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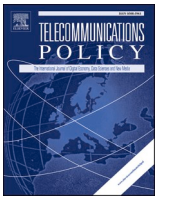

The impact of digitalisation on remittances. Evidence from El Salvador

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ABSTRACT

This paper carries out a microeconomic analysis of the determinants of remittances from a receiving perspective in El Salvador. Specifically, using data from the '*Encuesta de Hogares de Propósitos Múltiples of 2016*' (2016 Multi-purpose Household Survey -EHPM16), the characteristics of households that affect the reception of remittances in El Salvador in 2016 were analysed, focusing on the level of digitalisation in households. Determinants of remittances are not everlasting and are affected by social and economic changes. In this sense, the effect on remittances caused by an increase in the widespread use of Information and Communication Technologies (ICT) is not an exception. Based on a two steps selection model, the results point out that the household's level of digitalisation significantly increases the probability of receiving remittances, not their amount.

1. Introduction

In recent decades, there has been an increase in the widespread use of Information and Communication Technologies (ICT). Their development has been so prodigious that they have become one of the main vectors of economic and social activity, not only in developed countries, but also in developing countries. There is a growing literature that has analysed the connection between digitalisation and economic growth. For example, Lee et al. (2012) showed that the greater expansion of mobile telecommunications was an important determinant of the rate of economic growth in sub-Saharan Africa. Bojnec and Ferto (2012) found that the improved internet access channels per inhabitant and gross capital growth played a positive and significant role in the growth of the gross domestic product (GDP) per capita. This was because the use of ICT changed the ways of carrying out transactions through electronic commerce, the flexibility of banking operations and the improvement of communications.

This digitalisation helps to improve access to financial services, which could have a positive effect on remittances, established as one of the main sources of financing developing countries, more than official aid and foreign direct investment (Alvarez et al., 2015; Ratha, 2003; Tabit & Moussir, 2016). Bettin et al. (2017) found that remittances increase with the number of bank branches per inhabitant and decrease with the functional distance of the provincial banking system from the receiving province. In this sense the flexibility of banking operations due to digitalisation can reduce dependence on bank branches.

Furthermore, the improvement of access to financial services due to digitalisation is an opportunity to reduce costs (Rodima-Taylor and Grimes, 2019) and enhance financial inclusion, redirecting informal flows to formal channels (Emara & Zhang, 2021).

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Particularly, Guermond (2022) shows the effect of the digitalisation of remittances received in the advancement of digital financial inclusion in Ghana. Ratha and Shaw (2007) established that South-South remittance costs tended to be high due to the lack of competition in the remittance market in both the sending and the receiving countries. Transactional cost is an important determinant of remittance flow, and a reduction could improve workers' willingness to send remittances. Ahmed and Martínez-Zarzoso (2016), using panel data on remittance flows to Pakistan from 23 host countries, found that the effect of transaction costs on remittance flows was negative and significant. The same conclusion was established by Schiopu and Siegfried (2006) who examined bilateral flow from 21 Western European countries to seven EU neighbouring countries and found that remittances increased when remittance cost was lower. Freund and Spatafora (2008), using panel data from 104 countries in 1995–2003, pointed out that countries with high transaction cost experience larger informal remittance flows. They also explained that the increase in remittances in Latin America since 1995 is due to a greater use of formal channels compared to informal ones, given the developments of FinTech and the reduction of costs in the financial sector. High transaction costs implied not only a smaller volume of remittances, but also an increase in the use of informal channels for sending.

Digitalisation telecommunication services would enable cheaper, more accessible and flexible communication, thus helping to improve the link between migrants and their household (Engbersen & Dekker, 2014; Withaeckx et al., 2015).

Literature has studied in depth both macroeconomic and microeconomic determinants of remittances. However, the digitalisation factor was not introduced until recently, and it has only been analysed only from a macroeconomic perspective.

Macroeconomic studies usually focus on the number of workers, wage rates and the economic situation in the host country, the economic situation in the country of origin, the exchange rates and relative interest rate between the sending and receiving country, as well as the political risk and ease with which funds may be transferred (i.e. institutions) (Hagen-Zanker & Siegel, 2007).

Emara and Zhang (2021) examined the impact of digitalisation over the 2004–2018 period, as a proxy of Fintech, on the inflow of remittances for a sample of 34 developed and developing countries. Using the Digital Ecosystem Development Index developed by Katz and Callorda (2018), they found a nonlinear relationship between the improvement in digitalisation measures and the inflow of remittances with a specific threshold level for Brazil, Russia, India, China and South Africa. Initially, digitalisation increased remittance inflow, but once the digitalisation index reached its threshold level, further improvement in digitalisation tended to drop as penetration increased, leading to a decline in the rate of remittance inflow.

Gniniguè and Ali (2021) studied the role of digitalisation in the effect of remittances on economic growth in members of the Economic Community of West African States (ECOWAS) from 1980 to 2017. They pointed out a different effect from West African Economic and Monetary Union countries (WAEMU) (a sub-regional block of ECOWAS) where digitalisation did not have any effect, and non-WAEMU countries where digitalisation constituted a catalyst of the effects of remittances on economic growth.

Microeconomic studies have been based on household surveys that include remittance-receiving households (Gubert, 2002) or specific surveys on the migrants themselves, either in the home country (Amuedo-Dorantes & Pozo, 2006) or in the destination country (Aísa et al., 2011; Holst & Schrooten, 2006, p. 477). The lack of a dataset that includes information about remittances and digitalisation may be the main reason for the lack of microeconomic studies on this subject.

