c) but on several other variables.

$$j_c^* = f(r, w, \Delta_w, C, \Delta_c, P, A, B) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

The policy implication of the above result is that the cost of education should be subsidised because that would increase the likelihood of the child going to school by increasing the net-benefits of education and hence increasing the wait-time of the agent. It can be shown that $\frac{\partial j^*}{\partial \Delta_c} < 0$ which implies that annual increment in the cost of education also decreases *j**.

(2) Probability of Becoming Entrepreneur (p): If the agent has a higher probability that the child would turn into an entrepreneur in apprenticeship career, then the pay-back period (length of time for which agent is required to spare child for education) would increase:

$$\frac{\partial j^*}{\partial p} = \frac{rln\left(\frac{\gamma}{\alpha}\right)}{\left(r - \frac{\beta}{\alpha} - \frac{\gamma}{\tau}\right)^2}\left(\frac{(\Delta_{en} - \Delta_{em})(1+r)^{T-t} - rt - 1}{P}\right) < 0 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

because $\Delta_{en} > \Delta_{em}$ and $\gamma < \alpha$. If parents have higher expectations that the child would be able to become an entrepreneur, then their willingness to send the child to school would decrease as their wait-time decreases. This is because with higher *p*, the PV of net benefits of apprenticeship increases.

Proposition 2: If the agent has a higher likelihood of his child becoming entrepreneur in the apprenticeship career, his willingness to send the child for education would decrease.

Some more interesting results can also be derived using Equation (6). We move onto analyse the policy of minimum basic education using insights of the above model.

4.5. Failure of Minimum Basic Education Policies

We now discuss the implications of a policy that aims at some minimum education level j_T. Figure 4 plots the *PV* of benefits from both career paths. The dotted line is cumulative present value of benefits from apprenticeship career from time zero to *T*. It is positively sloped because w_t as well as $w_u > 0$ and is plotted convex because we have assumed Δ_c such that the rate of increase in wage is greater than *r* (the discount rate). Solid curves plot cumulative present values of net-benefits from education path at different levels of education. The curve labeled PV^1 is *PV* of education net benefits for education level 1 (say primary). The curve is drawn below throughout PV_A curve indicating the fact that *PV* of life-time net-benefits of education are less than PV_A at this education level. This curve shifts up as education level increases (say to education level 2) and at j^* level of education, *PVs* of both career paths are just equal. At all educations levels beyond j^* (such as j^{*+}) PV_E of education net benefits exceeds that of PV_A.

Fig. 4. Earning Path in Case of Education Career Choice

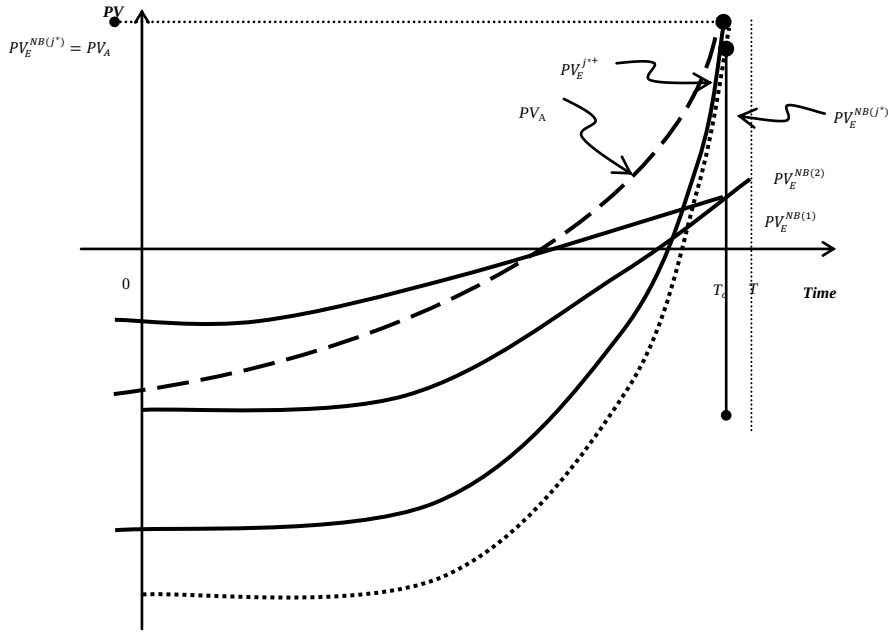
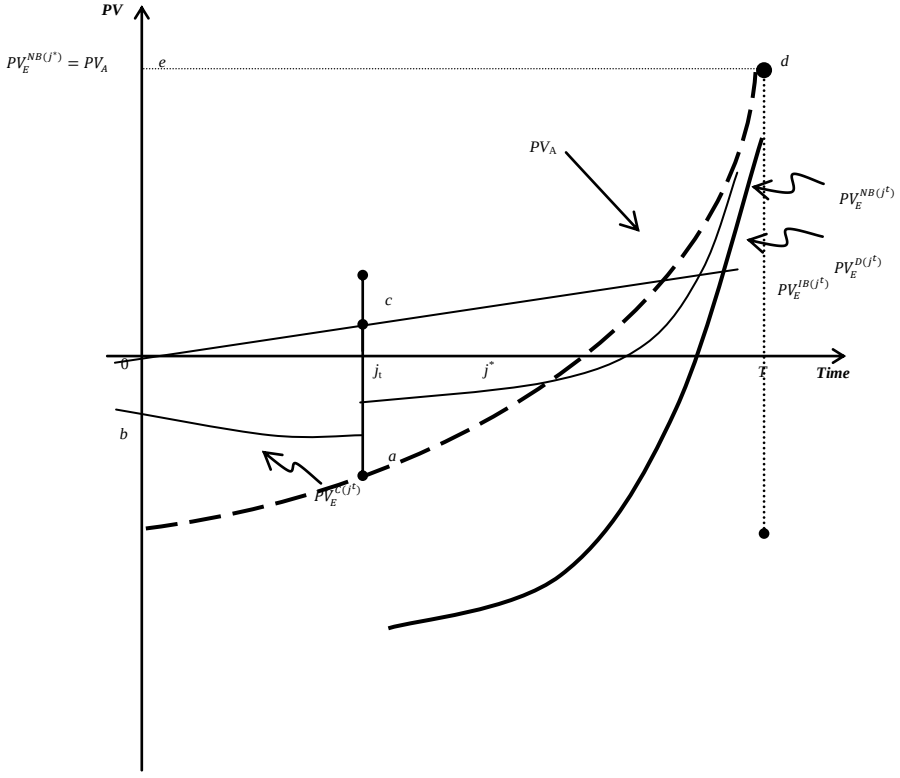


Figure 5 plots *PV* of education benefits for j^* level along with PV_A. The thinner lines are depicting the components of net benefits of education (i.e. *PV* of direct and indirect benefits and cost). Consider an agent who is poor and has low expectations of his child reaching j^* education level. He would send his child to school only if he expects the attainment of j^* level of education. In other words, his demand for education would be zero below j^* level. Suppose that the policy maker is targeting universal attainment of some education level j_t, say primary, such that $j_t<j^*$. Clearly, this agent would not be motivated to send child to school even if explicit cost $ab0j_t$ is waved and additional amount $0cj_t$ is given as conditional cash transfer to compensate implicit cost of sending the child to school till j_t period. Note that the implicit cost of j^* education level is given by area below PV_A curve (*dT0*) while explicit cost would be above cost line up to j^*. This agent would be motivated for child schooling only if the subsidy guarantees j^* (say graduation) level of education and not j_t. The farther is j^* from j_t level, the more is likelihood that the policy would fail in motivating this agent.

Fig. 5. Earning Path in Case of Education Career Choice



It is important to emphasise the reason of failure of this policy design for this specific agent. The policy-maker targets education level j_t (say primary) mainly due to external considerations of education (that it makes children better citizens, inculcates basic skills etc.) but the agent views this policy on the basis of the effects of this j_t education level on career earning path of the child. If the policy maker sets j_t much lower

than j^* of the agent, this is tantamount to leaving the poverty ridden agent far behind in his efforts to reach j^*. Hence, he would refuse to move along with this policy-maker to the point j_t.

The solution to this policy failure requires that j_t should be set as close as possible to j^* to motivate these agents for participating in such minimum education programs. In other words, the minimum is required to be as high as possible. The alternative method of making this policy more effective is to facilitate these children to acquire human capital through both sources simultaneously. This requires changing the existing institutional arrangements that can convert the 'dichotomy' between the two sources of acquiring human capital into 'complementarity'.

5. SIMULATION ANALYSIS

A comprehensive empirical analysis of the propositions developed in the previous section essentially requires data on the variables used in the theoretical framework. Unfortunately, data on these variables do not exist for any country. Alternatively, we carry out simulation analysis of final equations of the model using appropriate prior information and estimates from the literature. Table 2 gives the description of the parameters used in the simulation analysis. The estimates of starting wages for different education levels (W_j) are obtained from Labour Force Survey of Pakistan 2014-15 by using following criteria.

- Employed workers with j years of education are selected.
- Among the selected workers, those with minimum age are identified (e.g., 16 years of age for 8 years of education).
- The average wage of these workers is treated as starting wage after j years of education.

The growth rate of W_j is approximated by real per capita growth rate of 2014-15 with some adjustment for higher j levels. Similarly, cost of education and its increment are approximated keeping in view the expenditures in public sector education institutions. The estimates of data used for simulating equation for apprenticeship career are mostly based on the Survey conducted in three major cities of Pakistan namely Karachi, Lahore and Rawalpindi/Islamabad by Siddique and Ahmad (2018).

Table 3 gives the results of simulation. It shows how the lifetime net benefits of education (NBE) respond to different levels of education (j) acquired by the worker. The benefits of apprenticeship (BA) are assumed to be independent of education level in this calculation. The results clearly show that the net benefits of education are less than the benefits of apprenticeship until the higher secondary level of education (equivalent to Grade 12) is obtained by the individual. However, for all higher levels of education, the net monetary benefits of education are higher than the same for apprenticeship career path. Figure 6 plots the same information and shows that the net benefits of education get closer to the benefits of apprenticeship as j increases and these become equal at approximately 12 years of education. In other words, the present value of benefits from both career path become equal if a child achieves 12 years of education. Our results are based on two caveats. First, we assume for simplicity that there are no benefits other than the wage earned by the worker. Second, the benefits of education are assumed neutral to

Table 2

Definition of Variables Used in the Simulation Analysis

Notations	Description	Based on	Value Used
r	Discount rate	Real discount rate of last five years	3%
j	Number of years of education after which one joins job market	Years of schooling	Years from 8 to 16
P or Pj	Probability of completing j years of education	Intuitive guess values	$P_j(8) = 0.95$ $P_j(10) = 0.85$ $P_j(12) = 0.75$ $P_j(14) = 0.65$ $P_j(16) = 0.55$
S_o	School starting age	Age	5 Years for class one
W_j or W_{j*}	Starting wage rate after j years of education level	Average Wages of employed workers (Labour Force Survey, 2014-15)	$W(8) = 8000$ $W(10) = 11000$ $W(12) = 14500$ $W(14) = 20000$ $W(16) = 24000$
ΔW_j	Annual growth rate of Wj	Equal to real per capita growth	@4% for Grade-8-12 and @6% for Grade-13 onwards
ΔC	Annual growth rate of cost of education C		@3% annually
T	Retirement time (60 years of age)	Age	60 Years
$T - (j + So)$	Work time after completing j years of education	Productive age of a person	Calculated as required
W_o or W_t	Starting wage of trainee when he starts apprenticeship at $t = 0$	Siddique and Ahmad (2018)	Rs 150 daily
ΔW_o	Annual growth rate of W_o	Lump sum annual increase	Rs 500
W_u	Starting wage of Ustad (trainer)	Siddique and Ahmad (2018)	Rs 14,000
ΔW_u or Δ_{en}	Annual growth rate of W_u	Lump sum annual increase	Rs 2,000
W_{em}	Starting wage of trainee who remains employee	Siddique and Ahmad (2018)	Rs 14,000
ΔW_{em}	Annual growth rate of W_{em}	Lump sum annual increase	Rs 1,000
P	Probability of becoming trainer (*Ustad*) after training	Siddique and Ahmad (2018)	0.75
$1 - p$	Probability of remaining employee after training	Siddique and Ahmad (2018)	0.25
AC	Starting age of training in Apprenticeship career path	Age of trainee	10 Years
t	Years it takes to complete training in the apprenticeship career	Average training time	4 Years
$T - (AC + t)$	Working years after the completion of t years of training	Productive age of a person	Calculated as required

Table 3

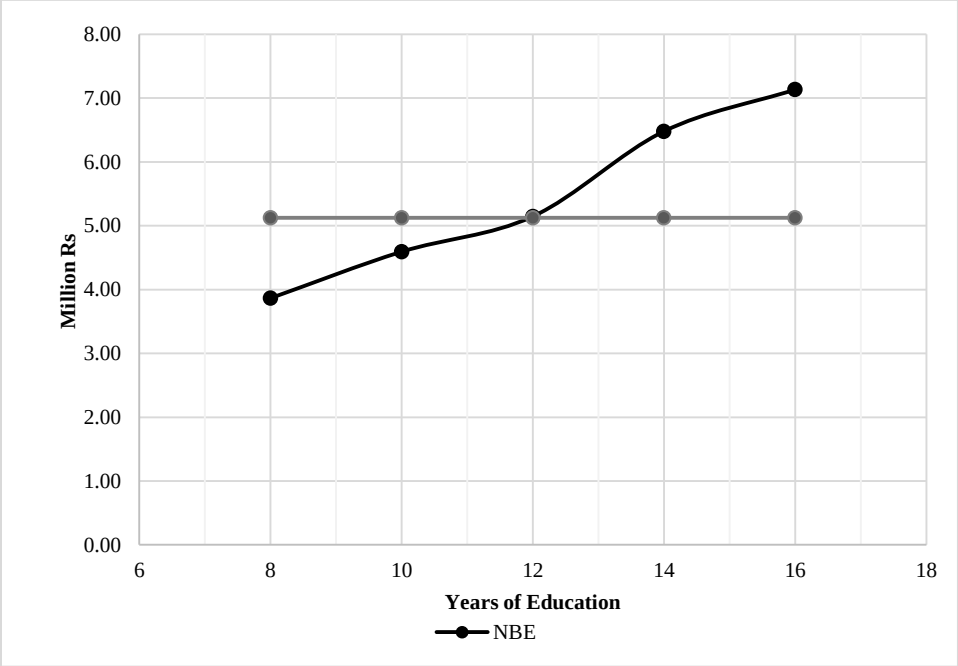
Results of Simulation Analysis

(Million Rupees)

Years of Education	Net Benefits of Education	Benefits of Apprenticeship	Difference
8	3.87	5.12	–1.25
10	4.59	5.12	–0.53
12	5.15	5.12	0.03
14	6.48	5.12	1.36
16	7.13	5.12	2.01

the quality of education. Both these assumptions are quite strong but are opted due to data constraints. Therefore, $j^* = 12$ is the level of education that approximately equalised the benefits of two alternative career paths (at least in the absence of stringent regulation banning the early age work choices). The results suggest that the policy of targeting 10 years of schooling is expected to fail as an incentivising tool. It essentially requires some sanctions for the parents who opt early age work for their children.

Fig. 6. Simulation Results of NPV of Education and Apprenticeship Career Paths



6. CONCLUSION

Child-labour is major cause of nonattainment of universal primary education among school age children. The conventional wisdom views early age work largely as an outcome of poverty whereby the agent seeks to ensure survival. The issue of out-of-school children signifies the important role of factors affecting both the demand for and supply of education. On the one hand, it implies the failure of the government to supply quality education. On the other hand, the benevolent parents may find it worthwhile to equip the child with some marketable skills for ensuring his future earnings. This view about the prevalence of child-labour cannot satisfactorily explain high rates of educational deprivation in Pakistan. A more relevant descriptive model is developed in this paper that can address this paradoxical evidence.

This paper highlights that early-age work can be a source of human capital accumulation when the agent opts it as an apprenticeship career path, mostly in the informal sector of the economy. There is also a general belief that child-labour necessarily compromises the development of human capital. The model takes into account the cost benefit framework for apprenticeship-education choice and reveals that

early-age work may not necessarily be inefficient when compared with different levels of education. The rational choice of parents depends upon the expected returns from education and apprenticeship career paths. If parents have low expectations regarding their child reaching the critical level of education where the expected benefits from education outweigh those from apprenticeship career, they are unlikely to send the child to school. This suggests that policies that aim at universal basic education may fail to achieve the desired outcomes.

The paper carries out the simulation analysis to validate the theoretical model by employing the most relevant available data and compare the benefits in the form of prospective income earned in the two career paths. It finds that at a lower level of education the net benefits of education are lower than the benefits of apprenticeship career path; however, as education level rise above the Grade-12, the net benefits of education are better than those of early age-work for all higher levels of education. The theoretical and empirical analyses clearly indicate the reasons for low educational attainments of education in poor households. The policy of universal education can be achieved by minimising the number of out-of-school children and drop outs. Moreover, the economy relies on the informal sector for a large number of economic activities and services for which no formal institutions exist and informal sector attracts resource poor households for career choices of their children.

To increase the effectiveness of policies, the targeted education level should be set as close as possible to a level whereby marginalised segments of the society can acquire education along with their apprenticeship career path. A limitation of the study is that it assumes a community where parents have discretion to choose between education and early-age work. The study offers a theoretical framework that needs to be empirically tested by using data of individuals choosing both the alternative career paths. This should be an interesting future undertaking for researchers especially in those countries where child-labour is a chronic issue.

