Revisting the effect of remittances on bank credit: a macro perspective

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Abstract: We investigate the effect of remittances on bank credit in developing countries. Understanding this link is important in view of the growing relevance of remittances as a source of external finance and of the beneficial impact that ﬁnancial intermediation is likely to have on economic growth. Our approach is essentially inductive and our contribution is twofold. First, we look at the evidence using a panel dataset for a large group of developing and emerging economies over the period 1960-2009. We ﬁnd that at initially low levels of remittances, an increase in remittances reduces the volume of credit extended by banks. However, at sufﬁciently high levels of remittances, the effect becomes positive. The turning point of the relationship occurs at a level of remittances of about 2.5% of GDP, which would imply that approximately 50% of our sample lie to each side of this threshold. Second, we present a theoretical model that rationalizes this non-linear effect of remittances on ﬁnancial development.

JEL: G21, O16, F24, C23.

Keywords: bank credit, remittances, panel data, ﬁnancial development.

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Abstract: We investigate the effect of remittances on bank credit in developing countries. Understanding this link is important in view of the growing relevance of remittances as a source of external finance and of the beneficial impact that financial intermediation is likely to have on economic growth. Our approach is essentially inductive and our contribution is twofold. First, we look at the evidence using a panel dataset for a large group of developing and emerging economies over the period 1960-2009. We find that at initially low levels of remittances, an increase in remittances reduces the volume of credit extended by banks. However, at sufficiently high levels of remittances, the effect becomes positive. The turning point of the relationship occurs at a level of remittances of about 2.5% of GDP, which would imply that approximately 50% of our sample lie to each side of this threshold. Second, we present a theoretical model that rationalizes this non-linear effect of remittances on financial development.

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1. Introduction

In capital scarce economies individuals are often trapped in poverty not because they lack profitable investment opportunities, but because they lack the initial finance needed to undertake such investments. It is therefore not surprising that the expansion of credit markets and banking services are now regularly placed at the core of development and poverty reduction strategies. Meanwhile, in recent years, remittances from abroad have come to be recognized as an important source of external finance for households in many developing countries. It is then important to understand how the inflow of remittances affects the volume of credit provided domestically. On the one hand, remittances might substitute for domestic credit as individuals who receive remittances would not need to borrow from the domestic banks (or other financial institutions) in order to invest. On the other hand, remittances might crowd-in domestic credit by increasing the volume of resources that banks can potentially mobilize and therefore lend. Moreover, individuals who receive remittances might become more financially literate and hence express a stronger demand for banking services and financial intermediation. In this paper we show that the balance between these two opposing effects depends on the volume of remittances received by a country. More specifically, when a country receives only a small amount of remittances, their effect on credit is negative. However, when the flow of remittances grows beyond a certain threshold, the effect becomes positive.

Our analysis is related to a burgeoning body of research that studies the relationship between remittances and broad financial development. Findings from this literature indicate that while remittances are often used to overcome credit constraints in financially underdeveloped economies (Giuliano and Ruiz-Arranz, 2009; Ramirez and Sharma, 2009; Arezki

\footnote{There is for instance a voluminous body of evidence suggesting that financial development promotes economic growth. See Loayza and Ranciere (2006), Mishkin (2007), and references therein.}
and Bruckner, 2011; Combes et al. 2011; Anzoategui et al. 2014), their aggregate effect on financial deepening is on balance positive (Hunte, 2004; Martinez et al. 2008; Billmeier and Massa, 2009; Gupta et al. 2009; Aggarwal et al. 2011; Demirguc-Kunt et al. 2011). However, there is also some (limited) micro-level evidence suggesting that the likelihood of a household having a bank account does not depend on the volume of remittances received (Mogilevsky and Atamanov, 2009 and Brown et al. 2013). This would in turn indicate that remittances do not necessarily increase household's demand for banking services.²

The existing work is almost exclusively empirical and focuses on the estimation of linear relationships. In our paper, instead, we combine empirics and theory to show that the relationship between remittances and credit provided by banks is likely to be non-linear. Our approach is essentially inductive. In the first part of our paper, we look at the data. A simple scatter plot with a non-parametric fit suggests that the relationship is possibly U-shaped, suggesting that the positive effect of remittances on credit occurs only at sufficiently high levels of remittances. Accordingly, we estimate a regression model of credit using a quadratic specification, with linear and squared remittances as explanatory variables. This estimation exercise is conducted using a panel data set for a large group of countries over the period 1960-2009. In the baseline regression, we control for several other determinants of credit and we deal with unobserved country heterogeneity using standard random and fixed effects estimators. We also present dynamic specifications that include a lagged dependent variable in addition to the other controls. These dynamic specifications are estimated using the difference-GMM estimator. Two key findings emerge. First, when remittances are entered linearly in the credit equation, their estimated coefficient is positive, but not statistically different from zero. Second, in a quadratic specification, the coefficient of the linear term

² A related branch of this literature looks at the effect of financial development and financial transaction costs on remittances (Freund and Spatafora, 2008; Adenutsi, 2011; Mokerjee and Roberts, 2011).
on remittances is negative, the coefficient of the quadratic term is positive, and both coefficients are strongly significant at usual confidence levels. This is evidence that the effect of remittances on credit is U-shaped rather than linear.\(^3\)

