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Prioritizing Policies for Pro-Poor Growth: Applying Bayesian Model Averaging to Vietnam

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Abstract

Pro-Poor Growth (PPG) is the vision of combining high growth rates with poverty reduction. Due to the myriad of possible determinants of growth and poverty a unique theoretical model for guiding empirical work on PPG is absent, though. Bayesian Model Averaging is a statistically robust framework for this purpose. It addresses the existent parameter and model uncertainty by not choosing a single model but averaging over all possible ones. Using data for the 61 Vietnamese provinces we are able to ascertain a prioritization of all used determinants of poverty, growth and of PPG of our large set of explanatory variables.

JEL Classification: C11, C52, R11
Keywords: Poverty determinants, growth determinants, pro-poor growth, model uncertainty, Vietnam

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1 Introduction

The UN Millennium Development Goals have recognized poverty reduction as the main goal of global development policy. Today, there seems to be a broad consensus that poverty reduction should not be separated from growth-supportive strategies but should be combined in a vision of pro-poor growth (PPG) (Shorrocks and van der Hoeven 2004). While there is still much debate on how to define PPG exactly, it is common sense nowadays that the poverty reducing effects of growth are more pronounced the less they are accompanied by increasing inequality (Ravallion 2001, 2004).

To be most valuable for guiding development policies, we feel empirical PPG research should not confine itself to evaluating only components of either poverty reduction or of growth strategies. Rather, we are interested in the prevailing interdependencies of these two phenomena. Moreover, empirical work should address the crucial problem of variable selection in setting up an empirical model for estimation as omitted variables can create spurious relations, while inclusion of irrelevant variables can bias the results of an estimate. Theory sometimes can support choices of some variables whereas the exact decision on inclusion or exclusion of variables mostly will be arbitrary. This fundamental model uncertainty results in a wide set of possible model specifications and, frequently, contradictory conclusions.[1] Besides, the results are often not robust to (minor) changes in model specification yielding uncertainty in valid interpretations of the results. Another problem often neglected is the need to prioritize policy recommendations as "governments face administrative and political limitations"[2] which is why "it is seldom helpful to provide governments with a long list of reforms".[3]

Many cross-country regressions as well as country specific studies applying various econometric techniques have been conducted to evaluate the numerous possible strategies for achieving PPG.[4] As PPG is supposed to be the result of complex relations between eco-

[1] Furthermore, selecting a single model for policy evaluation may not be appropriate given the dependency of the preferred outcomes on a chosen policy, available information and policy makers' preferences. Therefore, "conditioning policy evaluation on a particular model ignores the role of model uncertainty in the overall uncertainty that surrounds the effects of a given policy choice" (Brock et al. 2003, p.236). Recently, Rodrik (2005) has pointed out that the additional uncertainty about the way in which policies are used in practice can create significant problems for the interpretation of these results, too.

[2] Hausman et al. 2005, p.2; the interested reader is referred to this work for a theoretical framework for the prioritization of policies on the basis of *growth diagnostics*. A critical review of this approach can be found in Dixit (2006) where a Bayesian framework is proposed in turn.

[3] Hausman et al. 2005, p.2.

[4] An excellent survey of recent empirical PPG research is provided by Lopez 2004.

nomic growth and poverty reduction strategies, clear theoretical guidance on the choice of regressors is lacking heavily and empirical research in this context is faced with the problems just mentioned to an even higher extent. Besides, the numerous regression approaches render robust comparisons across studies practically impossible.

In standard growth regressions similar problems with uncertainties about the correct explanatory variables and justifications for well determined growth-promoting policies have led various researchers to proclaim the necessity of policy-relevant empirical analysis on the basis of Bayesian econometric methods.[5] In the same spirit, Bayesian Model Averaging (BMA) was pioneered by Fernández, Ley and Steel (2001) to deal with model uncertainty in cross-country growth regressions. The BMA framework has then been applied successfully to empirical studies of income convergence across Spanish provinces by Léon-Gonzalez and Montólio (2004) and of the determinants of African growth by Masanjala and Papageorgiou (2004, 2005).

Our paper applies this framework to a joint analysis of the determinants of poverty and growth aiming to contribute empirically and methodologically to the quest for pro-poor growth. We combine both cross-section and country specific approaches in focusing on one specific country while also taking into account spatial differences throughout the country by using sub-national-level data. From a large set of potential determinants of poverty and of growth we select not only those regressors having the highest solitary impact but also consider the most appropriate combination of variables in a model and provide endogenously determined rankings.

We chose Vietnam for our case study because this country is considered as a showcase for effective policies of poverty reduction and of PPG.[6] Most observers link this achievement to the high aggregate growth rates that Vietnam recorded during the 1990s.[7] Vietnam also serves as an example for strong pro-poor effects of a relatively equal initial distribution of income and assets, due to both its communist past and a deliberate policy of land allocation as part of the transition strategy. Finally, the Vietnamese government tried to attack poverty by a package of targeted public spending programs. We use data on Vietnam's 61 provinces to explain provincial poverty levels in 2002 in a first regression and then run a second regression on provincial annual growth rates of per capita household

[5] For a recent survey on the econometric problems of standard cross-country growth regressions see, for example, Durlauf et al. 2005. The need for Bayesian approaches is increasingly emphasized, among others in Brock et al. 2003; Ghura et al. 2002; Jones and Schneider 2006; Sala-i-Martin et al. 2004.

[6] Between 1986, the beginning of major policy reforms, and 2002, the year of the latest data available, the Vietnamese aggregate headcount index fell from over 70 per cent to under 30 per cent (Klump 2006).

[7] The average rate of per capita GDP growth was about 5 per cent (Klump 2006).

expenditures over the period 1998-2002. Comparing the most important regressors of the two BMAs, we are then able to determine the best policies for achieving PPG and, thus, to provide the favored prioritization of policy conclusions.

Regarding policy conclusions we find support for birth control, private sector development, state-owned enterprise (SOE) restructuring and promoting urbanization as the most effective instruments of pro-poor growth because they influence both poverty and growth in the right direction. Second, we expose Vietnam's increasing income inequality since the beginning of the economic reforms as growing obstacle for further poverty reduction why focusing more on the distributional aspects of pro-growth policies seems to be a reasonable advice. Finally, our results are ambiguous on the influence of existing national targeted programs (NTPs) which means that the NTPs should be reformed to contribute efficiently to PPG.

The paper is organized as follows. Section 2 provides a survey of the research on the complex relationship between poverty, growth, inequality and policy measures and of the various definitions and operationalizations of PPG. Section 3 briefly reviews the achievements of growth and poverty reduction in Vietnam and the open questions related to the relative importance of the various potential determinants. Section 4 presents variables and data for the estimation. Section 5 describes the methodology of BMA, while section 6 reports and discusses the results. Section 7 concludes.

2 Determinants of poverty, growth and pro-poor growth

2.1 The "poverty-growth-inequality triangle"

A major part of the research agenda on significant determinants of poverty reduction and of growth, leading jointly to PPG, concerns the so called "poverty-growth-inequality triangle" (Bourguignon 2004) which regards poverty as mainly influenced by growth and inequality but also highlights influences of inequality on growth. We take this concept as a starting point but go further by focussing on policies determining initial inequality of incomes and assets and the dynamics of growth and poverty. Empirical research should then be able to identify the most effective single and combined determinants of poverty and growth.