APPENDIX

Using:

$$PV_E^{NB(j^*)} = PV_A^B \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \text{(a)}$$

$$P_{j^*}\left(w_{j^*}\left(\frac{(1+r)^{T-j^*}-1}{r(1+r)^T}\right)+\Delta_{wj*}\left(\frac{(1+r)^{T-j^*}-r(T-j^*)-1}{r^2(1+r)^T}\right)\right)+(b+S)T-P_{j^*}\left(C\left(\frac{(1+r)^{j^*}-1}{r(1+r)^{j^*}}\right)+\Delta_c\left(\frac{(1+r)^{j^*}-r(j^*)-1}{r^2(1+r)^{j^*}}\right)\right)$$
$$=\left[w_o\left(\frac{(1+r)^t-1}{r(1+r)^t}\right)+\Delta_t\left(\frac{(1+r)^t-rt-1}{r^2(1+r)^t}\right)\right]+p\left[w_u\left(\frac{(1+r)^{T-t}-1}{r(1+r)^T}\right)+\Delta_{en}\left(\frac{(1+r)^{T-t}-r(T-t)-1}{r^2(1+r)^T}\right)\right]+$$
$$(1-p)\left[w_u\left(\frac{(1+r)^{T-t}-1}{r(1+r)^T}\right)+\Delta_{em}\left(\frac{(1+r)^{T-t}-r(T-t)-1}{r^2(1+r)^T}\right)\right] \quad \dots \quad \dots \quad \dots \quad \text{(b)}$$

or

$$P_{j^*}\left(w_{j^*}\left(\frac{(1+r)^{T-j^*}-1}{r(1+r)^T}\right)+\Delta_{wj}\left(\frac{(1+r)^{T-j^*}-r(T-j^*)-1}{r^2(1+r)^T}\right)\right)-P_{j^*}\left(C\left(\frac{(1+r)^{j^*}-1}{r(1+r)^{j^*}}\right)+\Delta_c\left(\frac{(1+r)^{j^*}-r(j^*)-1}{r^2(1+r)^{j^*}}\right)\right)=A-B$$

Where

$$A=\left[w_o\left(\frac{(1+r)^t-1}{r(1+r)^t}\right)+\Delta_t\left(\frac{(1+r)^t-rt-1}{r^2(1+r)^t}\right)\right]+p\left[w_u\left(\frac{(1+r)^{T-t}-1}{r(1+r)^T}\right)+\Delta_{en}\left(\frac{(1+r)^{T-t}-r(T-t)-1}{r^2(1+r)^T}\right)\right]+(1-p)\left[w_u\left(\frac{(1+r)^{T-t}-1}{r(1+r)^T}\right)+\Delta_{em}\left(\frac{(1+r)^{T-t}-r(T-t)-1}{r^2(1+r)^T}\right)\right]$$

and $B=(b+S)T$. Simplifying and combining *j*-terms on the left hand side:

$$\left(\frac{w}{r}+\frac{\Delta_{wj^*}}{r^2}+\frac{C}{r}+\frac{\Delta_c}{r^2}\right)\frac{1}{(1+r)^{j^*}}+\left(\frac{\Delta_c j}{r(1+r)^{j^*}}+\frac{\Delta_{wj^*}}{r(1+r)^T}\right)=\frac{A-B}{P}+\frac{w_{j^*}}{r(1+r)^T}$$

Multiplying both sides by $r^2(1+r)^{T+j^*}$ we have:

$$\frac{\alpha+\beta j^*}{\tau-\gamma j^*}=(1+r)^{j^*} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \text{(c)}$$

Where:

$$\alpha=\left(rw_{j^*}+\Delta_{wj^*}+rC+\Delta_c\right)(1+r)^T$$
$$\beta=r\Delta_c(1+r)^T$$
$$\gamma=\frac{r\Delta_{wj^*}}{(1+r)^T}$$
$$\tau=\frac{(A-B)r^2}{P}(1+r)^T+rw_{j^*}+r\Delta_{wj^*}T+\Delta_{wj^*}+(Cr+\Delta_c)(1+r)^T$$

Taking logarithm on both sides of (c), the equation can be written as follows:

$$ln\left[\alpha\left(1+\frac{\beta}{\alpha}j^*\right)\right]-ln\left[\tau\left(1-\frac{\gamma}{\tau}j^*\right)\right]=j^*(1+r)$$

Simplifying using logarithm expansion $ln\,(1+x)=x$ for $x<1$:

$$j^*=\frac{ln\left(\frac{\alpha}{\gamma}\right)}{ln(1+r)-\left(\frac{\beta}{\alpha}\right)-\left(\frac{\gamma}{\tau}\right)}=\frac{\alpha\tau\ ln\left(\frac{\alpha}{\gamma}\right)}{r\alpha-\beta\tau-\gamma\alpha}$$

Where $|j^*|<min\left\{\left(\left|\frac{\alpha}{\beta}\right|,\left|\frac{\tau}{\gamma}\right|\right)\right\}$

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The Effects of Agglomeration on Socio-economic Outcomes: A District Level Panel Study of Punjab

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This paper examines the variation of agglomeration across districts over time in Punjab and analyses the effects of agglomeration on socio-economic outcomes in terms of social inclusion and efficiency of firms at the district level in Punjab. Earlier studies in this regard faced multiple problems since they used cross-sectional data. To bridge the gap, a newly constructed panel data from CMI is used. Factor Analysis technique is used to analyse social-inclusion variable, in addition to some other control variables as well. Data Envelopment Analysis (DEA) with bootstrap technique (performed in R) is used to calculate district-wise firm efficiency. The study argues that agglomeration is a logical consequence of China Pakistan Economic Corridor (CPEC) through an increase in the economic activity in various districts of the province. The results show that district agglomeration has a positive effect on the average district-wise efficiency of firms and has a positive statistically significant relation with social inclusion. Interesting implications arise from results, setting up clusters in urbanised rather than highly urbanised areas under CPEC can be a game changer for the economy of Pakistan especially Punjab since it has significant potential positive effects on the economy of Punjab.

JEL Classification: D62, I38, L52, R13
Keywords: Agglomeration, CPEC, Social Inclusion, Factor Analysis, Data Envelopment Analysis, Efficiency

1. INTRODUCTION

Punjab is the biggest province of Pakistan with the total population of more than 100 million which is about 60 percent of the total population of the country. It is administratively divided into nine divisions and 36 districts. It has a long history of being overshadowed by agriculture sector which has resulted in the neglect of industrial sector. In the past, Punjab lacked a clear vision/policy for the industrial sector. The recent negative growth rate in the agriculture sector along with the positive trend of huge foreign direct investment from China has put the spotlight on the manufacturing sector.

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Manufacturing is the backbone of the industrial sector and large-scale manufacturing is the most pivotal subsector in manufacturing. It is the main source of tax proceeds for the government and also contributes significantly to the provision of job opportunities to the labour force. According to Pakistan Economic Survey 2015-16, the industrial sector of Pakistan contributes 20 percent to GDP. This sector has experienced dynamic changes over time.

Over the years clusters have been developed in Punjab due to geographical, social and historical reasons. Punjab has geographically divergent industrial clusters comprising Gujranwala, Sialkot, and Gujarat. In total, there are seven industrial zones/clusters in Punjab: Faisalabad, Lahore, Gujranwala, Sheikhupura, Sialkot, Rawalpindi and Wazirabad (Figure 1). One can clearly see that development in Punjab is only limited to industrial clusters present in North East and North West of Punjab (Figure 1). This has led to the uneven economic development in the province. Labour in Punjab is not very mobile that is why no new clusters have been able to develop over the years. Moreover labour is not skilled and mobile enough that it can switch within industries. That is why we do not see inter-industry spillovers in Punjab. Many studies [Glaeser, *et al.* (1992); Rizov, *et al.* (2012); Ciccone and Hall (1996) and Burki and Khan (2013)] have been conducted to examine the impact of such agglomeration (clusters) on firm efficiency/productivity. However, none of these studies have examined the welfare aspect of these clusters.

In the manufacturing sector, large producers manufacture high-quality output because of adoption of modern methods of production and employment of both skilled and unskilled labour that lead to the income generation and reduction of poverty in areas where these large businesses operate. This supports the hypothesis that industrialisation leads to social inclusion.[1] This idea is commonly known as *the trickle-down effect*, a phenomenon that has not yet been proven in the case of Pakistan. Only one study by Chaudhry and Haroon (2015) is available in the literature which examined the effect of entry of new firms on variables as diverse as employment, education, hospitals and schooling. Under China Pakistan Economic Corridor (CPEC) Pakistan will receive multi-billion-dollar investment which will be used to build infrastructure as well as industrial estates in various districts of Punjab. Setting up industrial estates will lead to clusters or agglomeration. Since clusters/districts are diverse in terms of industry type, average firm size, legal status, and geographical location, a "one-size-fits-all" industrial policy will not be suitable. Therefore, classifying constraints to industrial growth at the district level serves two important purposes: First, it helps policy-makers to classify and rank agglomeration constraints at the district rather than industry level. Second, this more detailed assessment can contribute to tailoring a policy for districts and sectors in order to spur industrial growth and productivity. That being said, it is equally important to look at the dynamics of industry as well. It needs to be seen what the trend in agglomeration is in overall industrial sector in Punjab. Thus looking at agglomeration at district[2] and industry[3] level may provide useful insights to policy-makers.

[1]Social inclusion is both an outcome and a process of improving the terms on which people take part in society. It is central to ending extreme poverty and fostering shared prosperity (World Bank).

[2]This will be measured through Lee and Lee Index.

[3]This will be measured through Ellison-Glaeser Index.

The second phase of CPEC is critically important that will emerge as an opportunity for the domestic and foreign investors to invest in industrial parks to seek the benefits of cheap labour. The designing of industrial parks by the provincial governments is in its initial phase. In this perspective, this study highlights the importance of social inclusion of labour force in the production process to seek the full benefits of CPEC. How clustering of business activities, that is, the development of industrial zones which is widely recognised as the agglomeration, will affect the social inclusion is an important point of concern among the civil society, academics and applied researchers but yet needed to explore through a strong micro-founded evidence. In this perspective, this study takes a lead over the existing literature. Further to it, under the assumption of the slow pace of change in social variables, the survey data of CMI and MICS are pooled.

CPEC especially special economic zones are in their infancy stage. However, researchers have used available datasets to draw an important conclusion regarding CPEC. For example, Chaudhry, *et al.* (2017) analysed Pak-China Free Trade Agreement (FTA) of 2007 to draw important lessons from CPEC. Malik, *et al.* (2017) did a similar thing but also used international trade data between Pakistan and China which was taken from IMF (Direction of Trade Statistics). Under CPEC many special economic zones will be established (see Table A1 for a list of proposed special economic zones). These zones will cluster business activities in pockets of geographical areas thus leading to agglomeration. We cannot presently see the impact of such proposed zones on socio-economic outcomes but we can see how much these economic zones have had the impact in the past. We will use historical data to draw an inference regarding the impact of CPEC. Our study finds out that agglomeration leads to social inclusion as seen by positive sign of agglomeration coefficient in Table 5. Since we have used agglomeration as a proxy for development of special economic zones we can safely say that CPEC will, in fact, lead to social-inclusion in future.

Punjab could ensure balanced development by developing different clusters located all over the districts. A smaller investment could be sufficient for establishing an assembling unit in a cluster where all backward as well as forward linkage industries are available. Therefore, cluster development could be a powerful tool for the inclusive and sustainable growth of Punjab as well as Pakistan. Provincial and federal governments can play a role in cluster development. Cluster initiatives alone are less effective if they are not part of an overarching approach to improve competitiveness on the national and/or regional level. There is a need to focus on cross-cluster issues that affect the whole economy. A sound macroeconomic, political, legal, and social context creates the potential for competitiveness but is not sufficient. Competitiveness ultimately depends on improving the microeconomic capability of the economy and the sophistication of local companies and local competition. The government may follow an approach to cluster development aimed at addressing the main causes of cluster stagnation and help unleash their growth potential. Hundreds of enterprises share few common problems in a cluster and it is worthwhile to solve a problem for hundred enterprises than that of a smaller group or few scattered entities. This type of agglomeration policy will be more inclusive and lead to better socio-economic outcomes for society as a whole.

In urban economics, and more recently in the international economics literature, agglomeration has been considered as a principal determinant of new investment

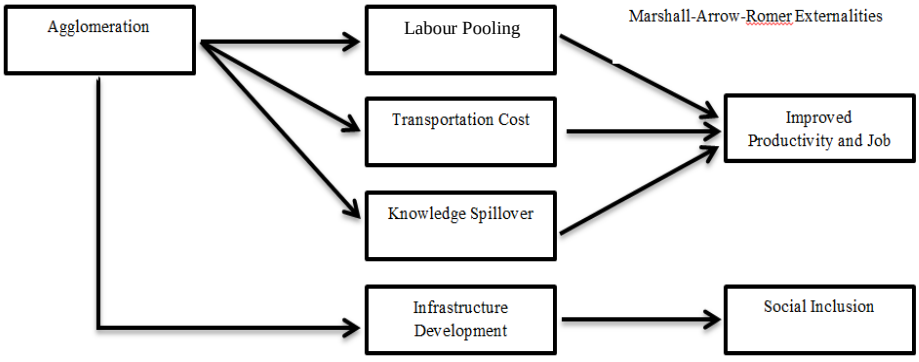
[Guimaraes, *et al.* (2000)]. Bronzini (2004) found strong evidence that specialised geographical areas attract FDI. This paper addresses the important question of how agglomeration economies affect socio-economic variables. It also studies the impact of agglomeration on average firm efficiency at the district level. The results provide evidence to support the hypothesis that agglomeration leads to social inclusion or that growth of the industrial sector has *trickle-down* effect by creating jobs and promoting income for the poor (Figure 2) and that if infrastructure is also provided with cluster development then binding social and economic constraints will also be removed.

Fig. 1. Industrial Zones and Their Major Industries

Source: Authors Illustration using GIS.
Note: Highlighted districts show major industrial centres of Punjab.

Districts	Specialisation
Rawalpindi	Food, Garment, Textile
Sialkot	Leather and Leather Products, Garment, Machinery and Sports
Gujranwala and Wazirabad	Textile, Machinery and Equipment and Electronics
Faisalabad	Textiles, Garments, Machinery and Equipment
Shiekupura	Textile, Food, and Machinery and Equipment
Lahore	Food, Garments, Textiles

Fig. 2. Theoretical Framework



Source: Authors' preparation.

Figure 2 shows the link between firm agglomeration and income/poverty. Agglomeration leads to positive externalities like labour pooling, reduction in transport cost, information and knowledge spillover etc. This leads to a rise in productivity of firms and more job opportunities in the area which in turn lead to rising income and reduction in poverty. In Solow's Model, productivity is a key link between the performance of firms, economic growth and improving the welfare of people. This productivity can only be gained if private sector takes charge of economy and government sets up industrial estates to help the private sector.

The main objective of the study is to examine the effects of agglomeration on socioeconomic outcomes at the district level in Punjab. The specific objectives of the study are to: examine whether agglomeration leads to social inclusion; find out the determinants of social inclusion; analyse the link between agglomeration and average district efficiency; find out socio-economic benefits of CPEC; and provide policy guidelines for government on how to improve efficiency and social inclusion. The rest of the paper is organised as follows. Section 2 presents literature review. Section 3 and 4 discusses data and econometric specification respectively. Empirical results are presented in Section 5 which is followed by conclusion and policy recommendations in Section 6.

2. REVIEW OF LITERATURE

There is wide literature on the benefits of urban economics in terms of growth of cities through expansion of industries. Cities grow initially because of geography, history and then by their industrial structures based on the extent of specialisation or diversity of business. With industrial growth, firms get benefit from other businesses or overall level of economic activity around them e.g., accessibility of infrastructure, access to financial establishments and publishing and marketing. These externalities are known as Jacob externalities which echo the diversity in the area which in the case of present study is a district. Localisation economies exist when firm gains value from within the industry or firms which are involved in matching activity. Firms benefit from knowledge spillover due to the collaboration of agents, availability of particular labour, availability of non-tradable intermediate goods and low transportation cost due to access to a market. These externalities are also known as Marshall-Arrow-Romer (MAR) externalities in dynamic form. Many benefits arise due to both of these agglomeration economies. Thus the location of a firm may depend on closeness to target market to reduce transportation cost or because the nature of the product is perishable and thus requires speedy delivery [Marshall (1890); Myrdal (1957) and LaFountain (2005)]. However, some firms may be constrained to locate near the source of raw material [Hirschman (1958)].

Firms locating closer to each other may have significant potential benefits at different levels of economic activity. Hazledine, *et al.* (2013) summarised that the benefits of agglomeration can occur at four different levels: (i) Internal to individuals/households—individuals gain from wider job opportunities and better amenity; (ii) Internal to firms—firms gain from larger labour markets, and from economies of scale generated by access to effectively larger accessible output markets; (iii) Internal to industries—technological (knowledge) spillovers; a better choice of intermediate inputs; larger skilled labour pool; (iv) Internal to the city—scale of local markets and more efficient provision of infrastructure, public administration, and amenities.

Additionally, agglomeration also has direct benefits as well. Giang, *et al.* (2015) found a linkage between agglomeration and poverty reduction in the case of Vietnam. This effect was greater for houses with male younger and more educated household heads. Firms can improve household welfare and reduce poverty by having a positive effect on employment and wages. Chaudhry and Haroon (2015) observed that in case of the manufacturing sector of Pakistan, firm entry has a significant impact on socio-economic outcomes and that these outcomes normally materialise with a lag. They recommended that policy-makers should recognise that different type of firms have a different type of impact which warrants the need for a customised approach to industrial development. Thus agglomeration can lead to social uplift of people. Confirming these findings, Quintana and Royuela (2014) showed that agglomeration processes can be associated with economic growth, at least in countries at early stages of development.

Apart from affecting the community, agglomeration contributes positively to firm-level variables as well. Albert and Maudos (2002) found that investment in the physical capital also positively relates to business efficiency. Beeson and Husted (1989) in a cross-state study for the US observed that a substantial part of the difference of efficiency can be credited to regional dissimilarities of the labour force features, the intensity of urbanisation and industrial structure. The New Economic Geography literature points out that transport cost explains agglomeration. [Fujita, *et al.* (2001)].

Agglomeration if unchecked may lead to diseconomies as well. According to [Lall, *et al.* (2004)] agglomeration may be associated with negative consequences as well. Krugman (1991a) argues that when transport cost of a region decreases then it begins to invite industries towards it hence increasing the concentration of industry and eventually increasing the population of the region. Fujita and Thisse (2002) found that when the concentration of industry in a specific area crosses a certain level it begins to raise the cost of functioning in that area due to greater labour wages, greater land prices and rent, overpopulation, congestion cost, higher transportation cost and communication costs. According to Kim (2008), while negative spillovers result from an increased cluster of industry, it will eventually raise the cost of production and it is known as "Thin Market Effect" by Cohen and Paul (2005). Rising costs due to agglomeration shrink additional concentration of industry in the nearby areas and disperse economic activities in the region [Fujita and Thisse (1999); Kim (2008)]. The equilibrium between two positive and negative forces—centripetal and centrifugal—leads to stability. For example, Mitra (1999) studied the connection between agglomeration economies and technical efficiency of electrical machinery and cotton textile sector through firm-level data. The outcomes indicate that agglomeration raises the efficiency of firms but the effect starts to diminish for cities which are very bigger in size.

3. DATA AND METHODOLOGY

In the previous studies, due to data constraints, industry level firm efficiency was measured using cross-sectional data. Lall, *et al.* (2004) in his study on agglomeration in India mentioned similar data constraints. To understand the true impact of the independent variable on the dependent variable we have to follow the same units over time. Lall, *et al.* (2004) thus mentioned that ideally for work on agglomeration panel data should be used.

For this study, we use panel data constructed from CMI (2001, 2005 and 2010). Since the data has same *i's* for each *t*. We merge the district level panel data with that of MICS (2003, 2007 and 2011). Here we assume that social level variables change slowly over time, thus allowing us to merge two different datasets that were collected at most two years apart. This allowed us to merge two unique datasets at the district level. However, this may be seen as a limitation in data collection by government agencies where different surveys are done irrespective of timings of each other. It is expected that unobserved effects might be correlated with the independent variables. If this is indeed the case, pooled OLS will lead to biased results. Hausman test was run to check if Fixed Effects (FE) or Random Effects (RE) technique is appropriate.[4] Result yielded p value of 0.1194; thus we failed to reject the null hypothesis that both FE and RE are consistent.[5] We believe that heterogeneity of districts is an important issue and thus requires controlling for it in regression; hence FE model is used. The significance of the model can be judged from F test whose p value is 0.073, which means that the estimated model is significant at 10 percent significance level.

Table 1

Variable and Their Data Sources

Variables	Methodology	Data Sources
District Agglomeration	Lee and Lee Agglomeration Index	CMI (2001, 2005, 2010)
Sectoral Agglomeration	Ellison-Glaeser	CMI (2001, 2005, 2010)
Efficiency	DEA Bootstrap	Calculated in R-Software
Social Inclusion	Factor Analysis/ Principal Component Analysis	MICS, Punjab Development Statistics
Road Density	Ratio Road Length to Total Area of District	Punjab Development Statistics
Education Index	Factor Analysis	Punjab Development Statistics
Investment	Taken as reported in the source	Directory of Industries
Employment Cost	Taken as reported in the source	Directory of Industries
Number of Factories	Taken as reported in the source	Directory of Industries

Note: Panel data and variables used in efficiency model mentioned in Appendix were constructed by Ahmad (2016). Efficiency was calculated in R using DEA Bootstrap technique.

Independent Variable of interest is Agglomeration which has been measured in literature in a variety of ways [Chaudhry and Haroon (2015); Ahmad (2016)]. For example, some studies used the number of firms in a geographic area while others used location Gini Coefficient as a formalisation of agglomeration [Aiginger, *et al.* (1999)]. The latter measure had the benefit of providing for the concentration of industry but it did not show how firms are distributed among regions [Capello, *et al.* (2010)]. This led to the development of a measure for regional specialisation and was popularised by Lee and Lee who defined this index as the share of industry i's employment relative to total industry employment in a specific region j by contrast to the share of region j's employment relative to total (provincial in our case) employment in industry. This Lee and Lee index has been used in international literature for the case of India by Lal, *et al.*

[4]For details on the need to use FE or RE please see Wooldridge (2009) and Gujarati (2003).

[5]Consistency property also holds in our case since degree of freedom is greater than thirty.

