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### **The Impact of the Credit Crisis on Poor Developing Countries and the Role of China in Pulling and Crowding Us Out**

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# The Impact of the Credit Crisis on Poor Developing Countries and the Role of China in Pulling and Crowding Us Out

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*Abstract.* We show that the credit crisis of OECD countries has a negative impact on the growth of the world economy according to an error correction model including China and Australia. This causes negative growth effects in poor developing countries. The reduced growth has a direct or indirect impact on the convergence issue, aid, remittances, labour force growth, investment and savings, net foreign debt, migration, tax revenues, public expenditure on education and literacy. We estimate dynamic equations of all these variables using dynamic panel data methods for a panel of countries with per capita income below \$1200 (2000). The estimated equations are then integrated to a dynamic system of thirteen equations for thirteen variables that allows for highly non-linear baseline simulations for these open economies. Then we analyze the effects of transitional shocks as predicted by the international organizations for the OECD and world growth for 2008 and 2009. Whereas growth rates return to the baseline scenario until 2013 with overshooting for China and Australia, the level of the GDP per capita shows permanent effects, which are positive only for China. In the poor countries, investment, remittances, savings, tax revenues, public expenditure on education, all as a share of GDP as well as literacy and the GDP per capita, are reduced compared to the baseline until 2087 where our analysis ends. Investment, emigration and labour force growth start returning to baseline values between 2013 and 2017. GDP per capita and tax revenues start returning to baseline around 2040. Education variables do not return to baseline without additional effort. Significantly positive short-run effects (the lagged growth rates) show that China has an impact on Australia, which has an impact on the OECD, which in turn affects the rest of the world. ROW has a significantly positive feedback effect on China.

JEL class.: F22, 24; G01, O15, J61.

Keywords: crisis; migration; remittances; accumulation; developing country growth.

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## 1. Introduction

In the business press and the publications of the OECD (see Schmidt-Hebbel 2009), the World Bank (see Ratha et al. 2008; World Bank 2009a) and the IMF (2009) some of the effects of the credit crisis on poor developing countries via reduced remittances, trade, aid and foreign debt are discussed. However, they are analyzed and discussed in a non-integrated manner using partial relations for short-term statements. In this paper we provide a model of difference equations that integrates many of the relevant aspects and allows having a look at the long and medium run as well, which are very uncertain so far (World Bank 2009b). We will discuss these aspects in the following and collect the arguments in Table 1 in order to allow the reader to follow the logic of the argument through the system.

The first aspect that has been discussed is the transmission of the recession in OECD countries to the world economy through reduction of demand for natural resources and other goods (12, 11)<sup>1</sup>. When the world economy grows more slowly or even at negative rates the world buys less machinery and other goods from the OECD countries. On the other hand, a reduced growth of the world economy leads to lower prices for natural resources and therefore is good for growth in the OECD. Which force dominates is an open issue a priori and may depend on the resource dependence and the size of the machinery sector of the respective countries (11, 12). The reduction in the growth of the world economy will lead to less demand for poor LDCs' exports (IMF 2009) – which are more dependent on world economic growth than richer countries (World Bank 2009b) - and therefore reduce their means to buy machines and therefore reduce growth (11, 2).

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<sup>1</sup> The numbers indicate the row from where the effect comes and the column where the effect arrives in Table 1. From the column of arrival one can trace all indirect effects through the matrix. The positive sign for OECD growth on World GDP growth holds for the world without China and OECD (ROW), and China separately in the short and the long run of the error correction model presented below. By implication the signs also hold for the China plus ROW indicated as WLD in the matrix.

A second issue that has been mentioned in IMF (2009) is the impact on development aid, which depends on growth of donors and recipients (12, 10), (2, 10). As the credit crisis hits first in the donor countries and only later in the receiving countries the fear is that aid first decreases before it perhaps increases later.

Third, worker remittances are expected to fall when the host countries of earlier migrants run into a recession (12, 4) and migrants may have to return (12,1).

The consequence of return migration is a larger labour force growth, (1, 3), slowing GDP per capita growth even further (3, 2) although it may encourage gross fixed capital formation (3, 6) if the latter becomes more profitable under a larger labour supply. Enhanced net immigration may increase savings (1, 5) brought into the country by immigrants, but remittances reduction through the crisis will decrease them (4, 5). Reductions in savings, if they are used as an indicator of a taxable surplus beyond existence minima will also result in less tax revenues (5, 7) and public expenditure on education (7, 8), and literacy (5, 9), indicating the possibility of serious social consequences of the crisis. A recovery will have the opposite effects. This leaves us with the question what happens in the short, medium and long run with all these variables. Table 1 indicates that there are many indirect effects among these variables as well.

In section 2 we discuss the methodology, in particular the data and the econometric method. Section 3 explains the results of the estimates. Section 4 presents the baseline simulations of the dynamic model. Section 5 compares the simulation to its counterpart after introducing the shock in line with current predictions for 2009 and its dynamic consequences. Section 6 summarizes and concludes.

TABLE 1 ABOUT HERE

## 2. Methodology

### *Modelling*

In order to estimate and integrate all the effects indicated in the introduction we set up a model consisting of thirteen equations. We cannot use the dynamic stochastic general equilibrium method for two reasons. First, the complexity of the issue is preventing modeling starting from utility maximization as there are many heterogeneous individuals: migrants and those left behind, migrants returning or not, lenders and borrowers, entrepreneurs and households, donor governments and receivers of aid. Second, migration and remittances beginning in the 1960s are a highly non-linear phenomenon of transitional growth that does not lend itself to log-linearized modeling for business cycles driven by stochastic trends models. We add the relevant non-linear relations<sup>2</sup> in accordance with the theory of migration and remittances (see Todaro 1969, Stark and Bloom 1985, Massey et al. 1993, Faini and Venturini 1994, Taylor 1999, Cinar and Docquier 2004, Rapoport and Doquier 2006, Bertoli 2006) and other areas of economics, in particular development economics, to lagged dependent variables well-known from the vector-autoregressive models (see Greene 2008).

Another interesting alternative tool could be computable general equilibrium models like USAGE (Dixon et al. 2008). It provides nice information on the macroeconomic variables and 38 sectors for the USA (and potentially Australia). However, international linkages other than trade and exchange rates are not present. For us the impact of aid, remittances and migration is essential in order to capture some of the most relevant development phenomena.

The last alternative model we like to discuss briefly is the computable general equilibrium model MAMS (Maquette for MDG Simulation; Lofgren and Diaz-Bonilla 2008). It has a module

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<sup>2</sup> The non-linear impact of the income difference between poor and OECD countries in the equations for migration and remittances below make it impossible to have a steady state.

for millennium development goals (MDG) and uses data from a social accounting matrix. Using this model Sanchez and Vos (2009) find interesting results for the effect of the 2007-2009 credit crisis on the MDGs and the cost to keep them on track. The model description mentions worker remittances only once in regard to the current account and migration not at all. Their effects can therefore only be included very implicitly. In a model which is to some extent dominated by constant-elasticity of substitution (CES) functions this may be not a serious drawback as the implied homotheticity property and the corresponding assumption of income and cost elasticities of unity do not provide much room for marginal income effects anyway. However, we could think of two places in MAMS where worker remittances could be integrated and achieve results similar to ours. First, in footnote 26 of Lofgren and Bonilla (2008) the possibility of having multiple households with different segments in the income distribution is mentioned. If their CES parameters are different from each other and remittances are received at an unequal amount by these groups they may have an impact in the core-CGE module for example on savings as in our regressions. Moreover, they may have an impact in the education part of the MDG module, if they were included, for example, in a similar way as per capita consumption. In addition, migration may be used in endogenizing population and labour force and perhaps other variables using arguments as in our regressions.

In order to avoid overlap and save space we postpone the detailed explanation of the regressions to the results section. We collect the estimated equations and specification details in an Appendix and refer to their number there in the subsequent text.

A major point of our approach is to take into account that remittances and aid do not only have a direct impact on growth but also many indirect ones, which are also relevant for the transmission of the crisis. These indirect channels - integrated into a system of equations - go

much beyond what pure growth regressions can show. Many of these effects may be standard reasoning in economics, but those in regard to remittances may be less familiar. Therefore we explain the logic of the indirect effects of remittances, but other effects only in the results section.

The first channel is as follows. Worker remittances are international transfers; therefore they enhance disposable income, which has an effect on savings ratios (equation (5)). In poor developing countries living in the neighborhood of an existence minimum one would expect that an increase in disposable income leads to an increase of the savings ratio. After remittances change savings, which finance literacy (equation (8)), literacy of the labour force makes investment more profitable and therefore enhances investment shares (equation (6)). Literacy also reduces population growth and reduces labour force growth many years later (equation (11)), which in turn reduces investment shares. Both labour force growth and investment have an impact on transitional growth rates of the GDP per capita and the level of per capita income (equation (3)). The second important economic mechanism is the effect of remittances directly and indirectly via savings – both providing the financial means either to migrate or to finance investment at home and stay - on migration in equation (12) and from there to labour growth in equation (11). The third channel is one of government reactions. Governments, when seeing remittances flowing into the countries, can increase or reduce tax rates and revenues (equation (9)) and public expenditure on education (equation (7)) depending on holding one of two competing views: If people have more money they can care for themselves and the government can withdraw and do less; alternatively, if people have more money co-financing of education may become promising in regarding to improvements of education. Again we get an impact on

literacy and from there on investment and labour force growth. These three channels go to the growth equation (3).

The link from migration to labour force growth and from there to growth is a strong feedback effect in our model. Another loop is the impact of growth on aid (equation (10)). This feeds back through the impact of aid on savings, taxes, public expenditure on education and literacy. It is this type of loops, which makes a dynamic system very interesting - as noted earlier by Lucas (2005) - in particular in connection with non-linear effects obtained in the estimates below. Once the credit crisis has affected GDP per capita, remittances (equation (4)), aid, and migration, they will carry the effects through the whole system. In particular, the direct effect of the (growth rate of the) GDP per capita in equations (4)-(6) and (10)-(12) also has a strong feedback impact on the whole system.

In order to run simulations with the estimated dynamic model, we also need an equation for the interest rate of the USA. As in dynamic stochastic general equilibrium models (DSGE) auxiliary equations are run just as autoregressive processes (equation (13)) in order to limit the number of equations of the model (see for example Acosta et al. 2008).

### *Data*

All data are taken from the WDI (World Development Indicators). We include 52 countries (listed in Appendix 1) selected by the criterion of having at least one dollar of remittances received in one of the recent years, receive development aid and have data for literacy and GDP. We include countries under (constant 2000) \$1200 GDP per capita. The reason is that we found in earlier work that the countries below \$1200 have slow growth in a panel average when looking at the period since 1960 (see Table 2). The richer countries mostly have a good growth

performance anyway. Poor countries may behave differently from the richer ones and therefore we concentrate on the poor ones who are likely to suffer more from a crisis and for whom shocks to remittances and aid are more important.

The data on remittances are official receipts in constant 2000 US\$.<sup>3</sup> Flows going via financial investments and withdrawals from related accounts are not included (see IMF 2005, p.99). Unofficial receipts may be high - Freund and Spatafora (2005) estimate that informal remittances are between 35 and 75% of the official ones - and important but we have no way to deal with the issue directly (see Adams and Page 2005). Data of the GDP per capita, *gdppc* and *OECD* are in constant 2000 US\$ and stem from national accounts. We would like to point out that not only remittance data but also GDP data underestimate economic activity because of the neglect of the informal sector. Schneider and Enste (2000, Table 2) report values of 25-76% of GDP for developing countries. This is the same order of magnitude as cited above for remittances. For developed countries these values are lower. The imperfection of remittances data is broadly discussed in all recent related papers. That of GDP data is not mentioned anymore, but it may be as severe.

Interest rates, *ri* and *rius*, are real rates as obtained by use of the GDP deflator and taken from the IMF IFS Yearbook into the WDI data. Savings, *savgdg*, are gross national savings from national accounts, calculated as GDP minus consumption, plus net current transfers and factor income from abroad and expressed as a share of GDP.<sup>4</sup> As investment, *invgdg*, relates to the demand of net debt flows we use gross capital formation (formerly called gross domestic investment) as a percent of GDP. The major difference with gross fixed capital formation as a

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<sup>3</sup> In the WDI there are surprisingly many zero values, which are quite implausible because they are preceded and followed by positive values of non-negligible size. We have turned them into 'non available'.

