Poverty Alleviation Policies in Madagascar: a Micro-Macro Simulation Model

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ABSTRACT

We present the framework of a macro-micro simulation model for the study of the impact of economic policies on income distribution and monetary poverty in Madagascar. Modelling options and choices are discussed for the micro-economic module and for the macro-micro linkages. Econometric estimations and calibration of the occupational choice / labor income part of the micro-economic module are presented and commented. Some illustrative simulations of poverty alleviation schemes are also implemented and analyzed.

Keywords: Economic Modelling, Micro-Simulation, Income distribution, Poverty Reduction, Dual Labor Markets, Occupational Choice, Madagascar

RÉSUMÉ

Nous présentons le cadre d'un modèle de simulation macro-micro pour l'étude de l'impact des politiques économiques sur la distribution du revenu et la pauvreté monétaire à Madagascar. Les options et les choix de modélisation sont discutés pour le module micro-économique et pour les liaisons micro-macro. Les estimations économétriques et la calibration du modèle de « choix » d'occupation et de revenu du travail sont présentées et commentées. Des simulations illustratives de stratégies de réduction de la pauvreté sont aussi mises en œuvre et analysées.

Mots-clefs: Modélisation économique, micro-simulation, distribution du revenu, réduction de la pauvreté, choix d'occupation, dualisme du marché du travail, Madagascar

JEL codes : C51, D31, D58, J24, O15, O21

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1   Introduction[1]

This chapter aims at presenting a modelling technique integrating a static
(CGE type) macro module with a static micro-simulation module of labor sup-
ply/income and consumption demand based on cross-section survey data. This
simulation model, thereafter designated as the micro-macro model, is dedicated
to simulate the short-medium term impact of economic shocks and policies on
income distribution and monetary poverty. It is applied to the case of Mada-
gascar. The micro-simulation module is built upon a structural micro-economic
model of occupational choices and labor income. It is estimated on a standard
cross-section micro-economic dataset deriving from a "multitopic household sur-
vey" (see Scott, 2003).

   Section 2 presents the options offered by current econometric practice and
the modelling choices that have been made for this work. Section 3 presents the
micro-simulation module and its econometric estimation. Section 4 presents the
integration procedure with the macro-module and simulations.

2   Motivations for an integrated micro-macro model

Most common macro models used to analyze distributional issues are able to
take into account some structural features of the economy and general equilib-
rium effects as well as the functioning of factor markets, but they usually rely
on the definition of representative household groups characterized by different
combinations of factor endowments and possibly different behaviors. The het-
erogeneity of the population of households is thus integrated in a scarce and
unsatisfactory way since the inequality modeled is essentially the inequality
between the representative groups. In many situations, the decomposition of
observed inequality evolution has shown that within-group inequality changes
are very often as important as between-group changes. This explains why tra-
ditional macro-economic models may appear unsatisfactory in dealing with dis-
tributional issues. Different approaches that rely on full household/individual
samples have been developed recently to overcome this difficulty. They differ

in how they account for micro-behaviors and in the degree of integration of the macro and micro "stories". Several approaches can be distinguished and are put in comparison in the present volume (see also Cogneau, Grimm, Robilliard 2003).

The "integrated micro-macro" approach presented here attempts to fully integrate household income generation modeling within a multi-market framework with endogenous commodity prices and factor returns. It also allows the simulation of structural policies that select individuals within the intra-group distribution. This kind of simulation is, by construction, made difficult by the representative groups assumption of standard macro economic models. In comparison with the "top-down" approach, the integrated approach puts more weight on the micro-economic side of the model; as a consequence, its macro-economic and multi-market framework is also less sophisticated.

2.1 Benefiting from advances in micro-economics and micro-econometrics

The first motivation for building an "integrated micro-macro" model is to take full advantage of the theoretical and technical advances in micro-economics and micro-econometrics of the modeling of complex micro-behaviors within specific market structures.

The "integrated micro-macro model" starts with a structural modelling of occupational choices and labor income formation. It may also include a micro-model of consumption choices. In the language of econometrics, "structural" means that the micro-behavior of agents is explicitly modeled as the result of an optimization program taking macro variables as given, such as returns to categories of labor, product prices or the unemployment risk. In the context of micro-macro models, micro-structural modelling of household and individual decisions draws on the large literature related to labor and consumption micro-economics and micro-econometrics. This allows the consideration of complex production, labor supply and consumption behaviors of heterogenous households and individuals confronted with transaction costs, information asymmetries, employment rationing, that is various kinds of "market imperfections". For instance, Cogneau and Robilliard (2001) take into account the non-recursive behavior of Malagasy agricultural households in the absence of a market for agricultural labor which prevents the equalization of the productivity of agricultural labor between households. Structural micro-econometric estimation also takes

explicitly into account the market structure which constrains the agents' decisions. For instance Cogneau (1999 and 2001) estimates a labor income and occupational choice model for the city of Antananarivo under various assumptions on the segmentation (dualism) of the urban labor market, drawing from Magnac (1991). The remaining micro-parameters which can not be identified in micro-econometric estimations, due to lack of information or other identification problems, are "calibrated" for the simulation, in line with the spirit of calibrated CGE macro-models. For instance, in both cited cases, heterogenous preferences for consumption decisions are calibrated on available survey data; some parameters related to labor supply like the variance of reservation wages are also calibrated.

2.2 Preserving the consistency between micro and macro variables

The second motivation for building an "integrated micro-macro" model is to preserve full consistency between the specification of micro-behaviors and the specification of macro aggregates. This may be desired on pure epistemological grounds : this is the "aggregation issue". But it may also be desired for welfare analysis purposes: this in turn is what we might call "interlinked welfare issues".

Micro-economic behavior can be made consistent with a multi-sector and multi-agents macro-economic framework through a number of calibration techniques that will be described thereafter. A fully consistent integration of micro-behaviors into a macro framework is not straightforward, and never completely achieved. It is however theoretically permitted by the structural nature of the specifications: agents react to prices and other signals which are determined at the macro-level. It is a fact that even simple micro-economic structural models do not lead to perfect aggregation: the "response function" of an average of agents does not look like the behavior of an individual agent, and most of the time has no analytical expression. This absence of a strong aggregation property prevents from separating the macro and the micro part if one wants to preserve mathematical consistency. As a result, in order to reach a consistent micro-macro equilibrium, micro-decisions have rather to be summed up and confronted with each other and with other macro-aggregates. At the end of the algorithmic resolution of the model, all aggregates coming from the households' micro-part, like the supply of categories of labor, the consumption demand, or total wage earnings must be equal to the corresponding macro-aggregates like

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the demand for categories of labor, the domestic supply of consumption goods, and the wage bill.

It is well known that the structural micro-economic modeling of labor supply and occupational choices (not to mention consumption demand behavior in some contexts) raises issues such as the heterogeneity of reservation wages, the indivisibility of hours worked or the rationing of labor supply in dualistic labor market. Discrete and/or constrained choices are the rule, between inactivity and work, between part-time jobs and full-time jobs, or between sectors or occupations. In this context, the envelope theorem no longer holds for computing equivalent welfare variations: one can not derive marginal welfare changes from observed choices and prices variations, even when price variations are small enough. Moreover, micro-agents welfare components are usually interlinked. One of the most simple examples of this is the structural relation that exists between the wage level and the utility of leisure: agents decide whether to accept a wage offer by comparing it with a "reservation wage". Another example is the link between wage offers and non-monetary utility of jobs: agents compare two wage offers on the basis of their heterogenous preferences for the jobs (compensating differentials story), or discount from each wage some cost of entry in the corresponding occupation (segmentation story).[2] If such phenomenons prevail, (i) wage earnings do not adequately reflect welfare levels, and (ii) some combinations of wages and occupational choices are not compatible. Therefore, separating income issues from occupational choice or labor supply issues at the micro-level, like in reduced form models, may lead to misrepresent not only the welfare distribution but also the income distribution.