(2004) and it has been used in the case of Pakistan by Burki and Khan (2013). To measure agglomeration albeit, in a different context, we, however, apply it for the first time in the context of Punjab with special district level focus. The formula for Lee and Lee Agglomeration (Diversity Index) is:

$$g_i^s = \sum_{n=1}^{N} \left[\frac{E_{ij}}{E_i} - \frac{E_j}{E}\right]^2$$

The above formula shows the agglomeration index used in this paper where *i* signifies district and *j* signifies industry, g_i^s represents the extent of localisation and urbanisation in the *i*th district, E_{ij} is employment in *the i*th district in *the j*th industry, *Ei* is employment in the *i*th district, E_j is employment in industry *j*, and *E* signifies total manufacturing sector employment. A lesser value of the index signifies high diversity which means urbanisation economies are stronger while a higher value represents that firms are specialising which indicates localisation economies are stronger. The index varies from 0 to 2 with zero meaning zero specialisation (high diversity) and two representing complete specialisation (zero diversity). In order to measure the extent and effects of localisation economies and urbanisation economies on technical efficiency, the diversity index has been used [as proposed by Henderson, *et al.* (2001)]. The index is calculated at the district level where district boundaries are frozen at 2000-01 level. The 29 districts that existed in Punjab at that time are used for the index.

In order to measure the agglomeration of industries, the Ellison Glaeser Index proposed by Ellison and Glaeser (1997) is adopted. A value of zero for this index means no agglomeration. We have computed this index at 3 digit level under Pakistan Standard Industrial Classification (PSIC) and industry codes are fixed at 2000-01 level to ensure uniformity across industry classification codes.

The formula for Ellison Glaeser is:

$$\emptyset_i = \frac{\sum_{j=1}^{n}(s_{ji} - x_j)^2 - (1-\sum_j x_j^2)H_i}{[1-H_i]\left[1-\sum_j x_j^2\right]}$$

Were s_{ji} is share of industry *i's* employment which is located in district *j*, x_j is share of industry's employment in district *j* as compared to the overall manufacturing sector employment. $\sum_{j=1}^{n}(s_{ji} - x_j)\text{^}2$ is referred to as Gini coefficient which shows raw geographical concentration of industry *i*. H_i is Herfindahl-index which measures plant share of employment in industry *i's* overall employment. The scores are allocated to each industry in Ellison Glaeser index. Average result of this index is presented in empirical results part of the paper.

Social Inclusion is a multi-dimensional concept. Its general definition is: *"Social inclusion is central to ending extreme poverty and fostering shared prosperity. It is both an outcome and a process of improving the terms on which people take part in society."* According to the World Bank, variables to include in this concept may be altered according to country specificity. In Pakistan researchers like Cheema, *et al.* (2008) have used health-related indicators as in its social variable formulation. These health level variables have cross-cutting importance since they also incorporate education/literacy levels as well. Eide and Showalter (2011) stated that there are numerous health benefits

associated with education. For example, education can play a positive role in the ability to manage health care [Kaplan, *et al.* (2015)]. Since education affects health, it leads to social inclusion. Thus we have taken only health variables in the definition of social inclusion. Additionally, we have education as an independent variable in our main regression so our model incorporates the effects of education as well.

Dependent Variable (Social Inclusion) in this paper is constructed by conducting Factor Analysis using four variables taken from MICS[6] (2003, 2007, and 2011) namely: infant mortality rate[7] (IMR); antenatal care;[8] improved water sources[9] and improved Sanitation.[10] The data from MICS and CMI have been merged district wise by assuming that social variables change slowly over time.

The Principal Component Analysis (PCA) and Factor Analysis are used to transforms a number of (probably) correlated variables into a (lesser) number of uncorrelated variables called *Principal Components*. The first principal component accounts for maximum variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible. The goal of the principal components analysis is to explain the maximum amount of variance with the fewest number of principal components. Factor Analysis is also used which is similar to PCA technique. The principal component with the smallest eigenvalue contributes the least variance and so is least informative and is thus discarded.

In order to control for infrastructure, we have taken road density as a suitable proxy. Employment cost and investment have been taken to see if firm efficiency is sensitive to cost and investment changes respectively. The results are robust as seen by minor changes in coefficients even if we add/drop few variables. Factors for education are calculated using variables such as primary enrollment of boys and girls, high school enrollment of boys and girls, staff number, enrollment in poly-technology institute etc. Factors for crime include murder, attempted murder, kidnapping, and burglary.

Table 2

Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
Lee and Lee Index	.2458	.2031	.0204	.9621
Ellison-Glaeser	0.142	0.200	–0.340	1.112
District Efficiency Score	.8508	.0533	.7424	.9571
Road Density	.3614	.2062	.0562	1.0291
Investment	21.9	33.3	0.389182	157
Employment Cost	0.014049.5	0.033365.15	0.000003	0.214907
No. of Factories	120	214	2	1170

Notes: Investment and employment costs are in millions.

[6]MICS collects important information on socio-economic variables.

[7]Probability of dying between birth and the first birthday.

[8]Skilled person providing antenatal care to women aged 15-49 who gave birth during preceding two years in Punjab.

[9]Percent distribution of household population according to the main source of drinking water and percentage of household population using improved drinking water sources.

[10]Percent distribution of the household population according to the type of toilet facility used by the household, and the percentage of the household population using sanitary means of excreta disposal.

Summary Statistics (see Table A2) show that the district with most agglomeration are Layah, Rajanpur, Mianwali, and Rahim Yar Khan whereas districts with most diversity include Lahore, Khanewal, Multan, Kasur, Attock and Shiekupura. Additionally, districts with highest average efficiency of firms are Sargodha, Jhangh, Kasur, Rahim Yar Khan, Sheikhupura and Faisalabad. Contrary to this, districts with lowest average efficiency[11] include Rawalpindi, Lahore, Sahiwal and Gujranwala.

Due to data constraints, the efficiency model could not be estimated with full robustness due to degrees of freedom problem. This issue was expected since we have used district-level data. The aforementioned problem could have been avoided had the regression was run at firm level but that would not have added anything substantial to the already dense literature on agglomeration. Perhaps future studies could address this degree of freedom limitation.

4. ECONOMETRIC SPECIFICATION

Following Buki and Khan (2011), we have estimated the following equation:

$$Y_{it} = B_1 X_{it} + B_2 X_{2it} + B_3 X_{3it} + \alpha_1 + \alpha_2 + \ldots . \alpha_n \epsilon_{it} \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

The use of above equation (Fixed Effects) addresses the problem of endogeneity by ensuring that the assumption of $Cov\,(X, U) = 0$ is not violated. Table 5 describes the data sources for different variables. The dependent variable is social inclusion and the independent variable of interest is agglomeration. Other control variables are road density, total education, crime factors, number of reporting factories and employment cost.

It is necessary to check whether data is normally distributed or not. Therefore, we use Cameron and Trivedi's (1990) decomposition of IM-test in Stata. Overall there is no skewness[12] or kurtosis[13] in the data. Individually the variables for social inclusion, agglomeration, road density and crime factors follow a normal distribution. Ramsey (1969) *reset* test checks for misspecification in a model and also omitted variable bias. P value is 0.4118 which is greater than 0.05. Therefore we failed to reject the null hypothesis. This implies the model is correctly specified and that it has no omitted variable bias.

Group-wise heteroscedasticity is checked by running Modified Wald test in the Fixed Effect regression model using Stata. The same results were obtained in terms of Breusch-Pagan (1979) and Cook-Weisberg (1983) tests for heteroscedasticity.[14] Therefore the null hypothesis is rejected which implies that heteroscedasticity exits. To counter this problem, we have used heteroscedastic robust standard errors.

Multicollinearity diagnostic criteria are given below:

[11]Larger districts e.g. Lahore etc. may have low average efficiency due to huge variation in the operations of firms.

[12]P value was 0.9908.

[13]P value was 0.1994.

[14]P value was 0.000.

Table 4

Multicollinearity Diagnostic Criteria

Variables	Eigenvalues	VIF	1/VIF
Agglomeration	2.0155	1.0847	0.9219
Road Density	0.8975	1.4904	0.6710
Crime	0.5899	1.3554	.7378
Total Education	0.4971	1.3867	0.7211

Source: Authors own Calculations.

The variance inflation factor (VIF) is most commonly used criteria to identify the problem of multicollinearity in regression analysis. According to Gujarati (2003), if VIF is above 10, then a severe problem of multicollinearity exists among the predictors. However, VIF calculated shows no issue of multicollinearity as all the values for VIF are lower than 10. If the Eigenvalues are close to zero then the chances are that multicollinearity exists, but none of the Eigenvalues is zero, so there is no issue of multicollinearity. The 1/VIF is called the tolerance test and if its value is less than 0.10 than there is multicollinearity but none of the explanatory variables has tolerance value less than 0.10 [Gujarati (2003)]. Since no multicollinearity exits, therefore, it shows that t values are robust.

5. EMPIRICAL RESULTS

The Agglomeration index indicates the specialisation/diversity. If the value of agglomeration index increases, then it means that specialisation is increasing and if its value falls then it means that diversity is increasing. Social Inclusion is the dependent variable of the the reported regressions given in Table 5. The slope parameter of agglomeration index is statistically significant at 1 percent level of significance. Thus benefits of industrial development in Punjab are being enjoyed by lower segment of the population as well. These positive effects of specialisation rather than diversity are supported by many empirical findings [Henderson, *et al.* (2001); Ciccone and Hall (1996) and Henderson (1990)].

As for the Ellison and Glaeser index we have estimated a score of greater than 0.05 for this index which indicates that industries in Punjab are very agglomerated. If the score is in between 0.02 and 0.05 it shows that the industry is reasonably agglomerated and a score of less than 0.02 shows very weak agglomeration. As shown in Table 2, the mean value of this index is 0.142 which according to aforementioned range shows that on average industries of Punjab are highly agglomerated.

Road density, agglomeration and total education have a positive relationship with social inclusion whereas crime has a negative association with social inclusion. All the signs are as expected. The main variable of interest is statistically significant at 10 percent level of significance.

Table 5

FE Estimates of Agglomeration Model

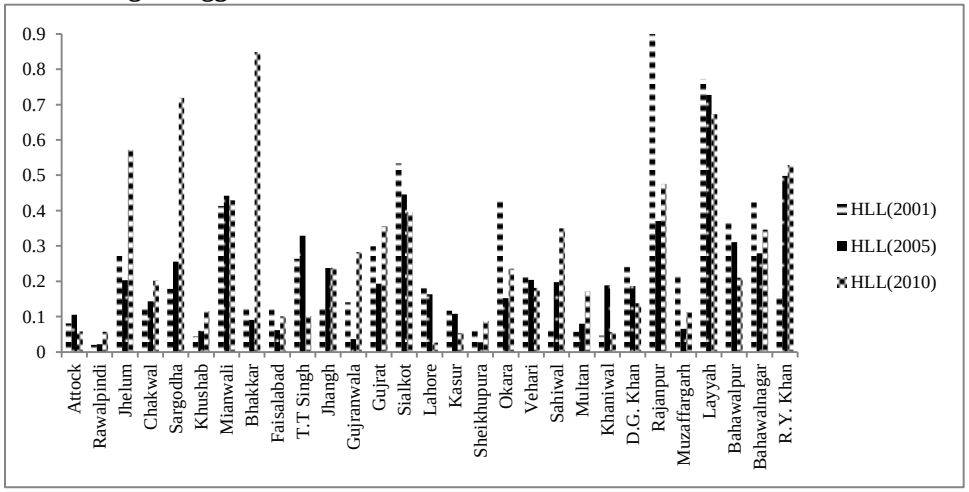
Variables	(1) Social Inclusion	(2) Social Inclusion	(3) Social Inclusion	(4) Social Inclusion
Agglomeration	0.457***	0.488**	0.494**	0.485**
	(0.165)	(0.179)	(0.180)	(0.177)
Road Density	0.260	0.542**	0.539**	0.535**
	(0.205)	(0.211)	(0.214)	(0.216)
Total Education	0.0806	0.101	0.109	0.117
	(0.157)	(0.144)	(0.143)	(0.140)
Crime Factors	–0.101	–0.0706	–0.0666	–0.0823
	(0.164)	(0.155)	(0.155)	(0.155)
No of Reporting Factories			0.000109	0.000153
			(0.000179)	(0.000187)
Employment Cost				8.18e-07
				(9.84e-07)
Constant	–0.206***	–0.250***	–0.260***	–0.261***
	(0.0703)	(0.0667)	(0.0677)	(0.0677)
District Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	No	Yes	Yes	Yes
Observations	87	87	87	87
R-squared	0.097	0.123	0.125	0.131

Source: Authors' own Calculations.

Robust Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 (Std. Err. adjusted for 29 clusters in districts).

Correlation between district efficiency and agglomeration is positive. There are only 42 observations and if fixed effects are used this number falls to 28. With *n* less than 30 the OLS assumptions of normality will be violated. There is a vast literature that supports the hypothesis that agglomeration increases the efficiency of firms. Thus sign and significance may be checked without going into the details of robustness of results (see Table A3).

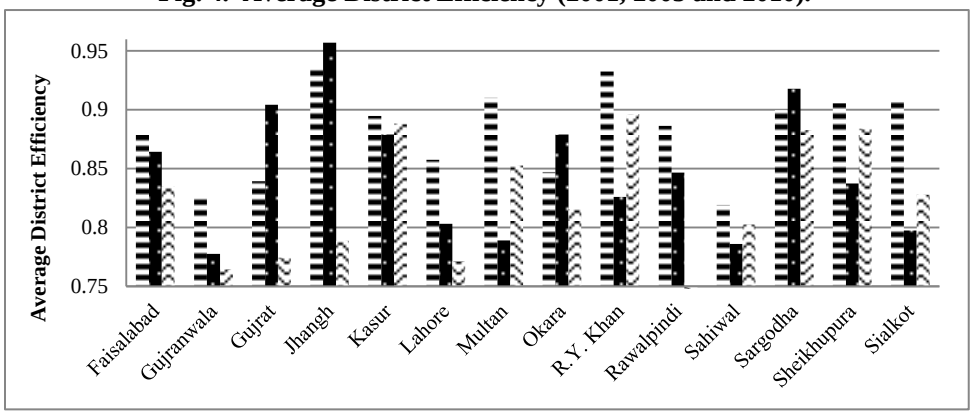
Fig. 3. Agglomeration of Districts in the Years 2001, 2005 and 2010



Source: Authors' Own rendering using Panel CMI data.

Agglomeration of each of the district in the sample is illustrated above. The x-axis shows time period (2001, 2005 and 2010) whereas y-axis shows agglomeration level. Districts show a considerable change in the level of agglomeration. A mixed trend of change in agglomeration levels is observed: there is a rise in agglomeration in Bhakkar, Sargodha and Jehlum whereas Rajanpur and Layyah show a fall in agglomeration level. On the other hand, Rajanpur, Layah, Sialkot, and Okara show the most level of agglomeration in the year 2001 whereas Layyah, Rahim Yar Khan, Sialkot, and Mianwali show the most level of agglomeration in the year 2005 and in the year 2010 the most level of agglomeration is shown by Layyah, Bhakkar, Sargodha, Jehlum.

Fig. 4. Average District Efficiency (2001, 2005 and 2010).



Source: Authors' Own rendering using Panel CMI data.

There has been a consistent fall in efficiency in Faisalabad, Gujranwala, and Lahore from 2001 till 2010 whereas no district has shown a consistent rise in average firm efficiency over the same period. For the most districts like Gujrat, Jhangh, Okara, and Sargodha, there has been a rise in average efficiency from 2001 till 2005 but for the next half-decade, we see a falling trend in efficiency level. The inputs used to calculate the efficiency are capital, labour, and materials and energy, whereas output is taken as value added by firms. The fall in efficiency from 2001 till 2005 can be attributed to the fact that due to opening up of Pakistan's economy it faced fierce competition from international firms. However, the fall in efficiency following this period was due to lack of business-friendly policies of the government.

As stated earlier, results for regression of district efficiency on agglomeration are not robust due to the degree of freedom problem. This problem arises because our regressions are run on the district basis and not on the basis of individual firm. Therefore, this paper utilises the trend of efficiency (Figure 4) over the years (2001-2010). This ensures robustness of results as well since same firms are followed over time to measure efficiency.

6. CONCLUSION AND POLICY IMPLICATIONS

This paper investigated the district level agglomeration economies in the manufacturing sector of Punjab. The DEA bootstrap analysis which incorporated

technical efficiency model was applied. Plant level panel data constructed from CMI dataset for the years 2000-01, 2005-06 and 2010-11 were used. The Agglomeration Index (Diversity index) was then calculated which measured local scale externalities at the district level while the mean agglomeration level of industries was also calculated. This study found that social inclusion and firm efficiency is positively related to agglomeration in districts.

The results indicate that industries in Punjab are agglomerated[15] thus showing intra industry spillovers in Punjab and that this agglomeration is positively associated with efficiency of firms. Agglomeration at district level is also positively associated with social inclusion in districts. Thus both firms and districts in Punjab are benefitting from positive externalities of agglomeration economies. Further, the results show that better infrastructure in districts also allows for more social inclusion. This means that government may focus on the provision of better infrastructure facilities such as better road network which will lead to greater connectivity and better social inclusion in districts of Punjab.

This study uses past information to draw inference about the potential future positive consequences of CPEC. The results show that agglomeration which will be a natural consequence of industrial development as a consequence of CPEC will yield social inclusion.

[15]As shown by high mean value of Ellison-Glaeser Index in Table 2.

APPENDIX A

Table A1

CPEC Special Economic Zones (SEZs)

Serial Number	Project Name
1.	Rashakai Economic Zone on M-1
2.	Special Economic Zone Dhabeji
3.	Bostan Industrial Zone
4.	Punjab - China Economic Zone, M-2 District Sheikhupura
5.	ICT Model Industrial Zone, Islamabad
6.	Development of Industrial Park on Pakistan Steel Mills Land at Port Qasim near Karachi

Source: Official CPEC website. Government of Pakistan.

Table A2

Summary Statistic (Mean) from 2001-2010

Districts	Agglomeration	Road Density	Social Inclusion
Attock	0.0816	0.233	–0.125
Rawalpindi	0.0335	0.537	1.098
Jhelum	0.351	0.291	0.651
Chakwal	0.156	0.292	–0.224
Sargodha	0.385	0.399	0.655
Khushab	0.0733	0.228	0.576
Mianwali	0.429	0.225	0.659
Bhakkar	0.357	0.197	–0.975
Faisalabad	0.0944	0.508	1.827
T.T Singh	0.232	0.456	0.819
Jhangh	0.201	0.333	–1.43
Gujranwala	0.154	0.598	0.577
Gujrat	0.283	0.49	1.031
Sialkot	0.459	0.579	0.733
Lahore	0.124	0.629	2.171
Kasur	0.0932	0.366	0.261
Sheikhupura	0.0584	0.35	0.946
Okara	0.272	0.501	–0.662
Vehari	0.199	0.481	–0.101
Sahiwal	0.203	0.645	–0.183
Multan	0.103	0.565	–0.46
Khaniwal	0.0974	0.401	–0.452
D.G. Khan	0.189	0.113	–1.776
Rajanpur	0.603	0.0965	–2.337
Muzaffargarh	0.131	0.236	–1.127
Layyah	0.725	0.175	–0.693
Bahawalpur	0.296	0.082	0.0157
Bahawalnagar	0.35	0.23	–0.583
R.Y. Khan	0.396	0.244	–0.893

Source: Authors' own Calculation.

Table A3

Regression of District Efficiency on Agglomeration

Variables	District Efficiency
Employment Cost	–1.47e-06***
	(4.90e-07)
No. of Reporting Factories	–0.000325***
	(0.000104)
No. of Reporting Factories Squared	1.80e-07*
	(9.09e-08)
Investment	7.06e-07***
	(2.51e-07)
Total Education	0.000530
	(0.0101)
Constant	0.881***
	(0.0138)
Observations	42
R-squared	0.383

Source: Authors' own Calculation.
Note: Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1.

Agglomeration (number of reporting factories), investment, and the number of reporting factories squared have a positive relationship with average district efficiency of firms whereas employment cost and the number of reporting factories in level form have a negative relation with average district efficiency of firms. The number of firms is taken as a proxy for agglomeration as taken in [Barry, Gorg, and Strobl (2003)].

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School Quality and Parental Schooling Decisions for Their Children: Public and Private Schools in Rural Pakistan

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This study uses the Pakistan Rural Household Survey 2004-5 (PRHS), a rich set of households and school data, to examine parents' schooling decision in rural Pakistan. Nested logit regressions are used to quantify the determinants of child school attendance. The analysis confirms that the greater the number of schools (public or private) in the local communities the higher is the attendance. Lower school attendance of boys seems to be the outcome of lower school quality more than it is for girls. A marginal increase in school quality correlates with increased school attendance in government schools more than in private schools. Nearly all school quality variables including control for number of schools in a community stand insignificant for girls. This shows that other factors might be of more importance than school quality of local schools for girl's low attendance in rural Pakistan. Besides, parental education, especially mother's education, and household income have strong positive impact on child school attendance. The greater the number of children in the household the lower is the child school attendance. Credit constraint seems not to be problematic as the estimated effect is statistically insignificant. The size of landholding seems to be important only in the case of girls schooling.

