Is Growth Enough? Macroeconomic Policy and Poverty Reduction*

Charalambos G. Tsangarides
George Washington University
cgt@gwu.edu

Dhaneshwar Ghura
International Monetary Fund
dghura@imf.org

Carlos A. Leite
International Monetary Fund
cleite@imf.org

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Abstract

This paper provides an empirical investigation of the poverty-growth nexus and assesses the prospects for poverty alleviation through economic growth. The paper employs a dynamic panel estimator to capture both across- and within-country effects, a novel Bayesian Model Averaging robustness analysis to explicitly account for model uncertainty, and the widest possible set of potential determinants to ensure a comprehensive search for super pro-poor policies. The empirical findings are broadly encouraging. Growth does indeed raise the income of the poor, although this relationship is less than one-to-one, in sharp contrast with previous results. One implication is that simply focusing on economic growth as a strategy to lower poverty may actually leave the poor worse off relative to the average population. More encouraging is the evidence on the existence of a set of policies and conditions which are super pro-poor, namely lower inflation, lower government consumption, higher levels of financial sector development and higher educational status.

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1 Introduction

The renewed sense of urgency for faster and deeper poverty reduction has spawned a growing discourse on the determinants of poverty and the strategies for poverty reduction. Recent issues of the *World Development Report* (most notably the editions for 1980, 1990 and 2000) have focused on poverty reduction, and the Human Development Report started publishing an annual index on human development in 1990. In the academic literature, a key point of reference has been the impact on poverty rates of recent periods of rapid economic growth in East Asia, with empirical research generally stressing the primacy of improvements in average income.

Nonetheless, little is known about: (i) the channels through which growth affects the income of the poor, (ii) the set of policies which have an additional impact (other than through growth) on poverty reduction, or (iii) the sufficiency of focusing on economic growth as a way of ensuring lasting poverty reduction. Interestingly for international financial institutions, this set of questions provides a natural setup for an investigation into the efficacy of their adjustment programs. More broadly, the design of effective poverty reduction strategies remains an open question.

The current paper contributes to the ongoing debate by providing empirical evidence on the elasticity of the income of the poor with respect to average income and on the set of macroeconomic policies which directly influence poverty rates. The basic setup is similar to Dollar and Kraay (2001), which in a provocative study, suggest that growth promotion is entirely sufficient for poverty reduction – with macroeconomic policy having no direct impact on rates of poverty. The investigation herein considers a larger set of policy variables, and explicitly accounts for model uncertainty by means of a formal Bayesian robustness check.

The empirical findings suggest that economic growth raises the income of the poor, although by less than one-to-one. This implies that, for a given target of poverty reduction over a certain period of time, the economic growth rates required may exceed what can be reasonably expected (compared with what would be required if an increase in economic growth resulted in a one-to-one or higher increase in the income of the poor). This also implies that there is a role for policies that take into account the distributional impact of economic growth. An interesting finding of this paper is that certain policies can have direct impact on the income of the poor, even after controlling for the effect of economic growth. These include policies that lower inflation, shrink government, promote financial development, and raise educational achievements. The policy-related variables are considered "super pro-poor" in the sense that they raise the income of the poor directly, as well as through the economic growth channel. The direct and indirect effects are mutually reinforcing, and thus there are no identified trade-offs between growth promotion and poverty alleviation. The results on the impact of policy-related variables on poverty stand in contrast to previous

studies,[1] which find that once the effect of overall income has been taken into account, there exist no such super pro-poor policies; instead, these results confirm the findings of Collier and Dollar (2001) that the policy environment has a direct impact on poverty reduction. At the same time, the result on the impact of inflation confirms that of Easterly and Fischer (2001), who find that direct measures of the well-being of the poor are negatively correlated with inflation.

After a brief review of the literature and the data, the paper discusses the theoretical and econometric framework, presents the econometric results, and finally, discusses the policy implications.

2 Literature Review

Empirical research has served to highlight how little we still know about the dynamics and causes of changes in income distribution. The current view is that: (i) growth does not consistently affect inequality one way or the other (the Kuznet's hypothesis having essentially been refuted by panel studies), and (ii) the initial level of inequality does appear to negatively impact subsequent growth. For the first proposition, Deiniger and Squire (1998) and Ravaillon and Chen (1997) provide key evidence, leading Kanbur and Squire (2001, p. 192) to conclude that "...inequality and income are not systematically related according to some immutable law of development". The policy-relevant conclusion is that we should identify "policies, or combinations of policies, which will generate growth without adverse distributional effects, rather than rely on the existence of an aggregative, reduced form, relationship between per capita income and inequality" (Kanbur, 1998, p.16).

On the second proposition, Bourguignon and Morrison (1990) find that land concentration is closely associated with cross-country measures of inequality, and Deininger and Squire (1998) suggest that land ownership concentration, perhaps proxying for wealth distribution, reduces subsequent growth. Deininger and Olinto (2000) confirm the negative impact of asset, but not income, inequality on subsequent growth, and in addition, suggest that unequal distribution of assets may reduce the effectiveness of education.

Focusing specifically on the more vulnerable groups, Dollar and Kraay (2001; henceforth, DK) suggest that the income of the poorest fifth of the population grows in direct proportion to average income; or equivalently, that there is no correlation between growth in average income and changes in inequality.[2] In addition to a timely re-affirmation of the conclusion that growth tends to be distributionally neutral and to reduce the *absolute* level of poverty, DK also find that economic policy (other than through its role in the growth process) has no impact on the share of the income of the poor.[3] Low inflation, which Fischer

[1] See, for example, Dollar and Kraay (2001) and Roemer and Gugerty (1997).

[2] The latter version of this proposition has been in the literature for some time; see Bruno, Ravaillon and Squire (1998) for a useful survey.

[3] For the debate on the impact of data quality, see Ravallion (2001) and the references therein.

and Easterly (2000) suggest does have a separate impact on poverty rates, is found by DK to be, at best, marginally significant.

Roemer and Gugerty (1997) report a relationship between the income of the poor and average income which is less than one-to-one when the poor, as in DK, are defined as the bottom 20 percent of the income distribution, and exactly one-to-one when the poor are defined as the bottom 40 percent of the distribution.[4] In addition, Roemer and Gugerty (1997) note that the degree of openness of the economy does not have an independent effect on the income of the poor once the effect of overall income is taken into account.

In investigating the connection between economic growth and human development, Moser and Ichida (2001) utilize the framework advanced by Ranis, Stewart and Ramirez (2000).[5] Measuring human development on the basis of life expectancy, infant mortality rates and primary school enrolment, Moser and Ichida (2001) report that, for sub-Saharan Africa, the average income of a country is significantly and positively associated with progress on the human development front – similar to the findings in Ranis, Stewart and Ramirez (2000), Anand (1991), and Anand and Ravaillon (1993).[6] Additionally, similar to DK, Moser and Ichida (2001) find that macroeconomic policy does not affect human development other than through its impact on economic growth.

Anand and Ravaillon (1993) find that, in explaining variations in life expectancy, average income loses its statistical significance once an index of poverty and the level of public health spending per person are added as explanatory variables. In a complementary exercise, Gupta, Verhoeven and Tiongson (2001), on the basis of survey data and dividing the sample into poor and non-poor, suggest that public spending on health care does affect the health status of the poor, even after controlling for mean consumption (which is itself insignificant). It bears emphasizing that none of these conjectures and results imply that economic growth is not a factor in human development. Instead, as Anand and Sen (2000, p. 2033) mention: "what they indicate is that the connections are seriously contingent, and much depends on how the fruits of economic growth are shared ... and how far the additional resources are used to support public services..."

To summarize, the existing empirical evidence on poverty reduction, and more broadly on human development, strongly supports the primacy of the role of economic growth. Given that the income distribution does not appear to un-

[4] This investigation did consider the relationship between different segments of the income distribution and average income with no discernible differences found. Only the results for the bottom 20 percent are discussed below.

[5] There is, of course, a long history to the debate on the relationship between economic and human development. For example, Anand and Sen (2000, p. 2031) quote Aristotle as favoring human development: "wealth is evidently not the good we are seeking, for it is merely useful and for the sake of something else." More recently, Sen (1980) proposes the concept of expanding human capability as the objective of human economic activity.

[6] Earlier evidence suggests that, at the aggregate level, the many aspects of poverty (including education and health) are highly correlated, or, as stated by Kanbur and Squire (2001, p.184), "... broadening the definition of poverty does not change significantly who is counted as poor."

dergo substantial changes over the process of economic development, this is an unsurprising conclusion. In terms of delineating a more complete poverty reduction strategy, the key question centers on the particular set of policies which can stimulate deeper and faster poverty reduction. As discussed above, existing evidence suggests that there are no super pro-poor policies at the macroeconomic level. Should the latter assertion hold up, the immediate implication would be that the only necessary macroeconomic input to an effective poverty reduction strategy is growth promotion.

3 Looking at the Data

3.1 Definitions and Sources

To focus the discussion on the determinants of poverty rates, the set of possible explanatory variables is divided into the following broad categories:

- internal environment or resources (including natural resources and ethnicity);
- institutions and governance (including rule of law and level of democracy);
- human capital (including educational outcomes and life expectancy);
- physical capital (including private and public investment);
- macroeconomic stability (including inflation and fiscal balance);
- government size (ratio of government consumption to GDP);
- trade regime (including share of exports and imports in GDP);
- external environment (including changes in terms of trade); and
- financial development (including the ratio of broad money to GDP).

Table A1 in Appendix A contains details for each category, the component variables and their source.

Additionally, it turns out to be useful to rank the 85 countries for which data were available according to the level of income of the poor. As shown in Appendix Tables A2 and A3, countries are grouped into four groups based on the distance from the overall mean of the income of the poor. The countries farther above the sample mean of income of the poor (essentially the OECD countries) are denoted as "High," while at the other extreme, the countries farther below the sample mean are denoted as "Very low." In between these extremes, there are "Medium" and "Low" countries which are, respectively, just above and below the sample mean. In general, countries with higher levels of income for the poor also had a higher level of overall income, lower levels of income inequality, better internal environment, healthier political institutions, improved governance (including more democratic government and more civil

liberties and political rights), higher levels of human capital (including better education outcomes), more macroeconomic stability, better trade regime, a more favorable external environment, and a higher level of financial development.

The data on inequality and income of the poor (defined as the income of the lowest quintile of the income distribution) are taken from DK, which contains a lengthy discussion on the sources and quality of the data. To ensure consistency, additions to the set of explanatory variables follow procedures similar to DK to arrive at an unbalanced, irregularly spaced panel set of observations covering 137 countries over the period 1950-99. For each country, the data set includes observations that are at least five years apart, yielding a maximum of 418 country-year observations. After filtering out countries with less than two observations, in order to enable examination of within-country changes, the sample size is reduced to 285 observations. For purposes of estimation, differences in data availability across countries and variables translate into further reductions in sample size for different combinations of explanatory variables.

3.2 Correlates of Poverty Rates

For an initial snapshot of the determinants of poverty, data summaries, for the period 1960 to 1999, by country group are presented in both tabular (Appendix Table A2) and graphical form (Appendix Figures A1-A6). In addition to higher income on average, countries with higher income of the poor tend to have generally better indices of institutional development and policy implementation, including the following:

- lower levels of income inequality;
- better internal environments;
- more democratic political institutions and improved governance;
- higher levels of human capital;
- more open trade regimes; and
- higher levels of financial development.

Higher income of the poor does tend to be associated with more macroeconomic stability, as measured by lower levels of inflation and a stronger government fiscal balance as a ratio to GDP. As regards government size, the positive relationship with respect to government consumption, as shown in Appendix Table A2 and Appendix Figure A5, suggests that governments may be able to spend their way to less poverty. An examination of the apparent paradox by country group begins to dispel the notion by revealing interesting non-linearities, as shown in the table below.