2.3 Simulating targeted policies with macro impacts

Even if it can be more justified on methodological grounds, structural modelling usually precludes a high level of disaggregation of market segments and/or sectors, because of intrinsic econometric and algorithmic difficulties on which we shall give more detail hereafter. As a result, the integrated approach is less suited for the study of subtle intersectoral reallocations of supply and demand and fine modifications of the price and earnings schedule. Besides, a full structural model of household behavior, including production, labor supply, consumption, schooling and migration decisions, can not be econometrically es-

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[2] A third example coming from another field is the interlinkage of consumption and production choices in quasi-autarkic agricultural households facing high costs of access to markets.

timated, even if it were theoretically available. One has to focus on the most relevant behavioral features for the policy question under review or else resort to "piecemeal modelling" following Orcutt's strand of micro-simulation analysis (Orcutt, 1976). This means that a multi-purpose model is relatively out of reach with this approach. An "integrated micro-macro model" is relatively more suited to exploring general poverty reduction strategies and demo-economic issues on the one hand, and micro-structural and targeted policies on the other hand.

The study of medium-term general poverty reduction strategies may require a lower level of disaggregation than the study of macro-structural policies like trade policies. For instance, trade-offs between a "rural stance" (productivity enhancing rural investments) or an "urban stance" (job creation in towns) in poverty reduction strategies may be usefully studied like in Cogneau and Robilliard (2001) within a dual economy model with two or three sectors (agriculture, informal, formal) which endogenize the labor allocation of households, consumption demand, and, if possible, migration decisions.[3] Demo-economic issues may also be studied by integrating a structural income micro-simulation module to a stochastic micro-demographic projection module, in the spirit of the micro-simulation models designed in developed countries to study the reform of pension systems. For instance, the distributional impact over fifteen years of the AIDS epidemics has been studied that way by Cogneau and Grimm (2002), as well as the long-term impact of education policies by Grimm (2003 and 2004), both in the case of Côte d'Ivoire. It should however be kept in mind that in such frameworks, dynamic investment decisions remain exogenous and call for other methods to be properly analyzed (see Townsend and Heckman contributions in this volume).

Aside from this kind of general statistically-grounded experiments, simulating short-term targeted policies with macro-impacts might be the true comparative advantage of the "integrated micro-macro" approach. This is the road that is explored in this contribution. By targeted policies we mean policies whose aim is to reach specific categories of the population, most usually among the poor, through various targeting devices. They include labor market interventions like wage policies, workfare programs or job creation linked to foreign direct investment, but also land reforms and product markets interventions like marketing boards. One first problem is to evaluate the efficiency of the targeting device.

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[3] See Bourguignon (1990) for a theoretical model around the Kuznet curve issue.

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When the targeting is imperfect and depends on self-selection of individuals, a micro-structural model may be most useful. For instance, how many people will choose the new wage offer from a workfare program or a from an export processing zone? Another problem is to assess the overall distributional impact of such policies within and outside the target population, when their magnitude is big enough to have a macro-economic impact. Here then, a micro-macro closure may help. For instance, how many people will benefit from an increase in the minimum wage, how will this increase be transmitted to other segments in the labor market through a raise in the informal labor earnings; or what are the respective impacts of a job creation policy and of a wage policy in a developing country urban labor market?[4] How much a food price subsidy operated through a marketing board will benefit to small farmers and how much will it benefit to the urban poor through a relative food price reduction? How much of the workforce a workfare program will attract and what will be the consequence on the production and prices of other sectors and hence on the overall income distribution? The empirical illustrations chosen in this paper try to address this type of questions.

3   A micro-simulation module

3.1   The main labor income model

The labor income model draws from the spirit of Roy's model (1951), as formalized by Heckman and Sedlacek (1985), which is pointed out by Neal and Rosen (1998) as the most convincing model for explaining labor income distribution.[5]

At each period, each individual pertain to a given family or household whose composition and location is exogenously determined.

If he/she is more than fifteen, he/she faces three kinds of work opportunities: (i) family work, (ii) self-employed work, (ii) wage work.

Family work includes all kinds of activities under the supervision of the household head or the spouse, that is family help in agricultural or informal activities, but also domestic work, non-market labor and various forms of declared "inactivity". In farming households, the farm head is considered as a

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[4] Cogneau (1999 and 2001) shows that a micro-macro model of the distribution of income is able to simulate the historical decrease in poverty observed in the city of Antananarivo during the 1995-99 period, thanks to job creation and minimum wage increases in the formal sector.

[5] See also Magnac (1991) and Cogneau (2001) in the case of urban labor markets in Colombia and Madagascar respectively

self-employed worker bound to the available land or cattle whose farming occupation never changes (although he may work part-time in another occupation, see extension below). Self-employed work corresponds to informal independent activities. Wage work includes all other kinds of workers, mainly civil servants and large firm workers.

3.1.1   Potential individual earnings outside of the household

To self-employed work ($j = 1$) and wage-work ($j = 2$) we associate two potential earnings functions. Individual potential earnings w_{ji} are seen as the product of a "task price" π_j ($j = 1, 2$) with a fixed idiosyncratic amount of efficient labor which depends on observable characteristics X_i (education, labor market experience and geographical dummies) and on unobservable skills t_{ji}:

$$\ln w_{1i} \quad = \quad \ln \pi_1 + X_i \beta_1 + t_{1i} \tag{1}$$

$$\ln w_{2i} \quad = \quad \ln \pi_2 + X_i \beta_2 + t_{2i} \tag{2}$$

Returns to characteristics β_j are differentiated by sector and by sex.

3.1.2   Reservation wage in non-farm households

To family work we associate an unobserved individual value that also depends on household characteristics, and on other members' labor decisions, gathered in a Z_0 vector:

$$\ln \widetilde{w}_{0i} = (X_{0i}, Z_{0h}) \beta_0 + t_{0i} \tag{3}$$

For non-agricultural households members, $\widetilde{w}_0$ may be seen as a pure reservation wage. X_0 contains the same variables as X (education, labor market experience and geographical dummies), plus a variable indicating the link to the household head (head/spouse/child/other), and the father's occupation for the head. Z_0 includes the demographic structure of the household. In order to account for collective hierarchical decisions and for an income effect on participation to the labor market, it also includes, in the case of non-head members, the head's occupational choices and earnings, and, in the case of non-spouse secondary members, the spouse occupational choice and earnings. Finally, it includes the household's non-labor income.

3.1.3 Farm income and reservation wage in farm households

To farming households we associate a reduced farm profit function derived from a Cobb-Douglas technology with homogenous labor:

$$\ln \Pi_{0h} = \ln p_0 + \alpha \ln L_h + Z_h \theta + u_{0h} \qquad (4)$$

We assume that the farm head always work on the farm. As a result, only non head members may choose whether to participate in farm work. Moreover, $\widetilde{w}_0$ is assumed to depend on the individual's contribution to farm profits. We evaluate this contribution while holding fixed other members decisions and the farm global factor productivity u_0:

$$\ln \Delta \Pi_{0i} = \ln p_0 + \ln \left(L_{h+i}^{\alpha} - L_{h-i}^{\alpha} \right) + Z_h \theta + u_{0h} \qquad (5)$$

where $L_{h+i} = L_h, L_{h-i} = L_h - 1$ if i is actually working on the farm in h, and $L_{h+i} = L_h + 1, L_{h-i} = L_h$ alternatively.

Here again the labor decision model is hierarchical between the household head and non-head members, and simultaneous among non-head members: in making his/her decision, each non head member does not take into account the consequences of it on other secondary members. In the case of agricultural households, we then write the family work value as follows:

$$\ln \widetilde{w}_{0i} = (X_{0i}, Z_{0h}) \beta_0 + \gamma . \ln \Delta \Pi_{0i} + t_{0i} \qquad (6)$$

where γ stands for the (non-unitary) elasticity of the value of family work in agricultural households to the price of agricultural products. In this case, X_0 includes the same variables as X (education, labor market experience and geographical dummies), plus a variable indicating the link to the household head (spouse/child/other), while Z_0 includes the household's demographic structure, non-labor income, and, should this happen, the (part time) occupation of the farm head .

