

Do remittances alter labour market participation?

Abstract

This article focuses on the impact of remittances on labour market participation using propensity score matching. Using household survey data for Albania, this article relies on the matching approach for identification. Nearest neighbour and kernel estimators are used to obtain the matching results. The vector of covariates includes information related to individual and household characteristics, such as; age; gender; schooling; area of residence; etc. In the model, household incomes are considered separately from remittances in order to identify whether income from remittances has the same effect as other types of household non-labour income in the decision as to whether or not to participate in the labour market. Empirical results show that remittances have a statistically negative impact as regards the labour market participation of women, both in terms of the probability of working and in terms of their hours of work. However, no evidence is found for the impact of such capital flows in the behaviour of men in their labour market activities.

Keywords: remittances, reservation wage, labour market participation, hours of work, propensity score matching

Introduction

Emigration from Albania during the transition to a market economy has been massive, relative to the population. According to the World Bank (2010), one out of every three households in Albania, 34 per cent, has at least one member currently living abroad and 50 per cent of those households have more than one. People from the urban coastal part of the country are those with the highest propensity to migrate, while people from the poorer, rural mountain part are the least likely.

Total remittances reported in the balance of payments increased from around €889m in 2003 to €1,317m in 2009, which is 10.9 per cent of GDP. These transfers from migrants can have a beneficial impact on the economy in the long-run if they are used in productive activities (Woodruff and Zenteno, 2001). However, remittances may have undesirable effects on the behaviours of those left behind. In particular, there is concern about whether remittances could cause Dutch disease effects (Acosta *et al.* 2009).

On the one hand, remittances may increase the reservation wage¹ of members living in households which receive remittances but, on the other, these transfers may be used to relax budget constraints and as a mean of capital imports, facilitating a climate for self-employment. Remittances may lead to better participation in business investment (Kilic *et al.* 2009) through self employment or asset accumulation (Adams, 1998).

1 The lowest wage rate at which a worker would be willing to accept a particular type of job.

Woodruff and Zenteno (2001) show that 27 per cent of micro-enterprises in urban areas in Mexico rely on remittances from abroad.

Literature review

Remittances have been examined from both micro and macro perspectives. Treating remittances as a household issue, the microeconomic literature examines the patterns of remittances, the motivations for making them and the impact they have on the labour market and on family consumption. In turn, the macroeconomic studies concentrate on the macro effects in recipient countries, including as regards economic growth, financial development and poverty reduction.

The study of remittances in relation to labour market participation

Remittances can increase consumption or stimulate investment in economies with liquidity constraints (Reilly and Castaldo, 2007; Woodruff and Zenteno, 2001). One of the first studies that examined the consequences of remittances on home countries² was that by Funkhouser (1992) who found that, in Nicaragua, remittances increased self-employment for men and reduced the labour supply of women. However, from a development perspective, a decline in the labour supply in recipient families should not necessarily be viewed as a negative effect. For instance, women in remittance-receiving households may carry out both parenting and domestic production activities (Acosta, 2006). Unemployment could increase if remittances are seen as providing a kind of welfare payment. However, remittances – by reducing credit constraints in developing economies – can encourage firms to increase their level of investment. The overall effect on unemployment will depend on which of these effects dominates.

Remittance inflows are simple income transfers, so recipient households may rationally substitute unearned remittance income for labour income. Regardless of their intended use, remittance transfers may be subject to moral hazard problems (Chami *et al.* 2003). These problems may induce recipients to divert resources to the consumption of leisure, thereby reducing their labour market effort. There are cases in which members of remittance-receiving families reduce their labour market participation in Pakistan (Kozelt and Alderman, 1990) and in Caribbean Basin cities (Itzigsohn, 1995).

The impact of remittances on the decision to work has been examined by Rodriguez and Tiongson (2001) in Manila. Without accounting for the endogeneity of remittances with respect to labour supply, they conclude that remittances reduce employment. Using 2002 data from Mexico, Amuedo-Dorantes and Pozo (2006) show that remittances appear negatively to affect the female work effort only in rural areas and in the informal sector. Additionally, their results indicate that remittance-receiving men do not reduce their participation in the labour market, but tend to shift into informal employment. Their study accounts for the endogeneity of remittance income and examines differences in hours worked in various types of employment by men and women in urban and rural areas.

