

*Full Length Research Paper*

# **The role of remittances in financial development in Lesotho: Evidence from alternative measures of financial development**

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**This article represents a modest attempt to empirically establish the effect of remittances on financial development in Lesotho. Remittances tend to have a long run effect on financial development; however, they do not cause financial development. In the short run this effect evaporates. Trade openness and inflation have significant effects on financial development both in the short and long run. The former has a negative long run effect and a positive short run effect, while the latter has a negative effect in the short and long run. Financial liberalisation and the size of the economy have only long run effects on financial development. The Granger causality test reveals that financial development Granger-causes remittances. Hence, looking at the role of remittances in Lesotho, the development of the financial sector can help increase the propensity to remit. This is an important lesson for the authorities, because a number of impediments to financial development relate to the creation of a conducive or enabling environment in which activities of financial intermediaries, particularly credit extension can flourish.**

**Key words:** Remittance in financial development, Lesotho.

## **INTRODUCTION**

The role of remittances in labour sending countries across the globe cannot be overemphasised. The migrants were estimated at about 3 percent of the world population in the dawn of the 21<sup>st</sup> century (United Nations, 2002). As a result, remittances by the migrants represent a significant source of external financing for many of the recipient developing countries after foreign direct investment (FDI) (Giuliano and Ruiz-Arranz, 2006). In Lesotho remittances consistently exceed official assistance (Gupta et al, 2007). Nonetheless, the importance of remittances to economic growth has received little attention. The growth augmenting effect of remittances may work through their role as either a substitute to (Giuliano and Ruiz-Arranz, 2005) or complement (Aggarwal et al., 2006) of financial development in a country.

A priori, a positive relationship between remittances and financial development is viewed to work through two

channels. First, remittances increase the demand for financial services either during transfer or when they are channelled into savings. Second, remittances provide an alternative option to finance entrepreneurs who do not qualify for credit in mainstreams commercial banks. These entrepreneurs may over time graduate to a "bankable" stage and influence commercial banks to compete for them (Giuliano and Ruiz-Arranz, 2006). However, the opposite of the second channel may result if, due to moral hazard, the remaining communities develop a remittance dependency syndrome and become unproductive (De Haas, 2007). It is therefore, crucial to measure the contribution of remittances to financial development in Lesotho which has a long history of sending labour to South Africa (SA). This is the task taken up in this essay.

Following this introduction, the rest of the essay is organised as follows: Discussion of the theoretical

arguments on the relationship between remittances and financial development; presentation of the analysis of trends and patterns of remittances and major indicators of financial development; discussion of the empirical model and results and conclusion of the paper.

## THE REMITTANCES-FINANCE NEXUS: OVERVIEW OF EMPIRICAL EVIDENCE

The importance of financial development for economic growth has been extensively studied in the literature. Some studies find that financial development is associated with greater growth, for example King and Levine (1993), Levine and Zervos (1998) and Beck et al. (2000). In Lesotho, financial development weakly causes economic growth (Mohapi and Motelle, 2007). Although, the literature is scanty on the relationship between remittances and growth, several studies have focused on their impact on poverty. For example, De Haas (2007) finds that remittances contribute positively to "household welfare, nutrition, food, health, and living conditions in places and regions of origin."

Another literature strand has studied the indirect role of remittances on economic growth. For instance, the role of remittances in education has also been documented. Cox and Ureta (2003) found that in El Salvador remittances are associated with improved schooling outcomes for children. Similar evidence is obtained by Yang (2005) who studied the remittance education effect in the Philippines, as well as Hanson and Woodruff (2003) who assessed the case of Mexico. Remittances help households to overcome financial restraints and enable them to send children to school. Furthermore, remittances have been found to boost investment by promoting entrepreneurship by Massey and Parrado (1998) and Ratha (2005). The following studies reach a similar conclusion; Adams (2006), Adam and Page (2004), Gustafsson and Makonnen (1993), Hildebrandt and McKenzie (2004), Lindley (2006), Bendixen and Onge (2005), Seddon (2004) and Nwajiuba (2005)

One aspect which has not been extensively studied is the link between remittances and economic growth that works through financial development. Giuliano and Ruiz-Arranz (2005) and Mundaca (2005) find the existence of the remittance-growth nexus through the positive contribution of remittances to financial development. Aggarwal et al. (2006) used a span of data from 1975 to 2003 for 99 countries and found empirical support for a positive influence of remittances on financial development. They state that an increase in ratio of remittances to GDP by one percent generates a rise of about 0.3 percent in credit and between 0.5 and 0.6 percent in deposits.