Country group	Correlation coefficient
High income	+0.43
Medium income	-0.38
Low income	-0.04
Very Low income	
All inclusive	-0.22
Excl. Madagascar and Sierra Leone	-0.59

Notes:

1. Simple correlation between government consumption and income of the poor.
2. See Appendix Tables A1-A3 for data.

It would thus appear that the overall positive correlation depends largely on the subgroup of "High" countries—perhaps a manifestation of the Wagner hypothesis on the relationship between the level of development and size of government. Moreover, a simple Ordinary Least Squares (OLS) regression indicates that the overall positive effect tends to abate once other country characteristics are taken into account. In fact, regressing the income of the poor on government consumption while setting an additional control for average income immediately reduces the slope of government consumption to statistical insignificance. On physical capital, the mixed nature of the evidence involves differences in patterns based on the source of the investment. Thus, private investment is found to be inversely related to poverty while the converse is true for public investment.

An examination of the best- and worst-performing countries with respect to levels of poverty yields similar correlations at the country level. For example, the three lowest-ranked countries in the sample—Mali, Tanzania, and Sierra Leone—tend to rank in the lower half of both institutional development and policy implementation. The depth of poverty is particularly well illustrated by their extremely low ranking in terms of educational outcomes and life expectancy, consistent with the observation that widening the definition of poverty does not tend to change who is considered as poor. The tendencies are preserved if, instead, the highest-ranked countries, (in this case, Luxembourg, Belgium, and Canada) are examined; that is, these countries rank higher in terms of low poverty and with respect to the other development dimensions.

It is informative to compare changes in correlation coefficients across groups to identify variables with a significant association with poverty rates. Here, a variable is defined as having a significant impact on poverty rates if the change in the correlation coefficient across groups is statistically significant. This analysis suggests that in order to reduce poverty at a rate consistent with a move from either "Low" to "High" or "Very low" to "High," countries must improve along a broad set of dimensions, namely income inequality, population growth rates, rule of law, level of education, terms of trade, and financial development. A lower level of ethnic heterogeneity is also (weakly) associated with lower rates of poverty.

4 Poverty, Growth and Macroeconomic Policy

Current theories on income distribution provide little in the way of additional policy-relevant insights, and Srinivasan (2001, p. 4) cautions that "there are in theory no 'deep' (in the Lucas sense) parameters to be found empirically in the data, inexorably linking growth with [poverty and inequality]."[7] The focus of this paper is therefore on an empirically-driven search for poor-friendly policies; deriving a grand theory linking poverty, growth and inequality remains for another rainy day. This section provides a description of the theoretical framework followed by a brief discussion on the determinants of poverty rates.

4.1 Theoretical Framework

In estimating the trickle down effect and searching for super pro-poor policies, policy makers must confront the possibility that public policy in this area may involve significant trade-offs with respect to the twin goals of growth promotion and poverty reduction. For example, critics of a strict focus on growth promotion as a poverty reduction strategy claim that the benefits of growth tend to reach the poor with long lags. The ensuing policy advice is that, notwithstanding possible negative impacts on growth, the government should intervene directly in improving the lives of the poor.[8]

A natural setup to investigate the competing claims on the importance of growth for poverty reduction is to regress the logarithm of per capita income of the poor, y^P, on the logarithm of average per capita income, y:

$$y^p_{ct} = \beta + \beta_1 y_{ct} + \beta_2 G_{ct} + \beta_3' \mathbf{Z}_{ct} + \eta_c + \gamma_t + \nu_{ct} \tag{1}$$

where c and t index countries and years, respectively; G is the Gini coefficient; $\mathbf{Z}_{ct}$ is a vector of other determinants of mean income of the poor; and $\eta_c+\gamma_t+\nu_{ct}$ is a composite error term including unobserved country effects. The coefficient on average income provides an estimate of the trickle down effect of economic growth while the coefficient on $\mathbf{Z}_{ct}$ identifies factors which have a direct impact

[7] In the absence of a unified theory on growth and distribution, current theoretical models (necessarily) focus on one particular transmission channel, thereby greatly increasing the ex ante set of possible determinants. For example, Durlauf and Quah (1999) find that in excess of 90 different variables have been proposed as determinants of growth, while there are only 120 countries over which observations can be gathered. A (more) unified theory would, for example, say something about the effect of both inequality and trade policy on growth and might even rule one of these out as a determinant of growth. Additionally, predictions from existing theory are just as ambiguous as those from empirical evidence in suggesting that higher inequality may be associated with either faster or slower growth. For a good overview, see Bertola (1998), and for a recent empirical exercise suggesting that higher inequality may actually foster growth, at least over short-run periods, see Forbes (2000).

[8] In practice, improvements in the provision of basic services, including by reallocation of government expenditures, are standard prescription for economic growth, and progress on the human development front (as measured by health and educational indices) tends to occur alongside increases in growth rates. The same tends to be true in reverse: when the economic growth environment reduces the rate of return for skills acquisition, the incentive to acquire those skills will be reduced, even if public monies are shoveled into educational facilities.

on poverty rates. In the case of macroeconomic policies, non-zero coefficients in $\mathbf{Z}_{ct}$ identify policies which are either super pro-poor or which involve trade-offs. The inclusion of a separate control for distributional changes, G_{ct}, is in accordance with the literature on the joint determination of growth, income, and poverty. Consequently, the inclusion of initial values of the Gini coefficient allows for a test on the effect of initial inequality on the rates of poverty, similar to the proposal in the literature on growth and inequality that initial levels of inequality may affect the subsequent evolution of average income.

To the extent that, following the literature on growth and distribution, the poor are defined as those who live below an absolute poverty line (for example, less than US$1 per day for abject poverty), the implication of $\beta_1 = 1$ (as in DK), is that growth promotion, by itself, will eventually eliminate poverty. In this sense, growth promotion is sufficient for poverty alleviation. A statistically significant value of $\beta_1 < 1$ would also indicate that growth is beneficial for poverty reduction, but, for a given level of poverty reduction, its impact would take longer to materialize (than for a value of $\beta_1 = 1$). In the case of $\mathbf{Z}_{ct}$, nonzero coefficients identify policies (or exogenous conditions) that are either super pro-poor or that involve trade-offs between growth promotion and poverty alleviation.

In terms of policy evaluation, a crucial question immediately arises: How robust is the DK conclusion on the lack of a direct impact for macroeconomic policy on poverty? In terms of equation (1), is β_3 ever statistically significant? To provide a comprehensive answer to this question, this paper expands the set of $\mathbf{Z}_{ct}$ regressors (even including some exogenous environment variables, such as terms of trade, which are nonetheless of interest), and tests for specification robustness, as suggested by the literature on Bayesian model averaging and applied, in the context of growth, by Brock and Durlauf (2000), and Doppelhofer, Miller and Sala-í-Martin (2000).

4.2 Determinants of Poverty Rates

The standard set of growth-stimulating policies – such as institution-building, trade openness, and prudent fiscal and monetary stances – increase the opportunity set of profitable investments, benefiting the poor primarily by an expansion of the opportunities to earn a return from labor employment. For example, trade restrictions that tend to protect capital-intensive importables reduce the returns to labor, and overvalued exchange rates that reduce the profitability of tradables, turn the terms of trade against the poor, which tend to be net producers of tradables.[9] Additionally, environmental influences like availability of arable land and reliance on natural resources, external factors such as changes in the terms of trade, together with institutional characteristics such as the level of

[9] Additionally, it is possible that policies such as trade openness affect human development more favorably in certain circumstances, for example, in a context of wider civil or economic freedom. Perhaps through improved equality of opportunity (either social mobility or degree of structural flexibility), a society characterized by a higher degree of economic freedom may allow its members faster access to the benefits of global competition.

democracy may plausibly have dissimilar impacts on different segments of the income distribution. This section expands the discussion in the literature review to poverty determinants other than economic growth. With respect to growth-related policies, this discussion focuses on the direct links to the income of the poor, abstracting for the most part, from discussing the growth implications. For a summary of the latter see Durlauf and Quah (1999).

Macroeconomic stability

The impact of macroeconomic stability is captured by inflation and the government budget balance relative to GDP. A stable macroeconomic environment—characterized by low and predictable inflation, sustainable budget deficits, and limited departure of the real exchange rate from its equilibrium level—sends important signals to the private sector about the commitment and credibility of a country's authorities to efficiently manage their economy. In addition to the beneficial effects on growth, investment, and productivity (see, for example, Easterly and Kraay, 1999; and Fischer 1993), some studies have identified an adverse impact of inflation on the poor. Using survey data from a cross section of countries, Easterly and Fischer (2001) find that the poor are more likely than the rich to mention inflation as a top national concern. In addition, using pooled time-series and cross-country data, these authors find that direct measures of the well-being of the poor (e.g., the change in their share of national income and the real minimum wage) are negatively correlated with inflation. Some of the arguments that have been advanced include the fact that the rich are more likely to have access to financial hedging instruments, that can be used to protect the real value of their wealth.

Inequality

The progress in reducing rates of poverty through economic growth depends crucially on its distributional characteristics. This is particularly true for statistical measures of poverty as relatively high numbers of people are clustered around typical poverty lines. As a corollary[10], the poverty gap in the developing world is surprisingly small, at about one-third of total consumption by the developing world in 1985 for the poorest fifth of the population in the developing world. While these characteristics do raise the prospects for poverty alleviation through growth, as in East Asia through the 1980s and first half of the 1990s, Lipton and Ravaillon (1995, p. 2585) point out that "only small deviations in neutrality" are necessary to reverse the poverty reducing effects of distributionally neutral economic growth. This study measures inequality with the Gini index of inequality.

Natural resources and labor productivity in agriculture

[10] As detailed in Lipton and Ravaillon (1995), the poverty gap index (PG) reflects the depth of poverty by taking into account how far the poor are below the poverty line as well as the number of poor. Policy-wise, PG indicates the "potential for eliminating poverty by targeting transfers to the poor" (p. 2579). Technically, $PG = 1 - \frac{y}{z}$, where y is the level of income and z is the poverty line.

It is likely that the source of the economic growth—for example dependence on natural resources—matters for inequality, poverty and human development. Lewis (1954), for instance, attributes the onset of growth to higher income in an enclave sector characterized by higher productivity of labor. Suppose, for example, that the sector initially more productive is either an oil- or mineral-extractive industry. Leite and Weidmann (1999) link economic dependence on oil and mineral resource sectors to the availability of appropriable rents, the higher incidence of corruption, and, subsequently, lower economic growth. Appropriation of such rents by a section of the population, say, the elite, would be expected to delay the propagation of economic development to the remainder of the economy (by reducing the level of investment in the nonresource sector), and to both widen the level of inequality and reduce the level of human development in the intervening period.

Returns that accrue initially to a wider set of agents, such as the case of a highly productive agricultural sector, may allow for more progress with respect to poverty alleviation. Ravallion and Datt (1996) find that the aggregate time-series data for India indicate that poverty measures have responded far more to rural economic growth than urban economic growth. For East Asia, some of the credit for the growth with equity experience is typically ascribed to the strong performance in the agricultural sector. Intuitively, it is likely that those poor economies with better-functioning credit and land markets, and with a distribution and system of landholding consistent with market incentives, are more likely to perform better in the area of poverty reduction. Given that a majority of poor people are in the agricultural (rural) sector, this study also measures the impact of the sectoral distribution of growth by the relative productivity performance of the agricultural sector.

Institutions and governance

The distribution, across income groups, of the benefits of growth are likely to depend, not just on the sectoral pattern of growth but also on the degree of popular representation at the policymaking level and the effectiveness of the governing institutions. Whereas economic freedom may herald stronger property rights and freer markets, and therefore impact the income of the poor mainly through its beneficial impact on overall economic performance, political emancipation may be associated with the tendency to enact income redistribution schemes (including land reforms), and it may shift the focus of economic policy towards equity, possibly at the expense of (some) economic growth. Through its likely positive impact on other variables (for example, the rule of law and the rate of investment), it may also be that democracy's main impact on the income of the poor (and on overall income) is indirect. Barro (1996) discusses the impact of the rule of law and free markets on economic growth, while Easterly and Levine (1997) provide an interesting evaluation of the role of institutions and economic policies in economic growth in Africa.

