Structural change and poverty:
Dynamic analysis of Bolivian Millennium trajectories

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Abstract

Several poor countries are currently implementing Poverty Reduction Strategies, aiming to halve extreme poverty by 2015. Output structure matters for poverty reduction. Dynamic input–output simulation is used to represent the effects of different strategies on the structure of output growth and income distribution. Model simulation shows that the current Poverty Reduction Strategy may not achieve the Millennium Goal of halving extreme poverty. Model optimisation is used to find feasible output trajectories minimising extreme poverty. Growth and changes in output composition are not sufficient to halve extreme poverty by 2015, and a simple income redistribution policy is simulated that achieves that goal.

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1. Introduction

By the Millennium Declaration of September 2000, the 191 members of the United Nations formally pledged to meet by 2015 eight ambitious goals, the so called Millennium Development Goals (http://www.un.org/millenniumgoals/). The first of these goals is to

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“eradicate extreme poverty and hunger,” operationally specified as to “reduce by half the proportion of people living on less than a dollar a day,” and “reduce by half the proportion of people who suffer from hunger.” According to another international initiative, the Debt Initiative for the Heavily Indebted Poor Countries, countries willing to reduce their debt with external official creditors may start a process which involves, among other things, the formulation of a poverty reduction strategy, a so-called poverty reduction strategy paper (PRSP). PRSPs often contain poverty reduction (and other) goals in line with the Millennium Development Goals.

PRSPs include in many cases projections — seldom based on economic models — of expected future growth and its likely effect on poverty on an aggregate basis. A problem with this approach is that aggregate analysis does not allow for the effects of structural change on poverty, while we know that output structure matters for poverty reduction. For a given overall rate of growth, different disaggregated output growth trajectories will in general have different impacts on poverty. Another, perhaps more fundamental problem, is that the approach does not allow for assessing the feasibility of the goals, or for analysing alternative ways of achieving them. A critical recommendation by an influential study on how to achieve the Millennium goals by Jeffrey Sachs and others (UN Millennium Project, 2005) is that PRSs be based on an assessment of investments and policies needed to reach the Goals by 2015 (Recommendation 2, p.xiv).

We present here a study of Bolivian strategies that attempts to remove the above limitations of current PRSs. In the next section, we try to briefly substantiate the claim that structural change matters for poverty alleviation. We then make in the subsequent section an intuitive and visual description of the dynamic input–output simulation model of the study — a detailed mathematical representation and data base can be found in Buzaglo and Calzadilla (2004). The simulation approach does not suffer from the drawbacks of usual approaches to dynamic input–output, most recently discussed by Mayumi (forthcoming). In Section 4 we use the model to analyse the effects of the evolving Bolivian PRSP — the Estrategia Boliviana de Reducción de la Pobreza (EBRP). According to the simulation, the output growth pattern of the EBRP does not succeed in achieving the Millennium poverty reduction goal of halving extreme poverty by 2015. Hence in Section 5 we use the model to select the output trajectory that minimises extreme poverty by 2015. Bolivian poverty is very resilient — growth and change in output structure are not enough for attaining the Millennium poverty goal. Section 6 thus describes the solution for the redistributive policy (tax reform) consistent with attaining the goal. Section 7 concludes.

2. Structural change and poverty

The importance of the evolution of the sectoral output pattern for the structure of income distribution and the incidence of poverty has been emphasised both in theory and in empirically oriented studies. Kalecki (1954) showed that the pattern of output growth sets a limit on income redistribution or poverty reduction. With the growth of the incomes of the poor, the demand for food staples and other essential goods and services increases more than proportionally, as the income elasticity of the demand for essential goods is relatively high for low-income groups. Given by assumption a limited capacity to import, the possibility of augmenting the real incomes of the poor rests on the possibility for the sectors producing essential goods and services of increasing their output at a sufficient rate, that is, above the rate of expansion of the economy at large. The impossibility for essential goods-producing sectors to grow at a pace compatible with the rate of growth in demand gives rise to price
increases, and to regressive income redistribution, that is, reduced real wages and real incomes of the poor.

Several recent empirical studies have shown that the pattern of output growth and trade specialization are critically important for income growth and poverty reduction. Sectoral specialization patterns as that of Bolivia, based on exports of natural resources and export crops agriculture, have been shown not to be propitious for domestic income growth and progressive redistribution. Statistical cross-country studies have found that inequality is positively correlated with a pattern of primary export specialization (Bourguignon and Morrison, 1990). Other, similar studies show that the ratio of natural resource exports to GDP is negatively correlated with growth (Sachs and Warner, 2001).