Depending on the type of survey, analyses can include variables about migrant characteristics, which reflect a sending perspective, and variables about household characteristics, which show a receiving one. There is extensive literature that studies how migrant characteristics influence the probability of sending remittances and the amount. Migrants' income, education, duration of migration, and gender have been found to be important determinants of remittances (Amuedo-Dorantes & Pozo, 2006; Craciun, 2006; Hoddinott, 1994). There is less literature that has studied the influence of the characteristics of receiving households. The variables included are: number of members, household income, location or information about the head of the household (Biyase & Tregenna, 2016, p. 176; Pardo-Montaño & Dávila-Cervantes, 2017; Samson, 2011). There are also papers that combine both types of variables (Durand et al., 1996; Lucas & Stark, 1985).

In contrast to Neoclassical Economics that considered migration as an individual optimising choice related to the difference between costs, and the benefits of migrating (Todaro, 1969), the New Economics of Labour Migration (NELM) contemplate the family instead of the individual as the relevant decision-making unit. Consequently, migration is considered a strategy for not only maximising expected earnings, but also diversifying the source of income, reducing income risk and overcoming barriers to credit and capital (Stark, 1978; Stark & Levhari, 1982). Taking into account the family as a decision-making unit, Lucas and Stark (1985), who initiated the current debate on the motivation to remit, established three theoretical motives for sending remittances: self-interest, altruism and tempered altruism.

Therefore, the decision to send remittances is also made in the household environment (Funkhouser, 1995) and, as a result, the characteristics of the migrant's household could be key when deciding whether or not to send remittances and the amount.

Samson (2011) examines the factors that affect the propensity to receive remittances and the value of those received in the Philippines. Her results suggest that household income has a negative effect. So, whenever there is an increase in the household income, it is less likely to receive remittances.

Based on a national survey, Pardo-Montaño and Dávila-Cervantes (2017) studied the characteristics of households and heads of households that influenced the propensity to receive domestic and international remittances in Mexico in 2014. They found that spending patterns on basic necessities, health and education were different if the households received internal or international remittances, or they did not receive any. However, to our knowledge, there is no literature analysing the effect of digitalisation on remittances, using the household as the unit for the analysis.

In this paper, we study this problem in one of the main receivers of remittances from the United States: El Salvador. According to World Bank 2016 Bilateral Remittance Matrix, $573 billion in remittances was sent in 2016 and $138 billion was sent from United States, being the main sender of remittances in the world. The main receiving region was Latin America, which received 41.49% of

these flows from the United States, followed by East and South Asia with 37%. If these amounts are taken in relation to the receiver country GDP, El Salvador, which received a 3% of all remittances sent from the United States, was the first receiver from United States with remittances that represented 17.33% of their GDP. Furthermore, regardless of the sending country, this country received the highest percentage of its GDP in remittances in Latin America, 18.86% (see Fig. 1).[1]

In addition, in 2016, El Salvador received $4.56 billion in remittances and the trend has been growing over recent years. There was a peak in the financial crisis of 2008, confirming the theory that there are more remittances in economic crises as an attempt to compensate (see Fig. 2). Frankel (2010), among other authors, documented that remittances responded positively to the cyclical position in the sending country and negatively to the cyclical position in the receiving country. In this way, remittance flows increased when the home-migrant economy was in recession and decreased when it was growing.

All this shows that El Salvador remittances are a relevant source of income for the country. For this reason, it is necessary to study the remittance enhancing factors.

Some years ago, Funkhouser (1995), using a dataset from 1987, studied the characteristics of households that affect the remittances received, by comparing El Salvador and Nicaragua. This paper also introduced variables about emigrants like family relationships, year of emigration, gender, age, labour status in the United States, living arrangements in the United States and variables about the characteristics of the household, region of the household, head of the household's employment status and number of adult emigrants. However, it would be a mistake to think that remittance determinants and their effect on the probability of receiving remittances and the amount received behave in a constant manner over different periods. Digitalisation is one of the most prominent processes of the last decade. However, there is a large gap between developed countries and developing countries, even among Latin American countries. As shown in Fig. 3, the countries that had the largest values of the remittances in respect to their GDP were below the average of Latin America and the Caribbean in terms of the percentage of population who used the internet. Specifically, only 29% of the population from El Salvador were internet users in comparison to an average of 57.23% in Latin America and the Caribbean[2] in 2016.

However, El Salvador population using the internet has increased significantly in the last decade, which means it is necessary to include its effect in the analysis. Against this background, the main contribution of this paper is to analyse the effect of digitalisation in remittances from a microeconomic perspective and, considering the receiving household characteristics in El Salvador that, as commented above, has been one of the main receivers of remittances from the United States, which represent a relevant source of income for the country. All this turns it into an excellent case study for analysing the effect of digitalisation in remittances.

The rest of the paper is organised as follows. The next section describes the database, methodology and shows some descriptive statistics. Section 3 displays the results. Finally, main conclusions are summarised in Section 4.

2. Materials and methods

2.1. Database description

The information for this study comes from the '*Encuesta de Hogares de Propósitos Múltiples of 2016*' (2016 Multi-purpose Household Survey -EHPM16) from El Salvador. The EHPM16 was carried out at national level in the country's 14 departments and covers urban and rural areas, and provides high quality data on remittances and digitalisation.

The EHPM16 includes information about households, their members, employment, income, expenses, housing conditions, health, education, migration, remittances received and, also includes an information technology and communication section.

The survey has information on 20,609 households in El Salvador and their members, although in our study we only include those for which reliable information is available: 20,282 households.[3] It shows 24.5% of households (4987 households) that receive remittances.

2.2. Methodology

In order to study the impact of digitalisation on remittances flows, the following model is proposed:

$$\text{Remittances}_i = f\left[\text{Household}_i\ , \text{Digitalisation}_i\right] + \epsilon_i$$

where f is a function, Remittances_i is the dependent variable and measures the remittances received by the i-th household; Household_i variable refers to the i-th household characteristics, and Digitalisation_i shows the level of digitalisation of the i-th household.

