A partial equilibrium approach to estimating the potential payoffs of providing improved agricultural market information in the form of price forecasts

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Abstract

This article develops a simple partial equilibrium model to provide lower-bound estimates of the potential payoffs of providing improved agricultural market information in the form of price forecasts to producers and consumers. It then applies the model to estimate the potential benefits to farmers and small-scale traders of improved market information on maize, millet, sorghum and paddy rice in Mali. The potential value of information is estimated as the reduction in deadweight loss when farmers and small-scale traders with rational expectations respond to hypothetical improved price forecasts from Market Information Systems (MIS). The study finds that potential benefits from improved information, which can also be viewed as a reduction of cost from being off the equilibrium price and quantity, are greater when there is high uncertainty about future prices, high own-price elasticity of supply, low own-price elasticity of demand, and high value of crop output. The study suggests that crop-specific MIS and MIS that provide region-specific information, based on local area supply and demand responses to prices, have potentially higher returns than national uniformly distributed MIS covering a wide range of commodities in the country.

Key words: impact assessment; food policies; market information services.

Subjects: economy and rural development; tools and methods.

Résumé

Une approche d'équilibre partiel pour estimer les bénéfices potentiels associés à une meilleure anticipation des prix du marché agricole

Dans cet article, nous développons un modèle simple d'équilibre partiel qui vise à mettre en évidence les gains potentiels associés à une meilleure anticipation des prix du marché. Nous appliquons les résultats du modèle au cas des agriculteurs et des petits commerçants intervenant sur le marché du maïs, du mil, du riz paddy et du sorgho au Mali. La valeur de l'information est mesurée par la réduction de la perte de bien-être liée aux erreurs d'anticipation des agents. Cette réduction est susceptible de se produire lorsque, par exemple, les agriculteurs et les commerçants qui ont accès à un système d'information de marché (SIM) sont en mesure de réviser leurs anticipations. Les résultats de l'analyse montrent que le gain potentiel lié à une amélioration de l'information est d'autant plus élevé que l'incertitude sur les prix futurs est grande, que l'élasticité-prix de l'offre est forte, que l'élasticité-prix de la demande est faible, et que la valeur de la production est élevée.

Mots clés : évaluation d'impact ; politique alimentaire ; service d'information de marché.

Thèmes : économie et développement rural ; méthodes et outils.

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Using a partial equilibrium model, this article analyses the potential payoffs of providing improved agricultural market information in the form of price forecasts on farmer and trader welfare. Presently, there is debate among market information systems (MIS) practitioners and donors on how: i) agricultural market information provided by the MIS can be improved to meet more and existing stakeholders' needs; and ii) how the potential benefits from investing in the provision of improved agricultural market information by MIS can be measured (Tollens, 2006; CIRAD, UMR MOISA, 2010). This article contributes to efforts aimed at providing relevant analysis tools to measure the potential benefit of providing improved agricultural market information in the form of price forecasts from a MIS, in order to improve the well-being of farmers, small scale traders, and consumers in developing countries.

In this article, Hayami and Peterson's production adjustment model is modified to provide a partial equilibrium model based on price forecasts rather than quantity forecasts (Hayami and Peterson, 1972). This article assumes that producers and consumers with rational expectation adjust their production and consumption decisions in response to new information in the form of price forecasts from the MIS (Grossman, 1981). The model is based on a simple economic concept, the partial equilibrium model, which many policy and decision-makers in developing countries, who may not be familiar with advanced analytical methods, can readily understand. The model is also parsimonious in its data requirements, giving it an advantage in developing countries where MIS mainly collect and report only commodity prices. The functioning of the model, its assumptions, and shortcomings are given in detail in the next main section below.

The theoretical approach of this article differs from that used by many recent studies that examine the role of access to information and availability of information and communication technologies, notably cell phones, on welfare in terms of: (i) potential efficiency gains (largely through improved arbitrage, reduction in asymmetric information, or reduction in transaction costs); and ii) welfare transfers among agents in the supply chain (mostly through market power, reduction in waste, and improved bargaining between farmers and traders or attainment of "fairer" markets) (Shahidur, 2004; Jensen, 2007; Aker, 2008; Svensson and Yanagizawa, 2009; Aker, 2010; Aker and Mbiti, 2010; Goyal, 2010; Jensen, 2010; Svensson and Drott, 2010).

The benefits estimated are lower-bound for at least two reasons. First, they represent only those benefits accruing to actors from being closer to the equilibrium output and price of a competitive market, but do not include any longer-term benefits that may derive from improved market policies made possible by improved market information. Second, the model does not assign any social value to redistribution of income among buyers and sellers as the result of improved market information; consistent with the approaches of social surplus analysis, the marginal value of a unit of income is assumed equal across all actors. In interpreting the results of any such effort to calculate returns to investment in market information, one needs to keep in mind that there are complementarities between provision of market information and other government reforms. In Mali, MIS activities supplemented market reforms that included redefinition of the role of the state cereal marketing board to focus on maintaining a national security stock and facilitating the role of the private trade, which led to increased private sector participation in trade within Mali and between neighbouring countries (Dembélé and Staatz, 1999; Dembélé *et al.*, 2003). Such programs led to increases in production and farm household incomes. Such complementarities can potentially lead to attribution problems. One way of dealing with this would be to jointly measure the benefits and costs of complementary programs.

