Child Mortality Reacts to Relative Prices

Christopher Grigoriou, Patrick Guillaumont

Document de travail de la série

Etudes et Documents

E 2008.14

Child Mortality Reacts to Relative Prices

Christopher GRIGORIOU and Patrick GUILLAUMONT[1]

[1] CERDI-CNRS, Université d'Auvergne
Tel : +33(0)473.17.74.19
Fax : +33(0) 473.17.74.28
Corresponding author : christopher.grigoriou@u-clermont1.fr

Abstract

This paper argues that, for a given average level of income per capita, the real currency depreciation has a negative impact on child survival, due to higher relative prices of tradable goods such as food and drug. This assumption is significantly tested from a dynamic panel model covering about one hundred developing countries and the period 1965-1999 and using a logit measure of child survival. Moreover, it appears that this effect of a real depreciation decreases when the rate of urbanisation increases, suggesting that rural and urban areas do not react similarly: dynamic panel estimates on a sub sample of 21 sub-Saharan African countries for which rural and urban data are available confirms that only in rural areas child survival is negatively affected by real depreciation. These estimates also shed light on an international convergence process for child survival which is limited to urban areas.

JEL classification: I12, 011, C33

Keywords: Developing countries, Child mortality rate, Convergence, Millennium Development Goals, Exchange rate

1. Introduction

One of the most meaningful Millennium Development Goals (MDGs) is the reduction by two thirds of the under-five mortality. It is obviously not independent from the other MDGs, which aim at decreasing poverty and starvation or improving the access to safe water. Moreover, it involves a decrease in mortality largely spread over the population, and henceforth a minor inequality towards survival. Consistently with these goals, both the *World Development Report* (World Bank 2006) and the *Human Development Report* (UNDP 2005) are widely targeted on the inequalities, but surprisingly enough, the move in relative prices, which used to be at the core of the structural adjustment programs, is not considered when debating the modalities to reach the MDGs.

The relative prices are one of the main determinants of income distribution. Hence they are likely to affect the move to the Millennium Development Goals and in particular the fall in child mortality. One of the main features of inequality in developing countries is the relative position of rural areas compared to that of urban areas, a position highly influenced by the relative prices. This paper investigates how economic policy and the inequality between urban and rural may impact the average level of child mortality through its influence on the relative prices.

We here focus on the relative prices of tradable (compared to that of the non tradable), which have an important role in the economic growth theory in the context of open economies. The decrease in the real exchange rate (RER), i.e. the real depreciation of the currency or the decrease in the relative price of the non-tradable has been a major feature of the structural adjustment programs. It was considered as an essential condition towards economic growth as well as macroeconomic balance in many countries. Real depreciation is supposed to have a positive impact on economic growth from which one can expect increased incomes as well as an improved health status. However, it can also have a negative effect through its impact on income distribution (notably between urban and rural areas).

Indeed, many goods with a fundamental consumption for health are tradable, the price of which impacts directly the satisfaction of basic needs[1]. For instance, the relative price of the medicines, typically tradable and often imported, is increased as a result of a depreciation of the real exchange rate. Hence, during the last decades, the increase in the relative price of tradable, captured by the real exchange rate depreciation, may have resulted in an increase or a lower decrease in child mortality, beyond it impact on competitiveness and economic growth.

The relation between the real exchange rate and the income distribution has often been presented as likely to be favourable to the farmers, who constitute the main part of the poor in many developing countries (see for instance Bourguignon, de Melo and Morrisson (1991), Bourguignon and Morrisson (1992), Minot (1998)). It is argued that the agricultural sector produces internationally tradable goods, to a large extent exportable goods the relative price of which is increased as a result of a currency depreciation. However the relation between the real exchange rate and the real producer price of exports seems to be less clear for the agricultural products than for the manufactured ones. The transmission of a real currency depreciation to the (real) producer price may be weak due to a relative increase of public levies and/or of transport and marketing margins following a nominal depreciation (see Guillaumont and Guillaumont-Jeanneney (1994)). Moreover price transmission has an impact on the rural households purchasing power depending on the share of the tradable in household consumption (see Guillaumont-Jeanneney and Hua (2001)). A real depreciation of the currency may then not have a favourable impact on child survival.

In this paper, the impact of a change in the relative price of tradable on child survival is tested, relying on dynamic panel data estimates, with the GMM-system method, on a sample of 103 countries, over 1965-1999. A negative average impact of real depreciation on child survival is evidenced. The impact is shown to depend on the rate of urbanisation. We then identify two different regimes, according to the area to be considered (rural or urban). We use DHS (Demographic Health Survey) data on 21 sub-Saharan African countries for which disaggregated data between rural and urban child survival rates are available (intra-country inequality). Real depreciation has a significant negative impact on child survival in rural areas, while it seems to be the opposite in urban areas. Real depreciation can then be considered as worsening inequalities between rural and urban areas with regard to under-five survival. Our findings also highlight the fact that the income is a stronger determinant of child survival in rural areas, probably due to an uneven access to infrastructures such as primary health care, education, housing, etc. (Smith, Ruel and Ndiaye 2005). Last, the dynamic panel estimates on the Sub Saharan African countries sub-sample evidences a convergence process in child survival which is limited to the urban areas. Thus the child mortality reduction goal may be obtained through an increasing inequality between rural and urban areas.