Remittances is a mixture of a discrete (zero remittances) and a continuous (positive remittances) variable. In this sense, literature has raised two options: one stage-decision or two stage-decision. The first considers that the decision to remit and the decision on the amount to be remitted are made simultaneously. A Tobit model is applied to treat the remitting process as one-stage decision in which

[1] Other countries (Haití, Honduras) were in a similar situation to El Salvador but with lower net migration rates (−7.6% in El Salvador, −3.2% in Haíti and −0.7% in Honduras, respectively) such that El Salvador was the non-island country with the highest net emigration in the American continent (UNdata | record view | Net migration rate (per 1,000 population). This highlights the necessity of a differentiated study for El Salvador.

[2] Led by Chile 83%, Argentina 70% and Puerto Rico 68%.

[3] In EHPM16 the interviewer analyses the reliability of the information.

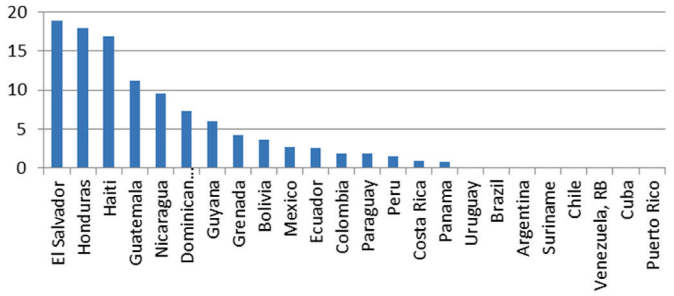

Fig. 1. Personal remittances, received in 2016 (% of GDP).
Source: World Bank

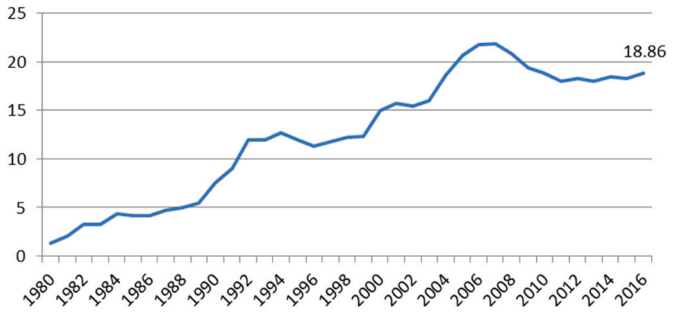

Fig. 2. Personal remittances, received (% of GDP).

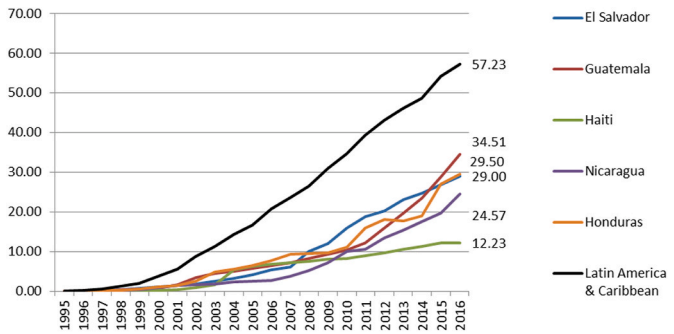

Fig. 3. Internet Individuals using the (% of population).

both decisions are explained by the same factors. This method is followed, for example, by Brière et al. (1997), Brown (1997), Cox et al. (1998), and Schrieder and Knerr (2000).

The second considers that the remitting process is formed by a two-stage sequential decision process: first the decision to remit and second the decision on how much to remit. In this case, the two steps selection approach is applied: the first decision is modelled using a Probit model and the second decision by a Linear Regression Model. This method corrects the estimation bias of the regression coefficients of the sample selection using the correction proposed by Heckman (1976). It allows the effects and the set of explanatory variables on the decision to remit to be different from the set of explanatory variables and their effects on the level of remittances. This approach is followed by Agarwal & Horowitz, 2002, Funkhouser (1995) and Hoddinott (1992, 1994), among others, and it is the preferred method of literature (Biyase & Tregenna, 2016, p. 176). Biyase and Tregenna (2016, p. 176) analysed the probability and level of domestic remittances in South Africa over the period 2008, 2014 and 2015 using information of the National Income Dynamics Survey and they found different effects. They analysed the age, gender, race, educational level, employment status of the head of the household and the area of the household. They found that the determinants of the probability of remitting are not the same and/or do not have the same type of effect as the determinants of the level of remittances. For example, the gender of the head of the household and size of the household had a positive effect on the probability of remitting, but a negative effect on the amount remitted.

Furthermore, ignorance of possible endogeneity issues between economic digitalisation and remittances due to the possible existence of a reverse causality problem, omission of relevant variables (labour conditions of the migrants as labour hours, wages, etc)

and the inclusion of dynamic effects,[4] may lead to a serious estimation error (Beyzatlar et al., 2014). To guarantee the validity of the econometric analysis, an instrumental variable regression analysis was adopted.

Gutiérrez and Gamboa (2010) concluded that education is the main determinant of ITCs. For this reason, two instrumental variables related to household education were selected: secondary education and higher education of household members. These variables represent the percentage of household members over 17 years who have middle school[5] or higher education,[6] respectively.

2.3. Variables and descriptive statistics

Based on the review of the literature on remittance determinants and on the availability of variables in EHPM16, the independent variables used in this study are defined in Appendix A. Appendix B[7] shows the results of a comparative descriptive statistical analysis of these variables by distinguishing between households that received remittances and households that did not receive remittances. There are statistically significant differences in all the variables. In general, we can see that households that receive are more digitalised (for instance 24.99% of the households that receive remittance use the internet vs 21.94% of the households that do not receive); furthermore, most of them are in the north of El Salvador (28.96% vs 12.85%) and rural areas (45.26% vs 34.03%).

The average number of migrants in each group of households is also significantly different: receiving households have an average of 1.87 migrated members while non-receivers have 1.53. Fig. 4 shows the proportion of receiving and non-receiving households according to the number of migrants. In households without migrants, only 11.87% of households receive remittances. This percentage increases significantly if the household has migrants: with one migrant, remittances are received by 75.54% of households, with two migrants 83.55% of the households receive remittances and with three or more migrants, 87.16%. Therefore, the number of the migrant's family members exerts a positive influence on sending remittance.