The rest of the article is organised as follows. In the next section, the model is applied to measure the value of returns to access of improved information in the form of more accurate price forecasts in the Malian cereal production sector. In the section that follows, the results are presented from the application of the model with accompanying sensitivity analysis, and in the last section, conclusions and implications of the findings for the design of future MIS are provided.

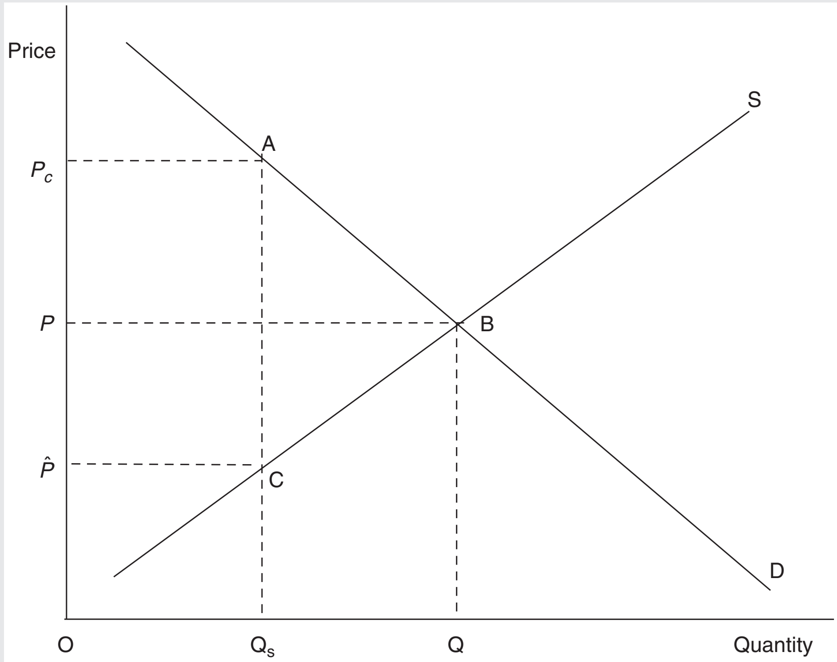
The partial equilibrium model with price forecasts

In this partial equilibrium model, the rationale is based on the fact that the MIS supplies improved information in terms of better price forecasts to farmers and small-scale traders *via* urban and rural radios, newspapers, emails, television, word of mouth, and meetings. The benefits of access to improved information are modelled as the reduction of social welfare loss due to better price forecast (reduction in forecasting errors) from the MIS. An alternative way of looking at this is to measure the benefit of access to improved information as the reduction in the cost of being off the equilibrium price and quantity. The model presented here assumes a closed economy with no international trade. In reality, some agricultural crops are exported from Mali. For landlocked countries like Mali facing high transport and transaction costs, most bulky commodities such as cereals are only semi-tradables, thus the general conclusions from a closed-economy model, such as this one, should be similar in terms of the general direction, if not the magnitude. Another assumption is that producers form rational expectations about quantity demanded when given future prices, and adjust their production outputs based on new information. Another assumption in the model is that the quantities produced are based on anticipated price changes and incentives. This, however, may not always be the case in Mali because many farmers are subsistence producers who produce for own consumption and only sell surplus output. Moreover, there are several other non-price factors that affect production decisions such as poor rainfall, poor capital, level of stocks, infrastructure development (*e.g.*, irrigation and storage facilities), and government policies (*e.g.*, import and export regulations, land restrictions, production quarters, and taxes). To the extent that other non-price factors that affect production other than anticipated price incentives are controlled for in the model through the elasticities of supply, this implies that this model may be most applicable to crops such as irrigated rice in Mali, which has a more commercial orientation.

The model is developed assuming a single homogenous commodity, but at the estimation stage, it is replicated to cover four separate commodities that are sold on the market. Another assumption is that users of market information have some capacity to use reported forecasts to make not only production strategies such as how much to grow, but also post-harvest marketing strategies such as when to sell or store (temporal arbitrage) and where to sell (spatial arbitrage)[1]. In the model, it is assumed that the farmers are the producers and the merchants (small-scale traders) are the consumers. In reality, both farmers and small-scale traders will take on the role of producer and consumers, interchangeably. These assumptions can significantly influence the nature of the results. Thus, the variables used in the analysis are conservative as much as possible, such that the estimates reflect the "lower bound" of social welfare loss due to price forecasting errors.

The graphical form of the partial equilibrium model is given in *figure 1*. The model uses linear demand and supply curves, and assumes that farmers adjust their production along an upward-sloping supply curve (*S*). Price P and quantity Q would be the theoretical competitive equilibrium if there were no market imperfections such as lack of complete and symmetric information, the presence of externalities, or transaction costs. At this point, there would be no deadweight loss and thus no welfare loss (*i.e.*, the cost of being off the equilibrium price and quantity is zero). The analysis in the model is based on price forecasts that are below the competitive equilibrium price.