The relationship between growth, inequality and poverty has been in the center of discussions about how to define and how to achieve PPG (Klasen 2003; Kraay 2006; Ravallion 2004). There is a broad consensus today that growth is the major prerequisite for (income) poverty reduction under the assumption that the distribution of income remains

more or less constant (Deininger and Squire 1996, Dollar and Kraay 2001; Ravallion 2001; Bourguignon 2003). Therefore, one should expect that growth-enhancing policies, such as higher investment or higher openness to international markets, should also improve the situation of the poor. However, the poverty reducing effect of income growth is diminished if the inequality of income and/or assets is high (Ravallion 1997). In particular, high inequality could reduce further growth and poverty reduction significantly via its negative effects on human capital formation, on agricultural productivity, on future investments and on the political stability and support for further growth (Alesina and Perrotti 1996; Viaene and Zilcha 2003). Furthermore, specific policy measures are meant to influence the well-being of the poor directly. They include targeted measures of social policy that redistribute from the rich to specific groups of the poor as well as public investment in infrastructure, education and health (Dagdeviren et al. 2004).

Dollar and Kraay (2002) presented cross-country evidence that growth is good for the poor. Inequality and specific pro-poor policies do not play a significant role according to this benchmark study. These results have been criticized from different sides, though. Ravallion (2001), for example, has pointed out that the national averages that have entered the Dollar-Kraay dataset hide a lot of interesting information about development on the sub-national level. If one looks beyond averages, inequality may become an impediment for growth and poverty reduction. In addition, Gundlach et al. (2004) present empirical cross-country evidence that public investment on education has a positive effect on the poor if the quality of education is taken into account more consistently than in the Dollar-Kraay study.

If one accepts the idea that growth is at least among the most important sources of poverty reduction, one has to think about the most significant and most effective determinants of growth. Empirical evidence in this field is even more debated. The Barro regressions (Barro 1991; Barro and Sala-i-Martin 1995) have identified numerous potentially important determinants of growth but they have also revealed the problems related to parameter and model uncertainty in the estimation of cross-country growth regressions (Levine and Renelt 1992; Durlauf and Quah 1999; Brock and Durlauf 2001). Investment and openness seem to belong to the most robust determinants of long-term growth. Nevertheless, further variables may also become relevant for growth-enhancing policies once other criteria for robustness are chosen (Sala-i-Martin 1997). This makes it impossible to derive clear prescriptions as to the optimal prioritization of growth enhancing policy measures.

2.2 Concepts of Pro-Poor Growth

A prioritization of policy measures becomes even more important when a strategy of PPG is followed. Over the past decade PPG has become the dominant goal of development economics and politics, although there is neither a unanimously shared definition nor an agreement on necessary or sufficient policy measures. Both, the debate on an operational definition of PPG and the discussion about adequate policy measures have been reviewed, among others, by Klasen (2003) and Lopez (2004).

A narrow definition of PPG as presented for example by Kakwani and Pernia (2000) requires that growth is accompanied by a redistribution of income from the rich to the poor meaning that the incomes of the poor grow faster than those of the rich. A broader definition developed by Ravallion and Chen (2003) speaks of PPG if there is simply growth in the income of the poor so that growth is accompanied by a fall in the poverty rate. The advantage of this broader definition is that the conceptional focus is more on income growth of the poor than on redistribution of incomes. It should be noted, however, that both concepts only cover income poverty and do not consider appropriate ways how to measure those forms of non-income poverty related to education, health and gender also addressed by the Millennium Development Goals (Klasen 2005).

Given the availability of reliable data it seems much more reasonable to consider aggregate growth and poverty reduction simultaneously than to measure the effective redistribution of incomes related to growth in any practical implementation of the income-related concept of PPG. This is why we concentrate our empirical analysis exclusively on the broader definition of PPG. It would not be too difficult to extend our approach to take into account the coincidence of income and non-income forms of poverty.

One important result of the World Bank's recent Operationalizing Pro-Poor Growth Project (Besley and Cord 2006) is the insight that the mixtures of policy measures best supporting strategies of PPG are very much country specific. There is certainly a broad range of possible policy instrument having an impact on growth, poverty or on both. The effective combination of various policy instruments seems to vary significantly between countries, though. This makes adequate policy recommendations, in particular if a bundle of possible policy interventions is discussed, highly dependent on reliable empirical country studies. Given the high degree of model and parameter uncertainty typically prevailing in country case studies, PPG oriented strategies should be based on empirical methods taking into account these types of uncertainties.

3 Growth and poverty reduction in Vietnam

3.1 Historical context and trends in growth, inequality and poverty

After decades of war Vietnam was reunited in 1975. The national development strategy at that time was based on the implementation of the socialist system of North Vietnam in the Republic of South Vietnam. All land was collectivized, markets were gradually abolished, and prices were strictly controlled. Production and investment followed strict central state planning. This strategy led to a severe economic crisis. Political tensions with China in the late 1970s, the mass exodus of ethnic Chinese, who had been the backbone of the South Vietnamese economy, as well as growing political and economic isolation forced Vietnamese political leaders to tackle fundamental reforms. Minor and uncoordinated reforms of the central planning system in the early 1980s only led to hyperinflation and trade imbalances. In this critical situation, the Sixth Congress of the Communist Party approved a comprehensive reform agenda under the name of *doi moi* (renovation) in 1986. *Doi moi* recognized the essential role of a multi-ownership structure of the economy, (re-) introduced free market prices for commodities and private property rights on land and enterprises and supported macroeconomic stabilization and external liberalization. These reforms have been remarkably successful. GDP growth averaged 6.8 per cent per year between 1987 and 2001 - one of the highest rates in the world. The rate of population growth also fell during those years keeping per capita income growth at an impressive rate of 5 per cent (White et al. 2001; Klump 2006).

Vietnam's aggregate Gini-coefficient was relatively low with a value of 0.34 in 1993, certainly a result of the long socialist era. However, the expenditure based Gini increased over time to arrive at a value of 0.37 in 2002. Also, the steadily growing factor between expenditures of the richest and poorest quintile of the population - from under 5 in 1993 to over 6 in 2002 - indicates growing distributional imbalances which already alarmed some observers (Fritzen 2002). Spatial differences in inequality are also pronounced in Vietnam. Urban areas recorded a Gini coefficient of 0.41 in 2002, whereas it was only 0.36 in rural areas. Regional Gini coefficients range between 0.42 in the South East around Ho Chi Minh-City and 0.35 in South Central Coast.

Furthermore, *doi moi* has led to an impressive reduction of poverty in Vietnam (World Bank 1999). Before 1986 the national poverty rate in Vietnam stood at over 75 per cent; by 2002 it had fallen below 30 per cent. In its Comprehensive Poverty Reduction and Growth Strategy (CPRGS) the Vietnamese government aims at achieving a national poverty rate of fewer than 20 per cent by 2010 (Socialist Republic of Vietnam 2002). Poverty in Viet-

nam has no particular gender-bias, but is concentrated in rural areas and among ethnic minorities. The regions with the higher poverty rates in 2002, North West (68 per cent) and Central Highlands (52 per cent), are mainly rural and have the highest share of ethnic minorities. The regions with the lowest poverty rates, South East (11 per cent) and Red River Delta (22 per cent), are located around the main economic centers, Ho Chi Minh City and Hanoi. Given the growing spatial variation in poverty, a "rolling out of CPRGS to the provinces" (World Bank 2003) has been proclaimed.

3.2 Single determinants of poverty and of PPG

Most empirical studies focusing on the determinants of poverty or PPG in Vietnam rely on single factor approaches. Given the theoretical debate about the strong growth-poverty linkages, the "pro-poorness" of growth has been analyzed in various ways and with different techniques. There also exist some investigations in the poverty effects of single pro-poor policy instruments, such as public spending for poor areas and households or investment in rural infrastructure.