The paper is organised as follows. Section 2 discusses and tests the best specification to use to assess the impact of economic policy on under-five survival. Section 3 details the expected impact of the relative prices on child survival. Section 4 provides econometric estimates of the relation between the relative prices and child survival on aggregated data. Section 5 deepens the former estimates by using disaggregated data on urban or rural survival. Section 6 concludes.

2. Specifying the child survival function

Measurement and specification

First, we consider the under-five mortality (or survival) because it seems to be the most relevant indicator to assess a population health status, preferable, for availability and logical reasons, to other indicators as life expectancy at birth or infant mortality[2]. Second, the measure of under-five survival we use is its logit transformation for the following reason: contrary to the income per capita, child survival is bounded (to one). There is thus a major difference between estimating a traditional economic growth model and a growth model applied to survival, from which the performance of a given economy with regard to health can be assessed. For any country considered, the distance to the bound has then to be taken into account to assess consistently the impact of each input on the outcome indicator. Hence, contrary to economic growth model, where a log-log equation is to be tested with the implicit assumption of a constant elasticity (of income related to its determinants), a formulation similar to that of Bhalla and Glewwe (1986) is here proposed:

$$\ln\left(\frac{sij_i}{1-sij_i}\right) = a + \beta.\ln x_i + \varepsilon_i$$

sij_i, x_i and ε_i being respectively the under-five survival rate of a country i, an explanation variables vector, notably the income per capita, and a random error.

The coefficient β to be estimated is then $\beta=\frac{dsij_i / sij_i}{dx_i / x_i} * \frac{1}{1-sij_i}$.[3] With x_i the level of income per capita, this coefficient is a weighted income elasticity of (under five) survival, the weight being the reverse of the (under five) mortality rate. The distance to the upper bound is then explicitly captured: for any relative increase in income, a same relative increase in child survival is a performance all the higher as the survival rate is close to one (mortality rate close to zero).

Specification tests.

The relevancy of this logit specification compared with the logarithmic specification, often used in mortality functions, is tested by cross-section regressions from a sample of 103 countries where the only explanatory variable is per capita income. The implemented tests are those of Godfrey-Wickens (1981) and Ramsey-

Reset (1969). The Godfrey-Wickens test relies on the Box-Cox transformation $F(x,\lambda) = \frac{x^{\lambda} - 1}{\lambda}$.

The findings presented in the table 1 unambiguously validate the specification with a logit transformation of child survival : the rejection of the hypothesis of a non-significant coefficient associated to the Godfrey-Wickens test variable, noted Box-Cox in the table 1, implies a rejection of the logarithmic functional form, while the logit formulation cannot be rejected (the hypothesis of a non-significant coefficient associated to the test variable is not rejected). Moreover, the Ramsey-Reset test leads to reject the null hypothesis of a good specification in the logarithmic case, but not in the logistic case[4]. We therefore choose to use the logit formulation.

Insert table 1

3. Expected impact of relative prices and other macroeconomic variables on child survival

Using the appropriate child survival function, we can test the impact of the real exchange rate i.e. of the tradable relative price, a key variable through which economic policy influences not only growth and exports performance, but also, in a more complex manner, poverty reduction.

Real exchange rate expected impact

We refer to a tradable and non-tradable goods and services structure such as presented in the table 2: the non-tradable goods are assimilated to services (education, health, housing, etc.), while the tradable goods are, as a first approximation, assimilated to agricultural products in rural area and manufactured products in urban areas.

Insert table 2

By definition, the real depreciation involves an increase in the price of tradable relatively to the non-tradable. The expected winners to the real depreciation of the currency are then the net producers of tradable and the net consumers of non-tradable, while the expected losers are the net producers of non-tradable and the net consumers of non-tradable.

As far as agricultural producers are producers of tradable, it is generally expected that they benefit from a currency depreciation (Krueger, Schiff, Valdes 1988). Child survival would consequently be supposed to be positively influenced by a depreciation of the currency. However, this effect can be cancelled or even reversed into a negative effect as a result of two other effects.

First let us note that there can be a weak transmission of the nominal currency depreciation to the real producer prices, i.e a weak transmission into real producer price improvement, or a possible transformation into a reverse effect (deterioration): this can result from a low effectiveness of nominal depreciation (induced inflation leading to weak real depreciation for a given nominal depreciation) or from that the nominal export gains of the depreciation are not transmitted to the producers (due to fiscal levies or trade costs): as far as we consider the effect of real depreciation only the latter is relevant for our purpose. In such a framework where the agricultural products are assimilated to tradable goods[5], Guillaumont and Guillaumont Jeanneney (1994) evidence that the increase in the real producer prices expected from a nominal depreciation of the currency not only has often be moderately effective in real terms as a result of inflation, but, more important for our concern, that real depreciation by the agricultural producers may be compensated by an increase in taxes or parastatal levies or domestic trade costs. All other factors disconnecting the domestic prices from the international prices, such as administrated prices or marketing boards, can also explain why the real depreciation could not lead to an increase in the real producer prices. Actually the non-transmission of real depreciation to the real agricultural prices has often resulted in a deterioration of the purchasing power of agricultural producers: indeed, they had to cope with the increase in the price of the imported goods as well as that of the national tradable goods, which both are either consumption goods or inputs for agricultural production.