<sup>4</sup> Using savings as share of GNI does not change regression results here. As we need investment as a share of GDP in the growth regression, we use also savings as a share of GDP to get an immediate view on the current account, which is the difference between the two.

share of GDP, *gfcfgdp*, is the inventories, which are not investments that add to the capital stock. All savings and investment data come from the national accounts. Literacy data, *lit*, from the UNESCO are available in the WDI. Data on public expenditure on education, *peegdp*, are from the UNESCO and we take those of several versions of the World Development Indicators. Data on official development aid include loans containing at least a grant element of 25%. Data on migration measured as number of persons are five-year estimates of the United Nations Population Division. Labour force data are from the ILO.

The panel average values and growth rates of these data are presented in Table 2. These data show positive growth rates of GDP per capita. Investment/GDP and savings/GDP ratios also have positive growth rates for these poor countries. Investment/GDP ratios are higher than savings/GDP ratios inducing indebtedness. Average remittances per unit of GDP are 2.9% and growing at a rate of more than 6%. It is often stated that remittances are larger than aid for all developing countries together. In our sample of poor countries though, aid is about 9% of GDP, more than three times as much as remittances.

TABLE 2 OVER HERE

### *Econometrics*

As we are dealing with a system of equations we might think of contemporaneous correlation and the related seemingly unrelated regression (SUR) method or three-stage least squares extensions, which take this into account. However, fixed effects and lagged dependent variables are also relevant. They require the use of dynamic panel data methods. Dynamic panel data methods lead to the use of system GMM estimators, which yield better results than OLS or fixed effect estimators according to Monte Carlo studies (Baltagi 2008; Soto 2009). Unfortunately, system GMM methods and the corresponding Monte Carlo studies have not yet been

investigated in connection with simultaneous equation models. Therefore we have to choose between using fixed-effects and system-GMM methods in separate estimations for the economic equations or using the methods for simultaneous equation systems but abandoning fixed effects. Fixed effects turn out to be never redundant and random effects are never outperforming fixed effects. We assume that the interaction of the residuals of the equations as taken into account in the SUR method have a much smaller impact on the coefficients than the fixed effects methods and their major impact is one on the standard error. Therefore we prefer to estimate equations separately using fixed effects and system GMM methods. The bias of fixed effects estimates of coefficients of lagged dependent variables is known to be of the order of magnitude  $1/T$ , where  $T$  is the number of periods. Fixed effects underestimate in principle, whereas OLS overestimates the coefficient of the lagged dependent variable. According to Judson and Owen (1999) the bias in case of fixed effects is very small when  $T$  is above 30. When  $T$  is below thirty we try the system GMM estimator as explained in greater detail in Chapter 8 of Baltagi (2008). This method specifies our equations in terms of levels using first-differences as instruments and in terms of first differences using level as instruments and restricts the coefficients of these equations to be the same for the corresponding variables. We use its orthogonal deviation variant of the Arellano-Bover (1995) method. The use of this method has to result in two properties of an estimator. First, the estimated coefficient should be between those of fixed effects and OLS estimates. Second, the Sargan statistic, which is increased through the use of instruments, should not be too high through the over-identifying constraints but rather at its value according to the chi-square distribution; but it should also not be too low, because this would indicate that either the instruments have no effect or too many are used (Roodman 2007). We have tried this for all equations. For the equations for growth, labour force, and migration, both conditions are fulfilled

although the difference between fixed effect and Arellano-Bover results are small. But the two criteria are never fulfilled simultaneously for the other equations. In these cases we probably have to live with a bias. The reason probably is that we mostly have close to thirty periods in the observations and then this bias may be very small. Moreover, we have used another advantage of the Arellano-Bover method. We run some regressions also using dynamic instruments for other supposedly endogenous regressors than just the lagged dependent variable (see Appendix 2 for the list of instruments). Results change only slightly.

The use of instruments in the system GMM method requires absence of unit roots. Applying standard panel unit root tests would not reject the null of a unit root hypothesis for the natural logarithm of the GDP per capita variable. However, in their standardized package version these tests do not take into account other regressors than a fixed effect and an individual specific time trend. Growth regressions though do this. There it is accepted wisdom that in the regression of the growth rate on other variables the lagged level of the GDP per capita has a significantly negative coefficient and by implication no unit root. Therefore system GMM is often applied to growth regressions (see Bond et al. 2001, and Giuliano and Ruiz-Arranz 2008). A similar argument can be made for worker remittances as a share of GDP. Standard tests for unit roots show mixed evidence in our sample as in that of Ramirez and Sharma (2008). We assume, as they do, that worker remittances as a share of GDP have no unit root. Note that a unit root in variables taken as natural logarithms would imply a constant growth rate which would imply that variables which are shares of GDP exceed unity or go to zero in the long run. Moreover, assuming a unit root below in the regression for remittances results in a strong fall of the adjusted R-squared. For a more exact test we do not have the critical values (corresponding to those in the standard tests) for cases with other regressors than fixed effects and individual time

trends. There are no strong indications for unit roots for worker remittances as well as for other variables expressed as share of GDP per capita. In the growth regression, the logs of world GDP and the labour force of the country are likely to have unit roots, but they are cointegrated according to the panel cointegration tests by Pedroni (1999), Kao (1999) and Maddala-Wu (1999) and therefore can be used in the regression. Finally, a standard ADF test suggests that US interest rates have unit roots. Where they appear in the equations they are also cointegrated with the income difference of the OECD and the poor countries in equation (4) below. The US interest rate will not be determined in the model but will be considered to be an autoregressive process. With the entire panel related variables and equations we remain in the realm of having more countries than periods and for panel cointegration methods the number of periods is too small.

On a more intuitive level we also carry out the following robustness checks. (i) We checked forecasting properties in Table A.1 for all fixed effects versions of the regressions (see working paper version). (ii) All non-linear results are plotted (not shown) in order to check for counterintuitive effects from over fitting that are unlikely to be working well in extrapolations. (iii) In the system simulations we check for end-of-sample realism meaning that simulation values should be within one standard deviation of that of the panel average of the most recent years. (iv) We check for the long-run stability by way of simulation for several decennia (the purpose is not to consider them as forecasts). Simulation is a simple spreadsheet exercise. Circular references between cells are solved iteratively. Whenever we detect a problem we try to improve the regressions by either improving t-values<sup>5</sup>, adjusted R-squared or Durbin-Watson

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<sup>5</sup> When regressions are run merely to compare them to some theory one may of course leave insignificant variables in the regression. When the validity of theory is unclear or several theories contain valid elements and the total body of theory is fairly complex as in an area of our paper we prefer to drop insignificant variables from simulations in order to avoid effects of collinearity on coefficients, which might have strange effects in the simulations.

statistics and not dis-improving the others. The more general point here is that any flaw in the regressions is likely to generate problems in the simulations through the interactions of the equations, which transport any flaw in one equation into unrealistic simulations results in other equations. In the estimation-of-systems literature this problem is called ‘contamination’ of equations through flaws in other equations (see Akhand and Gupta 2002). As a matter of experience with simulations we learned here that not all good-looking regression results yield good simulations and sometimes require searching for improvements.<sup>6</sup> It is this multiple check through estimation, forecast of single equations and simulations of the whole system that indicates the robustness of our results.

### 3. Estimation results

Estimation results are collected in equation form in Appendix 3. The starting point of the model is the growth relation for the natural logarithm of the GDP of China (CHN), Australia (AUS), the OECD without Australia (ROEC), and the world economy without OECD and China (ROW). We assume that they depend on each other in the form of an error correction model, which contains a long-term relation in the cointegrating equation (1), denoted *CE*, and the country equations (2a-d). The long-term relation in the error correction term can be read as a positive effect of the GDP of China, Australia and ROW on ROEC growth, the coefficient of which has been normalized to unity. Normalizing the coefficient of the rest of the world to unity instead (not shown) reveals that China and Australia have a negative long run relation with ROW, whereas the ROEC has a positive one. Normalizing the coefficient of China to unity (not shown) reveals that there is a negative long term relation with Australia. As the first Asian tigers, China

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<sup>6</sup> Nakamura and Nakamura (1998) also emphasize the relevance of simulations and caution against the disadvantages of instruments.

is a major competitor to all but ROEC in the long run. Coefficients of adjustment to the cointegrating equation (CE) show that only China and Australia react significantly to deviations from the long-term relationship.<sup>7</sup> Significantly positive short-run effects (the lagged growth rates) show that China has an impact on Australia, which has an impact on ROEC, which in turn affects the ROW. ROW has a significantly positive feedback effect on China. A less significant negative short-run effect goes from China to ROEC. As China reacts most strongly to a disequilibrium in regard to the long-run relationship as caused by the credit crisis, the indicated chain from China may be very important for the way out of the crisis.<sup>8</sup> Equations (2a-d) are four equations to determine the four GDP variables of China, Australia, ROEC and ROW once the cointegrating equation, *CE*, is inserted.

*The growth regression: The direct effects of the world economy and international transfers.*<sup>9</sup>

Equation (3) endogenizes the growth rate of the GDP per capita of the poor developing countries, which depends on the GDP of the World (obtained from adding the GDP of Australia to that of the OECD and OECD and China to ROW after simulating the ECM forward). We use five-year intervals for the lagged dependent variable here for three reasons. First, we do want to get rid of business cycle effects, which would be contained more strongly in one-year lags. Second, we do not want to apply the method of using five-year averages for reasons discussed extensively in Loayza et al. (2000) and Attanasio et al. (2000). Third, lagged dependent variables with a five-year lag are probably less strongly correlated with other regressors reducing effects from

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<sup>7</sup> Taking ROEC or the ROW out the error-correction model leads to much worse results. We leave all the four in the ECM because they have either a significant coefficient in the long-run relation or in the adjustment coefficient.

<sup>8</sup> Because of the low adjusted R-squared for ROW we have also tried other versions of the model, but then not all interactions are brought to the fore. Moreover, whenever one (group of) countries is taken out, the information criteria dis-improve considerably. Therefore the referee who suggested explicit consideration of China and Australia had a convincing guess. On the other hand, some skepticism seems due in regard to the very high long-run growth rate of China generated by the error-correction model.

<sup>9</sup> Two lagged dependent growth rates functioning as serial correlation correction in equation (3) are not reported.

multicollinearity. In regard to the variable ‘investment as a share of GDP’ Attanasio et al. (2000) have pointed out that growth regressions tend to use the investment data over the same period as the dependent variable whereas vector-autoregressive approaches use lagged investment and both get opposite signs. We try both but only current investments are significant. Gross fixed capital formation as a share of GDP and labour force growth have the expected sign and are significant. Current investment and labour force growth may suffer from an endogeneity bias. Using lagged instruments in the Arellano-Bover method corrects for this (see Appendix 2).

Remittances are also included because they may have direct effects via effort as in Chami et al. (2003) or via credit market effects as in the literature discussed above or via sectoral allocation effects.<sup>10</sup> In the relevant range remittances have a positive impact on growth in equation (3).

Foreign aid has a negative impact. The result is plausible because for poor countries much of the aid serves emergency and poverty alleviation and some parts are just lost in the political and administrative process. These effects may bias the sectoral structure towards consumption sectors, which possibly have lower growth than those of exports because they serve relatively more poor people and include agriculture whose growth rate is limited in many poor countries.<sup>11</sup> Aid may also weaken democratic institutions (Djankov et al 2008), which may have a negative impact on total factor productivity (Rodriguez 2006). The indirect effects of aid on growth via other equations discussed broadly in a companion paper are positive though and outweigh the direct ones. The amount of aid is also an indicator of bad times because of famines, earthquakes, and tsunamis et cetera, which may shift the sectoral allocation and can reduce the productivity of

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<sup>10</sup> See also Timmer and Szirmai (2000) and Rodriguez 2006. For references to single-country studies of the effects of remittances see Taylor (1999, p.70) and Ramirez and Sharma (2008).

<sup>11</sup> For the richer sample used in complementary work we find a significantly positive sign for aid. On the topic of parameter heterogeneity for different samples see Hineline (2008).

the economy. This is an endogeneity we deal with by use of lagged aid variables as instrument (see Appendix 2).

The opposite results for remittances and aid within the group of poor countries is also quite plausible in view of the fact that emergency aid may go predominantly to the poor strata whereas remittances are obtained by those who are able to afford the cost of migration (see IMF 2005, p.73), if the former spend more on non-traded goods with lower productivity.