3.1.4 Occupational choice

Finally, comparing the respective values attributed to the three labor opportunities, workers allocate their labor force according to their individual comparative

advantage:[6]

$$i \text{ chooses family work iff } \widetilde{w}_{0i} > w_{1i} \text{ and } \widetilde{w}_{0i} > w_{2i}$$

$$i \text{ chooses self-employment iff } w_{1i} > \widetilde{w}_{0i} \text{ and } w_{1i} > w_{2i} \quad (7)$$

$$i \text{ chooses wage-work iff } w_{2i} > \widetilde{w}_{0i} \text{ and } w_{2i} > w_{1i}$$

3.1.5 Labor market

These selection rules complete the theoretical occupational choice / labor income model on the supply side. For each segment of the labor market, one may define the set of individuals who supply labor on this segment:

$$S_j = \{i \ / \ w_{ji} = \max(\widetilde{w}_{0i}, w_{1i}, w_{2i})\} \quad (8)$$

Theoretically speaking, if one wants to keep in line with the Mincerian equations (1) and (2), labor supply in the wage-sector and in the self employment sector should be expressed in efficiency units of labor, that is:

$$L_1^s = \sum_{i \in S_1} \frac{w_{1i}}{\pi_1} \text{ and } L_2^s = \sum_{i \in S_2} \frac{w_{2i}}{\pi_2} \quad (9)$$

In the family work sector or in agriculture, since labor is not differentiated, the number of workers equals the quantity of labor.

$$L_0^s = \sum 1 \{i \in S_0\} = Card\left(S_0\right) \quad (10)$$

In the case of the family-work/agriculture sector and in the case of the self-employment sector, there is no labor market. Households or individuals either consume their own production or sell it on goods markets. Prices p_0 and π_1 are then determined on the goods market equilibrium.

In the wage-work/formal labor market, one has to add aggregate demand for labor functions in order to fully describe the labor market in the competitive case:

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[6] We introduce here the supplementary assumption that individuals compare self-employment and wage-work opportunities only in terms of earnings. In other words, these two work opportunities do not bring differential non-monetary benefits. This assumption is relaxed in the segmented model presented thereafter, which is the one that is empirically implemented.

$$L_2^d = L_2(\underline{\pi_2/\overline{q}_2})Q_2 \tag{11}$$

where $\overline{q}_2$ stands for the price of other inputs and where Q_2 is aggregate demand for good 2 (or production in sector 2).[7]

3.1.6 A pluri-activity extension[8]

We wish to allow individuals to pursue outside part-time activities when they work for the family. We first have to introduce a "part-time" variable in the wages and benefits equations to take into account the variability of hours worked:

$$\ln w_{1i} = \ln \pi_1 + X_{1i}\beta_1 + \delta_1.T_i + t_{1i} \tag{12}$$

$$\ln w_{2i} = \ln \pi_2 + X_{2i}\beta_2 + \delta_2.T_i + t_{2i} \tag{13}$$

with $\delta_1 < 0$, and $\delta_2 < 0$. We may then redefine "full time" incomes:

$$\ln \widehat{w}_{1i} = \ln w_{1i} - \delta_1.T_i$$

$$\ln \widehat{w}_{2i} = \ln w_{2i} - \delta_2.T_i$$

We finally simply assume that when reservation value is close enough to either "full-time" wage or self-employment benefits, individuals choose to work (simultaneously or successively) inside and outside the family. The listing of selection rules then becomes:

i chooses full time family work iff $\widetilde{w}_{0i} > (1+a).\widehat{w}_{1i}$ and $\widetilde{w}_{0i} > (1+a).\widehat{w}_{2i}$

i chooses family work and self-employment iff $(1+a).\widehat{w}_{1i} > \widetilde{w}_{0i} > (1-a).\widehat{w}_{1i}$ and $\widehat{w}_{1i} > \widehat{w}_{2i}$

i chooses family work and wage-work iff $(1+a).\widehat{w}_{1i} > \widetilde{w}_{0i} > (1-a).\widehat{w}_{1i}$ and $\widehat{w}_{2i} > \widehat{w}_{1i}$

i chooses full time self-employment iff $(1-a).\widehat{w}_{1i} > \widetilde{w}_{0i}$ and $\widehat{w}_{1i} > \widehat{w}_{2i}$

i chooses full time wage-work iff $(1-a).\widehat{w}_{2i} > \widetilde{w}_{0i}$ and $\widehat{w}_{2i} > \widehat{w}_{1i}$

The workfare program that is simulated thereafter introduces a new kind of

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[7] This demand for labor function could only be estimated using a time series of cross-sections, like in Heckman and Sedlacek (1985). In the empirical implementation, we shall however keep the total formal employment fixed as a matter of simplicity, even though it is at the expense of theoretical consistency.

[8] We thank François Bourguignon for a fruitful discussion about this extension.

part-time job offer which is paid at a rate w_3. In this case, once the former selection rule has been run, we add the following rules:

if i had chosen full-time family work i takes the workfare offer iff $2 \times w_3 > (1-a).\widetilde{w}_{0i}$

if i had chosen self-employment i takes the workfare offer iff $w_3 + w_{1i} > \widehat{w}_{1i}$

if i had chosen wage-work i takes the workfare offer iff $w_3 + w_{2i} > \widehat{w}_{2i}$

3.1.7 A segmented labor market extension

Suppose now that the labor market is segmented. This means that the selection conditions (7) do not hold in many observed cases: some individuals would prefer to work in a given segment but could not find any available job opportunity. In practice, we restrict the rationing of jobs to the wage-sector. Then, without loss of generality,[9] we may introduce a segmentation variable:

$$\ln \widetilde{w}_{2i} = \ln \widetilde{\pi}_2 + X_{2i}\widetilde{\beta}_2 + \eta_{2i} \tag{14}$$

And modify the selection rules as follows:

$$i \text{ is observed in family work iff } \widetilde{w}_{0i} > w_{1i} \text{ and } \widetilde{w}_{0i} > \frac{w_{2i}}{\widetilde{w}_{2i}}$$

$$i \text{ is observed in self-employment iff } w_{1i} > \widetilde{w}_{0i} \text{ and } w_{1i} > \frac{w_{2i}}{\widetilde{w}_{2i}} \tag{15}$$

$$i \text{ is observed in wage-work iff } \frac{w_{2i}}{\widetilde{w}_{2i}} > \widetilde{w}_{0i} \text{ and } \frac{w_{2i}}{\widetilde{w}_{2i}} > w_{1i}$$

The segmented labor market extension may be combined with the part-time extension (and actually is, in the empirical implementation).

The occupational choice / labor income may then be estimated by maximum likelihood like before. The segmented model contains the previous competitive model as a particular constrained case (Magnac, 1991).

Since the segmented model has more degrees of freedom than the competitive model, more parameters have to be calibrated.

With π_2 given exogenously by wage setting rules (minimum wage moves, price indexation, and Philips curve for instance), a decrease (resp. an increase)

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[9]The reservation value $\widetilde{w}_0$ then includes the cost of entry into the informal activities. See later about the simulation of the access to workfare programs job opportunities.

of $\widetilde{\pi}_2$ may then simulate hirings (resp. lay-offs) in the wage sector.

3.2   Results of estimation and of calibration

The micro-simulation module is based on a household sample provided by the EPM (Enquête Permanente auprès des Ménages) survey for the year 1993/94, and simulates income generation mechanisms for approximately 4,500 households. We use both the pluri-activity and the segmented labor market extensions for the estimated micro-simulation model. Econometric and calibration details are provided in the Appendix.[10]

Table 1 shows the agricultural profits function, associated to the farm heads in agricultural households.

[Insert Table 1 here]

The number of family workers comes out with a coefficient that is consistent with usual orders of magnitude: a doubling of the work force leads to an around 20% increase in agricultural profits. The amount of arable land and of capital also come out with a decreasing marginal productivity and a similar impact on profits (a doubling making a 20% increase again for land, and a 15% increase for capital). Age and education of the farm head also come out as significant.

Table 2 shows the partly estimated and partly calibrated $\left(\beta_1, \beta_2, \widetilde{\beta}_2, \beta_0\right)$ sets of parameters for the four categories of the labor supply model, and the calibrated variance-covariance matrix of $\left(t_1, t_2, \widetilde{t}_2, t_0\right)$.