JEL Classification: I21, I25, D13, C25
Keywords: Demand for Schooling, Public Education, Private Education, Pakistan

1. INTRODUCTION

Childhood in developed economies is a time for school learning, but the high level of dropout in poor countries suggests that children in these countries are deprived of learning opportunities. At the United Nations in 2000, almost 189 governments agreed to the Millennium Development Goal (MDG) that by 2015 every child (boy or girl) should complete primary schooling. This consensus substantiates the view of most economists and development agencies that schooling promotes individuals' wellbeing and economic development [Zhoa and Glewwe (2010)].

Pakistan's educational performance is poor relative to neighbouring countries as measured by Gross Enrolment Ratio (GER) and Net Enrolment Ratio (NER). In 2004-05 the country's adult literacy rate stood at 49.9 percent as compared to Sri Lanka (90.7 percent), India (61 percent), Iran (82.4 percent) and Indonesia (90.4 percent) [Pakistan (2009)]. The Human Development Index for Pakistan was 0.55, which is lower than that

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of some countries in the region but slightly better than that for Bangladesh and Nepal. Pakistan's performance is weaker on the Global Competitiveness Index (GCI) for health and education components than major competitors like India, China, Bangladesh, Malaysia and Sri Lanka. In terms of the quality of educational outcomes, Pakistani students are well below the international scaled mean of 495 in the Trends in International Mathematics and Science Study (TIMSS). This means that in Pakistani the performance of students is poorer than their counterparts in other countries in the region except Iran [Pakistan (2009)]. The current estimates show moderate improvement in adult literacy ratio (58 percent in 2015-2016) relative to the estimate of 49.9 percent in 2004-05. Low educational performance is always coupled with regional (rural and urban as well as provincial) and gender disparities in education provision. Adult literacy rate for males and females is 70 percent and 47 percent respectively. Literacy remains higher in urban areas (74 percent), while the rate for rural areas is 49 percent [Pakistan (2015-2016)]. With low level of literacy, it is most probable that they will have relatively low levels of income, social status and living conditions.

Research on the role of school quality in parental schooling decisions for their children from the perspective of public or private schooling is lacking in Pakistan. A few studies have used household survey data but these are usually confined to small population [e.g. Alderman, *et al.* (2001)]. Yet, no study has simultaneously considered the effects of household income, parental education and school quality in public or private schools. Moreover, due to limited data omitted variable bias may confound the true effect. This paper has tried to address, among the key questions, the relative importance of school quality on the one hand and family characteristics on the other. The investigation of these factors, and in particular school quality, will shed light on persistent low school attainment or enrolment; as it is plausible that low investment in children's human capital is the major cause of transition of poverty across generations.

This study uses the Pakistan Rural Household Survey (PRHS), a nationally representative dataset of rural households and schools, to investigate the role of school quality in child school attendance in rural Pakistan. The analysis estimates the impact of factors such as household income, parental education, land size and school quality, on school attendance.

The PRHS contain a comprehensive list of household and school level information in rural Pakistan, so the current study is less likely to suffer from omitted variable bias. In addition, it contributes to the literature on education in Pakistan in two ways. First, studies of the impact of school quality in rural Pakistan are extremely rare from the perspective of child school attendance in public or private schools. Secondly, it controls for the role of household income or wealth, credit constraint, other demographic indicators, along with school quality. School quality plays an important role in school attendance, learning and child stay at school for more years [Glewwe and Kremer (2006)]. This study analyses the effects of a comprehensive set of school-quality attributes on school attendance in public and private schools.

The results of studies carried out to date, which have focused on the relationship between school quality and student attendance/achievement, are inconsistent [Harbision and Hanushek (1992); Hanushek (1994); Greenwald, *et al.* (1996); Mora (1997); Behrman, *et al.* (1997); Alderman, *et al.* (2001)]. Robust results have been reported by a

very few studies from other countries with a lack of consensus on the effects of school quality even among these studies.

What is the role of school quality and other determinants? Two main approaches are used in the literature. In the first, cognitive functions are evaluated [Alderman, *et al.* (2001); Arif and Saqib 2003; Das, *et al.* (2006); Aslam (2009); Sandy and Duncan (2010)]. In the second, child school participation is modelled explicitly taking into account the schooling options. Alderman, *et al.* (2001) uses a nested logit framework to evaluate the child school participation in government versus private schools in Lahore, urban Pakistan. They employ an area-frame sampling methodology and included low-income areas, measuring household and school level characteristics. They incorporate controls for home background and school inputs into the nested logit framework. For rural Pakistan no similar exercise has been undertaken. This study provides one, focusing on quantifying child's school participation differences based on school quality provision in the two types of schools along with other important determinants. It is important to note that the studies of Arif and Saqib (2003), Das, *et al.* (2006) and Aslam (2009) looked for child achievement differences between state and private schools. But the research by Alderman, *et al.* (2001) is the only study that also evaluated child participation differences.

The nested logit framework has been widely used in the education economics literature for evaluating school choice decisions in other countries. Meschi, *et al.* (2011) investigates the relative importance of pupil attainment (test score), parental aspiration (whether the parent wants his child to stay at school) and local labour market conditions (unemployment rate) in post compulsory schooling decisions in England. They conclude that child's educational achievement and parental aspirations are the main drivers of the schooling rather than local market conditions. Checchi and Jappelli (2004) utilise a large cross-sectional data set on child's school attendance in private and public schools in Italy. They have information on household income, demographic characteristics, parental education and school quality. They control for school quality with an index of the subjective assessment of private and public schools by households. Their results show that school quality is the main factor in the choice between public and private schools in Italy. Private schools in the US are shown to have cream skimming effects;[1] that is, they skim off the most able and wealthiest students [Epple and Romano (2008)]. Also, in the United States, the private schooling decision depends on parental education, household income, racial composition of public schools, location, and crime rate in the area of residence [Lankford, *et al.* (1995)]. A proxy for school quality 'expenditure per student and tuition fee' does not affect parental school choice. Buddin, *et al.* (1998) establish that parental characteristics (age, income and education) are the main factors affecting private school choice. Proxies for school quality of public and private schools (teacher's salaries and expenditure per student) do not affect this decision. Overall the literature identifies a range of factors relevant to the private schooling choice but offers no consensus that school quality is the main driving factor affecting school choice decisions, perhaps partly because experience varies by country.

The paper is organised as follows. Section 2 presents an overview of schooling in Pakistan. Section 3 describes private-public school data. The nested logit framework is

[1]Epple and Romano (2008) did not utilise the nested logit framework.

presented in Section 4. In Section 5 results of the main econometric findings on child's school participation are discussed. Finally, Section 6 concludes.

2. EDUCATION IN PAKISTAN: AN OVERVIEW

Investment in education is a pre-requisite for sustained improvement in the wellbeing of individuals and societies. But Pakistan's social indicators are low in comparison to countries at the same level of development. Pakistan lies at the low end of Education Development Index (EDI) in the region [NEP (2017)].

Every child is entitled to free and compulsory education under article 25(A) of the Constitution which states that "The state shall provide free and compulsory education to all children of the age of 5-16 years in such manner as may be determined by law". Detailed laws and rules have been framed to enforce the said constitutional provision in the country but much needs to be done to execute it in true letter and spirit.

According to Pakistan Education Statistics (PEC) (2015-16) total education institutions in the country (from pre-primary to university level) are 303,446, comprising 191,065 public and 112,381 private institutions. Total enrolment, in both sectors, is 47.49 million, out of which 27.69 million is in public sector and remaining 19.80 million is in private sector institutions. Further disaggregation at the gender level shows that 56 percent of the total enrolled children are male while 44 percent are female students. At the pre-primary level total enrolment is 8.745 million (public 4.532 million (52 percent) and private 4.212 million (48 percent)). The primary level (I-V) of education in Pakistan accommodates 18.75 million children (public 11.461 million (61percent); private 7.290 million (39 percent)). The middle (VI-VIII) level of education enrols 6.445 million children (public 4.039 million (63 percent); private 2.403 million (37 percent)). The enrolment at secondary (IX-X) school level is 3.437 million (public 2.227 million (65 percent); private 1.209 million (35 percent)). Whereas total enrolment at higher secondary school level is 1.697 million (public 1.325 million (78 percent); private 0.372 million (22 percent).

In Pakistan there are almost 51.17 million children between the ages of 5 and 16 [PEC (2015-16)]. Out of these, about 28.53 million children go to any educational institution (government or private), and the rest (22.64 million children) are out of school. According to the available statistics, Pakistan stood 2nd in terms of out of school children in the world [NEP (2017)]. The out of school estimate for primary school going age children is nearly 5.03 million, while estimates for middle, high and higher secondary level are 6.40 million, 4.88 million and 6.33 million, respectively. Not surprisingly, more girls are out of school than boys. The under financing of education implies more illiterates, low enrolment, high dropout rate and low learning outcomes.

Spending on education has remained static at around 2 percent (of GDP) for the past couple of years, with about 92 percent being spent on salaries (recurrent head), only a meagre amount is spent on quality improvements (about 8 percent as development head) such as provision of school infrastructure, curriculum development, teachers' training, monitoring and supervision. More than half (64 percent) public sector primary schools have electricity. About 60 percent schools have drinking water, 54 percent have latrines, and 65 percent are with boundary wall. Nearly 80 percent of private sector primary schools are electrified. About 85 percent schools have drinking water facility, 84 percent

have latrines, and 81 percent have boundary wall [ASER (2015-16)]. This shows that education provision in public sector schools is not satisfactory. Barely 40 percent children, in public sector schools, have required competency in mathematics, science and languages [NEP (2017)]. Furthermore, public sector education provision also faces the problems of gender disparities, inequitable access and high dropouts. In this situation, considerable presence of private sector education provision is imperative. Accordingly, private sector is supporting the education in Pakistan by accommodating more than 41.69 percent of the total enrolment in the country, while providing quality education.

Expenditure on education (percent of GDP) in other countries of the region is greater than that in Pakistan. According to Pakistan Economic Survey (2015-16), expenditure as percent of GDP is 3.8 percent in India, 6 percent in Bhutan, 4.6 percent in Afghanistan and 5.2 percent in Maldives. The low level of education expenditures, as percentage of GDP, in Pakistan reveals a big gap in policy and practice.

3. DATA SOURCE AND SCHOOL CHOICE

The empirical analysis of this study is based on the Pakistani Rural Household Survey, second wave, of 2004-5 (PRHS-II). This data source offers a unique combination of child level data and a wide range of school quality indicators, essential for the present study. The PRHS-II, was restricted to Punjab and Sindh due to security concern, and is comprised of 1614 households. The PRHS-II also interviewed 293 split households[2] leading to a sample of 1907 households. The child age range of the present study is 5-15 years. Some of the PRHS-II households had no children less than 15 years of age. Therefore, the final sample is reduced to 1427[3] households (with 3918 children) spread over 94 rural communities (villages).

The PRHS-II survey collected information on agricultural-related activities, credit, employment, and several demographic events as well as households' consumption information for the month preceding the survey.

PRHS-II is a representative household survey data which combines information from a village and school census. The school census contains comprehensive information on all schools within each village and schools lying within a 2 km walk of the border of each settlement of the village. GPS coordinates were available, so the distance between each household and school could be calculated. The school census contains information on 1326 schools of which 1112 (84 percent) have classes at the primary level (up to grade 5). About 63 percent of these schools are solely primary/elementary schools, while the rest primary schools were attached to a middle or high school. Government school provision is central in determining access to education as nearly three-fourths of primary schools are public (90 percent in Sindh province).

The descriptive statistics based on Pakistan Rural Household Survey (PRHS) reported in Table 1 shows that more than half of school age children (51 percent) are not

[2]A split household is defined as a new household where at least one member of the previous panel household has established a new household permanently. The movement of the member from the panel household is due to the marriage of a female member or to a son or brother deciding to live separately from the panel household. In PRHS, households split only within a sampled village (PSU) were interviewed. Those households who split or moved out of the sampled villages were not followed due to high cost involved in this process [Arif and Farooq (2012)].

[3]667 households in Sindh and 760 households in Punjab.

in school. The relevant proportion of enrolled children is 49 percent. Besides, it is shown that there are two main school types in Pakistan, government and private. The relevant proportion of government school children in the survey is 88.96 percent. Whereas the same figure for private schools is 11.04 percent. Private schools are for profit in Pakistan.

The breakup of enrolled children over the provinces in Table 1 shows that out of 1708 (88.96 percent) enrolled children in government schools, 901 children are in Punjab and 807 children in Sindh. Total number of children enrolled in private schools is 212 (11.04 percent), of which 199 are in Punjab Province and the remaining 13 children are from Sindh. These figures support the FBS (2000) claims/estimates that much of the mushrooming of private institutions has happened in Punjab than anywhere else in the country in the last two decades.

Table 1

Enrolment by Province

School Type		Enrolment by Province								
		No			Yes			Total		
		Sindh	Punjab	Total	Sindh	Punjab	Total	Sindh	Punjab	Total
No-schooling	Count	1,124	874	1,998	–	–	–	1,124	874	1,998
	Percent	100	100	100	–	–	–	57.82	44.28	51.00
Government	Count	–	–	–	807	901	1708	807	901	1,708
	Percent	–	–	–	98.41	81.91	88.96	41.51	45.64	43.59
Private	Count	–	–	–	13	199	212	13	199	212
	Percent	–	–	–	1.59	18.09	11.04	0.67	10.08	5.41
Total	Count	1,124	874	1,998	820	1,100	1,920	1,944	1,974	3,918
	Percent	100	100	100	100	100	100	100	100	100

Source: Calculated from PRHS-II.

4. ESTIMATION STRATEGY

4.1. The Nested Logit Model

For modelling the outcome variable on child's school participation, unordered nested logit is preferred over other discrete choice models (multinomial or conditional logit models) because it relaxes the strong assumption of independence of irrelevant alternatives (i.i.a).[4] The nested logit model is interpreted with the underlying principles of utility-based choice theory, the random utility maximisation (RUM) model. Utility[5] in an indicator of value to the decision maker—here the parents—and is derived from the attributes of alternatives. The utility maximisation rules state that the decision maker will choose the alternative from the available set of alternatives that maximises his/her utility.

Suppose 'U_{ij}' is the true utility to the decision maker 'i' from alternative 'j'. Utility 'U_{ij}' is the sum of a deterministic (observable) part 'V_{ij}' and an unobserved stochastic part 'ε_{ij}';

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

[4]The conditional logit model takes into account alternative-specific regressors; however, like the simple multinomial logit model it assumes the independence of irrelevant alternatives. The independence of irrelevant alternatives (i.i.a) implies that the relative odds between two alternatives are the same no matter what other alternatives are available.

[5]The utility, here, is referred to the expected utility of the returns to investment in child schooling.

The estimated probability 'P_{ij}' that decision maker *'i'* selects alternative *'j'* is equal to the probability of 'U_{ij}' being the highest of all '$U_{i1},\ldots U_{ij}$'. The alternative that the decision maker *'i'* chooses is denoted by $y_i \in [1....J]$. Hence the probability is

$$P_{ij} = pro(y_i = j) = pro(U_{ij} > U_{ik} \qquad \forall j = 1,..k...,J : k \neq j)$$

$$P_{ij} = pro(y_i = j) = pro(\varepsilon_{ik} - \varepsilon_{ij} \leq V_{ij} - V_{ik} \ \forall j = 1,..k...,J : k \neq j) \qquad \ldots \quad (2)$$

Different assumptions regarding the distribution of the random error terms 'ε_{ij}' associated with the utility of each alternative, given the observable portion of the utility 'V_{ij}', result in different model representations and predicated choice probabilities [Koppelman and Bhat (2006); Cameron and Trivedi (2009)]. The observable portion of the utility 'V_{ij}' is specified as;

$$V_{ij} = X_{ij}^{'} \beta_j + Z_j^{'} \gamma_j \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Where 'X_{ij}' are alternative-specific regressors and 'Z' are individual specific regressors. Alternative-specific regressors vary over individual as well as alternatives. These variables include school quality characteristics of government and private schools available to the household. School quality variables have been made to vary by alternative, as these inputs may have different productivities in government and private schools and important for assessing parental choices between these schools. Similarly, for no-school choice the vector of school quality characteristics is a null vector. Alternative-specific variables accounted for in this study include:

X_{ij} = (number of schools in the community, student-teacher ratio, toilet facility for children, school boundary wall, electrified schools, furniture for students, textbooks for students, teacher experience, teacher qualification, schools with a playground, schools with a library).

Whereas, individual-specific regressors describe the characteristics of the decision maker. Specifically, individual specific variables accounted for in this study include:

Z_t = (Child sex, child age, own farm animals, own non-farm animals, household expenditure, fertility, mother's level of education, father's level of education, land owned, land owned squared, land ownership dummy, credit constraint, province).

The nested logit model requires that a nesting structure (D_n; n=1, ..., N) be specified that partitions the alternatives into groups. Errors are correlated within group but uncorrelated across groups. In the present context, the schooling decision is partitioned into two nests. Sending children to school modes (Government and Private) share the nest D_{Yes} = {*government, private*} and the other mode not sending children to school (no-schooling) belong to nest D_{No} = {*no-schooling*}. Further details about parental decision of child schooling decision are given in Appendix A.

Specifically, subscripts (j,k) denote the alternatives, where j denotes the upper level (limb) and k denotes the branch (lower level) within the limb (see Appendix A, Figure A1). For instance, $(1,2)$ denotes the second alternative in the first limb.

$$V_{jk} + \varepsilon_{jk} = Z_j^{'} \gamma + X_{jk}^{'} \beta_j + \varepsilon_{jk}, \quad j = 1, \ldots., J, \;\; k = 1, \ldots., K_j \quad \ldots \quad \ldots \quad (4)$$

Here $'Z_j'$ varies over the limbs and $'X_{jk}'$ varies over both branches and limbs. The subscript '*i*' for individual is suppressed, for ease of explanation. In nested logit model $(\varepsilon_{j1}, \ldots. \varepsilon_{jK})$ are distributed as Gumbel's multivariate extreme-value distribution. The probability that alternative (j,k) is selected is equal to;

$$p_{jk} = p_j \times p_{k/j} = \frac{\exp(Z_j^{'} \gamma + \theta_j I_j)}{\sum_{m=1}^{J} \exp(Z_m^{'} \gamma + \theta_m I_m)} \times \frac{\exp\left(X_{jk}^{'} \beta_j / \theta_j\right)}{\sum_{l=1}^{K_j} \exp(X_{jl}^{'} \beta_j / \theta_j)} \quad \ldots \quad \ldots \quad (5)$$

Here, $I_j = \ln \sum_{l=1}^{K_j} \exp(X_{jl}^{'} \beta_j / \theta_j)$ is called log sum and $'\theta_j'$ called the dissimilarity parameters.

The 'θ_j' characterises the degree of substitutability between government and private alternatives, and represents correlation between the unobserved (error) components for these two alternatives in the same nest. Its value is bounded by zero and one $(0 < \theta_j < 1)$ to ensure consistency with the random utility maximisation principles. The values outside this range mean that the model is inconsistent with random utility theory. Smaller value of 'θ_j' indicates greater substitution between government and private school alternative in the nest. The probability of private school is equal to the probability of choosing child schooling times the conditional probability of choosing private schooling given that child schooling mode is chosen. Similar interpretation could be undertaken for the government school option.

Estimation involves specifying the alternative-specific regressors 'X_{jk}' and individual-specific variables 'Z_j' (Equation 4) and inserting them into Equation 5. The log likelihood for Full Information Maximum Likelihood (FIML) estimation of the model [Green (1997)] is as follows:

$$LnL = \sum_{i=1}^{n} Ln(prob(j \setminus D) \times prob(D))_i$$

Where *'j'* represent alternative in each nest and *'D'* denotes the relevant branch/s or nest/s.