How can the observed non-linear effect of remittances be rationalized? To answer this question, in the second part of our paper, we present a theoretical model of banking and remittances in a hypothetical developing economy where the credit market is imperfectly competitive. We prove that the existence of positive adjustment costs (a likely occurrence in many economies) is sufficient to generate the type of non-linearities observed in the data. The intuition is as follows. A representative bank sets deposit and lending rates to maximize its profit. Starting from an initial position where the rates are set at the profit maximizing level, an increase in remittances reduces the demand for loans. This has two consequences: (i) the volume of credit provided by the bank declines (as less credit is demanded); and, (ii) the bank is no longer maximizing profits. To return to a profit-maximizing equilibrium, the bank should reset its rates. However, positive adjustment costs imply that the bank will do that only if the loss of profits from not adjusting is sufficiently large to make the adjustment of rates worthwhile. This loss of profits in turn is proportional to the inflow of remittances. So, for low levels of remittances, the loss is small, the bank does not adjust the rates, and credit declines. But for sufficiently high levels of remittances, the avoided loss is large enough to offset the adjustment cost and hence the bank resets its rates to stimulate greater demand for loans. As a consequence, more credit is provided in the new equilibrium.

The rest of the paper is organized as follows. Section 2 is devoted to the data analysis. Section 3 presents the theoretical argument. Section 4 concludes. Data description and

\(^3\) In addition to imposing a quadratic specification, we estimated a regression of bank credit on remittances (plus a set of controls) using non-linear least squares. We also fitted a spline model. Results are available upon request and generally confirm the finding that financial intermediation is first decreasing and then increasing in the volume of remittances.
sources are given in the Appendix.

2. Evidence

Figure 1 reports a scatter plot for remittances (horizontal axis) and credit provided by the banking sector (vertical axis). Both variables are measured in percent of GDP and observations are taken annually over the period 1960-2009 for a panel of 144 countries. The large cluster of observations at low values of remittances makes it difficult to identify a clear pattern. However, it is evident that the relationship is not necessarily positive and linear. In order to gain some more insights from this scatter plot, we trace out a non-parametric fit line using the lowess approach (see Cleveland, 1993 and 1994). The key feature of this method is that it does not require us to choose a parametric form for the relationship. The non-parametric fit line is represented in Figure 2, together with the relevant 95% confidence interval. It appears that the relationship is indeed U shaped rather than linearly positive. In the rest of this section, we present some more formal evidence concerning this non-linearity.

2.1 Model and estimation approach

We estimate the following econometric model:

\[ y_{it} = \rho y_{it-1} + f(x_{it}, \beta) + m_{it}'\theta + w_{it}'\delta + \epsilon_{it} \]  \hspace{1cm} (1)

More specifically, consider two variables \( y \) and \( x \), i.e. remittances (\( y \)) and bank credit (\( x \)). Data are structured as a panel of \( m \) cross sections and \( t \) years. We stack cross-section so to obtain for each variable a string of \( N = m \times t \) datapoints. For each data point \( x_n \), with \( n = 1, 2, \ldots N \), we fit a "local" regression \( y_i = \alpha + \beta_1 x_i + \beta_2 x_i^2 + \ldots + \beta_k x_i^k + \epsilon_i \) using only a subset of observations \((y_i, x_i)\) that lie around \( x_n \) and giving smaller weights to observations that are more distant from \( x_n \). The smoothed curve representing the relationship between \( y \) and \( x \) is then traced out from the fitted values of the \( N \) local regressions evaluated at \( x_n \). A relevant property of the smoothed curve is that its shape at high values of \( x \) is not affected by data points corresponding to low values of \( x \). In implementing the procedure, we use a bandwidth span of 80%; that is, each local regression includes only 80% of all sample observations. In this way, we increase the smoothness of the line. We also set the degree of polynomial of the local regression equal to one. The weighting system is such that observations that are relatively far from the point being evaluated get small weights in the sum of squared residuals of the regression.
where $i$ denotes a generic country and $t$ a generic year, $y$ is a measure of domestic credit provided by the banking sector, $x$ is the flow of remittances, $m$ is a vector of basic controls, $w$ is a vector of additional controls, $\varepsilon$ is a disturbance term, $f(\cdot)$ is a generic function, and $\rho$ and $\beta$ are the coefficients to be estimated along with the vectors $\theta$ and $\delta$. The disturbance term is defined as the sum of two orthogonal components: $\varepsilon_{it} = \mu_i + \nu_{it}$, where $\mu$ is a country specific effect (random or fixed) and $\nu$ is an idiosyncratic shock.

The model is estimated for two "competing" functional forms of $f(\cdot)$:

$$f(x_{it}, \beta) = x_{it} \beta$$

(2)

$$f(x_{it}, \beta) = x_{it} \beta_1 + x_{it}^2 \beta_2$$

(3)

The functional form (2) restricts the relationship to be linear, as assumed in most of the empirical work. The functional form (3) instead allows for a U-shaped relationship, as suggested from Figure 2.