Supposing that the MIS forecasts a higher price P in the next period below the equilibrium price P, and assuming that producers adopt the forecast, then the production strategy of the producers would be to produce less quantity Q_s. At quantity Q_s, consumers pay P_c, leading to a loss in welfare to society, equal to (ABC).



Proof of Equation 1

Let:

$$e_p = \frac{(\hat{P} - P)}{P} = \text{absolute forecast error which is a percentage of the true price } P$$

$$E_d = \frac{\Delta Q}{\Delta P} * \frac{P}{Q} = \text{absolute own-price elasticity of demand.}$$

$$E_s = \frac{\Delta Q}{\Delta P} \frac{P}{Q} = \text{the own-price elasticity of supply.}$$

$$\Delta P = |\hat{P} - P| = e_p P$$

$$\Delta Q = |Q_s - Q| = e_p E_s Q$$

$$\Delta P_2 = |P_c - P| = \frac{\Delta Q}{E_d} \frac{P}{Q} = e_p E_s P / E_d$$

The social loss of welfare (dead-weight loss), L resulting from sampling errors committed while forecasting *P* is given as:

$$L = \frac{1}{2} \Delta Q(\Delta P + \Delta P_2) = \frac{1}{2} e_p^2 PQ \left(\frac{E_s^2}{E_d} + E_s \right)$$

Figure 1. Price adjustment model.

Figure 1. Modèle d'ajustement des prix.

Terms of equation 1: *P* = producer price of the commodity; $\hat{p}$ = forecast producer price of the commodity; Q = the quantity of the commodity produced.

[1] The degree to which actors can respond to the price information is captured in the model in the supply and demand elacticities which, as shown below, emerge as important parameters in the model.

The social loss of welfare (deadweight loss), L, resulting from sampling errors committed while forecasting *P* is given as:

$$L = \frac{1}{2} e_p^2 PQ\left(\frac{E_s^2}{E_d} + E_s\right) \qquad (1)$$

The proof of *equation 1* is included in *figure 1*. The comparative statics below show how the social loss of welfare changes with a change of each variable in the model.

Factors affecting the impact of improved market information on farmer and trader welfare

Price forecast error

Holding other variables constant, the social welfare loss increases when there is higher previous uncertainty regarding the true future price, *i.e.* when the price forecast error, (ep), becomes large. That is:

$$\frac{\partial L}{\partial e_p} = e_p PQ\left(\frac{E_s^2}{E_d} + E_s\right) > 0 \qquad (2)$$

The intuition is that when farmers receive very low price forecasts for the next period, they will respond by producing very low output, which will lead to a large deadweight loss resulting from an excess demand in the closed economy. When the price forecast is far above the actual price level, but less than the equilibrium price, farmers produce more, leading to a smaller deadweight loss to society. The welfare loss tends to zero as the forecasts become perfect (*i.e.*, $L \rightarrow 0$ as $e_p \rightarrow 0$).

Low own-price elasticity of demand

Holding other variables constant, the welfare loss declines as the absolute own-price elasticity of demand increases (becomes less negative; *i.e.*, less elastic).

$$\frac{\partial L}{\partial E_d} = -\frac{1}{2} e_p^2 PQ\left(\frac{E_s^2}{E_d^2}\right) < 0 \qquad (3)$$

The intuition is that, by holding other factors constant, when the production decisions of the producers respond to price forecasts, but the consumption decisions (quantity demanded) do not, there is a misallocation of resources because consumers want a relatively fixed amount of production, but production is varying due to "mistaken" price forecasts. The presence of elasticities in the model accounts for other factors that affect the demand and supply of commodities other than its price and quantity produced. These may include climatic change, income, prices and quantities of substitutes and complements, and government policies such as regional trade regulations, land restrictions, production quarters, and taxes. Changes in these factors can affect the responsiveness of quantity demanded and supplied to prices even when prices and quantities are held constant.

High own-price elasticity of supply

Holding other variables constant, the welfare loss increase as the own-price elasticity of supply increases (becomes more positive; *i.e.*, more elastic).

$$\frac{\partial L}{\partial E_s} = \frac{1}{2} e_p^2 PQ\left(\frac{2E_s}{E_d} + 1\right) > 0 \qquad (4)$$

The intuition is that a poor price forecast would induce a relatively large shift in production, implying a relatively large misallocation of resources. For example, if the MIS predicted a large reduction in next-season price (*i.e.*, a large forecast error), farmers would respond by over-proportionately reducing the quantity produced in the next season. In the absence of imports, the reduction in quantity produced would lead to a higher loss in social welfare to both producers and consumers.

Large value of farm production

The larger the value of production (*P*Q) involved, the larger the potential misallocation of resources that can result from a poor forecast. The value of production is the product of two factors: the physical volume (Q) of the product entering the market and the per-unit value (P). This means that even if the per-unit value of a product is low (*e.g.*, for some cereals), if there is a large volume entering the market, then the cost to society of being off the equilibrium price and quantity, due a poor forecast price with respect to this crop, can be high. Similarly, even if a crop has a high unit value, if little is produced, then poor market information (or a poor forecast) may not lead to a higher cost to society as a whole from being off the equilibrium price and quantity, although the loss to the few individual producers involved in market production can be high.