[Insert Table 2 here]

For men, the returns to education are rather close in the informal and wage-sectors. For women, they are higher than for men and higher in the formal sector. Returns to labor market experience (or to job tenure) are higher in the wage-sector for both sexes and similar for men and women. Informal benefits are 25% lower in the rural areas, and 25% lower for women in the Antananarivo region (*faritany*) than in other *faritany*. Costs of entry in the wage-sector vary negatively with education and experience, are, not surprisingly, 20 to 25% higher in the rural areas and higher for women in the Antanarivo *faritany*. A household head working in the wage-sector leads other members of the household to do the same, which again is reflected in a lower cost of entry. The reservation wage (value of inactivity) in non-farm households is positively related to education, the effect of which lies in-between the returns to education in the informal

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[10]Detailed results from econometric estimation before calibration are available from the authors upon request.

sector and the "discounted" returns (monetary returns less cost of entry) in the wage-sector. Participation to the labor market is higher in both the rural area and the Antananarivo *faritany* (lower reservation wage). Almost by definition, heads are less often inactive and non-labor income increases the propensity to stay inactive. The demographic structure of the household and the hierarchical decisions of other members play only a minor role in the decision to participate. In farm households, educated people strictly prefer to work outside the farm, whether in informal or wage jobs. When the farm head already works part of his time in non-agricultural activities, other members tend to do the same. Activity is more diversified out of agriculture in the Antananarivo *faritany*. The estimate of the effect of the marginal productivity of labor has a negative effect on the farm-work value. This effect uncovers the fact that in resource-endowed agricultural households, with more land or more capital and hence a higher labor productivity, agents are more prone (have more opportunities) to diversify their activities. It should however be stressed that this diversification of activity is not frequent among agricultural households. Only 13% of the total agricultural households labor force works outside the farm at least part-time, the bulk of which (10%) working in part-time informal activities. Diversification is higher for household heads (20% work outside of the farm) than for other members (10% only work outside). This absence of real opportunities for diversification of activities among agricultural households, especially the poorest, is one of the most important features of the distribution of income in Madagascar, and strongly constrains the short-run impact of agricultural price and workfare policies that are examined in the remainder of this paper. This feature also explains why we could not obtain an acceptable estimate for the elasticity (γ, see above) of the farm-work choice to the agricultural price. In the remainder, we calibrate this elasticity to one, like in other sectors.

4 Macro-micro model characteristics and simulation

Once calibration has been achieved, the segmented occupational choice and labor income model is ready for simulation. With the price of the formal good p_2 taken as the numeraire, the relative prices, p_0/p_2 and π_1/p_2, and the cost of entry index for the wage-sector, $\widetilde{\pi}_2/p_2$, are determined by the general equilibrium on goods and labor markets, confronting the aggregate units of labor supplied by

individuals to the aggregate demand for each task derived from consumption choices and production processes, as explained hereafter.

4.1 The micro part

Starting from the micro-model of occupational choice and labor income presented in section 3.1, we detail how a simple and consistent general equilibrium model may be written, drawing from Cogneau (2001) and Cogneau and Robilliard (2001).

At the micro-level and on the supply side, complementary intermediate inputs are determined from idiosyncratic technical coefficients and added to real benefits to obtain the agricultural production of each household Q_{0h}. The resulting agricultural production is then split between the production sold in export markets and the production sold in domestic markets (or consumed inside the household), through a standard constant (and homogenous) elasticity of transformation function, with an idiosyncratic export orientation parameter calibrated from micro-data on agricultural production. This makes the composite agricultural producer price idiosyncratic (p_{0h}), depending on each household's specific technical coefficients and export orientation, on the exogenous agricultural export price $\overline{p}_0^e$ and on the domestic price p_0^d and on other input prices.

Self-employed informal production and producer price p_1 are computed the same way, starting from w_{1i}/π_1 and adding intermediary inputs. Informal production consists in non-tradable trade activities and services that are sold to households.

In formal production, capital use is complementary to the quantity of efficient labor $L_2^s = \sum_{i \in S_2} \frac{w_{2i}}{\pi_2}$. A fraction of capital income is distributed to resident households using the survey information on declared dividends: households declaring dividends are awarded a fixed share of total dividends from formal capital.

Household income is then equal to the sum of agricultural benefits (in farm households), self-employment benefits and wage earnings, non-labor income stemming from capital income, and transfers.

In the demand side, consumption choices are assumed separable from labor supply decisions. Idiosyncratic saving rates and idiosyncratic parameters of preference of an expenditure system with three goods (agricultural, informal, formal) are calibrated from micro-data on household expenditures. Consumption is then split between imported and domestically produced goods by

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calibrating a standard aggregate Armington CES function.[11]

Other components of demand for agricultural and informal products coming from the macro-part of the model add up with households' consumption demand. Once all these elements are gathered, a general equilibrium determination of prices p_0^d/p_2 and p_1/p_2 is completely defined. In the wage-sector, π_2/p_2 is fixed or exogenously determined, and $\widetilde{\pi}_2/p_2$ varies to adjust the supply of wage-labor to the exogenously determined (in the macro-part) demand for wage-labor.[12] The macro-part of the model is the part that determines all other supply and demand components other than (i) the supply for labor, agricultural goods and informal goods, and (ii) the demand for consumption from households.

4.2 The macro part

The macro-part of the model corresponds to a CGE framework. Markets for goods, factors, and foreign exchange are assumed to respond to changing demand and supply conditions, which in turn are affected by government policies, the external environment, and other exogenous influences. The model is Walrasian in that it determines only relative prices, and other endogenous real variables in the economy. Sectoral product prices, factor prices, and the real exchange rate are defined relatively to the formal price of goods p_2, which serves as the numeraire. The exchange rate represents the relative price of tradable goods vis-a-vis non traded goods (in units of domestic currency per unit of foreign currency).

As already said, domestic prices of agricultural (p_0^d) and informal (p_1^d) commodities are flexible, varying to clear markets in a competitive setting where individual suppliers and demanders are price-takers. Then, by Walras' law, the equilibrium of the formal goods market is automatically achieved. Following Armington, the model assumes imperfect substitutability, for the agricultural and the formal goods, between the domestic commodity and imports. What is demanded is a composite good, which is a CES aggregation of imports and domestically produced goods. For export commodities, the allocation of domestic output between exports and domestic sales is determined on the assumption that domestic producers maximize profits subject to imperfect transformability

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[11] In contrast with exportable agricultural production, survey information does not give this split at the household level, which unfortunately precludes the calibration of idiosyncratic import shares. For simulations on the distributional impact of trade or exchange rate policies, the impact of this lack of information should be studied in more detail.

[12] In all simulation exercises presented thereafter, total formal employment is fixed and $\widetilde{\pi}_2/p_2$ only varies to compensate for resignations (former wage-workers choosing other occupations).

between these two alternatives (at the household level, see micro-part above). The composite production good is a CET (constant-elasticity-of-transformation) aggregation of sectoral exports and domestically consumed products.

Equilibrium is defined by a set of constraints that need to be satisfied by the economic system but are not considered directly in the decisions of micro agents. Aside from the supply-demand balances in product and factor markets, three macroeconomic balances are specified in our model: (i) the fiscal balance, with government savings equal to the difference between government revenue and spending; (ii) the savings-investment balance; and (iii) the external trade balance (in goods and non-factor services), which implicitly equates the supply and demand for foreign exchange - flows, not stocks since the model has no assets or asset markets. The chosen macro closures are: (i) endogenous government savings; (ii) endogenous foreign savings; (iii) savings-driven investment. As a result, a decrease (resp. increase) in government income translates into a decrease (resp. increase) in government savings, which in turn leads to a decrease (resp. increase) in total investment (investment is driven by savings in all experiments).

4.3   Scenarios and simulations

The model represents the behavior of a sample of 4,500 households, representative of the Malagasy population in 1993/94, corresponding to a sample of 12,800 individuals aged 15 years and older, in an economy with three sectors (agricultural, formal and informal) and three goods. In order to achieve a certain consistency with previous CGE exercises, household statistical weights were recomputed to comply with the income structure of a Social Accounting Matrix (SAM) for the year 1995. Order aggregates were taken from the same source (see Table 3). The reweighting procedure relies on a cross-entropy estimation (Robilliard and Robinson, 2003).

[Insert Table 3 here]

We present exploratory simulations with the objective of improving the incomes of the poor.[13] In this paper we explore three alternative simulations to achieve this objective: a direct output subsidy on agricultural prices, a workfare program, and an untargeted transfer program. These policies are compared both in terms of their macroeconomic impact and in terms of their impact on

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[13]Previously we showed that neither a 20% devaluation, nor a four fold increase in agricultural tariffs could achieve a significant reduction in poverty and inequality indicators (Cogneau and Robilliard, 2003).

poverty and income distribution. All experiments are designed so that their *ex post* cost are equal (at formal prices).

The first simulation looks at the impact of a direct subsidy on agricultural production prices. The subsidy is set at 10% and is introduced as a negative tax on producer prices, thus creating a 10% gap between producer and consumer prices. Such a policy could be achieved by the intervention of a marketing board on agricultural goods markets, which would buy at high prices to producer and sell 10% lower to consumers.