Depending on whether or not the time trend is significant in standard growth regressions we would have permanent or only transitional growth. In models with imported inputs (see Bardhan and Lewis 1970) one finds also the growth rate of exports at constant terms of trade, which should be an income growth term in an export demand function, and therefore is approximated here by the world GDP. Constant long-run growth in the world economy allows for positive permanent growth in this model. Exports and this latter growth rate have to be taken relative to the size of the labour force of the country under consideration though. Therefore we include the natural logarithm of the labour force here as well.<sup>12</sup> The GDP of the world, included as  $\log(WLD)$ , and the level of the labour force,  $\log(L)$  have coefficients of the same order of magnitude and would be closer to each other if we had the lower employment data instead of those for the labour force.<sup>13</sup> Without the world income variable, a time trend would be

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<sup>12</sup> We will discuss the plausibility for the steady state results quantitatively below. As we need the world GDP here and not its per capita value, but we need the GDP per capita of the OECD in the migration and remittance equations we run a regression of the log of the OECD population on two of its lags and a time trend, and made a forecast of the growth rate and the level. This can be used to transform the GDP of the OECD into a GDP per capita. See also the footnote relating results to the growth model used by Mutz and Ziesemer (2008).

<sup>13</sup> The standard steady-state assumption from growth theory would be a constant value of all variables which are expressed as a share of GDP and constant growth rates. Under these assumptions taking first differences of equation (3) leads to a formula that is familiar from the Bardhan/Lewis (1970) model:  $d(\log(gdppc)) = 0.81d(\log(gdppc(-5))) + 0.196d(\log(wld)) - 0.148d(\log(l))$ . In terms of steady-state growth rates this implies  $g_y = 1.03g_w - 0.78g_L$  with  $g_y$  as the growth rate of the GDP per capita,  $g_w$  that of the GDP of the World, and  $g_L$  that of the labour force. Inserting 4% for World GDP growth we get  $g_y = 0.0412 - 0.78g_L$ . At a labour force growth rate of 2% will our result for poor countries be equal to 2.56%, that of the OECD. At a labour force growth rate of 1% we get a steady-state growth rate of 3.34%. As China gets an increasing share in World GDP and has a high growth rate, these are quite reasonable results for economies which import their capital goods and therefore are driven by the world income term

significant. The ordinary time trend would be associated with total factor productivity growth, whereas world income is an argument in the export function of models with imported inputs (see Mutz and Ziesemer 2008). As the time trend is insignificant when both are included, world income seems to be more relevant than the former in developing countries. The literacy variable is insignificant. If we drop  $\log(wld)$  and  $\log(l)$  - several of the papers cited do drop the labour variables from the regression although it is crucial in growth theory and often significant in the literature -, literacy becomes significant. In related work on richer countries we find a significant effect for both, literacy and world income. The reason for the insignificance may be that the countries are specialized in sectors that use predominately unskilled labour, because of the countries' low human capital endowments.

Finally, we will add some lagged dependent variables as an autocorrelation correction hoping that this absorbs the serial correlation and allows interpreting the other regressors as growth effects.<sup>14</sup>

We expect the credit crisis to affect growth through the reduced growth of the GDP of the world and through the reduction of remittances if it is larger than that of the GDP in its denominator of the variable,  $wr/GDP$ .

#### *Worker remittances: The credit crisis hits directly*

Equation (4), explaining worker remittances as a percentage of GDP  $wr/gdp$ , is the logical next

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in their export function (see Mutz and Ziesemer 2008 for a theoretical formulation and estimation of an explicit growth model without linearization).

<sup>14</sup> The ideal response to serial correlation in growth regressions is probably to merge models of growth and cycles. The fact that some exist does not automatically mean that serial correlation vanishes, because the integration is mostly based on one aspect only, such as stochastic technical progress. However, the serial correlation may have other causes such as changing situations of too optimistic and too pessimistic expectations. Therefore we work with the traditional serial correlation correction of adding (growth rates of) lagged dependent variables (see Greene 2008).

point. The equation is similar to that of Chami et al. (2003) and others earlier<sup>15</sup> containing the differences of income and interest rates of the recipient and the sender country. Therefore we include the income of the recipient country. The sender knows his own current income. As many migrants go to the OECD countries or want to go there after having migrated to other countries first we represent their income by per capita income of the OECD, *oec*.<sup>16</sup> The sender will have information on the recipient country only from data about earlier years because it takes about one year or more in many countries to make the data. An indicator of the recipients' income is therefore the Gross Domestic Product per capita with some lags, *gdppc(-x)*. The two income variables need not have the same absolute value of the coefficient because the OECD income is only a crude proxy that comes in because we use only one indicator for the host country of the senders.<sup>17</sup> The sender might consider saving the amount of money rather than transferring it. Therefore we use the real interest rate of the USA, *rius*, as an indicator of these opportunity costs, also because we don't have an average interest rate for the OECD countries. On the other hand the sender might consider putting the money into a bank account in the recipient country. Therefore we also include the real interest rate of the recipient country, *ri*, also with some information lag. Next, remittances are assumed to depend on (a polynomial of) their own past value, a constant and a time trend, which will be dropped if insignificant. As real interest rates can be highly negative we add a value of 1 to it, before taking natural logarithms, because we use interest rates in their scientific notation, that is, 5% is indicated by '0.05'. Essentially equation

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<sup>15</sup> See also El-Sakka and McNabb (1999) and the references there.

<sup>16</sup> Niimi and Özden (2006) provide some evidence that migration to Gulf countries does not yield different results than to the OECD in explaining remittances flows.

<sup>17</sup> We do not use the Gross National Income as senders are more likely to receive information on GDP than those of GNI through the media. Moreover, the effect of capital income may be captured by the interest rate arguments included and explained below.

(4) as explained so far is the one that appears also in Chami et al. (2003).<sup>18</sup> Using natural logs for the remittance variable gives slightly worse results.<sup>19</sup> Further below we will provide equations explaining the dynamics of the interest rates. Worker remittances as a share of GDP in equation (4) depend on their own past values in a highly non-linear way as one might expect for variables at the beginning of their history.<sup>20</sup> The sum of all lagged dependent variable expressions has a surprisingly constant negative value of about 0.06 if we plot it against the change of the remittance ratio. A negative value is plausible if sending money in one year implies a reduction in the next, be it because of the negative correlation of past unfavourable shocks in the income of the receiving countries or because of the limitations in money available. Next, interest rates in the USA reduce remittances. Domestic interest rates are insignificant. This confirms the result by Vargas-Silva and Huang (2006) for a smaller sample that home country variables have a weaker impact on remittances than host country variables.

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<sup>18</sup> Chami et al. (2003) use the real income of the USA instead of that of the OECD. The correlation of these two series is  $gdppcusa = 3071 + 1.12oec$  with an adjusted R-square of .99 and t-values 116 and 885 respectively. It should not matter which of these is used.

<sup>19</sup> An important variable related to the focus on market imperfections of modern migration theory is public expenditure on education as a share of GDP, *peegdp*, which indicates that migrants may send more money if the government spends less on education. If this is the case for current and lagged values then we would think of a structural relation indicating an investment motive. If, however, this occurs only when *peegdp* is currently low but not for lagged values we would interpret remittances as private 'emergency' aid making sure that schooling plans can be realized in times of budget cuts. Public expenditure on education as a share of GDP is a variable that is highly insignificant once we use panel corrected standard errors of the cross-section-weight type. If we drop it net immigration flows also become insignificant. Therefore we drop them both from this equation.

Past migration may have an impact on remittances. In the meanwhile Docquier has made data which can be found on the World Bank website [http://siteresources.worldbank.org/INTRES/Resources/469232-1107449512766/Docquier\\_1975-2000\\_data\\_Panel.xls](http://siteresources.worldbank.org/INTRES/Resources/469232-1107449512766/Docquier_1975-2000_data_Panel.xls). The stock data cover the migration stocks to six rich countries: US, UK, Canada, Australia, France and Germany. It is far from clear whether or not net migration flows, which are available, will have a significant impact.

<sup>20</sup> When the GDP part of a variable appears with a fraction sign for variables we have made ourselves, we have algebraic values like 0.02. Then high positive exponents make them even smaller because they are below unity as in the case of  $wr/GDP$ . The variables without a fraction sign like *peegdp* are taken from the WDI and 5% then is 5 because the World Bank multiplies them by 100. If we would multiply all the remittance variables by 100 the coefficient of -2.95 goes to 0.64 because of the highly nonlinear nature of the regression.

The major impact of the crisis in this equation is the fall of the OECD income leading to a drop of remittances two years later and when the GDP per capita of the recipient country falls as well this will increase remittances.

*Savings: Crisis effects via worker remittances and return migration*

The next step is to explain the impact of worker remittances on savings in equation (5). Remittances and migration are added to an equation explaining the savings ratio. Basically, we would assume that the savings ratio, *avgdp*, is driven by its own past value and, as in most of the literature (see Loayza et al. 2000, Table 1), by the growth of GDP per capita and real interest rates. As disposable income is conceptually probably a better variable (see Bertoli 2006, eq. (6)) but also less available in terms of data we may add worker remittances to the regression, which are part of disposable income but not part of GDP. The idea here is that higher disposable income and therefore remittances lead to a higher savings ratio as in theoretical models using the difference of consumption and an existence minimum for consumption in the utility function when the country in question is close to that minimum. Moreover, we add official development aid to the regression because aid is also an international transfer and might be significant according to the single-equation-estimation literature (see Doucouliagos and Paldam 2006). Again related to market imperfections, people may want to save less if the government takes over the cost of schooling through higher public expenditure on education as a share of GDP. Finally, immigrants bring savings with them and emigrants take savings out of the country. These savings of migrants may have an impact on the savings rate, in particular if migrants get work only with some delay but bring their savings into the country without delay. The results are presented in equation (5). The lagged dependent variable has a positive impact. Worker remittances have a positive, slightly decreasing effect for the relevant range until 11.7% of GDP.

Public expenditure on education (squared) has a slightly negative impact: If the government spends more on education households save less. Official development aid has a negative impact even if aid were tripled. Finally, an increase in net immigration, or less emigration, would increase savings ratios. Again we have a high loss of observations from gaps in the data. We also have a low Durbin-Watson statistic, but we don't worry about it here because it is probably due to the low number of observations in the time dimension when five-yearly migration data are used.<sup>21</sup>

Via the growth rate of the GDP per capita in the equation for remittances and migration (see below) the crisis shocks affect the savings rate. If growth rates and hence remittance ratios go down this has a negative effect but return migration may have a positive effect. The net effect is unclear unless one runs numerical simulations as we do below.<sup>22</sup>

#### *Investment rates decrease with growth in the crisis*

Gross fixed capital formation as a share of GDP depends on its own lagged value, and lagged growth rates, as an indicator of the business cycle and of expectations of future demand and the future need for investment. Moreover, as in the savings equation we add official development aid. Donors can try to enforce - by tying to imports from donor countries or through the World Banks Oil-and-Dams program - that aid is invested<sup>23</sup>. Investors can try to use the fungibility of money to leave investment unchanged by shifting their own money elsewhere. As the coefficient of aid is significant this also implies that the fungibility of money does not lead to a withdrawal

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<sup>21</sup> Interest rates could be added to this equation at the cost of reducing the significance of other variables and changing their values. In simulations the result are too high savings, going beyond investments, which is never the case in the sample period. Using the Arellano-Bover method we get lower coefficients of the lagged dependent unless the number of instruments is two-thirds that of the observations; then we get about equal coefficients; therefore we stick to the fixed effect method.

<sup>22</sup> The GDP per capita growth rate dropped out of a regression with yearly data when introducing the migration flows because of the implied five-year periods.

<sup>23</sup> This does not necessarily mean that the type of investment or even the enhancement of it is efficient.

of domestic money at an equal amount. Remittances may have a higher marginal propensity to invest than average income (growth) if the migrants are from relatively rich families and migrate in order to earn the money they can't get from imperfect capital markets. Poorer households are more subject to credit rationing (see IMF 2005, p.77 and Adams 2006). Then their investment may not exceed their savings. With investment limited by savings for sufficiently many households, investment may have the same sign for the interest rate variable as savings or be independent of interest rates. Remittances and aid may relax the credit constraint at the individual level and therefore be significant variables, although the economy has some capital inflows from abroad. Finally, we add employment growth approximated by labour force growth and changes of literacy. In accordance with production theory a higher input of skilled and unskilled labour increases the marginal product of capital and makes more investment profitable. Vargas-Silva (2007) finds a positive impact of remittances on investment for Mexico. This should not be the case if credit were freely available. However, firms and in particular household producers may be credit rationed. Taylor (1999) emphasizes the impact of multiplier effects occurring even if remittances go into consumption in the first instance. The preferred regression for investment is as in equation (6). Aid and lagged growth rates of GDP per capita have a positive impact on investment. As remittances have an impact on growth and therefore have an indirect impact here but no direct one is in line with the multiplier idea. The effect of aid may also stem from tying aid to the export of donor countries' machinery sector. Boone (1996) is often cited as finding a negative impact of aid on investment. However, he reports positive effects for small countries with high aid/GDP ratios, which are generally small and poor countries as many in our sample. Labour force growth and changes in literacy have both a positive impact on investment. We will see next that remittances enhance literacy and therefore

they have a second positive indirect impact here. A reduction in GDP per capita growth, in aid and labour force growth through the crisis will reduce investments of the poor countries.

