Overview

The distribution of stipends to female students is a key activity of the Punjab Education Sector Reform Program (PESRP) in order to improve gender parity in access to female education. This program is targeted to girls enrolled in grades 6-10 in government schools in 16 out of 36 districts of Punjab. Under the current program, Rs. 600 is provided on a quarterly basis to girls who maintained an attendance rate of at least 80%. In 2011-12, on average, 380,000 beneficiaries received stipends in each quarter. However, since its inception in 2004, the stipend amount has never been raised despite significant erosion in its real value over the intervening years. Consequently, it is likely that the incentive-effect of the benefit amount has also declined.

Going forward, the provincial government expects to revise the benefit level and test different design features to strengthen the effectiveness of the program in promoting its stated objectives, namely increasing transition to secondary school and retention/progression in secondary school for relatively disadvantaged girls. The Supplemental Stipends Pilot in Punjab (hereafter, SSPP) is proposed as a 3-year pilot, to be launched in April 2013, and will offer girls in grades 6-10 in select government schools in low participation tehsils a supplemental benefit amount, over and above the Rs. 2,400 per year that they are currently receiving. In addition, the proposed pilot will also test innovative design features, including but not limited to, a progression-based conditionality. Specifically, the following financial incentive packages (or “treatments”) have been proposed for piloting in a previous intervention note:

- **T1** = (i) Girls in grades 6-8 receive Rs. 900 per quarter; (ii) Girls in grades 9-10 receive Rs. 1200 per quarter + Rs. 2400 upon progression
- **T2** = (i) Girls in grades 6-7 receive Rs. 900 per quarter; (ii) Girls in grades 8 receive Rs. 900 per quarter + Rs. 1600 upon progression; (iii) Girls in grades 9-10 receive Rs. 1200 per quarter + Rs. 2400 upon progression
- **T3** = (i) Girls in grades 6-7 receive Rs. 900 per quarter; (ii) Girls in grades 8 receive Rs. 900 per quarter + Rs. 2400 upon progression (iii) Girls in grades 9-10 receive Rs. 1200 per quarter + Rs. 2400 upon progression

According to the appraisal document of the Second Punjab Education Sector Project, SSPP will be subject to a rigorous impact evaluation (IE) - using multiple rounds of data on households (children), schools, teachers, students, and secondary sources - to give us reliable evidence on the effectiveness of SSPP on schooling, cognitive, and welfare outcomes; the channels through which changes in outcomes are mediated; and spillover effects on intra-household behavior.

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1 To potentially maximize the incentive effect of the supplemental stipend benefit amount, SSPP is expected to be implemented in tehsils with relatively low levels of school participation of girls age 11-15 and large rural populations.
Sequencing of SSPP

SSPP will be piloted for a minimum period of 3 years (April 2013- June 2016). We propose that SSPP implementation be sequenced as follows:

- **Phase I**: Beginning in April 2013, only one financial incentive package (or “treatment”) will be piloted in some schools in select tehsils in two stipend districts. The financial incentive package to be piloted in Phase I is:
  
  - (i) Girls in grades 6-8 receive Rs. 900 per quarter; (ii) Girls in grades 9-10 receive Rs. 1200 per quarter.

  The choice of one treatment and two districts in this phase is based on practical considerations.

  - First, the implementation of some new design features, such as progression-based incentive payment, requires the capability to track students as they move from one grade to next, and from one school to another (this is especially relevant for girls completing grade 8). These capabilities are currently lacking and relevant administrative arrangements will have to be put in place and tested before such treatments can be introduced. On the other hand, raising attendance-tied benefit levels can be effectively implemented under the current stipend reporting and delivery regime, and is therefore proposed for piloting in Phase I.

  - Second, a phased design is a prudent approach in order to limit the implementation burden and ease in the program into the government school system in districts that have the largest implementation challenges.

  - Third, the approach to selection of schools in Phase I is not identical to (and less robust) than the approach proposed for Phase II of SSPP. Thus, by limiting Phase I in select tehsils in two districts (as explained later, one of the criteria for selecting Phase I localities is its separability from Phase II localities), we will have available to us a rich sample of schools in Phase II that is unaffected by introduction of supplemental stipends in Phase I. This way, we can evaluate true impacts with much precision when all treatments (T1, T2, and T3) are implemented in tandem.

