Agricultural Price Seasonality and Market Failure:
Examining the Net Seller Household and the Net Benefit Ratio Definitions

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Abstract

When the price of a food crop changes, the short term welfare variations of rural households is approximated thanks to the Net Benefit Ratio (NBR) defined by Deaton (1989). The NBR expression relies on a typology distinguishing between net sellers, net buyers and self sufficient households. We show that the typology's criteria and the classic formula of NBR use *i*) produced and consumed quantities rather than real marketed volumes and *ii*) a unique price for selling and buying for all surveyed households. In this paper, we propose another definition of a net seller and a new NBR expression that allow to take into account market failures (MF) and price seasonality (PS), which are two very common features in developing countries. We used two sets of data (from Mexico and Mali), and found that, if considering MF and PS, (1) the household typology can be partly reconfigured and (2) the distribution of the NBR over the household income profile slightly changes.

Key Words: household welfare, food crop, net buyer, net seller, Net Benefit Ratio, price seasonality, survey

JEL Code: D12, C14, Q12, D31, Q17, Q18

1) Introduction

Distributional impacts assessment of trade liberalization policies are a great concern for development economists. This kind of distributional analysis can be implemented *ex ante* or *ex post* for any type of household (rural, urban, high skilled, etc.) in any case of reform affecting the prices of factors (chemical inputs, land, labour) or goods (produced or consumed ones) such as food crop (Porto (2004). Since fight against poverty is a major goal and since an important proportion of the poor in developing countries live in rural area (Bardhan (2006), agricultural households are the centre of the attention. A common feature of agricultural households in developing countries is that, facing missing or failing markets, such as food or labour markets, they consume all or most of what they produce. Examples of both produced and consumed crops are millet and sorghum in Africa, maize and beans in Latin America, rice in Asia *etc*. In a quite adverse economic environment, relying on markets to get its own food is risky, so poor agricultural household first seek to satisfy their basic needs by producing their own food (Fafchamps, 1992). They do not buy all of their food needs nor sell all their production. If production exceeds consumption and market price worth it, they sell the surplus.

How are those agricultural households affected by a price variation of a good they both produce and consume? A first answer would be this one: let's imagine that the effect of trade reform is a sharp decrease in the price of maize in Mexico, households who sell maize are loosing while those who buy it are clearly favoured by the reform. But, since most of agricultural households both produce and consume maize (in this example), how do we know if they are loosing or wining from the price decrease? In economic literature on impact analysis of a food crop price change, part of the solution relies on a typology that cuts out inside the *agricultural households' continuum*, defining three types: the net buyer, the net seller and the self sufficient households (Sadoulet et de Janvry (1995)). Given this statement, it is well-known that a net buyer (resp. seller) will gain (resp. loose) from a price decrease while a self sufficient household will not be affected by the price change since it is isolated from the market (it is insensible to price variations because it doesn't sell nor buy) (Hoekman and al. (2001); McCulloch, Winters and Cirera (2001) ; de Janvry (2004))[2]. When the reform's effect is a price decrease, the more net buyers there are, the better effects the reform will have.

So a crucial feature of economic analysis of agricultural households is to determine whether a household is a net buyer, a net seller or self-sufficient (Sadoulet and de Janvry, 1995). In this paper we discuss the definition of those concepts, analysing the criteria employed to classify an agricultural household in one of those three types. We first show that the most common way in literature is to compare for every household its produced and consumed quantities over the survey period. The Net Benefit Ratio (NBR), a crucial concept developed by Deaton (1989) for non parametric analysis of short term distributional impacts of a price variation, also relies on these criteria (see Deaton (1997)). Chabe-Ferret (2005) showed that this common expression of the NBR (derived from the separable farm household model, see Annexe) is flawed in a multi output context (intermediary uses of the crop, sharecropping fees), and proved that the NBR can be adapted to the possible non separable household. In this paper, we criticize the classic NBR formula because, by using a unique price, it implicitly neglects possible food crop price seasonality. We propose a more flexible expression for the NBR which allows taking into account every market transactions and agricultural price seasonality and we compare both criteria using data of two household surveys from Mexico and Mali.

2) The "quantity definition"

2.1) The classic definition of a net seller and the NBR expression

Let's consider an agricultural household *h*, producing crop *i*, among others. During one year, we note Q its production and X its consumption of crop *i*. The most common definition of a net

[2] Dyer and al. (2005) showed it is not that simple: for example, a maize self-sufficient agricultural household can be affected by a price variation of maize if it rents land or sells labour to local big producers of maize (price of land or labour are linked to the price of maize).

seller (*resp.* net buyer ; self sufficient) agricultural household regarding crop *i*, is this one (for more simple notations we give up indice *i*):

$Q_h < X_h \Leftrightarrow h$ is a net buyer
$Q_h > X_h \Leftrightarrow h$ is a net seller
$Q_h = X_h \Leftrightarrow h$ is self-sufficient

Box 1: The "quantity definition" of a net buyer, net seller and self-sufficient agricultural household

We call it the "quantity definition" because it is based on the produced and consumed quantities. First of all, let's notice the semantic ambiguity of this definition: to be a *seller* or a *buyer* supposes a link with the market. Yet, the way to distinguish a net seller from a net buyer in Box 1 is based on quantities that are, at this stage, independent of marketed quantities. In our opinion, produced and consumed quantities would only allow to distinguish a net *producer* from a net *consumer* (but not a net *seller* from a net *buyer*). Although ambiguous, this definition is used very frequently (de Janvry, Sadoulet and Gordillo (1995), Robilliard (1998), Barrett and Dorosh (1996), Henning and Henningsen (2005), Ravallion (1989), Phelinas (1986), Hoyos (2005), Chabe-Ferret (2004, 2005)) or recommended (Deaton (1995, 1997), Hoekman and alli. (2001, p. 70)).