2 Home countries are the countries of origin of migrants.

Using household survey data from Moldova, Görlich *et al.* (2007) examine labour market inactivity by considering three potential explanations: a 'disincentive effect' in which leisure is considered a normal good and non-labour income raises the reservation wage of a potential worker; a labour substitution effect, in which people in remittance-receiving households allocate more time to household production than their counterparts in non remittance-receiving households; and an education effect, in which migration provides incentives for additional education³ and remittances are used to invest in the education of those remaining at home.

There are few empirical studies of the relationship between remittances and labour market issues in Albania. Konica and Filer (2009), using Albanian Living Standards Measurement Survey (LSMS) data from 1996, suggest that remittances have a negative effect on female labour market participation due to income from abroad being higher. This finding is consistent with studies conducted in other countries. In the Albanian case, however, Konica and Filer (2009) find that neither the existence of emigrants in the household nor the amount of remittances received has an effect on the labour force participation of Albanian males.

Using data from the 2005 Albanian LSMS, Kilic *et al.* (2007) measure the impact of the past migration experience of Albanian households on non-farm business ownership through instrumental variables regression techniques. These results indicate that households' past migration experiences exert a positive impact on the probability of owning a non-farm business. Using the same dataset, Dermendzhieva (2009) investigates the effect of migration and remittances on labour supply in Albania. A linear probability model is estimated for the probability of a household member to be working, using the sub-samples of male and female household members separately. Only after using the instrumental variable did Dermendzhieva (2009) obtain large and negative coefficients following the receipt of remittances among women and older men.

This same question can be addressed using an alternative method, that of propensity score matching. I use propensity score matching to pair individuals that receive remittances with other individuals that are like them, concerning what they expect from remittances. The question is whether remittances act as a disincentive to participation in the labour market through a substitution effect, or whether there may be an income effect on the basis that remittances may affect decisions to accept more hours of work.

To date, studies on Albania have focused mainly on the decision to work and have not considered that remittances may change the number of hours worked or the type of work performed in the receiving economy, without altering employment rates. Hence, by focusing on work performance, a clearer picture of the allocation of labour supply across different types of employment can be established.

Theoretical framework of labour market participation

In the neoclassical model of labour-leisure choice (Killingsworth, 1983), individuals allocate time to market activities and non-market activities, maximising their utility subject to the budget constraint. The model isolates the factors that determine whether an individual works and, if so, how many hours s/he chooses to work. This theory lets

3 A phenomenon stressed by the 'brain gain' literature.

us predict how changes in economic conditions or government policies will affect work incentives (Borjas, 2005). Individuals seek to maximise their well-being by consuming goods and leisure. The economic trade-off is clear. If individuals do not work, they may consume a lot of leisure, but they have to do without the goods and commodities that make their life more enjoyable; on the other hand, if individuals work, they will be able to afford many of these goods, but they must give up some of their leisure time. In this framework, the wage rate and other income represent the key economic variables that determine the allocation of time between the labour market and leisure activities.

According to Becker (1981), there are various divisions of labour among family members. These divisions are determined partly by biological differences and partly by different experiences and different investments in human capital. The theory of comparative advantage implies that the resources of the members of a household should be allocated to different activities according to their comparative or relative efficiencies. These differences can be distinguished by the assumption that an hour of household or market activity by one member of the household is not a perfect substitute for an hour of the time of another member of the household when they make the same investments in human capital. Specialisation of tasks, such as the division of labour between members of the household, implies a dependence on others for certain tasks.