- **Phase II**: Beginning in April 2014, all three treatments described above (T1, T2, and T3) will be piloted in multiple tehsils across multiple districts. The strategy for school selection in Phase II will be sketched in a separate note, and as mentioned earlier, is different in some respects from the selection approach used in Phase I.

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2 Given timing considerations, it is not possible to implement identical randomization strategy in Phase I and Phase II (in Phase II, we will use baseline data to inform randomization and ensure that treatment and control groups are similar or “balanced” at baseline). However, we might subject Phase I treatment and control units to similar surveys as Phase II sample units. This way, we can check for balance ex post and estimate causal impacts of Phase I; and/or use quasi-experimental techniques to compare Phase I and Phase II beneficiaries.
Selection of Schools for Phase I of SSPP

The selection of schools for Phase I of SSPP, commencing in April 2013, will proceed along three stages:

1) District and tehsil selection
2) Identification of school clusters
3) Assignment of school clusters to SSPP

(1) District and tehsil selection: As mentioned before, the first phase of SSPP will be piloted in select tehsils in two districts. The identification of these sample districts and tehsils is based on the following considerations:

- **Overlap with branchless banking pilot:** In April 2013, branchless banking pilot is being initiated in urban schools in 3 districts (Muzaffargarh, Okara, and Khanewal). Given time constraints, the introduction of two simultaneous new activities will be administratively burdensome for the district management. Hence, these districts that are slated to pilot branchless banking in April 2013 are excluded.

- **Availability of school GIS:** In order to proceed with identification of school clusters and their randomized assignment to treatment and control group, GIS data on schools is required. At this stage, we have GIS data on (almost) all female and secondary schools for all stipend districts, except Chiniot, Lodhran, Pakpattan and Bahawalnagar; hence these districts are not considered.

- **Rurality:** Since SSPP is intended to benefit girls in rural areas, only tehsils that are pre-dominantly rural will be considered. To this effect, tehsils with proportion of rural population ≤66% are excluded.

- **Participation rate:** The increase in stipend amount is intended to be targeted to rural beneficiaries in regions where their school participation is low. To this effect, we use MICS 2007/08 to measure school participation rates for girls age 11-15 in rural areas in each of the remaining tehsils; henceforth, only those tehsils where participation is < 50% are retained. Subsequently, for each district, we look at the number of retained (low participation) tehsils vs. total number of tehsils. Only districts where the majority of tehsils are retained are considered.

- **Separability from Phase II sample:** From the remaining low participation tehsils, we exclude those which are adjacent to multiple Phase II sample tehsils, and whose inclusion would otherwise greatly reduce the size of the Phase II sample if their adjacent tehsils are excluded from the Phase II sample. This restriction is imposed to ensure that Phase II sample size is not adversely affected, and that there be no externalities to Phase II beneficiaries of introducing supplemental stipends in Phase I localities (and vice versa), in order to estimate consistent (unbiased) impacts of SSPP.

- **Supply of schools:** Next, we enumerate the total number of rural girls’ middle and secondary schools in each remaining (i.e. eligible) tehsil, and aggregate these to the district level. Subsequently, we form
district pairs\(^3\) and rank these based on total number of schools previously calculated. Based on this, the district pair with the highest number of schools is selected. School supply is an important selection criteria in Phase I (but much less so in Phase II\(^4\)) because - while we aim to select few tehsils in only two districts in Phase I - we still need a large school sample to identify sufficient number of school clusters (preferably >50 clusters) for randomization.\(^5\)

Based on these considerations, we select **District Kasur and District Bhakkar** for Phase I of the pilot. Meanwhile, the tehsils eligible for inclusion are: Kasur; Kot Radha Kishan; Chunian; Darya Khan; Mankera; Kallur Kot. These tehsils represent reasonable geographic diversity (east, west) as well diversity in participation rates (each tehsil corresponds to a different participation decile).\(^6\) For information on number of schools and enrollment in selected Phase I tehsils, see Table A1 in Annex A.