Human development

Given a conducive environment, the productivity of the labor supplied by the poor is an important determinant of their ability to benefit from the enhanced opportunities—a situation that points to important synergies between growth promotion and initial conditions. Recent work in development economics acknowledges that a fundamental reason for the success of East Asia in promoting equitable growth was due not only to the labor-demanding nature of production but also to the relatively large stock of education and skills embodied in the labor force. This study captures the effect of human capital development through measures of health and educational status (such as life expectancy and school enrollment rates). In the case of educational status, these result-oriented measures also capture the effects of local incentives to acquire the related skills (more so than public expenditure data).

Financial sector development

Financial sector development may also benefit the poor by facilitating access to credit and improving risk-sharing and resource allocation. The poor, due to their lack of assets and the universal unacceptability of labor income as collateral, tend to have more difficulties than the rich in accessing credit. In particular, this prevents the poor from: (i) smoothing their consumption in bad times; and (ii) investing in riskier but more productive technologies (for which effective risk sharing is necessary). Observationally, two phenomena are likely to arise: (i) underinvestment by the poor will tend to be particularly large with respect to education, and (ii) a positive correlation between the distribution of resource levels and investment opportunities will tend to widen the extent of inequality. In both cases, there is the potential for significant policy complementarities between access to credit (with which to invest in education) and the increase in the returns to labor occasioned by growth promotion policies. In this study, financial sector development is measured by the ratio of broad money to GDP.

Physical capital

Empirical studies consistently report a positive role for the investment ratio in explaining international differences in both the standard of living (as measured by GDP per capita) and economic growth rates – see Mankiw, Romer and Weil (1992) for an example of both cases. A number of studies have also investigated the possibility that the public and private components of investment have different impacts on economic growth, for example Ghura and Hadjimichael (1996), although both components tend to be growth promoting. With respect to the impact on the income of the poor, it may be that public, compared to private, investment has more of a positive impact on the income of the poor, especially at low levels of development. Intuitively, basic investments in infrastructure may benefit the poor more than proportionately by facilitating initial access to markets or to basic social services. To the extent that the productivity of private investment is enhanced, the impact on the poor would be further strengthened.[11]

[11] As stated in Lipton and Ravaillon (1995), the consensus on inducing poverty-reducing

5 Econometric Methodology

The study of socioeconomic phenomena is typically plagued by inconsistent empirical estimates and model uncertainty.[12] The first case typically arises with omitted country specific effects which, if not uncorrelated with other regressors, lead to a misspecification of the underlying dynamic structure, or with endogenous variables which may be incorrectly treated as exogenous. To simultaneously address both omitted variable bias and issues of endogeneity, this paper follows DK in using panel data (to capture information from both cross-section and time-series), and employing a systems General Methods of Moments (GMM) estimator (which uses information from both a levels and a differences equation).[13]

Model uncertainty arises because the lack of clear theoretical guidance on the choice of regressors results in a wide set of possible specifications and, often, contradictory conclusions. Remedially, the analyst has three options: (i) arbitrarily select one model as the true model generating the data; (ii) present the results based on all plausible models without selecting between different specifications; and (iii) explicitly account for model uncertainty. While preferable, option (iii) presents enormous challenges at the level of both concept and statistical theory. Option (ii), although unsystematic, is preferable over option (i) but poses substantial logistical challenges. In practice, researchers tend to focus on one "channel" and choose option (i), ignoring model uncertainty altogether and risking overconfident inferences.[14] In theory, accounting for model uncertainty requires some version of a "robustness check", essentially an attempt to account for all possible combinations of predictors. This paper employs a Bayesian robustness check by considering all possible models given the specific set of regressors.

With income distribution data, a third potential econometric problem cen-

growth includes "investment in poor people's human capital" (p. 2571) and an acknowledgement that "markets may achieve [poverty-reducing growth] best where states do more – by providing infrastructural, public or merit goods – to enable the poor to be part of [the supply] response [to economic adjustment]"(p. 2570). It may also be that at higher levels of public investment, the effects of crowding out (in particular, of private investment) would increase. This would negatively impact the ability of the poor to exchange their most important asset, labor.

[12] The complex web of associations, that tends to characterize the evolution of socioeconomic processes works in tandem with a general lack of theoretical guidance on model specification to generate econometric results that are often not robust to (minor) changes in specification. For example, countries with more efficient bureaucracies tend to also perform better on dimensions such as the rule of law, corruption, financial development, and economic freedom. In addition, there may be a difference in the time dimension for separate transmission channels. For example, investments in education have stronger effects in the longer term. In addition to generating fragile estimates, this set of conditions implies that the resulting statistical bias, either in terms of magnitude or sign, is impossible to predict.

[13] For a discussion of both sources of bias, see Caselli, Esquivel and Lefort (1996) and Durlauf, and Quah (1999). For the original presentation of the GMM estimator, see Hansen (1982), and for applications in the context of economic growth, see Tsangarides (2002), Hoeffler (2000), and Bond, Hoeffer and Temple (1999).

[14] See, for example, Leamer (1978), and Raftery (1988) and (1996).

ters on measurement error, either random or systematic. Similar to DK and Forbes (2000), this paper addresses this issue by employing an improved dataset, originally compiled by Deninger and Squire (1998). The next two sections describe, first, the systems GMM panel-data estimator, and second, the proposed procedure for assessing the robustness of explanatory variables, which we label "Limited Information Bayesian Model Averaging" (LIBMA).

5.1 GMM: A Consistent Panel Data Estimator

GMM estimators hold the potential for both consistency and efficiency gains by exploiting additional moment restrictions. The systems GMM estimator used in this paper involves the estimation of two equations, one in levels and the other in differences, where the levels equation acts as an auxiliary equation to estimate the difference equation (growth rate). The estimates from the difference equation, constructed by taking first differences of the levels equation, account for country specific effects by eliminating the country specific effect η_c. For both equations, potentially endogenous explanatory variables are instrumented with their own lagged value, which deals with the issue of endogeneity. Estimating the equations as a system, the procedure constrains similar coefficients to be constant across equations.

To the extent that the lagged values of the regressors are valid instruments, this GMM estimator addresses consistently and efficiently both sources of bias. In evaluating the issue of weak instruments in panel data models, Blundell and Bond (1998), provide simulation-based evidence that the systems GMM estimator, has better finite sample properties than alternative estimators, such as the differenced GMM estimator used by Caselli, Esquivel and Lefort (1996) – which essentially uses only the estimates from a differences equation. The assumption that the instruments are uncorrelated with the error terms is tested using the Sargan J-test for overidentifying restrictions, as suggested by Newey and West (1987).

5.2 LIBMA: A Bayesian Approach to Model Uncertainty

To effectively sort out the underlying empirical model, econometricians employ two types of robustness checks: the Levine and Renelt (1992) version labels any variable that turns insignificant (under any specification) as "fragile", while the Sala-í-Martin (1997) version assigns a "level of confidence" to each variable (based on individual estimates from an extensive number of specifications). To date, these procedures have been applied only in the context of economic growth studies. The first procedure, an extreme bounds analysis based on Leamer (1983), typically results in few variables being labeled as robust, while the second procedure, a Bayesian approach, suggests that a relatively large number of variables are significant determinants of growth. The work of Levine and Renelt (1992) has been criticized for its restrictiveness[15], while Sala-í-Martin

[15]The usual argument is that, given a non-zero probability of a Type I [or II] error, it would always be possible to find some specification which renders insignificant any robust

(1997) has been criticized for the simplifying assumptions of a fixed model size and the existence of a set of "fixed regressors" appearing in each specification.

A conceptually attractive solution to the problem of model uncertainty is provided by Bayesian Model Averaging (BMA) although difficulties at the implementation stage sometimes render it impractical.[16] In particular, with a large number of regressors, K, the procedure may be infeasible due to the large number of models to be estimated, 2^K. Additionally, the researcher is required to specify the prior distributions of all relevant parameters. In practice, most applications of BMA utilize an arbitrary set of priors, without examining the impact of this choice.

This paper employs a modified version of BMA, which we label as LIBMA.[17] The LIBMA estimator incorporates a dynamic panel estimator in the context of GMM and a Bayesian robustness check to explicitly account for model uncertainty in evaluating the results of a universe of models generated by a set of possible regressors. This approach provides certain advantages over the Doppelhofer, Miller and Sala-í-Martin (2000) Bayesian Averaging of Classical Estimates (BACE) approach, and the approach of both Brock and Durlauf (2000) and Fernandez, Ley and Steel (2001). Significantly, LIBMA does not require the choice of (arbitrary) priors for all the parameters – instead, only one "hyperparameter" is specified, the expected model size, $\overline{k}$. Econometrically, the application herein differs from Doppelhofer, Miller and Sala-í-Martin (2000) in four important ways: (i) the use of the systems GMM estimator instead of ordinary least squares, which addresses the issues of endogeneity and omitted variable bias; (ii) the weights assigned to the different models are proportional to an explicitly defined Bayesian Information Criterion; (iii) the use of an unbalanced panel instead of balanced cross-section data, allowing a better analysis of the time-series dimension of the variables; and (iv) the estimation of the full set of models rather than relying on a random sample of the universe of models.

6 Econometric Results

6.1 The Impact of Model Uncertainty

Table 1 presents an initial evaluation of the fragility of the determinants of poverty. The second column, labeled as "DK", replicates the DK results, including the marginal significance of lower inflation. The next five columns indicate how drastically the policy conclusions can change with relatively small variations in the set of explanatory variables. For example, a simple test for the importance of private and public investment in explaining poverty might add measures for each of these variables to the DK specification, as in Specification 1. The hypothesis mentioned in an earlier section that public investment might

determinant.

[16] Madigan and Raftery (1994) show that BMA provides optimal predictive ability. Hoeting, Madigan, Raftery and Volinsky (1999) summarize recent work using BMA.

[17] For a discussion of the LIBMA see Tsangarides (2002). Also, the technical presentation in Appendix I supplements the overview provided in this section.

be super pro-poor is in fact corroborated but now government consumption is also marginally significant, and the set of super-pro poor policies is now at three.

Another hypothesis mentioned earlier is the possibility that growth from different sources (namely, agricultural and nonagricultural) has different impacts on the poor. Specification 2 tests for such an effect by adding a variable measuring the labor productivity of the agricultural sector (relative to productivity economy-wide). In addition, this specification also controls for a potentially important source of exogenous shocks, changes in the terms of trade. Now, terms of trade emerges as the only variable with a significant direct impact on the income of the poor.

Suppose instead that, focusing the search on identifying policies and conditions with differing impacts on growth and poverty, the researcher decides to include a set of explanatory variables more representative of typical growth equations, as in Specification 3. Suddenly, the relationship between growth and poverty is less than one to one, in contrast to the DK finding, and the set of super pro-poor policies or conditions is now significantly expanded to include inflation, income inequality, schooling, life expectancy and financial development.[18] These results confirm not only the tendency for empirical investigations into socioeconomic phenomena to yield fragile econometric estimates but also underscore the importance of a formal robustness check.[19]

6.2 Robustness Analysis of Poverty Determinants

Table 2 presents the results of the robust estimation, based on the results of estimating a universe of approximately 2^{18} regressions, and with a prior model size $\overline{k}$ of nine regressors.[20] The Bayesian nature of the procedure implies that it is possible to define different estimates, with appropriateness of a particular estimate depending on the intended use. The posterior inclusion probability shown in the second column reflects how much the data favors the inclusion of a variable in the regression. The conditional mean and variance, shown in the third and fourth columns, reflect only the regressions in which the variable actually occurs. The interpretation for the conditional mean is similar to a standard regression, which does not account for model uncertainty, in that it reflects a prior probability of inclusion equal to one for the particular variable, but equal to $\overline{k}$ divided by the total number of variables for the remaining variables. The conditional standard deviation does provide one measure of how well a particular variable is estimated, but the ratio of the mean to the standard

[18] Note that the validity of the instruments used in each of the four formulations is not rejected by the test on overidentification, suggesting that the specifications are acceptable.

[19] Although DK do engage in a "series of robustness checks" (p. 20), those are limited to (i) adding regional dummies, and (ii) dropping a subset of observations for which distribution data may be less reliable. As such, the DK tests do not constitute a comprehensive solution to the problem of model uncertainty.