Empirical studies have also found strong correlations between the growth of food staples production and poverty reduction or income equalisation. A study based on a wide survey of the literature (Lipton and Ravaillon, 1995) emphasizes the critical role of agriculture in sustaining a pro-poor pattern of development: "The key sector identified for pro-poor growth in most LDCs is the rural farming sector. Agricultural growth, especially growth and stabilization of food staples production, is likely to benefit poor people." (p. 2608.)

3. A model of structural change and poverty reduction

The model belongs to the classical tradition of Smith, Ricardo and Marx. The classical approach focuses on observable relationships of production, distribution and consumption, existing in time (see Kurz, forthcoming, for recent references). As in Marx’s reproduction schemes and Leontief’s dynamic input–output model, the basic law of motion of the economy is given by the investment of the social surplus (see e.g. Lange, 1957, 1969). For given capital/output ratios or investment efficiency coefficients, the rate of growth of the economy depends on the rate of saving/investment. (These classical ideas have in recent years been rediscovered by endogenous growth theory.)

The dynamic input-output model can be understood as a sectorally disaggregated Harrod-Domar model. Thus, the central equation of the model, which determines the economy's evolution through time is the difference equation:

$$x_{t+1} = \alpha^{-1} d_t + x_t$$

That is, the time-path of the n-vector of sectoral outputs \(x_t\) depends on the sectoral coefficients of investment efficiency \(\alpha^{-1}\) (a diagonal n-matrix) and on the sectoral investments \(d_t\) (an n-vector). The vertical sum of \(d_t\) is by construction equal to total saving, as will be shown below.

The usual approach of dynamic input–output analysis is to solve for the balanced growth path of the system, with equality between sectoral demands and supplies. In the solution — which depends on several restrictive conditions on the capital and input–output matrices — outputs stay in fixed proportions and grow at equal, constant rates. This poses several problems — most recently discussed by Mayumi (forthcoming) — such as the need of imposing unrealistic restrictions on initial values, or the difficulty of interpreting the model’s solution ("before the process gets started, the process must already have been on a balanced and sustained growth
The approach of the present study responds to the need of depicting implementable poverty reduction strategies, increasing the realism of the specification. First, the “balanced growth path” assumption — equality between domestic sectoral supplies and demands — must be removed. In the open economy, (internal) excess demands are internationally traded — e.g. excess supplies of oil are exported, excess demands for investment goods are imported. Second, the model must be able to describe implementable strategies. That is, the model should include — albeit stylised — policy variables, with known effects on the behaviour of the economy. Third, “the process must get started” exactly where the process is at the moment of starting the strategy — i.e. sectoral output composition, sectoral growth rates, sectoral excess demands, etc., must be what they are at the moment of starting the process.

To take the third condition first, this can be accomplished by adopting a simulation approach. This means that eq.1 is recursively solved (integrated) forward in time, starting in a given year. For given values of the economy’s initial outputs, and for given structural and policy coefficients (about which more details are given in short), a numerical solution of the model describes future output trajectories. Starting from existing conditions, a particular strategy has thus been simulated.

The second condition refers to the requirement for a strategy model of being able to describe probable effects of alternative sequences of actions. For inducing growth, the critical action within the classical and dynamic input–output theoretical context is investment. Also for Keynes (1936, p.164), the role of investment policy is to organize investment on long views and on the basis of the general social advantage, taking into account the efficiency of investments.

In order to specify an investment policy in the model of eq.1, let us distinguish between private investment $d_i^p$, and public investment $d_i^g$, of which sectoral investment $d_i$ is the sum. Total investment equals total savings, and we assume for simplicity that the overall equality between savings and investment also applies for the private and public sector taken separately. Then, in the context of the model, given endogenously determined public saving $s_t^g$ (a scalar), public investment is determined by investment policy:

$$d_t^g = z_t^g s_t^g,$$

where $z_t^g$ is a distribution vector of public investment allocation shares. An investment policy is a time sequence $\{z_t^g\}$ of public investment allocation shares. A $\{z_t^g\}$ sequence can be exogenously given, as for instance in a historical simulation, or when some particular policy is tested, or it can be also determined by optimisation of some expression of social welfare, e.g. minimisation of the share of the poor in year 2015.