We proceed to the estimation of equation (1) in two ways. First, we impose the restriction $\rho = 0$ and apply standard random and fixed effect estimators for panel data. Second, we relax the restriction on the autoregressive coefficient and estimate the resulting dynamic model using the difference-GMM procedure originally proposed by Arellano and Bond (1991). As is well known, this procedure involves taking first differences of equation (1) to remove the country effect component of the disturbance (which, in a dynamic setting, is necessarily correlated with the other regressors, thus biasing estimates). The first-differenced equation is then estimated using a set of internal instruments, built from past observations of the potentially endogenous regressors.

The difference-GMM procedure provides a convenient solution to the key consistency
issues that emerge in the estimation of dynamic panels. However, it is not immune from complications. First of all, the procedure hinges on the identifying assumption that the lagged values of the dependent variable and the other endogenous regressors are valid instruments. For this to be the case, the necessary condition is that there must be no first order serial correlation in the errors, which is equivalent to assuming that there is no second order serial correlation in the first differenced errors (that is, the errors in the first differenced equation). To verify this condition, we perform the Arellano and Bond (1991) test for autocorrelation in the first differenced errors. In addition, we also present the Hansen test of the null hypothesis that the overidentifying restrictions implied by the estimation procedure are valid. Rejection the null of this test can be taken as indication of the overall validity of the instruments.

A second major complication with the difference-GMM procedure is the risk of instrument proliferation. This can occur in panels with a long time series dimension because the procedure generates a total number of instruments that is quadratic in the number of time-series observations. Therefore the total instrument count can easily grow large relative to the sample size. When this happens, instruments overfit instrumented variables and fail to remove their endogenous components, thus making the entire estimation procedure invalid. This problem of instrument proliferation is likely to be particularly acute in our case given that our panel spans over a relatively long period of time. In fact, when implementing the procedure without imposing restrictions on the number of instruments, we obtain a p-value for the test statistic of the Hansen test that is equal to 1.000. This is a clear symptom of instrument proliferation. We therefore follow Roodman (2009) and take two corrective steps. First, we use only certain lags instead of all available lags for instruments. Second, we collapse the instruments through addition into smaller sets. In this way we significantly
reduce the instrument count and obtain more reasonable statistics for the Hansen test.\textsuperscript{5}

Finally, as a possible improvement on the difference-GMM procedure, Arellano and Bover (1995) and Blundell and Bond (1998) propose a system-GMM procedure where both the original levels equation and the first-differenced equation are jointly estimated as a system. By exploiting additional moment conditions, the system-GMM might be more efficient. However, the gain in efficiency is obtained only to the extent that the GMM-style instruments for the levels equation are valid. To check this, we initially ran the system-GMM procedure and conducted a difference-in-Hansen test. The test indicated that the instruments for the levels equation were not valid. We therefore prefer to report the results from the difference-GMM procedure, in addition to the random and fixed effects regressions.\textsuperscript{6}

\subsection*{2.2 Results}

The estimates of $\beta$ (linear specification) and $\beta_1$ and $\beta_2$ (quadratic specification) are presented in Table 1 together with a set of statistics, including the total number of observations used for estimation, the number of countries included, and the average number of observations per country. For the difference-GMM estimator (columns VI to X), the table also reports the two previously mentioned diagnostics test: the test of first and second order autocorrelation in first-differenced errors and the Hansen test of overidentifying restrictions. As can be seen, there is evidence of first order autocorrelation, but this is expected because the first-differenced errors are by construction serially correlated. However, the null hypothesis of no second-order autocorrelation can never be rejected, meaning that the errors in levels are

\textsuperscript{5} There is no specific theory indicating what is a safe number of instruments. The results presented in the next subsection are obtained by capping the number of lags to 16 for each period and the collapsing these instruments into subsets. This makes the total instrument count smaller than the number of countries in the panel, in line with a rule of thumb that is sometimes applied in the literature. However, we experimented with different caps, further reducing as well as increasing the total instrument count, but always making sure that the p-value of the Hansen statistic does not reach 1.000 (or very close to 1). Results did not differ qualitatively from those discussed below. All results are available from the authors upon request.

\textsuperscript{6} Results of the difference-in-Hansen test and from the system-GMM procedure are available upon request.
effectively not correlated. Similarly, the null hypothesis that the overidentifying restrictions are valid is never rejected. Taken together, these diagnostic tests support the identifying assumptions on which the difference-GMM procedure hinges.

Both domestic credit provided by the banking sector and remittances are expressed in percentage of GDP. The vector of basic control variables ($m$) includes the log of per-capita income, the exports to GDP ratio, the annual rate of inflation, and the inflow of official development assistance in per cent of GDP. The vector of additional controls ($w$) includes the log of aggregate GDP, the inflow of FDI in percentage of GDP, and the manufacturing share of total value added. This choice of controls is in line with previous theoretical and empirical findings on the determinants of financial depth.