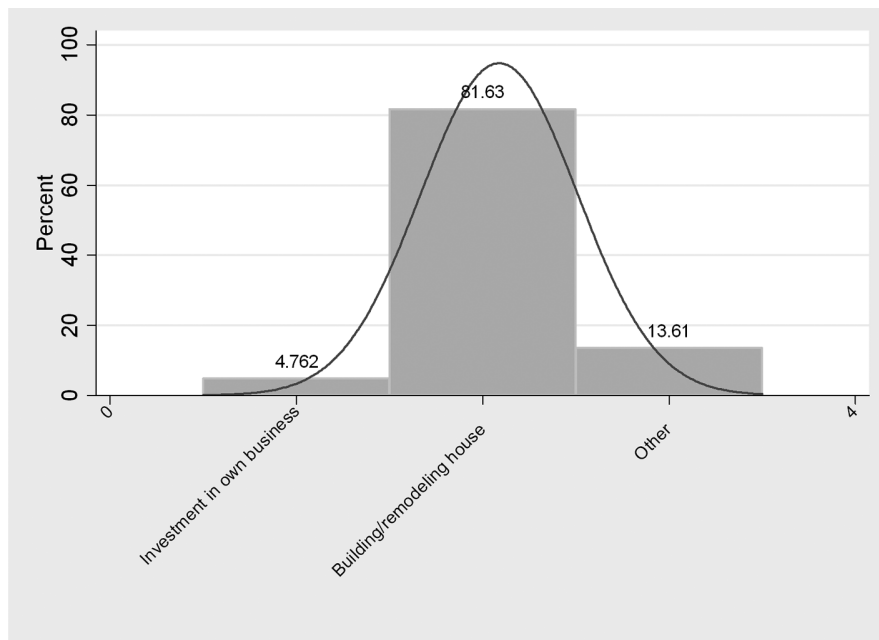
One important factor determining labour market participation decisions is the level of the reservation wage (the lowest wage rate at which a household member would be willing to accept a particular job). Furthermore, non-labour income is a determinant of the reservation wage. For an individual, the level of non-labour income depends on his or her own assets and the amount of income of the other household members. The higher is the income of the other members of the household, the higher the reservation wage of the individual (Cox-Edwards and Rodriguez-Oreggia, 2007). This reservation wage will influence the probability of the individual participating in the labour market. In this context, remittances may be considered as a disincentive to market activities because they increase the level of non-labour income, thus increasing the reservation wage.

Assuming that remittances are not randomly assigned, various factors may confound their impact on labour market participation rates from a direct comparison of remittance-receiving to non remittance-receiving households. Matching techniques helps to avoid these problems.

Results

In the study are included some 9 177 individuals between the ages of 19 and 65 from the four areas of Albania; coastal; central; mountain; and the capital, Tiranë. Figure 1 shows the distribution of remittances and their use. The majority, i.e. about 82 per cent, of remittances goes towards the building or re-modelling of houses; while only about five per cent serves as investment in household members' own businesses.

Figure 1 – Remittances in relation to their use



It is important to know who receives remittances before we may consider how different is such a household from one which does not receive anything, where significant differences exist. Table 1 presents statistical tests of the differences in the two groups of households based on those receiving remittances and those not receiving them.

Table 1 – Comparative descriptive statistics conditional on receiving remittances

	Non remittance-receiving household		Remittance-receiving household		Differences	
	Mean	Std. deviation	Mean	Std. deviation	Diffs.	Std. errors
Household size	4.902	1.799	4.279	1.865	.623***	.054
Urban	.543	.498	.395	.489	.148***	.015
Age	38.653	12.748	39.334	14.544	-.681*	.393
Female	.503	.500	.453	.498	.050***	.015
Education	9.055	3.672	8.724	3.230	.331***	.125
Not working	.348	.476	.274	.446	.073***	.014
Central (area)	.255	.436	.286	.452	-.030**	.013
Mountain (area)	.275	.446	.236	.425	.038***	.013
Hours worked (per week)	44.081	13.102	41.817	14.067	2.263***	.400
Head	.319	.466	.256	.436	.063***	.013
No. observations	7 909		1 268			

Note: ***, **, and * indicate statistical significance, respectively at the 1, 5 and 10 per cent level, or better.

Table 1 is designed to compare the means of the two groups and to test the statistical significance of the difference of the means.

We notice from the results that the differences are all statistically significant at different significance levels. Remittance-receiving households have a smaller household size (4.27) in comparison to non remittance-receiving households (4.90). This difference may be related to members, or part of a household, having migrated. Remittance receivers are more likely to be older and to be living in rural areas far from the central part of the country. The members of households who receive remittances are less likely to be the head of the family and also less likely to be female. Remittance-receiving individuals have completed fewer years of schooling (8.72) in comparison to individuals that do not receive remittances (9.05).

Not all the differences are statistically significant at the 1 per cent level. However, it is important to put an emphasis on the higher probability of not working for those individuals that live in remittance-receiving households. There is a statistically significant difference in the hours of work during a week, which are around 2.26 hours higher for those who live in non remittance-receiving households.

A rigorous propensity score modelling begins with an estimation of the conditional probability of receiving treatment, in our case: of receiving remittances. In this study, I have used logistic regression for estimating the conditional probability of receiving remittances using a vector of observed covariates, as shown in Table 2.