The second effect we consider has been evidenced by Guillaumont-Jeanneney and Hua (2001) in the case of China. If we challenge the tradable character of the agricultural goods[6], the price of the agricultural products imperfectly substitutable to traded goods will hardly increase (Devarajan and de Melo (1987) specify these goods as semi-substitutable to imported goods). Then, the households who produce mostly non-tradable goods will face the decrease of the relative price of their production, since they are affected by the increase in the price of the goods they consume, namely the manufactured domestic products (whatever the share of these goods they consume), and the imported goods, noticeably the medicines[7]. This effect is likely to be all the stronger as the farmers are poor, and as the products quality (and therefore the tradability) mostly decrease with the poverty of the farmers (due to the quality of the land, the equipments, the inputs, etc.).

It then can be assumed that beside a positive effect of the real exchange rate depreciation on health running through the usual relation between real depreciation and economic growth, real depreciation may have a negative impact on health of the poorest households, here associated to the rural households (see Cornia and Menchini, 2005, or Smith, Ruel and Ndiaye, 2005, for the inequalities between urban and rural areas[8]).

Control variables: inflation and income per capita

The impact of any change in real exchange rate on survival can be linked to the macroeconomic conditions which have induced this change. In particular, if its fluctuations result from high inflation, the negative impact of the real exchange rate depreciation is mixed up with the negative impact of inflation. Inflation is by itself a factor likely to slow down the reduction of mortality. Several authors, such as Dollar and Kraay (2001) or Romer and Romer (1999) have evidenced the negative relation between inflation and the assets of the poor. When looking for the impact of the real exchange rate fluctuations on child survival, it is then essential to control for the impact of inflation, which is connected to the real depreciation. Doing so we try to separate the effects on child mortality of the general price level ant those of relative prices.

Another major macroeconomic variable, itself influenced by the real exchange rate is the income per capita. The influence of per capita income on health has been tested at many times in cross-section as well as with panel data. It obviously has a positive impact on the health status (see for instance Bidani and Ravallion (1997), Filmer and Pritchett (1997), Filmer Hammer and Pritchett (2000)). The per capita income is itself partly an outcome of the (past and present) economic policy, in particular of the exchange rate policy. Real depreciation may have simultaneously an indirect effect on health and survival through income per capita (expected to be positive), and a direct effect (here assumed to be negative).

Another economic policy variable that is likely to have a direct impact on child survival is the level of public expenditures allocated to health. However, the efficiency of those expenditures is somewhat debated in the literature. Several studies, using infant mortality (between 0 and 1 year) or under-five mortality to assess the health status, have resulted in diverging findings with regard to the impact of public health expenditures. Anand and Ravallion (1993) emphasize a positive impact, while Filmer and Pritchett (1997) or Filmer Hammer and Pritchett

(2000) conclude on a non-significant impact. Moreover, Bidani and Ravallion (1997) as well as Gupta, Verhoeven and Tiongson (2001) evidence a positive impact on the poorest but not on the whole population. Unfortunately, the (weak) availability of public health expenditures data prevents us from testing this variable in a dynamic panel framework.

Then, we test the following dynamic relation, with panel econometrics, including country specific effect:

$$logitsij_{it} = \alpha_0 + \alpha_1 logitsij_{it-1} + \alpha_2 y_{it} + \alpha_3 \, tcer_{it} + \alpha_4 \, ipc_{it} + \eta_i + \varepsilon_{it} \qquad (1)$$

$logitsij_{it}$, $logitsij_{it-1}$, y_{it}, $tcer_{it}$, ipc_{it}, η_i and ε_{it} being respectively the logistic transformation of child survival in the country i at the time t, the logistic transformation delayed, the logarithm of the per capita GDP, of the real effective exchange rate and of the consumer price index, a fixed effect and an error term.
The expected signs are as follows; $a_1 > 0$, $a_2 > 0$, $a_3 > 0$, $a_4 < 0$.

4. Econometric estimates of the determinants of the aggregate level of under-five survival

A dynamic panel data is used, combining the cross-section dimension (103 countries) and longitudinal (seven 5-year periods). It is preferred to the estimate of a dynamic model with the fixed effect estimator (WITHIN estimator) which may result in several biases.

The first one deals with the endogeneity usually evidenced in economic growth studies, due to the correlation between any of the right hand side variables and the residual, resulting either from an inverse causality, measurement errors or from omitted variables.

The second kind of bias, more specific to the dynamic nature of this sort of model, results from the lag in the effect of the explanatory variable. Indeed, since the dependent variable is delayed, the within transformation implies by definition a correlation between an explanatory variable and the residual.

To correct theses biases, some authors have used an instrumental variable method; the GMM (Generalised Moments Method) estimator, and in particular the 1st-difference GMM, to estimate dynamic panel model (cf. Holtz-Eakin, Newey and Rosen (1988), Arellano and Bond (1991), Caselli, Esquivel and Lefort (1996)). It consists in transforming the equation to be tested in first difference in order to control for the country specific effects, before instrumenting the right hand side differenced variables by the delayed (at least two periods) variables in level (cf. notably Blundell and Bond (1998a) or Bond, Hoeffler and Temple (2001)). However, some authors (for instance Alonso-Borrego and Arellano (1996) have evidenced that in dynamic panel studies with finite sample, and in particular if the number of periods is low, the first-difference GMM estimator may not be robust and may itself be a source of biases. Blundell and Bond (1998a) highlight that in that context, the 1st difference GMM estimator suffers from significant biases since the delayed variables are weak instruments.