**2) Identification of school clusters:** In SSPP, randomization will be at the “school cluster” level, which means that we would assign whole clusters to either treatment or control (i.e. if a cluster is assigned to treatment, all schools in that cluster will be treated). In this context, a “school cluster” is defined as a girls’ secondary school and all feeder schools for girls offering grades 6-8 and which are designated “rural” in ASC. While it is evident that there is a symbiotic relationship between middle schools and the secondary school they feed into, these linkages have not been mapped. Hence, our next step is to identify “school clusters” in the six selected tehsils.

**Why do we need to identify school clusters?**

Before we go into the mechanics of identifying school clusters, let us first explain the rationale for using these as the unit of randomization. Recall that in the previous intervention note, we proposed SSPP be structured in such a way that:

\(#1.\) All girls in grades 6-8 in the same SSPP school will be offered the same quarterly stipend for reasons of political and administrative feasibility. Similarly, all girls in grades 9-10 in a given SSPP school will be offered the same quarterly stipend.

\(#2.\) If middle level grades in a school have been selected to receive supplemental stipends, all government girls’ secondary schools that serve this school will also be offered supplemental benefits at the secondary grade level. This will ensure that quarterly stipend payments that SSPP beneficiaries receive when they progress to secondary grades is not lower than the payments they received when

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\(^{3}\) That is, different combinations of districts for which we previously calculated the total number of schools.

\(^{4}\) In Phase II, we will select multiple tehsils and will have a large school sample. This means that we do not have to worry about having insufficient clusters, and can select tehsils irrespective of supply considerations.

\(^{5}\) In *Impact Evaluation in Practice*, Gertler et al. say that at least 30 to 50 clusters in each of the treatment and control group are required to obtain sufficient power and guarantee balance of baseline characteristics when using randomization. Simulations in Duflo, Mullainathan, and Bertrand (2004) also show that when the number of clusters is small (less than 50), the conventional method of hypothesis testing leads to over-rejection of the null hypothesis of no effect.

\(^{6}\) Since we are limited to selecting limited tehsils in two districts only and given our selection criteria, tehsils with participation in the bottom 3 deciles are not represented in Phase I, but will be represented in Phase II.
they were in middle grades in an SSPP school, so as to not disincentivize their participation in secondary grades.

This has several implications. Generally, in the IE literature, if spillovers (i.e. those who are not directly targeted by the intervention should not be affected by it) can be reasonably ruled out, it is considered best to perform randomized assignment of the treatment at the lowest possible level. In theory, we can randomize supplemental benefits (the “treatment”) at the lowest level i.e. the individual; however, it follows from rule #1 that individual level randomization within SSPP schools is not a feasible option. Since middle and secondary schools typically serve many villages, it is also not possible for us to undertake village-level randomization either because, like individual level randomization, it can potentially lead to different girls receiving different benefit schedules in the same school.

The next best option is to randomize schools to treatment and control; however, the second rule imposes some constraints on this option; namely, that if the girl was receiving supplemental stipend in grade 8, she cannot receive lower benefits when she transitions to grade 9 (which could be a different school). Combined with rule #1 under which quarterly stipend levels to individuals in grades 9-10 in the same school cannot vary, it implies that all secondary schools linked to middle schools that are treated would also be treated.

Given these considerations, the smallest unit feasible for randomization is the “school cluster” which typically nests a secondary school, feeder middle schools, their catchment localities and eligible individuals therein (see a simplified model of a “school cluster” in Fig 1).

While the concept of “school clusters” is intuitive, these clusters have not been mapped, and we will have to identify them. This begs the question “Why not randomize at a different level of aggregation that is more convenient (for e.g. at the UC or Markaz level)?” While UC or Markaz level aggregation is convenient, it is not possible to use these as the unit of randomization as it will violate the rules described above. For instance, using 5 km as a basis for defining school clusters, we find that less than half of school clusters (having more than one school) have all schools located in the same Markaz; this proportion is even lower in the case of UCs. This means that it becomes likely that a girl who was in a treated school in grade 8 ends up in an untreated school in grade 9, which is contrary to aforementioned rule #2. On the other extreme, randomizing at a very high level of aggregation (like the tehsil) will adversely affect the quality of evaluation design and reliability of any findings (refer to footnote 7).