4.2. Coefficient Interpretation of Alternative Specific Variables

Mathematically, the marginal effect of a change in characteristic *'r'* of alternative *'j'* on the likelihood that individual *'i'* would select alternative *'k'* (where alternative *'k'* may or may not be equal alternative *'j'*) is given as;

$$\partial prob\,[y_i = k] / \partial X_i(r \mid j) = [1(j = k) - P_{ij}] P_{ik} \beta_r \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

For example, a positive coefficient in the main utility function on one of the alternative-specific variables means that if the regressor increases for one category, then that category is chosen more and the choice for other categories decreases or chosen less. A positive coefficient on the variable 'Proportion of schools with a textbook for students' means that if the textbook proportion of one of the school options (government or private)

increases, then demand for that option increases and demand for other options decreases, and vice versa for a negative coefficient. The coefficients of case-specific variables (e.g. household expenditure and other socio-economic variables) are interpreted as the parameters of a binary logit model against the reference category.

There are two common ways to estimate the partial effect of a continuous variable on the response probability; Average Marginal Effects (AMEs) and Marginal Effects at sample Mean (MEMs).[6] Greene (2003) shows that the estimates from both AMEs and MEMs would be the same in large samples but may not be in moderate and small samples. But current practice favours AMEs, when possible, because econometric software packages were not supporting or able to calculate AME until recently. Therefore, AMEs has also been estimated in this study.

The definitions of the vector of alternative-specific variables (school quality) and vector of case-specific variables (child and household level controls) are given in the following.

4.3. Variable Definitions

The vector of school quality-related variables includes: number of schools in the community, student-teacher ratio, toilet facility for children, school boundary wall, electrified schools, furniture for students, textbooks for students, teacher experience, teacher qualification, proportion of schools having playground, and proportion of schools having library. School availability and accessibility in the community entails significant opportunity cost to the parents in terms of child's time going to and from school to home, as well as, if a particular school is not available in the community or nearby community with implied characteristics. Greater disutility associated with child's school farther from home and most importantly, travelling to and from school is not productive [Alderman, *et al.* (2001)]. Previous research in the area [as in Alderman, *et al.* (2001); Ersado (2005)] focussed on number of schools to proxy school accessibility/availability. However, even if schools are available to individual households in the local area, such schools do not have the appropriate quality attributes. Then number of schools alone would not be able to proxy school accessibility/availability. In such circumstances, the nearest school would have much more disutility to parents than the one a bit farther in the community. Therefore, we also control for the aforementioned school quality attributes/capacity variables along with the number of schools in the community. These capacity variables reflect the educational infrastructure available to all households in the community and could be an important determinant in the explanation of child's school participation. However, to distinguish school capacity/infrastructure effect from school crowding effect, we also control for the number of pupils per teacher. For instance, few schools might be available in a particular community having the implied school quality characteristics but might be over crowded due to greater parental evaluation/child participation.

A variety of variables are used in the literature for capturing school quality, including average expenditure per pupil and the student-teacher ratio. Hanushek (1994)

[6]For computing marginal effects, one usually evaluates Equation (6) at the sample mean of the data (Marginal Effect at Sample Means, MEMs). Alternatively, the marginal effects may be evaluated at every observation and then these individual marginal effects are averaged across the sample (Average Marginal Effects, AMEs).

concluded that increase in spending has no positive effects on student achievement/ attendance. However, Greenwald, *et al.* (1996) found that increased spending did significantly enhance student performance.

On the student-teacher ratio, Betts (1996) argues that a reduction in class size increases the length of stay of children in school. Reviewing evidence on school quality indicators for studies in the United States, especially the student-teacher ratio, Harbision and Hanushek (1992), found that out of 152 studies using the student-teacher ratio as a school quality indicator, 59 obtained positive effects (coefficients), 48 inferred negative effects and results from other 45 studies were undetermined. Mora (1997) has attached some other interpretation to the positive and negative coefficient on the student teacher ratio. He argues that secondary schools with relatively large student-teacher ratios have higher quality as secondary school teachers are more specialised; he refers to it as a school scale effect, whereas primary schools with bigger student-teacher ratios have lower school quality because teachers are unable to impart basic skills to primary school students due to lower interaction. A recent study from urban Lahore in Pakistan by Alderman, *et al. (*2001) found that the student-teacher ratio has positive coefficients in both the school attendance and cognitive achievement equations.

Teacher experience and teacher quality (qualification) have been employed to capture the school quality effect on attendance/student achievement as well e.g. see Behrman, *et al.* (1997) for a review. Furthermore, the size of the school has appeared as an indicator of school quality.

In their study for rural Pakistan Behrman, *et al.* (1997, p. 127) gave a summary of the evidence on school quality indicators, citing a survey of 96 studies for developing countries [Harbison and Hanushek (1992)]; none of six common input measures had statistically significant positive effects for more than two thirds of the studies and only half of them—facilities, teacher education, and expenditure per student (with the last of these based on relatively few studies)—had significantly positive effects in half of the studies. The student-teacher ratio had significant coefficients in half of the studies, but the sign was the opposite of that presumed in half of these significant cases.

All school quality related variables[7] are community-level averages/expected values of school quality inputs (by school type) used by households in the community (apart from number of schools in the community).

Community-level school quality variables/expected values of school quality inputs are used on the ground that these do not reflect the characteristics of the specific school a child attends [Alderman, *et al.* (2001)]. The characteristics of the specific school a child attends are determined jointly with the schooling decision, hence are endogenous to schooling [Deaton (1988); Alderman, *et al.* (2001)]. But community-level school quality variables/expected values of school quality inputs are not endogenous to household-level child schooling decisions [Alderman, *et al.* (2001); Ersado (2005)].

Alderman, *et al.* (1996) and Behrman, *et al.* (2008) assumed the availability and quality of local schools as exogenous for their estimates. The availability and quality of

[7]Our school quality correlates are village/community level averages of schools in a village and village level school quality regressors do not vary within a village. A small error correlation for children in each village would lead to a great downward bias in the default standard errors, as well as in heteroskedasticity-robust standard errors. Hence, given the importance of cluster standard errors we estimated cluster standard errors of the regression estimators over the villages.

local schools are determined by district and higher level decisions and are not in direct response to village characteristics and household demands.

The vector of family attributes contains different household level and child level characteristics. Other possible determinants of child schooling include child sex (gender), child age, household head age and sex, parental educational level and ownership of productive assets such as land and animals [Bhalotra (2003)]. The effect of age on child schooling has been reported from many empirical studies as negative and quadratic. Child schooling is decreasing in age if child labour productivity is increasing in age. The other view is that child labour may get social acceptability or viewed as less harmful as the child age advances [Bhalotra (2003)]. A gender differential in child schooling participation is measured because of variation in returns to education or remittance propensities between boys and girls.

Parental levels of education of both mothers and fathers are included to allow for their possible impact on child schooling and employment [Strauss and Thomas (1995); Bhalotra (2007)]. Educated mothers have a greater say in household decision making and may increase the efficiency of household resource allocation towards child schooling [Bhalotra (2007)]. Also, they may be more altruistic towards their children [Strauss and Thomas (1995)].

Parental income or wealth is measured by household level income (also known as 'household income net of child earnings') as calculated by Bhalotra (2007). This excludes income from child employment to measure household poverty more accurately and to avoid endogeneity with child labour, but includes non-labour earnings and savings income. The variable has been made consistent over households using the OECD (1982) Equivalence Scale [also called Oxford scale,[8] see Jenkins and Cowell (1994)]. It is desirable to utilise more than one indicator. Bhalotra and Heady (2003) reported that the children of households having *more* land are *less* likely to be in school than work.[9] Transaction costs for child labour (family and hired labour are not perfect substitutes) mean that a household with more land has an incentive to employ more of its children [Alderman, *et al.* (1996)]. Farm animals typically supply milk and milk products for their owners' consumption and also are a source of income from sale of the surplus. Non-farm animals usually provide power for agricultural operations.[10] The two categories of animals have different implications for child activity; child schooling is decreasing in farm animals and increasing in non-farm animals [Hou (2010)]. Hence, livestock ownership and possession of land variables are included as possible explanatory variables for schooling.

[8]Equivalence scales correct for the fact that the needs of the each household grow with each additional member but not proportionally. Needs for space, electricity and so on are not twice as high for a household with two members as for a single individual. With equivalence scales each household member is assigned a value in proportion to their needs. The OECD equivalence scale or the Oxford scale assigns a value of 1 to the first member of the household and of 0.7, 0.5 to each additional adult and child, respectively, in the household. Specifically the formula is; $H = 1 + \alpha(n_A - 1) + \beta n_C$, where $\alpha = 0.7$ and $\beta = 0.5$ and, n_A and n_c are the number of adults and children in the household.

[9]Bhalotra and Heady recognise that wealth is often stored as land/other productive assets. Wealth buys leisure but it also demands labour; given imperfect labour markets. So in interlocked and imperfect agrarian markets; there may be perverse or non-linear relationship of schooling/child labour and wealth.

[10]Farm animals include the cow, buffalo, goat and sheep, whereas non-farm animals include the horse, donkey, camel and bullock.

Income smoothing, from year to year, may matter [Jacoby (1994) and Fuwa, *et al.* (2009)]. But measurement of credit access is problematic [Ersado (2005)]. Distance from a commercial bank at the community level is used as proxy for access to the formal credit market - while recognising that it may be a poor indicator. A provincial (regional) dummy is included to capture spatial variation in labour demand, price and productivity, as well as in culture.

Table 2 shows that 47 percent of the children are female. Majority of the households (76 percent) own farm animals. Household income net of child earnings is Rs 15886 for all children. Average number of children born to a couple is 4.54. Parental education is quite low as evident from Table 2. About 44 percent of the households are land owners. The average plot size is nearly 4.52 acres.

Summary statistics for local school quality over the 94 villages are reported in Table 3. Public schools are higher in number than private schools. School quality variables show a wide variation between communities. Student-teacher ratio is higher in public schools than in private schools. Private schools compared favourably with government schools on the available school quality indicators except for playgrounds, textbook provision and average teacher experience. Provision of toilet facility, libraries, furniture availability for students, potable drinking water facility, black board/chalk, electricity in the schools, school boundary wall, is higher in private schools than in the public schools.

Table 2

Mean and Standard Deviation of Child and Household Characteristics

	All (N=3918)		Boys (N=2072)		Girls (N=1846)	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Child Sex (Female)	0.47	0.50				
Child Age	9.68	3.18	9.73	3.24	9.63	3.10
Child Age Squared	103.86	63.49	105.24	65.06	102.31	61.66
Own Farm Animals (Yes)	0.76	0.43	0.76	0.43	0.76	0.43
Own Non -Farm Animals (Yes)	0.27	0.44	0.27	0.45	0.26	0.44
Household Income net of Child Earnings	15886.31	11780.65	16182.68	12141.96	15553.66	11355.50
Fertility	4.54	1.95	4.45	1.95	4.64	1.94
Mother's Level of Education						
Primary	0.07	0.25	0.07	0.25	0.07	0.26
Middle	0.01	0.09	0.01	0.09	0.01	0.08
Secondary	0.01	0.10	0.01	0.10	0.01	0.11
Higher Secondary	0.01	0.07	0.00	0.07	0.01	0.08
Tertiary	0.00	0.04	0.00	0.05	0.00	0.02
Father's Level of Education						
Primary	0.24	0.43	0.24	0.42	0.24	0.43
Middle	0.06	0.23	0.06	0.24	0.05	0.22
Secondary	0.07	0.25	0.07	0.25	0.07	0.25
Higher Secondary	0.03	0.16	0.02	0.15	0.03	0.17
Tertiary	0.02	0.13	0.01	0.12	0.02	0.14
Land Owned in Kharif 2004	4.52	12.82	4.85	14.30	4.16	10.91
Land Ownership Kharif (Yes)	0.44	0.50	0.43	0.50	0.45	0.50
Distance to Nearest Bank	8.82	6.93	8.85	6.77	8.78	7.12
Province (Punjab)	0.50	0.50	0.52	0.50	0.48	0.50

Source: Calculated from PRHS-II.

Table 3

Mean and Standard Deviation of School Quality Attributes

	All Schools(N=94)		Public (N=93)		Private (N=37)	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Percentage of schools with a toilet facility	61.50	28.31	55.17	29.01	98.65	8.22
Percentage of schools with a furniture for students	73.33	27.20	69.57	30.07	70.90	36.95
Percentage of schools with a blackboard/chalk	90.16	19.03	87.64	20.82	90.99	25.34
Percentage of schools with a playground	40.51	29.84	41.89	32.17	38.29	34.32
Percentage of schools with a potable drinking water facility	65.46	32.20	61.37	33.38	94.73	18.63
Percentage of schools with a boundary wall	61.45	30.17	57.74	29.38	88.51	26.74
Percentage of schools with a library	21.63	21.55	20.66	22.27	35.99	37.08
Percentage of schools with textbooks for students	74.33	26.89	79.08	25.43	45.95	49.13
Percentage of electrified schools	51.05	31.23	45.49	31.15	87.75	31.60
Number of schools in a village	6.65	3.02	4.69	2.61	2.16	1.21
Student-teacher ratio	34.10	13.08	35.45	13.40	23.52	9.12
Average no. of teachers with primary qualification	0.07	0.20	0.06	0.21	0.14	0.39
Average no. of teachers with secondary qualification	1.24	0.98	1.23	1.02	1.43	1.28
Average no. of teachers with bachelor qualification	4.35	3.83	4.21	4.02	5.65	3.62
Average no. of teachers with master qualification	3.01	4.43	3.13	4.60	2.93	8.10
Average teacher experience (years)	11.23	7.22	12.46	4.51	5.64	4.19
Average no. of classrooms per school	2.56	2.42	5.39	3.83	7.94	5.34

Source: Calculated from PRHS-II.

5. SCHOOL CHOICE RESULTS AND DISCUSSION

This section presents results on nested logit multinomial model of child school participation in rural Pakistan. Important policy correlates are controlled for in the nested model estimation. The model notably identified many variables significantly affecting the child schooling decision. It shows the appropriateness of the nesting structure adopted that government and private schools are closer substitutes for each other than for the no-schooling option. (The estimate of 'θ_{Yes}' is in the range of $0 < \text{'}\theta_{Yes} < 1$).

Results on variables (case-specific variables) that are held constant across all three choices are reported in the first stage (top part of Table 4). The parameter signs of case-specific regressors indicate the relative utility from choosing the no-schooling option versus the schooling option. Results that allow differential utility across the three alternatives, parameter estimates of alternative specific variable, are presented in the second stage (bottom part of Table 4). A joint parameter has been estimated for each school quality attribute as school quality attributes vary over both alternatives as well as individuals. The direct and cross average marginal effects (AMEs) of statistically significant alternative specific variable (school quality indicators of government and private schools) are also calculated and interpreted subsequently (Tables 5-9). Tables 5 and 6 present AMEs for all children, Tables 7 and 8 present results for boys, and Table 9 presents results for girls.

Table 4

Nested Multinomial Logit Model for School Choice in Rural Pakistan (All Children, Boys and Girls)

	Column (1) All Children	Column (2) Boys	Column (3) Girls
No School versus School Option			
Child Sex (Female)	–0.845*		
	(–7.38)		
Child Age	1.126*	1.365*	0.867*
	(14.58)	(11.98)	(6.15)
Child Age Squared	–0.0577*	–0.0679*	–0.0472*
	(–14.76)	(–12.11)	(–6.53)
Own Farm Animals (Yes)	0.0809	0.0909	0.0553
	(0.56)	(0.58)	(0.30)
Own Non Farm Animals (Yes)	0.0531	–0.0263	0.146
	(0.41)	(–0.16)	(0.92)
Household Income net of Child Earnings [(a)]	3.825*	3.792*	4.761*
	(4.27)	(3.18)	(3.17)
Household Income net of Child Earnings Square[(a)]	–2.779*	–1.531	–5.499*
	(–2.99)	(–1.17)	(–2.23)
Fertility	–0.0908*	–0.0510+	–0.128*
	(–3.44)	(–1.72)	(–3.22)
Mother's Level of Education	0.611*	0.507*	0.656*
	(4.46)	(2.75)	(3.98)
Father's Level of Education	0.251*	0.254*	0.255*
	(5.22)	(4.15)	(4.38)
Land owned in Kharif 2004	0.0148	0.000660	0.0805*
	(1.63)	(0.03)	(2.22)
Land owned in Kharif Squared 2004	–0.0000713	0.000108	–0.00121
	(–1.22)	(0.50)	(–1.52)
Land Ownership Kharif (Yes)	0.252*	0.377*	–0.104
	(1.99)	(2.39)	(–0.43)
Distance to Nearest Bank	–0.0159	–0.0109	–0.0220
	(–1.12)	(–0.62)	(–1.34)
Province (Punjab)	–0.160	–0.231	0.0562
	(–0.65)	(–0.92)	(0.15)
Choice of School Mode (Public, Private or No-schooling	School-Mode Choice	School-Mode Choice	School-Mode Choice
Average no. of classrooms per school	0.0220	0.0455+	0.0000985
	(1.15)	(1.91)	(0.01)
Percentage of schools with a toilet facility	–0.000783	–0.000310	0.0000865
	(–0.26)	(–0.11)	(0.03)
Percentage of schools with a furniture for students	0.0000325	0.00179	–0.00210
	(0.01)	(0.69)	(–1.11)
Percentage of schools with a blackboard/chalk	0.00529	0.00356	0.00630
	(1.23)	(0.85)	(0.99)
Percentage of schools with a playground	0.000794	0.00249	–0.00170
	(0.37)	(1.24)	(–0.67)

Continued—

Table 4—(*Continued*)

Percentage of schools with a potable drinking water facility	0.00154	0.00144	0.00185
	(0.63)	(0.63)	(0.68)
Percentage of schools with a boundary wall	0.00139	–0.000336	0.00237
	(0.48)	(–0.12)	(0.68)
Percentage of schools with a library	0.00220	0.000518	0.00276
	(0.89)	(0.21)	(0.77)
Percentage of schools with textbooks for students	0.00364^{+}	0.00450*	0.00216
	(1.93)	(2.42)	(1.06)
Percentage of electrified schools	0.00314	0.00241	0.00392
	(1.05)	(0.76)	(1.14)
Number of schools in a village	0.0751*	0.104*	0.0448
	(2.56)	(3.31)	(1.44)
Student-teacher ratio	0.0124*	0.0116*	0.0121^{+}
	(2.52)	(2.49)	(1.69)
Average no. of teachers with primary qualification	0.332	0.285	0.292
	(1.24)	(1.05)	(0.69)
Average no. of teachers with secondary qualification	0.152^{+}	0.117	0.148
	(1.69)	(1.48)	(0.90)
Average no. of teachers with bachelor qualification	0.0273	0.0208	0.0342
	(1.62)	(1.11)	(1.47)
Average no. of teachers with master qualification	–0.0187^{+}	–0.0181^{+}	–0.0246^{+}
	(–1.86)	(–1.79)	(–1.81)
Average teacher experience (years)	–0.0624*	–0.0564*	–0.0631^{+}
	(–2.65)	(–2.61)	(–1.75)
Government			
_cons	–7.334*	–8.912*	–6.326*
	(–9.95)	(–10.15)	(–6.35)
Private			
_cons	–8.255*	–9.736*	–7.251*
	(–9.28)	(–10.08)	(–5.15)
yes_tau			
_cons	0.498*	0.534*	0.358
	(2.77)	(3.06)	(1.14)
no_tau			
_cons	1	1	1
Wald chi2	573.0	502.9	242.3
d.f	32	31	31
P	0.000	0.000	0.000
No of observations	11754	6216	5538
No of cases	3918	2072	1846
Alts per case			
Min	3	3	3
Avg	3	3	3
max	3	3	3
Log pseodolikelihood	–2753.22	–1474.17	–1238.24

t-statistics in parentheses (Std. Err. adjusted for 94 clusters in villages).

$^{+}p< 0.10$, $^{*}p< 0.05$

[a]Variable divided by 100000 for estimation.