Table 2 – Estimation of the probability of receiving remittances

Receiving remittances	Logistic regression (1)
Household size	-.221 (.023)***
Urban	-.587 (.087)***
Education	.499 (.140)***
Education Squared	-.099 (.025)***
Age	-.049 (.021)**
Age Squared	.008 (.003)**
Female	-.519 (.095)***
Married	.083 (.031)*
Coastal	.302 (.121)
Central	.128 (.123)
Mountain	-.005 (.129)
Head of household	-.814 (.117)***
Cons	-.439 (.524)

From the logistic estimation, the probability of receiving remittances is influenced by the household living in the urban area and where the size of the household is smaller. Being married and not the head of the family increases the probability of receiving remittances; this is potentially related to it being mostly male heads of family who migrate, leaving behind the rest of the household. There is an interesting, and contrasting with Table 1, positive relationship between years of education and the probability

of receiving remittances. However, as expected, the square of the years of education is negatively related with the conditional probability. Younger members of the household are more likely to receive remittances. The area of residence of the household is not statistically significant.

By definition, a propensity score is a conditional probability of a study participant receiving treatment given the observed covariates; hence, not only treated participants, but also control ones, have non-zero propensity scores. Having obtained the propensities, I used nearest neighbour matching within a calliper of $.25\sigma_p$. For each treated observation, I locate the non-treated observations that are closest to the treated observation to serve as the corresponding control observation.

Figure 2 – Propensity score histogram by treatment status

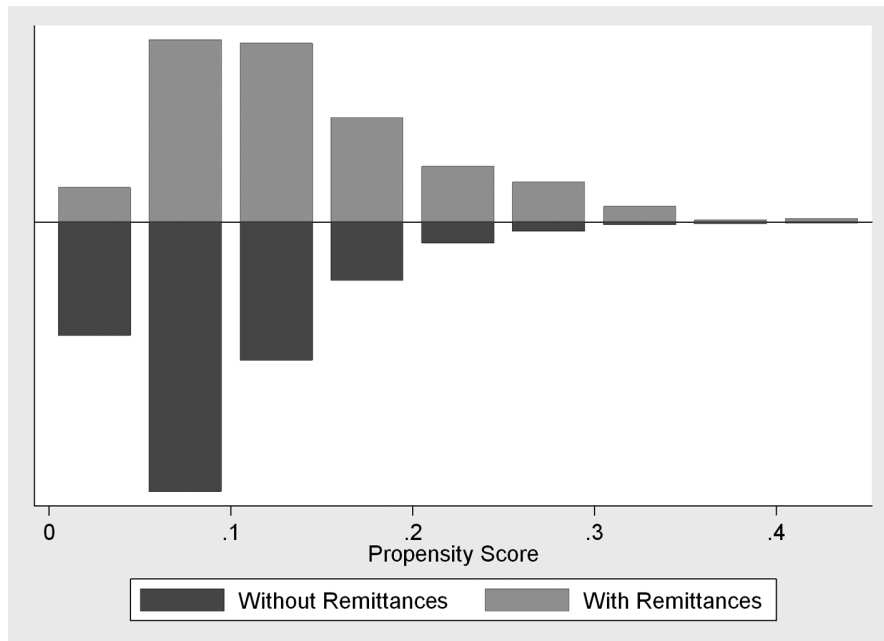


Figure 2 represents the differences in terms of participation in the labour market of the two groups of remittance-receiving and non remittance-receiving households, conditional to the covariates.

In order to answer the question posed at the beginning of the article, I examined the difference in the probability of not working and hours of work per week. I grouped the data into three categories; treated individuals; non-treated individuals; and matched control individuals. There are a total of 1 268 treated, or remittance-receiving, household members. However, the common support is made of 953 household members.

Table 3 sets out the differences between treated and matched controls and tests their significance. There is an expected difference between treated and non-treated individ-

uals, either in terms of the probability of not working or in the quantity of hours worked per week.

However, the most important difference as far as we are concerned is the one between treated individuals and the matched control. The comparison between a remittance-receiving individual and a non remittance-receiving individual does not give us an insight to comprehend completely the issue of labour market participation. This is why we need an individual that is, in every dimension, exactly alike to the individual who is receiving remittances (other than for the receipt of remittances). This is the matched control. Table 3 shows that the difference between matched and treated males is not statistically significant. In the case of women, the probability of not participating in the labour market is greater for those receiving remittances; this difference is not sufficiently large in relation to its standard error to conclude that there is a significant difference in this probability. However, the receipt of remittances does affect the number of hours worked by women, who are found to work around three hours fewer per week where they receive remittances. This difference is statistically significant.