This is why we use the GMM-system estimator that combines (first) differenced variables instrumented by the delayed variables (in level) and variables in level instrumented by the delayed differences, accordingly with Arellano and Bover (1995) and Blundell and Bond (1998a). Blundell and Bond (1998b), as well as Bond, Hoefler and Temple (2001), evidence the consistency of the GMM-system estimator on dynamic growth estimates with five or six 5-year periods, which is exactly our case. We then use the GMM-system estimates and present the usual tests. In particular, a Sargan test is presented in order to reject or not the instruments validity. We also test the presence of an autoregressive process (both AR(1) and AR(2), the instrumental method here requiring to conclude on an AR(1) but not AR(2) process.

We run our estimates for 103 countries of seven 5-year periods (from 1965-1969 to 1995-1999). The data come from the *World Development Indicators* (World Bank 2003) for the per capita GDP, from Ahmad, Lopez and Inoue (2000) for the under-five survival. We use the real effective exchange rate since the consistent relative prices evolution for economic analyses is not that of the relative prices towards an only trade partner but that of the relative prices variation, on average, towards the main trade partners. The real effective exchange rate is computed as a weighted geometric average of the bilateral exchange rate with the fifteen main trade partners[9], the weights being modified yearly from Paasche indices. Last, the consumer price indexes come from the Global Development Finance (2002).

Insert table 3

Regressions (i) and (ii), table 3, rely on a sample of 103 and 87 countries[10]. The convergence hypothesis, tested through the delayed dependent variable is rejected for both of the estimates.[11] The impact of the per capita GDP (y_{it}) on survival is, as expected, significantly positive (regression (i)). As for our both interest variables, namely the real effective exchange rate ($tcer_{it-1}$) (an increase in the variable reflecting a real appreciation of the country's currency) and the general level of prices (ipc_{it}) (regression (ii), their coefficient appear to be significant and with the expected signs: the influence of inflation on child survival is negative as well as that of the real appreciation. Once controlled for income per capita and general price level (both possibly influenced by exchange rate policy, a real currency appreciation (depreciation) appear to result in an improved (deteriorated) child survival.

The assumption of a negative impact of the real depreciation on the health status is supposed to result from a movement in the relative price of the imported or more generally tradable goods (medicines, foods). Our assumption on the negative impact of the depreciation corresponds to an impact on the poorest people, in particular in the rural areas, where real income is relatively more affected by the increase in the import price (foods, medicines) while the prices paid to the producers are not proportionally increased.

This negative impact of the real depreciation can then be expected to be all the stronger, as the country's urbanisation is low. A simple test (regression (iii) table 4) enables us to evidence two distinct regimes respectively related to urban and rural areas. It consists in including in the regression the urbanisation rate, not only additively (urb_{it}), but also multiplied by the real exchange rate ($urb_{it}.tcer_{it}$), the inflation rate ($urb_{it}.ipc_{it}$) and the per capita GDP ($urb_{it}.y_{it}$). The urbanisation process is expected to result in an increase in child survival, accordingly to the literature on the child mortality gap between rural and urban areas (see for instance Cornia and Menchini, 2005). The location matters, in particular with regard to the access to sanitary infrastructures, to housing health and education services (Defo, 1996, Sastry, 1996, Jhamba, 1999). Moreover, in a study on the malnutrition gap between the children of rural and urban areas, Smith, Ruel and Ndiaye (2005) highlight that the urban households are less unsafe with regard to food and have a greater access to insure health cares to their children. The impact of income is then expected to be less important in urban than in rural areas (the coefficient associated to the interactive variable urbanisation and income is expected to be negative). The following equation is then tested:

$$logitsij_{it} = a_0 + a_1 logitsij_{it-1} + a_2 y_{it} + a_3 tcer_{it} + a_4 ipc_{it} + a_5 urb_{it} + a_6\, urb_{it} y_{it} + \alpha_7 urb_{it} tcer_{it} + \alpha_8 urb_{it} ipc_{it} + \eta_i + \varepsilon_{it}\,; \qquad (2)$$

With the following expected signs:

$a_1 > 0$, $\alpha_2 > 0$, $a_3 > 0$, $a_4 < 0$, $a_5 > 0$, $\alpha_6 < 0$, $a_7 < 0$, a_8 ?

Table 4 reports the findings[12][13].

Insert table 4

The results support our assumption of the impact of relative prices for a given level of income: a real depreciation of the currency involves a deterioration of the health status all the stronger as the level of urbanization of the country is lower[14]. There are then two different regimes according to the location, urban or rural. Indeed, the rural are more sensitive than the urban to the relative price of the tradable, as suggested by the table 5.

Insert table 5

Both the higher impact of income in rural area (connected with the lower health care and infrastructures supply) and the impact of the real depreciation of the currency all the more negative as urbanisation is low (connected with an increase in the medicine or food prices) are consistent with a higher child malnutrition in rural area and bring an additional explanation to that gap[15].

5. Rural versus Urban model

A better understanding of the influence of the rate of urbanisation on the survival impact of relative prices can be obtained if we consider this impact separately in rural and urban areas. This can be done using data from Demographic and Health Surveys and relying on a sample of sub Saharan countries. The DHS surveys rely on household surveys with questionnaire to the mothers who are between 15 and 49 years old. Data are collected from similar methodological surveys, which makes them comparable across countries.

We have disaggregated data on child survival between rural and urban areas for 21 sub-Saharan countries. Then the same model is tested for both areas, similar to that used in table 3, in order to explain the (logit transformation of the) under-five survival, either in rural or in urban area. The two economic policy variables (the general level of the prices and the relative price index) are kept at the aggregate level, i.e. identical between rural and urban areas, because of a lack of disaggregated data[16]. The results are given in the table 6[17][18].