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1 Investment is defined in a very wide sense, as the cost of productivity-increasing changes. Public investment includes the costs of explicit or implicit subsidisation of private investment (such as, for instance, “industrial policy”). The applicability of these definitions is in practice limited by data availability.
Private investment, on the other hand, endogenously allocates private savings. Private investments are intersectorally allocated according to an accelerator function.²

We have thus far described the investment of private and public savings and their effects on output growth, given investment efficiency parameters, as shown in the South-West half of Fig. 1. Let us now complete the loop, describing how savings are determined from incomes generated in production, for given income distribution and savings coefficients.

Fig. 1. Flow diagram of the dynamic core of the model

Miyasawa and Masegi (1963) introduced Kaldor’s approach to income distribution (Kaldor, 1956) into the input–output framework. They defined income (value added) distribution coefficients by income class (e.g. capitalists and workers), with particular consumption and saving behaviours. In line with this approach, incomes by income group $y_t$ (a $k$-vector) depend linearly on sectoral gross outputs $x_t$:

$$ y_t = V_t \cdot x_t, \quad (3) $$

² Private sectoral investments are: $d_t = z_t s_t, \text{ where: } z_t = \frac{\alpha(x_t - x_{t-1})}{t'\alpha(x_t - x_{t-1})}$, in which $t$ is a summing vector $(1,1,...,1)'$. (The estimated function is a distributed accelerator including three previous periods, see Buzaglo and Calzadilla (2004), Appendix A eq.(15).)
in which \( V_i \) is a \( k \times n \) matrix of shares of income (value added) by income-group, specific to each production sector. One of the rows of \( V_i \) matrix describes the public sector’s income generation.

The \( V_i \) matrix of sectoral income distribution may assume different specifications. The Kaldor-Miyasawa-Masegi specification above analyses the sectoral distribution of income among socio-economic classes. This type of disaggregation is an important instrument for understanding the socio-economic dynamics of growth and development. The analysis of poverty and poverty reduction policy also requires a representation of the size distribution of incomes. Unless defined very narrowly, socio-economic groups may include both poor and non-poor households. Thus, a \((10 \times n)\) matrix \( V_i^{*} \) is defined, describing the sectoral income shares by deciles. The 10-dimensional vector:

\[
y_i^{*} = V_i^{*} x_i
\]  
(4)

depicts now the overall size distribution of incomes by deciles, with its elements showing the income of the corresponding deciles. Given the poverty line income \( y^* \) (a scalar), the sum of deciles of \( y_i^{*} \) under the poverty line gives the number of deciles affected of poverty in period \( t \).

An income distribution policy is a sequence \( \{ V_t \} \) of income distribution matrices. In Section 6, we solve for an income distribution policy — a tax reform — satisfying the Millennium Goal of halving extreme poverty by 2015.

Finally, to close the loop of Fig. 1 we briefly describe the determination of saving and consumption from incomes generated in production.

In the context of the highly indebted economy, foreign savings and foreign indebtedness are highly relevant. We extend the usual input–output framework, to allow for foreign savings (equal to the trade deficit). Exogenously given (negative or positive) foreign savings \( \phi \) are added (at an equal rate) to private and public saving, thus increasing (or decreasing) the volume of funds available for domestic investment. (Also, foreign savings add to the external debt of the period, and the effect of the rate of interest on debt growth is included.)

Domestic savings in the model are simply non-consumed incomes:

\[
s_i^{*} = y_i - c_i,
\]  
(5)

in which \( s_i^{*} \) is a \( k \)-vector of saving by income group, \( y_i \) is a \( k \)-vector of incomes by group, and \( c_i \) is a \( k \)-vector of consumption demands by income group.

Consumption by type of output is of the form:

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3 The present study defines the following socioeconomic classes: owners, rural smallholders, landless rural workers, skilled workers, non-skilled workers, and self-employed (see Buzaglo et al., 2002).
4 In order to obtain a poverty measure which changes by steps of one percentage point, a submatrix of percentiles is also included (see Buzaglo and Calzadilla, 2004).
\[ c_t^* = \Gamma \ y_t, \quad (6) \]

where \( c_t^* \) is now an \( n \)-vector of consumption demands, and \( \Gamma \) is a \((n \times k)\) matrix of consumption propensities. (Consumption by income group \( c_t \) is obtained by transposing and diagonalising the \( \Gamma \) matrix.)