Application and results from the partial equilibrium model

The model uses producer price data for four major cereals (millet, maize, sorghum, and rice), released by the Agricultural Market Watch (OMA[2]) in Mali and hypothetical price forecasts. Millet, maize, sorghum, and rice are selected because they account for more than 85% of the cereal calories in Mali (Dembélé and Staatz., 1999). The results are summarised in *table 1* for 2002. Part 1 of *table 1* provides elasticities of demand and supply. The demand elasticities are taken from a study by Camara and the crop yield elasticities, with respect to own-crop prices for the sub-Saharan region estimated by IFPRI, are used as the proxy for the elasticity of supply for the cereals crops (Rosegrant *et al.*, 2001; Camara, 2004).

Part 2 of *table 1* contains production and producer price data for 2002, and value of farm production in USD. Production data was obtained from FAOSTAT data (http://faostat.fao.org/). For example, the value of farm production is estimated to be $38 million for maize, $105 million for millet, $130 million for paddy rice, and $80 million for sorghum.

Loss of social welfare

The loss of welfare to society resulting from price forecast errors is computed

[2] OMA - *Observatoire du marché agricole* - by its French acronym.

Table 1. Estimates of social returns from access to improved market information

Tableau 1. Estimation des bénéfices de l'accès à une meilleure information de marché.

Part 1: Elasticities of demand and supply					
	2002				
Elasticities	Maize	Millet	Rice, Paddy	Sorghum	
Elasticity of demand	-1.968	-0.691	-0.767	-0.691	
Elasticity of supply	0.17	0.14	0.18	0.14	
Part 2: Production, prices and value of farm production, 2002					
Crop production and prices	Maize	Millet	Rice Paddy	Sorghum	
Production (MT)	363,629	795,146	710,446	641,695	
Price CFA (CFAF/MT)	72,200	92,100	127,600	87,000	
Value of farm production (1,000,000,000 CFAF)	26.25	73.23	90.65	55.82	
Value of farm production (1,000,000 USD)*	37.66	105.07	130.06	80.09	
Part 3: Social loss corresponding to percentage of forecasting error in USD for 2002					
Hypothetical price forecast error (in %)	Maize	Millet	Rice, Paddy	Sorghum	Total
High (40)	556,533	1,415,210	2,312,450	1,078,853	5,363,046
35	426,095	1,083,520	1,770,469	825,997	4,106,082
30	313,050	796,056	1,300,753	606,855	3,016,713
25	217,396	552,816	903,301	421,427	2,094,940
20	139,133	353,803	578,112	269,713	1,340,761
15	78,262	199,014	325,188	151,714	754,178
10	34,783	88,451	144,528	67,428	335,190
5	8,696	22,113	36,132	16,857	83,798
0	0	0	0	0	0
Part 4: Marginal social returns from reduction of price forecasting error in USD					
Price forecast error of (in %)	Maize	Millet	Rice, Paddy	Sorghum	Total
40 to 35	130,437	331,690	541,980	252,856	1,256,964
35 to 30	113,046	287,465	469,716	219,142	1,089,369
30 to 25	95,654	243,239	397,452	185,428	921,774
25 to 20	78,262	199,014	325,188	151,714	754,178
20 to 15	60,871	154,789	252,924	118,000	586,583
15 to 10	43,479	110,563	180,660	84,285	418,988
10 to 5	26,087	66,338	108,396	50,571	251,393
5 to 0	8,696	22,113	36,132	16,857	83,798

* 2002 Exchange rate 1 USD = 696.99 CFA. Source: CIA World Fact Book.