Insert table 6

The two regressions evidence an opposite impact of the real exchange rate depending on the location. The coefficient associated to the real effective exchange rate is significantly positive to explain the child survival in rural area, while significantly negative in urban areas. The initial hypothesis of a negative impact of a real depreciation (a decrease in the $tcer_{it}$) on survival is then only validated for the rural areas. The opposite result we found in urban areas can result from the increased relative income of the urban areas due to the real depreciation, the potential gains being stronger in urban areas and the supply adjustment more sensitive to the relative price changes than in rural areas (see Smith, Ruel and Ndiaye (2005)).

Moreover, equation (v) leads not to reject the hypothesis of convergence for urban areas, the coefficient associated to the delayed dependent variable being significantly inferior to 1 (equals to 0,83 with a standard error equals to 0,07). This could implies that the reduction in the under-five mortality targeted by the millenniums goals could be only due to the urban reduction coming with an increasing inequality between rural and urban areas.

6. Conclusion

Relying on a dynamic panel data with GMM system estimates and on a sample of 103 countries, we argue that independently of its effect on average income (i.e. controlling for the level of income) a real depreciation of the currency has a negative average impact on child survival. This effect is supposed to be channelled through higher relative prices of some tradable goods such as food and drugs, prices to which mortality is particularly sensitive. We also show that the relation between the relative price of tradable goods and under-five survival is all the more strong that the rate of urbanisation is lower, suggesting that it depends on the location of population either in rural or in urban areas. The assumption has been validated on a sample of 21 sub-Saharan African countries for which we had DHS data on under-five survival disaggregated between urban and rural areas (intra-country inequality). The negative impact of the real depreciation of the currency on the under-five survival appears to be limited to rural areas. A real depreciation can then lead to worsen the health inequalities between rural and urban areas, if it has no compensatory effect through a change in income distribution favouring rural areas. Moreover using dynamic panel estimates on a sub sample of 21 sub-Saharan African countries we find that the impact of the average income on child survival is significant only in rural areas, what can be explained by an uneven access to infrastructure as primary health care, education, housing, etc. (cf. Smith, Ruel and Ndiaye (2005)). These estimates also evidence a convergence process of child survival which is limited to urban areas. The Millennium Development Goal of reduction in under-five mortality could then be reached with an increased inequality, leaving behind the rural areas.

References

Ahmad, Omar B., Alan D. Lopez and Mie Inoue. 2000. The Decline in Child Mortality: a Reappraisal. *Bulletin of the World Health Organisation*, Vol.78(10), p. 1246-1255.

Alonso-Borrego, Cesar and Manuel Arellano. 1996. Symmetrically normalised instrumental variable estimation using panel data. *CEMFI Working Paper* N°9612, september.

Anand, Sudhir and Martin Ravallion. 1993. Human Development in Poor Countries: On the Role of the Private Incomes and Public Services. *Journal of Economic Perspectives*, Vol.7(1), Winter, p. 133-150

Arellano, Manuel, and Stephen Bond. 1991. Some tests of specification for panel data : Monte Carlo evidence and an application to employment equations. *Review of Economic Studies*, Vol.58, p.277-297.

Arellano, Manuel and Olympia Bover. 1995. Another look at the instrumental-variable estimation of error-components models. *Journal of Econometrics,* Vol.68, p.29-52.

Bhalla, Surjit S. and Paul Glewwe. 1986. Growth and Equity in developing countries: a reinterpretation of the Sri Lanka's experience. *The World Bank Economic Review*, Vol.1, p.35-63

Bidani, Benu and Martin Ravallion. 1997. Decomposing Social Indicators Using Distributional Data. *Journal of Econometrics*, Vol.77(1), p.125-139

Blundell, Richard and Steve Bond. 1998a. Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics,* Vol.87, p.115-143.

Blundell, Richard and Steve Bond. 1998b. GMM Estimation with persistent panel data : an application to production functions. IFS, *Working Paper* Series N°.W99/4.

Bond, Steve, Anke Hoeffler and Jonathan Temple. 2001. GMM Estimation of Empirical Growth Models. *Economics Papers*, 2001-W21, Economics Group, Nuffield College, University of Oxford.

Bourguignon, François, Jaime de Melo, Christian Morrisson. 1991. Poverty and Income Distribution during Adjustment: Issues and Evidence from the OECD Project. *World Development,* Vol.19(11), p.1485-1508

Bourguignon François and Christian Morrisson. 1992. Ajustement et équité dans les pays en développement, OCDE / Etudes du Centre de développement, Paris.

Caselli, Francesco, Gerardo Esquivel, and Fernando Lefort. 1996. Reopening the convergence debate: a new look at cross-country growth empirics. *Journal of Economic Growth*, Vol.1, p.363-389.

Cornia, Giovanni A. and Leonardo Menchini. 2005. The Pace and Distribution of Health Improvements during the last 40 years : some Preliminary Results. Forum on Human Development. hdr.undp.org/docs/events/global_forum/2005/papers/Giovanni_Andrea_Cornia.pdf

Defo, Bathélémy 1996. Areal and Socioeconomic Differentials in Infant and Child Mortality in Cameroon. *Social Science and Medicine*, Vol.42(3), p.399-420.

Devarajan, Shantayanan and Jaime de Melo. 1987. Adjustment with a Fixed Exchange Rate Cameroon, Ivory Coast and Senegal. *The World Bank Economic Review*, Vol.1 (3), p.447-487.