In the second experiment, we simulate the implementation of a workfare scheme. Workfare programs, whereby participants must work to obtain benefits, have been widely used for fighting poverty, usually in times of crises due to macroeconomic or agro-climatic shocks (Ravallion, 1999). The workfare scheme we study is assumed to be highly labor intensive. The government buys at a fixed rate the services of labor in order to build or to rehabilitate roads and other infrastructures.[14] Given the occupational choice model described in the previous section, the workfare scheme designed in our experiment can be summarized by two characteristics: the workfare wage level and the corresponding work load. We choose to design a part time workfare scheme whereby participating individuals are allowed to remain working in part in their original occupation. Whether individuals choose to participate in the workfare program depends on the level of the workfare wage and on their formal, informal, and reservation wages (see selection rule at the end of section 3.1.6). As mentioned earlier, the level of the workfare wage is fixed *ex ante* so that the *ex post* cost of the scheme matches the cost of the agricultural price subsidy. The resulting yearly wage is 257,625 Malagasy francs, which translates into 515,250 Malagasy francs in full time equivalent. Table 4 shows official minimum wages in different sectors from 1990 to 1996. Our database has been scaled to match structural and demographic features of the year 1995. Consequently, the meaningful figures are in the 1995 column. They show that our simulation workfare wage is relatively close to official minimum wages and represents 87% of the minimum wage in non agricultural sectors. Given this workfare wage level, a total of 908,470 workers - corresponding to 12.7% of the labor force – choose to participate in the workfare scheme.

[Insert Table 4 here]

The third and last simulation is a uniform untargeted per capita transfer

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[14] For a historical record of this kind of programs in Madagascar, see Razafindrakoto and Roubaud (1996).

program. Again, the amount paid is computed so that the aggregate *ex post* cost of the program matches the cost of the previous programs. The resulting amount is 17,887 Malagasy francs per capita which adds up with household non-labor income (and has the corresponding micro-economic effects of an increase in the value of inactivity in non-farm households).

All three programs share a high budgetary cost equivalent to almost 5% of GDP. They should therefore have large macro-economic impacts as well as the intended distributional micro-impacts.

4.3.1 Targeting issues

A central issue related to the poverty and income distribution impacts of all three simulations is the targeting properties of each scheme. Obviously, the uniform untargeted transfer per capita is distributed evenly across quintiles of income, but this not the case for the agricultural subsidy and workfare simulations. In order to explore this issue, Table 5 presents the distribution of individuals in beneficiary households across quintiles of per capita income for these two simulations.

[Insert Table 5 here]

Not surprisingly, the agricultural subsidy appears to have good targeting properties in terms of the distribution of beneficiary households. But this result does not hold when one considers the distribution of the program cost: while 83.9% of individuals in the first quintile are in a household which benefits from the agricultural subsidy, only 7.2% of the total program cost accrues to these, and the largest share (37.7%) accrues to the last quintile. This result is related to the fact that the price subsidy is proportional to agricultural output and thus, by construction, regressive in terms of program cost allocation.

When compared to the agricultural subsidy, the workfare scheme appears to be less progressive in terms of the distribution of individuals in beneficiary households, since they are distributed evenly across quintiles. But since the benefits accruing to households are not proportional to their incomes, the distribution of the program cost is actually less regressive than in the agricultural subsidy experiment. The targeting performance of the workfare scheme is nevertheless disappointing as it fails to reach a large number of workers in poor households. This is explained by the fact that the reservation value ($\widetilde{w}_0$) estimated and calibrated from actual data not only reflects preferences for family work but also includes a cost of entry component in outside informal activities.

Estimated parameters indicate for instance that activity is more diversified out of agriculture in households living in the Antananarivo *faritany* or in urban areas, and also more in land-rich households. As a result, individuals from poor agricultural households dwelling in remote areas are given large reservation values which reflect large costs of access to all markets, including the labor market. This cost of access prevents some agricultural workers from seizing the workfare job opportunities. In other words, since the workfare scheme fails to take these costs into account, it is implicitly targeted towards urban areas. As a result, it has a large impact on urban poverty (see next section).

4.3.2 Results

Table 6 shows various price and macro aggregate changes as a result of the three programs. Macro aggregate changes are presented in real terms.

[Insert Table 6 here]

One common point across all three experiments is the increase in the agricultural relative price. In particular, even the subsidy simulation leads to a 3.1% increase in the consumers' agricultural price (relative to the consumer price index). This result stems from large income effects which raise the demand for agricultural products. The three transfer schemes in fact all reallocate demand out of formal goods towards agricultural goods. In all scenarios, the budgetary cost is financed by a cut in investment demand, 87% of which is demand for formal good while it is zero for the agricultural good. Given that all three simulations benefit households, whose average budget share are 32%, and 57% for the agricultural and formal goods respectively, the ex ante net demands are positive for the agricultural good in all three experiments. The workfare program has the strongest impact of all on the agricultural prices (6.4% increase against 3.1 and 4.5% in the other simulations) as it also leads to a decrease in the labor available for agriculture (see table 7).

Results also show that the macroeconomic impact of all three policies is dramatic in terms of investment. This result stems from the fact that the subsidy simulation has a huge budgetary cost (4.9% of GDP) which translates into an income effect through the closures of both the fiscal balance and the savings-investment balance.[15] The GDP impact of the workfare scheme is big

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[15] While this cut in investment appears somewhat unrealistic and rather unsustainable in the long run, these closures were chosen because they appeared to be the most neutral in terms of their ex ante income distribution impact. Given the budgetary cost of the policies simulated here, any closure based on fixed government savings and investment would entail

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(4.5% in real terms). The workfare program indeed corresponds to a new highly labor-intensive production of non-tradable goods (construction), which we have assumed to be entirely consumed by the government. Both the agricultural subsidy policy and the uniform transfer simulation, have small and negative GDP impacts. In the case of the uniform transfer, households are given money but they do not have to work in exchange. As mentioned earlier, all experiments were designed in order to equalize their ex post cost. As a result, all three simulations have the same impact on private consumption.

The employment impact is presented in Table 7. The top part of the table shows numbers of workers in terms of their occupational choices while the lower part presents aggregate values of the sectoral allocation of labor. Results show that the subsidy simulation leads to a mild increase in total employment. In terms of sectoral employment, labor appears to be reallocated from the informal (-6.3%) to the agricultural sector (+1.4%). As expected, the workfare scheme has a strong impact on urban under-employment with the number of inactive workers decreasing by more than 15%. It also leads to important reallocations of labor out of agricultural (-3.9%) and informal sectors (-13.3%) into workfare. As a result, the total active population increases by 3.0%. Given its design, the workfare program obviously drives transitions out of full time work and into part time work. The uniform transfer scheme has only a mild impact on the structure of employment.

[Insert Table 7 here]

Table 8 shows results in terms of poverty and income distribution for all households, and in both urban and rural areas. Changes in three indicators of inequality are presented: the Gini index as well as two entropy indices.

[Insert Table 8 here]

All indicators show that the agricultural price subsidy simulation leads to an improvement in the distribution of income at the national level. A closer look into each area suggests that the decrease in overall inequality is mainly driven by the convergence in urban and rural per capita incomes. The introduction of a subsidy on agricultural production leaves the inequality within the rural area almost unchanged (the Gini index slightly increases by 0.8%), as well as within the urban area. As mentioned above, this absence of change in rural inequality stems from the targeting property of the subsidy whereby agricultural

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endogenizing either tax or saving rates, resulting in a higher *ex ante* impact on households' income distribution. Another possibility would be to finance these policies using international aid.

households with higher incomes benefit more (in absolute terms) than small agricultural households. As a result, changes in poverty indicators are mainly driven by changes in per capita income.

In terms of poverty reduction, the workfare scheme has a stronger impact than the subsidy program: the poverty headcount is reduced by 6.5% while the subsidy program reduces it by 5.6%. It also has a stronger effect on income distribution with a 3.7% decrease in the Gini Index (compared to a 1.6% decrease with the subsidy program) and with a 17.8% decrease in the poverty severity indicator (compared to a 11.3% decrease with the subsidy program). This strong decrease in inequality is explained both by the convergence of average per capita incomes between urban and rural areas and by the decrease of inequality within both areas. The workfare scheme has by far the strongest impact on inequality and poverty in urban areas. Thanks to the workfare scheme, poverty incidence in urban areas decreases by more than 6%, while it remains unchanged in the case of the agricultural subsidy and is only reduced by 3.7% with the uniform transfer. Although the GDP impact of the untargeted transfer program is mild, both the poverty and income distribution impacts are significant: the program reduces the poverty headcount by 6.4% and the Gini Index by 5.1% and its impact on poverty severity is the highest among the three experiments. These results again show that the workfare scheme does not achieve much better targeting than the untargeted transfer program, and does not satisfactorily reach the poorest of the poor (see above).