Table 5

Nested Logit Average Marginal Analysis for Alternative Specific Variables (All Children): Government Alternative

Variables	Summary of d(P_j)/d(Government)				
		School-mode	Mean	Std. Dev.	Freq.
Number of schools in a community or village	Direct effect	Government	0.018	0.006	3918
	Cross effect	Private	–0.005	0.007	3918
	Cross effect	No-schooling	–0.014	0.004	3918
Student-teacher ratio	Direct effect	Government	0.0030	0.0010	3918
	Cross effect	Private	–0.0008	0.0012	3918
	Cross effect	No-schooling	–0.0022	0.0007	3918
Percentage of schools with textbooks for students	Direct effect	Government	0.0009	0.0003	3918
	Cross effect	Private	–0.0002	0.0003	3918
	Cross effect	No-schooling	–0.0007	0.0002	3918
Average no. of teachers with secondary qualification	Direct effect	Government	0.036	0.012	3918
	Cross effect	Private	–0.009	0.014	3918
	Cross effect	No-schooling	–0.027	0.009	3918
Average no. of teachers with master qualification	Direct effect	Government	–0.0045	0.0015	3918
	Cross effect	Private	0.0011	0.0018	3918
	Cross effect	No-schooling	0.0034	0.0011	3918
Average teacher experience (years)	Direct effect	Government	–0.0150	0.0050	3918
	Cross effect	Private	0.0038	0.0059	3918
	Cross effect	No-schooling	0.0112	0.0037	3918

Note: Calculation based on column 1, Table 4.

Note: d (P_j)/d (Government) stands for change in the probability of each alternative with respect to a given change in the attributes of government school.

Table 6

Nested Logit Average Marginal Analysis for Alternative Specific Variables (All Children): Private Alternative

Variables	Summary of d(P_j)/d(Private)				
		School-mode	Mean	Std. Dev.	Freq.
Number of schools in a community or village	Direct effect	Private	0.0060	0.0086	3918
	Cross effect	Government	–0.0045	0.0071	3918
	Cross effect	No-schooling	–0.0015	0.0024	3918
Student-teacher ratio	Direct effect	Private	0.0010	0.0014	3918
	Cross effect	Government	–0.0008	0.0012	3918
	Cross effect	No-schooling	–0.0002	0.0004	3918
Percentage of schools with textbooks for students	Direct effect	Private	0.0003	0.0004	3918
	Cross effect	Government	–0.0002	0.0003	3918
	Cross effect	No-schooling	–0.0001	0.0001	3918
Average no. of teachers with secondary qualification	Direct effect	Private	0.012	0.017	3918
	Cross effect	Government	–0.009	0.014	3918
	Cross effect	No-schooling	–0.003	0.005	3918
Average no. of teachers with master qualification	Direct effect	Private	–0.001	0.002	3918
	Cross effect	Government	0.001	0.002	3918
	Cross effect	No-schooling	0.0004	0.001	3918
Average teacher experience (years)	Direct effect	Private	–0.0050	0.0071	3918
	Cross effect	Government	0.0038	0.0059	3918
	Cross effect	No-schooling	0.0012	0.0020	3918

Note: Calculation based on column 1, Table 4.

Note: d (P_j)/d (Private) stands for change in the probability of each alternative with respect to a given change in the attributes of private school.

Table 7

Nested Logit Average Marginal Analysis for Alternative Specific Variables (Boys): Government Alternative

	Summary of d(P_j)/d(Government)				
Variables		School-mode	Mean	Std. Dev.	Freq.
Number of schools in a community or village	Direct effect	Government	0.025	0.008	3918
	Cross effect	Private	–0.006	0.010	3918
	Cross effect	No-schooling	–0.019	0.006	3918
Student-teacher ratio	Direct effect	Government	0.0028	0.0008	3918
	Cross effect	Private	–0.0007	0.0011	3918
	Cross effect	No-schooling	–0.0021	0.0007	3918
Percentage of schools with textbooks for students	Direct effect	Government	0.00109	0.00033	3918
	Cross effect	Private	–0.00028	0.00041	3918
	Cross effect	No-schooling	–0.00081	0.00027	3918
Average no. of classrooms per school	Direct effect	Government	0.0110	0.0033	3918
	Cross effect	Private	–0.0028	0.0042	3918
	Cross effect	No-schooling	–0.0082	0.0027	3918
Average no. of teachers with master qualification	Direct effect	Government	–0.0044	0.0013	3918
	Cross effect	Private	0.0011	0.0017	3918
	Cross effect	No-schooling	0.0033	0.0011	3918
Average teacher experience (years)	Direct effect	Government	–0.014	0.004	3918
	Cross effect	Private	0.003	0.005	3918
	Cross effect	No-schooling	0.010	0.003	3918

Note: Calculation based on column 2, Table 4.

Table 8

Nested Logit Average Marginal Analysis for Alternative Specific Variables (Boys): Private Alternative

	Summary of d(P_j)/d(Private)				
Variables		School-mode	Mean	Std. Dev.	Freq.
Number of schools in a community or village	Direct effect	Private	0.008	0.012	3918
	Cross effect	Government	–0.006	0.010	3918
	Cross effect	No-schooling	–0.002	0.003	3918
Student-teacher ratio	Direct effect	Private	0.0009	0.0013	3918
	Cross effect	Government	–0.0007	0.0011	3918
	Cross effect	No-schooling	–0.0002	0.0004	3918
Percentage of schools with textbooks for students	Direct effect	Private	0.00036	0.00050	3918
	Cross effect	Government	–0.00028	0.00041	3918
	Cross effect	No-schooling	–0.00008	0.00014	3918
Average no. of classrooms per school	Direct effect	Private	0.0037	0.0050	3918
	Cross effect	Government	–0.0028	0.0042	3918
	Cross effect	No-schooling	–0.0008	0.0014	3918
Average no. of teachers with master qualification	Direct effect	Private	–0.0015	0.0020	3918
	Cross effect	Government	0.0011	0.0017	3918
	Cross effect	No-schooling	0.0003	0.0006	3918
Average teacher experience (years)	Direct effect	Private	–0.0045	0.0062	3918
	Cross effect	Government	0.0035	0.0052	3918
	Cross effect	No-schooling	0.0010	0.0018	3918

Note: Calculation based on column 2, Table 4.

Table 9

Nested Logit Average Marginal Analysis for Alternative Specific Variables (Girls): Government and Private Alternative

Variables	Summary of d(P_j)/d(Private)	School-mode	Mean	Std. Dev.	Freq.
Student-teacher ratio	Direct effect	Government	0.003	0.001	3918
	Cross effect	Private	–0.001	0.002	3918
	Cross effect	No-schooling	–0.002	0.001	3918
Average no. of teachers with master qualification	Direct effect	Government	–0.0061	0.0028	3918
	Cross effect	Private	0.0018	0.0031	3918
	Cross effect	No-schooling	0.0042	0.0015	3918
Average teacher experience (years)	Direct effect	Government	–0.016	0.007	3918
	Cross effect	Private	0.005	0.008	3918
	Cross effect	No-schooling	0.011	0.004	3918
	Summary of d(P_j)/d(Private)				
Student-teacher ratio	Direct effect	Private	0.0012	0.0018	3918
	Cross effect	Government	–0.0009	0.0015	3918
	Cross effect	No-schooling	–0.0003	0.0005	3918
Average no. of teachers with master qualification	Direct effect	Private	–0.0024	0.0036	3918
	Cross effect	Government	0.0018	0.0030	3918
	Cross effect	No-schooling	0.0005	0.0009	3918
Average teacher experience (years)	Direct effect	Private	–0.0061	0.0093	3918
	Cross effect	Government	0.0047	0.0078	3918
	Cross effect	No-schooling	0.0013	0.0024	3918

Note: Calculation based on column 3, Table 4.

School Choice (All Children, Boys and Girls)

Table 4 column (1) reports estimates on school choice while controlling for family background and correlates on school quality.

In Table 4, school-mode choice[11] is a dependant dummy variable coded 0/1 and is important for modelling differential utility across the nested alternatives; namely government, private and no schooling. One parameter estimate is identified for each alternative-specific variable as these vary across individuals as well as alternatives. However, direct and cross-marginal effects of the reported parameters are calculated henceforth for a detailed explanation.

The dissimilarity parameter 'θ_{Yes}' is within the unit interval and corresponds to a correlation of about 0.49 between the error terms of government and private school alternatives (Table 4, column 1).

Girls are less likely to be in school than boys (Table 4, column 1). Schooling increases in child age but non-linearly. Relative to the probability of no-schooling, an increase in income leads to an increase in the probability of child schooling. However, the relationship holds non-linearly. The probability of child schooling decreases with

[11]It is also possible to estimate school-mode equation. Variable school-mode model the relative utility of case-specific variables from selecting the no school option versus the government and private school options. School quality variables could either go to the school-mode choice equation as alternative specific variables or as case specific variables to the school-mode equation but not both. Modelling school quality though school-mode choice equation permits estimating differential utility across the nested alternatives.

couple level fertility. Parental education is important for child schooling. Relative to the probability of no-schooling, an increase in parental education leads to an increase in child education. The effect of household plot size on child schooling, relative to no-schooling, is significant only in the case of girls (column 3). Girls' schooling increases in household plot size unlike boys. Households having more land are able or willing to finance their daughter's education. The variable measuring access to credit (distance to the nearest bank) has no effect on child schooling. The estimated coefficient has the implied sign (negative) but insignificant.

The coefficients on control for number of schools and school quality variable, percentage of schools with textbooks for students, is positive and significant for all children and boys only sample. When the percentage of free textbooks in private schools increases, then demand for private schooling increases and demand for government and no-schooling decreases. The coefficient on student teacher-ratio is positive and significant for the whole sample as well as for boys and girls. Similarly, when student teacher-ratio in private schools increases, then private schooling is chosen more than government and no-schooling options. The parameter estimate of variable (average number of teachers with secondary qualification) is significant only in the case of all children regression. The coefficients on variables average number of teachers with masters degree and average teacher experience per school are negative and significantly different from zero in all three equations.

Average Marginal Effects of Alternative Specific Variables (All Children)

Average marginal effects (AMEs) of alternative specific variables (school quality attributes) and control for number of schools are presented in Tables 5 and 6 for government and private schooling alternative, respectively. All own (direct) effects are positive and all cross effects are negative. Referring to Table 5, the probability of government schooling marginally increases (by 0.0009 percent)[12] with a small rise in the textbook provision percentage in government schools, while keeping all other variables at the sample mean. Similarly, the cross-derivative shows that with the same small rise in textbook percentage in government schools, the probability of private schooling and no-schooling falls by 0.0002 and 0.0007 percent, respectively. The interpretation of parameter estimates of direct and cross derivatives for average number of teachers with secondary qualification remains the same as for textbook percentage; however, the small increase in number of teacher with secondary qualification have bigger marginal impact than the same small increase in textbook percentage. Similarly, the probability of government schooling marginally increases (by 0.018 percent) with a small rise in the number of government schools in a community, while keeping all other variables at the sample mean. Similarly, the cross-derivative shows that with a small increase in government schools, the probability of private schooling and no-schooling falls by 0.05 and 0.14 percent, respectively. Table 6 reports average marginal effects (AMEs) with respect to private school attributes. The probability of private schooling marginally increases (by 0.0003 percent) with a small rise in the textbook

[12] As X (e.g. a school quality indicator) is in percent and Y is enrolment probability. Changing X by 100 percent means that the enrolment changes by 0.09 percent.

percentage in private schools, while keeping all other variables at the sample mean. Similarly, the cross-derivative shows that with the same small rise in textbook percentage in private schools, the probability of government schooling and no-schooling falls by 0.0002 and 0.0001 percent, respectively. The parameter estimates of average number of teachers per school with secondary qualification (direct and cross marginal effects) are interpreted similarly as for textbook percentage. However, a small rise in the number of teachers with secondary qualification has a bigger marginal impact than the same small rise in textbook percentage (Table 6). Also, the probability of private schooling marginally increases by (0.006 percent) with a small rise in the number of private schools in a community, while keeping all other variables at the sample mean. Similarly, the cross-derivative shows that with a small increase in private schools, the probability of government schooling and no-schooling decreases by 0.0045 and 0.0015 percent, respectively. An important observation follows from these direct and cross marginal effects for government and private school's quality attributes. Marginal improvements in quality of either private or government schools are equally likely to displace each other's children. However, a marginal increase in school quality correlates with increased *school attendance* in government schools more than in private schools.

Average Marginal Effects of Alternative-Specific Variables (Boys)

Average marginal effects (AMEs) of school quality attributes are presented in Tables 7 and 8 for government and private schools, respectively. All direct effects are positive and cross effects are negative. Referring to Table 7, the probability of government schooling marginally increases (by 0.0011 percent) with a small rise in the textbook provision percentage in government schools, while keeping all other variables at the sample mean. Similarly, the cross-derivative shows that with the same small rise in textbook percentage in government schools, the probability of private schooling and no-schooling falls by 0.00028 and 0.00081 percent, respectively. The interpretation of parameter estimates of direct and cross derivatives for student teacher-ratio, average number of classrooms per school in the community and control for number of government schools in a community remain the same as in the case of whole sample analysis.

Table 8 reports average marginal effects (AMEs) with respect to private school attributes. The probability of private schooling marginally increases (by 0.00036 percent) with a small rise in the textbook percentage in private schools, while keeping all other variables at the sample mean. Similarly, the cross-derivative shows that with the same small rise in textbook percentage in private schools, the probability of government schooling and no-schooling falls by 0.00028 and 0.00008 percent, respectively. Overall the AMEs for boys display similar behaviour as is the case of whole sample estimates; a marginal increase in school quality correlates with increased school attendance for boys in government schools more than in private schools.

Average Marginal Effects of Alternative Specific Variables (Girls)

Nearly all school quality variables including control for number of schools in a community are statistically not different from zero in the case of girls. Student

teacher-ratio is significant, while average number of teachers with masters degree and average teacher experience (years) are significant only at 10 percent level of significance. This shows that other factors might be of more importance than school quality of local schools for low attendance of girls in rural Pakistan. Average marginal effects (AMEs) for student teacher-ratio, average number of teachers with masters degree and average teacher experience (years) are presented in Table 9 for government and private schools respectively. All the direct effects are positive and cross effects are negative. In Table 9, the probability of government schooling marginally increases (by 0.003 percent) with a small rise in student teacher-ratio in government schools, while keeping all other variables at the sample mean. Similarly, the cross-derivative shows that with the same small rise in student teacher ratio in government schools, the probability of private schooling and no-schooling falls by 0.001 and 0.002 percent, respectively.

Average marginal effects (AMEs) with respect to private school attributes are provided in the same Table. The probability of private schooling marginally increases (by 0.0012 percent) with a small rise in student teacher-ratio in private schools, while keeping all other variables at the sample mean. Similarly, the cross-derivative shows that with the same small rise in student teacher-ratio in private schools, the probability of government schooling and no-schooling falls by 0.0009 and 0.0003 percent, respectively.

6. CONCLUSION

The aim of this paper has been to investigate the role of school quality in parental schooling decisions for their children in Rural Pakistan. Research from the perspective of public and private school phenomenon is lacking in rural Pakistan. This study uses a rich set of households and school data (nationally representative data of rural Pakistan) to conduct a comprehensive investigation of the factors that have been ignored in previous research. The analysis confirms that lower school attendance of boys seems to be the outcome of lower school quality than girls. The greater the number of schools (public or private) in the local communities the higher is the attendance. Class size also seems to be important for raising school attendance in rural Pakistan; however, the estimated coefficient is positive. Free textbooks provision to students is also important for improving school attendance in either public or private school. Teacher qualification also positively impacts all children attendance. Nearly all school quality variables including control for number of schools in a community are insignificant for girls. This shows that other factors might be more important than school quality in explaining low attendance of girls in rural Pakistan.

Furthermore, the result also shows substitution in enrolment, whereby increase in enrolments of one sector (public or private) leads to a decline in the share of the other. Both sectors are equally likely to displace each other's child enrolment. The magnitude of the coefficients on public school quality indicators is larger than the magnitude of the coefficients on private school quality indicators for the choice of enrolment in school. A marginal increase in school quality correlates with increased school attendance in government schools more than in private schools. The incremental benefits from improving state schools are much higher because the initial average quality is so low.

Improving the quality of public schools would require several considerations. First, research is needed on how best to improve school quality in rural Pakistan. Second, the role of school inputs provision needs to be investigated further to check whether school inputs really make a school more attractive; the most effectivee way to do this is to administer a randomised trial that provides school inputs to randomly selected schools. Third, the competence and willingness of the state authorities to improve state school quality are important. Fourth, there is a need to assess the balance of costs and benefits of raising school quality in state schools versus alternative programmes such as distributing subsidies to low income families to pay private school fees. The distributional consequences of this particular alternative are likely to be unacceptable to children who continue to be educated in state schools and continue to receive poor quality education. Fifth, the feasibility of public-private partnerships in schooling needs to be checked. Finally, once children are in school they must get the skills important for their life when they finish their schooling, therefore, more needs to be learned on how to make schools more effective in imparting important skills to children.

As far as individual and household factors are concerned, parental education, especially mother's education and household income have strong positive impact on child school attendance. Most recently, Andrabi, Das, and Khwaja (2012) also found in the case of Pakistan that educated mothers spend more time with their children and make certain that their children devote more time on homework when at home. In addition, the greater the number of children in the household the lower is the child school attendance. Credit constraint seems to be not problematic as the estimated effect is statistically insignificant. Size of landholding seems to be important only in the case of girls' schooling.

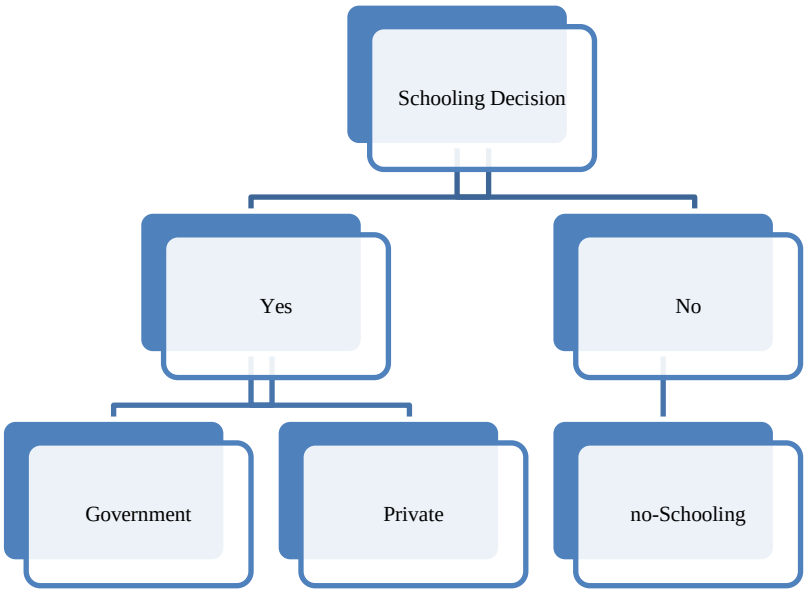
APPENDIX A

Generally the choice set is partitioned into '*N*' subsets (nests) 'D_n', *n=1,....., N*. The present case involves only one nesting level. Each available alternative in the choice set belong to exactly one nest. Nest '$D(j)$' to which alternative *j=1,.....,J* belongs is denoted as;

$$D(j) = \{D_n : j \in D_n, n = 1,.....N\} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

In the context of the present study, parental decision of child school participation is depicted in Figure 1. The schooling decision is partitioned into two nests *(N=2)*. Sending children to school modes (Government and Private) share the nest $D_{Yes} = \{government, private\}$ and the other mode not sending children to school (no-schooling) belong to nest $D_{No} = \{no - schooling\}$. Private and government schooling alternatives are more similar to each other than no-schooling alternative. Usually it is viewed convenient to interpret the choice as if there are two levels of decision; however, the derivation of nested logit model does not make such an assumption. The decision tree (Figure 1) and the hierarchy of choice are purely analytical devices and do not imply that a decision maker makes decision in certain order [Borsch-Supan (1987), cited in Koppelman and Bhat (2006), p.160]. Figure 1 shows an upper level (marginal) choice between going to school and not going to school and a lower level (conditional) choice between government and private schooling, given that going to school is chosen.

Fig. A1: Parental Child Schooling Decision (Decision Tree)



This representation is based on the assumption that some of the alternatives share common components in the error terms. The error term in the nested logit model is decomposed into a portion associated with each alternative and a portion associated with the group of alternatives in the same nest.