Devarajan, Shantayanan, Andrew S. Rajkumar and Vinaya Swaroop, 1999. What does aid to Africa finance ? *Policy Research Working Paper Series n°2092*, World Bank, Washington DC.

Dollar, David and Aary Kraay. 2002. Growth Is Good for The Poor. *Journal of Economic Growth*, Vol.7(3), p.195-225.

Fay, Marianne, Danny Leipziger, Quentin Wodon and Tito Yepes. 2005. Achieving Child-Health-Related-Millenium Development Goals : The Role of Infrastructure. *World Development*, Vol.33(8), p. 1267-1284.

Filmer, Deon and Lant Pritchett. 1997. Child Mortality and Public Spending Health. How does it much matter?, *World Bank Policy Research Working Paper*, N°.1864

Filmer, Deon, Jeffrey Hammer and Lant Pritchett. 2000. Weak Links in the Chain: A Diagnosis of Health Policy in Poor Countries, *World Bank Research Observer*, Vol.15(2), Aout, p. 199-224

Godfrey, Les G. and Michael R., Wickens. 1981. Testing Linear and Log-linear Regressions for Functional Form. *Review of Economic Studies*, Vol.48, p.487-496.

Guillaumont Patrick and Sylviane Guillaumont-Jeanneney. 1994. Dévaluation et Prix Réels Payés aux Producteurs Agricoles dans les Pays en Développement. Explication d'un Paradoxe. sous la direction de M.Benoit-Cattin, M.Griffon et P.Guillaumont, *Economie des politiques agricoles dans les pays en développement,* Vol. 2 - *les aspects macroéconomiques.* Ed. de la Revue Française d'Economie, p.151-182.

Guillaumont-Jeanneney Sylviane and Ping Hua. 2001. How Does Real Exchange Rate Influence Income Inequality Between Urban and Rural Areas in China. *Journal of Development Economics*, Vol.64(2), p.529-545.

Gupta, Sanjeev, Verhoeven Marijn and Erwin Tiongson. 2001. Public Spending on Health Care and the Poor. *IMF Working Paper*, WP/01/127.

Holtz-Eakin, Douglas, Whitney Newey and Harvey S. Rosen. 1988. Estimating vector autoregressions with panel data. *Econometrica,* Vol.56, p.1371-1396.

Jhamba, Tapiwa, 1999. Regional Variation in Childhood Mortality in Zimbabwe. *Geography*, Vol.84(4), p.319-330.

Krueger, Anne, Maurice Schiff Alberto Valdes. 1988. Agricultural incentives in developing countries: measuring the effect of sectoral and economy wide policies, *World Bank Economic Review*, Vol.2(3), p.255-272.

Minot, Nicholas, 1998. Distributional and Nutritional Impact of Devaluation in Rwanda. *Economic Development and Cultural Change*, Vol.46(2), p.379-402.

Pradhan, Menno, David E. Sahn and Stephen D. Younger. 2003. Decomposing world health inequality. *Journal of Health Economics*, Vol. 22(2), p. 271-295.

Ramsey, James B., 1969. Tests for Specification Errors in Classical Linear Least Squares Regression Analysis. *Journal of the Royal Statistical Society* B, Vol.31, p. 350-371.

Romer, Christina and David Romer. 1999. Monetary policy and the Well-Being of the Poor. *NBER* N°6793.

Sahn, David and David Stiefel. 2003. Progress toward the millennium development goals In Africa. *World Development,* Vol.31(1), p.23-52.

Sastry, Narayan, 1996. “Community characteristics, Individual and household attributes, and child survival in Brazil”, *Demography* 33: 211-29.

Smith Lisa C., Marie T. Ruel and Aida Ndiaye. 2005. Why is Child Malnutrition Lower in Urban than Rural Areas? Evidence from 36 Developing Countries. *World Development*, Vol.33(8), p.1285–1305.

United Nations Development Program. 2003. Rapport Mondial sur le Développement Humain 2003- Les Objectifs du Millénaire pour le Développement : Un Pacte entre les Pays pour Vaincre la Pauvreté Humaine. PNUD, Economica.

United Nations Development Program. 2005. Who's got the power ? Transforming health systems for women and children. Task force on Child health and Maternal health, UN Millenium Project.

World Bank. 2004. World Development Indicators 2004. CD-ROM.

World Bank. 2004. World Development Report 2004- Making Services Work for Poor People. World Bank Publications, Washington DC.

---

[1] Since a large part of the feedings is completed by imports in most of the developing countries (cf. Guillaumont and Guillaumont-Jeanneney 1994).

[2] However, the life expectancy at birth requires to have the mortality quotient by age, which is only possible for a limited number of countries, while under-five survival rates can be computed from household surveys, in particular with interviews of the mothers, cf. the DHS (Demographic and Health Surveys). Moreover, the life expectancy at birth is less sensitive than that of young children survival. On the opposite, infant mortality, i.e under-one mortality is far too restrictive and too strongly influenced by peri-natal mortality.

[3] Let sij_i be the under-five survival rate of the country i and x_i be the income per capita (for instance) of the country i and *logitsij*$_i$= $\ln\frac{sij_i}{1-sij_i}$; then, $\ln\frac{sij_i}{1-sij_i} = \alpha + \beta.\ln x_i + \varepsilon_{it}$;

hence $$\frac{1}{sij_i(1-sij_i)}dsij_i = \beta.\frac{1}{x_i}dx_i$$

and then $$\beta = \frac{dsij_i / sij_i}{dx_i / x_i} * \frac{1}{1-sij_i}$$

[4] Moreover, the explanation power of the logit formulation (0,79) is much higher than that of the logarithmic formulation (0,57).