The empirical literature on the relationship between remittances and financial development tests two hypotheses; the substitutability hypothesis on the one

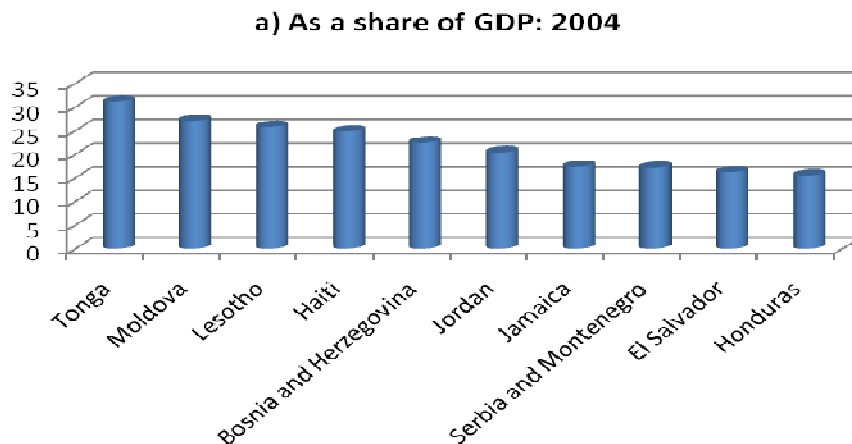
hand, and the complementarity hypothesis, on the other. Giuliano and Ruiz-Arranz (2005) use a cross-section of 73 countries over a period of 1975 - 2002 to test the substitutability hypothesis. They find that a high degree of financial development reduces the investment creating role of remittances, while the growth impact of remittances is more pronounced in under-developed financial markets. They interpret this finding to suggest that in shallow financial markets where potential investor lack collateral and face a credit constraint remittances support entrepreneurial activities, conversely in developed markets entrepreneurs can access credit through formal channels.

Calderon et al. (2007) find additional support for this hypothesis that a one standard deviation increase in remittances would result in higher growth rate of 0.46, 0.39 and 0.31 percent in Argentina, Peru and Brazil, respectively. This is found in order because the Brazilian financial markets are more developed than the Peruvian followed by the Argentinean ones. However, Aggarwal et al. (2006) present the flip-side of the substitutability hypothesis. They argue that in an economy where people distrust financial institutions remittances may not boost deposits in the financial system and if they spend the remittances mainly on consumption, then the credit creating role of remittances would be undermined. Nonetheless, there is no empirical support of the negative impact of remittances on the financial sector.

Terry and Wilson (2005) reason that a complementarity hypothesis also is true in that increased financial development help migrants to transfer funds home. Furthermore, remittance receipts help previously unbanked people to gain access to the financial services (De Marulanda et al., 2006). Alberola and Salvado (2006:9) find that low fees charged for transfers of money home encourage more remittances. Gupta et al (2007) reached a similar conclusion for Sub-Saharan Africa.

This is corroborated by Ratha (2005) who indicates that inefficiencies in the financial sector manifested in delays in money transfers, high intermediation costs and unfavourable exchange rates deter remittances. Moreover, Mundaca (2005) postulates that since efficient financial systems enjoy allocative efficiency, they can channel remittances towards the most productive investment projects. This screening is especially necessary when credit is extended to small and medium-sized enterprises.