Various measures of the "pro-poorness" of aggregate income growth in Vietnam have been calculated by Klump (2006). For the period 1993-2002 he finds a poverty elasticity of growth of about -1.5, what is relatively high in an international perspective. Also a look at the growth incidence curve (Ravallion and Chen 2001) — depicting income growth for every percentile of the household distribution — underlines that growth must have been essential for the broad and fast reduction of poverty. The *rate of pro-poor growth*, which can be calculated from the growth incidence curves, range at 4.3 per cent over the period 1993-2002. Over the whole period these rates are much higher in urban than in rural areas of the country.

Van de Walle (2004) studied the poverty effects of public safety nets and derives sceptical conclusions. Given that available funds at the local level mainly depend on the relative development level, social transfers will not contribute actively to a catching-up of poorer areas. More is spent relatively and absolutely on the poor in the better-off communes. Larsen et al. (2004) investigated the poverty impact of Vietnam's public investment program (PIP) that is basically spent on the improvement of public infrastructure. They conclude that spending an additional one per cent of GDP in public investment would be associated with a reduction of poverty in the order of 0.5 per cent. Fan et al. (2003) analyze the poverty and the growth effects of selected forms of public investment in rural infrastructure. They find that both growth and poverty reduction could be supported most efficiently by public investment in agricultural research and development.

What is lacking so far is an explicit test for the impact of income and asset inequality on poverty and PPG in Vietnam. From a decomposition of aggregate poverty changes into growth and redistributional components over the period 1993-2002, one can draw the conclusion that income inequality had a significant and rising impact (Klump 2006). Additionally, a recent study on land distribution in Vietnam by Do and Iyer (2004) showed that inter-provincial differences in the allocation of land-using rights had a significant impact on the productivity of agriculture and on the extent of off-farm employment. They argue that one should also expect explicit effects on poverty.

3.3 Multiple determinants of poverty and of PPG

Empirical studies considering multiple determinants of poverty and PPG in Vietnam are still rare due to several reasons. First, there are problems with the availability of data for many relevant variables: The three existing household surveys, the Vietnam Living Standard Survey (*VLSS*) 1992/93 and 1997/98 and the Vietnam Household Living Standard Survey (*VHLSS*) 2002, are not fully comparable as the 2002 survey lacks a panel dimension; data from government sources, national accounts, and census data are sometimes highly inconsistent and unreliable. Second, there is no broad consensus about which variables other than growth should be considered as important determinants of poverty (World Bank 1999, 2003). Third, there is a conjecture that different models should explain poverty in urban and rural areas so that spatially disaggregated non-household survey data should be available; this is a highly delicate requirement. Therefore, Minot et al. (2003) test for determinants of rural and urban poverty in Vietnam by employing spatial regression analysis to data from different levels (so-called "Poverty Mapping"). They start with a model which includes 32 agro-climatic and socio-economic variables and then proceed to selective models of rural and urban poverty. They find that 74 per cent of the variation in rural poverty can be explained by geographic variables and the distance from towns; whereas not even 30 per cent of the variation in urban poverty is related to agro-climatic variables or measures of market access. On the one hand, this study shows the power of small-area estimation methods to study the spatial pattern and determinants of poverty. Swinkels and Turk (2004), for example, use the poverty mapping approach to investigate the spatial impacts of targeted poverty alleviation programmes. On the other hand, the fundamental problem of model uncertainty is not solved by this estimation method. As in many growth regressions the optimal combination of significant regressors is chosen on an ad hoc basis.

Balisacan et al. (2003) analyze panel data of 4,302 households and a sub-sample of 3,494

rural households from the VLSS 1992/93 and 1997/97. They test for the determinants of poverty across Vietnam's 61 provinces, measured by the per capita expenditure of the lowest quintile. In a fixed effects regression they find that among a multitude of significant socio-economic variables (such as household size, number of children and gender of the head of household) it is mean provincial income which has the most significant effect. The elasticity of local poverty reduction with regard to local income growth was found to be higher than 1.3. Provincial income growth has significant interactions with dummies for two regions (South Central Coast and Mekong River Delta) and with the availability of perennial land for households. However, this study does not take into account measures of income or asset inequality nor the effects of targeted pro-poor policies.

Given that the VHLSS 2002 does not have the appropriate panel dimension, the estimations of Balisacan et al. (2003) cannot be replicated with more recent data. However, we take these estimations as a support for our hypothesis that a proper understanding of poverty in Vietnam should pay special attention to its spatial dimensions. The two last Vietnam Development Reports (VDRs) (World Bank 2003, 2004) have underlined that poverty dynamics in Vietnam cannot be properly understood without looking at sub-national-level developments. Despite a history of socialist planning there is a much older tradition of strong local and provincial autonomy that has witnessed a revival after the beginning of *doi moi*.[8] On that account, one of the distinctive features of economic transition in Vietnam is, in fact, the uneven progress in structural, social and governance reforms across provinces.

Provincial income growth seems to play a major role for poverty reduction and PPG, but theoretical reasoning strongly suggests that measures of inequality, a wide range of structural variables and many pro-poor policies also have some influence. Based on the existing empirical results it is very difficult to draw strong conclusions regarding the relative efficiency of the various policy instruments other than simple aggregate pro-growth measures. Therefore, we propose a new approach for selecting the most relevant determinants of growth and poverty in Vietnam relevant for shaping an effective strategy of pro-poor growth. In order to compensate for the missing panel dimension and to account for spatial differences in poverty, we base our study of the 61 Vietnamese provinces on data from household surveys and other sources. Moreover, we do not apply classical econometric methods but BMA that explicitly deals with the high degree of parameter and model uncertainty. Additionally, the shortcomings of varying model specifications and estimation techniques are eliminated with our approach, thus allowing for comparisons and robustness

[8] See the contributions in Kerkvliet and Marr (2004) or by Malesky (2004).

checks across different studies.

4 Variables and Data

We include in our BMAs all those variables that had been related to poverty and growth in earlier studies on Vietnam, that seem likely to influence poverty or growth due to theoretical findings in a particular way and for which data are available on the provincial level. The use of disaggregated sub-national-level data from the *VHLSS* 2002, has major advantages over cross-country regressions because the problem of weak comparability of the primary data used for poverty measurement and the explanatory variables is much less serious. Thus, the potential bias due to the correlation between those data and the unobserved individual (country-)specific effects can be eliminated or reduced dramatically.[9] Answering this question with cross-country data raises many problems, including .

Not all of our explanatory variables should be considered as policy instruments because they cannot be changed ex post. Examples are the past levels of per capita expenditures, presenting a possible convergence effect on expenditure growth, or a dummy for the division of Vietnam before 1975. Most variables, however, can be influenced by direct or indirect policy interventions. Obviously, the time horizon of such interventions may vary significantly between the share of agriculture in provincial GDP, the Gini coefficients, life expectancy or special targeted programs for the support of poor provinces. We decided to include the expenditure Gini and a so-called Land Gini due to the interdependencies of growth and changes in inequality for poverty reduction described in Bourguignon (2004). This should improve our results substantially as, according to this author, the basic identity between mean income growth, the change in the distribution of incomes and the reduction of poverty leads to a double role for the income distribution in poverty reduction. A permanent redistribution reduces poverty instantaneously via a "distribution effect" and it contributes to a permanent increase in the elasticity of poverty reduction with respect to growth and, therefore, to an acceleration of poverty reduction for a given rate of economic growth.