The '95% of family members abroad' reside in USA, less than 2% reside in Mexico, Australia, Canada or Spain, and the rest in other unspecified countries. This homogeneity of the destination countries does not allow us to exploit the available information about the level of financial development in the country of residence of the migrant. Additionally, 26.76% of rural households receive remittances, whereas only 18.56% of urban households receive them. According to literature, localisation is relevant for receiving remittances. Biyase and Tregenna (2016, p. 176) found that households in urban and farm areas were less likely to receive remittances than households in traditional rural areas. The reason could be that rural areas are characterised by higher poverty and unemployment levels. This idea links with the effect of income: non-receiving households have a higher average monthly income per capita ($166.01) than receiving households, which earn $115.02. The main literature found a significant negative effect on income (Agarwal & Horowitz, 2002; Germenji et al., 2001, pp. P97–8158; Osaki, 2003; Samson, 2011), so poorer households are more likely to receive remittances. However, there is literature that shows a positive effect on the probability of receiving remittances (Biyase & Tregenna, 2016, p. 176).

The average number of members of receiving households is equal to 3.52 while that of non-receiving household is equal to 3.68 members. A positive sign is expected based on literature (Amuedo-Dorantes & Pozo, 2006; Banerjee, 1984; Biyase & Tregenna, 2016, p. 176; Lucas & Stark, 1985; Massey & Basem, 1992).

As regards the head of the household's gender, in 47.4% of receiving households it is a woman versus 33% in non-receiving ones. They are also older in receiving households: the mean age is 54, whereas it is 48 in non-receiving households. Literature found that a household with a female head is more likely to receive remittances (Biyase & Tregenna, 2016, p. 176; Pardo-Montaño & Dávila-Cervantes, 2017). However, the age does not have a clear effect: Biyase and Tregenna (2016, p. 176) found a negative effect, whereas Pardo-Montaño & Dávila-Cervantes (2017) found a positive effect, albeit only for domestic remittances. As for higher education, in receiving households a lower percentage of household heads have higher studies (5.9%), compared to non-receivers (9.29%).

Furthermore, 15.1% of households that receive remittances have a child whose father, mother or both have emigrated, compared to 0.7% of non-receiving households. In addition, 17.6% of the members of receiving households have been sick versus 14.4% in non-receiving households.

Regarding household digitalisation variables, the availability of EHPM16 data and the indicators used to measure the household digitalisation pillar in the digital ecosystem index developed by Katz and Callorda (2018) have been taken into account. The percentage of household members who use the internet has been selected as the main variable because it is one of the 64 indicators used by these authors. In receiving households, a mean of 25% of their members used the internet while the mean was 21.9% in non-receiving homes.

3. Results

This section analyses the impact of household characteristics and the level of digitalisation on remittances.

[4] We thank the three reviewers of the paper for pointing out these potential problems in the estimation process.

[5] Middle school includes tenth to thirteenth grades (first, second and third year of high school, including those who complete high school in 4 years).

[6] Both university and non-university. University includes careers in which doctorate, master's, postgraduate, bachelor's, engineering and/or architecture degrees are obtained and non-university includes technical careers levels that require high school as a minimum requirement (includes social work, teachers, agronomist and nursing) and taught in institutes or universities.

[7] HH refers to household and HHH to head of household.

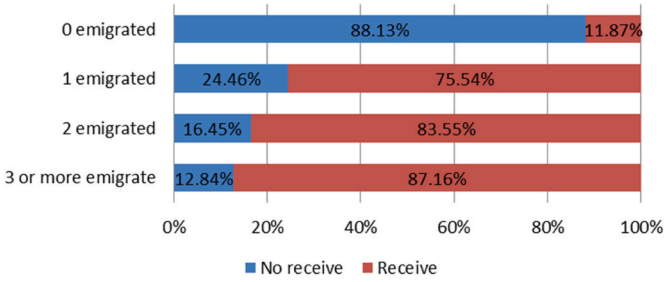

Fig. 4. Receiving and non-receiving households according to number of emigrated members.
Source: EHPM16.

The estimation of the model parameters was carried out using the Stata 15 program.[8] The results are reported in Table 1 (Model 1) where we show the coefficients of the probit model used as selection equations and the coefficients of the main regression while Appendix C shows the estimated first-stage regressions models of the 2SLS method used to correct the bias in the estimation of the parameters of the two-stage decision model.

The main regression shows the marginal effects of each independent variable on the logarithm of the amount of remittances received by households; the selection equation shows the estimated coefficients of a probit model, which predicts if a household receives remittances or not. Furthermore, average probit marginal effects are reported in Table 2 (Model 1). In all models, the χ^2 Wald test rejects the hypothesis that all the coefficients in the regression model (except the constant) are 0. In addition, the χ^2 Wald exogenity tests rejects the exogeneity hypothesis of the digitalisation indicator (the percentage of household members who use the internet has been selected) in the probit model used to estimate the probability of receiving remittances (see Table 1), confirming the endogeneity of economic digitalisation and the need to use instrumental variables. The analysis of these results indicates the validity of the instruments, given that the coefficients of the instrumental variables in the first-stage regression models are significant and have the expected positive sign (see Appendix C) and, in the case of the second-stage linear regression of the main model, the test of endogeneity and overidentifying restrictions do not find any significant results (see Table 1).

It can be observed that digitalisation of households, measured as the percentage of family members who use the internet, has a significant and positive effect on the probability of receiving remittances. Specifically, if there is a 1% increase in the proportions of household members that use the internet, the probability of receiving remittances is expected to increase by 0.13% (Table 2). However, with respect to the amount they receive, and although the estimated effect is also positive, it is not significant (see Table 1).