[20] The current limit of 18 explanatory variables is a result of computational constraints which we are working to overcome. The choice of $\overline{k}$ is essentially ad-hoc but Table 3 provides evidence that the results in Table 2 are not sensitive to this choice.

deviation cannot, strictly speaking, be interpreted as a t-statistic, as noted by Doppelhofer, Miller and Sala-í-Martin (2000, p. 24).

The fifth column shows the sign certainty probability, a measure of the significance of each variable, defined as the probability that a coefficient has the same sign as its (posterior) mean. A sign certainty probability equal to one means that the variable has the same sign in every single regression in which it is included, a clear indication of a robust relationship. In earlier investigations, Sala-í-Martin (1997) has attempted to assess robustness by estimating the area under the normal $CDF(0)$, a concept analogous to the sign certainty probability. The boxed area in Table 2 comprises those variables for which (i) the posterior inclusion probability is high and (ii) the sign certainty probability is at least 90 percent, the equivalent to performing a one-sided test of significance at the 10 percent level in classical statistics.[21] In this case, the choice of cutoff is merely indicative of a set of variables that are relatively well estimated or, robust.

The results from the robustness analysis on poverty determinants can be summarized as follows:

- The elasticity of the income of the poor with respect to average income (measured by β_1 in equation (1)) is positive and significant providing further empirical evidence that increases in average income is an important avenue for poverty reduction.

- The effect of an increase in average income on the income of the poor is significantly less than one-to-one when the effects of other variables are taken into account, implying that growth promotion, by itself, will *not* eventually eliminate poverty. This is in contrast with the results of DK, who find the trickle down effect to be one-for-one, and do not identify any conditioning variables.[22] This result, while not weakening the strong impact of economic growth on poverty reduction, implies that, for a given target of poverty reduction over a certain period of time, the economic growth rates required may exceed what can be reasonably expected (than if the coefficient of average income were one or higher).[23]

- It is possible to identify four robust, "super pro-poor" conditions—low inflation, a high level of schooling, a high level of financial development, and small government size (captured by government consumption)—that are influenced by policy. These policy variables are super pro-poor in the

[21] While the chosen cutoff is not strictly grounded in statistical theory, for each individual regression, the posterior density (from which the sign certainty probability is calculated) is equal to the classical sampling distribution of the coefficient. Overall, however, the posterior density is not a sampling distribution; this is also why the ratio of the conditional mean to the standard deviation cannot be interpreted as a t-statistic, as noted previously.

[22] See Foster and Szekely (2001) for an exhaustive survey and further evidence on the growth elasticity of the income of the poor.

[23] An interesting experiment would be to ask if it is feasible for policymakers to rely on economic growth as the sole engine that drives poverty reduction strategies. For example, is growth enough to ensure that the International Development Goal (IDG) on poverty is met?

sense that they raise the income of the poor directly (as well as through the growth channel). In each case, the direct effect, as estimated above, and the indirect effect, as typically estimated in the growth literature, are mutually reinforcing.[24] In other words, there are no identified trade-offs between growth promotion and poverty alleviation.

- The results on the impact of policy-related variables on poverty stand in contrast to previous studies (namely, DK), which find that, once the effect of overall income has been taken into account, there exist no such super pro-poor policies; the results do confirm those of Collier and Dollar (2001), who find that the policy environment has a direct impact on poverty reduction. The result on the impact of inflation confirms that of Easterly and Fischer (2001), who find that direct measures of the well-being of the poor (for example, the change in their share of national income and the real minimum wage) are negatively correlated with inflation.

- In concert with the literature on the joint determination of growth, income and poverty, the high statistical significance of income inequality confirms that it is an important determinant of poverty. Lower levels of inequality are found to have a direct, beneficial impact on poverty reduction.[25]

- The finding on the terms of trade suggests that the poor may be especially vulnerable to adverse movements in the price of tradables. This would be consistent with the usual characterization of the poor as net sellers of tradables.

- The direct negative impact of dependence on natural resource exports is consistent with the nonintegrated nature of these sectors in low-income countries. It is common, for example, for oil rents to accrue (almost) entirely to the treasury with very few (backward or forward) linkages from the sector to the rest of the economy. Inefficiencies in government expenditures would then combine with the induced ("Dutch disease") incentives against the production of other tradables to have a negative impact not just on overall growth, as in Leite and Weidmann (1999), but also on poverty, as suggested by the results herein. It would thus appear that, for the poor, natural resource riches are double cursed.

- The results indicate that a number of variables—such as trade openness, the investment rate, budgetary stance, extent of democracy, life expectancy, and extent of civil wars—that have been shown in the empirical literature to have an impact on overall economic growth, do not directly influence the income of the poor (once the level of overall average

[24] For the effects on growth, see Fischer (1993) and Easterly and Fischer (2001) on inflation; Mankiw, Romer and Weil (1992) on schooling; King and Levine (1993) on financial development; and Fischer (1993) and Easterly and Rebelo (1993) on government consumption.

[25] The estimate of the coefficient of overall income is robust to the inclusion of additional inequality-related terms. This study specifically tested for nonlinear effects in the context of robust estimation and for threshold effects in the context of single regressions.

income has been accounted for). As regards trade openness, the theoretical literature indicates that, over the medium term, it helps poverty alleviation through its effects on the rate and the efficiency of the sectoral pattern of growth. Empirically, the literature on the links between international trade and poverty is in its infancy, and the theoretical literature does recognize that trade reform could have "... redistributive effects on income which can hurt the rich and the poor alike" (Bannister and Thugge, 2000, p. 4).

7 Policy Implications and Conclusions

The paper investigates the magnitude of the elasticity of the income of the poor with respect to average income and the existence of "super pro-poor policies," that is, policies that directly influence the income of the poor after accounting for the effect of growth. The relevance of the findings of this paper is strengthened by the use of three econometric tools: a dynamic panel estimator, which allows the results to be interpreted as measuring how changes in the income of the poor are related to changes in average income, both across countries and within a given country; a formal, Bayesian-type robustness check, which explicitly accounts for model uncertainty; and a wide set of poverty determinants.

The empirical findings indicate that growth is an important vehicle for poverty reduction, thereby confirming the results of previous studies. Nonetheless, the results also indicate that the impact of economic growth is less than one-to-one, which implies, that for a given target of poverty reduction over a certain period of time, the economic growth rates required may exceed what can be reasonably expected (than if economic growth resulted in a one-to-one or higher increase in the income of the poor). This result also implies that there is a role for policies that take into account the distributional impact of economic growth.

This paper identifies a set of super pro-poor policies—that is, those that lower inflation, reduce government size, deepen the financial sector, and raise educational achievement. However, the paper does not investigate the channels through which these policy-related variables directly influence the income of the poor. For such an evaluation, it would be necessary to specify relevant transmission mechanisms and to rigorously test their empirical relevance.

The results in this paper are based on the average experience of a large number of countries and, therefore, should not obscure the importance of dealing effectively with country-specific circumstances. The links between policy and institutional reform, on one hand, and policy and the income of the poor, on the other, are complex, with many transitions taking place under the surface of a generally favorable impact. Although this paper does reaffirm the primacy of improving average income among the actions that can be taken to generate sustainable poverty alleviation, the methodology herein does not constitute an investigation into how growth and poverty reduction and their underlying determinants are explicitly interconnected.

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Tables

Table 1: Growth Determinants and Incomes of the Poor
GMM System Estimation on Levels and Difference Equations

Specification:	DK Variables	Specification 1	Specification 2	Specification 3	Simulation Set	Simulation Set No Regions
Constant	-1.758 **	-1.596	-1.280	0.743	1.300 **	1.003 ***
	(0.768)	(0.993)	(1.760)	(0.453)	(0.501)	(0.297)
ln(Per capita GDP)	1.109 ***	1.095 ***	1.033 ***	0.824 ***	0.748 ***	0.778 ***
	(0.099)	(0.119)	(0.173)	(0.068)	(0.072)	(0.057)
LINVPRIINI		-0.074	-0.033			
		(0.061)	(0.075)			
LINVPUBINI		0.067 *	0.032			
		(0.039)	(0.044)			
LNININ				0.013	0.026	0.036
				(0.035)	(0.039)	(0.038)
GINI				-0.035 ***	-0.036 ***	-0.036 ***
				(0.002)	(0.002)	(0.001)
LPOPGR				0.004	0.005	-0.051
				(0.058)	(0.057)	(0.065)
NATRESAV				0.034	0.007	0.006
				(0.137)	(0.159)	(0.160)
SECDAV				0.033	0.046 *	0.045 **
				(0.024)	(0.025)	(0.022)
LNINFLAV	-0.139 *	-0.202 **	-0.083	-0.053 **	-0.066 **	-0.032
	(0.084)	(0.087)	(0.076)	(0.024)	(0.032)	(0.026)
BALYAV			-0.554	-0.291	-0.340	-0.338
			(0.602)	(0.252)	(0.260)	(0.254)
OPENAV	0.076	0.045		-0.005	0.013	-0.017
	(0.065)	(0.060)		(0.070)	(0.077)	(0.069)
TOTGRAV			1.552 ***	0.226	0.280	0.301 *
			(0.385)	(0.174)	(0.188)	(0.176)
PRIMEDAV				-0.043 ***	-0.038 **	-0.027 **
				(0.014)	(0.016)	(0.011)
LFEXPTAV				0.017 ***	0.019 ***	0.017 ***
				(0.004)	(0.004)	(0.004)
BRMYAV			0.115	0.077 *	0.085 *	0.058
			(0.144)	(0.046)	(0.051)	(0.043)
DMBCBAV	-0.188	-0.160				
	(0.154)	(0.193)				
AGRPRODAV			0.152	-0.047	-0.076	-0.065
			(0.096)	(0.057)	(0.056)	(0.047)
PW10				-0.023	-0.022	-0.027
				(0.019)	(0.023)	(0.023)
POLL1				-0.003	-0.002	-0.002
				(0.002)	(0.002)	(0.002)
LANDAV				0.016	0.023	0.018
				(0.014)	(0.016)	(0.016)
GOVAV	-0.608	-0.866 *	-0.974	-0.325	-0.465	-0.606 **
	(0.400)	(0.453)	(0.599)	(0.315)	(0.349)	(0.268)
RULELAW	-0.016	0.072		-0.010		
	(0.061)	(0.062)		(0.030)		
DEMCHGL				0.012		
				(0.009)		
POID	0.40	0.717	0.60	0.60	0.77	0.93
Observations	241	198	169	107	109	109
P-value Ho: *a1=1*	0.27	0.42	0.85	0.01	0.00	0.00

Notes:
1. The depended variables in the system are log(income of the poor) and the first difference of log(income of the poor). Unless indicated otherwise, all regressions include regional dummies.
2. Three asterisks, two asterisks, and one asterisk denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively; standard errors in parentheses.
3. For the system estimation on the levels and difference equations only ln(per capita income) was treated as endogenous. For the levels equation, the instrument was growth in mean income over the five years prior to t; for the difference equation the instruments were the level of mean income at the beginning of the period and the growth of mean income for the five years preceding t-k.