To account for potential endogeneity, we use past values of variables that are susceptible to be endogenous in the poverty- or in the growth-BMA. The regressors life expectancy, literacy rate, birth rate and infant mortality rate are, for example, measured in 1999,

[9] When necessary, we also use data from the Vietnam National Human Development Report 2001. This is the first report to cover a broad range of human development indicators at the level of Vietnam's provinces. Additional variables come from the Ministry of Planning and Investment (MPI) or from the General Statistics Office (GSO).

public expenditures on health and education are measured in 1998 and public and private investment in 1999. Apart from the usual difficulties in finding viable instruments for growth regressions, it is still an open research question how to include instrumental variables in the BMA framework.[10] Therefore, we think our approach is suitable until more elaborate methods have been developed to deal with endogeneity problems.

We first run a BMA looking for the most effective determinants of poverty across Vietnam's provinces, measured by the respective poverty rates in 2002.[11] Table1 in the appendix lists all variables used in detail as well as their definitions and additional remarks. The provincial poverty rate is calculated with the official general poverty line corresponding to the cost of purchasing a basket of food and non-food items that provide 2,100 calories per day as well as a set of non-food basic needs.[12] Then we carry out a second analysis regressing the same 36 determinants on the annual growth rate of per capita expenditures in the Vietnamese provinces from 1998 to 2002.

We run two regressions instead of only a poverty-BMA in which growth is included as an additional explanatory variable because we do not only want to analyse the effects of various determinants on poverty after having controlled for growth effects. Rather, we are interested in the effects of different explanatory variables on growth *and* on poverty, respectively. Comparing the results of the poverty- and of the growth-BMA allows us to first prioritize endogenously what the actually relevant determinants of poverty reduction and growth promotion are. Second, in comparing these insights we get a deeper understanding of what actually drives PPG. This methodological search for policies generating PPG, thus, enables us to overcome the usual deficiencies of empirical pro-poor growth analysis as mentioned, for example, in Lopez (2004).

[10] See Durlauf et al. 2005.

[11] Following Balisacan et al. (2003), we base our estimations on the level of the poverty rate and not on its change. Two reasons account for this: First, we wanted to resemble the "poverty-growth inequality-triangle" and the comprehensive study of Balisacan et al. (2003) as much as possible. Second, as poverty is such a sensitive measure, we did not want to compute its change from 1998 to 2002 as the data lack the appropriate panel dimension. As a kind of robustness check for our results we run a BMA with the change in the provincial poverty rates. Interestingly, the most important regressors resemble those of the poverty- and the growth-BMA. Obviously, one should rerun this regression when the adequate panel data set becomes available.

[12] This poverty line is a national one that reflects national average price changes. The individual expenditure data in the VHLSS used here, however, have already been corrected to make them comparable to this national average by correcting for price differences among rural and urban areas and among regions. So there are no proper provincial poverty lines, but we can use the general one with our spatially adjusted expenditure data.

5 Methodology

5.1 Motivation

As with empirical work on growth determinants, the evaluation of the most effective PPG strategies is exposed to severe criticism based on the inherent uncertainty of which explanatory variables to include. The lacking theoretical guidance has led to the increasing use of BMA to deal with parameter and model uncertainty within a formal framework based on sound statistical theory.[13] Bayesian econometrics is of particular benefit for model averaging since classical econometrics does not treat models as random variables and, thus, the concept of averaging over models cannot be given a rigorous statistical foundation. There are, however, various ad hoc classical methods of model averaging, for example, the analyses of Levine and Renelt (1992) or Sala-i-Martin (1997) which are based on Leamer's (1983, 1985) extreme-bounds analysis (EBA) and a slight modification respectively.

In particular, BMA does not require selecting a subset of the regressors, that is a special model. All inference is averaged over models, using the corresponding posterior model probabilities (PMPs) as weights. First, given a set of potential explanatory variables, BMA separately identifies models that are expedient to explain poverty and growth, by allowing for any subset of the explanatory variables to combine in a regression and to estimate the posterior probability of any such combination of regressors. Second, conditional on the posterior model probabilities, the issue of model uncertainty concerning the most efficient means of poverty alleviation and of growth can be resolved by estimating the posterior probabilities of all possible explanatory variables commonly used.

The methodology of this paper extends the seminal work of Fernández, Ley and Steel (henceforth FLS) (2001) by indicating not only the posterior probabilities of each regressor and of the ten best models but by disclosing as well their respective regressors as in Masanjala and Papageorgiou (2004). These combinations of variables yield high explanatory power and are therefore important for guiding provincial growth and poverty alleviation in Vietnam.

[13] See Hoeting et al. (1999) for an overview. Another slightly different approach than BMA is the Bayesian Averaging of Classical Estimates (BACE) framework proposed by Sala-i-Martin, Doppelhofer and Miller (2004). Due to the fact that this method combines Bayesian with classical estimation techniques, it abandons the 'truly Bayesian' framework of proper, informative priors. As we are highly aware of the caveats related to this abandonment (see discussion in section 5.2), we prefer using BMA. For more information on BACE, the interested reader is referred to that literature.

5.2 BMA

Within the Bayesian framework, one can handle model uncertainty automatically by not choosing a special model but simply averaging the results over all models using PMPs as weights. Alternative models M_j, with $j = 1, ..., J$, will be defined through the set of K regressors they include, which means that there are 2^K possible models. They are all linear regression models that differ in their explanatory variables and contain an intercept, α. We have data for N provinces. The dependent variable is grouped in vector y, and the explanatory variables are stacked in a design matrix X of dimension N x K. We assume that rank $(\iota_N : X) = K + 1$, where ι_N is an N-dimensional vector of ones,[14] and β is defined as the full K-dimensional vector of regression coefficients. With the submatrix X_j (N x k_j), containing the regressors of model M_j, and the corresponding regression coefficients $\beta_j \; \epsilon \; \Re^{k_j} (0 \leq k_j \leq K)$, each model is represented by:

$$y = \alpha \iota_N + X_j \beta_j + \varepsilon \tag{1}$$

where ε follows an N-dimensional normal distribution with zero mean and identity covariance matrix. Although normality is not necessary for consistency, it guarantees good finite sample properties (FLS 2001b). The effect of variables not contained in X_j is assumed to be zero.

By averaging over all models the marginal posterior probability of including a certain variable is simply the sum of the posterior probabilities of all models containing this variable. Formally, the posterior distribution of any quantity of interest, say θ, is an average of the posterior distributions of that quantity under each of the models with weights given by the PMPs:

$$p(\theta \mid y) = \sum_{j=1}^{2^K} p(\theta \mid y, M_j) \; p(M_j \mid y) \tag{2}$$

This procedure is typically referred to as BMA and it follows from direct application of Bayes' theorem (Leamer 1978). $P(\theta \mid y, M_j)$, the posterior distribution of θ under model M_j, is typically of standard form. However, we have to compute the PMPs due to model uncertainty. Using the standard way in this case and allocating equal prior model probabilities, this yields

$$p(M_j \mid y) = \frac{p(y \mid M_j)}{\sum_{i=1}^{2^K} p(y \mid M_i)} \tag{3}$$

where $p(y \mid M_j)$ is the marginal likelihood of Model M_j. This is given by

$$p(y \mid M_j) = \int p(y \mid \alpha, \beta_j, \sigma, M_j) \; p(\alpha) \; p(\sigma) \; p(\beta_j \mid \alpha, \sigma, M_j) d\alpha \; d\beta_j \; d\sigma \tag{4}$$

[14] The design matrix will be transformed by subtracting the mean, so that $\iota_N' X = 0$.

with $p(y \mid \alpha, \beta_j, \sigma, M_j)$ the sampling model corresponding to equation (1) and $p(\alpha)$, $p(\sigma)$ and $p(\beta_j \mid \alpha, \sigma, M_j)$ the priors defined below in equations (5), (6) and (7), respectively. Since marginal likelihoods can be derived analytically[15], the same holds for the PMP given in (3) and the distribution given in (2).