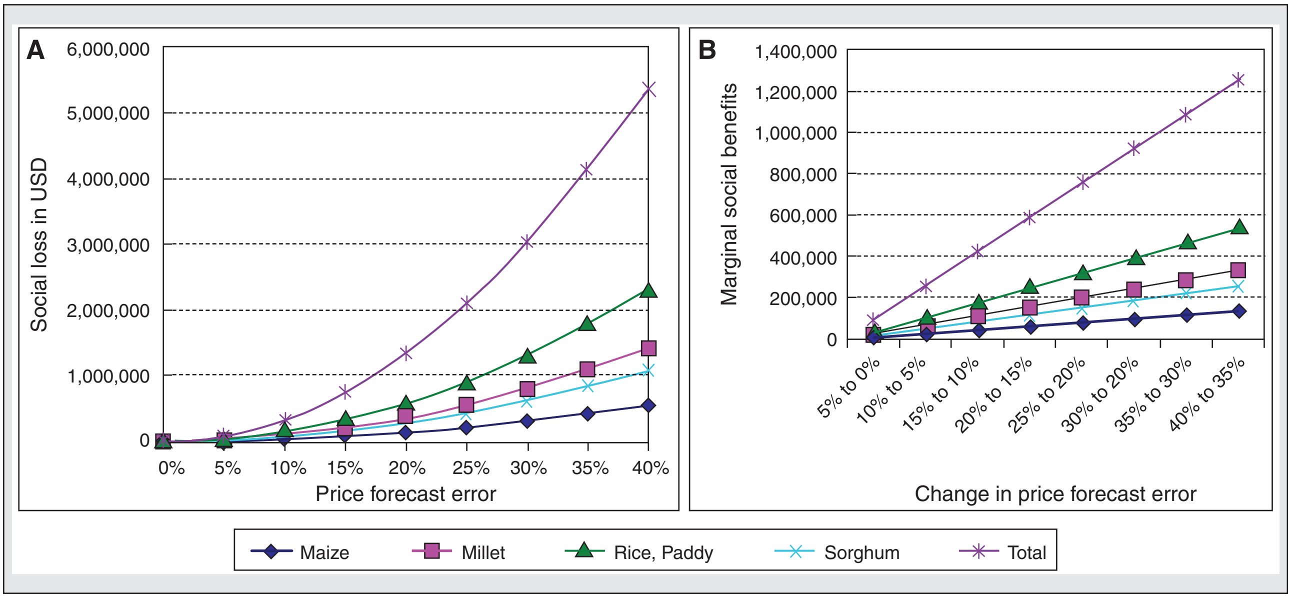


Figure 2. Social welfare loss and marginal social returns associated with reduction in forecast errors for maize, millet, paddy rice, and sorghum in Mali, 2002.

Figure 2. Perte de bien-être social et bénéfices liés à une réduction des erreurs de prévision des prix du maïs, du mil, du sorgho et du riz paddy au Mali (pour l'année 2002).

A) Percentage of price forecasting error in 2002; B) Marginal social returns in US dollars from reduction of price forescasting errors for 2002.

in part 3 of *table 1*. The first column contains the absolute hypothetical price forecast errors in the range of zero to forty percent of the true observed prices. Nine discrete levels of forecast errors are developed to show how loss in social welfare, or the cost of being off the equilibrium price and quantity, reduces with reduction in the price forecast error. Starting at 40%, the error is decreased in a discrete descending order in intervals of 5%, up to 0% error. An error of 40% would depict a bad forecast and an error of 0% a perfect forecast. For

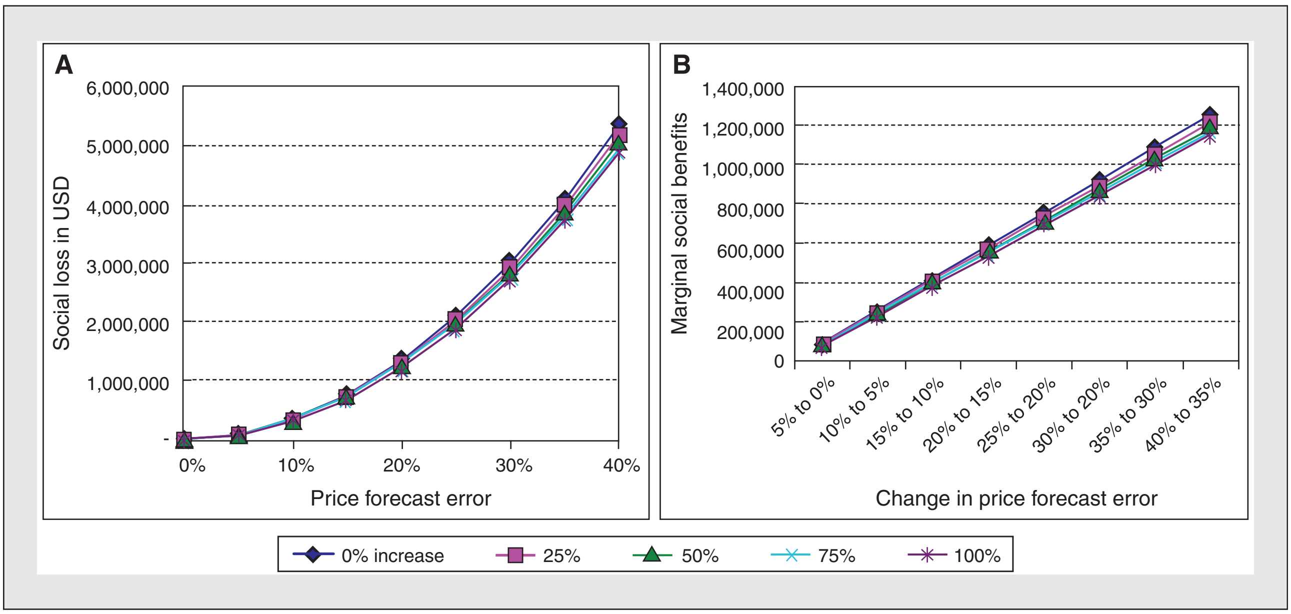


Figure 3. Effect of an increase in elasticity of demand on loss in social welfare and marginal returns from access, and improved price forecasts for maize, millet, paddy rice, and sorghum in Mali, 2002.

Figure 3. Effet de l'augmentation de l'élasticité de la demande sur la perte de bien-être social et les bénéfices liés à une réduction des erreurs de prévision des prix du maïs, du mil, du sorgho et du riz paddy au Mali (pour l'année 2002).

A) Effect of an increase in elasticity of demand to loss in social welfare; B) Effect of an increase in elasticity of demand to marginal benefits from improved price forecasts.