Table 2: Robustness of Poverty Determinants
Marginal Evidence of Importance

	Regressors	Posterior Inclusion Probability	Posterior Mean Conditional on Inclusion	Posterior Variance Conditional on Inclusion	Sign Certainty Probability	*Elasticities at country group means*	
						Low	*Very Low*
1	Log(average GDP)	1.000	0.7940	0.0104	1.00	0.794	0.794
2	Inequality (GINI) index	0.920	-0.0373	0.0001	1.00	-1.567	-1.753
3	Log of Inflation	0.917	-0.0576	0.0073	0.98	-0.058	-0.058
4	Secondary Schooling (Years)	0.917	0.0420	0.0011	0.98	0.039	0.026
5	Financial depth (M2 to GDP)	0.881	0.0661	0.0164	0.98	2.367	1.871
6	Government consumption (to GDP)	0.919	-0.6419	0.1980	0.96	-0.085	-0.082
7	Terms of Trade (Growth)	0.906	0.3182	0.0732	0.93	0.255	0.032
8	Natural resource exports (to GDP)	0.799	-0.0849	0.0584	0.90	-1.095	-1.298
9	Log (overall investment to GDP), initial	0.565	0.0299	0.0042	0.85		
10	Fiscal balance (to GDP)	0.874	-0.2293	0.1892	0.80		
11	Population growth	0.918	-0.3527	11.0952	0.73		
12	Trade openness (X+M as share of GDP)	0.898	-0.0001	0.0073	0.68		
13	Primary schooling	0.916	-0.0250	0.0004	0.67		
14	Life expectancy	0.906	0.0154	0.0001	0.63		
15	Democracy index	0.908	-0.0014	0.0000	0.50		
16	Civil War (in the last 10 years)	0.918	-0.0315	0.0016	0.49		
17	Relative agricultural labor productivity	0.893	-0.0380	0.0073	0.47		
18	Arable land	0.919	0.0206	0.0005	0.36		

Notes:

1. Bayesian Model averaging techniques are applied using a panel data systems GMM estimator; the depended variables in the system are log(income of the poor) and the first difference of log(income of the poor).
2. Overall income is always included in the pool of regressors.
3. The results are ranked by the sign certainty probability.
4. The prior mean model size *kbar* is 9; qualitative conclusions are robust to the choice of *kbar* (as shown in Table 3).
5. Classification in groups based on the level of average income of the poor; see Data section for details.

Table 3: Sensitivity Analysis on Prior Model Size

Posterior Conditional Means and Variances With Different Prior on Modle size, *kbar*

	Regressors	Sign Certainty	kbar = 5 Mean	kbar = 5 Variance	kbar = 6 Mean	kbar = 6 Variance	kbar = 8 Mean	kbar = 8 Variance
1	Log(average GDP)	1.00	0.8232	0.0183	0.8116	0.0156	0.7978	0.0118
2	Inequality (GINI) index	1.00	-0.0369	0.0002	-0.0370	0.0002	-0.0372	0.0001
3	Log of Inflation	0.98	-0.0964	0.0155	-0.0838	0.0127	-0.0649	0.0087
4	Secondary Schooling (Years)	0.98	0.0425	0.0016	0.0426	0.0015	0.0423	0.0012
5	Financial depth (M2 to GDP)	0.98	0.1077	0.0266	0.0947	0.0237	0.0742	0.0186
6	Government consumption (to GDP)	0.96	-0.5865	0.2913	-0.6032	0.2620	-0.6311	0.2167
7	Terms of Trade (Growth)	0.93	0.3105	0.1093	0.3138	0.0980	0.3175	0.0804
8	Natural resource exports (to GDP)	0.90	-0.1527	0.1150	-0.1271	0.0942	-0.0952	0.0673
9	Log (overall investment to GDP), initial	0.85	0.0376	0.0065	0.0354	0.0058	0.0316	0.0046
10	Fiscal balance (to GDP)	0.80	-0.2462	0.3435	-0.2337	0.2918	-0.2272	0.2170
11	Population growth	0.73	-1.4623	16.1041	-1.1388	14.7377	-0.5906	12.2545
12	Trade openness (X+M as share of GDP)	0.68	-0.0109	0.0105	-0.0069	0.0094	-0.0016	0.0078
13	Primary schooling	0.67	-0.0206	0.0008	-0.0222	0.0007	-0.0243	0.0005
14	Life expectancy	0.63	0.0118	0.0002	0.0130	0.0002	0.0147	0.0001
15	Democracy index	0.50	-0.0007	0.0000	-0.0009	0.0000	-0.0013	0.0000
16	Civil War (in the last 10 years)	0.49	-0.0207	0.0023	-0.0245	0.0021	-0.0298	0.0018
17	Relative agricultural labor productivity	0.47	-0.0102	0.0092	-0.0180	0.0086	-0.0317	0.0077
18	Arable land	0.36	0.0155	0.0007	0.0178	0.0007	0.0201	0.0006

	Regressors	Sign Certainty	kbar = 10 Mean	kbar = 10 Variance	kbar = 12 Mean	kbar = 12 Variance	kbar = 13 Mean	kbar = 13 Variance
1	Log(average GDP)	1.00	0.7917	0.0092	0.7903	0.0072	0.7909	0.0064
2	Inequality (GINI) index	1.00	-0.0374	0.0001	-0.0376	0.0001	-0.0377	0.0001
3	Log of Inflation	0.98	-0.0513	0.0061	-0.0409	0.0041	-0.0365	0.0034
4	Secondary Schooling (Years)	0.98	0.0415	0.0010	0.0404	0.0009	0.0398	0.0008
5	Financial depth (M2 to GDP)	0.98	0.0591	0.0144	0.0476	0.0108	0.0429	0.0093
6	Government consumption (to GDP)	0.96	-0.6508	0.1808	-0.6638	0.1500	-0.6682	0.1357
7	Terms of Trade (Growth)	0.93	0.3184	0.0668	0.3172	0.0555	0.3159	0.0505
8	Natural resource exports (to GDP)	0.90	-0.0767	0.0513	-0.0647	0.0409	-0.0600	0.0370
9	Log (overall investment to GDP), initial	0.85	0.0284	0.0038	0.0255	0.0030	0.0242	0.0027
10	Fiscal balance (to GDP)	0.80	-0.2338	0.1658	-0.2474	0.1283	-0.2560	0.1129
11	Population growth	0.73	-0.1324	9.9677	0.2688	7.7548	0.4547	6.6484
12	Trade openness (X+M as share of GDP)	0.68	0.0010	0.0068	0.0020	0.0060	0.0020	0.0057
13	Primary schooling	0.67	-0.0255	0.0004	-0.0262	0.0003	-0.0264	0.0003
14	Life expectancy	0.63	0.0159	0.0001	0.0168	0.0001	0.0171	0.0000
15	Democracy index	0.50	-0.0016	0.0000	-0.0019	0.0000	-0.0020	0.0000
16	Civil War (in the last 10 years)	0.49	-0.0327	0.0015	-0.0341	0.0012	-0.0343	0.0011
17	Relative agricultural labor productivity	0.47	-0.0442	0.0070	-0.0565	0.0062	-0.0627	0.0058
18	Arable land	0.36	0.0208	0.0005	0.0203	0.0004	0.0199	0.0004

Notes:

1. Bayesian Model averaging techniques are applied using a panel data systems GMM estimator; the depended variables in the system are log(income of the poor) and the first difference of log(income of the poor).
2. Overall income is always included in the pool of regressors.

Appendix A

Tables and Figures

Table A1: Sample Data
Variable Definitions and Sources

Variable	Source	Definition
Dependent Variable		
YP	DK	Logarithm of average incomes in lowest quintile, constant 1985 US dollars at PPP.
Explanatory Variables		
Y	DK	Logarithm of average per capita overall income, 1985 US dollars at PPP.
GINI	DK	GINI coefficient (initial value).
Internal environment/resources		
LPOPGR	WEO	Logarithm of population growth rate, average over specified period.
NATRESAV	Leite/Weidermann	Natural resource exports as share of GNP.
AGRPRODAV	DK	Labor productivity in agriculture relative to economy wide labor productivity, measured as current-price LCU value added in agriculture/agricultural labor force divided by current price LCU GDP divided by total labor force average over five years up to and including indicated year.
LANDAV	DK	Logarithm of arable land per capita, hectares, average over five years, up to and including indicated year.
EHET	Sambanis	Ethnic heterogeneity; sum of racial division, national language division, and religious division (Vanhanen (1999)).
ELFO	Sambanis	Updated index of ethnolinguistics fractionalization.
Institutions/governance		
RULELAW	DK	Rule of Law Index 1997-98, higher values indicate stronger rule of law, time invariant.
VOICE	DK	Index of formal democratic institutions, greater values indicate more democracy, 1997-98, time-invariant.
POLL1	Sambanis	Aggregate index of autocracy and democracy; lagged once (Source: PolityIII).
DEMCHG	Sambanis	Annual change in the democracy index, lagged once (Source: PolityIII).
FREE	Freedom House	Index of civil liberties.
POLR	Freedom House	Index of political rights.
PW10	Sambanis	Incidence of civil war in the last 10 years.
Human capital		
PRIMEDAV	DK	Average stock of years of primary education, average over five years up to and including indicated year.
SECEDAV	DK	Average stock of years of secondary education, average over five years up to and including indicated year.
AILITTAV	DK	Adult total illiteracy ratio, average over specified period.
LFEEXPTAV	World Bank	Life expectancy at birth (total), average over specified period
Physical capital		
LNINVPRIINI	WEO	Logarithm of private investment as a share of GDP, constant LCU, initial value of specified period.
LNINVPUBINI	WEO	Logarithm of public investment as a share of GDP, constant LCU, initial value of specified period.
LNIINI	WEO	Logarithm of overall investment as a share of GDP, constant LCU, initial value of specified period.
Macroeconomic stability		
LNINFLAV	DK	Logarithm of 1+inflation rate, average over five years up to and including indicated year.
BALYAV	WEO	Government balance as share of GDP, current LCU, average over specified period.
GOVAV	WEO	Government consumption as share of GDP, current LCU, average over five years up to and including indicated year.
Trade regime		
IMPTAXAV	DK	Import taxes collected as share of imports, current LCU, average over five years up to and including indicated year.
OPENAV	DK	Exports Plus Imports as share of GDP at PPP, average over five years up to indicated year.
External environment		
TOTGRAV	WEO	Terms of trade (goods and services) growth, average over specified period.
Financial development		
DMBCBAV	DK	Ratio of assets of deposit money banks to total bank assets, average over five years up to and indicated year.
BRMYAV	WEO	Ratio of broad money to GDP, average over specified period.
Dummy variables		
EAP	DK	East Asia and Pacific Regional Dummy.
ECA	DK	Europe and Central Asia Dummy.
MENA	DK	Middle East and North Africa Dummy.
LAC	DK	Latin America and Caribbean Dummy.
SA	DK	South Asia Dummy.
SSA	DK	Sub-Saharan Africa Dummy.

Table A2: Sample Data
Country Group Unweighted Averages

	Country Group				
Variable	**High**	**Medium**	**Low**	**Very Low**	**Overall**
YP (log income of poor)	8.33	7.41	6.50	5.34	6.89
Y (log average GDP)	9.30	8.53	7.75	6.84	8.10
GINI (inequality index)	31	35	42	47	39
Internal environment/resources					
POPGR (in percent)	0.7	1.3	2.1	2.8	1.8
NATRESAV (in percent)	9.5	14.4	12.9	15.3	10.1
AGRPRODAV (in percent)	86.1	74.2	68.7	77.8	73.1
LANDAV (in logs)	-1.35	-1.27	-1.04	-0.90	-1.09
EHET (index: 0-100)	22	31	40	71	38
ELFO (index: 0-100)	24	21	38	60	33
Institutions/governance					
RULELAW	1.43	0.51	-0.27	-0.42	0.27
VOICE	1.30	0.73	-0.12	-0.22	0.37
POLL1	8.33	3.20	1.38	0.77	2.95
DEMCHG	0.01	0.12	0.11	0.40	0.12
POLR	1.63	3.55	4.07	4.73	3.09
FREE	1.70	3.69	4.10	4.81	3.15
PW10	0.04	0.00	0.37	0.32	0.21
Human capital					
PRIMEDAV (years)	5.25	4.13	2.74	2.56	2.78
SECEDAV (years)	2.45	1.55	0.94	0.62	1.07
AILITTAV (illiteracy ratio)	7.96	13.64	30.64	43.86	21.59
LFEEXPTAV (years)	72.85	68.73	62.99	54.27	63.57
Physical capital					
LNINVPRIINI (log of share of GDP)	2.89	2.89	2.55	2.42	2.31
LNINVPUBINI (log of share of GDP)	1.38	1.69	1.82	1.79	1.42
LNIINI (log of share of GDP)	3.18	3.22	3.14	2.97	2.69
Macroeconomic stability					
LNINFLAV (log)	0.07	0.26	0.31	0.21	0.22
BALYAV (in percent)	-2.4	-3.6	-4.7	-5.6	-3.9
GOVAV (in percent)	16.4	16.0	13.3	12.7	14.5
Trade regime					
IMPTAXAV (in percent of imports)	2.6	7.8	12.5	19.4	8.3
OPENAV (in percent)	71.5	45.4	20.9	24.6	36.6
External environment					
TOTGRAV (in percent)	-0.3	1.2	0.8	0.1	0.5
Financial development					
DMBCBAV (share of GDP)	88.5	88.4	70.6	55.5	72.4
BRMYAV (share of GDP)	64.6	52.8	35.8	28.3	44.1
Memorandum items:					
Average number of periods	5	3	3	2	3
Number of countries	20	18	30	17	85

Notes:
1. Classification based on the number of standard deviations from the sample mean for the income of the lowest quintile in each country; high (greater than 0.80 deviations), medium (between 0.79 and 0 deviations), low between (-0.01 and -0.75 deviations), and very low (less than -0.76 deviations).
2. The average number of periods is the average number of observations of each group in the data set. A period consists of two observations that are, at minimum five years apart.