In sum, the two targeted programs which have been examined here have indeed large impacts on monetary poverty alleviation, even once general equilibrium effects are taken into account. Given the large budgetary amounts which are transferred to households, it does not come as a surprise. Apart from scaling and financing issues, the simulations however reveal that there is room for improvements in the quality of targeting. Indeed, a general subsidy to agricultural producers does not appear to be an adequate scheme for reaching the poorest farmers as it fails in doing better than an untargeted transfer or even a workfare scheme, even in rural areas. A general workfare program offering part-time job opportunities paid around the minimum wage also reaches somewhat disappointing results, especially in rural areas. Costs of access to the labor market prevent individuals living in remote areas and/or in poor autarkic agricultural households from seizing the workfare opportunities. The workfare scheme performance is relatively good in urban areas where it draws a lot of people out of inactivity or out of informal under-employment, but falls short in rural areas

where it is outperformed by the untargeted transfer.

All three schemes have been designed in order to have the same ex post budgetary cost in terms of the total amount of transfer received by households. It should however be kept in mind that they all have specific implementation costs that should be taken into account when comparing their relative efficiency. For instance, the implementation of an agricultural subsidy would call for the reconstruction of a marketing board which raises many institutional issues and might imply high administrative costs. Likewise, the implementation of a workfare scheme has other costs than pure wage costs, however labor intensive it is: organizational and administrative costs, advertisement costs and input costs (see Ravallion, 1999). In this case however, we have seen that part of these additional costs are internalized by individuals who give up the workfare job offers when they are too far from them. Finally, even the untargeted transfers scheme would entail an additional cost of bringing the cash to the households, even in very remote areas.

5   Conclusion

This chapter has presented the basic motivations for the construction of an integrated static micro-macro model for a low-income economy. It has outlined the main features of such a model in terms of micro-econometric specifications and macro-closures. Finally it has explored the use of this kind of model for the simulation of targeted transfer schemes dedicated to poverty alleviation. These kind of transfer schemes might be implemented either following a macro-economic shock or as permanent safety nets. For illustrative purposes, three large scale transfer schemes have been simulated and compared: (i) a price subsidy to agricultural producers, (ii) a general workfare program proposing part-time job opportunities paid around the minimum wage and (iii) a uniform unconditional and untargeted transfer provided to each individual regardless of her age and job situation. The micro-macro model gives interesting results on the counter-factual impacts of each program on the overall distribution of income, taking into account both micro-economic targeting issues and macro-economic general equilibrium effects. Considerations about the financing of the programs and about their technical implementation costs could supplement the simulations in order to build realistic, efficient and sustainable poverty alleviation schemes.

To conclude, it may be useful to review briefly the comparative advantages

and disadvantages of the integrated micro-macro approach. In the first section of this chapter, we advocated the use of integrated micro-macro models on the basis of three main arguments. We first argued that the approach was well suited to incorporating current advances in the micro-econometrics of households behaviors and markets structure in developing countries. The illustrations presented show the usefulness of a thorough modeling of labor supply behavior in the context of highly segmented markets. However much remains to be done to improve the modeling of agricultural households behavior whose collective production in family farms does not fit as well our "individualistic" framework (see Cogneau and Robilliard, 2001, for an alternative). Moreover, it should be emphasized that structural estimation based on cross-sectional data may either overstate or understate the true reaction of poor households with respect to labor incentives. It would greatly benefit from the availability of dynamic panel data and/or from experimental knowledge on poor households' responses to programs (Duflo, 2003). Second, we argued that integrated tools might be desired for the sake of micro-macro consistency, as far as "aggregation issues" and "interlinked welfare issues" are concerned. It should however be stressed that such a consistency in the modeling of household welfare (labor supply, earnings, consumption) is obtained at the expense of sectoral disaggregation and of dynamic considerations. Depending on the policy problem at stake, trade-offs must be solved inside a triangle made of "household heterogeneity", "sectoral detail" and "intertemporal issues". We therefore argued that the static integrated tool might be better suited for analyzing the distributional aspects of general development strategies on the one hand, and for evaluating the impact of short to medium term targeted programs with macro-impacts. Through the applications we implemented, we hope to have shown that integrated micro-macro modeling could be useful in the design of these latter programs. The design of other structural policies, like minimum wage increases or foreign-investment led jobs creation, could also benefit from this type of approach.

Appendix. Econometric estimation and calibration for simulation

We present here the econometric estimation and calibration of the segmented model for occupational choices and labor income.

For econometric identification, in line with our 'hierarchical-simultaneous' model of labor decisions within the household, we must assume independence for the $\left(t_1, t_2, \widetilde{t}_2, t_0\right)$, between individuals even among members of the same household. In the case of farm households, we also assume that u_0, the idiosyncratic total factor productivity of the household, is independent from $\left(t_1, t_2, \widetilde{t}_2, t_0\right)$ for all household members[16]. We assume joint normality for the $\left(t_1, t_2, \widetilde{t}_2, t_0\right)$ vector:

$$\left(t_1, t_2, \widetilde{t}_2, t_0\right) \rightsquigarrow N\left(0, \Sigma\right) \tag{16}$$

Under these assumptions, we may adopt the following estimation strategy:

(i) for non-agricultural households, we estimate by maximum likelihood the occupational choice / labor income model represented by the (1)-(3) and equations and the series of selection conditions (15) ; we obtain a bivariate tobit, like in Magnac (1991). We make separate estimations for each sex.

(ii) for agricultural households we follow a limited information approach: in a first step, we estimate the reduced profit function (4) then derive an estimate for the individual potential contribution to farm production (5); in a second step, estimate the reservation wage equation (3) including this latter variable as in (6), and retaining the wage functions estimated for non-agricultural households[17]. Again, we make separate estimations for each sex, excluding the farm heads whose occupational choice is not modelled.

Maximum likelihood estimation allows for the identification of some functions of the coefficients of wages, self-employment benefits and family work value equations. Likewise, only some elements of the underlying covariance structure between unobservables can be identified, because of the segmentation hypothesis and because observed wages are measured with errors and include a transient component ε_j $(j = 1, 2)$ which does not enter in labor supply decisions of (risk-neutral) individuals and which may also include the variance of hours worked.

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[16]This latter assumption should allow for a direct identification of the $\Delta\Pi_0$ effect in $\widetilde{w}_0$, through the effect of u_{0h}. However, as $\Delta\Pi_0$ is presumably affected by large measurement errors, we exclude 'available land' from the variables in $\widetilde{w}_0$, taking it as an instrument for the identification of the effect of $\Delta\Pi_0$.

[17]This latter option is rather inocuous for potential earnings outside the farm, as only a very small number of individuals declare out-of-farm earnings in agricultural households.

We then assume for estimation:

$$\left(t_1, t_2, \widetilde{t}_2, t_0, \varepsilon_1, \varepsilon_2\right) \rightsquigarrow N\left(0, \Sigma^*\right) \qquad (17)$$

Once this posed, nine variance or correlation parameters may be identified: $\rho = corr\left(t_1 - t_0, t_2 - \widetilde{t}_2 - t_0\right)$, $\sigma_j = \sqrt{var\left(t_j + \varepsilon_j\right)}$, $k = \frac{\sqrt{var\left(t_1 - \widetilde{t}_0\right)}}{\sqrt{var\left(t_2 - \widetilde{t}_2 - \widetilde{t}_0\right)}}$, $\lambda_1 = corr(t_1 + \varepsilon_1, t_1 - t_0)$, $\lambda_2 = corr(t_2 + \varepsilon_2, t_2 - \widetilde{t}_2 - t_0)$, $\mu_j = corr(t_j + \varepsilon_j, t_2 - \widetilde{t}_2 - t_1)$ for $j = 1, 2$. While all the parameters of observed earnings are identified, only the contrasts $\frac{\beta_1 - \beta_0}{\sigma(t_1 - t_0)}$ and $\frac{\beta_2 - \widetilde{\beta}_2 - \beta_0}{\sigma(t_2 - \widetilde{t}_2 - t_0)}$ are identified. Finally, as only the reservation value function is distinct between members of agricultural households and members of non-agricultural households, two series of estimates are computed for $\frac{\beta_1 - \beta_0}{\sigma(t_1 - t_0)}, \frac{\beta_2 - \widetilde{\beta}_2 - \beta_0}{\sigma(t_2 - \widetilde{t}_2 - t_0)}, \rho, k, \lambda_j$, whereas only one series is computed for the parameters of informal benefits and wage-earnings $\mu_j, \beta_j, \sigma j$ and for part-time parameters δ_j and a (see above, the pluri-activity extension).