Table 2. Sensitivity analysis of effect of an increase in elasticity of demand, loss in social welfare and marginal social returns, and access to improved price forecasts for maize, millet, paddy rice, and sorghum in Mali, 2002.

Tableau 2. Analyse de sensibilité de l'effet d'un accroissement de l'élasticité de la demande sur la perte de bien-être social et les bénéfices liés à l'accès à de meilleures prévisions des prix du maïs, du mil, du sorgho et du riz paddy au Mali (pour l'année 2002).

Part 1: Sensitivity of loss in social welfare and increase in elasticity of demand

	Percentage increase in elasticity of demand				
Price forecast error (in %)	**0% increase**	**25%**	**50%**	**75%**	**100%**
40	5,363,046	5,182,252	5,061,723	4,975,631	4,911,062
35	4,106,082	3,967,662	3,875,382	3,809,468	3,760,032
30	3,016,713	2,915,017	2,847,219	2,798,793	2,762,472
25	2,094,940	2,024,317	1,977,236	1,943,606	1,918,384
20	1,340,761	1,295,563	1,265,431	1,243,908	1,227,766
15	754,178	728,754	711,805	699,698	690,618
10	335,190	323,891	316,358	310,977	306,941
5	83,798	80,973	79,089	77,744	76,735
0	-	-	-	-	-

Part 2: Sensitivity of marginal social returns and increase in elasticity of demand

	Percentage increase in elasticity of demand				
Price forecast error from (in %)	**0% increase**	**25%**	**50%**	**75%**	**100%**
5 to 0	83,798	80,973	79,089	77,744	76,735
10 to 5	251,393	242,918	237,268	233,233	230,206
15 to 10	418,988	404,863	395,447	388,721	383,677
20 to 15	586,583	566,809	553,626	544,210	537,147
25 to 20	754,178	728,754	711,805	699,698	690,618
30 to 25	921,774	890,700	869,984	855,187	844,089
35 to 30	1,089,369	1,052,645	1,028,163	1,010,675	997,560
40 to 35	1,256,964	1,214,590	1,186,341	1,166,164	1,151,030

example, in part 3, for sorghum, when the price forecast error is 40%, there are society losses of $ 1.1 million, and if the forecasting error is reduced to 35%, there are society losses of $0.8 million. When there is a perfect price forecast, meaning a 0% forecast error, then the loss in social welfare from future price uncertainty, holding other factors constant, is zero.

Benefits of MIS through improved market information

Part 4 of *table 1* shows the marginal social returns from reducing the price forecasting error. It shows how much society would save if the price forecasting error were reduced to different ranges between 40 and 0%. The model computes the reduction in the deadweight loss when farmers with rational expectations respond to improved price forecasts provided by MIS. For example, in part 4 of *table 1*, reducing the price forecast error for paddy rice in 2002 from 40 to 35% would save $0.54 million of social welfare, while reducing the forecast error from 10 to 5% would save 0.11 million dollars worth in social welfare. For all the four

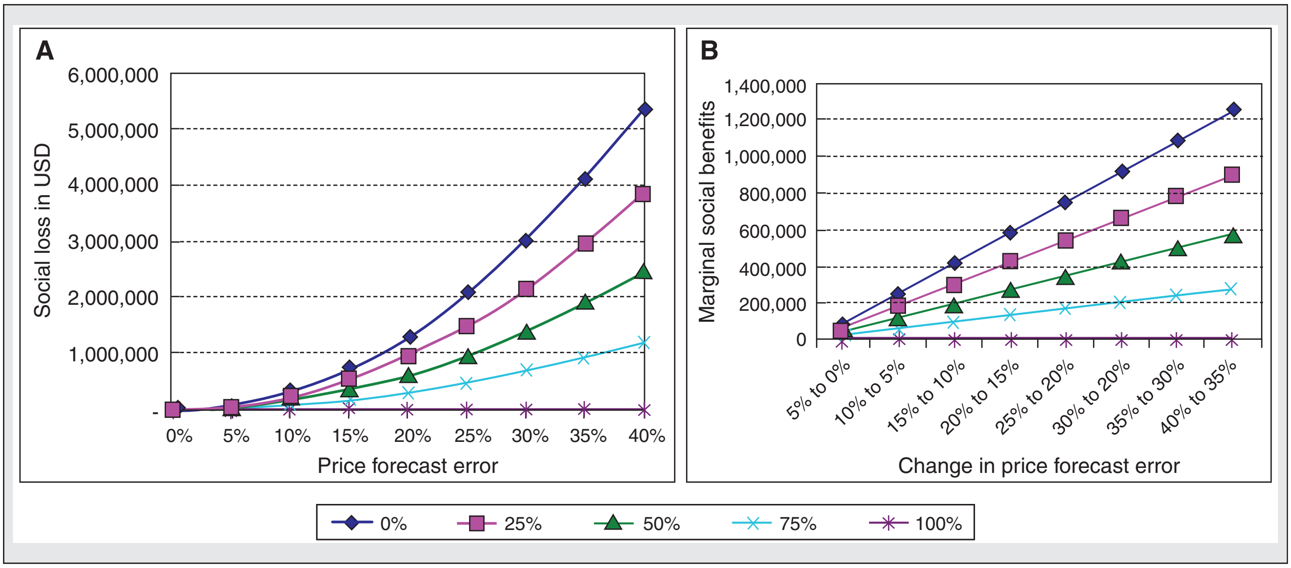


Figure 4. Effect of a decrease in elasticity of supply on loss in social welfare and marginal returns from access and improved price forecasts for maize, millet, paddy rice, and sorghum in Mali, 2002.