Table A3: Sample Data
Country Group Membership

Country Group				Periods			
High	Medium	Low	Very Low	High	Medium	Low	Very Low
Hungary	Slovak Republic	Nepal	Sierra Leone	5	1	2	1
France	Bahamas, The	Egypt	Tanzania	5	3	3	2
Singapore	Portugal	Bolivia	Mali	4	3	1	1
Hong Kong SAR	Poland	Panama	Ethiopia	4	4	3	1
Spain	Venezuela	Pakistan	Lesotho	5	5	5	1
Norway	Taiwan Province of China	Bangladesh	Zambia	6	6	4	2
Japan	Greece	Seychelles	Madagascar	6	3	1	1
New Zealand	Bulgaria	China	Mauritania	3	1	3	1
Italy	Trinidad and Tobago	Dominican Republic	Nigeria	3	4	3	3
Finland	Ireland	Moldova	Honduras	5	2	1	3
Denmark	Belarus	Tunisia	Ivory Coast	4	1	4	1
Australia	Mauritius	Brazil	El Salvador	4	2	5	3
United Kingdom	Estonia	Indonesia	Ghana	6	2	5	2
Netherlands	Puerto Rico	Ecuador	Guyana	4	3	2	1
Unites States	Latvia	Russian Federation	Guatemala	7	2	2	1
Germany	Korea, Republic of	Morocco	Philippines	5	6	1	5
Sweden	Malaysia	Thailand	India	5	4	6	6
Canada	Jordan	Colombia		6	3	4	
Belgium		Jamaica		2		3	
Luxembourg		Peru		1		4	
		Sri Lanka				5	
		Yemen, Republic of				1	
		Romania				1	
		Costa Rica				5	
		Turkey				3	
		Algeria				1	
		Chile				3	
		Fiji				1	
		Iran, Islamic Republic of				1	
		Mexico				6	

Notes:
1. Country groups defined on the basis of income of the poor; see Table A2 for definitions.
2. "Periods" is the number of observations each country contributes to the data set. A period consists of two observations that are at minimum five years apart.