As interest rates have no impact on savings and investment we refer the reader to the working paper version for results on interest rates.<sup>24</sup>

*Public expenditure on education: The crisis hits via reduced remittances and tax revenues*

Besides the impact of remittances on physical investment and savings, remittances may encourage public expenditure on education in financing schooling, directly or via savings. However, it may also be the case that governments provide less money for education if people have more private money from remittances. When more tax money or aid is available expenditures on education are likely to rise. Equation (7) tries to capture this political behavior. Public expenditures on education are positively related to the amount of taxes raised (by the central government as a share of GDP). Remittances and aid have positive effects in poor countries. Governments react positively to aid and remittances, which could express an attitude of co-financing: if donors and domestic people put in more money the government may get convinced of doing the same, in particular because they do not have to pay alone and get a stronger effect for a certain amount of additional money.

If the crisis reduces tax revenues, aid and worker remittances as a share of GDP public expenditure on education will fall as well. This will also depend on effects on the denominator of all of them.

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<sup>24</sup> Investments are independent of interest rates or, alternatively, would have a positive sign, which could be justified by a strong impact of credit rationing for a large part of investors or interest ceilings. In both cases investments are limited to savings, for example of producer households, and savings react positively to interest rates and so do investments. If the share of the population suffering from credit rationing is large enough, a positive impact of interest rates on investments is also plausible. We use the regression without positive interest effect because it has a much higher adjusted R-squared and it covers eight countries more.

*The crisis hits education: Change of literacy financed by aid, savings and public expenditure*

Public expenditure on education is then used together with savings and aid to finance schooling. This results in higher literacy, which is captured in equation (8). Savings, if available at the moment of enrolment, can be used to avoid credit constraints. A higher savings ratio together with higher public expenditure on education and development aid leads to higher literacy with some lags. By implication, the concept is that remittances have an impact on human capital via savings; via savings entering the equation for public expenditure on education, and savings and public expenditure on education entering the literacy equation.<sup>25</sup> Literacy data are used as a proxy for human capital. They have a good variation in our sample over time and across countries. Cinar and Docquier (2004), Rapoport and Docquier (2006) and Adams (2006) report evidence of positive impacts of remittances on education.<sup>26</sup> In equation (8), we have to resort to polynomial distributed lags (Almon lag) again probably because effects are spread out over five years from money financing beginners and preventing drop outs. Development aid, savings and public expenditure on education all enhance literacy. For savings there are three lags and the current value and for public expenditure on education there are four lags and the current value. Polynomial distributed lags are well known to be a good way of handling multi-collinearity but also to cause serial correlation resulting in a low Durbin-Watson statistic (here also in connection with a time dimension lower than five because of five-years data for literacy). As all these variables are measured as a percentage of the GDP it is interesting to see the differences in the coefficients. Development aid has the highest coefficient, perhaps because aid, for example from the Netherlands, is often tied to education. Probably this induces some reduction of private

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<sup>25</sup> Mazumdar (2005) has suggested public expenditure on education as a share of GDP. It is insignificant in his cross-country regressions but significant in our fixed effects estimate with lagged dependent variables presented below, which suggests that there is a dynamic impact.

<sup>26</sup> See also the theory of Cinar and Docquier (2004) and Bertoli (2006).

savings being used for this purpose because they have the lowest coefficient. But this reduction is still imperfect because under imperfect capital markets savings remain important. There is no complete crowding out of private money through aid. The expected reduction of aid and the following two channels are important ways how the crisis affects literacy. The effects of emigration and remittances on savings presented above have an indirect effect on literacy. Similarly, the effect of remittances on public expenditure on education has an indirect effect on literacy.

*Lower savings and remittances reduce taxes during the crisis*

As public expenditures on education are dependent on tax money we explain the latter in equation (9). Tax revenues as a share of GDP depend on their own past value. If people save more they signal that they have a surplus product and therefore might be willing and/or able to pay more taxes. More worker remittances resulting in higher savings therefore may be an argument to tax people more or less heavily. On the one hand there is more money available that can be taxed. On the other hand the government may want to tax less as people can care better for themselves if they have more money and the government may want to withdraw. In equation (9) tax ratios depend on their own lagged values and a very small quadratic one, which is positive. Worker remittances have a negative impact in the relevant range. Via this channel remittances reduce education working against the positive effects discussed above. But if people save more, indicating a higher surplus product, the tax ratio is also increased.

The credit crisis will have an effect on the denominator of the tax ratio. Indirect effects come via savings and remittances to the tax variables. These effects are similar to those of remittances and savings on the education variables.

*Aid: Donors react to growth of the poor countries and to their own and transmit the crisis*

Official development aid helps financing literacy directly in equation (8) and indirectly by providing an incentive for more public expenditure on education in equation (7). Aid as a share of GDP depends on its own lagged value and is negatively dependent on the growth rates of the recipient countries and positively on that of the OECD countries, the major donors, in equation (10). In other words, aid is reduced if a country is doing better relative to the donors. Low growth countries will therefore keep a high share of aid, but high growth countries will get less aid over time.

As the crisis first hit in the OECD and then in the poor countries the  $oda/gdp$  ratio will first go down and then up because of the lags and the long term effects do their work.

*Endogenous labour force growth*

Next, we need an equation for the growth of the labour force. According to growth theory and empirics, a major contribution to growth may come from the reduction of population growth. However, in empirical work the crucial variable is the one entering conceptually the production function: equilibrium employment or its growth, approximated here by labour force growth rates. Labour growth is preceded by population growth. The literature there says that education of women leads to a slow down of population growth. Therefore we include literacy with a large lag. Labour market literature says that higher growth encourages people to (re-)enter the labour market in some countries but not in others.<sup>27</sup> This suggests including the growth rate of GDP per capita. Development aid may encourage people not to go to work but rather to education or other (in-)activities and to return to the labour market later or aid may save lives and thereby increase labour supply sooner or later. Literacy has no direct impact on growth according to equation (3),

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<sup>27</sup> See López-Bóo (2008) for a recent discussion.

but it has an indirect one via the labour force growth in equation (11). These are two indirect channels for remittances to have an impact on growth via labour force growth. Labour force growth depends on its own linear quadratic lagged values. Literacy as of 13 years ago reduces it. This effect probably stems from lower population growth 13 years earlier. Development aid as of five years earlier also enhances labour force growth. Net immigration also increases the labour force immediately, indicating that some people are allowed to immigrate for the purpose of work. Finally, growth of GDP per capita in the previous year encourages people to enter the labour market in poor countries.

The crisis leads to a decrease of the GDP per capita growth and therefore one of the labour force growth whereas return migration (higher emigration) does the opposite (the same) at least in the short run.

#### *Return migration or more emigration after the crisis?*

As immigration has an impact on labour force growth according to equation (11) and on savings according to other equations we need an equation for them to have all variables endogenous in the system. In equation (12), the lagged dependent variable normally is interpreted to reflect network effects and expected to have a positive sign (see for example Hatton and Williamson 1998, Chap.4, and Mayda 2007).<sup>28</sup> We get a positive sign for an OLS estimate (known to be too high in dynamic panels), but a negative one when using fixed effects (known to be underestimating) or the panel systems GMM reported. The negative sign may stem from migration that is caused by natural disasters or political conflict including war and civil war. These may be negatively correlated with similar events five years later. In addition, if a person in a network has financed the costs of migration for one person then, for relatively poor countries

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<sup>28</sup> For an extensive discussion of international migration theories see Massey et al. (1993).

like those in our sample, the probability that another one can be financed five years later may be very low and affected negatively. This may be different for large stocks of migrants when such uncertainties and fluctuations are averaged out over a large number of people. Our result is more plausible for small stocks of migrants with much temporary migration as Hatton and Williamson (2002) report for Africans in the USA constituting a small network whose behaviour may resemble that of single persons in the presence of fluctuations.

The second argument is the backwardness in GDP per capita,  $GDP_{pc}$ , relative to that of the OECD,  $oec$ , which matters in a highly non-linear way. Most international migrants in the meanwhile go to OECD countries. However, many do not but go to richer neighboring countries. Only 15% of the migrants to the OECD come from low-income countries (Skeldon 2008). Countries that are loosing people to the OECD directly are willing to allow for immigrants from other countries. These countries in turn are willing to allow for immigrants from the next poorer countries. This constitutes a chain from rich to poor countries, where the incentive essentially stems from the rich end of the chain (see Ratha and Shaw 2007). In this perspective the GDP per capita in the OECD reflects the income that can be earned in the upper end of the chain. This income difference is only a rough indicator of what the migrant gets as an income change when changing the country of his location. Of course, he may not exactly have the average income before and after migration and the probabilities of getting a job in the new and old locations may differ. But still the income difference between the places of origin and destination is a good proxy for the revenue gain of the national and international migrants since the work of Todaro (1969) (see Mayda 2007 for an extensive discussion of modern literature).<sup>29</sup> According to our combination of data and simulations presented below the gap in terms of log-differences

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<sup>29</sup> Hatton and Williamson use wages instead of income in their papers. Note that for a CES production function the logs of relative wages are proportional to those of per capita GDP.

increased from -3.34 to -3.66 in the period 1960-1989 and the ratio of GDP per capita in the poor sample and the OECD goes from 3.44% to 2.56%, and improves afterwards; then catching up takes place in our simulations until a value of (-2.74 for log differences and 6.44% for the ratio) in 2092 when our simulation ends because remittances become zero. Briefly speaking, we first have slight divergence and then slight convergence tendencies, making emigration first more and later less attractive.

The next argument appearing in the form of current and lagged, linear and quadratic terms are worker remittances as a share of GDP.<sup>30</sup> This is what those who are left behind by the migrants get in order to solve the market imperfections like insurance problems and related credit constraints emphasized by modern migration theory (see Stark and Bloom 1985, Taylor 1999 and Rapoport and Docquier 2006). Remittances predominantly increase net immigration (rather than financing emigration) and reduce emigration in a slightly non-linear way. This makes sense because reducing problems from market imperfections makes sense only if some members of the family want to stay in the country of origin.

The last regressor is the savings ratio as of three years ago. In poor countries with less than \$1200 per year or \$100 per month it will hardly be possible to pay migration costs out of current income even if reconsidered in terms of purchasing power parity. It is necessary to save first. Whereas the income difference and remittances represent the incentives to migrate or stay, the lagged savings ratio represents an important part of the means available to carry the costs of migration. Remittances then finance emigration via their impact on savings. With a savings ratio of  $1/6 = 16 \frac{2}{3} \%$  an average family saves \$200 of the \$1200 or \$100 if it is half as rich. Over

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<sup>30</sup> Note that worker remittances as a share of GDP is a value below unity. Therefore the exponents do not have a strong impact as they would for values above unity.

three years this cumulates to \$300 plus interest earned. This might be enough to cover the migration costs without being payable out of current income.

The first and direct impact of the credit crisis then is the fall of OECD income inducing return migration and less emigration. This effect will be mitigated by slower growth in the poor countries themselves. For the remittances and savings variables it is a priori unclear whether their denominators or numerators are more likely to decrease.

The equations provided so far are the heart of the model. In addition, we have used US interest rates in equation (4) for remittances. For this variable we provide only an auxiliary equation in order to round off the model in a way that limits the number of variables in it. For US interest rates we find that they depend only on their own lag as shown in equation (13). In order to allow for a transition from OECD GDP to GDP per capita we need population data for the whole horizon. We run a regression of population growth on two of its lags and a time trend (equation (14) and use it for forecasts. The estimated equations of the error-correction model form a dynamic system in 4 variables; equations (3)-(12) form a system in ten other variables into which equation (13) feeds the values for US interest rates. The signs of the significant effects for the whole system are summarized in Table 1 – except for Australia and China who have an effect on the other equations as part of the OECD and the World GDP respectively - in order to allow for a quick check of the dynamic interactions. The system is used for a dynamic simulation and an analysis of the effects of the crisis in the next sections.