**Fig 1: Anatomy of a School Cluster**

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7 There are three reasons why it is considered best to randomize treatment at the lowest possible level. First, sample size and evaluation cost increases with higher levels of aggregation and fewer units available for randomization. Second, in order to obtain causal impacts, treatment and control groups must be similar (i.e. “balanced”). The key to balancing the treatment and comparison groups is the number of units assigned to the treatment and comparison groups, not the number of individuals or households in each unit. Third, the robustness or internal validity of the evaluation is more likely to be threatened with large-scale units of randomization.
What is the procedure for identifying school clusters?

The cluster identification procedure comprises of the following key steps:

1) Identify all girls’ schools offering grades 9-10 in sample tehsils. We will call these schools $S_{H}$.

2) Identify all girls’ schools offering grades 6-8, and with designation “rural” in the ASC, in sample tehsils. We will call these schools $S_{M}$.

3) Exclude $S_{M}$ and $S_{H}$ for which school GIS data is inaccurate. This is based on plotting school GIS on province/district/tehsil boundary maps and comparing it with their location in the ASC. $S_{M}$ and $S_{H}$ that were outside the administrative boundary specified in the ASC are excluded.

4) Map $S_{M}$ and $S_{H}$ to middle and secondary schools in adjacent tehsils. If either $S_{M}$ or $S_{H}$ is adjacent to a Phase II tehsil, we drop it from the sample if it is within 20 km of the Phase II tehsil in order to prevent spillovers. However, if either $S_{M}$ or $S_{H}$ is adjacent to a tehsil that is not part of the Phase II...
sample, we exclude it from the sample if there is more than 1 school in the adjacent tehsil within a 4 km distance.\textsuperscript{8}

5) For the remaining schools, identify school clusters are defined based on distance and proximity considerations.\textsuperscript{9} The steps involved in identifying sample school clusters are:

a) Map all S\textsubscript{M} to nearest S\textsubscript{H}, based on straight-line distance between schools, using school GIS data. Fig 2 below shows how distance between rural middle and nearest secondary schools in our sample tehsils is distributed.

![Fig 2: Distance to Nearest Middle/ Secondary School](image)

*Note: 55 secondary schools are not reflected in the y-axis of the graph since for girls in grades 6-8 in these schools, the distance to nearest school offering grades 9-10 is 0 km.*

b) If the nearest S\textsubscript{H} is within 6 km of an S\textsubscript{M}, both S\textsubscript{M} and S\textsubscript{H} are retained in the sample. Subsequently, each S\textsubscript{H} and all S\textsubscript{M} mapped to it, provided the distance between the S\textsubscript{M} and S\textsubscript{H} is < 6 km, will constitute a unique “school cluster”. We apply a distance threshold of 6 km because:

a. Around three-quarters of all middle schools are within 6 km of a secondary school (Fig 2); this improves our chances of finding a secondary school match for our sample of middle schools;

b. A distance of 6 km (which typically takes more than an hour to cover on foot\textsuperscript{10}) ought to be sufficiently wide to capture a high proportion of catchment localities. For instance, based on PSLM 2010/11, for 84% of girls residing in rural areas in stipend districts and currently

\textsuperscript{8} In addition, we also exclude those S\textsubscript{M} and S\textsubscript{H} from the sample that have more than 4 schools in adjacent tehsils (not part of Phase II) within a 6 km distance.

\textsuperscript{9} Using straight line distance between schools to define a school's catchment area is simplistic. However, in the absence of sufficiently granular information on which localities are served by each of the schools, or GIS data (such as, number of roads available; whether roads were used for motor transport, public transport or walking; natural boundaries like rivers without bridges, etc) to approximate the actual time it takes for an individual in each locality to travel to the closest school, we rely on calculating linear distances.