To recapitulate, we can see that the model above fulfils the second and third “Mayumi conditions” referred to at the beginning of this section. That is, the model describes the structural evolution of the economy under different policy sequences, starting from a given initial situation. Given: (a) initial outputs \( x_0 \) and \( x_{-1} \), (b) investment efficiency parameters \( \alpha^{-1} \) and consumption coefficients \( \Gamma \), and (c) policy sequences \( \{ z_t \}, \{ V_t \} \) and \( \{ \varphi_t \} \), the model can be recursively solved forward in time so as to determine sectoral output trajectories. Associated income levels are obtained from output trajectories — for given distributional structures. Income levels (by income class) in turn determine poverty incidence (for a given poverty line) and other welfare indicators. Policy sequences can be exogenously given, or they can also be determined by optimisation of some expression of social welfare.

Let us finally try to respond to the first condition, the “balanced growth path” assumption of equality between domestic supplies and demands. In other to enquire into the sectoral balances between supplies and demands in the context of our model, we must distinguish among: (i) consumption demands, (ii) intermediate demands, and (iii) investment demands. Consumption demands by type of good or service where described in eq.6 above. Intermediate demands result immediately as the product \( Ax_t \), given the \((n \times n)\) \( A \) matrix of technical coefficients. Investment demands are related to investment by destination \( d_t \) through the capital coefficients \((n \times n)\) matrix \( B \), of sectoral composition by sector of origin of investments by destination. Then, the \( n \)-vector of sectoral excess demands \( b_t \) is the difference between sectoral supplies and demands:

\[ b_t = x_t - c_t - Ax_t - Bd_t, \quad (7) \]

When all output is internationally tradable and world prices prevail in the economy, \( b_t \) represents sectoral trade balances, i.e. positive elements are net exports and negative elements are net imports. The \( b_t \) vector thus reflects the effect of the strategy on international trade specialization. In the framework of this model, a “balanced growth path” — in practice, an investment policy that minimizes sectoral excess demands (in absolute value) — is one of many different possible strategies. It would be the case of a particular pattern of structural change, from a certain specialisation profile toward a more self-sufficient economy.

In the next section, we present the results of solving the model for the exogenously given \( \{ z_t^g \} \) investment policy of the Bolivian PRSP. In Section 5, we solve for the \( \{ z_t^g \} \) sequence that minimises extreme poverty by 2015. As changes in output structure are not enough for fulfilling the goal of halving extreme poverty, Section 6 solves for the income distribution policy \( \{ V_t \} \) that fulfils that goal.

4. The base scenario: Bolivia’s PRSP
The Estrategia Boliviana de Reducción de la Pobreza (EBRP) contains an advanced study of poverty and its causes (see Bolivia, 2001). It also includes ambitious goals for poverty reduction and other human development indicators, in line with the Millennium Development Goals. For instance, the incidence of extreme poverty, affecting 36 percent of the population (according to the official definition) would be more than halved by 2015. The EBRP is however rather parsimonious in relation to the measures and policies required to fulfil these ambitious targets. There are no projections of probable trajectories given present and intended policies, and no estimations of resulting income and poverty levels. That is, there is no formal framework estimating the resources — in particular, budgetary resources — necessary to attain stated poverty reduction goals.

The EBRP is not explicit about its desired pattern of growth. It does not seem to be aware of the importance of the multisectoral structure of output documented in Section 2, both in explaining the past resilience of poverty, and in supporting poverty reduction strategies. Our “basic” interpretation of the EBRP strategy is that it maintains the focus of the past pattern of growth in capital intensive, primary sectors such as gas, oil, minerals and soybeans, and that it general, it maintains the same pattern of sectoral priorities than in the past. The “stylized fact” about the EBRP investment policy is that the EBRP evidences a preference for maintaining the present specialization and output patterns, that is, of continuing with the investment policy of the recent past.

It is also difficult to dispel the income distribution policy of the EBRP. The EBRP seems to continue with the present distributional pattern, adding now a set of assistance programs targeted towards the poor. Tax policy, a crucial instrument of redistribution policy and an indicator of distributional preferences, does not show any change. The tax system, which has a low and regressive profile, does not seem to be a candidate for reform. Our stylized interpretation of the EBRP distribution policy is that it will be unchanged.