[5] If these products are provided to industry, foodstuffs or food-producing (even if the products are not supposed to be exported, we can consider that their price is largely influenced by the price of the substitutable products on the local market).

[6] It is the case for the weak food-producing quality.

[7] Even if they do not pay them, the depreciation can lead to ration the medicine imports and hence an increase in the implicit price of the medicines.

[8] Smith et al. (2005) evidence that poverty is much more expanded in rural area than in urban areas. They estimate that approximately 77% of the rural households are poor in sub-Saharan Africa, while 34% of the urban households (p.1298).

[9] Computations are from the CERDI.

[10] Instruments to be used for the GMM-system estimates are Δs^*_{it-1}, $\Delta y_{i,t-1}$, ,$\Delta tcer_{i,t-1}$, $\Delta ipc_{i,t-1}$ for the level equations, s^*_{it-2}, $y_{it-2,}$ $tcer_{i,t-2}$, $ipc_{i,t-2}$ and other delays for the differenced equations.

[11] The coefficient associated to the delayed dependent variable (the logit transfomation of under-five survival) is always statistically significantly different for one (as the dependent variable is expressed in level and not in variation, the coefficient associated to the delayed dependent variable has to be significantly inferior to one to conclude on convergence, that is why we indicate the standard errors associated to the coefficient: these are 0.2 for the two regressions of the table 2.

[12] Instruments to be used for the GMM-system estimates are Δs^{*}_{it-1}, $\Delta y_{i,t-1}$, ,$\Delta tcer_{i,t-1}$, $\Delta ipc_{i,t-1}$, Δurb_{t-1} for the level equations, s^{*}_{it-2}, $y_{it-2,}$ $tcer_{i,t-2}$, $ipc_{i,t-2}$, $urb_{i,t-2}$ and other delays for the differenced equations.

[13] The standard error associated to the delayed dependent variable is here 0,2.

[14] Urbanization dampens the negative impact of the real depreciation without reversing the sign of this impact: positive sign virtually occurs for an urbanization rate higher than 100% (109%).

[15] According to Pradhan, Sahn and Younger (2003) this gap, i.e this intra-country inequality, explains a substantial part of the health inequality in the world.

[16] Then, an implicit assumption is then that there is no significant segmentation of the markets between rural and urban areas inside each country.

[17] Instruments to be used for the GMM-system estimates are Δs^{*}_{it-1}, $\Delta y_{i,t-1}$, ,$\Delta tcer_{i,t-1}$, $\Delta ipc_{i,t-1}$ for the level equations, s^{*}_{it-2}, $y_{it-2,}$ $tcer_{i,t-2}$, $ipc_{i,t-2}$ and other delays for the differenced equations.
$y_{it,}$ $tcer_{it}$, ipc_{it} and urb_{it} are expressed in logarithms.

[18] The standard errors associated to the delayed dependent variable are here respectively 0,05 and 0,07.

Appendix 1. Availability of the data on public health expenditures (share of public health expenditures in GDP).

The three following tables indicate the number of countries with at least 5, 10, 15, 20 or 25 observations (yearly series), according to three sources:

- Data from the World Development Indicators (WDI 2002);
- Data from the Global Development Network (GDN), which refers to the Government Financial Statistic (GFS).
- A working paper from Shantayanan Devarajan, Andrew Sunil Rajkumar and Vinaya Swaroop (1998) « What does Aid to Africa finance ? »

Table 1, 2 and 3 rely respectively on as much countries as possible (206), on African countries (51), and on the countries included in Devarajan et al. (1998) (16 sub-Saharan African countries).

Table1- Data availability on health expenditures for as much countries as possible

	WDI	GDN
> 5 observations	155	98
> 10 observations	80	78
> 15 observations	-	60
> 20 observations	-	44
> 25 observations	-	26

Table2- Data availability on health expenditures for African countries

	WDI	GDN
> 5 observations	40	21
> 10 observations	5	17
> 15 observations	-	10
> 20 observations	-	5
> 25 observations	-	-

Table3- Data availability on health expenditures for African countries in Devarajan et al.

	WDI	GDN	Devarajan et al.
> 5 observations	15	9	16
> 10 observations	4	9	16
> 15 observations	-	7	9
> 20 observations	-	3	5
> 25 observations	-	-	1

Appendix 2: List of the Countries- tables 3 and 4

Algeria	Greece	Pakistan
Argentina	Guatemala	Panama
Australia	Guyana	Papua New Guinea
Austria	Haiti	Paraguay
Bahamas, The	Honduras	Peru
Bangladesh	Hungary	Philippines
Barbados	Iceland	Portugal
Belgium	India	Russian Federation
Benin	Indonesia	Rwanda
Bolivia	Ireland	Salvador, El
Botswana	Israel	Saudi Arabia
Brazil	Italy	Senegal
Bulgaria	Jamaica	Sierra Leone
Burkina Faso	Japan	Singapore
Burundi	Kenya	Solomon Islands
Cameroon	Korea, Rep.	South Africa
Canada	Kuwait	Spain
Central African Republic	Latvia	Sri Lanka
Chad	Lesotho	Sweden
Chile	Luxembourg	Switzerland
China	Madagascar	Syrian Arab Republic
Colombia	Malawi	Thailand
Congo, Dem. Rep	Malaysia	Togo
Congo, Rep	Mali	Trinidad and Tobago
Costa Rica	Malta	Tunisia
Cote d'Ivoire	Mauritania	Turkey
Denmark	Mauritius	United Kingdom
Dominican Republic	Mexico	United States
Ecuador	Morocco	Venezuela, RB
Egypt, Arab Rep.	Nepal	Zambia
Fiji	Netherlands	Zimbabwe
Finland	New Zealand	
France	Nicaragua	
Gabon	Niger	
Ghana	Nigeria	
Gambia, The	Norway	

Appendix 3: List of the countries- Table 5.