For simulation purposes, we need to recover the parameters β_0 and $\widetilde{\beta}_2$ for $\widetilde{w}_0$ and $\widetilde{w}_2$ respectively, and the whole covariance structure Σ^*. We therefore proceed to a calibration. In practice, we assume (i) that measurement errors are white noises (uncorrelated with others) and fix their variance, (ii) we fix the correlation (ρ_{12}) between t_1 and t_2 and (iii) we fix the standard error of $(t_2 - \widetilde{t}_2 - t_1)$. We then draw for each individual a whole set of unobservables $\left(t_1, t_2, \widetilde{t}_2, t_0, \varepsilon_1, \varepsilon_2\right)$, within the multidimensional normal distribution with the covariance structure Σ^* and constrain the drawings to respect the occupation selection rules. For instance, for an individual who is observed in the informal sector, we start from the observed $t_1 + \varepsilon_1$ and draw all other unobservable components conditionally on it, constraining the drawings to respect $w_1 > \widetilde{w}_0$ and $w_1 > w_2 / \widetilde{w}_2$. We finally obtain for each individual the set $(\widetilde{w}_0, w_1, w_2, \widetilde{w}_2)$ at base prices $(p_0, \pi_1, \pi_2, \widetilde{\pi}_2) = (1, 1, 1, 1)$.

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Table 1 : Agricultural profit function

Independent variables	Agricicultural profit (log)	
	Est.	s.e.
# workers (log)	+0.22**	0.04
Land (log)	+0.21**	0.01
Capital (log)	+0.15**	0.01
Farm Head female	-0.07	0.05
Farrm Head age	+0.002*	0.001
Farm Head Education	+0.29**	0.06
Rural Areas	-0.19**	0.06
Fianarantsoa faritany	-0.04	0.05
Toamasina faritany	-0.03	0.05
Mahajanga faritany	-0.09	0.06
Toliary faritany	-0.38**	0.06
Antsiranana faritany	-0.02	0.07
Intercept	+3.10**	0.11
σ		0.76**
N		2287
Adjusted R^2		0.35

Data Source: EPM 1993/94 survey. Field: All farming households. ** (resp. *): Significant at the 1% (resp. 10%) level.

Table 2: Occupational choice / labor income model parameters after micro-calibration

Men - Non Farm Households

Coefficients of observables

	β1	β2	~β2	β0
Number of years of education (/10)	0,9841	0,8995	-1,3384	0,9429
Number of years of experience (/10)	0,3232	0,5100	-0,7785	0,1533
Number of years of experience squared (/1000)	-0,3879	-0,6276	1,1335	0,0315
Region of Antananarivo (=1)	-0,0561	-0,0689	0,1520	-0,2380
Rural area (=1)	-0,2504	-0,0891	0,4053	-0,0039
Father in the informal sector (=1)	0,0	0,0	0,1901	-0,1696
Father in the formal sector (=1)	0,0	0,0	-0,0695	0,0485
Household head in the informal sector (=1)	0,0	0,0	0,4913	-0,0505
Household head in the formal sector (=1)	0,0	0,0	-0,4124	0,2920
Spouse in the informal sector (=1)	0,0	0,0	-0,2107	0,1436
Spouse in the formal sector (=1)	0,0	0,0	0,7386	-0,0473
Number of children aged 0 to 9 years old	0,0	0,0	0,0	-0,0641
Number of males aged 10 to 14 years old	0,0	0,0	0,0	-0,0160
Number of males aged 15 to 69 years old	0,0	0,0	0,0	0,0261
Number of females aged 10 to 14 years old	0,0	0,0	0,0	0,0150
Number of females aged 15 to 69 years old	0,0	0,0	0,0	-0,0134
Number of adults aged 70 years and older	0,0	0,0	0,0	0,1188
Household head (=1)	0,0	0,0	0,0	-0,7030
Spouse of the head (=1)	0,0	0,0	0,0	-0,5665
Child of the head (=1)	0,0	0,0	0,0	0,1395
Non labor income	0,0	0,0	0,0	0,6465
Household head wage income	0,0	0,0	0,0	0,7335
Spouse wage income	0,0	0,0	0,0	0,2203
Constant	3,8386	3,3470	1,6192	4,8406

Standard errors (diagonal) and correlation of unobservables

	t1	t2	~t2	t0
t1	0,9740	0,5000	-0,5020	0,8580
t2		0,5940	0,0180	0,5110
~t2			1,8330	-0,6220
t0				1,4780

Men - Farm Households

Coefficients of observables

	β1	β2	~β2	β0
Number of years of education (/10)	0,9841	0,8995	-1,8892	0,8106
Number of years of experience (/10)	0,3232	0,5100	-1,4856	-0,1862
Number of years of experience squared (/1000)	-0,3879	-0,6276	3,8351	0,6089
Region of Antananarivo (=1)	-0,0561	-0,0689	-0,5764	-0,8237
Rural area (=1)	-0,2504	-0,0891	0,8868	0,3592
Household head in the informal sector (=1)	0,0	0,0	6,6620	-0,6282
Household head in the formal sector (=1)	0,0	0,0	-1,5937	0,0513
Number of children aged 0 to 9 years old	0,0	0,0	0,0	-0,0611
Number of males aged 10 to 14 years old	0,0	0,0	0,0	0,0738
Number of males aged 15 to 69 years old	0,0	0,0	0,0	0,0598
Number of females aged 10 to 14 years old	0,0	0,0	0,0	0,0824
Number of females aged 15 to 69 years old	0,0	0,0	0,0	0,0252
Number of adults aged 70 years and older	0,0	0,0	0,0	0,1822
Spouse of the head (=1)	0,0	0,0	0,0	-0,1442
Child of the head (=1)	0,0	0,0	0,0	0,1180
Non labor income	0,0	0,0	0,0	-0,3589
Marginal productivity of agricultural labor	0,0	0,0	0,0	-0,1510
Constant	3,8386	3,3470	4,1720	6,1760

Standard errors (diagonal) and correlation of unobservables

	t1	t2	~t2	t0
t1	0,9760	0,3000	0,0280	0,8930
t2		0,5140	0,1040	0,5940
~t2			2,0450	-0,4120
t0				1,7070

Women - Non Farm Households

	β1	β2	~β2	β0
Number of years of education (/10)	1,0697	1,3439	-1,6047	0,8535
Number of years of experience (/10)	0,2387	0,5243	-0,4425	-0,1333
Number of years of experience squared (/1000)	-0,2571	-0,6476	0,7708	0,3569
Region of Antananarivo (=1)	-0,2530	0,0541	0,2790	-0,3937
Rural area (=1)	-0,2494	-0,0135	0,3500	-0,1241
Father in the informal sector (=1)	0,0	0,0	-0,2720	0,1344
Father in the formal sector (=1)	0,0	0,0	-0,2139	0,2915
Household head in the informal sector (=1)	0,0	0,0	0,3239	0,1247
Household head in the formal sector (=1)	0,0	0,0	-0,1145	0,2320
Spouse in the informal sector (=1)	0,0	0,0	-0,3565	0,2135
Spouse in the formal sector (=1)	0,0	0,0	-0,4257	0,1466
Number of children aged 0 to 9 years old	0,0	0,0	0,0	0,0038
Number of males aged 10 to 14 years old	0,0	0,0	0,0	-0,0675
Number of males aged 15 to 69 years old	0,0	0,0	0,0	0,0046
Number of females aged 10 to 14 years old	0,0	0,0	0,0	-0,0187
Number of females aged 15 to 69 years old	0,0	0,0	0,0	-0,0124
Number of adults aged 70 years and older	0,0	0,0	0,0	0,1094
Household head (=1)	0,0	0,0	0,0	-0,3917
Spouse of the head (=1)	0,0	0,0	0,0	0,0583
Child of the head (=1)	0,0	0,0	0,0	0,2056
Non labor income	0,0	0,0	0,0	1,1474
Household head wage income	0,0	0,0	0,0	0,0574
Spouse wage income	0,0	0,0	0,0	-0,7528
Constant	3,5774	2,4824	2,0197	4,7003