Putting the evidence on the complementarity hypothesis together, four major pillars seem to lend it support. First, as remittance recipients demand financial products such as bank accounts and debit or credit cards, the financial system becomes more consolidated. Second, if the remittances are in excess of immediate needs of the recipients, the surplus may be saved thereby boosting domestic resource mobilisation. Third, the regular flows of remittances into recipients' accounts make them eligible for bank credit, which in turn expands the size of the



**Figure 1.** The importance of remittances for top 10 world recipient countries. Source: World Bank (2006).

credit market. Fourth, remittance recipients can be eyed as a market segment and banks may want to take the largest share of this segment. This would encourage completion, reduce transfers costs and result in more remittances.

**TRENDS AND PATTERNS OF REMITTANCE FLOWS AND INDICATORS OF FINANCIAL DEVELOPMENT IN LESOTHO**

This section puts the discussion in perspective by providing a picture of the size and trend of remittances and majors pointers of financial development. According to Ghosh (2006), Lesotho tops the list of 20 remittance recipient countries with a 40 percent share of GDP which he computes as an average for the period 1990-2003.

The World Bank (2006) estimates 25.8 percent share of GDP in 2004 Figure 1, panel (a) demonstrates that remittances were so important to the economy in 2004 that the country ranked third in the list of top ten remittance recipient countries in the world. Panel (b) indicates that they account for 60 percent of export earnings in 2006. This shows that the dwindling of the remittance flows, which is not accompanied by an alternative source of financing, would have adverse implications for the economy of Lesotho.

Figure 2 shows that the trend in remittances since 1996 to 2008 has been declining over the period. This trend is in line with that observed in the author’s employment figures which also fell over the period. However, an exceptional period is the 1998/1999 period which validates the altruistic remittance hypothesis that emerges from the literature. This was a period of political



**Figure 2.** The recent pattern of mine migrant employment and remittances. Source: Bureau of Statistics, Statistical Year Book 2008.

**Table 1.** Credit extension.

	2000	2001	2002	2003	2004	2005	2006	2007
Credit/Deposit ratio	0.20	0.22	0.23	0.23	0.25	36.9	0.27	0.31
Business credit/Credit ratio	0.37	0.42	0.38	0.35	0.36	0.40	0.51	0.45
Liquidity ratio	0.74	0.76	0.72	0.64	0.72	0.67	0.80	0.77

Source: Central Bank of Lesotho.

upheavals in Lesotho which resulted in the burning and looting in the main towns in the country with enormous damage in the capital Maseru. The slump in economic activity during this period was reflected in the negative growth rate (-4.8) recorded in 1998 (Central Bank of Lesotho, 2006). This likely influenced many migrants to remit more to their families. Regular remittance senders who are normally in circular migration because they have not migrated with their primary families could have increased the size of the remittance amount during the period. In addition, irregular senders who have migrated with their primary families could have remitted funds during this peculiar period to support their extended family members in crisis.

The attainment of private sector led growth depends on the availability of the much needed funds to finance business projects which are important to foster economic growth. In this paper, the credit-deposit ratio is used to gauge the depth of financial intermediation in the economy (Motelle, 2008a). This ratio established the degree to which banks attempt to allocate deposits between competing sectors throughout the economy. Although the ratio has been rising during the sample period from 20.1 to 31.0 percent, it is still relatively low to credit granted to businesses to total credit reflected that more of households than businesses benefit from the

pool of loanable funds. This bias in credit extension in favour of households indicated that deposits that were mobilised by the banking system were channelled to finance more of consumption expenditure than productive investment.

Motelle, (2008a) elaborated on several impediments that hinder credit extension. The first category of impediments has to do with market imperfections, the second relates to environmental factors such as the legal framework, the entrepreneurial capacity, availability of bankable projects, lack of know-your-customer tools like identity documents, etc. The composition of M2 in Lesotho indicates that it is difficult for banks to match deposits with loans. This is so because about 55 percent of M2 is demand and call deposits which are withdrawable without notice or on very short notice. Banking practice is that long term deposits would be placed back-to-back with loans in order to strike the best investment-liquidity mix. Commercial banks keep funds in placements and government securities which are of a short term nature. This explains the high liquidity ratio observed in Table 1. Therefore, creation of a suitable impact on economic growth. In addition, the low ratio of environment by the authorities and the introduction of more long term investment instruments such as bonds can go a long way in lowering the liquidity ration in the