African countries with available DHS data for our study:

Benin, Burkina-Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Ethiopia, Ghana, Guinea, Kenya, Madagascar, Mali, Mozambique, Niger, Nigeria, Senegal, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

Table 1- Functional forms and specification tests: logarithmic versus logistic formulation

	Dependent variable: Lnsij	Dependent variable: logitsij
lnGDP	0,36***	0,91***
(p-value)	(0,00)	(0,00)
R^2 adjusted	0,57	0,79
Box-Cox :		
t-test	9,58***	-0,14
(p-value)	(0,00)	(0,89)
Ramsey-Reset (p-value)	0,00	0,42

The p-value represents the type 1 error (rejecting wrongly H_0)

The data on the per capita income and on under five survival come from respectively the World Development Indicators (World Bank 2004) and from Ahmad, Lopez and Inoue (2000). They are averaged over 1995-1999.

Table 2- Tradable/non-tradable structure between urban and rural areas

	Urban		Rural	
	Production	Consumption	Production	Consumption
tradable	manufactured products	-agricultural products (locals) -manufactured products -imported products	agricultural products	-agricultural products (locals) -manufactured products -imported products
non-tradable	services	services	services	services

Table 3- The Impact of the Relative Prices on Under-five Survival : GMM-System estimate with robust standard-errors

	The dependent variable is the logit transformation of the SIJ	
	(i)	(ii)
s^{*}_{it-1}	0,99***	1,00***
	(0,00)	(0.00)
y_{it}	0,03***	0.06**
	(0,01)	(0.02)
$tcer_{it}$		0,15*
		(0,08)
ipc_{it}		-0,004***
		(0,00)
, and ***represent respectively 10, 5 et 1% thresholds p-values are indicated under brackets.*		
sargan (p-value)	0,16	0,25
AR(1) (p-value)	0,00	0.00
AR(2) (p-value)	0,72	0.72
Obs	618	576
Countries	103	97

The p-values indicate respectively the probability not to reject the hypothese of instruments validity, to reject the hypothese of an AR(1) process and to reject the hypothese of an AR(2) process.

Table 4- Impact of Relative Prices on Under-five Survival according to the Urbanisation Rate GMM-System Estimates with robust standard-errors

The dependent variable is the logit transformation of the SIJ

	(iii)
s^{*}_{it-1}	1,02***
	(0,00)
y_{it}	0,04*
	(0,08)
$tcer_{it}$	0,18*
	(0,09)
ipc_{it}	-0,75***
	(0,01)
urb_{it}	5,88**
	(0,02)
$urb.y_{it}$	-0,55**
	(0,03)
$urb.tcer_{it}$	-2,07*
	(0,08)
$urb.ipc_{it}$	0,09
	(0,98)

*,** and ***represent respectively 10, 5 et 1% thresholds p-values are indicated under brackets.*

Sargan (p-value)	0,34
AR(1) (p-value)	0,00
AR(2) (p-value)	0,61
obs	570
countries	96

The p-values indicate respectively the probability not to reject the hypothesis of instruments validity, to reject the hypothesis of an AR(1) process and to reject the hypothesis of an AR(2) process.

Table 5- Impact of a 10% real depreciation of the currency on the Under-five Survival (SIJ)

SIJ (‰) Urb(%)	750‰	850‰	950‰
25%	-57	-39,1	-14,25
50%	-30	**-20,4**	-7,6
75%	-14,25	-10,2	-3,8
90%	-7,5	-5,1	-1,9

Example : a country with an urbanisation rate of 50% and a SIJ rate of 850‰ faces a relative deterioration in its survival rate of 2,4%, i.e. a decrease in its SIJ rate from 850 to 829,6‰, or equivalently an increase in its mortality rate of 20,4 points.

Table 6- The impact of the relative prices on the under-five survival: rural vs urban regime GMM-System Estimates with robust standard-errors

The dependent variable is the logit transformation of the under-five survival
21 sub-Saharan African countries

	Rural area	Urban area
	(iv)	(v)
s^{*}_{it-1}	0,96***	0,83***
	(0,00)	(0,00)
y_{it}	0,04**	-0,002
	(0,03)	(0,85)
$tcer_{it}$	0,23**	-0,15*
	(0,03)	(0,09)
ipc_{it}	-0,45*	0,05
	(0,06)	(0,79)

, and ***represent respectively 10, 5 et 1% thresholds*
p-values are indicated under brackets.

	Rural area	Urban area
Sargan (p-value)	0,99	0,99
AR(1) (p-value)	0,04	0,04
AR(2) (p-value)	0,19	0,17
obs	108	100
Countries	21	21

The p-values indicate respectively the probability not to reject the hypothesis of instruments validity, to reject the hypothesis of an AR(1) process and to reject the hypothesis of an AR(2) process.