In practice, however, computing the relevant posterior distributions is still subject to challenges as the number of models to be estimated increases with the number of regressors at the rate 2^K. Furthermore, the derivation of the integrals implicit in (4) may be difficult because the integral may not exist in closed form. As we have 36 possible regressors in each of our two BMAs, we would, thus, need to calculate the posterior probabilities for each of the 2^{36} models and average the required distributions over all these models. Given these difficulties, we will approximate the posterior distribution on the model space $\mathcal{M}$ by simulating a sample from it, applying the Markov Chain Monte Carlo Model Composition (MC^3) methodology by Madigan and York (1995) described in section 5.3.

This Bayesian framework needs to be completed with prior distributions for the parameters in each model M_j which are α, β_j and the scale parameter σ. While the inclusion of prior information is a particular feature of Bayesian inference, in the context of model uncertainty the choice of this distribution can have substantial impact on the PMPs. Furthermore, in a context where there are many potential explanatory variables, but one cannot be sure about which ones to include, this prior information is rare. Accordingly, non-informative priors would be preferable. However, PMPs cannot be meaningfully calculated with improper non-informative priors for parameters that are not common for all models. Thus, many researchers have attempted to develop proper priors which can be automatically used without requiring subjective input or fine tuning for each individual model. Therefore, we use for β_j the *benchmark priors* developed in FLS (2001b) that have little influence on posterior inference as the incorporation of substantive prior information is not necessary. For the two parameters common to all models we use the following improper priors

$$p(\sigma) \propto \sigma^{-1} \tag{5}$$

$$p(\alpha) \propto 1 \tag{6}$$

To make absolutely certain that the non-informative prior for the intercept has the same implications for every model, we will standardize all regressors by subtracting off their means as recommended by FLS (2001b). This will have no effect on the slope coefficients, β_j, but ensures that the intercept can be interpreted in the same way in every model as

[15] For the case with demeaned regressors, FLS (2001a) derive it in their equation (8), on p. 566.

measuring the mean of y.[16] The prior for α implies that all its values, from minus infinity to infinity, are equally plausible and the prior for σ implies that all values for $\ln(\sigma)$ are given equal prior weight. Furthermore, this distribution is the only one that is invariant under scale transformations as for example a change in the units of measurement.
For β_j we choose an informative g-prior structure according to FLS (2001b)[17]

$$p(\beta_j \mid \alpha, \sigma, M_j) \sim N(0_{k_j}, \sigma^2[g_j X_j' X_j]^{-1}) \tag{7}$$

It is common practice to center priors over the hypothesis that explanatory variables have no effect on the dependent variable, especially when there are many regressors but it is suspected that many of them may be irrelevant. Therefore, we set the mean of $\beta_j = 0_{k_j}$. Hence, one only has to elicit the scalar hyperparameter g_j and, following FLS (2001), we choose

$$g_j = \begin{cases} \frac{1}{K^2} & : \quad N \leq K^2 \\ \frac{1}{N} & : \quad N > K^2 \end{cases} \tag{8}$$

Finally, the $K - k_j$ components of β which do not appear in M_j are exactly equal to zero. As we have to deal not only with parameter but as well with model uncertainty, we need to choose a prior distribution over the space $\mathcal{M}$ of all 2^K possible models. Following the standard practice for BMA in linear regression models, especially in the context of economic growth (FLS 2001a; Masanjala and Papageorgiou 2004, 2005; Leon-Gonzalez and Montolio 2004), we allocate equal prior model probability to each model and set

$$p(M_j) = 2^{-K} \tag{9}$$

This yields a uniform distribution on the model space which implies that the prior probability of including a regressor is $\frac{1}{2}$, independently of the combination of regressors included in the model.[18]

[16] To be precise, if regressors are measured as deviations from means then, by construction, they will have mean zero. Since the error also has mean zero, this implies the mean of the dependent variable is the intercept.

[17] This prior is slightly unusual as it depends upon X_j, the regressor matrix. However, as we are later conditioning on X_j in the likelihood function and the posterior as well, we are not violating any rule of probability by conditioning on X_j in the prior already.

[18] Some authors recommend different choices for $p(M_j)$. For instance, many researchers prefer parsimony and feel that simpler models should be preferred to more complex ones, all else being equal. In contrast, Durlauf et al. (2005) argue against priors promoting parsimonious models that the underlying "presumption is unappealing as our own prior beliefs suggest that the true growth model is likely to contain many distinct factors" (p. 83). Moreover, regular posterior odds ratios already do include a reward for parsimony and the Bayes factor obtained in (2) has a built-in mechanism to avoid overfitting. Brock and Durlauf (2001) and

5.3 Implementation

In Bayesian econometrics, models are random variables (albeit discrete ones), just like parameters. Hence, posterior simulators drawing from model space (i.e. the posterior distributions of the models) can be derived for both, single regressors and complete models. These algorithms do not need to evaluate every model, but rather focus on the models of high PMP.

The most common MC^3 algorithm is based on a Random Walk Chain Metropolis-Hastings algorithm which draws candidate models from regions of the model space in the neighborhood of the current draw and then accepts them with a certain probability. Posterior results based on the sequence of models generated from the MC^3 algorithm can be calculated by averaging over the draws. As with other Markov Chain Monte Carlo algorithms, a starting value for the chain must be chosen and a reasonable number of burn-in replications should be discarded to eliminate the effects of this choice.

It is important to verify convergence of the algorithm and to estimate the accuracy of approximations such as the posterior mean. FLS (2001b) suggest a simple way of doing this: based on a reduced set of models, for example every model visited by the MC^3 algorithm, they calculate the PMP first analytically and then using the algorithm. If the algorithm has converged, then these two ways should yield the same results. The relationship between the analytical and MC^3 results give an idea of approximation error and simple diagnostics can be constructed to check for convergence. For instance, FLS (2001b) suggest calculating the correlation between the analytical and MC^3 PMPs and taking enough replications to ensure this correlation is above 0.99.

6 Estimation Results

6.1 Posterior probabilities

The following results are based on taking 2,500,000 draws and discarding the first 500,000 as burn-in replications. As a test for convergence of the algorithm and as a diagnostic that the model performance is satisfactory, we checked for the correlation coefficient between

Brock et al. (2003) raise objections against uniform priors on the model space because of the assumption that the probability that one regressor should appear in a growth model is independent of the inclusion of others. Some regressors are similar to others whereas others are not and, therefore, they suggest a tree structure to organize model uncertainty in linear regression models. Hoeting et al. (1999), however, state that when there is little prior information about the relative plausibility of each model, the assumption that all models are equally likely a priori is a reasonable "neutral" choice.

visit frequencies and posterior probabilities. For our two BMAs it lies above the recommended threshold of 0.99.

Dealing firstly with the inherent model uncertainty and with the significance of a particular regressor in the presence of other regressors, we report the PMPs for the ten best models of the poverty- and the growth-BMA and their respective regressors in Tables 2 and 4 in the appendix. The ten best models explaining poverty levels account for more than 8 per cent of the total posterior mass and the ten best models of the growth-BMA alone account for even 24.94 per cent.