\textsuperscript{10} In the case of traffic, road availability, natural boundaries etc., travel time on foot would of course be higher.
enrolled in grades 6-8, travel time to nearest middle school by usual means of transport is < 30 minutes (the usual means of transport for 85% of these girls is non-mechanical or on foot). Meanwhile, for 77% of girls residing in rural areas in stipend districts and currently enrolled in grades 9-10, travel time to nearest secondary school by usual means of transport is < 30 minutes (the usual means of transport for 72% of these girls is non-mechanical or on foot). See Fig 3 below for break down by distance and means of transport.

**Fig 3: Travel Time to Middle/Secondary School by Usual Means of Transport**

Looking at MICS 2007/08 instead, which has a larger sample and reports distance (rather than travel time) to different types of schools, we also find some evidence to support our choice of distance threshold. According to MICS, more than 80% of the girls residing in rural areas in stipend districts and enrolled in grades 6-8 in government school report their nearest government middle school for girls to be within 5 km. Meanwhile, more than 60% of the of the girls residing in rural areas in stipend districts and enrolled in grades 9-10 in government schools report their nearest government secondary school for girls to be within 5 km.11

c) If the nearest $S_H$ is more than 6 km away, the $S_M$ will constitute a single school cluster. However, only those $S_M$ are considered if their nearest $S_H$ is one of the secondary schools retained in the sample in the previous step; otherwise the $S_M$ is dropped.12

d) If for an $S_M$, the nearest $S_H$ is an urban school, we exclude both $S_M$ and $S_H$ from the sample to ensure that SSPP stays focused on rural beneficiaries. The only exceptions to this rule are (i) if the only other school within 6 km distance of the urban $S_H$ is a rural $S_M$, or (ii) in the event that

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11 The assumption we make is that girls are likely to go to the school that is situated closest to their homes.

12 The sample is restricted to those middle schools whose nearest secondary school is already in the sample, and therefore subject to IE survey.
there are other schools within 6 km of the urban S_{H}, the ratio of rural female enrollment in grades 6-8 in the school cluster is ≥ 67%.

e) If there is a rural S_{H} only mapped to itself and no other S_{M}, the S_{H} is excluded if all schools within a 6 km distance are urban schools; otherwise it is retained.

f) The above cluster identification strategy is based on matching S_{M} to nearest S_{H} so each cluster has no more than one secondary school. However, some S_{M} are located close to multiple S_{H} (and vice versa), even though these might not be the closest, and therefore have overlapping catchment areas. We will therefore “merge” clusters where (i) the minimum distance between S_{H} in one cluster and S_{M} in the other cluster is < 4 km, or (ii) the minimum distance between S_{M} in one cluster and S_{M} in the other cluster is < 3 km. This would ensure that where catchment areas of two clusters are likely to overlap considerably, girls in overlapping catchment localities are exposed to the same treatment.

Based on this, we identify 62 school clusters (comprising of 146 schools and 21,493 female students in grades 6-10). These clusters can be differentiated into:

- Clusters comprising of at least one S_{M} and no S_{H} within 6 km (25 clusters with 25 schools).
- Clusters comprising of at least one S_{M} and one S_{H} within 6 km (37 clusters with 121 schools).\(^\text{15}\)

(3) Assignment of school clusters to SSPP:

In this stage, we will randomly assign school clusters identified above to either treatment or control group. If a school cluster is selected into the treatment group, all schools in that cluster will get the treatment. The assignment of school clusters to treatment and control is based on “matched-pair randomization”. In matched pair randomization, we first select pairs of school clusters that are matched, or at least are as similar as possible, on a set of available background characteristics. Then, we randomly choose one of the two clusters within each pair to receive treatment and the other to be the control. Matching on baseline characteristics (also called “covariates”) before randomization can increase balance on these covariates, increase the efficiency of estimation and the power of hypothesis tests, and reduce the required sample size for fixed precision or power (Greevy, Lu, Silver, & Rosenbaum 2004).\(^\text{16}\)

\(^{13}\) An assumption made in causal inference is that of no interference between individuals (or units): a violation of this would occur if individuals in the control group also get the same treatment as those in the control group. For schools that are very close by, and have overlapping catchment areas, the no-interference principle cannot be enforced.