Before turning to the key results on the effect of remittances, it is worth summarizing the findings concerning the controls (to save space, their estimated coefficients are not reported in the table, but are available upon request). Higher per-capita and aggregate GDP tend to increase credit, meaning that richer and/or bigger countries can generally afford wider and deeper financial intermediation. Exports instead appear to have a negative effect, in contrast with some previous results reported, for instance, by Aggrawal et al. (2011). Inflation is found to reduce credit, most likely because it reduces individual’s incentive to save in financial assets (as opposed to real assets) and hence discourages financial intermediation. A bigger share of the manufacturing sector has a generally positive effect, albeit not always

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7 See Appendix for variables’ description, sources, and summary statistics. Note that we use World Bank data for remittances. However, as discussed below, we test the sensitivity of our results using an alternative dataset for remittances that Paola Giuliano kindly made available to us. Results are qualitatively very similar in the two cases.

8 The literature has also emphasized the contribution of time invariant factors, such as legal origins and colonial heritage, to financial development (Beck and Levine, 2003; Harper and McNulty, 2008). These factors are captured by the country specific effect in equation (1) and therefore do not need to be measured by a specific empirical proxy.

9 We argue that theoretically the effect of exports on financial development is ambiguous and depends on the structure of exports. Manufacturing exports are likely to have a positive effect, while primary commodity exports may have a negative effect. In our sample, this negative effect prevails.
significant. Our interpretation is that the manufacturing sector, more than agriculture and services, is likely to express a strong demand for credit. Therefore, the bigger this sector is, the more scope for credit market development there is. Finally, neither FDI nor foreign aid is statistically significant.

INSERT TABLE 1 ABOUT HERE

Random effects estimates of the coefficients of remittances in model (1) are reported in column I (linear specification) and II (quadratic specification). Fixed effects estimates are presented in columns III and IV. All four equations are estimated assuming no dynamics of the dependent variable and using the set of basic controls only. There is clear evidence of a U-shaped relationship. When entered linearly in the model as in equation (2), remittances have a positive, but largely non-significant coefficient. Instead, with the non-linear specification (equation 3), the linear term is negative, the quadratic term is positive, and both coefficients are significant. This suggests that at initially lower levels of remittances, a further increase in remittances reduces the volume of credit. However, past a certain threshold level of remittances, the effect becomes positive. The point estimates indicate that this threshold level of remittances is around 2.5% of GDP. For approximately 51% of our sample, remittances in 2010 were greater than 2.5% of GDP.

In the remaining columns of Table 1, a dynamic version of the model is estimated. The results in column V are still obtained using the standard fixed effect estimator, which is however biased in the presence of a lagged dependent variable, as previously discussed. The other columns instead present difference-GMM estimates. The linear specification in column VI and the quadratic specification in column VII again only include the basic set of controls. The central finding does not change qualitatively from the estimates of the static model: the relationship between credit and remittances is U-shaped. This same result holds when we use
total domestic credit to the private sector (in % of GDP) as the dependent variable (column VIII) and when we include additional controls in the specification (column IX - dependent variable is credit provided by banks - and column X - dependent variable is domestic credit to the private sector).

As a sensitivity check, we re-estimated all the models in Table 1 using the data series for remittances of Giuliano and Ruiz-Arranz (2009). They observe that the definitions used to identify remittance flows in the World Bank data are not always consistent across countries. Therefore, they use IMF Balance of Payments Statistics and additional information from IMF country desks to build a new dataset that covers more than 100 countries for the period 1975-2003. It turns out that the estimated coefficients obtained from their data are qualitatively very similar to those presented in Table 1. In particular, the coefficient of remittances is always insignificant in the linear specification. The quadratic specification instead returns a negative coefficient on remittances and a positive coefficient on remittances squared. Quantitatively, the level of the remittances-to-GDP ratio which minimizes financial development is still located at around 2.5%.

3. Theoretical formalization

The evidence reported in the previous section indicates that the effect of remittances on domestic financial development is U-shaped. How can this non-linearity be rationalized? To answer this question, we present a stylised model of the credit market of a developing or emerging economy that receives remittances. The focus is not on the channels through which remittances are transferred from abroad, but rather on the impact that the inflow of remittances has on the domestic supply and demand of credit.

\footnote{In spite of the differences in definitions and coverage, the correlation between the World Bank data and the Giuliano and Ruiz-Arranz data for the period 1975-2003 is 0.94. The full set of estimates obtained using the Giuliano and Ruiz-Arranz data is available from the authors upon request.}
Our formalization of the credit market hinges on two assumptions. First, the market is imperfectly competitive. More specifically, in line with the existing evidence on the structure of the banking sector in developing and emerging economies, we consider a representative bank that has some monopoly power (see Mamatzakis et al. 2005; Yildirim and Philippatos, 2007; Mandelman, 2010; Maudos and Solis, 2011). This means that the bank can set its lending and deposit rates to maximize its profit.

Second, bank rates change infrequently. The theoretical foundation of this assumption follows the tradition of adjustment costs theories of price dynamics. For instance, Hannan and Berger (1991) use the menu cost model of Rotemberg and Saloner (1987) to explain price stickiness in the banking sector, while Klemperer (1987) suggests that his model of switching costs could also be used for the same purpose. Hannan and Liang (1993) model sticky bank rates as a consequence of lack of competition. Fried and Howitt (1980) applies the Azariadis (1976) model of implicit insurance contracts in labour markets to explain how infrequent adjustments are the way in which banks assure risk averse lenders of a relatively constant interest rate. In a broader perspective, a number of theoretical models of bank rates stickiness take into account the special nature of a loan contract (Stiglitz and Weiss, 1981 and Ausbel, 1991).