Women - Farm Households

	β1	β2	~β2	β0
Number of years of education (/10)	1,0697	1,3439	-2,3181	0,7551
Number of years of experience (/10)	0,2387	0,5243	-0,5943	-0,2368
Number of years of experience squared (/1000)	-0,2571	-0,6476	0,4778	0,5286
Region of Antananarivo (=1)	-0,2530	0,0541	-0,1836	-0,5821
Rural area (=1)	-0,2494	-0,0135	0,5646	0,3172
Household head in the informal sector (=1)	0,0	0,0	0,1660	-0,6827
Household head in the formal sector (=1)	0,0	0,0	-0,8654	-0,1080
Number of children aged 0 to 9 years old	0,0	0,0	0,0	0,0074
Number of males aged 10 to 14 years old	0,0	0,0	0,0	0,1417
Number of males aged 15 to 69 years old	0,0	0,0	0,0	-0,0070
Number of females aged 10 to 14 years old	0,0	0,0	0,0	0,0670
Number of females aged 15 to 69 years old	0,0	0,0	0,0	-0,0311
Number of adults aged 70 years and older	0,0	0,0	0,0	-0,1026
Spouse of the head (=1)	0,0	0,0	0,0	0,0994
Child of the head (=1)	0,0	0,0	0,0	-0,1417
Non labor income	0,0	0,0	0,0	0,2221
Marginal productivity of agricultural labor	0,0	0,0	0,0	-0,0650
Constant	3,5774	2,4824	3,9111	6,3980

Standard errors (diagonal) and correlation of unobservables

	t1	t2	~t2	t0
t1	0,9750	0,5000	-0,4960	0,8760
t2		0,5590	0,0890	0,3300
~t2			1,8810	-0,6530
t0				1,4520

Standard errors (diagonal) and correlation of unobservables

	t1	t2	~t2	t0
t1	0,9740	0,3000	0,0900	0,8340
t2		0,5580	0,5100	0,0950
~t2			1,9590	-0,4470
t0				1,7470

Table 3: Aggregated Social Accounting Matrix (billions of Malagasy francs)

	AGR	INF	FOR	L	T	K	HH	GOV	RDM	S-I	TOT
AGR	210	381	206				1348		156		2301
INF	179	120	181				505			62	1046
FOR	299	132	2271				2422	234	978	405	6741
L	429	345	860								1634
T	1000										1000
K		69	1721								1790
HH				1634	1000	1790		78	99		4601
GOV	38		250				92				381
RDM	146		1251					234			1630
S-I							234	-164	397		467
TOT	2301	1046	6741	1634	1000	1790	4601	381	1630	467	

Table 4: Minimum Yearly Wages, 1990-96 (in 1993 Malagasy francs)

	1990	1991	1992	1993	1994	**1995**	1996
Agricultural sector	576,015	614,821	543,323	494,400	554,188	**603,866**	557,053
Non agricultural sector	566,458	604,270	533,960	485,880	537,589	**592,923**	547,576
Public sector	774,965	811,706	716,329	651,828	665,334	**719,102**	653,844

Source: Ministry of Finance and Ministry of Civil Service and Labor.

Table 5: Distribution of beneficiary households across quintiles

	Agricultural Subsidy			Workfare Scheme		
	Beneficiary households	Row %	Share of program cost	Beneficiary households	Row %	Share of program cost
1st quintile	2,184,281	83.9	7.2	821,244	31.5	16.4
2nd quintile	2,073,064	79.5	12.6	842,288	32.3	17.1
3rd quintile	2,073,970	79.4	18.5	919,525	35.2	23.9
4th quintile	1,752,415	67.2	24.0	829,048	31.8	22.0
5th quintile	1,036,771	39.7	37.7	715,063	27.4	20.6
Total	9,120,501	69.9	100.0	4,127,168	31.6	100.0

Notes: 1. Quintiles are computed using per capita income in the base year.
2. Row percent figures are shares of beneficiary population by quintile.

Table 6: Macroeconomic impact of alternative policies

	BASE	SUB10	WFPT	UNIPC
Agricultural price	1.0	3.1	6.4	4.5
Informal price	1.0	1.2	2.5	1.1
Formal price	1.0	-2.0	-4.1	-2.8
Consumption Price Index	1.0	0.0	0.0	0.0
GDP at Market Prices	4712.7	-0.2	4.5	-0.3
Absorption	4975.2	0.1	4.4	-0.2
Private Consumption	4274.5	4.8	4.7	4.7
Investment	467.2	-41.5	-41.5	-43.6
Government Consumption	233.6	-2.0	90.4	-2.8
Exports	1134.4	-2.6	-3.6	-3.0
Imports	1396.9	-1.1	-2.6	-2.3
Cost (in billions of Malagasy francs)		229.1	229.9	230.0
Cost (% of base GDP)		4.9	4.9	4.9

Notes: 1. Base values for BASE column and percent changes for the simulations.
        2. SUB10 = agricultural subsidy; WFPT = part time workfare scheme; UNIPC = untargeted uniform transfer par capita.
        3. Cost figures are *ex post*.

Table 7: Employment impact of alternative policies

	BASE	SUB10	WFPT	UNIPC
Full time inactive workers	1 144.3	-1.6	-15.8	-0.7
Full time agricultural workers	4 248.9	2.7	-5.3	1.3
Full time informal workers	324.6	2.0	-44.6	-0.2
Full time formal workers	527.0	-0.1	-4.2	-0.1
Part time workers	874.9	-11.5	65.6	-5.4
Agricultural labor	4536.3	1.4	-3.9	0.7
Informal labor	687.0	-6.3	-13.3	-3.5
Formal labor (incl. workfare)	602.1	-0.2	73.7	-0.1
Total active workers	5825.4	0.3	3.0	0.1

Notes: 1. Base values for BASE column and percent changes for the simulations.
        2. SUB10 = agricultural subsidy; WFPT = part time workfare scheme; UNIPC = untargeted uniform transfer par capita.
        3. Part time workers category include either part time formal or informal work with inactivity, part time formal or informal work with agricultural activity, as well as part time inactivity, agricultural activity, formal or informal work with workfare in the case of the workfare scheme simulation.
        4. Total active workers and sectoral labor are in full time equivalent, whereby full time workers count for 1.0 and part time workers count for 0.5.

Table 8: Social impact of alternative policies

NATIONAL	BASE	SUB10	WFPT	UNIPC
Per Capita Income	352.7	4.8	4.7	4.7
General Entropy Index 0	45.2	-3.0	-7.8	-11.7
General Entropy Index 1	59.0	-3.6	-7.2	-8.8
Gini Index	51.1	-1.6	-3.7	-5.1
Poverty Incidence	59.0	-5.6	-6.5	-6.4
Poverty Gap	24.9	-9.3	-13.8	-16.4
Poverty Severity	13.4	-11.3	-17.8	-24.2
URBAN	**BASE**	**SUB10**	**WFPT**	**UNIPC**
Per Capita Income	631.1	-0.3	1.3	0.6
General Entropy Index 0	48.1	-2.0	-7.7	-6.4
General Entropy Index 1	62.8	-1.6	-5.8	-4.5
Gini Index	52.7	-0.9	-3.5	-2.7
Poverty Incidence	30.5	0.3	-6.5	-3.7
Poverty Gap	10.3	-4.0	-21.6	-16.0
Poverty Severity	4.5	-6.6	-28.0	-24.8
RURAL	**BASE**	**SUB10**	**WFPT**	**UNIPC**
Per Capita Income	260.7	8.8	7.3	7.9
General Entropy Index 0	33.2	2.0	-6.1	-12.8
General Entropy Index 1	39.7	2.6	-5.2	-9.5
Gini Index	44.0	0.8	-3.0	-5.6
Poverty Incidence	68.4	-6.4	-6.5	-6.8
Poverty Gap	29.7	-9.9	-12.9	-16.5
Poverty Severity	16.4	-11.8	-16.9	-24.1

Notes: 1. Base values for BASE column and percent changes for the simulations.
2. SUB10 = agricultural subsidy; WFPT = part time workfare scheme; UNIPC = untargeted uniform transfer par capita.