To evaluate the distributional effects of a variation of crop *i*'s price, Deaton (1989) developed the concept of Net Benefit Ratio (NBR), which represents the budget share of crop *i* for each household *h* (it can also be interpreted as the elasticity of income with the price of good *i*) . It is written:

$$NBR_{ih} = p_i \frac{Q_i - X_i}{C_h} \quad , \tag{0}$$

where C_h is total expenditure of household *h*, and *pi* is the price of crop *i*. Budd (1993) clearly stated the importance of the NBR: "*The manner in which this ratio varies across the income distribution illuminates how a price change affects income across the income distribution* ". As a matter of fact, the NBR variation (ΔNBR_{ih}) for household *h* is proportional and takes the opposite sign of the income equivalent transfer to realize to household *h* to compensate its welfare change caused by the price variation of *i* (Δpi) (see Annexe). We easily verify it: suppose *pi* increased ($\Delta pi > 0$) and *h* produces more than it consumes ($Q_i - X_i > 0$), then *h*'s welfare is increasing because of the price variation. $NBR_{ih} > 0$, which means that the equivalent income transfer must be negative to re-establish his initial utility level. Here, let's just remark that this NBR expression also relies on the produced and consumed quantities as well as it is to define a net seller (*resp.* buyer) in Box 1. The marketed surplus, which is said to be proportional to the household welfare change, is inferred from the collected data of produced and the consumed quantities during the survey.

2.2) The links with real marketed quantities

Definitions in Box 1 assume that Q – X is the marketed quantity (bought or sold depending on the sign), valued at the unique price *pi* in the NBR expression (0). By taking those definitions and expressions you suppose that *h* is facing perfect market for commodity *i*. In this perfect market framework, we note Q_b the total bought quantity of *i*, Q_s the total sold quantity of *i*, B the total value of purchases of *i* and S the total value of sales of *i*, by household *h*. It is possible to write:

$Q < X$	$\Leftrightarrow$	[$X \geq Q_b \geq X - Q$ and $Q_b > Q_s \geq 0$	]	(1)
$Q > X$	$\Leftrightarrow$	[$0 \leq Q_b \leq X$ and $0 \leq Q_b < Q_s \leq Q$	]	(2)
$Q = X$	$\Leftrightarrow$	[$Q \geq Q_b = Q_s \geq 0$	]	(3)

Box 2: Possible relations between produced, consumed and marketed quantities if assuming a perfect market

But in fact, when using the NBR expression (0), you implicitly consider that (1) means $Q_b = X – Q$ and $Q_s = 0$, that (2) means $Q_s = Q – X$ and $Q_b = 0$ and that (3) means $Q_b = Q_s = 0$ (you take convenient values in the possibility interval). In a nutshell, three critics can be done to the "quantity definition" and this associated NBR expression (0):

1. It contains a semantic ambiguity. It only considers the marketed quantities indirectly, inferring them from the produced and consumed quantities by household *h*. Yet welfare impacts are channelled through the effective marketed quantities.
2. By considering a unique price *pi*, it implicitly supposes a perfect market for household *h* and crop *i*, and we know how far this assumption can be from developing countries' rural areas.
3. Finally, by taking into account a unique price in the NBR expression, it also neglects the possibility of price seasonality (two different sales can be done at two different prices by the same household).

3) Market failure and price seasonality: a proposition of a "value definition"

3.1) Allowing for a difference between the buying and the selling price of the food crop

Though using the "quantity definition", Ravallion (1989) recognizes that: "*all households face the same prices, which do not vary according to whether one buys or sells the commodity in question. The realism of* […] *these assumptions can be questioned*". Some authors have taken into account market failure by considering that households have to face a "price band", which means that bought and sold quantities are exchanged at different prices on the market (Minot and Goletti (1998); Benoit-Cattin (1994); Omamo (1998); Nicita (2004)). Minot and Goletti, for instance, use data from a household survey in Vietnam to estimate the possible effects on farmers' welfare of a liberalization of rice exports. They calculate the transmission to regional prices (selling (P_s) and buying prices (P_b)) induced by a change in the border price. So they clearly consider the possibility of market failures for Vietnamese rice producers. Minot and Goletti utilized a slightly different NBR (compared to (0)): first of all they made up a second order (long term) effects (but we do not consider it here after since we concentrate on first order effects assessments) and, second, they took into account market failures by allowing, for each region, two different prices for households' bought and sold quantities. Unfortunately, they calculated the regional buying and selling prices, but they do not apply them to each household's real bought and sold quantities but to marketed quantities derived from Q and X, assuming the relations in Box 3.

If $Q < X$ then $B = Pb * (X – Q) > 0$ and $Qs = S = 0$ ⇔ *h* can only be a buyer, it never sells *i*	(4)
If $Q > X$ then $B = Qb = 0$ and $S = Ps * (Q – X) > 0$ ⇔ *h* can only be a seller, it never buys *i*	(5)
If $Q = X$ then $B = Qb = 0 = S = Qs$ ⇔ *h* never buys nor sells *i*	(6)

Box 3: Possible relations between produced, consumed and marketed quantities if assuming market failures

So the first order part of their NBR can be written as:

$$NBR_{ih} = \frac{1}{C_h}(P_s \sum_s Q_s - P_b \sum_b Q_b) \qquad (7)$$

Two critics can be done to this approach:

- as de Janvry, Fafchamps and Sadoulet (1991) mentioned, "*market failure is not commodity specific but household specific*": although differentiating selling and buying prices ($P_s < P_b$), and allowing them to take regional values, the prices Minot and Goletti used are the same for all households living in a same region.
- Second point is that (Q_b, Q_s) are hypothetical because they are derived from Q and X (as it was in the perfect market framework). In Fig. 1, we represent those assumed relations between Q, X, Q_b and Q_s in both frameworks (perfect or imperfect markets).