**Table 2.** Unit root test results of variables in levels.

	<i>ADF</i>	<i>PP</i>	<i>KPSS</i>
lnF11	0.421122	-2.546750	1.156339
lnF12	-1.028318	-0.806124	0.930997
lnF13	-1.957189	-2.592087	0.622227
Lncap	-1.501678	-4.692661	1.015551
Lnopen	0.057841	-0.689811	1.161461
Lninf	-2.630525	-2.735117	0.841938
Lnrem	-3.043245	-3.043245	0.462534
Critical value at 1%	-3.51	-3.506	0.739
Critical value at 5%	-2.90	-2.895	0.347

Stationary at 1 percent level of significance.

economy.

**METHODOLOGY**

**The model and data**

A simple model was estimated to measure the contribution of remittances in financial development in the economy of Lesotho. The model was specified as follows:

$$F_{1t} = \beta_0 + \beta_1 Rem_t + \beta_2 X_t + \varepsilon_t \tag{1}$$

In (1) *i* refers to the *ith* measure of financial development, *Rem<sub>t</sub>* refers to the value of remittances in year *t*, and *X<sub>t</sub>* is a vector of explanatory variables such as inflation, trade openness, dummy for financial liberalisation which takes the value of 1 after 1999 and economic development (Appendix A1 for details on variable definitions). *ε<sub>t</sub>* is the stochastic error term.

**The vector error correction model**

Engle and Granger found that if two time series *y<sub>t</sub>* and *x<sub>t</sub>* are both integrated of order *d* that is, *I(d)*, then any linear combination of these series will also be *I(0)*. Therefore, the residuals obtained on regressing *y<sub>t</sub>* on *x<sub>t</sub>* are *I(0)*. The economic interpretation of co-integration is that if two series are linked to form long run equilibrium, then even if the series themselves may be non-stationary, they trend so closely over time that their difference will be stationary. The long run relationship is the equilibrium to which the system converges over time, and the disturbance term *ε<sub>t</sub>* is the deviation from the long run equilibrium or the error of disequilibrium at time *t* (Johnston and Dinardo, 1997).

This study utilises the Johansen procedure which extends the Engle and Granger methodology to a system of equations. The genesis of the Johansen methodology is the estimation of a Vector Autoregression (VAR) of order *p* (Hjalmarsson and Osterholm, 2007) given by:

$$y_t = \beta + A_1 y_{t-1} + \dots + A_p y_{t-p} + \varepsilon_t \tag{2}$$

Where *y<sub>t</sub>* is an *nx1* vector of *I(1)* variables and *ε<sub>t</sub>* is an *nx1* vector

of innovations. A dynamic version of (2) can be expressed as follows:

$$\Delta y_t = \beta_0 + \delta y_{t-1} + \sum_{i=1}^{p-1} \omega_i \Delta y_{t-i} + \varepsilon_t \tag{3}$$

If the coefficient matrix in (3) *δ* has a reduced rank of *r < n*, then there exists *nxr* matrices *α* and *ū*, each with rank *r* such that *δ = αū'* and *ū'y<sub>t</sub>* is stationary. *r* is the number of co-integrating relationships and the elements of *α* are adjustment parameters in the vector error correction model and each column of *ū* is the co-integrating vector. The test procedure for the reduced rank of *δ* uses two likelihood test ratios, namely the trace test and the maximum eigenvalue test which are not reproduced here.

**RESULTS AND DISCUSSION**

**Unit root test results**

The analysis resumes with the tests of stationarity of the variables by studying their unit root properties. The conventional tests in this regard such as the Augmented Dickey-Fuller (ADF) and Phillips-Perron (1988) (PP) tests are plagued by size and power problems. As a result the Kwiatkowski, Phillips, Schmidt and Shin (1992) KPSS test which is less sensitive to size distortions is used as a robustness check. The decision as to whether a variable is stationary or not is made on the basis of a simple majority of the three tests.