Looking secondly at the importance of single regressors in affecting poverty or growth the second columns of Tables 3 and 5 in the appendix, report the BMA posterior probability (or probability of inclusion) for each of the 36 explanatory variables in our two BMAs. It can be interpreted as the probability that the respective regressor should be included in the evaluation as it exerts some influence on the dependent variable regardless of which other explanatory variables are included as well. We ranked the variables according to their probability of inclusion and will discuss their respective effects in the next section. As there is no theoretical justification for any threshold of posterior probability over which to call a regressor 'very important', we base our discussion on the eight regressors with the highest posterior probabilities in the poverty-BMA and on the eight most important growth-determinants. These numbers stem from the estimated mean number of regressors in all of the models of our two BMAs, which is 7.95 in the poverty-BMA and 7.83 in the growth-BMA. Interestingly, these numbers reproduce the suggested number of at least seven regressors in growth regressions (Sala-i-Martin 1997). Furthermore, we discuss the regressors used in one of the ten best models (which do not exert a high posterior probability themselves).

6.2 Discussion and policy implications

Our BMAs lead to some rather remarkable results concerning the actual effectiveness of the potential determinants of poverty, growth and pro-poor growth in Vietnam. Among the regressors with the highest posterior probabilities in the poverty-BMA, as well as in the respective sets of regressors of the ten best models, we find variables belonging to five different categories: structural, institutional, distributional, pro-growth and pro-poor variables. In the growth-BMA the most relevant variables can be arranged in four clusters only: structural, institutional, pro-growth and pro-poor.

In the poverty-BMA the expenditure Gini is the most important determinant. Its relevance stems from the various links between inequality, growth and poverty reduction mentioned

in section 2. For example, high inequality could harm future poverty reduction significantly via its negative effects on human capital formation and on the (political) support for further growth strategies. As we can see growing inequality of income and expenditure in Vietnam[19] this result becomes even more important for future poverty reduction.

The negative sign of the land (use) Gini seems to be astonishing at first sight. This variable is an approximate measure of the distribution of private property rights for land. The land reform started in Vietnam in 1988 when rural households were officially entitled to use the land they already cultivated while so called land-use certificates (LUCs) were distributed. At the beginning, the distribution of LUCs was remarkably egalitarian but since then the tendency towards a growing concentration of land is clearly visible (Ravallion and van de Walle 2001, 2006; World Bank 2003). Nevertheless, poverty declined remarkably over the same period. At closer inspection the negative effect of the land Gini on poverty should be interpreted in close relation with another important regressor of our poverty-BMA, which is the relative size of perennial farm land. It is especially this type of land that yields higher incomes to rural households because of a higher diversification and commercialization of crops. The distribution of perennial farm land is particularly biased towards the rich in some of the poorer provinces.[20] This phenomenon can best be explained by economies of scale in productivity and in investment possibilities, be it in the type of crops, be it in equipment. Combined with the liberalization of the markets for agricultural products, higher diversification of agricultural production and higher agricultural investments led to a sustainable reduction in rural poverty (Deininger and Jin 2003; Benjamin and Brandt 2003).

We also find the two NTPs in a prominent position in the poverty-BMA although with extremely low posterior means. This result mirrors their actually rather ambiguous effect. The NTPs are important for the reduction of poverty in Vietnam as they favor or compensate households or communes. But the are exposed to continuous complaints about their effectiveness to explicitly alleviate poverty.[21] Program 135, which offers a range of local investment programs to communes, has a broad coverage as it reaches one fifth of all communes. Coverage varies across the individual components of the Hunger Eradication and Poverty Reduction (HEPR) program but the fraction of the poor benefiting from some of

[19] See the discussion in section 3.1 and in the VDR 2004.

[20] For example, in the provinces of the Central Highlands or the North West, the richest fifth of the rural households have 2.5 times and 11 times respectively more perennial crop land than the poorest fifth (World Bank 2003, p. 39).

[21] It should be stressed that our data for these variables originate from 2003 and we use them as a proxy for the 2002 allocations only. The estimation should be repeated with appropriate data when available.

those components is not irrelevant (World Bank 2003, 2004). The effects of all components are very diverse, though, as they are more or less suitable for sustainable poverty reduction and are widely distributed among the Vietnamese provinces (World Bank 2003, 2004; Swinkels and Turk 2004). Finally, there has been evidence of a significant lack of efficiency in these important pro-poor policies (van de Walle 2004). The negative growth impact of per capita public expenditure on health seems to indicate again inefficiency problems of some of the Vietnamese social policy programs. As expected, private investment is poverty reducing both through its growth-enhancing influence and its direct effects for example on employment possibilities, infrastructure investments or human capital formation.

Looking at the growth-BMA, we find five out of the eight most important regressors resemble those of the poverty-BMA. One further important regressor only included in the growth-BMA is the share of locally managed SOEs whose negative influence stems from their function as the most important local competitors of newly founded small private businesses. Besides, they are much smaller than centrally managed SOEs, employ less workers and are typically dominated by local party elites. Another regressor is the south dummy meaning that a part of the spectacular achievements of Vietnam is caused by the economic dynamics in that part of the country which had already experienced an internationally integrated market economy before 1975 and could reactivate personal and business links to global markets after 1986.

Next, the share of industry in provincial GDP is only important in the growth-BMA, which is one of the usual growth determinants in a developing economy. It can best be explained in conjunction with the closely related regressors showing up in both BMAs: private business implementation and urbanization discussed below. Also associated with this regressors is another one, namely, the share of agriculture in provincial GDP included in one of the ten best models and exerting the expected negative influence on growth. In addition, inter-provincial transfers are included there. They have a negative influence on growth with an extremely low posterior mean, however. This result can again be regarded as an indicator of the lacking efficiency of any public social policy program in Vietnam. In one of the models also the implementation of land reform is included. This land reform, differing significantly among provinces, induced as well the emergence of a land market[22] which, in turn, improved not only the mobility of the labor force but also eased financial restrictions on new farm investment. The positive influence on growth reflects the importance of larger and especially more diversified and more productive farms in fostering

[22]The land market increased up to 15 per cent for whole Vietnam in 2002. In 1993 only 5 percent of households participated in such land transactions (World Bank 2003).

economic development. Furthermore, off-farm employment is assumed to increase with agricultural productivity which could evoke a virtuous circle in promoting growth and escaping poverty (Ravallion 2001; World Bank 2003).

Finally, one can take a closer look at those five variables playing a major role in both BMAs and, thus, constituting important elements of a true PPG strategy. Interestingly, one of the most important regressors in most growth regressions, the convergence term, is as well important for explaining provincial poverty rates in our analysis. In the poverty-BMA it has the same negative sign implying that a higher level of initial wealth (measured indirectly by a household's expenditures) and development reduces poverty. It is not difficult to explain the high importance of the birth rate in both BMAs, which despite impressive achievements in the past is still high for some ethnic minorities in Vietnam (World Bank 2003). Theoretical considerations on the links between high fertility and its effects on human capital formation, growth and poverty reduction show that "the comparative advantage of the poor in child quantity" (Ahituv and Moav 2003, p. 82) is characterized by low investments in human capital, low capital ratios and low income.

The role of private business implementation is as well intuitive. It serves as an indicator for Vietnam's transformation to a market based economy and the varying implementation of market structures across different provinces. Private firms play a significant role for the future development of the country and the ongoing poverty reduction as they make the necessary off-farm activities available and exert pressure on the SOEs to become even more productive. This determinant is, therefore, closely related to two other important determinants not only in the growth- but as well in the poverty-BMA: urbanization and south dummy.