There is also strong empirical support to the stickiness assumption, particularly in markets characterized by higher levels of concentration (see, inter alia, Hannan and Berger, 1991, Neumark and Sharpe, 1992; Mester and Sounders, 1995 Scholnik, 1996; Craig and Dinger, 2010). Some recent evidence on the slow and incomplete adjustment of retail bank interest rates to changes in monetary policy (Hofmann and Mizen, 2004, de Graeve et al. 2007, Sander and Kleimeier, 2006) is also relevant to support our assumption.
### 3.1 Set-up

There are two groups of households, respectively labelled as $R$ and $P$. The representative household in each group has access to an investment project characterized by a return $r_i$. The distribution of investment returns across households in each group is uniform, with supports $(0, 1)$. There are $N(1 − δ)$ households in group $R$ and $N(1 + δ)$ households in group $P$. Each household in group $R$ is endowed with one unit of wealth (e.g. investible funds) which can be either used to finance the investment project or stored in a bank at a deposit rate $r_d$. Households in group $P$ have no initial wealth, but they can borrow one unit of wealth from the bank at a lending rate $r_b$. They can then use this wealth to finance their investment project.

The representative household in group $R$ will invest its unit of wealth in the project if $r_i > r_d$, otherwise it will deposit this wealth in the bank. This implies that the "supply" of funds in the financial market is $S = r_dN(1 − δ)$. Similarly, the representative household in group $P$ will borrow and invest as long as $r_i > r_b$. Therefore, the "demand" for loans is given by $D = (1 − r_b)N(1 + δ)$. The bank optimally chooses $r_d$ and $r_b$, and therefore the interest rate differential, in order to maximize its profit given the demand and supply schedules.\footnote{For simplification, we are assuming that the interest charged on loans is the only source of revenue for the bank. One can then think of $r_b$ as inclusive of other possible sources of revenue, such as administrative fees and charges.}

The market equilibrium and the maximization problem of the bank are represented in Figure 3.

INSERT FIGURE 3 ABOUT HERE

Formally, the bank is to choose $r_d$ and $r_b$ to maximize the area of the rectangle inscribed in the triangle with vertex M and hypotenuse on the horizontal axis. This problem is...
equivalent to choosing \( r_d \) and \( r_b \) such that \( S(r_d) = D(r_b) = y \) where \( y \) is obtained from the maximization of the profit function:

\[
\pi = \frac{2x}{N(1 - \delta^2)} \left( \frac{N(1 - \delta^2)}{2} - y \right)
\]

(4)

The first order condition for the maximization of (4) yields \( y = \frac{N(1 - \delta^2)}{4} \). The corresponding interest rates are \( r_d = \frac{(1 + \delta)}{4} \) and \( r_b = \frac{(3 + \delta)}{4} \). The profit of the bank is then \( \pi = \frac{N(1 - \delta^2)}{8} \). Clearly, this equilibrium involves a lower volume of credit being extended, and at a higher cost, than what would occur under perfect competition in the banking sector. The perfect competition equilibrium is in fact characterized by \( r_d = r_b = 1 + \frac{2}{\delta} \) and \( S = D = \frac{N(1 - \delta^2)}{2} \). The profit of the banks in this case would obviously be zero.

3.2 The effect of remittances

We model remittances as a change in the relative size of the two groups. The underlying intuition is that, at some point in time, one member of some of the households in group \( P \) will migrate abroad and start sending remittances back home. More specifically, we assume that \( \delta N \) households in group \( P \) receive exactly one unit of wealth in remittances while none of the households already in group \( R \) receives any remittances. These assumptions are not essential to our argument, but they do make the model analytically more tractable (see also the discussion below).\(^\text{12}\)

As a result of the inflow of remittances, there are now \( N \) households in each group. The conditions for investment and deposit remain the same as before and hence the new supply and demand schedules are, respectively, \( S' = r_d N \) and \( D' = (1 - r_b)N \). This shift in the supply and demand schedules clearly requires the bank to adjust its rates in order to

\(^{12}\)In fact, our assumption that only individuals from group \( P \) migrate finds some significant support in the literature. For instance, Massey et al. (1994) and McKenzie (2006) demonstrate that poorer, less educated individuals have a much stronger incentive to migrate abroad than the wealthier and better educated ones.
maximize profit. Formally, the new profit function to be maximized by the bank is written as:

\[ \pi' = \frac{2y'}{N} \left( \frac{N}{2} - y' \right) \] (5)

The first order condition yields \( y' = N/4 \) and the associated interest rates are \( r'_d = \frac{1}{4} \) and \( r'_b = \frac{3}{4} \). The associated profit of the bank is \( \pi' = \frac{N}{8} \). The optimal response of the bank to the inflow of remittances therefore involves a reduction in both the deposit and the lending rate and an increase in the volume of credit provided to the households. By undertaking such a response, the bank also increases its profit.