#### **4. Baseline simulations with the dynamic system**

The model is driven by the error correction model, its effects on the other equations, and the feedback effects in the system of equations (3)-(12). Forward simulation with the error-

correction model yields values for Australia and ROEC, which can be added up to yield values for the OECD, and values for China and ROW, all of which can be added up to world GDP. From there the effects go to aid and remittances, which feed back to growth of poor countries, and to savings, migration, public expenditure on education, and taxes revenues. Indirect effects go via savings to public expenditure on education and to literacy, and from there as well as from migration to population and labour force growth. The simulation of the system allows us to take all of these effects jointly into account. Thereby we automatically include second and higher round effects, which are missing in many other types of studies (see Adams 2006).<sup>31</sup>

#### FIGURE 1 OVER HERE

The simulation for equation (13) leads to a real US interest rate of about 4%. Equations (1) and (2a-d) result in steady-state growth rates of 8.16% for China<sup>32</sup>, 3.5% for Australia, 3.2% for ROEC, and 3.95% for ROW. The world GDP growth rate keeps approaching that of China, because of an increasing share of China in the World GDP due to its highest growth rate. In 2090 it is 7%. The other equations form a fairly complex non-linear system for which we cannot make many simple statements. The growth of the GDP per capita is shown in Figure 1. Its long run value goes from about 2% to higher values because of the increasing growth rate of the world economy. It gets larger than that of the OECD. Ultimately, in this simulation the increasing share of China ensures an asymptotic tendency towards convergence. In Figure 1 the lower curve is net immigration as a share of the labour force.<sup>33</sup> Values are negative and therefore we have net

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<sup>31</sup> As all regressions employ lags of some variables we have to construct initial values for each series. We do this by regressing the variable in question on a constant and a (quadratic) time trend for the first five years or more if necessary and use simple regressions in some cases for the early periods.

<sup>32</sup> The error-correction model does not generate a strong decrease in China's growth as one would expect from the perspective of a decreasing marginal product of capital. For the longer run some caution is in order here.

<sup>33</sup> The values of the first four periods stem from a simple regression on a linear-quadratic time trend. These are needed as initial values as difference equation (12) has five-year lags. As we have also ten-year lags of remittances, we add lagged dependent variables next for some periods. This variant of our regression is used until 1983. From

emigration. The highest emigration of about 2.9% is obtained in 1989-1990 and 2004-2005. An implication from the negative sign of the lagged dependent variable in the migration equation is that the increase in emigration in the first phase does not come from self-perpetuating forces. Rather three forces are at work here explaining the phase of increasing emigration, the crucial and controversial part of the emigration curve. First, after a very early peak of remittances as a share of GDP in 1979 (the dotted curve in Figure 1) this percentage rate is falling providing less means for financing the desire to stay at home and to solve problems from market imperfections. After the 1979 peak, lower remittances contribute to higher emigration. Second, the mild convergence of incomes leaves the income gap fairly large thereby stimulating further emigration. Third, according to Figure 2, savings are increasing in the first phase beyond 20% and allow financing more emigration and fall later below 16%, whereas investment is fairly stable above 20% of GDP. The fall in savings and the decreasing income difference are the dominant force for migration. Whereas the income differential changes only slowly, the fall in remittances goes finally as far as zero because of its own non-linearities and negative effects of lagged variables.

#### FIGURE 2 OVER HERE

The labour force growth in Figure 1 goes from above 2% during the initial years to about 1%. It follows the emigration curve with a similar but less drastic curvature: The growth of the labour force goes down when emigration increases, and when net immigration goes up labour force growth follows, with much smoother curve though.

In regard to the savings ratios in Figure 2 we see that they follow the path of remittances, which both first move up and then go down. Tax revenues, going slightly beyond 14 percent of

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1984 onwards we use regression equation (12). The points of changes from the simplified regressions to (3)-(12) have always been chosen in a way that minimizes frictions at the point of switching to the estimated equation.

GDP, and public expenditure on education as a share of GDP, going a bit higher than 4 percent, as well as literacy - going to about 80 percent in Figure 2 - do not reflect much of the ups and downs of migration and remittances, although they are all connected via savings ratios. They all are not decreasing as much as savings do. Public expenditure on education as a share of GDP and literacy parallel the pattern of total investment from very low values to a high and almost constant level although a value of not more than 80 percent for literacy is somewhat disappointing. Getting a better performance in regard to literacy requires a structural break. Finally, development aid, the highest curve in Figure 1, goes to a maximum of 9.8% of GDP and then back to 9.3% thus contributing to the stable values of investment and education variables together with the stable value of taxes as a share of GDP.

In these simulations there are some aspects, which are highly sensitive to changes in the regressions, whereas others are very robust. The robustness is present in the first part of the migration curve<sup>34</sup>. Slight changes in the regression can switch the point where emigration is half its maximum value in the end of our simulations by some decennia. This is easy to understand, because now it takes decennia to get from a low value of 1.7% in 2011 to a peak in the simulation of 2.5 % in 2059. That is a very long period for a fairly small change. A slight shift of the line upward or downward then easily translates into some decennia in the horizontal direction. One aspect that can easily change is whether or not savings will exceed investment. For example allowing for a positive interest rate in the investment and savings functions will increase investment, therefore also net debt flows, which in turn will enhance the interest rate again. However, this mechanism leads to savings larger than investment at times for within sample simulations although this can never be found for a panel average value at any time. It also increases the effects of more aid discussed in a companion paper dramatically and therefore we

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<sup>34</sup> Plotting net immigration against the GDP per capita yields a very similar curve known as ‘migration hump’.

stick to the choice of an investment function presented above, which is also justified by the highest adjusted R-squared. Another point that is highly sensitive is that a temporary increase in labour force growth by a half percentage point reduces growth, postpones convergence and dramatically increases migration and remittances to levels which are known from countries with the highest levels of remittances.

TABLE 3 OVER HERE

### **5. The crisis as transitional shock: Simulations compared**

In order to analyze the impact of the crisis we add shocks to the baseline simulation in equations (1), and (2a-d). The shocks are chosen such that the predictions of the international organization for OECD growth and GDP growth of the world economy as summarized in panel (a) of Table 3 are realized approximately. The predicted values for 2009 by Schmidt-Hebbel (2009) and Ratha et al. (2008) are a growth rate for OECD GDP per capita of -3.6 and -4.9% after our subtraction of 0.6% population growth.<sup>35</sup> For the World GDP the scenarios go from -1.7% to -4.2%. In panel (b) of Table 3 we show the shocks we add to equations (1) and (2a-d) in order to get the predicted values of the medium scenarios. With these shocks imposed for the years 2008 and 2009 we re-run the simulations. Then we divide the values of these re-runs by those of the baseline scenarios. Values below (above) unity then reflect that shocks decrease (increase) the respective variable compared to the baseline scenario.

FIGURE 3 OVER HERE

Figure 3 shows the crisis relative to the baseline scenario for China, Australia, the rest of the OECD and the rest of the world (ROW) economy. The value of -1.5 is the result of dividing the after shock value of -4.5% for the OECD by that of the baseline, 3%. OECD growth rates do not overshoot their baseline value after the crisis. China's growth drops by much less during the

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<sup>35</sup> See also Bhaskaran (2009, chart 1.2)).

crisis and then overshoots due to the high adjustment coefficient in the error correction model. Australia shows a similar but less strong and slightly delayed pattern indicating that China helps pulling Australia out of the crisis. But the impact on the OECD then is seemingly weak simply because Australia is too small, and China's direct effect is not strong either. The ROW has a pattern that is more similar to that of the OECD, a large drop and no overshooting. Growth rates are back to the baseline values not before 2013.

These simulations should not be viewed as predictions because (i) policy will react to predictions; (ii) the bad-credit-bad-bank cum problem is not in the data from which the error-correction model was estimated (a credit crunch problem may turn out to be persistent); (iii) other shocks may come in like currently the swine flu. These aspects may perhaps invalidate our simulations. If this were the case, the recovery may be even more pessimistic, because multi-period shocks would have to be imposed, whereas ours are only temporary.

#### FIGURE 4 OVER HERE

For levels the quick return to baseline does not hold. Figure 4 shows that the OECD does not come back to the baseline in terms of GDP levels because the lack of overshooting of growth rates implies that all values below baseline are lost forever, indicating how huge the costs of the credit crisis are. In contrast, China has huge overshooting and therefore gains by 11% compared to baseline. Australia and the rest of the world (ROW) also loose, but less than the OECD does. In the case of Australia the overshooting is too weak to outweigh the losses. The impact on the level of the GDP per capita of poor developing countries and that of the OECD and the GDP of the World are shown in Figure 5. The loss for the OECD is of course similar to the GDP plot of the previous figure. The world, containing China and the OECD, gains (more than the OECD and others loose) only after 2065 when the shift to higher shares of China's GDP in the world

economy works through. The GDP per capita of the poor countries follows that of the World economy, first down, then up. Increasing shares of China's GDP mitigate the effects on the world GDP and later also on the poor countries. Effects here are decreasing but do not vanish until the end of the simulations in 2090.

FIGURE 5 OVER HERE

Although the shocks assumed are only temporary, they translate into very serious level effects. The effect for the poor countries in the first years is about -3% as predicted by some policy notes (see Massa and te Velde 2008; Committee 2009) but even lower at the most extreme point because the drops in the growth rates add up over time if there is no overshooting. As the GDP per capita of the OECD goes down by more than that of poor countries the crisis has a positive impact on convergence in the short and medium run.<sup>36</sup>

Aid, which depends only on the growth rates of the OECD and the poor countries, first goes down by almost 6 percent and then back to baseline (see Figure 6) as a mirror image of the recovery of that of the growth rates in Figure 3. The initial fall of aid is weaker than that predicted by IMF (2009) for a slightly different sample though, perhaps because the fall in GDP in developing countries is larger here.

FIGURE 6 OVER HERE

Figure 6 shows that investment as a share of GDP goes down for many years by about one percent compared to the benchmark. The savings ratio will be lower for the whole period. As investment and savings both change, it is important to see what happens to their difference, the new net foreign debt, which is equal to the current account. In 2008 and 2009 the current account

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<sup>36</sup> In the working paper version, the error-correction model did not dis-aggregate with respect to China and Australia. Growth rates did overshoot for the OECD and levels returned approximately to the baseline value. Therefore the crisis did not work towards convergence. By implication migration, remittances and savings, both depending on income differences were higher.

deficit is larger as suggested by IMF (2009) but then it is less for six years, then higher in all later periods.

#### FIGURE 7 OVER HERE

The development of savings essentially follows that of remittances in Figure 7. The larger strength of the shock in the OECD also causes remittances to go down by more than the GDP and therefore remittances only have a limited insurance function because OECD income is falling more than that of the poor countries. But rather the differences in the persistence in the level effects of the GDP of the poor countries and the OECD keeps them low as a percent of GDP in the long run. According to the growth equation this fall in the remittance ratio reduces growth, which in turn causes the partial effects of enhancing remittances and this enhancement mitigates the fall in growth.<sup>37</sup> Figure 7 shows the net effect of all interactions of our system of equations on remittances.

Labour force growth is lower from 2008 until 2047 and then higher afterwards, three years after the GDP per capita turns from going away towards back to the baseline (Figure 6).

Figure 7 shows that emigration goes up<sup>38</sup> - in spite of some expected return migration under the convergence shock – until 2055 although the OECD growth is falling by more than that of poor countries. But as remittances are also lower staying at home is more difficult to finance. The crisis generates less pull and more push migration. Later the convergence lets emigration drop below the benchmark level.

#### FIGURE 8 OVER HERE

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<sup>37</sup> The stabilizing effect of remittances on output volatility of five-year periods has been shown by Chami et al. (2009).

<sup>38</sup> These are ratios of net immigration numbers with a minus sign which drops out when ratios are formed. The interpretation therefore is emigration.

The plots for tax revenues has a similar curvature as those of savings as shown in Figure 8. For public expenditure on education the fall due to the crisis follows remittances, aid and taxes. For literacy the worst effect is less because literacy is a cumulative variable; it falls by less than one percent – an order of magnitude that is similar to that of investments.<sup>39</sup>

The strongest effects of the crisis appear in OECD GDP growth rates and levels, remittances, emigration, aid and savings ratios. It seems to be this latter channel via international transfers that shows the strongest effects together with that via World GDP growth on the GDP per capita of the poor countries.

## **6. Summary and conclusion**

The model we have used has the following properties. First, we estimate more equations than just one for growth of the GDP per capita getting the following main results. Remittances have not only direct positive effects on the level and growth rates of the GDP per capita but also on the rate of savings and public expenditure on education. They also decrease tax revenues and emigration. Emigration has the direct effect of reducing the rate of savings and the rate of growth of the labour force. The labour force and literacy have an impact on investment and therefore direct and/or indirect effects on growth.

A second major difference between our study and earlier ones is that we analyse the interactions between the effects of several equations in a dynamic system running simulations of the whole system. Existence of a solution at reasonable values for all variables and stability of the model for a fairly long period is shown through forward iteration of the model.