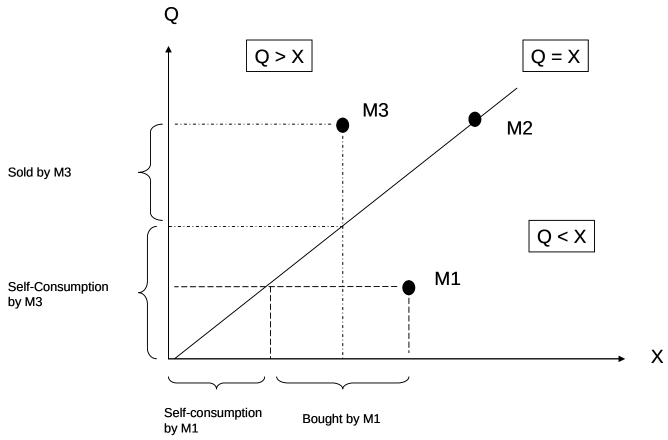


Fig1: Assumed relations between Q, X, Q_b and Q_s

These assumed relations are the same in both frameworks but their justifications differs. In the perfect market framework, those relations are justified by the fact that only one price is used in the NBR expression, so $Q - X > 0$ implies that $Q_s = Q - X$ and $Q_b = 0$ (it will not have consequences on the NBR calculation). If considering two prices for sold and bought marketed quantities, those relations are justified by the fact that $P_b > P_s$ (the retail price is always greater than the farm gate price), so farmers prefer their own maize which is cheaper than buying it on the market (see Jayne (1994)).

Let us introduce another definition of a net seller (*resp*. buyer; *resp*. self-sufficient) agricultural household, based on total value of real marketed declared quantities during the survey period (and not on produced and consumed quantities). We call it the "value definition":

$$B_h < S_h \Leftrightarrow h \text{ is a net seller}$$
$$B_h > S_h \Leftrightarrow h \text{ is a net buyer}$$
$$B_h = S_h \Leftrightarrow h \text{ is self-sufficient}$$

Box 4: The "value definition" of a net buyer, a net seller and a self-sufficient agricultural household

3.2) Allowing for price seasonality

The more flexible and the more adapted to developing countries realities, the better the NBR will be to represent farmers' welfare variations. So, including a possibility for two different prices for sales and purchases makes the expression (7) better than the (0). But (7) still does not enable to consider price seasonality, which is another constancy in rural area in developing countries (Sahn, 1989), along with market failures. Price seasonality only means that prices on local markets depend on the period of the year:

$$P_b = P_b(t), t \in [january...december]$$
$$P_s = P_s(t), t \in [january...december]$$

Let's imagine a farmer which produces 2 tons of maize per year and his family needs are 1,5 tons. He is classified as a net seller according to the "quantity definition". Supposed that, pressed by cash requirements, he had to sell 1,5 tons so he could only keep 0,5 ton for his own consumption. He sold 1,5 tons at market price of 100$/ton and then obtained 150$. But, when what he kept to feed his family is over, he has to buy 1 ton. He is poor and can only buy small quantities because he does not have enough money to buy 1 ton in one purchase (revealing a credit constraint which is also a common feature of rural households in developing countries). Suppose he buys this ton in 5 purchases (200 kg each times) during post harvest period while prices are going up. For each purchase market prices are 130, 160, 200, 230 and 250 ($/ton). So total expenditure to buy maize are 194$ > 150 $: he is a net seller according to the "value definition". If, during the survey, interviewer only asks for Q and X, the economist will conclude that this household would benefit from a price increase, whereas he would not.

The new definition of a net seller we propose here is thus relying on the same idea than in Box4: monetary values of marketed quantities are more important than produced and consumed quantities to classify a net seller. Moreover, we define B_h and S_h differently by allowing every market transactions *t* of household *h* to be described (traded volumes and related market prices). Subscript *t* characterizes the transaction but also generally symbolizes time showing that we now can consider price seasonality, each household is possibly facing:

$$B = \sum_t P_b(t)Q_b(t) \tag{8}$$

$$S = \sum_t P_s(t)Q_s(t) \tag{9}$$

Consequently, we propose a new NBR formula for household *h* and good *i*:

$$NBR_i = \frac{1}{C_h}[\sum_t P_v(t)Q_v(t) - \sum_t P_a(t)Q_a(t)] \tag{10}$$

Are biases of household's classification frequent? Does the use of one or another expression of NBR have any consequences on the results of a distributional analysis? This is what we will study in the next part of this paper, using data of Mexican and Malian agricultural households.

4) The data

We use two data base of agricultural households: the first one was constituted by the author and Bouthier (2006) between april 2006 and july 2007, in the *Municipio* of Teopisca (Chiapas, Mexico) and concerns 215 small to medium maize growers; the second was buld by IER (Institut d'Economie Rurale) and CIRAD (Centre de Coopération International en Recherche Agronomique pour le Développement) in 2004 in the region of the "Office de la Haute Vallée du Niger", and was related to the program "Politiques agricoles et Développement Régional" (ECODIS). Two geographic zones have been surveyed: the cotton zone and the rice zone; total number of surveyed households was around 400. This survey was quite focused on cotton and rice production as cash crops but all food crops' data had been recorded. After eliminating absurd data, we have 166 maize producers, 158 sorghum producers and 161 millet producers[3]. To know more about the farmers of this region, see Bélières et *al*. (2002; 2005), Coulibaly et *al*. (2006), Djouara et *al*. (2006).

5) Results

5.1) Time, price seasonality and aggregated traded quantities

5.1.1) In Chiapas, Mexico

Mexican agricultural households can sell at farm gate to a local independent trader called "*coyote*" at price P_s or travel to the certified silo to sell at price $P_{s'} > P_s$. Consumption unit of the household can buy maize on the village market at retail price $P_b \geq P_{s'}$ (Fig.2).