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Public Spending, Quality of Bureaucracy and Economic Growth: A Theoretical Analysis

SHAHEEN NASEER

This paper develops a theoretical framework to investigate the relationship between public spending and economic growth, where public spending provides both productive capital and unproductive services. We take into account the quality of bureaucracy with the possibility of rent-seeking motives. A key feature of the model is that it distinguishes between utility enhancing and productivity enhancing public spending. In the absence of rent-seeking motives, the paper demonstrates that public spending will promote economic growth only if marginal productivity of spending is high enough to offset the potential output loss due to increased taxation. In the presence of rent-seeking, however, the impact of public spending on economic growth depends on the quality of bureaucracy and how the latter impinges upon the rent-seeking behaviour. The analysis shows that while improvement in bureaucratic quality would unambiguously raise the share of utility enhancing public spending, its impact on economic growth would depend on how bureaucratic quality influences the relative magnitudes of the two types of public spending as well as on how far bureaucratic extraction will be controlled as a result of improvement in bureaucratic quality. Bureaucratic extraction is likely to be minimised with strong institutions and effective monitoring and accountability mechanisms thereby improving the prospects of economic growth.

JEL Classification: C61, D23, D61, D73, H50
Keywords: Rent-seeking, Quality of Bureaucracy, Public Goods, Public Expenditures

1. INTRODUCTION

The role of public spending in the process of economic growth has received a great deal of attention in the literature [see, for example, Barro (1990); Barro and Sala-i-Martin (1992); Devarajn, Swaroop, and Zou (1996); Easterly and Rebelo (1993); Glomm and Ravikumar (1997) and Ghosh and Mourmouras (2002)]. Most of the studies, however, ignore bureaucratic quality and the possibility of rent-seeking that is linked with public spending and provision of public goods. It is well known that public spending programmes can be used as a vehicle for rent-seeking which can adversely impact the effectiveness of public spending and hurt economic growth [see, for example, Gupta, Davoodi, and Tiongson (2000); Johnson, Kaufman, and Zoido-Lobatan (1999); Mauro (1998) and Tanzi and Davoodi (1997)]. Our starting point in this research is to argue that the effectiveness of public spending depends crucially on the quality of bureaucracy that is responsible for administering the public spending programmes.[1] If bureaucracy is

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[1]According to Acemoglu (2005) bureaucratic quality is one of the most important factors determining the overall quality of governance in an economy. Acemoglu (2005) argues that the nature of government determines whether it is creating positive externalities or extracting from the society.

efficient with proper incentives for performance, it will tend to adopt public spending policies that can promote economic growth. On the other hand, as is commonly observed in many developing economies, if the bureaucracy lacks effective checks and balances on its performance, then the consequent lack of accountability makes government officials prone to abuse of power and rent-seeking from public spending projects which ultimately impede the process of economic growth.[2]

The aim of this paper is to explore the relationship between public spending and economic growth while taking into account the quality of bureaucracy with the possibility of rent-seeking behaviour. In particular, we develop a theoretical framework that endogenises public expenditure policies in a setting that explicitly incorporates the role of bureaucracy in determining public spending. A key feature of our study is that it makes a distinction between productivity enhancing and utility enhancing public spending.[3] The two types of public spending may have different implications for economic growth for at least two reasons. First, the two types of spending may influence productivity in different ways and thus may have different impacts on economic growth. For example, Devarajan, *et al.* (1996) find that growth increases with an increase in the current expenditures of the government while it declines with an increase in the stock expenditures of the government. This result questions the policy of giving more attention to capital expenditures rather than current expenditures especially in the context of developing economies. It is noteworthy that previous work has mainly focused on productivity enhancing expenditures and largely ignored the utility enhancing expenditures. In this respect, our study makes an important contribution to the literature by incorporating the two types of spending in a rigorous growth framework.[4] Second, the two types of public spending may entail different incentives for the bureaucracy in terms of opportunities for rent-seeking resulting in different growth outcomes. For example, if bureaucratic extraction takes place in utility enhancing expenditures, growth may still be achievable if substantial resources are allocated to the productivity enhancing expenditures. So this type of extraction may be less harmful for the economy. On the other hand, however, if bureaucratic extraction takes place in productivity enhancing expenditures, it may have deleterious consequences for economic growth by stifling private activity.

The analysis provides insights into how rent-seeking behaviour may impact growth outcomes of public spending programmes. In particular, the analysis points out what type of bureaucratic extraction would be more harmful for economic growth.[5] For example if extraction takes place in utility enhancing expenditures then welfare of the

[2]Keefer (2004) argues that in economies with bad governance, public spending is not deployed productively and is rather often used as an instrument for maximising rents by bureaucrats. So even if public spending is high in such economies, it does not necessarily mean that it is growth promoting because it may be wasted on non-productive activities.

[3]Productivity enhancing expenditures include spending on public goods such as physical infrastructure while utility enhancing expenditures include social security programmes, income transfer programmes, and health and education spending.

[4]In the growth literature, the famous optimising models of Ramsey (1928), Cass (1965) and Koopmans (1965) are aimed at studying the required savings rate to put the economy on a balanced steady state growth path. However, these models are silent on the role of composition of public expenditures on economic growth.

[5]Some studies have argued that exclusive focus on overall public spending does not fully capture the bureaucratic rent-seeking in public spending policies as different types of public spending may entail different rent-seeking opportunities [Aberbach and Rockman (1976); Bendor and Moe (1985)].

citizens may be compromised while growth may still be achievable through productivity enhancing expenditures. On the other hand, rent-seeking opportunities in productivity enhancing expenditures may hamper economic growth by raising transactions costs of the private enterprises.

The rest of the paper is organised as follows. Section 2 provides a brief review of literature. Section 3 develops the model while Section 4 discusses the key implications of the model considering a benchmark case when public spending is taken as exogenous and there is no rent-seeking. Section 5 introduces bureaucratic choice in the model to endogenise the composition of public spending in terms of bureaucratic quality and the associated issue of rent-seeking. Section 6 provides summary and conclusions. The appendix provides detailed derivations.

2. REVIEW OF LITERATURE

The literature that deals with the question of public spending and economic growth can be broadly classified into neoclassical/endogenous growth models, and the new institutional approach.[6] The neoclassical and endogenous growth models pay scant attention to the material self-interest of key actors (e.g. bureaucrats) involved in the policy-making process. The new institutional approach takes into account the incentives and constraints faced by these actors that influence the public spending outcomes. This section provides an exposition of the literature in particular on two thematic areas including public choice and bureaucracy and institutional quality.

Starting from the seminal work of Arrow and Kurz (1970), the growth literature in the tradition of neoclassical and endogenous growth models provides robust evidence of positive link between economic growth and public spending. In the neoclassical tradition, some authors follow Devarajan, *et al.* (1996) and explore the link between public expenditures and economic growth in a growth framework that distinguishes between productive[7] and unproductive[8] expenditures [Chen (2006); Ghosh and Roy (2004); Carboni and Medda (2011)]. These studies analyse optimal composition of government expenditures in a setting where public expenditure is composed of two types—one leads to growth and the other leads to welfare—and investigate which composition is optimal to maximise the long-run growth rate [Turnovsky (2000a)]. However, the growth literature pays scant attention to the quality of bureaucracy duly taking into account the rent-seeking motives which may contribute to wasteful public spending.

In a departure from the neoclassical tradition, an influential strand of literature incorporates self-interest motives that determine the constraints and incentives faced

[6]Early neoclassical growth models envisaged no role of public expenditures in economic growth and instead emphasised savings rate and physical capital accumulation as the main drivers of economic growth [Ramsey (1928); Cass (1965); Koopmans (1965); Solow-Swan (1956)]. Arrow and Kurz (1970) first described the scope of fiscal policy within the neoclassical framework and since then a vast body of literature has explored the linkages between public spending and economic growth emphasising a variety of transmission channels [Barro (1990); Barro and Sala-i-Martin (1992); King and Rebelo (1990]. While the theoretical literature generally predicts a positive relationship between public spending and economic growth, the empirical studies have found mixed results.

[7]See, for example, Barro (1990).

[8]Some studies argue that public consumption expenditures are always unproductive and hence resources should be allocated to physical capital alone. See, for example, Barro (1990), Barro (1991), Aschauer (1989) and Grier and Tullock (1989).

by key actors including politicians and bureaucrats who are responsible for devising and implementing public spending policies [see, e.g. Buchanan (1968); Carpenter (2001); Milward (1980); Rochefort and Cobb (1994)]. Following the seminal work of Tullock (1967) who first introduced the idea of rent-seeking, Krueger (1974) describes rent-seeking as the behavior of public officials acting as self-interested economic agents who try to maximise their individual gains which results in social losses. Pursuing this line of inquiry, the public choice paradigm explores how bureaucrats who are responsible for the implementation of public spending policies can be involved in rent-seeking activities[9] [see, e.g. Hillman (2003), Chapter 6; Mueller (2003), Chapter 15, for a survey of rent-seeking literature]. Furthermore, dynamic growth models based on public choice approach provide insights into how public spending may lead to negative growth outcomes in the presence of rent-seeking behaviour.[10] A key point of this line of research is that inefficiencies may be explained by maximisation of personal gains[11] by public agents [Mises (1944); Parkisnson and Osborn (1957) and Niskanen (1971)].

Following the arguments of Niskanen (1971), budget-maximising bureaucracy is shown to result in an overprovision of public goods,[12] as bureaucrats try to maximise the size of budget. It follows that the growth framework with productive public spending in the presence of rent-seeking bureaucrats would result in sub optimal provision of public goods.[13] Dethier (1999) departs from the conventional view of government officials as benevolent who seek to maximise social welfare to argue that government agencies are complex entities characterised by agency relationships. Efficient utilisation of public resources not only depends on the quality of institutions but also on incentive schemes in public organisations. Therefore, reforms need to be focused on designing appropriate incentive schemes that ensure effective implementation of policies so as to maximise social welfare. Such reforms would also ensure good governance that in turn would lead to better growth outcomes supported by physical and human capital accumulation and efficiency in the use of resources. Niskanen (1968) develops a model of the bureaucracy in which bureaucrats enjoy absolute powers and use their power to maximise their budget resulting in outcomes that are suboptimal from a social point of view.

Several studies have extended Niskanen's budget maximisation framework to incorporate more nuanced approaches for modelling the budgetary allocations, emphasising in particular the discretionary powers of bureaucracy [see, for example, Breton and Wintrobe (1975); Romer and Rosenthal (1978); Mackay and Weaver

[9]See, for example, Evans (1989), Weingast and Moran (1983), Epstein and O'Halloran (1999), and Keefer and Stasavage (2003). McNubbis, Noll, and Weingast (1987) describe in detail the bureaucratic discretion imposed by the US Congress through the Administrative Procedures Act.

[10]Public choice literature that emphasises rent-seeking originated with the works of Buchanan and Tullock (1962) and Olson (1971).

[11]See Mueller (1989).

[12]Earlier studies that investigate the issue of overprovision of public goods include Orzechowsky (1977), Breton and Wintrobe (1975), Tullock (1965), and Romer and Rosenthal (1978).

[13]Some authors have highlighted the potentially positive impact of rent-seeking on public goods provisions. For example, Rose-Ackerman (1996) notes that in the presence of rent-seeking opportunities, public officials are more motivated to maximise gains from public projects and thus generate aggregate benefit for the overall society.

(1981); Miller and Moe (1983); Conybeare (1984); Bendor, Taylor, and Van Gaalen (1985) and Bendor and Moe (1985, 1986)]. In an influential contribution, Migue and Belanger (1974) develop a model of bureaucratic discretion and argue that bureaucrats maximise their budget leeway, defined as the total budget less the cost of production of the bureau's output. It is shown that the equilibrium output may range from the level of a profit-maximising monopolist to that of an output maximising bureau, depending on the bureaucrat's utility from productive and non-productive spending. In any case the budget of a bureau is too large and the output is not produced at the minimum cost.

The problem of rent-seeking in public spending programmes varies across sectors. Mauro (1998) argues that corrupt officials will choose to spend public resources on activities with greater opportunities to extract bribes. The study finds that rent-seeking reduces public expenditures on education as such spending is often more transparent leaving little room for public officials to engage in extractive practices. Building on the same line of argument Tanzi and Davoodi (1997) find that higher rent-seeking is related to higher public investment, lower government revenues, lower expenditures on operations and maintenance, and lower quality of public infrastructure. Moreover, rent-seeking is likely to increase the number of large and more complex public investment projects because of greater rent-seeking opportunities associated with such projects. This is because more complex expenditures cannot be easily scrutinised by the public thus providing better opportunities to extract rents. The same argument holds for defense spending which is kept away from public scrutiny purportedly for security reasons.[14]

Besides bureaucratic quality, the distortion in fiscal policy and development budgets can originate from many sources such as the nature of the political process, lack of transparency, and low level of public awareness of the budgetary process. A number of studies in the political economy literature have emphasised the role of the political process in generating sub-optimal public spending outcomes [Alesina and Perotti (1995); Eslava (2006)]. Furthermore, the politico-institutional approaches show that even in the democratic countries with accountable bureaucracy, distortions in the public spending can stem from lack of awareness by the voters that makes it easy for the bureaucrats to seek rents. This point has been highlighted, in the context of Pakistan, by Uppal (2011) who examines political institutions and budgetary processes that affect the fiscal policy, and shows how greater transparency and strong institutional checks and balances can encourage fiscal discipline [Ghani and Din (2006); Easterly (2001)].

To sum up, a rich body of literature has explored the role of public spending on economic growth. However, the quality of bureaucracy and the associated problem of rent-seeking have received little attention in the theoretical discussions that link efficiency of public spending to economic growth. Adding to this stream of research the present paper aims at investigating the impact of rent-seeking behaviour of bureaucrats on public policy outcomes, when it is assumed that public spending is composed of utility enhancing and productivity enhancing expenditures. In the next section, we propose a simple theoretical framework to explain how the quality of bureaucracy and the presence of rent-seeking motives may impinge on growth outcomes of public spending policies.

[14] See also Gupta, Mello, and Sharan (2001) for a similar argument.

3. A FORMAL ANALYSIS OF PUBLIC SPENDING COMPOSITION AND QUALITY OF BUREAUCRACY

The model is an extension of Devarajan, *et al.* (1996) in two ways. First, in contrast to Devarajan, *et al.* (1996) who distinguish between productive and non-productive expenditures in the production function, our study focuses on utility enhancing and productivity enhancing public expenditures and examines how this composition of public spending impacts economic growth. Second, while Devarajan, *et al.* (1996) treat public spending as exogenous, our study incorporates bureaucratic choice in the model so that public spending policies are endogenously determined. The model developed here provides a simple framework to study the determination of sectoral composition of public expenditures and their impact on growth and welfare in the presence of rent-seeking bureaucracy.

A representative infinitely lived household in a closed economy maximises:

$$U = \int_0^\infty u(c, g_u) e^{-\rho t} dt \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Where c is per capita consumption, g_u is per capita public spending on utility enhancing goods and services, and $\rho > 0$ is the constant rate of time preference. Population is assumed constant.

Let the utility function be additively separable and logarithmic:[15]

$$u(c, g_u) = \ln c + v \ln g_u \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Where $v \geq 0$ measures the weight given to public consumption relative to private consumption.

Each household producer has the production function:

$$y = f(k, g_p) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Where y is output per capita, k is private capital per capita, and g_p is per capita public spending on productivity enhancing goods and services. We assume such public goods and services are provided free of charge and there is no congestion. Following Barro (1990), the production function in the paper represents government expenditures as a public good into the production process. Here the idea is that public good characteristics of public expenditures raise productivity and hence boost economic growth. In the literature on public spending, both approaches are used by researchers treating public expenditures as stock variable[16] [Futagami, *et al.* (1993) or flow variable[17] [Barro (1990)] that directly raises the marginal product of capital. More specifically, the public expenditures are described as public capital and treated as stock variable where these expenditures solely represent infrastructure, which affects marginal product of private capital. In our case, we use public spending to represent the availability of productivity enhancing public goods and hence the use of flow variable is more appropriate. Furthermore, if the public expenditures are introduced as stock variables then the analysis becomes more complex as it would

[15]See, Park and Philippopoulos (2005).

[16] See for example, Fisher and Turnovsky (1998), Rioja (1999), Rivas (2003), Turnovsky (2004), and Agénor (2012).

[17]See for example, Rebelo (1991), Glomm and Ravikumar (1994), Turnovsky and Fisher (1995), Turnovsky (2000a).

require the introduction of an additional variable such as expenditures on maintenance of stock of public capital. It is mostly believed that the tradeoff between stock and flow variable treatment of public expenditures is more of a choice between analytical tractability and scope of research. Furthermore, flow and stock treatment have been shown to yield empirically similar results in most cases [Posada, *et al.* (2015)].

The production function is assumed to be Cobb-Douglas which can be written as:

$$y = k^{\alpha}.g_p^{1-\alpha} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

We assume that government expenditure on the two types of public expenditures is financed contemporaneously by a flat-rate income tax:

$$\tau y = g_u + g_p \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

Where τ is tax rate.

Now let $\theta_p = {g_p}/{y}$ and $\theta_u = {g_u}/{y}$ be the shares of productivity enhancing expenditure and utility enhancing expenditure respectively in national output. Then the budget constraint can be written as:

$$\tau = \theta_p + \theta_u \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

Taking $\tau,\ g_u$ and g_p as given, the representative agent chooses consumption c and capital k to maximise:

$$\text{Max } (\ln c + v \ln g_u)\, e^{-\rho t} dt \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

$$\text{Subject to } \dot{k} = (1-\tau).k^{\alpha}.g_p^{1-\alpha} - c \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

Where Equation (8) defines investment as after-tax output less consumption. Solving the optimisation problem using optimal control methods yields the following growth equation of the economy.

$$\gamma = [\,\alpha.\left(1-\theta_p-\theta_u\right).\left(\theta_p\right)^{{1-\alpha}/{\alpha}} - \rho] \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

According to Equation (9), the growth rate depends on the output elasticities with respect to private capital and public good, composition of public spending, and discount rate.

4. A BENCHMARK CASE WITH NO RENT-SEEKING

For comparative purposes, we first examine a benchmark case when the composition of public spending is exogenous and there is no rent-seeking. First, we explore the impact of an increase in the ratio of productivity enhancing public spending on economic growth. Differentiating Equation (9) with respect to θ_p:

$${\partial\gamma}/{\partial\theta_p} = (1-\tau).(1-\alpha).\theta_p^{{1}/{\alpha}} - \alpha.\theta_p^{{1-\alpha}/{\alpha}} \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

Slight manipulation shows that:

$${\partial\gamma}/{\partial\theta_p} > 0 \text{ if } (1-\tau).(1-\alpha).\theta_p^{-1} > \alpha \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (11)$$

Where $(1-\tau).(1-\alpha).\theta_p^{-1}$ is the after tax marginal product of productivity enhancing goods and services and α is the output elasticity of capital.

Proposition 1: *An exogenous increase in the share of productivity enhancing public spending will have a positive impact on economic growth as long as the after tax marginal product of productivity enhancing goods and services is greater than the output elasticity of capital.*

An increase in productivity enhancing spending directly raises the productive capacity of the economy which contributes positively to economic growth. However, as the share of utility enhancing spending is held constant, an increase in the share of productivity enhancing spending necessitates an increase in the tax rate which reduces output and hence capital. So as long as the contribution of the productivity enhancing spending outweighs the loss in output caused by decline in capital, economic growth would increase. This result has an important implication. Even if public spending is concentrated on productivity enhancing goods and services, economic growth would only accrue when the contribution of such goods and services in terms of their marginal productivity is high enough so as to outweigh potential loss of output as a result of increase in taxation. This implies that government may have to prioritise its spending in terms of allocating budget to those public goods and services which have the highest potential to raise productivity. For example, the government may choose to invest in physical infrastructure such as roads, railways and bridges as such investments are likely to substantially raise productivity and hence boost economic growth. Similarly, public spending on education and health may significantly boost productivity and hence economic growth.

The theory suggests that the public expenditures have both short run demand effects as well as long run supply effects. However the magnitude of these effects depends on many factors such as efficiency of public investment that affects the long run elasticity of output with respect to public expenditure and how public spending is financed such as taxes.

By explicitly referring to these magnitudes the proposition (1) suggests that beyond the share of public expenditures the government also controls other policy instruments such as tax rate which govern the total size of public intervention in the spirit of Devarajan, *et al.* (1996). These results essentially describe how the growth effects of public good provision may be mediated by the changes it induces in marginal productivity of capital and its magnitude in relation to the elasticity of capital.