Figure A1: Determinants of Poverty
Inequality and Internal Environment

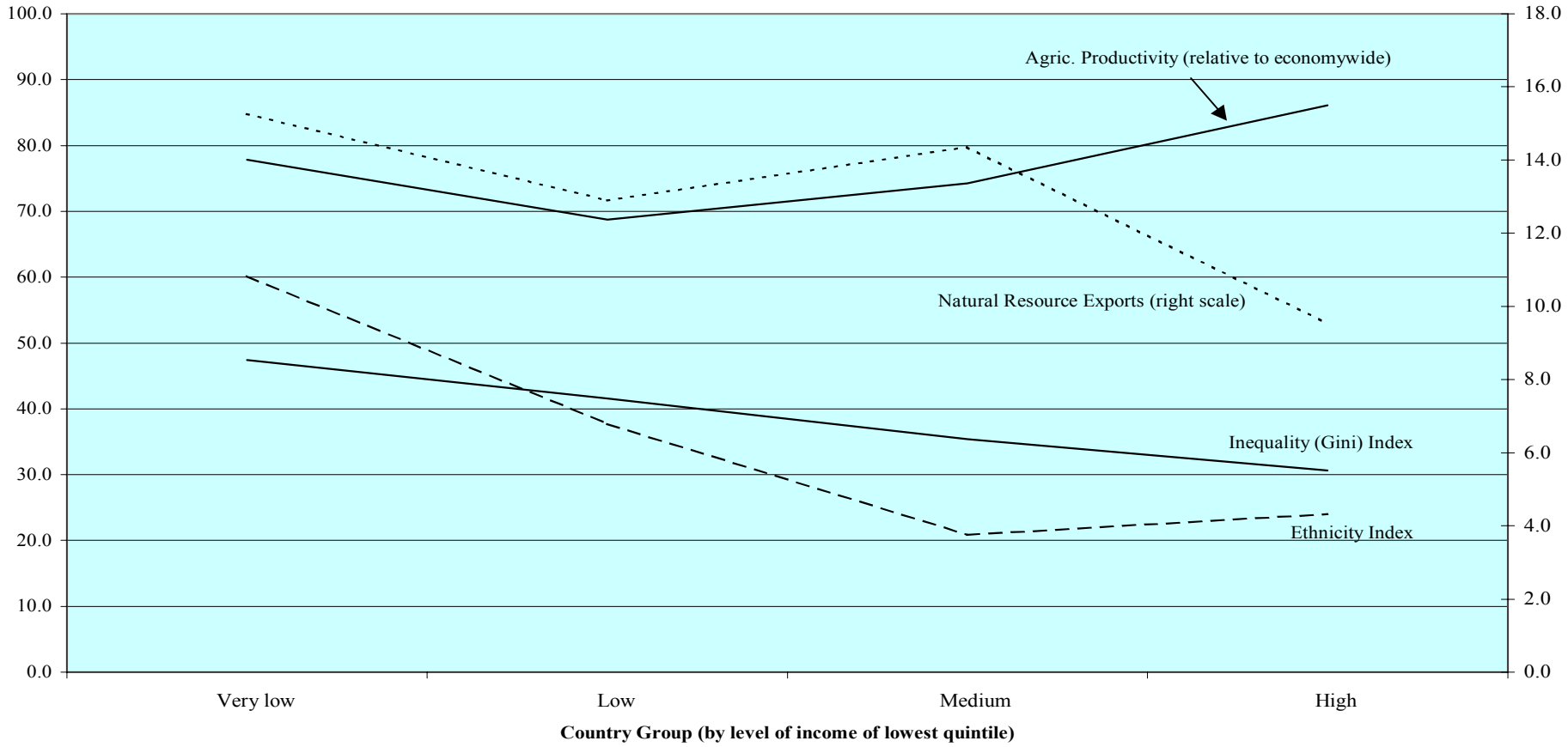


Figure A2: Determinants of Poverty
Institutions/Governance

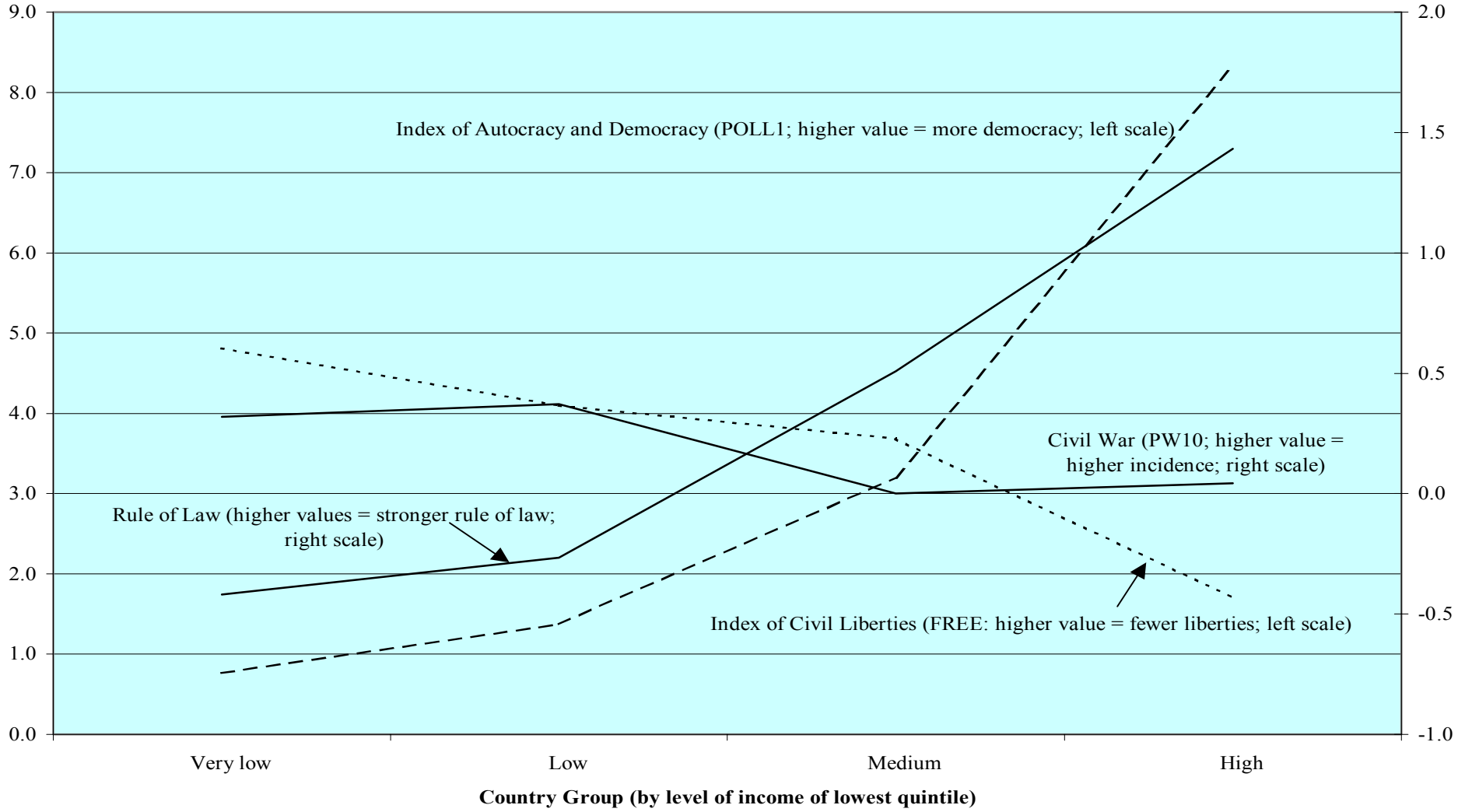


Figure A3: Determinants of Poverty
Human Capital

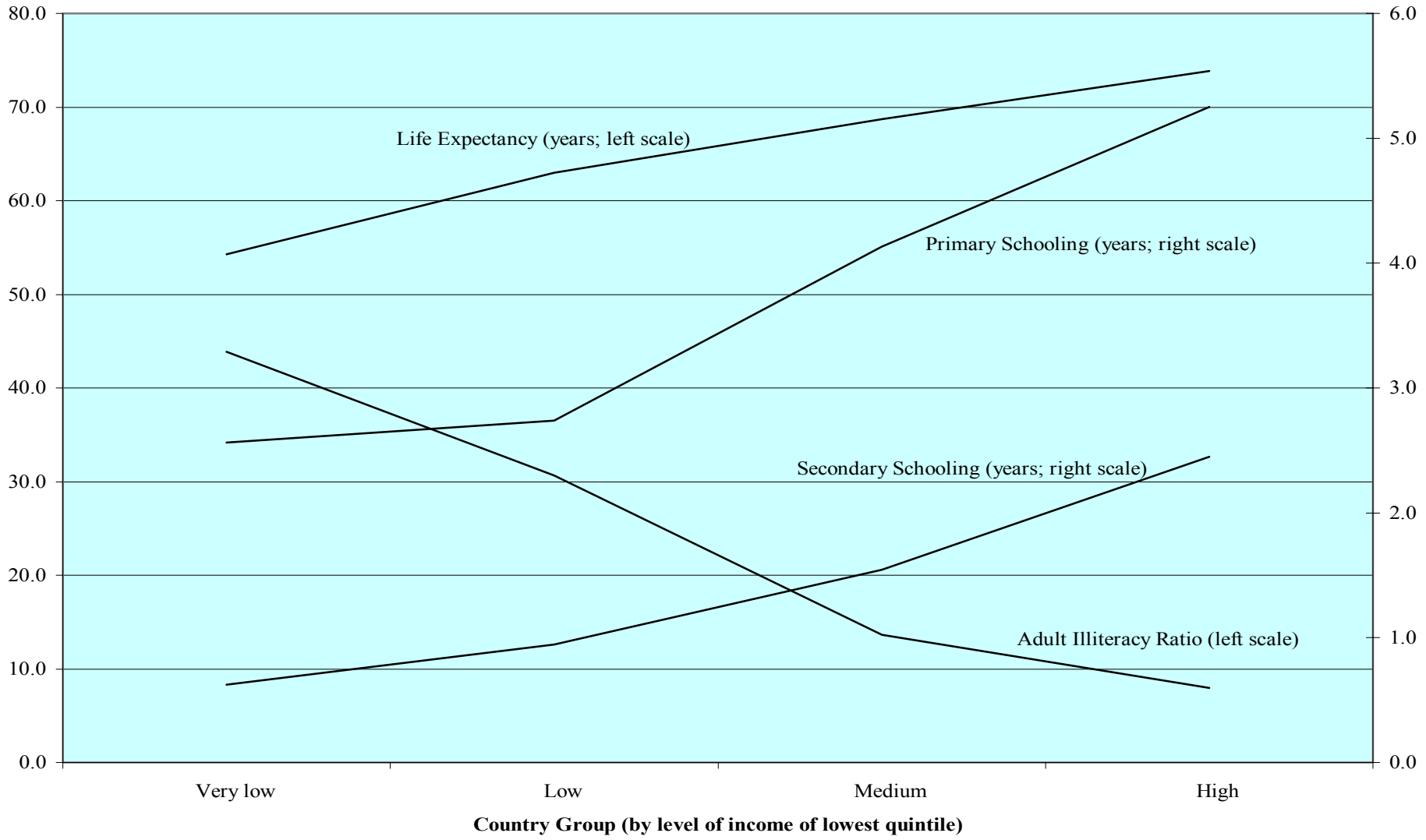


Figure A4: Determinants of Poverty
Physical Capital (log of ratio to GDP)

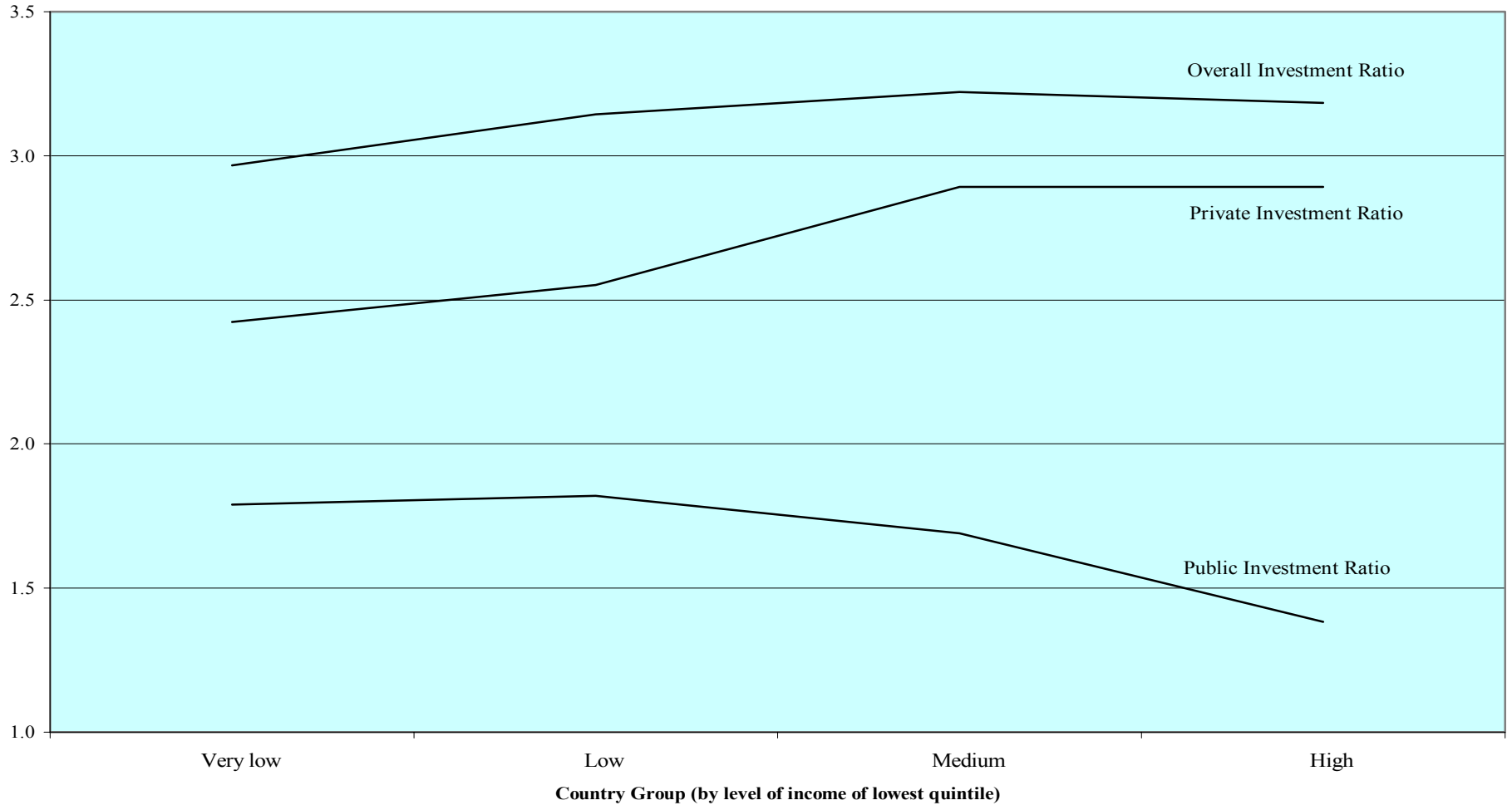


Figure A5: Determinants of Poverty
Macroeconomic Stability

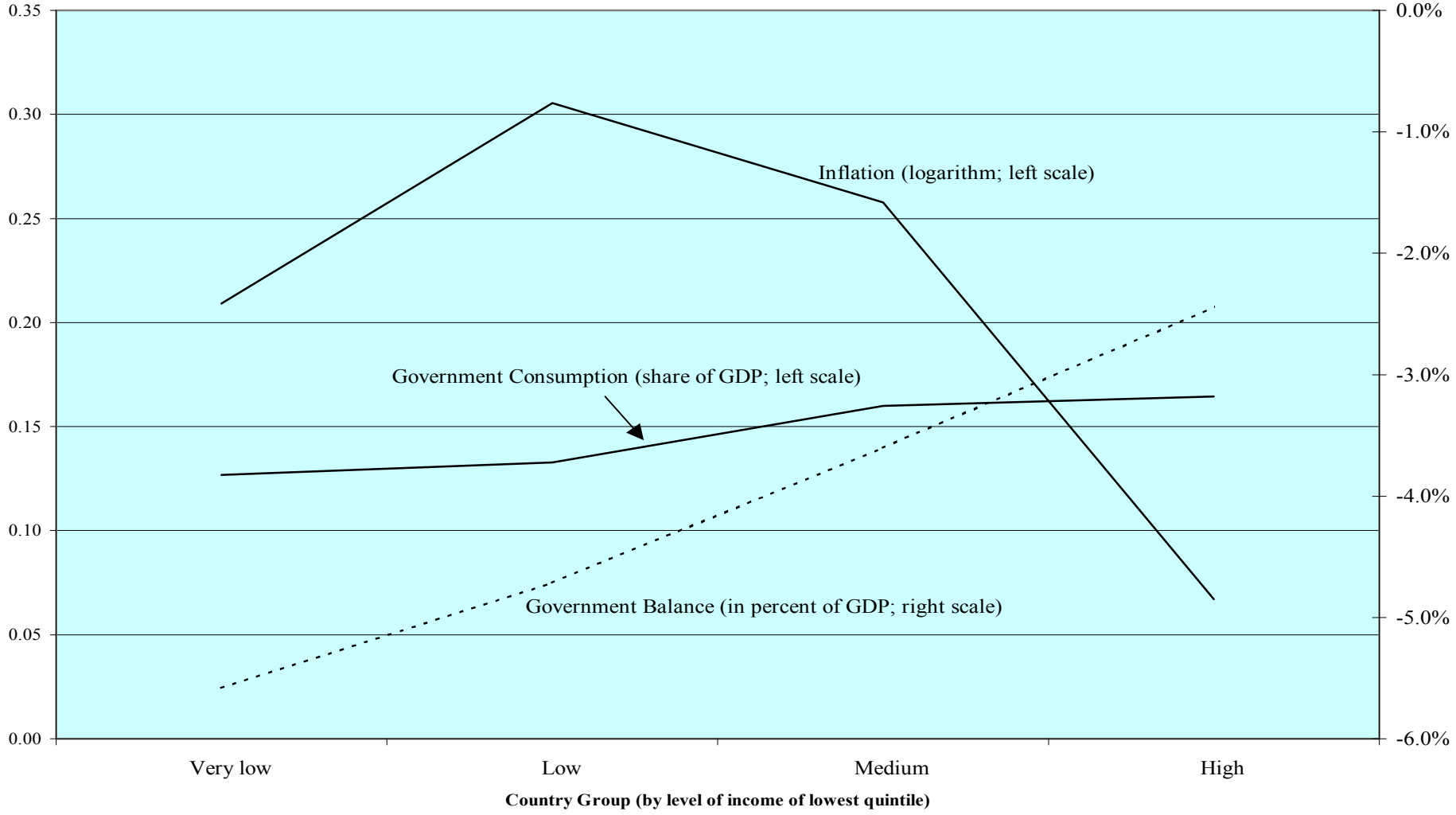
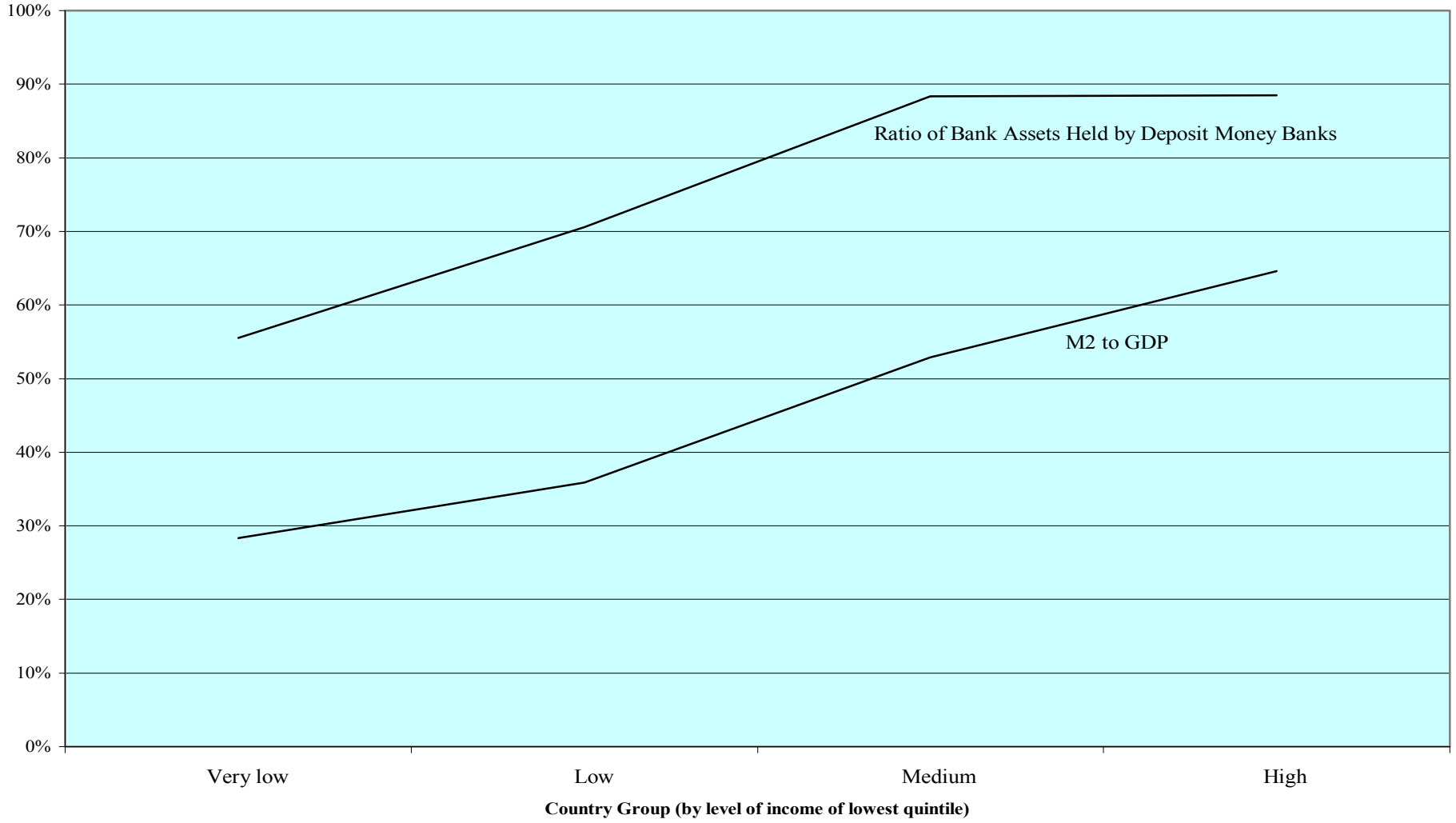