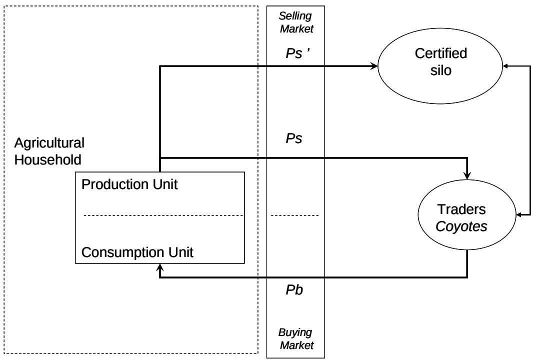


Fig2: Relations between household and market (source: author)

In the *Municipio* of Teopisca (Chiapas), the first harvests of rain fed maize (the most abundant maize) begin in December and finish at the end of January. Climate and access to irrigation only allow the major part of peasants to cultivate only one crop per year, but some of

[3] Agricultural households produce several crops but their classification as a net seller, buyer, and self-sufficient is relative to one crop only.

them can irrigate and sow maize in January / February to harvest in july / august (Bouthier, 2006). *In situ* observations and field work show that it exists a difference between the selling (to the *coyote*) and buying (smaller quantities on the local retail market) prices across agricultural households. Fig. 3 shows the average (over all the recorded transactions of all households) monthly selling and buying prices.

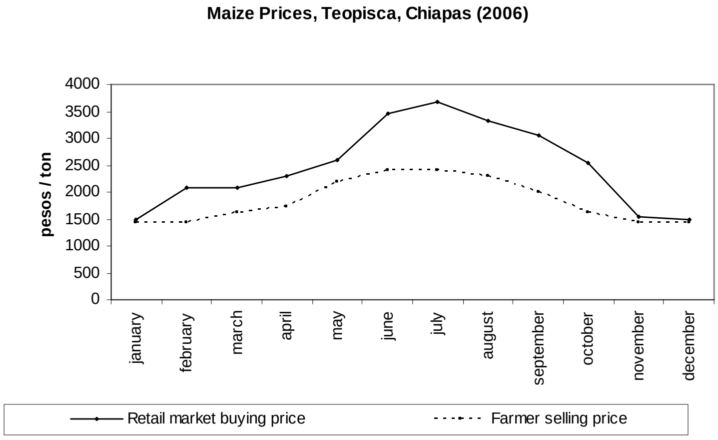


Fig3: Seasonality of Price of Maize in Teopisca, Chiapas, Mexico (source: author)

This difference is observable and does not correspond to the unobservable transactions costs that are household specific. The gap varies across the months and can be important in both absolute and relative terms. Sales to the *Coyote* are done at a price varying between 1500 and 2200 pesos / t, while purchases on the market (to retailers which can be the same *Coyotes*) are associated with prices varying between 1500 and 3600 pesos / t. From November to February, the certified silo is open and it is possible to sell at 1500 pesos / t. During this period, the retail price of maize on the market is close to its sale price, because maize is locally abundant. After February, it is only possible to sell or buy to the *Coyotes* and no more to the silo which is closed. No other maize has been harvested in the neighbouring regions. Then, storage loss, transport costs, capital immobilization, labour time, are remunerated and both selling and buying maize price increase (see Ninin-Massenet and Ribier, 1998). Observable price band amplitude reaches a maximum in July: retail price of maize is equal to 163% the farm gate selling price. In August and September, irrigated maize is harvested and prices begin to decrease.

For each Mexican agricultural household we surveyed, we asked for annual maize production, consumption and marketed volumes (sold and bought), but unfortunately we do not have the date of each market transaction so we can not represent the aggregated trade dynamic. Although we have recorded prices of each transaction we can not find the corresponding date using Fig. 3, since to one price it is possible to match two different dates (there is no bijection).

5.1.2) In Mali

Here we can build the intra annual dynamic of traded volumes (Fig. 4). The first point we want to emphasize is price seasonality. For all the three crops we observe, as in the case of Teopisca (Chiapas, Mexico), the monthly average of households' buying and selling prices vary across the year. Next point is that buying price (retail price) is always higher than farmer's selling price (except for millet in July and August). This price band is represents the fact that there are non household specific market failures in the region. Lastly, let's notice that this price differential strongly decreases during harvest period (July, August, September).

Second range of observations concerns the aggregated marketed volumes of cereals. For all the three crops, aggregated sales are much more concentrated in the time than are aggregated purchases. Much part of the sales are occurring right after the harvest, we suppose it is so to be able to repay the inputs related credit(s). Those sales are made at a relatively low price, if compared to the maximum selling price during the year. For maize and millet, an important part of aggregated purchases are made just before harvest at relatively high prices.