It is also worth noting that the effect of the HH_North variable[9] in the selection model is significant positive. According to Model 1, if the household is in the North, on the Honduras border, the probability of receiving remittances is expected to increase a 6,41% (see Table 2).

In general, the rest of independent variables have the expected sign based on literature. Having emigrated member in the family affects positively to the probability of receiving remittances by increasing it a 30.10% if the household has one emigrant, a 35.15% if it has two emigrants and a 36.53% if it has three emigrants (Table 2). Regarding the amount received, positive effects are also estimated, but there is no significant effect.

Regarding rural results, rural households tend have higher probability of receiving remittances (Table 1) with an expected increase of 0.31% (Table 2) but they received −20.26% (Table 1) less than urban households. This result agrees with the results obtained by Rodriguez and Horton (1995).

Household per capita income has a significant negative effect on the probability of receiving but not in the amount received, specifically, a 1% increase in monthly income reduces the probability of receiving remittances by 7.95% (Table 2).

Household size has a significant negative effect on the probability of receiving remittances: one extra member reduces the probability by 1.01% (Table 2), while it has a significant positive effect on the amount, which grows by 4.68% (Table 1). If the household lives in a rented home, this fact is only significant in the selection equation and the probability of receiving remittances is expected to increase by 2.81% (Table 2).

If the head of the household is a woman, it is more likely that they receive remittances (expected probability increases by 1.26%, see Table 2). The positive effect on the probability of receiving remittances is in accordance with Biyase and Tregenna (2016, p. 176), It is

[8] We use the ivprobit (resp. rbiprobit) program to estimate the probability that a household receives remittances using a probit model with continuous endogenous covariates (resp. discrete), and the ivregress program to fit a linear regression model where one or more of the regressors are determined endogenously to estimate the logarithm of the amount of remittances received by a household. To correct the selection bias, we incorporated the Mill's lambda calculated with the previous probit model as an additional regression.

[9] It is chosen as an exclusion restriction variable, by highlighting the fact that households living in the north of El Salvador have a greater probability of receiving remittances due to their proximity to Honduras border area. However, this location does not affect the amount received due to the lower cost of crossing the borders to work. The probability of receiving remittances for those residing in the North is 37%, while this percentage decreases to 19% for those outside the area. But the mean of the log remittances is 4.75 and 4.73 respectively for those in and out of the North and there is no significant difference between the means for both subsamples using the *t*-test.

Table 1
Two steps selection models (coefficients of the probit selection equation and of the main regression).

VARIABLES	Model 1		Model 2		Model 3		Model 4	
	Selection	Main regression	Selection	Main regression	Selection	Main regression	Selection	Main regression
HH_North	0.3472***		0.2977***		0.3107***		0.4614***	
	(0.0306)		(0.0343)		(0.0254)		(0.0477)	
HH_emigrated_members_1	1.5245***	−0.1694	1.0401***	0.0518	1.6337***	−0.2512*	1.4078***	−0.5156
	(0.0734)	(0.2293)	(0.1750)	(0.6591)	(0.0402)	(0.1481)	(0.1768)	(1.0135)
HH_emigrated_members_2	1.7554***	−0.0758	1.1374***	0.1532	1.9698***	−0.1753	1.8187***	−0.5277
	(0.1220)	(0.2434)	(0.2308)	(0.6602)	(0.0678)	(0.1574)	(0.2803)	(1.2204)
HH_emigrated_members_3	1.8500***	0.1950	1.0679***	0.4122	1.9285***	0.1219	1.7811***	−0.4433
	(0.1045)	(0.2454)	(0.2398)	(0.6031)	(0.0676)	(0.1579)	(0.4207)	(0.9615)
HH_rural	0.0862*	−0.2026**	0.0716**	−0.1706	−0.0111	−0.2037**	0.0503	−0.3936**
	(0.0449)	(0.0849)	(0.0364)	(0.1379)	(0.0296)	(0.0841)	(0.0615)	(0.1803)
HH_ln_income	−0.4477***	−0.0700	−0.4552***	−0.1156	−0.4112***	−0.0601**	−0.3601***	0.0079
	(0.0232)	(0.0458)	(0.0189)	(0.1490)	(0.0133)	(0.0288)	(0.0491)	(0.2003)
HH_size	−0.0623***	0.0468***	0.0892***	0.0689	−0.0486***	0.0453***	−0.0760***	0.0203
	(0.0094)	(0.0123)	(0.0207)	(0.0956)	(0.0067)	(0.0127)	(0.0223)	(0.0490)
HH_rent	0.1318**	0.0548	0.0639	0.0708	0.1666***	0.0530	0.0522	0.0642
	(0.0610)	(0.0984)	(0.0585)	(0.1041)	(0.0399)	(0.0988)	(0.0924)	(0.1824)
HHH_gender	0.0491	0.0654	0.1000***	0.0852	0.1292***	0.0463	0.0016	0.0454
	(0.0373)	(0.0432)	(0.0316)	(0.0773)	(0.0247)	(0.0432)	(0.0719)	(0.1109)
HHH_age	0.0076***	0.0022	0.0057***	0.0034	0.0042***	0.0015	0.0058***	0.0072
	(0.0012)	(0.0032)	(0.0009)	(0.0057)	(0.0007)	(0.0015)	(0.0019)	(0.0077)
HHH_high_education	−0.2298*	0.2357	−0.0403	0.2027	0.1062	0.2257	−0.2243	0.6069***
	(0.1248)	(0.1659)	(0.0803)	(0.1734)	(0.0647)	(0.1470)	(0.2625)	(0.2187)
HHH_children_emigrate_parents	0.6357***	0.2754***	0.6184***	0.3494	0.6168***	0.2833***	0.6455***	0.2769
	(0.1064)	(0.0622)	(0.1048)	(0.2491)	(0.0641)	(0.0524)	(0.2198)	(0.3524)
HHH_ill_members	0.0012**	−0.0031***	0.0015***	−0.0029***	0.0010***	−0.0031***	0.0016*	−0.0056***
	(0.0006)	(0.0007)	(0.0005)	(0.0011)	(0.0004)	(0.0007)	(0.0009)	(0.0022)
HH_useinternet	0.0144***	0.0002					0.0166***	−0.0045
	(0.0028)	(0.0046)					(0.0042)	(0.0117)
HH_number_mobile			2.6433***	0.4631				
			(0.3257)	(1.8248)				
HH_internet					0.4371***	−0.0180		
					(0.1076)	(0.2909)		
Constant	0.2904**	6.2054***	−1.1023***	5.3153*	0.4497***	6.4067***	−0.0156	7.2085***
	(0.1129)	(0.7385)	(0.2106)	(3.1361)	(0.0827)	(0.3874)	(0.2280)	(2.7585)
Observations	20,282	4987	20,282	4987	20,282	4987	8408	1226
R^2 squared		0.2744		0.2691		0.2788		0.2006
lambda of Mills		−2.8388***		−1.8809		−3.0981***		−4.6507
		(0.9594)		(2.8723)		(0.5977)		(4.3350)
Wald test χ	2551.41	1284.20	4165.16	1284.51	7768.54	1275.79	454.16	464.05
pvalue	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Test of Endogeneity: Selection model								
corr (e.endogvariable,e.HH_received remittances)	−0.2048**		−0.6299***		−0.0575		−0.2294	
	(0.0804)		(0.1032)		(0.0576)		(0.1105)	
Wald test of exogeneity (corr = 0)	6.12		18.76		0.0100		4.01	
pvalue	0.0133		0.0000		0.9204		0.0453	
Test of Endogeneity: main Regression								
Robust score chi2 (1)		0.7288		0.0376		2.7664*		1.6475
pvalue		0.3933		0.8462		0.0963		0.1993
Robust regression F		0.3206		0.0179		1.3827		0.8819
pvalue		0.5713		0.8936		0.2397		0.3479
Test of overidentifying restrictions		0.9261		0.7780		6.4027**		1.9311
pvalue		0.3359		0.3778		0.0407		0.3808