The propensity score matching method accounts for endogeneity because it captures the unobservable characteristics which distinguish remittance-receiving households from non remittance-receiving ones.

Table 3 – Descriptive statistics for treated, non-treated and matched groups

	Treated	Not treated	Test of diffs.	Matched	Test of diffs.
Male					
Not in the labour force	.214	.165	.048 (.019)**	0.213	.011 (.044)
Hours per week	42.623	45.307	-2.684 (.616)***	44.793	-2.171 (2.023)
Female					
Not in the labour force	.486	.428	.058 (.025)**	.483	.003 (.011)
Hours per week	41.486	43.011	-1.524 (.666)**	44.357	-2.871 (1.192)**

Note: ***, **, and * indicate statistical significance respectively at the 1, 5 and 10 per cent levels, or better.

Empirical results show that the receipt of remittances among men does not have any impact on the probability of working or the number of hours worked per week. The receipt of remittances does, however, seem to have an impact on the labour market behaviour of women, because they reduce their hours worked in the presence of remittances.

Conclusions and comments

This article analyses whether the receipt of remittances has any effect on labour market participation. I used the propensity score matching procedure to assess the relationship between remittances and the probability of participating in the labour market.

The results show that remittances do not alter the behaviour of men as regards their labour force participation or the number of hours they work per week. However, there is a statistically significant change in the labour market participation of women. Women who work appear to reduce their hours worked by 2.8 per week. A possible explanation for this is that remittances increase the reservation wage for women. Another explanation may be related to the departure of a family member potentially increasing the need for a greater presence in the domestic environment.

It is important to highlight that remittances are received by households with significant differences in characteristics. According to the statistical test of mean differences, remittances are more likely to be received by older people living in the rural area of the country. Remittance-receiving household members tend to have fewer years of schooling. Being older and less educated puts people in a bad position in the labour market, even without the presence of remittances.

Furthermore, micro aspects of the distortion in labour market participation due to the presence of remittances may be an explanation for the macro dynamics of the labour market. During the last two decades of the open economy era for Albania, there has been a paradox in the relationship between the growth rate and the unemployment rate. Increasing trends as regards economic growth have not been accompanied by an increase in the size of the labour market. This can be considered to be a consequence of remittances: these capital flows discourage participation in the labour market without decreasing the unemployment rate but, on the other hand, they do encourage the consumption of goods and services.

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Annex

The estimation framework

The relationship between remittances and labour market participation has been examined before for Albania, but the methodology in this article differs from previous attempts. The comparison between remittance-receiving households and those who are not in such a position leads to an identification problem because the presence of remittances may be correlated with unobserved determinants of participation among household members. To overcome this potential bias, I use propensity score matching to find a comparison group for individuals in remittance-receiving households.

The question arises because I would like to capture the difference between the household member's participation in the labour market with and without remittances. It is obvious that we cannot observe both outcomes for the same member at the same time. Taking the mean outcome of non-participants as an approximation is not advisable, since participants and non-participants usually differ even in the absence of treatment (Caliendo and Kopeinig, 2005). This problem is known as selection bias. The matching approach is one possible solution to this problem.

Heckman's (1974, 1978, 1979) sample selection model was developed using an econometric framework for handling limited dependent variables. Heckman's original model focused on the incidental truncation of a dependent variable. Maddala (1983) extended the sample selection perspective to the evaluation of the effectiveness of treatment. The treatment effect model differs from the sample selection model in two respects: firstly, a dummy variable indicating the treatment condition w_i ($w_i = 1$ if the participant i lives in the remittance-receiving household, and $w_i = 0$ otherwise) is directly entered into the regression equation; and, secondly, the outcome variable y_i of the regression equation is observed for both $w_i = 1$, and $w_i = 0$. Specifically, the treatment effect model may be expressed in two equations:

$$\text{Regression equation: } y_i = x_i\beta + w_i\delta + \varepsilon_i$$

$$\text{Selection equation: } w_i^* = z_i\gamma + u_i, \quad w_i = 1 \text{ if } w_i^* > 0, \text{ and } w_i = 0 \text{ otherwise}$$

$$P(w_i = 1|z_i) = \Phi(z_i\gamma) \text{ and } P(w_i = 0|z_i) = 1 - \Phi(z_i\gamma)$$

where ε_j and u_j are bivariate normal, with mean zero and the covariance matrix

$$\begin{bmatrix} \sigma_\varepsilon & \rho \\ \rho & 1 \end{bmatrix}$$

This article estimates the probability of receiving remittances as a function of individual and household characteristics; ranks remittance-receiving and non-receiving individuals by their propensity score; pairs those individuals with similar propensity scores; and calculates the average difference in labour force participation between them.