The unit root test results on the variables at levels, including a constant, are reported in Table 2. The table shows that calculated ADF values are less than the critical values at 1, 5 and 10 percent levels of significance, which indicates that we cannot reject the null hypothesis of non-stationarity using level data for all variables.

In order to eliminate non-stationarity first differences for all the variables are taken and the test is repeated.

**Table 3.** Unit root test results of variables in first differences.

	<i>ADF</i>	<i>PP</i>	<i>KPSS</i>
lnF11	-6.186108	-19.77078	0.260386
lnF12	-8.209378	-9.346103	0.099214
lnF13	-4.499397	-19.72265	0.147833
lnCap	-9.157656	-21.79496	0.100593
lnopen	-9.236634	-21.31205	0.312913
lninf	-9.157656	-9.159968	0.066746
lnrem	-8.651098	-11.70558	0.084802
Critical value at 1%	-3.51	-3.507	0.739
Critical value at 5%	-2.90	-2.895	0.463

All variables are stationary at 1 percent level of significance.

**Table 4.** Results of the co-integration test.

Series	Max-Eigenvalue statistic	95% critical value	Trace statistic	95% critical value
<b>F11*</b>				
r=0	39.58918	38.33101	73.75751	69.81889
r≤1	18.45838	27.58434	41.22087	47.85613
<b>F12**</b>				
r=0	39.58918	33.87687	74.14240	69.81889
r≤1	18.55447	27.58434	34.55321	47.85613
<b>F13***</b>				
r=0	33.44165	30.43961	63.57823	60.06141
r≤1	17.42397	24.15921	30.13658	40.17493

\*The trace test shows CE and max-eigenvalue none. \*\*both trace and max-eigenvalue show one CE. \*\*\*both trace and max-eigenvalue show one CE.

Table 3 shows that all variables are stationary since the calculated ADF exceeds the critical value at 1 percent levels of significance. Hence, all the variables are integrated of order 1, that is,  $I(1)$ . The PP test supports the findings of the ADF test except for per capital GDP which is stationary at levels at 1 percent level of significance. Taking a decision on a simple majority of the unit root test all variables can be used to run the co-integration test.

### Co-integration test results

In performing the co-integration test, each equation was estimated in levels in order to decide on the appropriate order using the Schwartz Information Criterion (SIC). The choice of this, the SIC is motivated by the fact that it favours more parsimonious specifications (Verbeek, 2000). The results are summarised in Table 4.

Table 4 indicates that both the trace and maximum-

eigenvalue suggest rejection of the null hypothesis of no co-integrating equation ( $r=0$ ) at 5 percent level of significance for F12 and F13. At the same level of significance, both tests point to the presence of one co-integrating equation for F12 and F13 and the null hypothesis of  $r\leq 1$  is not rejected. For F11 only the trace test shows evidence of one co-integrating equation and the max-eigenvalue suggests none at 5% percent level of significance. In general the co-integration results indicate that there is a long run relationship between financial development, openness, size of the economy and the inflation rate.

### Discussion of results

The long run results indicate that inflation bears a negative sign in two models, F11 and F13. This shows that inflation is detrimental to financial development. The dummy for financial liberalisation appears to have a

**Table 5.** Results for the long run relationship.

	<i>F11</i>	<i>F12</i>	<i>F13</i>
Constant	-8.87	232.81	-11.12
Inopen (-1)	-0.89 (-11.03)	24.36 (4.67)	-0.73 (-4.30)
Inrem(-1)	0.08 (2.06)	3.69 (1.50)	-0.09 (-1.14)
Incap(-1)	1.11 (7.21)	-37.23 (-3.83)	1.57 (4.86)
Ininf(-1)	-0.32 (-3.47)	33.71 (5.63)	-0.88 (-4.50)
Finlib(-1)	-0.33 (-3.70)	6.45 (1.13)	-0.34 (-1.75)
R <sup>2</sup>	0.37	0.17	0.37
Sample size	86	86	86