Figure 4. Effet de l'augmentation de l'élasticité de l'offre sur la perte de bien-être social et les bénéfices liés à une réduction des erreurs de prévision des prix du maïs, du mil, du sorgho et du riz paddy au Mali (pour l'année 2002).

A) Effect of a decrease in elasticity of supply to loss in social welfare; B) Effect of decrease in elasticity of supply to marginal benefits from improved price forecasts.

cereal crops, reducing the price forecast error from 40 to 35% would save $1.3 million in social welfare, while reducing the forecast error from 10 to 5% would save 0.25 million dollars worth in social welfare.

The above estimates are computed using a partial equilibrium model and the estimated benefits are for each individual crop. Aggregating the benefits makes the sum significant in comparison with the setup and running costs of MIS in developing countries. For instance, one of the assumptions in this model is that MIS forecast and disseminate information to farmers using mostly radio, television, newspapers, billboards, and word of mouth. Estimated costs of disseminating information by radio have been reported to be US$120,000 per annum in Kenya, US $20,000 per annum per language in Uganda, and US$10,000 per annum in Tanzania (Shepherd, 2001). In Uganda, the overall costs of setting up and running a localised micro information service, serving a population of about one million households growing maize and beans, was estimated to be US $30,000 per annum. This study, conducted with more improved economic tools and using empirical parameters, indicates that the social benefits of providing improved information to farmers and small-scale traders far outweigh the required investment costs.

In 2006, the cost of running the market information service in Mali was estimated at $0.35 million per year. Given that this figure covers many crops and the whole country, and that the estimates in parts 3 and 4 of *table 1* cover only four commodities, it is reasonable to state that the benefit of providing market information, which results in reducing price forecast errors within a 10 to 15% range ($0.42 million), outweighs the costs of running the service. This argument can be made stronger given that this model does not capture all the benefits of providing improved MIS to farmers and small-scale traders.

As a caveat, these figures are obtained from a partial equilibrium model and therefore face an aggregation problem due to summing up the expected gains from better MIS forecasts, without taking care of the nature of complementary and supplementary relationships between the four commodities in the model. By summing up across all changes in social welfare from MIS, individual forecasts of each crop are unlikely to be the same when all crops faced the same poor forecast at the same time, because: i) the elasticity of supply of all cereals in the aggregate is likely to be less than that for any one cereal individually (as there is less room for inter-crop substitution in production if all cereals are affected at once). This would mean that the current summing up of all four separate crops would tend to overestimate the cost of poor forecasts of all grains in aggregate; ii) on the other hand, the price elasticity of demand for all grains in aggregate is likely to be lower than that for the grains individually, as there is less scope for substitution between grains and other foods as there is among grains. Thus, this would tend to underestimate the effect of a poor price forecast for all grains in the aggregate. Whether the aggregation error leads to an underestimate or an overestimate of the total cost of poor price forecasts for all grain crops at once, depends on the relative balance of these two effects and cannot be answered *a priori*.

Sensitivity analysis of the benefits to forecast errors, demand, and supply elasticities

Sensitivity analysis was performed for 2002, but can be applied to any year.

Table 3. Sensitivity analysis of effect of a decrease in elasticity of supply, loss in social welfare and marginal social returns to access, and improved price forecasts for maize, millet, paddy rice, and sorghum in Mali, 2002.

Tableau 3. Analyse de sensibilité de l'effet d'un accroissement de l'élasticité de l'offre sur la perte de bien-être social et les bénéfices liés à l'accès à de meilleures prévisions des prix du maïs, du mil, du sorgho et du riz paddy au Mali (pour l'année 2002).

Part 1: Sensitivity of loss in social welfare to decrease in elasticity of supply

	Percentage decrease in elasticity of supply				
Error (in %)	**0%**	**25%**	**50%**	**75%**	**100%**
40	5,363,046	3,852,791	2,455,531	1,171,268	-
35	4,106,082	2,949,793	1,880,016	896,752	-
30	3,016,713	2,167,195	1,381,236	658,838	-
25	2,094,940	1,504,996	959,192	457,526	-
20	1,340,761	963,198	613,883	292,817	-
15	754,178	541,799	345,309	164,710	-
10	335,190	240,799	153,471	73,204	-
5	83,798	60,200	38,368	18,301	-
0	-	-	-	-	-

Part 2: Sensitivity of marginal social returns and decrease in elasticity of supply

	Percentage decrease in elasticity of supply				
Price forecast error from (in %)	**0%**	**25%**	**50%**	**75%**	**100%**
5 to 0	83,798	60,200	38,368	18,301	-
10 to 5	251,393	180,600	115,103	54,903	-
15 to 10	418,988	300,999	191,838	91,505	-
20 to 15	586,583	421,399	268,574	128,107	-
25 to 20	754,178	541,799	345,309	164,710	-
30 to 25	921,774	662,198	422,044	201,312	-
35 to 30	1,089,369	782,598	498,780	237,914	-
40 to 35	1,256,964	902,998	575,515	274,516	-

Effect of changes in price forecast errors

Figure 2A shows that the losses in social welfare increase with price forecast errors, keeping elasticities of demand and supply constant. The figure illustrates that the losses to society increase as uncertainty regarding future prices increases. The results are a graphical representation of the information contained in part 3 of *table 1*. For example, the total loss in welfare to society when a 40% forecast error is committed, is $5.4 million while a 10% forecast error results in a $.34 million loss per annum.