\(^{14}\) The modal distance between an S_{M} and its nearest S_{H} is 2-3 km, whereas the modal distance between an S_{M} and its nearest S_{H} is 3-4 km. Also, as seen from PSLM and MICS findings, girls going to secondary schools travel longer distances than girls going to secondary schools.

\(^{15}\) This includes 5 clusters comprising of one rural secondary school offering both grades 6-8 (so considered S_{M}) and grades 9-10 (so considered S_{H}).

\(^{16}\) Matching before randomization does not seem to have major disadvantages, except in sample sizes smaller than we have, where efficiency is still improved, but power can be reduced.
An additional advantage of the matched pair design from our perspective is that it enables us to protect the validity of Phase I evaluation design from loss of clusters. As mentioned before, cluster identification is not exact\(^\text{17}\); so, in a later stage, if a cluster is dropped or its composition modified because it was misspecified, no bias would be induced for the remaining clusters. That is, if we delete the remaining member of the pair that suffered a loss of a cluster under these circumstances, the set of all remaining pairs in the study would still be as balanced – i.e. matched on observed background characteristics and randomized within pairs - as the original full data.

Based on data availability, we match school clusters in each of the two districts on baseline characteristics that are likely to affect potential outcomes. These characteristics are:

- **Cluster size**: This is defined as (i) total female enrollment in grades 6-10 in the cluster, and (ii) number of schools in the cluster. The data source is ASC 2011. The clusters in our sample are of unequal size, and the variations in cluster size and density could reflect differences in population size and socio-economic conditions in catchment localities. For this reason, we match on cluster size.

- **School Quality**: This is defined as average test score of female students in grade 5 exams in the cluster.\(^\text{18}\) The data source is PEC 2011. It is used as a matching variable because uptake of SSPP can be affected by perceived quality of schooling.\(^\text{19}\)

- **Access to Schools**: This is defined as average distance to nearest secondary school in each cluster. The data source is school GIS and ASC 2011. Access to schools is a key determinant of program uptake, and the impacts of SSPP are likely to be different for girls that are located close to schools than those who are further away.

- **Absorptive Capacity**: This is defined as (i) student teacher ratio in the cluster, and (ii) classroom size in the cluster. For instance, one factor which could affect outcomes is congestion; schools that are already operating at full capacity could be overstretched with the influx of new students, which would affect student outcomes. For this reason, we match on these indicators of school absorptive capacity.

- **Urbanity**: While our sample consists of rural beneficiaries, some rural localities are closer to urban centers than others, and are likely to have access to better community infrastructure, more reliable transportation, and diverse schooling and work options, etc. Since these factors would affect SSPP outcomes, we use it as a matching variable, and proxy it by average distance to nearest urban school in each cluster. The data source is school GIS and ASC 2011.

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17 One issue is that we use simple linear distance between schools as information on catchment localities or travel time is not available. A second issue is potential measurement error in GIS data, which is used for school assignment to clusters.

18 Using grade 8 test scores was not feasible since no exam scores are reported for some of the sample schools in either PEC 2011 or PEC 2012.

19 Imagine two households that are similar in all respects (including their costs of schooling), but one is situated close to low-quality schools, while the other is close to better-quality schools. It stands to reason that for households with access to low quality schools, the perceived returns to schooling would be lower than for households with access to better quality schools, which means that the incentive effect of SSPP would be different for these two households.
Unfortunately, we do not have cluster-level data on community characteristics and demographics; hence these could not be used for finding matched school cluster pairs.

After we implement our matching procedure\(^{20}\), we identify 30 matched school cluster pairs (15 in each district).\(^{21}\) Next, within each pair, we randomly assign one cluster to treatment and the other cluster to control group. This gives us a total of 15 treatment clusters comprising of 68 schools (9,968 girls in grades 6-10), and 30 control clusters comprising of 68 schools (10,211 girls in grades 6-10). As mentioned before, if the cluster has been assigned to the treatment group, all schools in that cluster will receive supplemental stipends. The list of treatment schools is given in the accompanying Excel file (see worksheet “treatment schools”). See Fig A1 in Annex A for the map of schools assigned in treatment and control groups.