Along with investment policy and distribution policy, the model of the previous section assumes a third policy variable that — within certain limits — is available for poverty reduction policy, namely foreign saving. The net inflow of foreign resources — equivalent to the trade deficit — adds to the investment and growth potential of the economy. The HIPC Initiative of the international financial organizations has reduced the external debt of Bolivia. Debt relief diminishes future outflows and increases the growth capacity of the economy.

The above interpretation of the EBRP as a rather stationary strategy makes our EBRP simulation similar to a base or status quo scenario. Development strategy is unchanged, with the only exception of foreign savings $\varphi_t$, now increased by the HIPC debt relief.\footnote{For the assumed values of investment policy $\{z^g_t\}$ and distribution policy $\{\psi^t\}$, see Buzaglo and Calzadillla (2004, Appendix B). They are constant for 2000-2015. The model is formulated and solved within the general algebraic modelling system GAMS (see e.g. Brooke et al., 1992).}
Fig. 2 shows the evolution of extreme poverty incidence in 2000-2015 under different strategies. The initial value of extreme poverty (50 percent) corresponds to the extreme poverty line of 1 US dollar a day, the threshold commonly used in international comparisons — the 36 percent figure mentioned above corresponds to the official line. It is clear that under the assumptions of our model the EBRP does not succeed in halving the incidence of extreme poverty by 2015. The reduction in the share of the extremely poor is 5 percent, that is, 20 percentage points below the goal. The effect on overall poverty is even less (2 percent) — not shown in the Figure (detailed results are available on request from the authors).

Fig. 3 shows the effects of the EBRP strategy on the number of the poor.
The effects on the number of people in extreme poverty can be seen in Fig. 3. The number of people in extreme poverty increases under the EBRP, due to the fact that the rate of poverty reduction is lower than the rate of population growth (2.3 percent per year). The number of people in absolute poverty increases by 25 percent. The number of people under the 2 dollar’s poverty line (not shown in the figure) increases by 36 percent.

The EBRP has been revised and some changes have been introduced, although its targets and general strategic approach seem to be maintained (Bolivia, 2003). In fact, the revised version of the EBRP seems to implicitly admit that the poverty reduction objectives will not be attained under present circumstances. According to this document, a growth rate twice as high as that of the last two decades, or alternatively, a reduction in the Gini index of inequality of one percentage point a year until 2015 would be necessary. But the policies required to produce such results do not seem to be available.
Fig. 4. Output pattern of the EBRP

Let us now turn to the effects of the EBRP on output structure (Fig. 4). According to the model simulation, the investment policy of the EBRP accelerates the growth of the oil, gas and mining sector, and this sector rapidly increases its weight in total output, although its relative importance diminishes with time. It becomes the largest sector for the most part of the period. Export crop agriculture also follows a path of rapid expansion. Food crop, traditional agriculture, on the other hand, continues its past stagnating trend, and its share in total output is further reduced. As commented in Section 2, and confirmed by model simulation, this sectoral pattern of growth is not particularly favourable to poverty reduction. From the multisectoral perspective of the present study, the EBRP fails in significantly reducing poverty due to both the low overall growth capacity of the economy and the unhelpful pattern of growth adopted. A more helpful growth pattern should imply higher poverty reduction outcomes for equivalent rates of overall growth. This is the object of the next section.

5. Growth pattern minimising poverty by 2015

In this section, we assume that the aim of investment policy is achieve the Millennium Goal of halving extreme poverty by 2015. That is, we assume that the aim of investment policy is to induce such changes in the structure of output growth so as to achieve a reduction of extreme poverty as close to a half of what it was in 2000 as possible. Formally, we search for the \( \{z^s_t\} \) investment policy sequence that makes the share of the extremely poor by 2015 as close to 25 percent as possible — all other coefficients being equal to the previous EBRP scenario.\(^6\) In particular, the \( \{r^*_t\} \) status quo income distribution policy sequence of the EBRP

\(^6\) For simplicity, we solve in fact for a constant \( \{z^s_t\} \) sequence for the whole period. A restriction is imposed on the excess demands of non-tradables’ sectors (7th to 12th), so as to maintain the initial equilibria. A third of the public investment budget is distributed equally to all sectors. The optimization algorithm (Drud, 1992) is based
is maintained — overall income distribution only changes through changes in sectoral output composition (let us recall that $V_i^*$ depicts the size income distribution specific to each sector). Fig. 2 shows the effect of this “Millennium investment policy” on the incidence of extreme poverty.