Third, we construct a shock scenario by generating transitional shocks to the GDP growth of Australia, other OECD countries, and the rest of the world (excluding China), which make sure

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<sup>39</sup> This result is in accordance with that of Sanchez and Vos (2009) for an expected drop in primary schooling.

that the predictions which have been published in March 2009 by some international organisations appear in our simulations. The results in comparison with the baseline scenario show that growth rates are back to baseline in 2013. Levels will be permanently above benchmark for China and below it for the OECD, Australia and the rest of the world and also in the poor countries. The strongest negative effects of the crisis come via world GDP growth to that of the GDP per capita of poor countries and via the remittances channel: their fall enhances emigration, reduces savings, tax revenues and public expenditure on education.

In regard to the broader discussion of normative recommendations for policy we refer to Lin (2008, p.13-23) and Naudé (2009). In view of the fact that one major impact of the crisis in our analysis is the retardation of long-run growth levels we think policy should put more emphasis on aspects of long-term growth and have short-term policies that avoid ‘anti-growth policy syndromes’ (Fosu and Naudé 2009; World Bank 2009b). The damage to education should be counteracted together with that of other millennium development goals (see Sanchez and Vos 2009 again) and perhaps the contribution of those who caused the crisis should be increased in a way reducing the risk of a new one with such high costs.

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## Appendix 1: List of Countries

*Countries with GDP per capita below \$1200 (2000):*

Armenia, Azerbaijan, Bangladesh, Benin, Bolivia, Burkina Faso, Cambodia, Cameroon, Comoros, Congo Rep., Cote d'Ivoire, Djibouti, Ethiopia, Ghana, Guinea, Guyana, Haiti, Honduras, India, Indonesia, Kenya, Kyrgyz Republic, Lesotho, Madagascar, Malawi, Mali, Mauritania, Moldova, Mongolia, Mozambique, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Papua New Guinea, Philippines, Rwanda, Senegal, Sierra Leone, Sri Lanka, Sudan, Syria, Tajikistan, Tanzania, Uganda, Ukraine, Vanuatu, Yemen, Zimbabwe.

## Appendix 2: Instrumental variables

This appendix provides the list of instruments used in the regressions, starting with the number of the respective regressions. The first number after a variable gives the first lag used and the second the last lag. These are used as dynamic instruments (see Baltagi (2008, Chap.8). If only one lag is mentioned we have a simple standard instrument.

(3): (LOG(GDPPC), -5, -5), (LOG(GFCFGDP), -1, -1), D(LOG(L)), WR(-1)/GDP(-1), (WR(-1)/GDP(-1))<sup>2</sup>, ODA(-1)/GDP(-1), (ODA(-1)/GDP(-1))<sup>2</sup> LOG(WLD(-1)), LOG(L(-1)), LOG(GDPPC(-1))-LOG(GDPPC(-6)), LOG(GDPPC(-2))-LOG(GDPPC(-7)).

(11): ( D(LOG(L)),-2,-7), (D(LOG(L))<sup>2</sup>,-2, -7), ODA(-5)/GDP(-5), LIT(-13), NM(-5)/L(-5), D(LOG(GDPPC(-1), -1, -5))

(12): NM(-10)/L(-10), NM(-15)/L(-15), ((LOG(GDPPC)-LOG(OEC)),-1,-1), ((LOG(GDPPC) -LOG(OEC))<sup>2</sup>,-1,-1), ((LOG(GDPPC)-LOG(OEC))<sup>3</sup>,-1,-1), ((WR/GDP)<sup>2</sup>,-1,-3), WR(-10)/GDP(-10), (WR(-5)/GDP(-5))<sup>2</sup>, (WR(-10)/GDP(-10))<sup>2</sup>, SAVGDP(-3).

The last two instruments in equation (3) are identical to the regressors added for serial correlation correction. They are not reported in the text and not included in the simulations.

Gross fixed capital formation is essential for growth, whereas for net foreign debt investment as a share of GDP matters. The difference of the two is inventories. Their relation then is needed to come from one to the other. It is expressed in the following regression.

$$\text{Invgdp} = 1.562113 + 1.003\text{GFCFGDP}; \text{Adj.R}^2 = 0.875; \text{DW} = 0.9$$

(0.01)      (0.0000)

### Appendix 3: Estimation results<sup>40</sup>

$$CE \equiv \text{Log}(\text{ROEC}(-1)) - 16.455\text{log}(\text{CHN}(-1)) - 4.125\text{log}(\text{AUS}(-1)) - 18.87\text{log}(\text{ROW}(-1)) + 2.2(t-1) + 1002.17 \quad (1)$$

(-5.99)
(-0.98)
(-4.49)
(6.96)

$$d(\text{log}(\text{ROEC})) = 0.0048(CE) + 0.3d(\text{log}(\text{ROEC}(-1))) - 0.038d(\text{log}(\text{CHN}(-1))) + 0.258d(\text{log}(\text{AUS}(-1))) +$$

(0.21)
(1.92)
(-1.3)
(1.95)

$$0.031d(\text{log}(\text{ROW}(-1))) + 0.015 \quad (2a)$$

(0.29)
(2.35)

$$d(\text{log}(\text{CHN})) = 0.034(CE) + 0.225d(\text{log}(\text{ROEC}(-1))) + 0.435d(\text{log}(\text{CHN}(-1))) - 0.09d(\text{log}(\text{AUS}(-1))) +$$

(6.68)
(0.62)
(6.47)
(-0.3)

$$0.531d(\text{log}(\text{ROW}(-1))) + 0.025 \quad (2b)$$

(2.15)
(1.68)

$$d(\text{log}(\text{AUS})) = 0.006(CE) + 0.29d(\text{log}(\text{ROEC}(-1))) + 0.07d(\text{log}(\text{CHN}(-1))) + 0.13d(\text{log}(\text{AUS}(-1))) +$$

(2.14)
(1.92)
(1.88)
(0.75)

$$0.046d(\text{log}(\text{ROW}(-1))) + 0.014 \quad (2c)$$

(0.32)
(1.64)

$$d(\text{log}(\text{ROW})) = 0.00037(CE) + 0.51d(\text{log}(\text{ROEC}(-1))) - 0.01d(\text{log}(\text{CHN}(-1))) - 0.05d(\text{log}(\text{AUS}(-1)))$$

(0.4)
(1.94)
(-0.2)
(-0.24)

$$- 0.06d(\text{log}(\text{ROW}(-1))) + 0.028 \quad (2d)$$

(0.33)
(2.59)

Per.: 45 (1962-2006); adj.R<sup>2</sup>=0.25/0.6/0.11/-0.004.

$$\text{log}(\text{gdppc}) = c_{it} + 0.81\text{log}(\text{gdppc}(-5)) + 0.051\text{log}(\text{gfcfgdp}) - 0.327d(\text{log}(l))$$

(0.0000)
(0.005)
(0.015)

$$+ 0.52 \text{wr}(-1)/\text{gdp}(-1) - 2.44(\text{wr}/\text{gdp})^2 - 1.1\text{oda}/\text{gdp} + 0.365 \text{oda}(-1)/\text{gdp}(-1) + 1.61(\text{oda}/\text{gdp})^2$$

(0.032)
(0.0223)
(0.0025)
(0.0001)
(0.0334)

$$+ 0.196 \text{log}(\text{wld}) - 0.148 \text{log}(l) \quad (3)$$

(0.0022)
(0.017)

Per.: 30 (1976-2005); Countr.: 48; Obs.: 644. S.E.E.: 0.057; J-stat.: 74.7; Instr.rank: 68; p(J): 0.07. This p-value belongs to the Sargan J-statistic.

$$\text{wr}/\text{gdp} = -0.12 - 2.95\text{wr}(-1)/\text{gdp}(-1) - 0.08 \text{log}(1+\text{riusa}(-1)) - 12.3 (\text{wr}(-1)/\text{gdp}(-1))^2$$

(0.005)
(0.012)
(0.0001)
(0.0079)

$$- 226.15 (\text{wr}(-1)/\text{gdp}(-1))^4 - 0.005(\text{log}(\text{wr}(-1)/\text{gdp}(-1))) - 7.17 (\text{log}(\text{wr}(-1)/\text{gdp}(-1)))^3$$

(0.0003)
(0.0079)
(0.0013)

$$0.034(\text{log}(\text{oec}(-2)) - \text{log}(\text{gdppc}(-2))) - 0.003(\text{log}(\text{oec}(-2)) - \text{log}(\text{gdppc}(-2)))^2 \quad (4)$$

(0.06)
(0.06)

Per.: 34 (1972-2005); Countr.: 51; Obs.: 777. Adj. R<sup>2</sup> = 0.926; DW stat.: 2.02.

$$\text{savgdp} = 5.92 + 0.67 \text{savgdp}(-1) + 79.1 \text{wr}(-1)/\text{gdp}(-1) - 338(\text{wr}(-1)/\text{gdp}(-1))^2 - 0.006(\text{peegdp})^2$$

(.0001)
(.0000)
(0.013)
(0.004)
(0.000)

<sup>40</sup> In parentheses: t-values of equations (1), (2a-d) and for polynomial distributed lags; p-values otherwise.

$$-24.1 \text{ oda/gdp} + 40.1(\text{oda}(-1)/\text{gdp}(-1))^2 + 22\text{nm/l} \quad (5)$$

(0.027) (0.072) (0.004)

Periods: 7 (1975-2005). Countries: 41. Observations: 106. Adj. R<sup>2</sup> = 0.86; DW stat.: 0.85.

$$\begin{aligned} \log(\text{gfcfgdp}) = & 0.52 + 0.776\log(\text{gfcfgdp}(-1)) + 0.45\text{d}(\log(\text{gdppc}(-1))) + 0.27(\text{oda}(-1)/\text{gdp}(-1)) \\ & (0.00) (0.00) (0.00) (0.002) \\ & + 31.25 \text{d}(\log(\text{l}(-1)))^2 - 24.89 \log(1+\text{d}(\log(\text{l}(-1))))^2 + 0.028\text{lit}(-5) - 0.0265 \text{lit}(-6) \\ & (0.05) (0.06) (0.006) (0.01) \end{aligned} \quad (6)$$

Periods: 30 (1974-2005). Countries: 43. Observations: 1066. Adj. R<sup>2</sup> = 0.86; DW = 1.96

$$\text{peegdp} = 0.66 + 0.84 \text{peegdp}(-1) - 0.0226 \text{peegdp}(-1)^2 + 0.04 \text{taxy} + 1.69 \text{oda}(-5)/\text{gdp}(-5) + 0.114 \log(\text{wr}(-1)/\text{gdp}(-1)) \quad (7)$$

(0.015) (0.00) 0.018 (0.023) (0.008) (0.0012)

Periods: 25 (1981-2005). Countries: 35. Observations: 219. Adj. R<sup>2</sup> = 0.95; DW = 2.07.

$$\text{lit} = 8.2 + 0.831\text{lit}(-5) + 6.465\text{oda}/\text{gdp} + 0.09512 [\text{sum of lags savgdp}] + 0.75[\text{sum of lags peegdp}] \quad (8)$$

(0.02) (0.00) (0.063) (t-value:1.94) (t-value:2.13)

Periods: 18 (1985-2004). Countries: 30; Observations: 171. Adj. R<sup>2</sup> = 0.99; DW = 0.81.

$$\text{taxy} = 1.3 + 0.83 \text{taxy}(-1) + 0.0012 \text{taxy}(-1)^2 - 7.53 \text{wr}/\text{gdp} + 51.1(\text{wr}(-1)/\text{gdp}(-1))^2 + 0.05 \text{savgdp} \quad (9)$$

(0.05) (0.00) (0.018) (0.09) (0.0008) (0.0013)

Periods: 31. Countries: 35. Observations: 348. Adj. R<sup>2</sup> = 0.975; DW = 2.02.

$$\text{oda}/\text{gdp} = 0.016 + 0.82 \text{oda}(-1)/\text{gdp}(-1) - 0.0186 \text{d}(\log(\text{gdppc}(-1))) + 0.056 \text{d}(\log(\text{oec}(-2))) \quad (10)$$

(0.00) (0.00) (0.0004) (0.0007)

Periods: 43 (1963-2005). Countries: 52. Obs.: 1775. Adj. R<sup>2</sup> = 0.90; DW = 2.18.

$$\begin{aligned} \text{d}(\log(\text{l})) = & c_{10i} + 0.17\text{d}(\log(\text{l}(-1))) + 1.39 \text{d}(\log(\text{l}(-1)))^2 - 0.00018\text{lit}(-13) + 0.015 \text{oda}(-5)/\text{gdp}(-5) + \\ & (0.005) (0.005) (0.025) (0.09) \\ & + 0.04\text{nm}/\text{l} + 0.018 \text{d}(\log(\text{gdppc}(-1))). \end{aligned} \quad (11)$$

(0.05) (0.12)

Per.: 4 (1990-2005). Countr.: 43. Obs.:153. SEE: 0.0072. J-stat.: 72.4. Instr.rank:71. p(J): 0.25

$$\begin{aligned} \text{nm}/\text{l} = & c_{11i} - 0.18\text{nm}(-5)/\text{l}(-5) + 2.97(\log(\text{gdppc})-\log(\text{oec})) + 0.73(\log(\text{gdppc})-\log(\text{oec}))^2 \\ & (0.06) (0.002) (0.0014) \\ & + 0.058(\log(\text{gdppc})-\log(\text{oec}))^3 + 1.29 \text{wr}(-10)/\text{gdp}(-10) - 1.36(\text{wr}/\text{gdp})^2 + \\ & (0.0013) (0.0000) (0.006) \\ & + 12.8(\text{wr}(-5)/\text{gdp}(-5))^2 - 19(\text{wr}(-10)/\text{gdp}(-10))^2 - 0.00118\text{savgdp}(-3) \end{aligned} \quad (12)$$

(0.0000) (0.000) (0.0001)

Per.: 4 (1990 2005). Countr.: 20. Obs.: 46.<sup>41</sup> S.E.E...: 0.012655. J-stat.: 23.69. Instr. Rank 30. p (J): 0.31.

$$\text{riusa} = 0.59 + 0.85\text{riusa}(-1) \quad (13)$$

(12)

<sup>41</sup> Remittance data are available for all 52 countries but only since 1971. GDP per capita data are available for all 52 countries and 46 periods, but with some gaps: instead of 52x46 = 2392 we have only 1957 observations. Savings data start in 1965 with gaps again, leaving us with 1423 observations instead of 41x52=2132. As a consequence, we lose more than half the possible observations in both dimensions.