The influence of the share of urban population mirrors the transformation from an agriculture based to an industry and service based economy during economic development and its associated effects on growth and poverty reduction (Henderson 2004). In Vietnam, this development and its positive impacts are reflected in the poverty profiles of the different provinces. Those provinces that are metropolitan areas, contain big urban centers or are proximate to such provinces register not only the highest growth rates but also the largest poverty reduction (e.g. the provinces of the Red River Delta comprising Hanoi, the region South Central with Danang or the South East around Ho Chi Minh City).

Next comes the share of centrally managed SOEs whose influence is not only effective for poverty and growth but also contrary to that of the share of locally managed SOEs. For the centrally managed SOEs the intensive restructuring in the state owned sector in Vietnam, the higher competitiveness of the surviving firms and the hardening of the budget

constraints have improved their productivity (World Bank 2003, 2004). Therefore, they provide many of the needed off-farm employment possibilities and are able to pay higher wages thereby increasing the income of poor households. The majority of locally managed SOEs, which remained under a high degree of local political control, were not able to increase their efficiency and therefore could neither contribute to higher growth nor to effective poverty reduction.

What are the insights that policy makers can draw from our investigation based on the BMA approach? First, our findings strongly support some of the policy measures which already rank high in Vietnam's CPRGs approach. These include birth control, support for private sector development, effective restructuring of SOEs and ongoing reorganization of the agricultural sector. This reorganization could happen through a further implementation of land reform, a broadening of land markets or the intensification and diversification of agricultural production in order to make the most efficient use of the available land. Second, we find evidence that promoting urbanization should also be part of a reasonable pro-poor growth package. This supports the strategy of the Vietnamese government to develop a third urban growth pole in the middle of the country which should attract people from the neighboring poor rural provinces. Third, we find some influence of the NTPs on poverty and even on growth, but this influence is unclear and not very pronounced, supporting the view that these important pro-poor policies show a significant lack of efficiency. Therefore, the two NTPs should be reformed to contribute to the prevention of further poverty. More decentralized approaches in the application of targeted pro-poor policies might be one possible way to overcome the existing inefficiencies (World Bank 2003, 2004; Klump 2006; Swinkels and Turk 2004; van de Walle 2004).

7 Conclusion

Our paper is motivated by the apparent problems that the policy relevance of empirical development research faces due to parameter and model uncertainty. We propose BMA as a powerful method to deal with these problems in a sound statistical way by 'unconditioning' the dependence of the parameter estimate for a given variable on the model in which it was estimated.

By applying BMA we estimate the posterior probabilities of a large number of potential explanatory variables in a myriad of model specifications. Thereby, we explain poverty and growth in Vietnam and contribute to the existing literature in two ways. First, our contribution is a methodological one because we show that BMA is an appropriate tech-

nique addressing complex, theoretically not exactly defined phenomena such as PPG and producing superior outcomes to econometric techniques not taking into account model uncertainty. Second, our contribution is an applied one because we show that BMA is especially valuable in yielding results relevant for policy practice due to the endogenous prioritization of all analyzed policy measures.

Vietnam is an especially interesting country for analyzing the phenomenon of PPG as it managed to combine high growth rates with a substantial reduction of national poverty. On the other hand, as a transition country, Vietnam is an outstanding example for observing the transformation process from a former socialist country to one based on a market economy in which shifts in the distribution of incomes and expenditures and their effects on growth and poverty can be watched closely.

Using data for Vietnam's 61 provinces we find that poverty and growth in Vietnam are best explained by the convergence term plus four additional variables from which the following policy conclusions can be drawn: (i) Vietnam should maintain its efforts of birth control and try to enforce them even more among ethnic minorities, (ii) private sector development has to be supported strongly, (iii) a more intensive restructuring of the SOEs is required and (iv) development and extension of metropolitan areas need to be promoted. Furthermore, we expose Vietnam's increasing income inequality since the beginning of the economic reforms as growing obstacle for further poverty reduction why focusing more on the distributional aspects of pro-growth policies seems to be a reasonable advice. Also, our results seem to indicate — given a high degree of data uncertainty — that the influence of the currently existing NTPs on poverty reduction is ambiguous which is why the NTPs should be reformed to actually contribute to PPG.

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9 Appendix

9.1 Variable Definitions and Data Sources

Variable	Definition	Source	Remarks
POV	Provincial poverty rate based on general poverty line of 1,916,000 VND (Vietnamese Dong) per person and year	VHLSS 2002	Poverty rates use real per capita expenditures of households (HHs) weighted with individual/HH sampling weight to make this expenditure variable representative for the population
GROWTH	Annual growth rate of mean per capita HH expenditure 1998 - 2002	VHLSS 2002	As all the variables calculated from the VHLSS it includes individual/HH sampling weight to represent the number of HHs
Exp98	Per capita HH expenditure 1998	VLSS 1998	
PUB	Public investment in non-state sector 1999-2000	Ministry of Planning and Investment (MPI)	"2003 Statistics of Investment in Vietnam"
PRIV	Private investment in non-state sector 1999-2000	MPI	"2003 Statistics of Investment in Vietnam"
GOV	Share of government expenditures in provincial GDP	World Bank Hanoi	By courtesy of Rob Swinkles
Transfers	Per capita transfers from each province to the central budget in 2002	World Bank Hanoi	By courtesy of Rob Swinkles
HEPR	HEPR program investments 2003, in per capita terms in 1,000 VND	World Bank Hanoi	HEPR program is conducted by Vietnamese central government 2001-2005; Data of two NTPs by courtesy of Rob Swinkles
Program 135	Commune-level investments 2003, in per capita terms in 1,000 VND	World Bank Hanoi	Program 135 is conducted by Vietnamese central government 2001-2005

Variable	Definition	Source	Remarks
Openness	Share export + import values in provincial GDP 2000, in per cent	GSO	"Socioeconomic statistical data of 61 provinces and cities in Vietnam"
Central SOEs	GDP Mill. VND by central government 2000 (at 1994 constant prices), in per cent	GSO	Statistical Yearbook of Vietnam
Local SOEs	GDP Mill. VND managed by local government 2000 (at 1994 constant prices), in per cent	GSO	Statistical Yearbook of Vietnam
FDI	Share of FDI sector in provincial GDP 2000 (at 1994 constant prices)	Nguyen et al. (2002)	This database makes necessary adjustments so that the adjusted output data of the 61 provinces sum up to the national GDP and that the regional implicit price indices are compatible with the national implicit price indices
Sanitation	Population in province having no access to sanitation 1999, in per cent	NCSSH	National Human Development Report 2001
Electricity	Population in province having no access to sanitation 1999, in per cent	NCSSH	National Human Development Report 2001
Roads	Volume of freight by the road of the local transport by province 2002	GSO	http://www.gso.gov.vn.
Literacy	Adult literacy rate 1999, in per cent	NCSSH	National Human Development Report 2001
Graduates I	Percentage of graduates of grade schools on primary level compared with total candidates on that level by province	GSO	http://www.gso.gov.vn
Graduates II	Percentage of graduates of grade schools on lower secondary level compared with total candidates on that level by province	GSO	http://www.gso.gov.vn