By 2015, the share of the extremely poor has diminished by 20 percent. Changes in the output composition of growth are not enough to fulfil the Millennium Goal. Yet this is still a much better performance than the EBRP, with fourfold times a poverty reduction rate. Also in terms of the absolute number of the extremely poor (Fig. 3), the Millennium investment policy shows a much better result, with about a half as much an increase by 2015 (13 percent). This means half a million less people in extreme poverty by 2015.

Let us now turn to the output trajectories resulting from the Millennium investment policy. Fig. 5 shows that this policy reduces the oil and gas specialisation of the economy, as compared to the EBRP. Investment and growth in the oil and gas sector contribute relatively little to the reduction of poverty, due to the income distribution structure of that sector. The Millennium investment policy promotes instead Small and medium industry to the place of leading sector — it surpasses the oil and gas sector halfway the time horizon. The relatively high response of poverty to investment in this sector — that is, the combined effect of higher investment efficiency and more equal distribution — gives this sector a higher weight in investment policy.

![Fig. 5. Output pattern minimising extreme poverty by 2015](image)

The food staples agricultural sector deserves a special comment. The importance of food staples production for “pro-poor growth,” both in theory and according to empirical observation, was substantiated in Section 2. However, the Millennium investment policy

\[
\begin{align*}
z^* &= 0.029 0.029 0.238 0.029 0.078 0.029 0.374 0.054 0.043 0.037 \\
\end{align*}
\]

on Wolfe’s reduced gradient method (Abadie and Carpentier, 1965). The resulting $z^*$ vector is: $(0.029, 0.029, 0.238, 0.029, 0.078, 0.029, 0.374, 0.054, 0.043, 0.037)^\top$. 

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seems to neglect this sector, in spite of the fact that it lodges 60 percent of the poor population. In 2000-2015, Food staples agriculture continues to show the stagnating behaviour it had during the 1990s, with growth below population growth. This is the consequence of two converging factors, namely a very low investment efficiency and very low income generating capacity. On the one hand, the output response to investment in Food staples agriculture is very low, as estimated according to data for the 1990s. On the other, the extremely poor peasants producing food staples work at very low productivity levels, under very difficult climatic and soil conditions, and lack of roads, electricity, irrigation, credit and technical assistance. Poor peasants are further away from the extreme poverty line than other groups. Food staples producing agriculture seems to be in need of an encompassing reform program. Such a thorough agricultural reform would increase the feasibility of the Millennium Goals.8

Finally, it is interesting to note that the “pro-poor” Millennium investment policy is as “pro-growth” as the natural resource intensive EBRP — both strategies result in the same GDP growth rate, namely 4.5 percent in average for 2000-2015.

6. Halving extreme poverty by 2015

The investment policy inducing poverty minimising output growth, discussed in the previous section, reaches (almost) half way to the Millennium Goal — while the EBRP attained one tenth of that way. A natural question, within the context of the multisectoral/distributional model of the present study is: Is there any realistic redistribution policy capable to complete the road towards the Millennium Goal? Or, in the formal idiom of the model, Is there any income distribution policy sequence which along with the poverty minimising investment policy of the previous section may halve extreme poverty by 2015?

To answer that question, we design the simplest possible redistributive policy — a tax reform — consisting of a tax applied at a constant rate (a “flat tax”) on all incomes above twice the poverty line (of 2 dollars a day). The fund thus collected is equally distributed to all people below the line of extreme poverty (1 dollar a day). This is of course a very rough picture of what an income redistribution policy might be, but it is here attempted only as a first feasibility check of possible redistributive taxes.

The optimisation exercise of this section consists thus in solving the model for the income tax rate which would make the share of the extremely poor in 2015 to approach 25 percent as much as it is possible — i.e. a half of what it was in 2000. The Millennium investment policy of the previous section is now supplemented by a straightforward tax reform directly connected to a scheme which redistributes incomes toward the extremely poor. All other things — initial conditions, behavioural coefficients and in particular, investment policy parameters — are equal to those of the previous section. The income tax-plus-redistribution

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7 Investment efficiency parameters are determined by historical optimization so as to track past sectoral output trajectories (1990-1997) as accurately as possible. $\alpha_{\text{Food}}$ is the second highest marginal capital output coefficient, after Transport (see Buzaglo and Calzadilla, 2004, Appendix B).