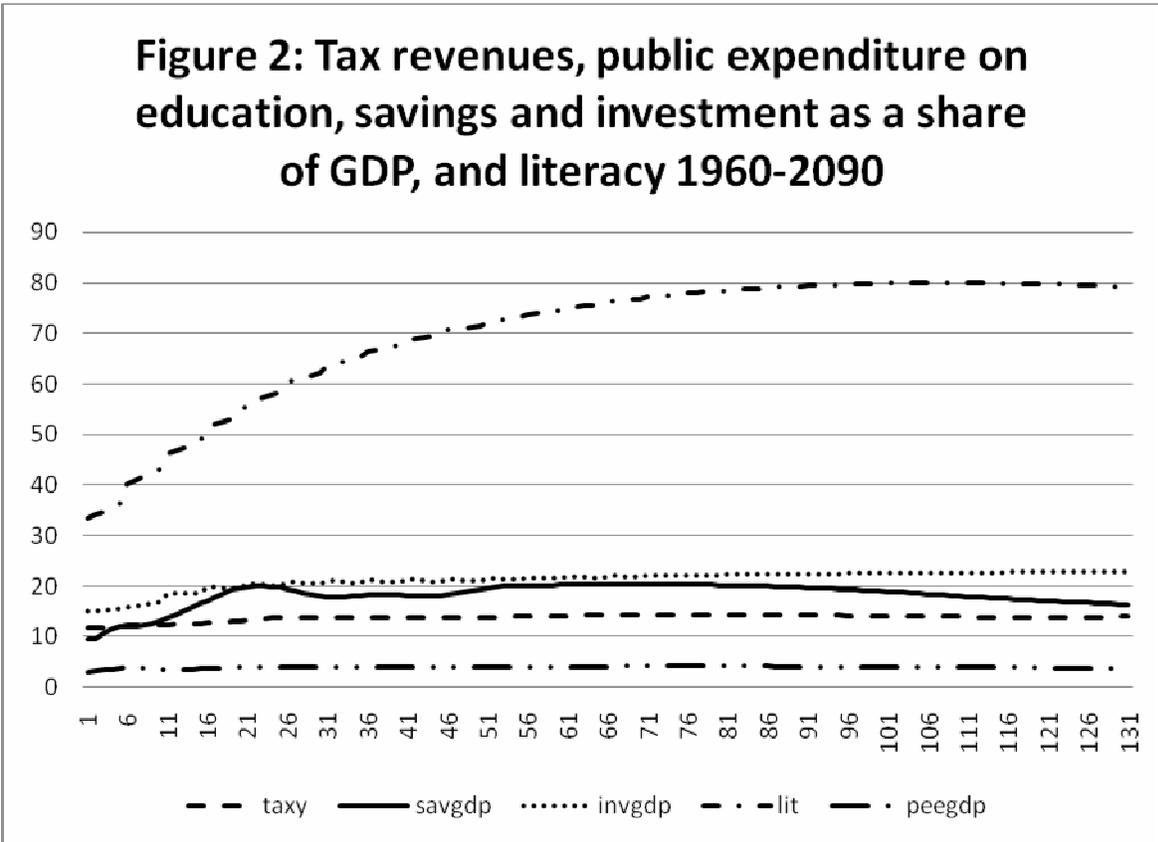
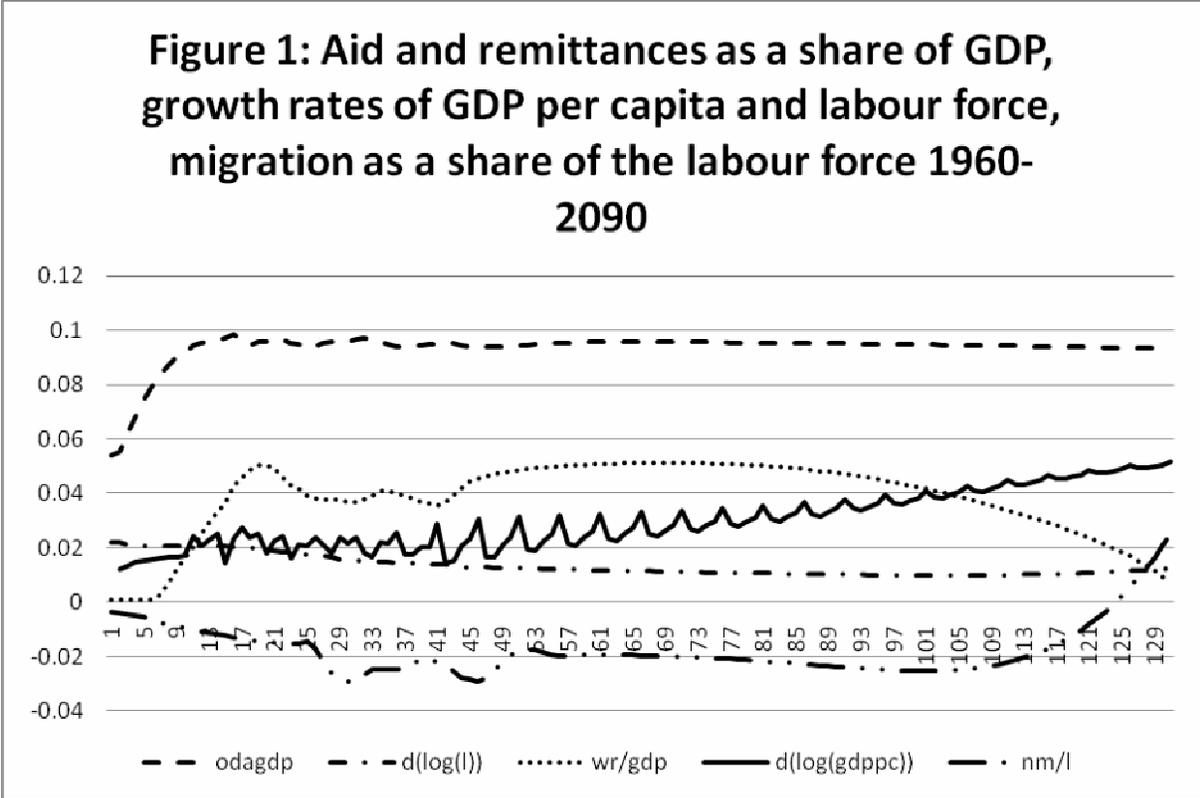
(0.0422) (0.00)

Periods: 43 (1963 -2005). Adj. R<sup>2</sup> = 0.718. DW: 1.785.

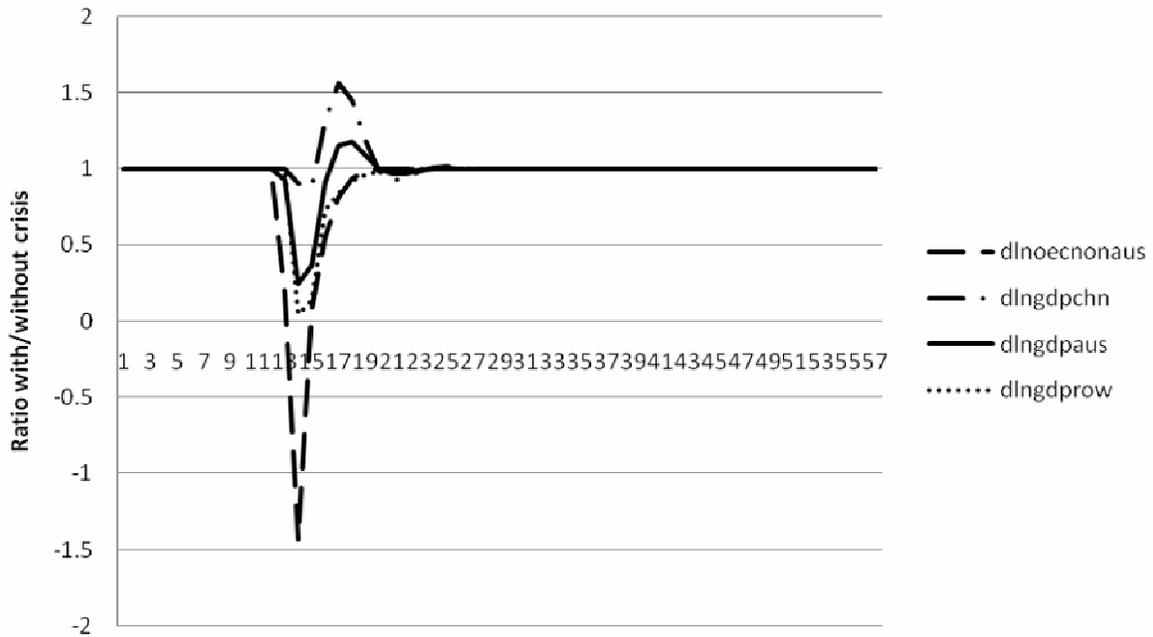
$$\text{LOG(POPOEC)} = 3.485 + 0.55\text{LOG(POPOEC(-1))} + 0.28\text{LOG(POPOEC(-2))} + 0.001091t \quad (14)$$

(0)   (0.0003)                      (0.042)                      (0.0003)

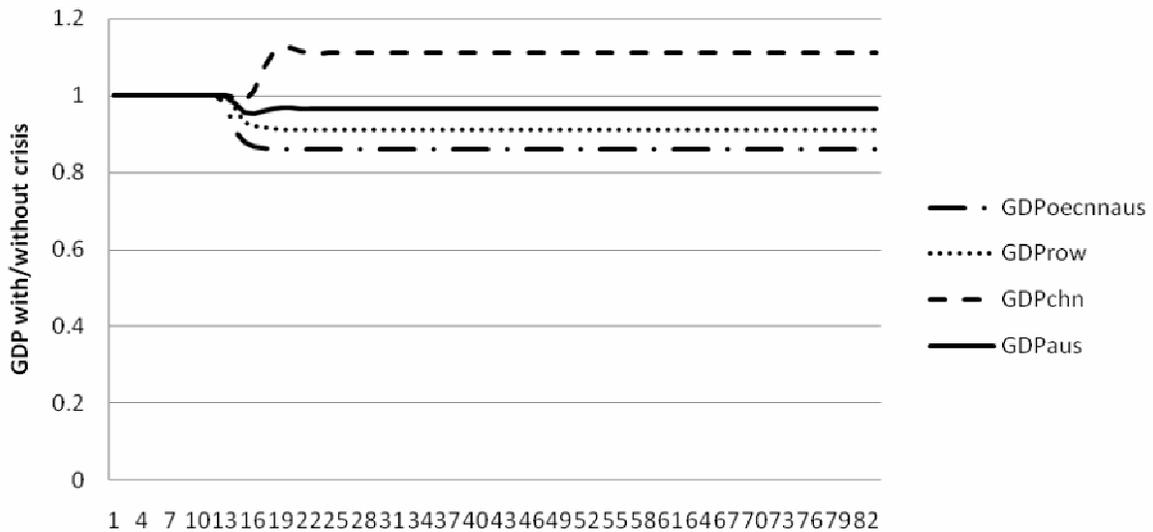
Period: 1962-2006. Adj. R<sup>2</sup> = 0.999. DW: 2.10