Suppose however that to change the rates, the bank has to pay some adjustment cost \( z \). The bank will then compare the adjustment cost \( z \) against the loss of profits arising from not adjusting the rates. This loss is simply the difference between \( \pi' \) and the profit \( \pi^0 \) that the bank makes if the interest rates are kept at their original level (that is, the level they were before remittances started flowing in). Formally:

\[ \pi^0 = r_b D' \big|_{r_b = \frac{(3+\delta)}{4}} - r_d S' \big|_{r_d = \frac{(3+\delta)}{4}} \] (6)

where \( D' \big|_{r_b = \frac{(3+\delta)}{4}} \) is the demand of funds at the original lending rate given the new demand schedule determined by the inflow of remittances and, similarly, \( S' \big|_{r_d = \frac{(3+\delta)}{4}} \) is the supply of funds at the original deposit rate given the new supply schedule. By substitution of \( r_d = \frac{(1+\delta)}{4} \) and \( r_b = \frac{(3+\delta)}{4} \) into \( S' = r_d N \) and \( D' = (1 - r_b) N \), respectively, we have

\[ D' \big|_{r_b = \frac{(3+\delta)}{4}} = \frac{N}{4} (1 - \delta) \] and \( S' \big|_{r_d = \frac{(3+\delta)}{4}} = \frac{N}{4} (1 + \delta) \). Then from (6) \( \pi^0 = \frac{N}{8} (1 - 2\delta - \delta^2) \) and the loss is \( \ell = \frac{N(\delta^2 + 2\delta)}{8} \). So, if \( z > \frac{N(\delta^2 + 2\delta)}{8} \), the bank does not change its interest rates and the volume of credit provided by the bank declines from \( \frac{N(1-\delta^2)}{4} \) to \( \frac{N(1-\delta)}{4} \).

Note however that the supply of funds is now greater than the demand for loans. This
means that if the bank does not adjust the interest rate, then it will collect excess funds on which it will have to pay interest, but which will not produce any profit as they cannot be lent. In this case, the bank might impose a cap on deposits (in practice, one can think that the bank does not pay any interest on deposits in excess of loans demanded). The cap implies that \( S' = D' = \frac{N}{4}(1 - \delta) \) and \( \pi^0 = \frac{N}{8}(1 - \delta) \). The corresponding loss of profits, \( \ell = \frac{N\delta}{8} \), is smaller than the loss suffered when deposits are not capped. Therefore, with a cap on deposits, a lower adjustment cost is needed for the bank to decide not to adjust its rates.

Figure 4 depicts the equilibrium when \( z \) is high enough to prevent the bank from adjusting its deposit and lending rates. If the bank does not place a cap on deposits, then the profit \( \pi^0 \) is equal to the difference between area \( A \) and area \( B \). If instead the bank caps deposits, then \( \pi^0 \) is equal to area \( A \). The rectangle marked in thicker lines is instead the profit that the bank makes when it adjusts its rates.

Whether the bank caps deposits or not, the loss from not adjusting is always increasing in the inflow of remittances \( \delta N \). Hence, the bank becomes more likely to adjust as the inflow of remittances grows. This is likely to result in the relationship between credit provided by the bank and remittances to be non-linear. Before remittances are received, credit is \( \frac{N(1-\delta^2)}{4} \). At low levels of remittances, the loss of profits is small, the bank is less likely to adjust, and hence credit is reduced to \( \frac{N(1-\delta)}{4} \). At high levels of remittances, the loss is large, the bank is more likely to adjust, and hence credit increases to \( N/4 \). Empirically, we would therefore expect a U-shaped relationship between volume of remittances and volume of credit granted by banks.
3.3 Generalization and propositions

The previous results can be generalized to the case where migration and the associated inflow of remittances do not necessarily result in two equally sized groups of households. That is, we now assume that \( \alpha N \) (where \( \alpha \neq \delta \)) households in group \( P \) receive remittances and hence move to group \( R \). The initial equilibrium is the one depicted in Figure 3. Two propositions then follow:

**Proposition 1** If the bank faces sufficiently high costs of adjustment, then the effect of remittances on credit is non-linear (U-shaped) unless the bank can place a cap on the volume of deposits received and the migration flow is so strong that the majority of households can invest without having to borrow from the bank, in which case the relationship is linear and negative.