The t-ratios are in parenthesis.

negative effect on financial development in F11 and F13 specifications; however this variable is significant only in the F11 specification. This finding may indicate that removal of controls on interest rates did affect the financial sector positively suggesting that financial repression persisted even after the liberalisation reform (Motelle, 2008b). In equation F11 and F13, the ratio of per capita income to GDP emerges with a positive sign. This is in line with the demand leading hypothesis (without reference to any causal relationship) that as the economy grows, the demand for financial services increases thereby contributing positively to financial development. Trade openness bears a negative sign in two specifications (F11 and F13), which indicates that openness to trade has an adverse effect on financial development. This can be a puzzling result in sophisticated financial markets in which export firms rely on domestic finance to meet their needs and remit their earnings through the financial sector. Nonetheless, this is a plausible result for Lesotho because most of (if not all) the export firms are externally financed and remit their export earning straight to their countries of origin with an insignificant portion remitted back to Lesotho to pay running costs such as wages. Remittances are insignificant in the F12 and F13 specifications; however, they appear significant with a positive sign in the F11. This suggests that in the long run remittance flows into Lesotho contribute positively to financial development perhaps by 1) helping children in recipient households to get education and gain labour market access and demand financial services, 2) overcoming the credit constraint they foster entrepreneurial activity in recipient households through creation of alternative vehicles of credit and 3) enabling recipient households to have a windfall to meet immediate needs and save the surplus in financial institutions.

In the short run, remittances seem to have a positive effect on financial development but the effect is insignificant. In fact, all the variables do not seem to explain the short run dynamics in financial development that well because they are insignificant except inflation

and trade openness. This is in line with the low R<sup>2</sup> observed for the specifications which may point to omission of some important variables in the model. Inflation has a negative effect on financial development in the short and openness to trade has a positive effect. This may just have point to the need for intermediation of funds that come from abroad (external financing) to fund operations of foreign export firms. However, as seen in the discussion of results from the long-run model, these funds swiftly evaporate as export earnings are repatriated to home countries with the wage bill and other running costs being the only residue. An important variable that have been omitted from the model is the anatomy of institutions in Lesotho. Law and Habibullah (2009) observe that institutions are a major determinant of financial development. This is in line with the findings of Mohapi and Motelle (2007) that lack of leasing industry and credit bureau complicate the role of banks as financial intermediaries and downplays their role in the economy.

### Causality expose

Granger (1988) has shown that if two variables are co-integrated there must be a causal relationship between them at least in one direction. This study used a Granger causality test to determine the causal relationship(s) between remittances and financial development (Appendix A2). Results of the test are presented in Table 5.

Table 6 depicts that there is no causality running from remittances to financial development, nor is there any bi-directional causality between the two. Rather, F11 and F12 appear to Granger cause remittances since the null hypothesis of no causality cannot be rejected at 5 and 10% levels of significance, respectively. Hence, the more developed the financial sector is, the higher the propensity to remit funds perhaps due to the ease with which this can be done, or the cost efficiency with which it can be done.

**Table 6.** Granger causality between remittances and financial development.

Pair (rem and F1i)	Result	Decision
Inrem and lnF11	<i>Inrem</i> does not Granger cause F11 F11 does not Granger cause <i>Inrem</i>	Cannot reject Reject*
$\Delta$ Inrem and $\Delta$ lnF11	$\Delta$ <i>rem</i> does not Granger cause F11 F11 does not Granger cause $\Delta$ <i>rem</i>	Cannot reject Cannot reject
Inrem and lnF12	<i>Inrem</i> does not Granger cause F12 F12 does not Granger cause <i>Inrem</i>	Cannot reject Reject**
$\Delta$ Inrem and $\Delta$ lnF12	$\Delta$ <i>rem</i> does not Granger cause F12 F12 does not Granger cause $\Delta$ <i>rem</i>	Cannot reject Cannot reject
Inrem and lnF13	<i>Inrem</i> does not Granger cause F13 F13 does not Granger cause <i>Inrem</i>	Cannot reject Cannot reject
$\Delta$ Inrem and $\Delta$ lnF13	$\Delta$ <i>rem</i> does not Granger cause F13 F13 does not Granger cause $\Delta$ <i>rem</i>	Cannot reject Cannot reject

\*denotes 5 percent level of significance and \*\* denotes 10 percent level of significance.