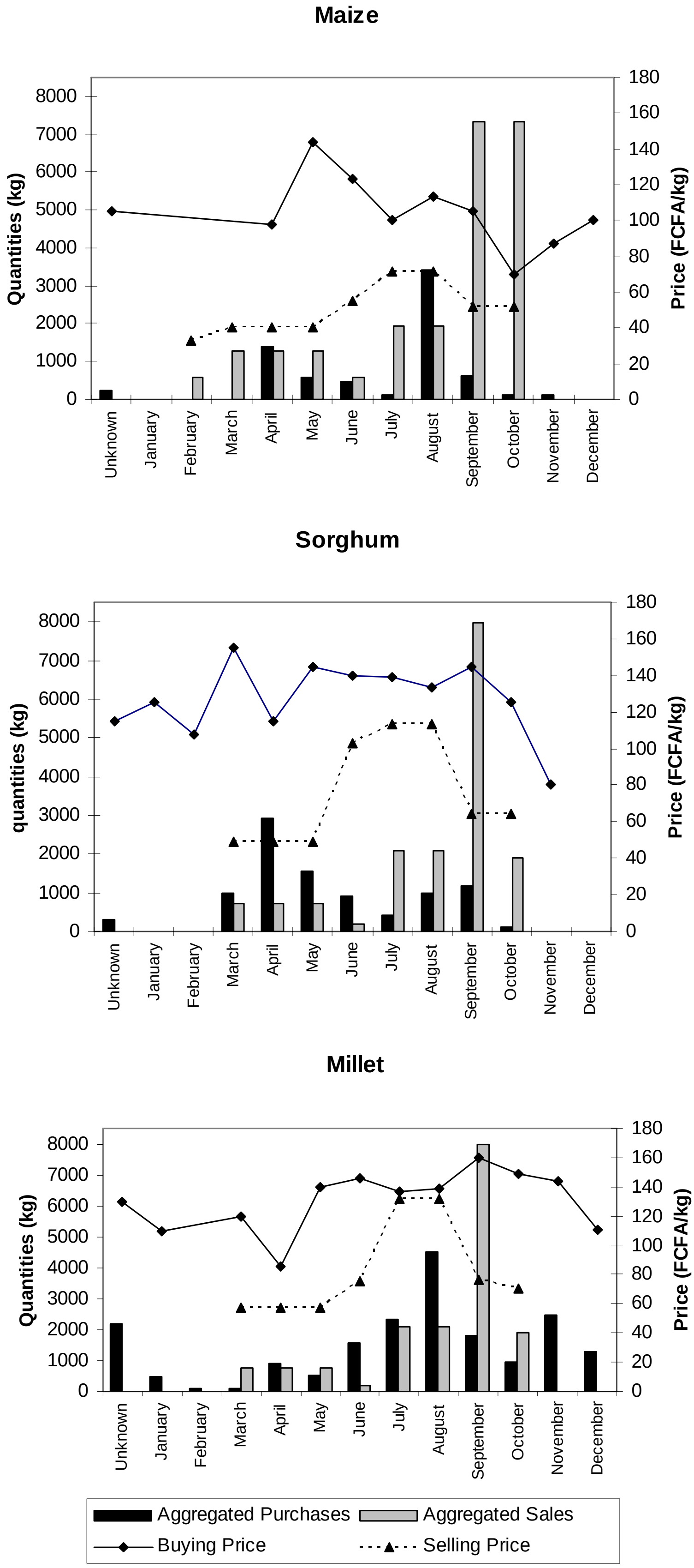


Fig4: Intra annual dynamic of aggregated marketed quantities of three crops in Mali.
Harvest months are from July to September. (Unknown = undated traded quantities)

Those graphics show that farmers are far from selling at the highest price and buying at the cheapest one. This very well-known fact has already been studied and is often related to their cash and storage constraints (see Ellsworth and Shapiro (1989)). Moreover, Attanasio and Frayne (2006) showed that the poor pay more in general for the same product because they buy smaller quantities at retail (and higher) prices.

The data show in both cases the existence of market failures and price seasonality. So in order to analyze effective marketed quantities by rural households, it is important to take into account two different prices for each commodity: it is the obvious sign of market failure which is a very common feature in developing countries' rural areas. Depending on its intensity (evolution of the ratio P_s (t) / P_b (t); P_s (t) / P_s (t=0) and P_b (t) / P_b (t=0) over time), it would also be convenient to consider price seasonality both in the definition of a net seller (*resp.* buyer; *resp.* self-sufficient) and in the expression of the NBR formula which is used to assess welfare effects of price changes. In a nutshell, it is important to record precisely every transaction of each household.

5.2) Comparing the quantity and value definitions

Here we compare the "quantity definition" of Box 1 to the "value definition" of Box 4. B and S were calculated by the author with relations (8) and (9). Table 1 presents the number and proportion of each household type (net buyer, net seller and self-sufficient) in both countries and for four food crops.

			Quantity Definition		Value Definition	
			N	%	N	%
Mexique (Teopisca, Chiapas)	Maize [215]	Net Buyer	49	*22,8*	60	*27,9*
		Net Seller	163	*75,8*	152	*70,6*
		Self-sufficient	3	*1,5*	3	*1,5*
Mali	Maize [166]	Net Buyer	35	*21,1*	39	*23,4*
		Net Seller	53	*31,9*	40	*24,1*
		Self-Sufficient	78	*47*	87	*52,5*
	Sorghum [158]	Net Buyer	31	*19,6*	30	*19*
		Net Seller	46	*29,1*	43	*27,2*
		Self-sufficient	81	*51,3*	85	*53,8*
	Millet [161]	Net Buyer	25	*15,6*	30	*18,6*
		Net Seller	33	*20,5*	38	*23,6*
		Self-Sufficient	103	*63,9*	93	*57,8*

[ ] : Total number of households producing the crop

Table 1: Number and proportion of agricultural households per type according to both definitions

Using the quantity definition drives to:

- in the Mexican household survey:
  - under-estimate the net buyers (22,8% *vs.* 27,9%)
  - over-estimate the net sellers (75,8% *vs.* 70,6%) and let the proportion of self-sufficient households unchanged
- in the Malian survey:
  - under-estimate the net buyers (except for Sorghum) and the self-sufficient (except for millet)
  - over-estimate the number of net sellers (except for millet)

So a first conclusion is that using one or the other definition has an influence on the typology's structure, but that the estimation bias depends on the crop. Let's remind the importance of the global proportion of the three household categories in a region (or a country). It gives the economist or the policy maker a good idea of the rural population sensibility to a political reform such as trade liberalization. In Table 2 we investigate, the movements of each household from one category to another under both definitions.

				Value Definition		
				Net Buyer	Net Seller	Self-Sufficient
Quantity Definition	Mexico (Teopisca, Chiapas)	Maize [215]	Net Buyer	47	2	0
			Net Seller	13	150	0
			Self-Sufficient	0	0	3
	Mali	Maize [166]	Net Buyer	34	0	1
			Net Seller	3	38	12
			Self-Sufficient	2	2	74
		Sorghum [158]	Net Buyer	29	0	2
			Net Seller	2	31	13
			Self-Sufficient	0	11	70
		Millet [161]	Net Buyer	24	1	0
			Net Seller	5	23	5
			Self-Sufficient	1	14	88

[ ] : Total number of households producing the crop

Table 2: Definition crossing and estimation bias of number of household per type

For each crop, diagonal numbers are invariant households: they do not change of category while definition changes. Detailed results are:

In the Mexican survey:

- 8% of net sellers *in quantity* become net buyers *in value*
- 4,1% of net buyers *in quantity* become net sellers *in value*. Thus we can suppose that cash constraint is binding harder for net buyer households (only a very few of them can speculate on prices).