Variable	Definition	Source	Remarks
Graduates III	Percentage of graduates of grade schools on upper secondary level compared with total candidates on that level by province	GSO	http://www.gso.gov.vn
Private education	Mean per capita expenditure on education of each HH 2002, nominal	VHLSS 2002	Due to missing price deflators no real expenditures could be calculated for this variable; including individual/HH sampling weight to represent the number of HHs
Public education	Public expenditure on education per province 1998	NCSSH	National Human Development Report 2001
Birth	Crude birth rate 1998, per million	NCSSH	National Human Development Report 2001
IMR	Infant mortality rate 1999, per million	NCSSH	National Human Development Report 2001
Life	Life expectancy at birth 1999	NCSSH	National Human Development Report 2001
Private health	Mean per capita expenditure on health of each HH 2002, nominal	VHLSS 2002	Due to missing price deflators no real expenditures could be calculated for this variable; including individual/HH sampling weight to represent the number of households
Public health	Public expenditure on health per province 1998	NCSSH	National Human Development Report 2001
GINI	Expenditure GINI 2002	VHLSS 2002	
Land GINI	Distribution of land titles among HHs per province	VHLSS 2002	
Land market	Share of rural HHs with land leased in or out	VHLSS 2002	Including individual/HH sampling weight to represent the number of HHs

Variable	Definition	Source	Remarks
Land reform	Share of agricultural HHs holding land use certificates to all agricultural HHs per province	VHLSS 2002	Including individual/HH sampling weight to represent the number of HHs; variable can be seen as indicator of administrative quality of provincial institutions
Perennial land	Share of land used for perennial crops to agricultural land in general per province	VHLSS 2002	Including individual/HH sampling weight to represent the number of HHs
AGRI	Share of agriculture in provincial GDP 2000, at 1994 constant prices	Nguyen et al. (2002)	Data adjusted so that data of the 61 provinces sum up to national GDP and that regional implicit price indices are compatible with national ones
IND	Share of agriculture in provincial GDP 2000, at 1994 constant prices	Nguyen et al. (2002)	Data adjusted so that data of the 61 provinces sum up to national GDP and that regional implicit price indices are compatible with national ones
MIN	Share of ethnic minorities in provincial population	VHLSS 2002	Ethnic minorities comprises all Vietnamese nationals except for Kinh and Chinese
Urban	Share of urban population in total provincial population	VHLSS 2002	Including individual/HH sampling weight to represent the population
Business	Distribution of newly registered firms per province 2002	CIEM/UNDP	Implementation of private business according to the "Enterprise Law" of 2000
South dummy	Dummy variable valued 1 for provinces located south to the border created by the Geneva accords in 1954 (between Quang Binh and Quang Tri)	Own calculation	32 out of 61 provinces

9.2 Tables

Table 2: Regressors and PMP of ten best models in poverty-BMA

Model	Regressors	PMP (in per cent)
1	Gini, Land Gini, Urban , Birth, Program 135, Perennial land, Exp98	13.28
2	Gini, Land Gini, Urban, Birth, Program 135,	12.50
3	Gini, URBAN, Perennial land, Exp98, Public health	11.67
4	Gini, Land Gini, Urban, Birth, Program 135, Perennial land	11.16
5	Gini, Land Gini, Urban, Birth, Perennial land, HEPR, Exp98	10.69
6	Gini, Land Gini, Urban, Birth, Perennial land, HEPR	9.30
7	Gini, Land Gini, Birth, Program 135, Central SOEs	8.78
8	Gini, Land Gini, Urban, Perennial land, Business	8.39
9	Gini, Land Gini, Urban, Perennial land, HEPR, Exp98	7.28
10	Gini, Land Gini, Urban, Perennial land, Business, PRIV	6.96

Table 3: Comparison of regressor's posterior probabilities in poverty-BMA

	Regressors	BMA Post. prob.	Post. means
1	Gini	0.9757	146.9337
2	Land Gini	0.6605	-26.6973
3	Urban	0.6532	-0.3564
4	Birth	0.5700	0.5457
5	Program 135	0.4732	0.0002
6	Perennial land	0.4313	0.0207
7	HEPR	0.3955	0.0001
8	Exp98	0.3828	-0.0016
9	Public health	0.2701	0.2924
10	Central SOEs	0.2570	-0.0634
11	South dummy	0.1598	-1.2466
12	AGRI	0.1568	0.0264
13	Land reform	0.1445	-0.0239
14	Business	0.1351	-0.0308
15	Life	0.1305	-0.0722
16	Private education	0.1124	-0.0779
17	Local SOEs	0.0968	0.0207
18	PRIV	0.0931	-0.0004
19	MIN	0.0771	-0.0198
20	FDI	0.0732	0.0026
21	Literacy	0.0718	-0.0212
22	Public education	0.0577	0.0028
23	Electricity	0.0536	-0.0028
24	PUB	0.0519	-0.0001
25	Roads	0.0513	-0.0281
26	IMR	0.0509	0.0002
27	Sanitation	0.0495	0.0035
28	IND	0.0471	-0.0042
29	Land market	0.0388	-0.0031
30	Transfers	0.0363	0.0001
31	Graduates I	0.0354	0.0112
32	Graduates III	0.0348	0.0015
33	Openness	0.0345	-0.0009
34	Graduates II	0.0340	-0.0031
35	Private health	0.0320	0.0131
36	GOV	0.0304	-0.007

Table 4: Regressors and PMP of ten best models in growth-BMA

Model	Regressors	PMP (in per cent)
1	Exp98, Business, Birth, South dummy, Central SOEs	26.62
2	Exp98, Business, Birth, South dummy, Central SOEs, IND	21.35
3	Exp98, Business, Birth, South dummy, Central SOEs, Local SOEs	17.08
4	Exp98, Business, Birth, South dummy, Central SOEs, AGRI	7.06
5	Exp98, Business, Birth, South dummy, Central SOEs, Local SOEs, IND	5.68
6	Exp98, Business, Birth, South dummy, Central SOEs, Urban, Local SOEs	5.22
7	Exp98, Business, Birth, South dummy, Central SOEs, Urban	5.06
8	Exp98, Business, Birth, South dummy, Central SOEs, Transfers	4.24
9	Exp98, Business, Birth, Urban, Program 135	4.14
10	Exp98, Business, Birth, South dummy, Central SOEs, Land reform	3.54

Table 5: Comparison of regressor's posterior probabilities in growth-BMA

	Regressors	BMA Post. prob.	Post. means
1	Exp98	1.0000	-0.0101
2	Business	0.9996	0.2814
3	Birth	0.9469	-0.4474
4	South dummy	0.8098	3.8524
5	Central SOEs	0.7588	0.1008
6	Urban	0.3383	0.0547
7	Local SOEs	0.3039	-0.0308
8	IND	0.2336	0.0164
9	Program 135	0.1064	-0.0001
10	AGRI	0.1034	-0.0046
11	HEPR	0.0914	-0.0001
12	GOV	0.0788	-0.0039
13	Land reform	0.0755	0.0030
14	Graduates III	0.0640	0.0045
15	Transfers	0.0636	-0.0001
16	Sanitation	0.0598	-0.0018
17	Public health	0.0573	0.0014
18	Gini	0.0540	-0.7858
19	Land Gini	0.0536	0.2605
20	Public education	0.0509	0.0010
21	Private health	0.0499	-0.4474
22	Electricity	0.0468	0.0010
23	Perennial land	0.0416	-0.0002
24	MIN	0.0415	0.0018
25	FDI	0.0413	0.0006
26	Graduates II	0.0375	0.0028
27	Graduates I	0.0369	-0.0092
28	Roads	0.0351	0.0034
29	IMR	0.0345	-0.0001
30	Literacy	0.0343	0.0014
31	PRIV	0.0338	0.0001
32	PUB	0.0334	-0.0001
33	Life	0.0333	0.0011
34	Private education	0.0310	0.0165
35	Land market	0.0299	0.0001
36	Openness	0.0288	0.0001