8 The Chinese experience of recent decades may illustrate a “two track” strategy of rural reform and small-scale industrialisation of the countryside. This experience shows the large potential residing in expanding non-farm capacities in the rural sector. In 1978-1994, the average annual rate of growth of the rural non-farm sector was 18 percent (Bramall, 2000, Table 16.4).
policy transforms the \( \{ \mathbf{r}^*_t \} \) status quo income distribution policy sequence of the EBRP into a new, post-redistribution sequence \( \{ \mathbf{r}^{**}_t \} \).

Fig. 2 shows the evolution of poverty in what results to be an industrialising growth-cum-redistribution poverty reduction strategy — a poverty minimising policy focusing particularly on industrial growth, combined with a redistributive “Millennium tax” reform. The effect of the reform is to immediately from its inception reduce extreme poverty by 10 percentage points, and to continue to progressively cut it until the Millennium Goal is attained in 2015. The number of the extremely poor has by then diminished by 1.1 million — i.e. 27 percent (Fig. 3).

The Millennium tax rate that obtains this result is, from an industrialised country perspective, fairly low — 8.1 percent. Current income tax rates are very low, and the system present several loopholes. Yet of course our Millennium tax rate is a very rough estimate that does not include such costs as for instance the administration of the redistributive system itself.

The effect of the tax is to reduce the disposable income of those who earn more than twice the poverty line (i.e., above 120 dollars a month). Expectedly, this has a negative impact on the rates of saving, investment and growth in the economy. But this effect is not large, and GDP growth is reduced by 0.3 percentage points as compared to the base scenario without redistribution of the previous section (i.e., the average annual growth rate is 4.3 percent).

Income inequality, on the other hand, is 14 percent lower — the Gini coefficient for 2015 is 0.58 as compared to 0.67.

To end this section, let us present the effects of a more fully “Rawlsian” strategy. A fully Rawlsian strategy would probably adopt the more ambitious goal of totally eliminating extreme poverty by 2015, giving absolute priority to the needs of the extremely poor. The “Rawlsian tax” obtained by solving the model in exactly the same way as in the Millennium tax above — except that the objective is zero extremely poor in 2015 — is 16.7 percent.

Average GDP growth is now 4.1 percent, and \( Gini_{2015} \) is 0.50.

7. Final reflections

From several widespread doctrinal points of view, the premises of the study above may seem rather naïve. For several schools of economic thought, economic policy is not the outcome of an enlightened social choice, but the result of the competition among groups trying to impose their own interests. The conclusion is often laissez faire or, as the ancient Chinese philosopher recommends, wu wei — do what consists in taking no action. The problem is that the strongest and best organised interests will probably differ from the general interest — however defined.

Our study need not be interpreted as an attempt to represent the general or social interest — although our objective functions are goals formally endorsed by the 191 UN members. It may also be interpreted as a technically sophisticated, empirically grounded argument in favour of the interests of the poor — a large majority of the population.

According to our study — and to other studies such as e.g. World Bank (2003) — current policies do not lead to fulfilment of the Millennium poverty reduction goals. We also show that there exist feasible — and in some specific sense, optimal — policies for structural
change in both output composition and income distribution that would make it possible to
achieve them. As far as we know, dynamic input–output simulation is the only effective
instrument in the analysis of these highly relevant types of problems.

References

cas des contraintes non-linéaires. Note HR6678, Electricité de France, Paris. English


Bourguignon, F., Morrison, C., 1990. Income distribution, development, and foreign trade: A
cross-sectional analysis. European Economic Review 34, 113--132.

Press, Oxford.

Francisco.


The Bolivian PRSP. International Conference on Policy Modelling, Brussels, September 2004.
(http://www.ecomod.net/conferences/iioa2004/iioa2004_papers/12.pdf)

Drud, A., 1992. CONOPT – A Large-Scale GRG Code. ORSA Journal on Computing 6, 207-
216.

Duchin, F., Szyld, D., 1998. A Dynamic Input-Output Model with Assured Positive Output,
in: Kurz, H., Dietzenbacher, E., Lager, C., (Eds.), Input-Output analysis, Vol. 1. Elgar,

100.


Keynes, J.M., 1936. The general theory of employment, interest and money. MacMillan,
London.
Kurz, H., forthcoming. The agents of production are the commodities themselves: On the classical theory of production, distribution and value. Structural Change and Economic Dynamics.