Figure 2B shows the marginal social returns related to a five percent decrease in price forecast errors. For example, when the price forecast error is reduced from 40% to 35% and from 10 to 5%, society benefits by saving $1.2 and $0.25 million, respectively. The figure shows that as the forecasting errors fall, the marginal benefits from the MIS also decline.

Effect of changes in elasticity of demand

As the own-price elasticity of demand increases, holding other factors constant, the expected loss in social welfare reduces. *Figure 3A* and part 1 of *table 2* show that the total social loss in welfare from access to more accurate information does not respond very much to changes in elasticities of demand, compared to changes in supply elasticities, as will be seen in the next section. For example, if a 40% forecast error is committed, according to the elasticities of demand and supply in *table 1*, part 1, the total loss in welfare from the four commodities is $5.4 million. When the elasticity of demand is increased by 50%, holding the price forecast error at 40%, the total loss in welfare from the four commodities reduces to $5.1 million, representing only a 6% reduction in welfare loss. *Figure 3B* and part 2 of *table 2* show that at any given price forecast error level change (*e.g.* from 40 to 35%), benefits from access to better information show less variability due to changes in elasticities of demand.

Effect of changes in supply elasticities

Figure 4A and part 1 of *table 3* show that for any given level of forecast error, as the elasticity of supply falls, the loss of social welfare declines more rapidly than in the case of elasticity of demand in *figure 3A*. For example, in 2002, if a 40% forecast error is committed, at the base-case elasticities of demand shown in *table 1*, part 1, the loss to society is $5.4 million for the four cereal crops in 2002. When the elasticities of supply are reduced by 50%, holding price forecast errors at 40%, the loss to society is $2.5 million for the four cereal crops, representing only a 54% reduction in welfare loss. A comparison between *figure 3A* and *figure 4A* shows that variations in the level of elasticity of supply are more likely to affect the payoffs to investing in MIS than variations in the levels of elasticity of demand.

Conclusions and implications of the design of future MIS

In this simple, restricted model, the value of information is estimated as the reduction in net social welfare loss when farmers, traders, and consumers with rational expectations adjust their production and consumption behaviour in response to improved information from the MIS. The benefits from access to improved information can also be viewed as the reduction of the cost of being off the equilibrium price and quantity. The results indicate that there would be more returns if improved market information is targeted to farmers and traders when:

– the level of uncertainty about future market price in the market is high;
– the own-price elasticity of demand for agricultural commodity is low;
– the own-price elasticity of supply for the agricultural commodity is high;
– the value of farm production of the crop is high.

This article also shows that the payoffs of investing in MIS, which results in reducing price forecast errors within a 10 to 15% range for the four main staple crops (maize, millet, sorghum, and paddy rice), are more than the annual operating costs of the MIS in Mali. Since the elasticities of supply and demand and the value of farm production are likely to be different for the four crops in different regions in Mali, the findings in this study suggest that crop-specific information services and information services that provide region-specific information, targeted based on the above criterion, may have more returns than large centralised and uniformly distributed information services. For example, the supply elasticity is likely to be low in some areas with low resources, such as poor rainfall and lack of capital. This implies subsistence farmers in low-resource areas may not change their producing behaviour, even if provided with relevant market information.

Crop-specific MIS and region-specific information:

Conceptually, these results suggest that the MIS needs to produce and diffuse information specific for each crop in each region. Although the analysis in this study was not performed on a regional basis, the results suggest that provision of information services be targeted such that crop-specific information is collected, analysed, and disseminated to areas where the value of agricultural production of the selected crops is high. For instance, if the value of agricultural production is high for rice, and not for millet and sorghum, then it is better that the MIS provides price forecasts and other market information on rice. This would be cost-saving in terms of time and money, and increases the accuracy and timeliness which results in higher benefits to society. Another key consideration here concerns emerging new crops or crops, of which market outlooks are changing. When the MIS is keen to observe changes in supply and demand trends, such as other productions that might be interesting and could replace grains (*e.g.*, groundnuts and cowpeas), then providing such information may result in stronger impact.

The weakness of this simple partial equilibrium model is that it assumes a closed economy and does not account for the stocks. The model also does not account for the impact of MIS on better government policies resulting from the use of MIS information (*e.g.*, monitoring food security and distribution of food assistance in ways that do not distort markets based on information signals from the MIS), which can have important long-run dynamic effects. This article is a first step in quantifying the impact of MIS on the welfare of producers and consumers. ■

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