## Conclusion

This essay attempted to empirically establish the effect of remittances on financial development in Lesotho. Remittances tend to have a long run effect on financial development; however, they do not cause financial development. In the short run this effect evaporates. Trade openness and inflation have significant effects on financial development both in the short and long run. The former has a negative long run effect and a positive short run effect, while the latter has a negative effect in the short and long run. Financial liberalisation and the size of the economy have only long run effects on financial development. The Granger causality test reveals that financial development causes more remittances. Hence, looking at the role of remittances in Lesotho, as discussed at the outset of the essay, the development of the financial sector can help increase the propensity to remit. This is an important lesson for the authorities.

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**Appendix A1.** Definition of variables used in the model.

Variable	Definition	Data Source
$F_{11}$	Ratio of liquid liabilities (broad money) to GDP	IFS
$F_{12}$	Ratio of demand, savings and time deposits to GDP	IFS
$F_{13}$	Ratio claims on the private sector to total credit	IFS
$Remu_t$	Value of remittances in year t	Central Bank of Lesotho
$X_t$	A vector of other variables: i) Inflation ii) GDP per capital iii) Trade openness (volume of export plus imports to GDP)	IFS
<i>Finlib</i>	Dummy variable for financial liberalisation: assuming the value of zero prior to 1997 and 1 thereafter	

All variables except finlib were used in natural logarithms.

**Appendix A2.** Causality test.**Pairwise Granger causality tests****Lags: 2**

Null Hypothesis	Obs	F-Statistic	Probability
LNREM does not Granger Cause LNF11	87	2.17364	0.12027
LNF11 does not Granger Cause LNREM		3.29204	0.04215

**Lags: 4**

Null Hypothesis	Obs	F-Statistic	Probability
D(LNREM) does not Granger Cause D(LNF11)	84	0.56998	0.68521
D(LNF11) does not Granger Cause D(LNREM)		0.81101	0.52207

**Lags: 1**

Null Hypothesis	Obs	F-Statistic	Probability
REM does not Granger Cause F11	88	1.47450	0.22800
F11 does not Granger Cause REM		6.79503	0.01079

**Lags: 2**

Null Hypothesis	Obs	F-Statistic	Probability
LNREM does not Granger Cause LNF12	87	0.42117	0.65769
LNF12 does not Granger Cause LNREM		2.53890	0.08515

**Lags: 2**

Null Hypothesis	Obs	F-Statistic	Probability
D(LNREM) does not Granger Cause D(LNF12)	86	0.25693	0.77405
D(LNF12) does not Granger Cause D(LNREM)		0.20032	0.81887

**Lags: 4**

Null Hypothesis	Obs	F-Statistic	Probability
REM does not Granger Cause F12	85	0.90409	0.46597
F12 does not Granger Cause REM		0.82177	0.51531

## Appendix A2. Cont,d

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<b>Lags: 2</b>			
<b>Null Hypothesis</b>	<b>Obs</b>	<b>F-Statistic</b>	<b>Probability</b>
LNREM does not Granger Cause LNF13	87	1.79722	0.17223
LNF13 does not Granger Cause LNREM		2.34548	0.10220
<b>Lags: 2</b>			
<b>Null Hypothesis</b>	<b>Obs</b>	<b>F-Statistic</b>	<b>Probability</b>
D(LNREM) does not Granger Cause D(LNF13)	86	0.55872	0.57413
D(LNF13) does not Granger Cause D(LNREM)		1.09444	0.33962
<b>Lags: 2</b>			
<b>Null Hypothesis</b>	<b>Obs</b>	<b>F-Statistic</b>	<b>Probability</b>
REM does not Granger Cause F13	87	3.13129	0.04892
F13 does not Granger Cause REM		3.25145	0.04376

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