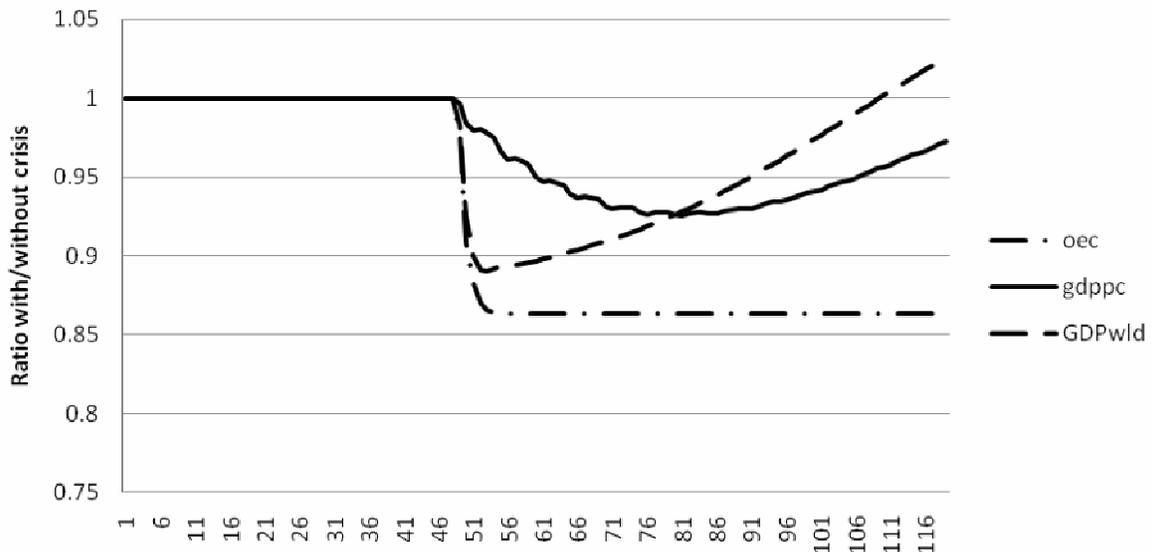
**Figure 3: Ratio of GDP growth rates of China, Australia, other OECD, and Rest of the World**



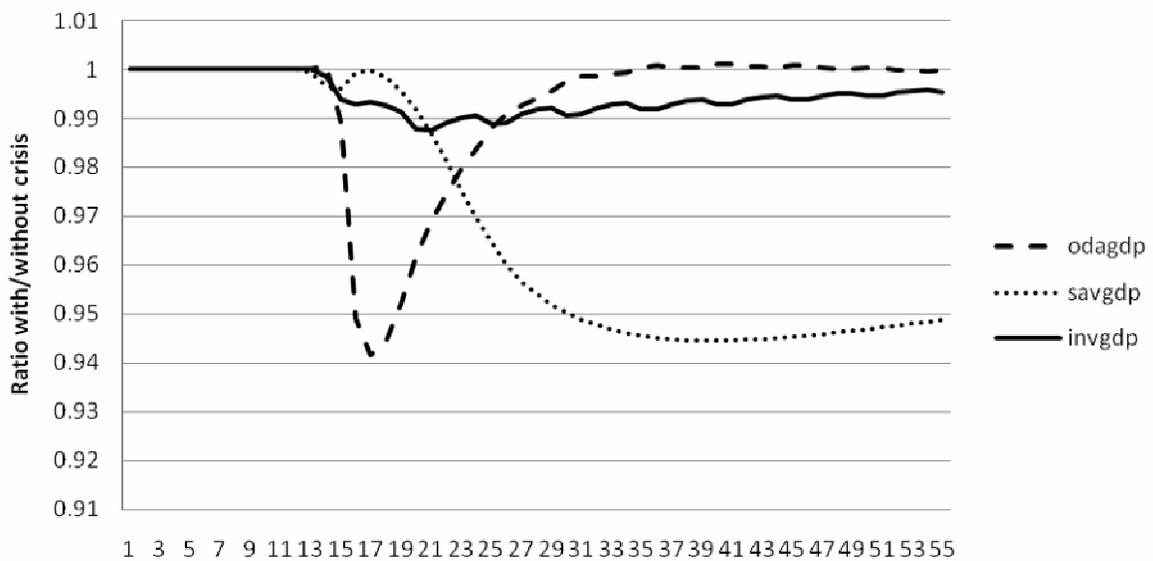
**Figure 4: China's GDP improves through the permanent effects of transitory shocks, but all others loose through the crisis**



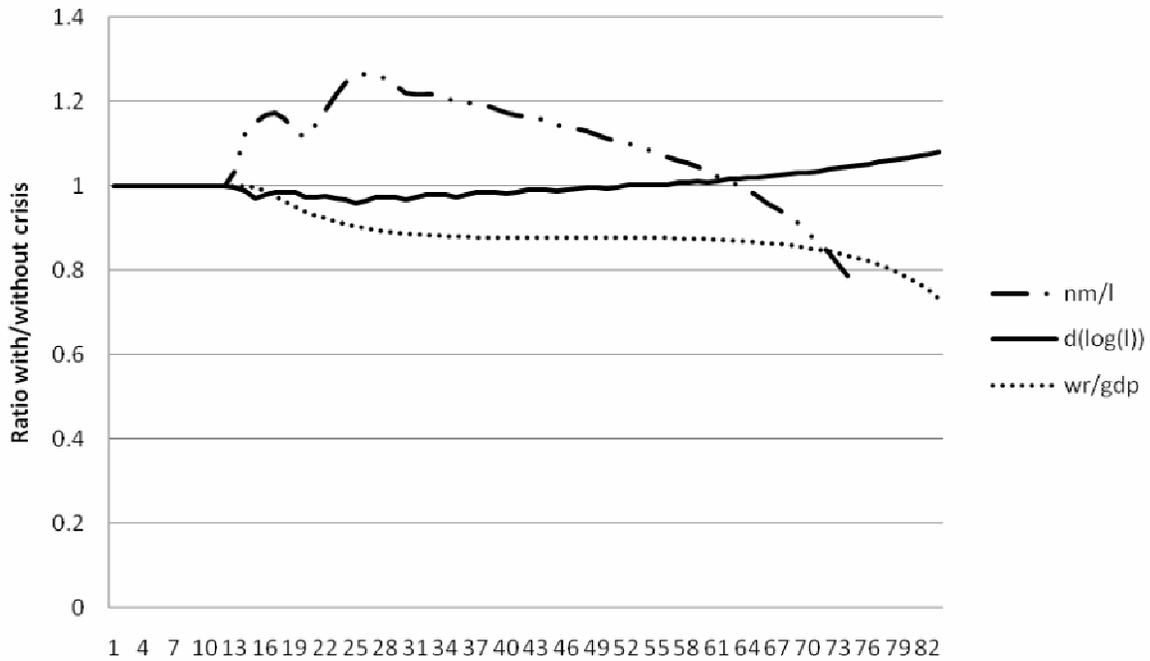
**Figure 5: Poor developing countries' GDP per capita falls less than the OECD's and follows World GDP growth**



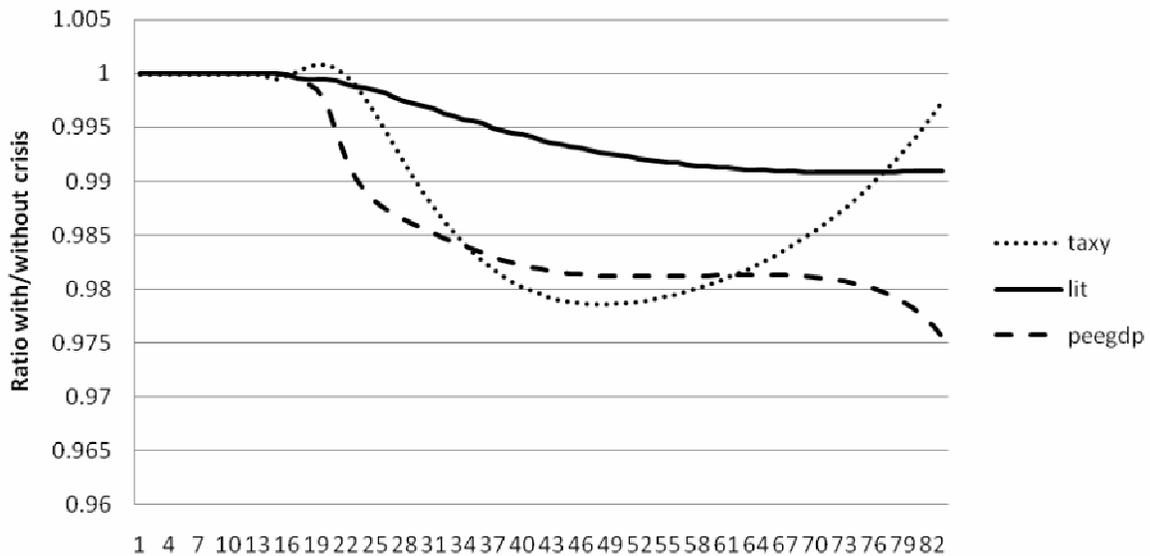
**Figure 6: Investment, savings and aid as a share of GDP are reduced**



**Figure 7: Less remittances, more net immigration, less labour growth**



**Figure 8: A long-run fall in tax revenues and public expenditure on education as a share of GDP and literacy**



**Table 1: The dynamic system: Signs of partial effects**

	1	2	3	4	5	6	7	8	9	10	11	12	13
<i>regr.</i> ↓ <i>dep. var.</i>	nm/l	gdppc	d(log(l))	wr/gdp	savgdp	gfcfgdp	taxy	peegdp	lit	odagdp	wld	oec	riusa
1. nm/l	-	0	+	0	+	0	0	0	0	0	0	0	0
2. gdppc	+	+	+	-	0	+	0	0	0	-	0	0	0
3. d(log(l))	0	-	+	0	0	+	0	0	0	0	0	0	0
4. wr/gdp	+	+	0	+	+	0	-	+	0	0	0	0	0
5. savgdp	-	0	0	0	+	0	+	0	+	0	0	0	0
6. gfcfgdp	0	+	0	0	0	+	0	0	0	0	0	0	0
7. taxy	0	0	0	0	0	0	+	+	0	0	0	0	0
8. peegdp	0	0	0	0	0	0	0	+	+	0	0	0	0
9. lit	0	0	-	0	0	+	0	0	+	0	0	0	0
10. odagdp	0	-	+	0	-	+	0	+	+	+	0	0	0
11. wld	0	+	0	0	0	0	0	0	0	0	+	+	0
12. oec	-	0	0	+	0	0	0	0	0	+	+	+	0
13. riusa	0	0	0	-	0	0	0	0	0	0	0	0	+

**Table 2 Data description of the poor country sample**

Variable	Panel average <sup>a</sup>	Growth rate <sup>b</sup>
Remittances/GDP	0.029	0.065
GDP per capita \$	470	0.006
Investment/GDP	0.21	0.0143
Savings/GDP	0.13	0.069
net immigration/labour force	-0.0094	-0.00084 <sup>c</sup>
Literacy	45.6	0.0244
Publ. exp. Educ./GDP	4.13	0.024
Tax rev./GDP	17.3	0.031
Labour force growth rate	0.021	0.0088 <sup>d</sup>
Oda/GDP	0.089	0.0017 <sup>c</sup>
Real interest rate USA	0.04	-
Real interest rate	0.012	0.0018
GDP per capita OECD	18975.43	0.0245
GDP World	1.98x10 <sup>13</sup>	0.034

a Least-squares dummy variable regressions of the variable on a constant.

b Least-squares dummy variable regressions of the natural log of the variable on a constant and a time trend.

c In case of negative values we use  $\log(1+x)$  rather than  $\log(x)$  in (b).

d Insignificantly different from zero.

<b>Table 3: Predictions and the shocks that realize them</b>			
<i>Predictions of GDP (GDP per capita) growth (%)</i>			
Year (Org.)	OECD	World	AUS (b)
2008 (Worldbank)	0.7 (0.1)	1.9	2.38
2009 (OECD)	-4.3 (-4.9)	-2.75	0.01
<i>Shocks on baseline imposed to get predicted values (%)</i>			
	OECD non AUS	ROW (a)	AUS
2008	-2.4	0	-0.19
2009 (OECD, med.)	-6.6	-2.5	-1.5
(a) ROW is world without China and OECD			
(b) Information on Australia is from Global Economics Research. <a href="http://www.tradingeconomics.com/Economics/GDP-Growth.aspx?Symbol=AUD">http://www.tradingeconomics.com/Economics/GDP-Growth.aspx?Symbol=AUD</a>			

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