Robust standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.

Table 2
Average marginal effects of the selection equation of the two steps selection model.

VARIABLES	Model 1	Model 2	Model 3	Model 4
HH_North	0.0641***	0.0639***	0.0609***	0.0813***
	(0.0057)	(0.0067)	(0.0050)	(0.0083)
HH_emigrated_members_1	0.3010***	0.3011***	0.3201***	0.2704***
	(0.0096)	(0.0096)	(0.0071)	(0.0282)
HH_emigrated_members_2	0.35156***	0.3562***	0.3860***	0.3493***
	(0.0183)	(0.0177)	(0.0126)	(0.0493)
HH_emigrated_members_3	0.3653***	0.3586***	0.3779***	0.3478***
	(0.0163)	(0.0174)	(0.0126)	(0.0749)
HH_rural	0.0031	−0.0048	−0.0022***	−0.0033
	(0.0085)	(0.0077)	(0.0058)	(0.0110)
HH_ln_income	−0.0795***	−0.0799***	−0.0806***	−0.0571***
	(0.0052)	(0.0095)	(0.0025)	(0.0099)
HH_size	−0.0101***	−0.0039	−0.0095***	−0.0095**
	(0.0018)	(0.0044)	(0.0013)	(0.0042)
HH_rent	0.0281**	0.0292**	0.0326***	0.0135
	(0.0113)	(0.0115)	(0.0078)	(0.0162)
HHH_gender	0.0126*	0.0169**	0.0253***	0.0063
	(0.0069)	(0.0067)	(0.0048)	(0.0128)
HHH_age	0.0011***	0.0009***	0.0008***	0.0008*
	(0.0002)	(0.0002)	(0.0001)	(0.0004)
HHH_high_education	−0.0254	−0.0098	0.0208***	−0.0333
	(0.0236)	(0.0192)	(0.0127)	(0.0463)
HHH_children_emigrate_parents	0.1330***	0.1451***	0.1209***	0.1267***
	(0.0193)	(0.0196)	(0.0125)	(0.0396)
HHH_ill_members	0.0002**	0.0002**	0.0002***	0.0003*
	(0.0001)	(0.0001)	(0.0000)	(0.0002)
iv_HH_middleschool	0.0002***	0.0004***		0.0002***
	(0.0000)	(0.0001)		(0.0000)
iv_HH_highereducation	0.0005***	0.0008***		0.0006***
	(0.0000)	(0.0001)		(0.0001)
HH_useinternet	0.0013**			0.0014*
	(0.0005)			(0.0008)
HH_number_mobile		0.1011		
		(0.0924)		
HH_internet[a]			0.0968***	
			(0.0266)	
iv_useinternet_2015				0.0176***
				(0.0020)

[a] This binary variable reports the average treatment effect.

also expected to receive a 6.54% higher amount of remittances, although this effect is not significant (Table 1) If the head of household is a year older only affected to the probability of receiving remittances increases by 0.11% (Table 2). The effect of the head of the household's higher level of education on the probability of receiving remittances is significantly negative (Table 1) with an expected decrease of the probability of −2.54% (Table 2) even though this average effect is not significant. It is expected that the amount of remittances received will increase a 23.57% but, again, this effect is not significant (Table 2).

A household with children and emigrating parents has a higher probability of receiving remittances (13.30%, Table 2) and the amount it receives grows by 27.54% (Table 1). Finally, the percentage of ill members in the household increases the probability of receiving remittances by 0.02% (Table 2) but the amount drops by −0.31% (Table 1).

3.1. Robustness issues

In this sub-section we analyse the robustness of the digitalisation effects with respect to the instrumental variables and the digitalisation indicator.