In the Malian survey:

- 23,1% (*resp*. 28,3%; *resp*. 15%) of net sellers of maize (*resp*. sorghum; *resp*. millet) *in quantity* become self-sufficient *in value*: the associated household behaviour is quite difficult to understand. It is possible that these households sell part of their maize after harvest and dedicate the same amount of money (and even the same physical money) to buy more maize later. This case of "*different sources of income allocated to different uses depending on their origin*" has already been reported by Duflo (2003) and was named "*mental accounts*".
- 5,8% (*resp*. 4,3% ; *resp*. 15%) of maize (*resp*. sorghum ; *resp*. millet) net sellers *in quantity* are net buyers in value.
- 13,6% of all self-sufficient *in quantity* become net sellers *in value*

In both surveys and for each crop, most of net buyers *in quantity* stay net buyers *in value*. This is because most of the net buyers *in quantity* (consuming more than producing) usually do not sell, even if considering the higher prices incentive in *post* harvest periods: they consume what they produced and buy the rest of what they need on the market (which is coherent with the central assumption when considering the "quantity" definition). An important and interesting bias of category allocation is to classify a household as a net seller (in quantity) whereas it is a net buyer (in value). The reason of this fact could correspond to the "cash constraint – price seasonality" explanation we have already given in 3.2 : even if the household produce more that what it consumes, it is possible that it sells more than Q - X at low prices (because of urgent cash requirements) and has to buy later at higher prices.

Our intuition is that the probability of committing an error when classifying households in the three categories increases as the mean of the price differential ($P_b - P_s$) increases and when the Q / X ratio is close to 1^+. Suppose a small $\varepsilon > 0$ and a given (fixed) price differential:

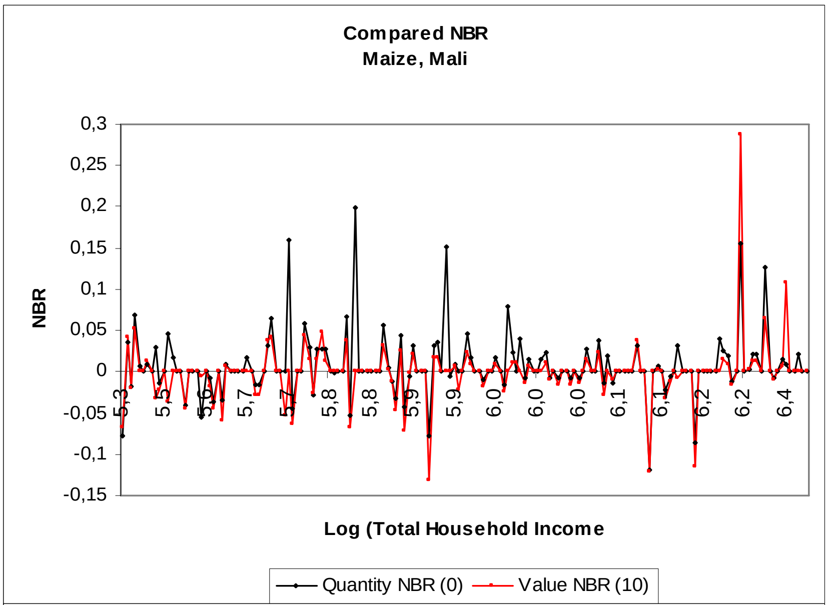
- if $0 < Q / X < 1- \varepsilon$, almost all households never sell, so they are net buyers according to both "quantity" and "value" definitions

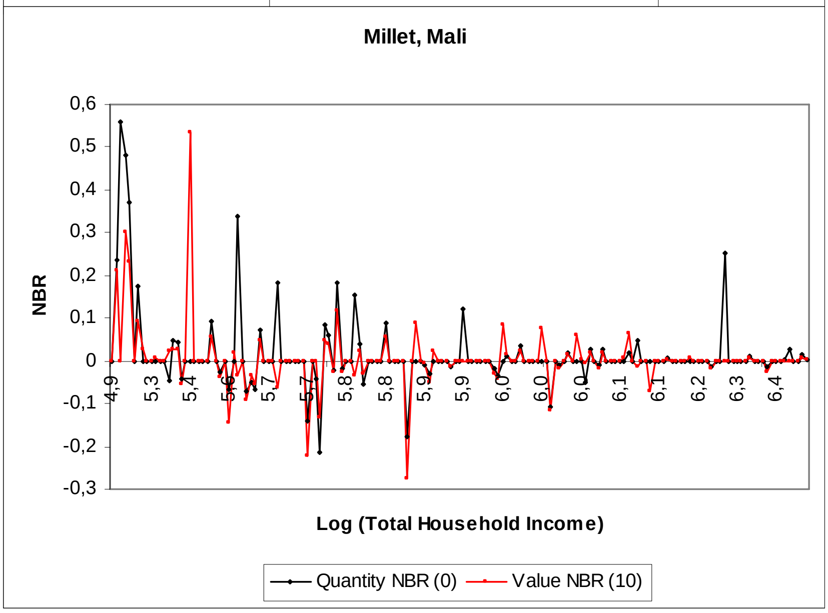
- if Q / X ≈ 1^+ which means $1 < Q / X < 1 + \varepsilon$, households are classified as net sellers *in quantity* but some of them could in fact be net buyers *in value* because of the cash constraint. Probability of classification mistake could be high.
- if Q / X >> 1, even if households do buy the food crop they also sell, it is very unlikely that B will exceed S.