Figure A6: Determinants of Poverty
Financial Development



Appendix B

Computational Aspects

This Appendix provides a summary of the LIBMA approach and presents all the calculated quantities and summary statistics on which the robustness analysis is based. More detailed explanations can be found in Tsangarides (2002).

Bayesian Hypothesis Testing and BMA

We begin with a probability model for the data D,which is specified by a vector of d unknown parameters $\boldsymbol{\theta} = (\theta_1, ..., \theta_d)$. Prior to observing the data, our beliefs are represented by a prior probability density $p(\boldsymbol{\theta})$, and the probability model is specified by the likelihood $p(D|\boldsymbol{\theta})$,the probability of observing the data D given that $\boldsymbol{\theta}$ is the true parameter. Having observed the data D we update our beliefs about $\boldsymbol{\theta}$ using Bayes' theorem to get the posterior distribution of $\boldsymbol{\theta}$ given the data D, or $p(\boldsymbol{\theta}|D) = \frac{p(D|\boldsymbol{\theta})p(\boldsymbol{\theta})}{\int p(D|\boldsymbol{\theta})p(\boldsymbol{\theta})d\boldsymbol{\theta}}$.

Suppose now that we want to use data D to test two competing hypotheses presented by the models M_1 and M_2 with parameter vectors $\boldsymbol{\theta}_1$ and $\boldsymbol{\theta}_2$. By Bayes' rule the posterior probability that M_1 is the correct model is:

$$p(M_1|D) = \frac{p(D|M_1)p(M_1)}{p(D|M_1)p(M_1) + p(D|M_2)p(M_2)} \tag{2}$$

where (for $k = 1, 2$), $p(D \mid M_k)$ is the marginal probability of the data given M_k, and $p(M_k)$ is the prior probability of model M_k.

The *marginal likelihood* (or marginal probability of data) is obtained by integrating over $\boldsymbol{\theta}_k$, so for the numerator of (2)

$$p(D|M_1) = \int p(D|\boldsymbol{\theta}_1, M_1)p(\boldsymbol{\theta}_1|M_1)d\theta_1 \tag{3}$$

which suggests that the posterior distribution is proportional to the likelihood times the prior.

The *posterior odds* ratio for M_2 against M_1 (i.e. the ratio of their posterior probabilities $\frac{p(M_2|D)}{p(M_1|D)}$ can be used to measure the extend to which the data support M_2 over M_1. Using (2) the posterior odds ratio is

$$\frac{p(M_2|D)}{p(M_1|D)} = \frac{p(D|M_2)}{p(D|M_1)} \times \frac{p(M_2)}{p(M_1)} \tag{4}$$

where the first term on the RHS of (4) is the *Bayes factor* for M_2 against M_1,denoted by B_{21}, and the second term is the *prior odds* ratio. Sometimes the prior odds ratio is set to 1, representing the lack of preference for either model, in which case the posterior odds ratio is equal to the Bayes factor. When the posterior odds ratio is greater (less) than 1 the data favor M_2 over M_1 (M_1 over M_2).

Evaluating the Bayes factor in (4) requires calculating the marginal likelihood which can be a high-dimensional and intractable integral. Various analytic and numerical approximations have been proposed. The BIC approximation is a simple and accurate method to estimate Bayes factors. We focus on approximating the marginal likelihood for a single model, i.e. the RHS of (3). As discussed in Kass and Raftery (1995), an approximation to the Bayes factor B_{21} is the *Bayesian Information Criterion* (BIC)

$$BIC = 2\log B_{21} = 2[\log p(D|\widehat{\boldsymbol{\theta}}_2, M_2) - \log p(D|\widehat{\boldsymbol{\theta}}_1, M_1)] - (d_2 - d_1)\log n + O(n^{-\frac{1}{2}}) \tag{5}$$

Now suppose we can divide the parameter space into regions (models). Let Δ be the quantity of interest. Then Bayesian inference about Δ is constructed using *Bayesian Model Averaging*, based on the posterior distribution

$$p(\Delta|D) = \sum_{k=1}^{K} p(\Delta|D, M_k)p(M_k|D) \tag{6}$$

This follows by the law of total probability. Thus, the *full* posterior distribution of Δ is a weighted average of the posterior distributions under each model $(M_1, ..., M_K)$, where the weights are the posterior model probabilities $p(M_k|D)$.

Using Bayes' theorem, the posterior model probabilities are obtained using

$$p(M_k|D) = \frac{p(D|M_k)p(M_k)}{\sum_{j=1}^{K} p(D|M_j)p(M_j)} \tag{7}$$

which is essentially (2) extended from 2 to K models. Further, it can be shown that $p(D|M_k) \propto \exp(-\frac{1}{2}BIC_k)$ (7) becomes

$$p(M_k|D) = \frac{\exp(-\frac{1}{2}BIC_k)p(M_k)}{\sum_{j=1}^{K} \exp(-\frac{1}{2}BIC_j)p(M_j)} \tag{8}$$

The expression in (8) uses the "full information" BIC shown in (5). In the framework of our GMM analysis, we modify (8) to incorporate the "limited information" criterion, namely the LIBIC.

$$p(M_k|D) = \frac{\exp(-\frac{1}{2}LIBIC_k)p(M_k)}{\sum_{j=1}^{K} \exp(-\frac{1}{2}LIBIC_j)p(M_j)} \tag{9}$$

Equation (9) defines the LIBMA estimator, an extension of the BMA in the case of a limited information likelihood. The LIBMA incorporates a dynamic panel estimator in the context of GMM and a Bayesian robustness check to explicitly account for model uncertainty in evaluating the results of a universe of models generated by a set of possible regressors.[26]

[26] The derivation of the LIBIC as well as further details of the LIBMA approach to model uncertainty can be found in Tsangarides (2002).

Computed Statistics for the Robustness Simulations

We now have all the needed information to calculate the statistics required for the robustness analysis. From (4) the posterior odds ratio for two models M_j, M_l is $B_{jl} = \frac{p(M_j|D)}{p(M_l|D)} = \frac{p(D|M_j)}{p(D|M_l)} \times \frac{p(M_j)}{p(M_l)}$. The first term on the RHS, $\frac{p(D|M_j)}{p(D|M_l)}$ is the Bayes factor and can be approximated using (5). The second term, $\frac{p(M_j)}{p(M_l)}$is the prior odds ratio. In the case where there is no preference for a specific model, $p(M_1) = p(M_2) = ... = p(M_K) = \frac{1}{K}$ and the posterior odds ratio is equal to the Bayes factor. We *do not* assume equal inclusion probability for each model. Instead, following Doppelhofer, Miller and Sala-í-Martin (2000) we represent a model M_j as a length k^* binary vector in which a one indicates that a variable in included in the model and a zero indicates that it is not. Assuming that each variable has an equal inclusion probability, the prior probability for model M_j is

$$p(M_j) = (\frac{\overline{k}}{k^*})^{k_j}(1 - \frac{\overline{k}}{k^*})^{1-k_j} \tag{10}$$

and the prior odds ratio is

$$\frac{p(M_j)}{p(M_l)} = (\frac{\overline{k}}{k^*})^{k_j-k_l}(1 - \frac{\overline{k}}{k^*})^{k_j-k_l} \tag{11}$$

where k^* is the total number of regressors, $\overline{k}$ is the researcher's prior about the number of regressors with non-zero coefficients, k_j is the number of included variables in model M_j, and $\frac{\overline{k}}{k^*}$ is the prior inclusion probability for each variable. Since $\overline{k}$ is the only prior that arbitrarily specified in the simulations, robustness checks of the results can be estimated by changing the value of this parameter.

If the set of possible regressions is small enough to allow exhaustive calculation, we can substitute (10) into (12), to calculate the posterior model probabilities (where the weights for different models are assigned based on posterior probabilities of each model, essentially normalizing the weight of any model by the sum of the weights of all possible $K = 2^{k^*}$ models):

$$p(M_j|D) = \frac{\exp(-\frac{1}{2}LIBIC_j)p(M_j)}{\sum_{l=1}^{2^{k^*}} \exp(-\frac{1}{2}LIBIC_l)p(M_l)} \tag{12}$$

Next, we can use (12) to estimate the *posterior mean* and *posterior variance* as follows:

$$E(\theta_k|D) = \sum_{j=1}^{2^{k^*}} p(M_j|D)E(\theta_k|D, M_j) \tag{13}$$

and

$$
\begin{aligned}
Var(\theta_k|D) &= E[Var(\theta_k|D, M_j)|D] + Var[E(\theta_k|D, M_j)|D] \qquad (14)\\
&= \sum_{j=1}^{2^{k^*}} p(M_j|D) \left\{ Var(\theta_k|D, M_j) + E(\theta_k|D, M_j)^2 \right\} - E(\theta_k|D)^2
\end{aligned}
$$

Other statistics relevant to the study are the posterior mean and variance *conditional on inclusion*. First we calculate the *posterior inclusion probability*, which is the sum of all posterior probabilities of all the regressions including the specific variable (regressor). Essentially, the posterior inclusion probability is a ranking measure to see how much the data favors the inclusion of a variable in the regression, and it is calculated as

$$
posterior\ inclusion\ probability = p(\theta_k \neq 0|D) = \sum_{\theta_k \neq 0} p(M_j|D) \qquad (15)
$$

If $p(\theta_k \neq 0|D) > p(\theta_k \neq 0) = \frac{\overline{k}}{k^*}$ then the variable has high marginal contribution to the goodness of fit of the regression model. Then, the posterior mean and variance conditional on inclusion are the ratios of the posterior mean and variance divided by the posterior inclusion probability, $\frac{E(\theta_k|D)}{\sum_{\theta_k \neq 0} p(M_j|D)}$, and $\frac{Var(\theta_k|D)}{\sum_{\theta_k \neq 0} p(M_j|D)}$, respectively.

Finally, we compute the *sign certainty probability*. This measures the probability that the coefficient is on the same side of zero as its mean (conditional on inclusion) and is calculated as

$$
\begin{aligned}
sign\ certainty\ for\ \theta_k &= p[sgn(\theta_k) = sgnE(\theta_k|D)|D, \theta_k \neq 0] \qquad (16)\\
&= \sum_{j=1}^{2^{k^*}} p(M_j|D) \left\{ p[sgn(\theta_k) = sgnE(\theta_k|D)|M_j, D] \right\}
\end{aligned}
$$