The focus will be on a comparison of the labour market participation of individuals exposed to no treatment (non remittance-receiving households) and the labour market participation of individuals exposed to treatment (remittance-receiving households). Only one of these two outcomes may be observed for each individual, so I estimate the difference in labour market participation between those treated and those with the same probability of being treated (Ichino and Mealli, 2005).

Propensity score enables the use of one-dimensional nonparametric regression techniques to estimate the average treatment effect. Rosenbaum and Rubin (1983) showed that, if treatment assignment and potential outcomes are independent conditional to covariates X , then they are independent conditional on a one-dimensional propensity score, which is the probability of treatment given X . Hence, instead of regressing on all covariates X , it is sufficient to regress on this propensity score to avoid selection bias.

The propensity score is:

$$p(x) \equiv P(D=1 | X=x) = E(D | X=x)$$

where:

$$p(X) = F(h(X_i))$$

$F(\cdot)$ can be the normal or the logistic cumulative distribution,

$D = 1$ if the subject is treated (receives remittances) and 0 otherwise, and

X_i is the vector of pre-treatment characteristics.

Rosenbaum and Rubin (1983) established the following conditions to estimate the Average Treatment on the Treated (ATT) effect based on propensity score:

Condition 1: The Balancing Hypothesis

$$D \perp X | p(X)$$

This means that, for observations with the same propensity score, the distribution of pre-treatment characteristics must be the same across the control and the treated group. That is, conditional on the propensity score, each individual has the same probability of assignment to treatment, as in a randomised experiment.

Condition 2: 'Unconfoundedness' given the propensity score

Suppose the assignment to treatment is 'unconfounded':

$$Y_1, Y_0 \perp D | X$$

Then, assignment to treatment is 'unconfounded', given the propensity score:

$$Y_1, Y_0 \perp D | p(X)$$

The matching methods

The estimate of the propensity score is not enough to estimate the ATT of interest. The reason is that the probability of observing two individuals with exactly the same value of propensity score is, in principle, zero since $p(X)$ is a continuous variable (Becker and Ichino, 2002). To overcome this problem, the most widely-used techniques are nearest neighbour matching, radius matching, kernel matching and stratification matching.

The nearest neighbour method consists of matching each treated (i.e. remittance-receiving) individual with the control (non remittance-receiving) individual that has the closest propensity score. The method is usually applied with replacement in the control units. The nearest neighbour matching estimator sorts all records by the estimated propensity score, and then searches forwards and backwards for the closest control units. Treated i is matched to non-treated j , such that:

$$|p_i - p_j| = \min_{k \in \{D=0\}} \{|p_i - p_k|\} .$$

If, for a treated unit, forwards and backwards matches happen equally well, then either the forwards or the backwards match will be drawn. Nearest neighbour matching with a replacement will be used, in cases where an individual can be used more than once as a match. Matching with a replacement involves a trade-off between bias and variance (Caliendo and Kopeinig, 2005). With replacement, the average quality of the matching will increase and the bias will decrease. On the other hand, this increases the variance of the estimator (Smith and Todd, 2005). With the nearest neighbour method, each treated unit has a match, but this is not necessarily the best match since we are looking for the closest.

A solution to the problem is to define a neighbourhood within which a match can be considered. This method is called radius matching. The selection of the radius should be appropriate, since a very small radius can reject the treated observation.

The kernel estimator compares the outcome of each treated unit to the average outcome of a group of non-treated individuals, in which the weight of each individual in the comparison group is proportional to the individual's closeness to that in the comparison group. Kernel and local linear matching are non-parametric matching estimators that use the weighted average of all individuals to construct a counterfactual outcome.