Next, we differentiate Equation (9) with respect to θ_u to obtain:

$$\partial\gamma/\partial\theta_u = -\alpha.\theta_p^{1-\alpha/\alpha} < 0 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (12)$$

Proposition 2: *An exogenous increase in the share of utility enhancing public spending will have a negative impact on economic growth.*

The above result follows from the fact that an increase in utility enhancing spending does not add to the productive capacity of the economy but has to be financed by taxes which negatively affect the growth rate.[18] Furthermore, the impact on growth

[18] In a similar vein, Barro (1990) argues that government consumption necessitates higher taxes which introduce distortions in the economy and hence negatively impact economic growth. See also Grier and Tullock (1989).

rate will be more pronounced the higher is the output elasticity of capital. This result serves to underscore the fact that the impact of public spending on economic growth depends on the type of public spending which must be taken into account while analysing public spending-growth nexus. In contrast to the counterintuitive findings of Devarajan, *et al.* (1996) which suggest that switching public spending from investment to consumption would promote economic growth, our result is more plausible and captures the idea that consumption related public spending would hamper economic growth by pulling resources away from productivity enhancing public investments, a point also highlighted by Gupta, *et al.* (2001).

5. PUBLIC SPENDING, BUREAUCRATIC QUALITY AND RENT-SEEKING

We now introduce the bureaucratic choice to endogenise the composition of public spending in terms of bureaucratic quality and the associated issue of rent-seeking. We assume that a representative bureaucrat chooses the composition of public spending to maximise the following weighted utility function:

$$\text{Max } u_g = \pi.(\ln c + v \ln g_u) + (1-\pi).(\varrho(\pi).g_p) \quad \ldots \quad \ldots \quad \ldots \quad (13)$$

$$\text{Subject to } \tau y = g_u + g_p \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (14)$$

Where $\ln c + v \ln g_u$ is the utility of the representative consumer, the parameter π captures bureaucratic quality, and $\varrho(\pi)$ is the proportion of g_p extracted by the bureaucrat as rent which is assumed to be a function of bureaucratic quality. We assume that the extent of rent-seeking declines with the bureaucratic quality and hence $\varrho_\pi < 0$. We suppose that $\pi \in (0,1)$ with higher values of π reflecting better quality of bureaucracy. The higher is the bureaucratic quality, the higher is the weight attached to the maximisation of social welfare by the bureaucrat. On the other hand, with weak institutions the bureaucracy is likely to be geared less towards maximisation of social welfare and more towards rent-seeking activities. We assume that only productivity enhancing spending is prone to rent-seeking. This is plausible because spending on physical infrastructure is often non-transparent and complex creating possibilities for rent-seeking.[19] On the other hand public consumption expenditures such as wages and salaries are quite transparent and offer little chance for rent-seeking. The solution of the above optimisation problem yields the following values for g_u and g_p:

$$g_u = {}^{\pi.v}/_{(1-\pi).\varrho(\pi)} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (15)$$

$$g_p = \tau y - {}^{\pi.v}/_{(1-\pi).\varrho(\pi)} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (16)$$

Slight manipulation yields:

$$\theta_u = {}^{\pi.v}/_{y.(1-\pi).\varrho(\pi)} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (17)$$

[19]This assumption also lends analytical tractability to the model by simplifying the analysis. While relaxing these assumptions may change the inner dynamics of the model with more complex derivations, it will likely not change the major thrust of the theoretical arguments and overall direction of the conclusions.

$$\theta_p = \tau - {}^{\pi.v}/_{y.(1-\pi).\varrho(\pi)} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (18)$$

It is clear from Equations (17) and (18) that for a given level of income, both θ_u and θ_p are functions of bureaucratic quality directly as well as indirectly through its influence on rent-seeking, i.e.:

$$\theta_u = \theta_u(\pi, \varrho(\pi)) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (19)$$

$$\theta_p = \theta_p(\pi, \varrho(\pi)) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (20)$$

The above equations can be used to derive the following result (see Appendix for detailed derivations).

Proposition 3: *An improvement in bureaucratic quality will increase the share of utility enhancing public spending while squeezing the share of spending on productivity enhancing goods and services.*

With strong institutions and better quality bureaucracy, the policy-makers would be more inclined to maximise social welfare and thus public spending will be tilted towards public goods and services that lead to maximisation of social welfare. In this case, public spending will be channelled more into utility enhancing public goods and services because these entail no rent-seeking and raise the level of welfare. On the other hand, with weak institutions and poor accountability the opportunity cost of extracting rents is low so bureaucrats have an incentive to allocate public spending towards those expenditures that maximise rents rather than social welfare. In this case, since productivity enhancing public spending is prone to rent-seeking, such spending will increase to maximise rents. Similarly, more rent-seeking opportunities will curtail utility enhancing spending and expand public spending on productivity enhancing goods and services.

How do these impacts translate into changes in economic growth? To see this, we plug Equations (19) and (20) in the growth Equation (9) to obtain:

$$\gamma = [\,\alpha.\big(1 - \theta_p(\pi, \varrho) - \theta_u(\pi, \varrho)\big).\big(\theta_p(\pi, \varrho)\big)^{{}^{1-\alpha}/_{\alpha}} - \rho] \quad \ldots \quad \ldots \quad (21)$$

Now we can investigate how variations in the parameters of bureaucratic quality and rent-seeking impact economic growth through their impact on the composition of public spending (see Appendix for detailed derivations).

Proposition 4*: The impact of an improvement in bureaucratic quality on economic growth depends on the relative magnitudes of changes in the shares of utility enhancing and productivity enhancing spending resulting from an improvement in bureaucratic quality.*

The above result shows the importance of explicitly recognising the role of bureaucratic quality in the process of economic growth. It is generally believed that an improvement in bureaucratic quality will be beneficial for economic growth. However, our results show that this may not be necessarily the case because bureaucratic quality and the associated problem of rent-seeking affect the composition of public spending in different ways which may result in different implications for economic growth. To see this, observe that the impact on economic growth is composed of two opposing forces. On the one hand, there is an *allocation effect* whereby an improvement in bureaucratic

quality leads to an increase in the share of utility enhancing spending and a reduction in productivity enhancing spending both of which constrain economic growth. On the other hand, an improvement in bureaucratic quality leads to an *efficiency effect* which reduces the bureaucratic extraction in the productivity enhancing spending thus freeing up resources that can be deployed for increasing production which spurs economic growth. So the net impact of an improvement in bureaucratic quality on economic growth depends on the relative magnitudes of changes in the two types of public spending. More importantly, the impact of bureaucratic quality on economic growth depends on how strongly an improvement in bureaucratic quality curtails the incentives for rent-seeking. For example, strong institutions and robust mechanisms for monitoring and accountability can be very effective in checking the rent-seeking behaviour, as argued by Uppal (2011) in the case of Pakistan. In this case, an improvement in bureaucratic quality will be likely to produce favorable growth outcomes. In contrast, as argued by Kimenyi and Tollison (1999), weak institutions may permit diversion of resources to wasteful rent-seeking activities thus contributing to adverse public policy outcomes.

A significant body of literature emphasises the role of institutional quality in ensuring positive growth outcomes of public policies [see, for example, Acemoglu (2005) and Keefer (2002)]. In economies with good governance and effective checks and balances on institutions, public spending tends to be productively used thus contributing positively to economic growth. However, in economies with bad governance, public spending is not deployed productively and is rather often used as an instrument for maximising rents by bureaucrats and politicians [Keefer (2002)]. The governments tend to be responsive to its citizens in terms of provision of soft public goods such as property rights, and rule of law in countries where institutions are strong and provide right incentives for government officials to cater to the demands of the citizens [Keefer (2004)]. However, in economies with weak institutions rent-seeking opportunities are pervasive and are often linked to the size of public sector [Ott (2005)]. If incentives for rent-seeking are sufficiently high, the size of public investment would be strongly associated with rent-seeking as public officials would have an incentive to undertake public investment to maximise their rents. As our analysis suggests, such investments may be counterproductive if quality of the bureaucracy is low implying strong incentive for rent-seeking in the public sector.

One implication of the model developed in this paper is that rent-seeking governments may actually deliver high economic growth by channeling resources into public investments that offer more rent-seeking opportunities while also raising productive capacity of the economy. However, this can only come at the cost of potential loss in public welfare as resources are diverted from utility enhancing public spending.[20] This issue has been debated in the policy circles as well as in the academic literature and a number of empirical studies show that the link between democratic institutions and economic growth is tenuous [Rioja (1999); Rivas (2003)].

6. CONCLUDING REMARKS

This paper has analysed the relationship between public spending and economic growth by developing a model that explicitly incorporates quality of bureaucracy with the

[20] The author is thankful to an anonymous referee for highlighting this point.

possibility of rent-seeking behaviour, and that distinguishes between utility enhancing and productivity enhancing public spending. In the benchmark case of no rent-seeking, the paper shows that even when public spending is channelled into productivity enhancing goods and services it may not achieve the desired growth outcomes if the marginal productivity of such spending is low. We show that economic growth would result only if marginal productivity of public spending is high enough so as to outweigh the potential loss of output as a result of increase in taxation. This highlights the need for prioritising public spending and allocating resources to public goods and services that have the potential to raise productivity. In the presence of rent-seeking motives, it is shown that while an improvement in bureaucratic quality would unambiguously raise the share of utility enhancing public spending, its impact on economic growth would depend on how bureaucratic quality influences the relative magnitudes of the two types of public spending as well as on how far bureaucratic extraction will be curtailed as a result of improvement in bureaucratic quality. In cases where bureaucratic reforms create strong institutions and effective monitoring and accountability mechanisms, bureaucratic extraction is likely to be minimised and public spending is more likely to foster economic growth.

A key limitation of the analysis is that rent-seeking is assumed to take place only in productivity enhancing public spending. Though this is a plausible assumption, future work may focus on extending the model to incorporate rent-seeking in the utility enhancing spending on goods and services. Also, though the tradeoff between economic growth and public welfare is not the focus of the paper, maximisation of economic growth by the policymakers at the expense of public welfare is not endorsed by the paper. Finally, we have assumed that bureaucratic quality affects economic growth only indirectly through the composition of public spending. However, bureaucratic quality may also directly affect economic growth through an improvement in overall policy and regulatory environment that may raise total factor productivity in the economy. The model can be extended to incorporate this direct impact in the production function.

APPENDIX

Derivations for Propositions 1 and 2

The optimisation problem can be solved in terms of the current value Hamiltonian which is given by:

$$H = (\ln c + v \ln g_u)\, e^{-\rho t} + q[(1-\tau).k^{\alpha}.g_p^{1-\alpha} - c] \quad \ldots \quad \ldots \quad \ldots \quad \text{(A1)}$$

Where $q = \lambda e^{-\rho t}$ … … … … … … (A2)

First Order Conditions

$$\frac{\partial H}{\partial c} = (1/c).e^{-\rho t} - \lambda.e^{-\rho t} = 0 \Rightarrow \lambda = 1/c \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{(A3)}$$

$$\dot{q} = -\frac{\partial H}{\partial k} \Rightarrow \dot{\lambda}e^{-\rho t} - \rho\lambda e^{-\rho t} = -\lambda e^{-\rho t}.[\alpha(1-\tau).k^{\alpha-1}.g_p^{1-\alpha}] \quad \ldots \quad \text{(A4)}$$

Equation (A4) simplifies to:

$$\dot{\lambda} = -\lambda[\alpha(1-\tau).k^{\alpha-1}.g_p^{1-\alpha} - \rho] \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{(A5)}$$

Differentiating (A3) with respect to time, we have:

$$\dot{\lambda} = -\dot{c}/_{c^2} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (A6)$$

Substituting (A3) and (A6) in (A5), we obtain:

$$\dot{c}/_{c} = \gamma = \alpha(1-\tau).k^{\alpha-1}.g_p^{1-\alpha} - \rho \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (A7)$$

Where γ denotes steady state per capita growth rate of private consumption.

In this model the economy is always at a steady state growth in which all variables c, k and y grow at the rate γ shown in Equation (A7).

Now notice that:

$$g_p = \theta_p.y \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (A8)$$

Substituting (A8) in (A7) we have:

$$\gamma = \left[\alpha.(1-\tau).k^{\alpha-1}.(\theta_p.y)^{1-\alpha} - \rho\right] \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (A9)$$

Now notice that:

$$y = k^{\alpha}.g_p^{1-\alpha} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (A10)$$

Slight manipulation of (A10) yields:

$$y = k.(\theta_p)^{1-\alpha/\alpha} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (A11)$$

Substituting (A11) into (A10), we have:

$$\gamma = [\,\alpha.(1-\tau).k^{\alpha-1}.\theta_p^{1-\alpha}.\left(k.\theta_p^{1-\alpha/\alpha}\right)^{1-\alpha} - \rho] \quad \ldots \quad \ldots \quad \ldots \quad (A12)$$

Simplifying this expression we have:

$$\gamma = [\,\alpha.(1-\tau).\left(\theta_p\right)^{1-\alpha/\alpha} - \rho] \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (A13)$$

On substituting for $\tau = \theta_p + \theta_u$ we have:

$$\gamma = [\,\alpha.\left(1-\theta_p-\theta_u\right).\left(\theta_p\right)^{1-\alpha/\alpha} - \rho] \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (A14)$$

According to (A14), the growth rate depends on the output elasticities with respect to private capital and public good, composition of public spending, and discount rate.

Derivation of Equations (15) and (16) in the Text

Consider the following optimisation problem:

$$\text{Max } u_g = \pi.(\ln c + v \ln g_u) + (1-\pi).(\varrho(\pi).g_p) \quad \ldots \quad \ldots \quad \ldots \quad (A15)$$

$$\text{Subject to } \tau y = g_u + g_p \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (A16)$$

Forming the Lagrangian function:

$$L = \pi.(\ln c + v \ln g_u) + (1-\pi).\left(\varrho(\pi).g_p\right) + \lambda[\tau y - g_u - g_p] \quad \ldots \quad (A17)$$

Differentiating with respect to g_u gives:

$$\pi.\frac{v}{g_u} = \lambda \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \text{(A18)}$$

Similarly, differentiating with respect to g_p gives:

$$(1-\pi).\varrho(\pi) = \lambda \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \text{(A19)}$$

From (A18) and A(19) we obtain:

$$g_u = {\pi.v}/{(1-\pi).\varrho(\pi)} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad .. \text{(A20)}$$

Which is Equation (15) reported in the main text.
Plugging (A20) into (A16) we obtain:

$$g_p = \tau y - {\pi.v}/{(1-\pi).\varrho(\pi)} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \text{(A21)}$$

Which is Equation (16) reported in the main text.

Derivations for Proposition 3

Differentiating Equations (19) and (20) reported in the main text yield the following expressions.

$${\partial\theta_u}/{\partial\pi} = \{v.y(1-\pi)[\varrho(\pi) - \pi.\varrho_\pi] + \pi.v.y.\varrho(\pi)\}\Big/{[y.(1-\pi).\varrho(\pi)]^2} > 0 \text{ (A22)}$$

$${\partial\theta_p}/{\partial\pi} = -\{v.y(1-\pi)[\varrho(\pi) - \pi.\varrho_\pi] + \pi.v.y.\varrho(\pi)\}\Big/{[y.(1-\pi).\varrho(\pi)]^2} < 0 \quad \ldots \text{(A23)}$$

Derivations for Proposition 4:

Taking derivative of Equation (21) with respect to π we have:

$${\partial\gamma}/{\partial\pi} = \psi.\left[(1-\alpha).\left({\partial\theta_p}/{\partial\pi}\right) - \alpha\left({\partial\theta_p}/{\partial\pi} + {\partial\theta_u}/{\partial\pi}\right)\right] \quad \ldots \quad \ldots \text{(A24)}$$

Where

$$\psi = (\theta_p(\pi,\varrho))^{{1-\alpha}/{\alpha}}\left(1 - \theta_p(\pi,\varrho) - \theta_u(\pi,\varrho)\right).(\theta_p(\pi,\varrho))^{-1} > 0 \quad \ldots \text{(A25)}$$

The signs of the derivatives inside the brackets of (A24) are as in (A22) and (A23).

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Book Review

Hafeez A Pasha. *Growth and Inequality in Pakistan*, Volume-I. Islamabad, Pakistan: Friedrich Ebert Stiftung. 2018. v+218 pages. Price not given.

The book, *Growth and Inequality in Pakistan*, is written on a very important theme. In this book, important economic issues of Pakistan economy are touched upon carefully, using recent facts and figures, and far-reaching practical associations are also made a part of this book. The book proceeds in a logical manner and the topics covered in the book capture the deep attention of the reader. The book is divided into seven sections and each section is further divided into chapters related to the issues of concern.

As the rising population is an important concern for any economy, therefore, before policy options, the initial discussion in this book focuses on the issues concerning the population of Pakistan. As the population census has been carried out after a gap of nineteen years, it becomes inevitable to start addressing issues related to population, its growth, and international comparisons. Section one presents a good review of the population of Pakistan, which has reached 207.8 million.[1] The discussion is followed by focusing on the distribution of population and its growth. The growth rate for the period 1998-2017 revealed by the census is 2.4 percent, which, according to the author, is worrisome. The size and growth of cities is also a concern, which shows that the fastest growing cities in Pakistan are Lahore and Islamabad. Overall, in Pakistan urbanisation is taking place at a moderate rate but imbalances are observed in the size distribution of the cities.

Discussion about Pakistan's economy and its international ranking is also made a part of the book. Mainly, the state of the economy is discussed, in terms of international comparisons of key macroeconomic indicators. Economic growth is discussed and compared with the economic boom in Asian economies and the reasons for slow economic growth and macroeconomic imbalances are also pondered over in detail. To stay competitive, it is important for a country to be informed about its position in international rankings and, to this end, the author has done a good job by providing details of six key international indices provided by international institutions, including the UN agencies, World Bank, World Economic Forum, and others.

The book also discusses and evaluates different IMF programmes. It gives an overview of IMF programmes in Pakistan, along with projections, and reasons for their success and failure. The author provides a good picture of the record of economic growth, starting from the 60s onwards. According to the author, annual growth rates were impressive in the 60s and the 80s but after that annual GDP growth rates have remained low. As the Pakistan economy needed stabilisation, Pakistan remained under an IMF programme from 2014-15 to the first quarter of 2016-17.

[1]Provisional figure.

The latter parts of the book focus on the importance of investment in Pakistan's economy. The long-term decline, according to the author, is due to a significant fall in economic growth. The cause of this decline is accounted for by changes in the roles of the public and private sectors. As the discussion proceeds further, the review of the federal Public Sector Development Programme gives the reader a clear picture of the implementation issues and allocation priorities. The China Pakistan Economic Corridor (CPEC) projects and other special programmes are also discussed in terms of their importance for Pakistan. CPEC is quite important for Pakistan as it can boost infrastructure investment, provide large scale investment, and increase the power generation capacity. The author has rightly discussed the potential macroeconomic impact of CPEC related to the growth of the Pakistan economy. Further, potential impacts of CPEC on balance of payments, public finances, regional trade, and development are discussed, along with the associated risks.

Moreover, labour laws, which is an important issue of Pakistan's labour market, are also debated in the book. The discussion proceeds based on the findings of the Labour Force Survey, 2014-15. It is reported by the author that there were 3.6 million unemployed workers by the end of 2014-15, which reaches 5.3 million if discouraged workers are also added. Additionally, other issues of labour market are also discussed, namely bonded labour, child labour, and female workers. The book also discusses labour laws that are in place in Pakistan.

The book also focuses on the growth of provincial economies. At first, it examines a complex interface of the size and shares of provincial economies in different eras. Punjab is the largest provincial economy, which had 54 percent share in the total economy, has seen its share declined compared to previous years. Sindh economy's share was 30 percent in 2014-15 and there is a moderate increase in its share since 1999-2000. Khyber Pakhtunkhwa, having 13 percent share in the national economy, has shown a significant increase since 1999-2000, while Balochistan has seen its share decline. The analysis of the economic growth of all the individual provinces offers an interesting picture.

Anyone who opts to read this book will positively get valuable insights. I am sure that social science researchers, policy-makers, and other stakeholders will find this book interesting. Readers will encounter a convincing argument that challenges and shapes new ideas to work on. Overall, the reader will end up having immense information from this book.

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