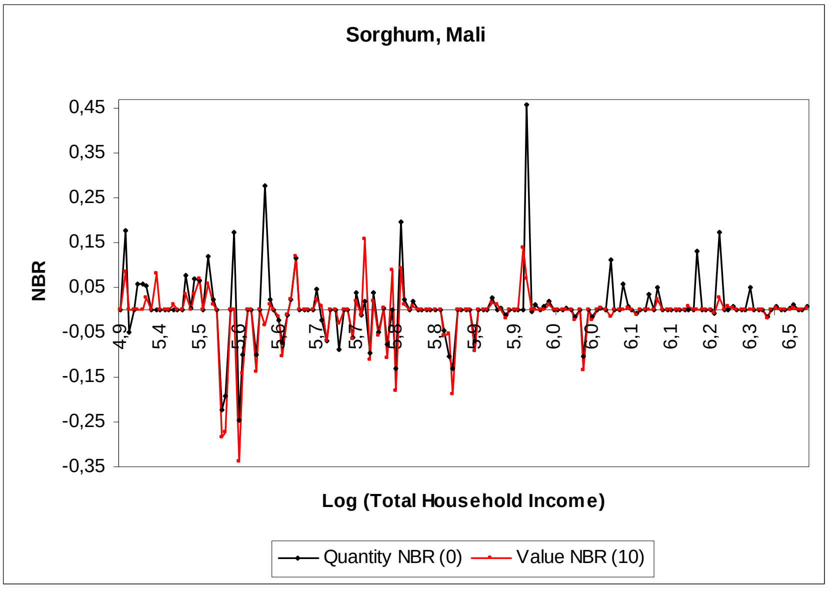
We just showed that the global proportion of net buyer, net seller and self-sufficient agricultural households can vary according to the definition. This is important because knowing those relative proportions gives a first idea of the global welfare impact of a trade reform. If one expects price to decrease after the reform, it is useful to know whether the proportion of net seller households, which are the reform losers, is closer to 30% than to 40%. Knowing the proportion of real self-sufficient households ($Q_s = Q_b = 0$ and not Q = X) can also be important because self-sufficient rural households are said to be insensible to reforms and prices changes.

5.3) Comparing NBR formulas

The question we ask now is: how does the use of one or another NBR formula affect the distributional welfare impact profile over the household income distribution? To investigate it, we have constructed four graphics to compare NBR expressions (0) and (10) for each crop. Both NBR formulas are displayed over the logarithm of total household income. Because we do not have enough points, we did not smooth (using kernel and bandwidth techniques) the data over the income profiles as it is the case in Deaton (1989, 1997): it enables us to see if there are real differences between both expressions.







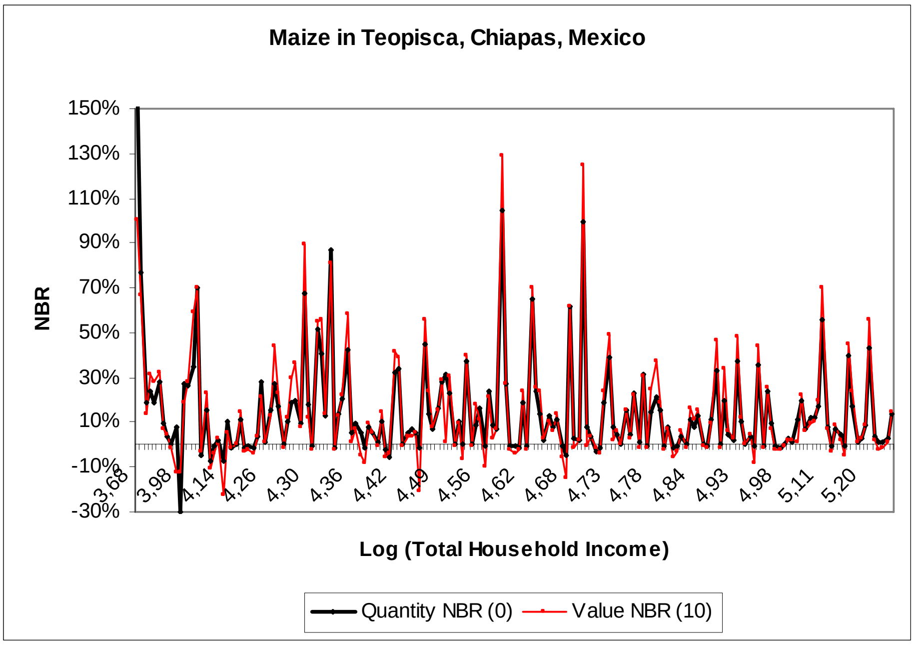


Fig5: “Quantity” and “value” NBR comparisons

Results with the NBR that integrates price seasonality (10) differ from the NBR expression (0) that does not integrate it every time the red line does not coincide with the black one (Fig. 5). Graphic for maize producers in Teopisca (Chiapas, Mexico) show very little discrepancies between both methods. This is because the majority of surveyed households produce much more than their annual consumption ($Q/X >> 1$ and so the “quantity” NBR > 0) and although price seasonality is locally very pronounced (see Fig3) the “value” NBR is also positive. Graphics for the three crops in Mali show a little more discrepancy between both methods. There is no clear evidence of a link between the differences between both NBR expressions and households’ income level. Yet, we observe an interesting point: in the upper half of the graphs (NBR>0 meaning that the household is a net seller), it seems that the “value” NBR is often inferior to the “quantity” NBR. This means that the calculated benefit of a price increase would be smaller. On the other hand, calculated welfare loss caused by a price increase would be exaggerated for the net buyers if using the (10) NBR, since black line is often inferior.