To assess the quality of randomization, we checked for differences between treatment and control schools (and clusters) on a number of available background indicators, whether it was used or not used for pair matching. These indicators are: enrollment (in grades 6-8, 6-10, and overall school enrollment), number of teachers, test scores, distance to nearest secondary school, school facilities (building condition, number of usable toilets, sewerage, electricity, number of open-air and covered classrooms, number of students with no furniture), classroom size, student teacher ratio, urbanity, number of schools in a cluster, etc.\(^ {22}\) Our analysis suggests no observed differences between treatment and control groups on these school characteristics.

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\(^{20}\) To form matched-pairs, an *optimal greedy* matching algorithm, based on Mahalanobis distance between the observations, was used (note that the values of matching variables were standardized before computing distances). The optimal greedy matching procedure first calculates the Mahalanobis distance between every feasible pair of school clusters in the district based on the aforementioned matching variables, and then selects the pair of school clusters with the least Mahalanobis distance as a matched-pair. This selected pair is then removed from the pool of feasible pairs. These steps are then repeated until all the school clusters are matched in pairs. This procedure differs from optimal matching, which selects pairs to minimize the total Mahalanobis distance between each of the pairs. The drawback with optimal matching is that any reduction in the sample results in a loss of optimality. As mentioned before, cluster identification is not exact; so, to protect study design from the event that some school clusters have to be dropped because of misspecification, we decided to use optimal greedy matching.

\(^{21}\) Since we had odd # of clusters in each district (31), 1 cluster in each district could not be matched, and was dropped.

\(^{22}\) Standard errors are clustered at the school cluster level. When assessing differences in cluster means, we ran two models, one in which we weighted cluster means by size of the cluster, and one where we did not weight the data. In both cases, the differences in baseline indicators were not statistically significant.
Annex A

Table A1: Overview of Sample Tehsils

<table>
<thead>
<tr>
<th>District</th>
<th>Tehsil</th>
<th>Participation Rate</th>
<th>Participation Rank</th>
<th>Participation Decile</th>
<th>Number of Rural Middle Schools</th>
<th>Number of Rural Secondary Schools</th>
<th>Female Enrollment in Grades 6-8 in Rural Schools</th>
<th>Female Enrollment in Grades 9-10 in Rural Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>KASUR</td>
<td>CHUNIAN</td>
<td>37%</td>
<td>21</td>
<td>4</td>
<td>25</td>
<td>12</td>
<td>4,454</td>
<td>968</td>
</tr>
<tr>
<td>BHAKKAR</td>
<td>DARYA KHAN</td>
<td>39%</td>
<td>23</td>
<td>5</td>
<td>15</td>
<td>1</td>
<td>1,326</td>
<td>180</td>
</tr>
<tr>
<td>BHAKKAR</td>
<td>KALLUR KOT</td>
<td>47%</td>
<td>32</td>
<td>6</td>
<td>15</td>
<td>9</td>
<td>1,585</td>
<td>518</td>
</tr>
<tr>
<td>KASUR</td>
<td>KASUR</td>
<td>48%</td>
<td>33</td>
<td>7</td>
<td>43</td>
<td>15</td>
<td>6,692</td>
<td>1,637</td>
</tr>
<tr>
<td>KASUR</td>
<td>KOT RADHA KISHAN</td>
<td>49%</td>
<td>37</td>
<td>7</td>
<td>12</td>
<td>5</td>
<td>2,094</td>
<td>415</td>
</tr>
<tr>
<td>BHAKKAR</td>
<td>MANKERA</td>
<td>49%</td>
<td>37</td>
<td>7</td>
<td>12</td>
<td>5</td>
<td>1,284</td>
<td>508</td>
</tr>
</tbody>
</table>

Source: MICS 2007/08, ASC 2011. Note: Kot Radhan Kishan was part of Kasur tehsil at the time of MICS survey.

Fig A1: Map of Treatment and Control Schools

Note: Points on the map that have the same color belong to the same matched pair. Points on the map that have the same shape and color belong to the same cluster. Points that are diamond-shaped are Treatment schools, while circle-shaped points are Control schools.