Kernel matching associates, to the outcome y_i of treated i , a matched outcome given by the kernel-weighted average of the outcome of all non-treated points, where the weight given to the non-treated j is in proportion to the closeness between i and j :

$$\hat{Y}_j = \frac{\sum_{j \in D=0} K\left(\frac{P_i - P_j}{h}\right) Y_j}{\sum_{j \in D=0} K\left(\frac{P_i - P_j}{h}\right)}$$

Control j 's outcome Y_j is weighted by:

$$w_{\hat{j}} = \frac{K\left(\frac{P_i - P_j}{h}\right)}{\sum_{j \in D=0} K\left(\frac{P_i - P_j}{h}\right)}$$

where h is the closeness of the matches.

The weights depend on the distance between each individual from the control group for which the counterfactual is estimated. The application of kernel matching needs to choose the kernel function and the bandwidth parameter. The second appears to be more important, with high bandwidth values leading to a better fit and a decreasing variance between the estimated and the true density function. The difference between kernel and local linear matching is that the second includes, in addition to the intercept, a linear term in the propensity score of a treated individual. This seems to be an advantage when the comparison group is distributed asymmetrically around the treated individuals, e.g. when there are gaps in the propensity score distribution (Caliendo and Kopeinig, 2005).

Another method, consisting of the division into intervals of the range of the variation of propensity score, is stratification matching. Within each interval, treated and control individuals have, on average, the same propensity score.

The set of covariates includes the following individual and household characteristics: age; age squared; gender; schooling; marital status; and number of children fewer than six in the household; area of residence; region; and income net of remittances.

Sensitivity analysis

The reason for developing propensity scores and then seeking matches is that the data are not usually balanced (Gou and Fraser, 2010); hence, the treatment assignment can not be ignored. After matching on the estimated propensity scores, at least the sample is balanced on the covariates and, therefore, we can conduct multivariate analyses and undertake covariate adjustments for the matched sample, just as in randomised experiments.

Selection bias is sometimes called 'selectivity bias' (Maddala, 1983) or 'hidden bias' (Rosenbaum, 2002b). Selection effects are often categorised on the basis of the source of the bias, such as self-selection, researcher selection, geographic selection,

etc. Whenever an observational study presents selection bias, treatment assignment (i.e. remittances) becomes a matter of great importance.

A variety of techniques have been developed for correcting for selection bias. In this article, I carry out a sensitivity analysis using the Rosenbaum bounds method (Rosenbaum, 2002). The aim of this method is to determine if the average treatment effect may be modified by unobserved variables. This type of analysis seeks to answer the question as to how sensitive are the findings to so-called ‘hidden bias’. According to Rosenbaum (2005), sensitivity analysis addresses the question about what the unmeasured covariate would have to be like to alter the conclusions of the study. Therefore, the fundamental task for this analysis is to derive a range of possible values indicating ‘hidden bias’.

Suppose that there are two units j and k , and that the two units have the same observed covariates x but possibly different chances of receiving treatment π ; that is $\chi_j = \chi_k$, but $\pi_j \neq \pi_k$. Then, units j and k might be matched to form a matched pair or placed in the same sub-class. The probability that units j and k receive the treatment are $\pi_j / (1 - \pi_j)$ and $\pi_k / (1 - \pi_k)$, respectively. The probability ratio is:

$$\frac{\pi_j / (1 - \pi_j)}{\pi_k / (1 - \pi_k)} = \frac{\pi_j / (1 - \pi_k)}{\pi_k / (1 - \pi_j)}$$

Sensitivity analysis assumes that this ratio for units with the same covariates x is, at most, some number $\Gamma \geq 1$, that is:

$$\frac{1}{\Gamma} \leq \frac{\pi_j (1 - \pi_k)}{\pi_k (1 - \pi_j)} \leq \Gamma \quad \text{for all } j, k \text{ with } \chi_j = \chi_k.$$

By the above definitions, if Γ were 1, then $\pi_j = \pi_k$ whenever $\chi_j = \chi_k$, so the study would be free of ‘hidden bias’. If $\Gamma = 2$, then two units that appear similar, and that have the same x , could differ in their chances of receiving the treatment by as much as a factor of 2; so one unit might be twice as likely as the other to receive the treatment.

Rosenbaum’s bound method uses matching estimates to calculate the confidence intervals of the treatment effect, for different values of Γ . If the lowest Γ producing a confidence interval that includes zero is small (i.e. less than two), it is likely that such an unobserved characteristic does exist and, therefore, that the estimated treatment effect is sensitive to being unobserved.