6) Conclusion

To conclude we will insist on four points:

1. Expressions (8) and (9), which define a net seller (*resp*. buyer) comparing the marketed values, seem to be the more relevant to classify agricultural households in categories than produced and consumed quantities.
2. The new NBR formula we proposed permits to take into account market failures and agricultural price seasonality, by integrating every household's market transactions (marketed quantities and related prices). Our reformulation follows the original idea of the NBR concept since it still represents the budget share of crop *i* for household *h*:

$$NBR_i = \frac{1}{C_h}[\sum_t P_v(t)Q_v(t) - \sum_t P_a(t)Q_a(t)]$$

3. As a first step of distributional impacts assessment of a trade reform affecting the price of a food crop, knowing the global proportion of net buyers, net sellers and self-sufficient (those who never sell nor buy and not those who produce the same quantity that they consume) is crucial. It gives to the policymaker and the economist a first idea of the overall effect of the reform. For example, if trade reform is supposed to increase food crop prices in a developing country (increases in world food crop prices are to be expected if developed countries agricultural policies are eliminated (Chabe-Ferret, 2003) or if some are used for ethanol for instance), under estimating the proportion of net buyers drives to under estimate the global rural population's welfare lost. Our results showed little discrepancies between both "quantity" and "value" NBR so using one or another formula could not have strong consequences on the assessment of the distributional impacts. But this could be an effect of the few household data we have utilized (the Mexican and Malian survey accounts for no more than 215 households per crop whereas in Deaton (1989) more than 9000 household are treated for rice in Thailand).
4. This leads us to make a practical recommendation for survey designers: if the applied use of this reformulated NBR could contribute to get more precise impacts assessments, it implies to collect more data while doing surveys, by recording every market transactions of each household (bought, sold quantities and related prices). This would enable to reflect market failures and seasonality of food crop prices, which are two constancies agricultural households have to face in developing countries.

Finally, we would like to propose three directions for future research:

1. In this paper we assumed that, consecutively to an agricultural trade reform, an exogenous change of border price is uniformly translated at every moment of the year by lowering or raising the price seasonality curves. But this is a strong hypothesis that lead us to ask two questions: what is the specific impact on (a) the regional differential between farm gate price and retail market price?, and (b) the regional price seasonality?
2. Lederman and al. (2005) wrote about the "surprising resistance of mexican maize" in Mexico (price of maize sharply decreased since NAFTA[4] but maize superficies rose). Léonard and Losch (2005) explained it by showing regional differentiations in agricultural productivity but our analysis could offer another explanation. Does the local price seasonality of maize, as we observed in Teopisca (Chiapas, Mexico), act as a buffer for net seller producers who can wait for higher prices to sell their harvest (coping with price decrease by delayed sales)?
3. Lastly, at the frontier of a policy implication and a direction for future research, improving the storage capacity and reducing the cash constraint for targeted poor rural households, both by improving access to the credit market, could be accompanied by non negligible welfare gains.

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ANNEXE

The prices of I tradable goods are changing (we suppose an infinitesimal variation) because of a trade reform. We look for the income equivalent associated to the welfare change of household h, which is the exogenous amount of money to transfer or to quit to h, to restore its initial level of utility.

We write ψ, the indirect utility function of h. We note F the set of factors, P the set of outputs with $P = Ps \cup Psc \cup Pc$ where Ps is the set of produced but not consumed outputs, Psc the set of both produced and consumed outputs and Pc the set of consumed but not produced goods by h. We note $\psi = \psi\ (C; p)$ where $p \in F \cup P$ and $C =$ Total expenditures = Total Income. We do not consider here leisure time. Deaton (1997) assume that household h is separable, meaning that it faces perfect and complete set of markets an dit takes production and consumption decisions sequentially. We can write $\psi = \psi\ (b + \pi(p); p)$ where $\pi(p)$ is the agricultural profit function and b an exogenous transfer. Let's note Qi output supply ($Qi > 0$) or input demand($Qi < 0$) and Xi household marshalian demand for i.

According to Hotelling's lemma :

$$Qi = \frac{\partial \pi}{\partial pi} \text{ if } i \in Ps \cup Psc \cup F \text{ , 0 if } i \in Pc$$

According to Roy's identity:

$$Xi = -\frac{\partial \psi}{\partial pi} \bigg/ \frac{\partial \psi}{\partial C} \text{ if } i \in Pc \cup Psc \text{, 0 if } i \in Ps \cup F$$

Equivalent income associated to the welfare change is found by totally diferenciating ψ, by setting ($d\psi = 0$) and using Hotelling's lemma and Roy's identity :

$$d\psi = \frac{\partial \psi}{\partial C} dC + \frac{\partial \psi}{\partial p} dp = \frac{\partial \psi}{\partial C}(db + \sum_{i \in I} \frac{\partial \pi}{\partial pi} dpi) + \sum_{i \in I} \frac{\partial \psi}{\partial pi} dpi = 0$$

$$d\psi = \frac{\partial \psi}{\partial C}(db + \sum_{i \in I} Qidpi) + \sum_{i \in I} - Xi \frac{\partial \psi}{\partial C} dpi = 0$$

We simplify by $\frac{\partial \psi}{\partial C}$, resolve it for db and we divide by C :

$$\frac{-db}{C} = \sum_{i \in I} pi \frac{Qi - Xi}{C} \frac{dpi}{pi}$$

Net Benefit Ratio for good I and household h is defined as :

$$RBNi = pi \frac{Qi - Xi}{C} \quad \text{so} \quad \frac{-\Delta b}{C} = \sum_{i \in I} RBNi \frac{\Delta pi}{pi}$$

We observe here that the NBR formula is close to the net buyer (resp. seller) « quantity » definition. Writing a first order Taylor approximation of ψ we find :

$$\Delta \psi = \frac{\partial \psi}{\partial C} \sum_{i \in I} (Qi - Xi) \Delta pi = -\frac{\partial \psi}{\partial C} \Delta b \, .$$

First element of right hand is unobservable but we suppose it is positive for all households (the household's utility increases with its income). The relation between the variation of the indirect utility function of household h and Δb is thus shown, as well as the relation between NBRi and Δb.