**Proof.** For convenience, denote the term \( \delta - \alpha \) by \( \gamma \). Then, the new demand and supply schedules are \( D' = N(1 - r_b)(1 + \gamma) \) and \( S' = N r_d (1 - \gamma) \). If there are no adjustment costs, then the bank adjusts the rates to \( r'_d = \frac{1+\gamma}{4} \) and \( r'_b = \frac{3+\gamma}{4} \). The associated volume of credit and profit of the bank are, respectively, \( y' = \frac{N(1-\gamma^2)}{4} \) and \( \pi' = \frac{N(1-\gamma^2)}{8} \). If instead the adjustment cost is sufficiently high to deter the bank from adjusting the interest rates, then the profit is \( \pi^0 = \frac{N(1+\gamma)(1-\delta)}{8} \) if the bank is able to place a cap on deposits and \( \pi^0 = \frac{N(1+2\gamma-2\delta-\delta^2)}{8} \) if the bank does not place a cap on deposits. The volume of credit provided by the bank is \( y' = \frac{N(1-\delta)(1+\gamma)}{4} \) in both cases and is lower than the volume of credit provided when the interest rates are adjusted. The loss of profits is \( \ell = \frac{N(1+\gamma)(\delta - \gamma)}{8} \) if deposits are capped and \( \ell = \frac{N(\delta^2 - \gamma^2 + 2\delta - 2\gamma)}{8} \) if deposits are not capped. For \( \alpha < \delta \), both losses are increasing in \( \alpha \) and hence the relationship between credit and remittances is likely to be U-shaped. For \( \alpha > \delta \); that is, when the migration and remittance inflows are so strong that the majority of households end-up being in group \( R \), then the loss of profits is increasing in \( \alpha \) only in the case where deposits are not capped. If instead deposits are capped and \( z \) is sufficiently high to prevent the bank from adjusting when \( \alpha \) is low, then further increases
in $\alpha$ will not result in any subsequent adjustment. The implication in this case is that the relationship between remittances and credit is linear and negative. ■

**Proposition 2** If adjustment costs are low and do not deter the bank from adjusting the interest rates, then the effect of remittances on credit is linear and either positive or negative depending on the initial size of the two groups. If group $P$ is initially larger, then the inflow of remittances increases credit. If instead $R$ is initially larger (or if the two groups are initially of the same size), then the inflow of remittances reduces credit.

**Proof.** In the equilibrium without remittances, the volume of credit is always equal to $y = \frac{N(1-\delta^2)}{4}$. If interest rates are immediately adjusted, then the volume of credit grows to $y' = \frac{N(1-(\delta-\alpha)^2)}{4}$ when group $P$ is initially larger. But if group $R$ is initially larger, that is, if the initial demand and supply schedule are respectively $D = (1-r_b)N(1-\delta)$ and $S = r_dN(1+\delta)$, then the inflow of remittances causes the supply and demand schedules to shift to $D' = (1-r_d)N(1-\delta-\alpha)$ and $S' = r_bN(1+\delta+\alpha)$. These schedules in turn imply a volume of credit in equilibrium equal to $y' = \frac{N(1-(\delta+\alpha)^2)}{4}$, which is smaller than $y = \frac{N(1-\delta^2)}{4}$ for any $\alpha > 0$. ■

Propositions 1 and 2 summarize our argument: the type of non-linearities observed in the data can be generated by adding sufficiently high adjustment costs to a model of bank credit with imperfect competition. We believe that this explanation is potentially relevant because both imperfect competition and sizeable adjustment costs are likely features of credit markets in developing and emerging economies.

### 3.4 Further extensions

To complete the presentation of the theory, we provide a brief intuitive discussion of two possible extensions of the basic framework.

The first extension concerns the assumption that only households in group $P$ have a family member who migrates and sends remittances back home. Allowing households in
group $R$ to receive remittances is however unlikely to produce major substantive changes to the results. If some proportion $\epsilon$ of households in $R$ have a migrant member, then these households will receive an extra unit of wealth which, again they can invest (assuming that they have more than one valuable investment opportunity) or deposit in the bank. If they invest it, then there is no effect on the credit market equilibrium. If instead they deposit it, then the supply schedule in the credit market shifts further upward. If the bank immediately adjusts the interest rates, then the volume of credit increases relative to the case where households in $R$ do not receive remittances. If instead the bank does not adjust the interest rates, but places a cap on deposits, then the equilibrium is the same as the case where households in $R$ do not receive remittances. Finally, if the bank does not adjust the interest rates and does not cap deposits, then the profit $\pi^0$ of the bank shrinks, thus lowering the threshold value of $z$ below which adjustment occurs. This in turn will shift the turning point of the U-shaped relationship between remittances and credit to the left.

The second extension relates to the assumption that the distribution of investment projects over households in the two groups is uniform. Clearly, one can assume different distributions, which would in turn generate supply and demand schedules that cannot be represented as straight lines. However, as long as such supply and demand schedules are monotone with respect to the interest rate, then the basic mechanics of the model will hold and the predictions summarized in the two propositions above will still be qualitatively valid. The main complication would be that the profit of the bank can no longer be determined as the area of a rectangle inscribed in a triangle (as in Figures 3 and 4) and, therefore, the closed form solutions of the model would be mathematically more tedious.
4. Conclusions

The purpose of this paper is to further our understanding of the impact remittance inflows on the development of the credit market in the recipient country. On the one hand, remittances might reduce the need for individuals to borrow from the banks to finance their investment projects. This substitution effect would cause remittances to reduce credit. On the other hand, once received, remittances can be channelled into the formal financial system, thereby increasing banks’ capacity to mobilize and lend funds. The net effect is therefore uncertain. We examine these empirically and offer a theoretical explanation for our findings.