3.1.1. Digitalisation indicators

We have used other digitalisation variables, available in EHPM16: HH_number_mobile and HH_internet (see Appendix A for definition). Over 90% of the households have mobile phones, regardless of whether they receive remittances or not. The ratio of mobile phones for members of receiving households is higher: 0.61 versus 0.57 in non-receiving homes. Regarding households with an internet connection, the percentage is very low in both cases; 17.33% of receiving households have internet and 15.19% of non-receiving homes.

The results are shown in Tables 1 and 2 and Appendix C: Model 2 for the indicator HH_number_mobile and Model 3 for the HH_internet. The results of both models are very similar to those of Model 1: a significant positive effect of digitalisation in the probability of receiving remittances but not in the amount received. All these results provide robustness to the results obtained.

3.1.2. Instrumental variables

In order to take to incorporate dynamic effects in the estimation process, we have constructed a new database adding information from 2015 EHPM wave. Although the households of 2015 and 2016 waves are not the same, a 50% of the sample are common or have a similar structure (they have the same municipality, household members, household with members abroad, number of household foreign members and the head of the household has the same sex, age, education and ability of reading and writing). Therefore, we merged both waves in such a way that we had information on 8299 households. In this way, our final dataset incorporates digitalisation variables in 2016 and digitalisation variables in 2015. The 2015 digitalisation values were used as and additional instrument for the estimation of effect digitalisation on remittances. According to Zhong et al. (2019) using the lagged endogenous variables as instrumental variables is appropriate because they are less likely to be influenced by the dependent variable.

The results are shown in Tables 1 and 2 and Appendix C under the heading Model 4. They are very similar to those of Model 1 with similar values with respect to the values of the estimated effects. All these results show the robustness of the obtained results[10].

4. Conclusion

Determinants of remittances are not everlasting and are affected by social and economic changes. In this sense, the effect on remittances due to an increase in the widespread use of ICT is not an exception.

This paper studies the effect of digitalisation on remittance flows received by households from a micro perspective. Some literature has been developed in recent years but from a macroeconomic perspective. Microeconomic analyses can avoid the limit of aggregated variables but are obliged to focus on one country. This paper has selected El Salvador, not only because of the available dataset, but because remittances play an important role in their economy. Furthermore, El Salvador is one of the main receivers of remittances from the United States, and this study helps to understand how the digitalisation of households in receiving countries affects these flows. Regarding digitalisation, the population of El Salvador who use the internet has increased significantly in the last decade, although there is still a large gap with developed countries. To our knowledge, this study is the first microeconomic analysis on how digitalisation affects the probability of receiving remittances and their amount.

Our results point out that in El Salvador digitalisation increases significantly the probability of households receiving remittances, but not the amount they receive. These results seem logical: ICTs are a tool that facilitates communication with the relatives of migrants abroad and can help in the timely transfer of money but, by themselves, they cannot be a element that increases the amount of remittances. This amount depends on migrants labour conditions and their costs of sending money.[11]

These results may be representative for other countries with digitalisation levels and economic situation similar to El Salvador. To verify this point, it would be necessary to carry out this study in other countries, including information not only about their digitalisation level but also on the labour situation of the emigrants (labour hours, job stability, wages) and the cost of sending money (financial fees) to their relatives in order to evaluate their impact on the amount of remittances they send them. In this way, it would be possible to design action policies that improve the socio-economic and social situation of the recipient countries.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Appendix A. List of variables used in the study.

Variable	Definition
HH_North	household is in the North = 1, border with Honduras, otherwise = 0
HH_migrated_members	Number of migrated members
HH_migrated_members_1	household has 1 migrant = 1, otherwise = 0
HH_migrated_members_2	household has 2 migrants = 1, otherwise = 0
HH_migrated_members_3	household has 3 or more migrants = 1, otherwise = 0
HH_rural	household is rural = 1, urban = 0

(*continued on next page*)

[10] This exercise has also been carried out with the 2014 database, instead of the 2015, obtaining similar results.

[11] We thank reviewers for highlighting this explanation of our results.

(*continued*)

Variable	Definition
HH_income	household income per capita (without remittances)
HH_ln_income	natural log of household income per capita (without remittances)
HH_size	total number of members in the household
HH_rent	the house is rented = 1, otherwise 0
HHH_gender	gender of head of household (female = 1, male = 0)
HHH_age	Age of head of household (in years)
HHH_high_education	education of head of household (higher education = 1, 0 otherwise)
HH_children_emigrate_parents	children with emigrated parents = 1, otherwise 0
HH_ill_members	% of members who are ill
HH_useinternet	% of members who use the internet
HH_number_mobile	% of mobiles by household members
HH_internet	household has an internet connection = 1, otherwise = 0

Appendix B. Comparative Descriptive Analysis of the Variables

	No received		Received		Total		T test
	Mean	**sd**	**Mean**	**sd**	**Mean**	**sd**	**pvalue**
HH_North	0.1285	0.3347	0.2896	0.4536	0.1632	0.3696	0.0000
HH_migrated_members	1.5300	1.1018	1.8779	1.3632	1.8067	1.3212	0.0000
HH_rural	0.3403	0.4738	0.4526	0.4978	0.3645	0.4813	0.0000
HH_income	166.0164	193.4094	115.0264	191.5018	155.0280	194.1311	0.0000
HH_ln_income	4.7910	0.7872	3.7469	1.8498	4.5660	1.1865	0.0000
HH_size	3.6888	1.7951	3.5273	1.8654	3.6540	1.8117	0.0000
HH_rent	0.1437	0.3508	0.1098	0.3127	0.1364	0.3432	0.0000
HHH_gender	0.3303	0.4703	0.4737	0.4994	0.3612	0.4804	0.0000
HHH_age	48.4709	16.2263	54.1470	17.8773	49.6941	16.7589	0.0000
HHH_high_education	0.0929	0.2903	0.0594	0.2364	0.0857	0.2799	0.0000
HH_children_emigrate_parents	0.0075	0.0863	0.1507	0.3578	0.0384	0.1921	0.0000
HH_ill_members	0.1444	0.2765	0.1762	0.3076	0.1513	0.2838	0.0000
HH_useinternet	0.2194	0.3136	0.2499	0.3247	0.2260	0.3163	0.0000
HH_number_mobile	0.5767	0.3157	0.6161	0.3116	0.5851	0.3152	0.0000
HH_internet	0.1519	0.3589	0.1733	0.3786	0.1565	0.3633	0.0000