We first present some empirical evidence that the effect of remittances on financial development is likely non-linear. A non-parametric scatter plot indicates that the relationship is actually U-Shaped. We substantiate this finding by estimating a more formal econometric model using panel data for a large sample of countries. We fit both linear and quadratic specifications, allowing for a dynamic dependent variable and a broad set of controls. We use the volume of credit provided by the banking sector and the volume of total domestic credit to the private sector as our dependent variables. The empirical results strongly support the non-linear specification. In a linear specification, the coefficient of remittances is positive, but statistically never significant. In a quadratic specification, the linear term is negative, the square term is positive, and both are statistically significant. This means that as remittances increase, credit first decreases and then increases. Estimates indicate that the turning point occurs at a level of remittances of about 2.5% of GDP, which would imply that approximately 50% of our sample lie on each side of the turning point.

To explain the source of the non-linearity, we present a simple theoretical model of an imperfectly competitive credit market with adjustment costs. A representative bank
chooses the lending and deposit rates to maximize its profit, as it is indeed in the case in many developing countries. The inflow of remittances modifies the credit supply and demand schedule, thus requiring the bank to adjust the rates in order to achieve profit maximization. However, as suggested by a large body of theoretical and empirical work on the stickiness of bank rates in developing countries, adjustment is costly. Therefore, the bank effectively adjusts its rates only if the avoided loss of profits from adjusting is larger than the adjustment cost. This type of friction generates the possibility of a non-linearity in the relationship between remittances and credit. Intuitively, remittances tend to reduce the equilibrium level of credit if the bank does not adjust its rates in responses to changed supply and demand conditions. At the same time, the loss of profits from not adjusting increases as the inflow of remittances increases. This is because the larger the volume of remittances, the bigger the difference between the profit-maximizing level of the interest rates and the current level of the interest rates. So, at initially low levels of remittances, the bank does not adjust the rates and credit decreases. But as more remittances are received, the loss of profits increases, eventually inducing the bank to adjust its rates. This in turn leads to an increase in the equilibrium level of credit.

Remittances are a very important source of external finance in many developing and emerging countries. The expansion of credit and financial deepening are recognised as key drivers of economic growth and development. We therefore expect the literature on the relationship between remittances and credit to expand considerably in the future. We suggest two possible items for the research agenda in this area. First, it would be interesting to combine the macro with the micro perspective, especially in regard to the econometric analysis. For instance, household level data on the banking behaviour of remittance recipients and non-recipients would allow for more direct examination of the relationship between...
remittances and demand for banking services.

Second, it would be important to see whether the effect of remittances on credit is conditional on factors such as the channels through which remittances are transferred from abroad, the country from which the remittances originate, and the economic conditions and/or institutional features of the recipient country. For instance, if migrants and the recipient households have reasons for wishing to avoid the costs of formal financial sector transfers and/or the official recording of these transfers, it is conceivable that the demand for financial services will be negatively affected by the inflow of remittances.
5. Appendix

Variables definition, sources, and summary statistics (1960-2009)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
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<tr>
<td>Credit</td>
<td>Two definition are used:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(i) Credit provided by banks (% of GDP)</td>
<td>44.44</td>
<td>34.51</td>
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<td></td>
<td>(ii) Domestic credit to the private sector (% of GDP)</td>
<td>32.84</td>
<td>26.48</td>
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<td>Workers’ remittances, compensation of employees and migrant transfers received (% of GDP)</td>
<td>4.14</td>
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<td>Per-capita GDP at constant 2000 US$ (logs)</td>
<td>7.13</td>
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<tr>
<td>Aggregate GDP</td>
<td>GDP at constant 2000 US$ purchaser’s prices (logs)</td>
<td>22.77</td>
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<td>Exports</td>
<td>Total exports of goods and services (% of GDP)</td>
<td>37.00</td>
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<td>Inflation</td>
<td>Annual percent change of CPI (%)</td>
<td>23.07</td>
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<td>FDI</td>
<td>Foreign direct investment flows (% of GDP)</td>
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<td>Aid</td>
<td>Net official development assistance and official aid received (% of GDP)</td>
<td>5.93</td>
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<td>Manufacturing</td>
<td>Net output (subtracting intermediate inputs) of ISIC division 15-37 (% of GDP)</td>
<td>14.93</td>
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Notes: All variables but FDI are from the World Development Indicators of the World Bank. FDI is from the Balance of Payment Statistics of the International Monetary Funds. Mean and standard deviation are computed from the sample used for the estimation of the equations in columns IX and X. For remittances we also used the data available from Giuliano and Ruiz-Arranz (2009)
List of references


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### Table 1: Econometric results, panel data 1960-2009.

<table>
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<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
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Notes: vector m includes: log per-capita GDP, exports (% of GDP), aid (% of GDP), and inflation. Vector w includes aggregate GDP, FDI (% of GDP), and manufacturing share of total value added. Estimators are: GLS random effects (RE), fixed effects (FE), and difference-GMM (with robust std. errors) (diff-GMM). Dependent variables are: credit provided by banks (% of GDP) in columns I to VII and in column IX; domestic credit to private sector (% of GDP) in columns VIII and X. *, **, *** denotes statistical significance at 10%, 5%, and 1% confidence levels respectively.
Figure 1: Scatter plot of bank credit and remittances
Figure 2: Non parametric scatter plot