Appendix C. First-stage regressions of the 2SLS instrumental variable estimation method

VARIABLES	Model 1		Model 2		Model 3		Model 4	
	Selection	Main regression	Selection	Main regression	Selection	Main regression	Selection	Main regression
HH_North	−1.3845***		−0.0148***		−0.0234		−1.3106*	
	(0.4599)		(0.0057)		(0.0339)		(0.7099)	
HH_emigrated_members_1	7.5667***	−45.4927***	0.0930***	−0.3601***	0.4116***	−0.4410***	9.8685***	−81.5262***
	(1.0952)	(3.1290)	(0.0120)	(0.0317)	(0.0480)	(0.0399)	(2.8335)	(5.6003)
HH_emigrated_members_2	12.1601***	−47.1206***	0.1520***	−0.3586***	0.6021***	−0.4889***	12.7496**	−95.7420***
	(1.7974)	(3.4845)	(0.0147)	(0.0348)	(0.0705)	(0.0536)	(5.6106)	(8.5404)
HH_emigrated_members_3	9.1842***	−48.1419***	0.1877***	−0.3271***	0.5669***	−0.4757***	15.9898***	−77.3011***
	(1.4214)	(3.6056)	(0.0155)	(0.0369)	(0.0751)	(0.0438)	(4.8942)	(10.065)
HH_rural	−9.1735***	−13.7181***	−0.0412***	−0.0659***	−1.0243***	−0.0191***	−7.6568***	−11.7457***
	(0.5319)	(1.1403)	(0.0060)	(0.0113)	(0.0395)	(0.0310)	(0.7542)	(1.8418)
HH_ln_income	3.9281***	8.4752***	0.0559***	0.07955***	0.1874***	0.0633***	4.9305***	15.1824***
	(0.3021)	(0.5715)	(0.0030)	(0.0055)	(0.0147)	(0.0083)	(0.5821)	(1.2794)
HH_size	1.2304***	0.5918**	−0.0473***	−0.0523***	0.1041***	0.0063***	2.6195***	2.4707***
	(0.1473)	(0.2937)	(0.0015)	(0.0028)	(0.0076)	(0.0041)	(0.2931)	(0.7908)
HH_rent	2.1178*	−3.0405	0.0255***	−0.0211	−0.0490	−0.0382***	2.5032	−6.5798***
	(1.1707)	(2.4891)	(0.0091)	(0.0172)	(0.0405)	(0.0302)	(1.5769)	(3.4842)
HHH_gender	2.2481***	0.3610	−0.0134**	−0.0367***	0.0592**	−0.0290***	3.7383***	0.5135***
	(0.6217)	(1.1827)	(0.0062)	(0.0106)	(0.0295)	(0.0153)	(1.0069)	(2.4789)
HHH_age	−0.2114***	−0.5480***	−0.0009***	−0.0028***	0.0050***	−0.0012***	−0.1338***	−0.5516***
	(0.0182)	(0.0362)	(0.0002)	(0.0003)	(0.0009)	(0.0004)	(0.0252)	(0.0620)
HHH_high_education	12.6702***	8.4168*	−0.0001	0.01657	0.4567***	−0.0205***	4.4727	−5.5216***
	(2.3438)	(4.6346)	(0.0175)	(0.0341)	(0.0653)	(0.0728)	(4.3301)	(7.0375)
HHH_children_emigrate_parents	8.3427***	−6.7532***	−0.0078	−0.1319***	0.2824***	−0.0886***	6.1754*	−27.6681***
	(1.4519)	(1.7871)	(0.0139)	(0.0158)	(0.0670)	(0.0253)	(3.3645)	(4.2151)
HHH_ill_members								

(*continued on next page*)

(*continued*)

VARIABLES	Model 1		Model 2		Model 3		Model 4	
	Selection	Main regression	Selection	Main regression	Selection	Main regression	Selection	Main regression
	0.0023	−0.0569***	−0.0002**	−0.0004**	−0.0022***	−0.0001***	0.0158	−0.1017***
	(0.0100)	(0.0180)	(0.0001)	(0.0002)	(0.0005)	(0.0002)	(0.0130)	(0.0264)
iv_HH_middleschool	0.1534***	0.1540***	0.0007***	0.00034*	0.0062***	0.0000***	0.1050***	0.0862***
	(0.0116)	(0.0256)	(0.0001)	(0.0002)	(0.0005)	(0.0003)	(0.0152)	(0.0366)
iv_HH_highereducation	0.3497***	0.2484***	0.0014***	0.00072*	0.0128***	−0.0000***	0.3907***	0.2039***
	(0.0294)	(0.0544)	(0.0002)	(0.0004)	(0.0009)	(0.0009)	(0.0460)	(0.0921)
iv_internet_hat						0.9879***		
						(0.1237)		
iv_useinternet2015								9.1771***
								(3.6428)
lambda of Mills		−185.3972***		−1.553***		−1.6922***		−342.7537***
		(10.994)		(0.1086)		(0.1451)		(19.957)
constant	4.0496**	142.3181***	0.5256***	1.6958***	−2.9071***	0.95054***	−11.3822***	219.0231***
	(1.9795)	(7.3570)	(0.0191)	(0.0662)	(0.0971)	(0.0969)	(3.4623)	(12.145)
Observations	20,282	4987	20,282	4987	20,282	4987	8408	1226
Adj. R-squared		0.3399		0.2471		0.2788		0.4580

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