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ESTIMATING THE BENEFITS FROM IMPROVED MARKET INFORMATION

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ABSTRACT

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Using a partial equilibrium model, the benefits of providing improved agricultural market information to farmers and small-scale traders of maize, millet, sorghum and paddy rice in Mali are estimated. The value of information is estimated as the reduction in dead-weight loss when farmers and small-scale traders with rational expectations respond to improved price forecasts from Market Information Systems. The study finds that benefits from improved information, which can also be viewed as a reduction of the cost of being off the equilibrium price and quantity, are great 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, localized Market Information Systems (MIS) designed based on local area supply and demand responses to prices have higher returns than national uniformly distributed MISs covering a wide range of commodities in the country.

To Juliet, Lydia, Jesse, Jenell and Lyndsey

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CHAPTER 1: INTRODUCTION

1.0 Introduction

In the 1980s and 1990s many developing countries, with donor support, invested in Market Information Systems (MIS) and other reforms to strengthen markets so as to increase incomes in rural households by inducing increased production through market incentives. As part of the changes, MIS's were established to provide support services to market participants such as farmers, traders and consumers (Dembélé and Staatz, 2000, Dembélé, et al., 2000, Dioné, 2000, Ferris, et al., 2004, Shepherd, 1997). While many advantages of MIS's have been observed, such as reduction in transaction costs, encouragement of arbitrage, and market transparency, which enhance competition in the market, not many economic tools, readily understood by policy and decision makers, have been developed and applied to estimate their welfare effects to households in developing countries.

A number of issues have emerged among stakeholders such as donors, government and the private sector regarding investment in MIS. First, there is need to demonstrate how provision of improved information leads to increased social welfare of households. A second question is whether the social welfare is redistributed so as to benefit farmers, small-scale traders, and consumers. The third issue is whether the benefits of providing market information to farmers and traders exceed the costs involved in setting up and running information services. As a result, in the past 5 to 10 years, many development partners have encouraged governments, NGO and other interested parties to strengthen impact assessment of program and project activities to help answer some of the above concerns.

The performance MIS's in developing countries often declines once donor funding is withdrawn. This is because policy and decision makers do not readily adjust government budgets to fill up the financial vacuum (Aldridge, 1999, Shepherd, 1997). While this is partly due to lack of alternative and sustainable source of funding, the main problem is that benefits from MIS's are not easily quantifiable and have some "public-good" characteristics.

This study aims at quantifying the benefits to society from investing in provision of improved market information in the form of more accurate price forecasts. The model estimates the reduction in the dead-weight loss when producers with rational expectations respond to improved price forecasts provided by Market Information Systems. Another way of looking at this is in terms of the role of access to improved information in reducing the costs of being out of equilibrium.

The study will supplement efforts aimed at providing relevant analysis tools to governments, development partners and the private sector on how to measure the role of MIS's in improving the well-being of farmers, small scale traders and consumers in developing countries. 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. Also, the data required by complex models are not readily available in developing countries, where MIS's mostly collect and report commodity prices (Aldridge, 1999).

1.1 Benefits of an MIS

This section summarizes some of the benefits that farmers and small scale traders can obtain from access to improved market information.

1.1.1 Market Transparency and Arbitrage

Market Information Systems can lead to greater market transparency. Market transparency refers to a situation in which transacting parties have access to prices and other market information such as location of available supplies. Market transparency helps lead to both spatial arbitrage, a process where traders transfer goods and services from areas of lower prices to those with higher prices, and temporal arbitrage, which refers to the storage of goods in order to obtain expected higher prices in the future. Arbitrage eventually results in increased quantity demanded of commodities in areas where prices are low, leading to a rise in farm gate prices. On the other hand, spatial arbitrage tends to increase supplies in areas where prices exceed the cost of supply.

Coupled with the improved ability of farmers to negotiate selling prices as they are better informed about price levels and trends, the net effect of providing market information is that aggregate prices across the country become truer reflections of the overall patterns of supply and demand and the transaction and transport costs (Shepherd, 1997).

1.1.2 Reduction of Transaction Costs

Market Information Systems can help farmers to reduce transaction costs. Williamson refers to transaction costs as "the economic equivalent of friction in physical systems". He grouped transaction costs into two types: the first are *ex ante* transaction costs, which include "costs of drafting, negotiating and safeguarding an agreement" (Williamson, 1985). These include costs of gathering, processing and coming to a decision within an organization and between transaction parties, sometimes including third parties such as government regulatory agencies. The second type is the *ex post* transaction costs, which refer to costs of monitoring performance and enforcement of the agreement, including costs of dispute resolution. Williamson refers to *ex post* as follows:

> These include (1) the maladaption costs incurred when transactions drift out of alignment...(2) the haggling costs incurred if bilateral efforts are made to correct *ex post* misalignments, (3) the setup and running costs associated with the governance structures (often not the courts) to which disputes are referred, and (4) the bonding costs of effecting secure commitments (Williamson, 1985).

For example, Market Information Systems can help farmers reduce the time and money involved in finding partners with whom to trade and reduce the time they use to bargain to come to an agreeable price with traders. Also, when traders work with the MIS, they can obtain information that can help them to identify who reliable partners are in a short time, which cuts down on transaction costs.

1.1.3 Identification of New Markets

Market information can help farmers identify distant and new markets. This can be in terms of new products for which information becomes available or expansion of the geographical coverage of markets within and or outside the country, hence developing and facilitating extra and intra-regional trade. This have been observed in Mali, where increased access to improved market information increased market transparency and facilitated the entry of new cereal traders in assembly, wholesale and retail markets following market reforms that led to disengagement of the national grain board from commercial trading ((Dembélé and Staatz, 2000, Staatz, et al., 2004a);

1.1.4 Design of Better Policy

Market Information Systems can help provide information to design better policies. MIS collect and compile data which can be used for statistical and planning purposes and monitor the impacts of policies by governments, research organizations and development partners. For example, unusually high prices can be an indicator of shortages and lower prices an indicator of excess supply in the market. While many policy makers understand this phenomenon, Market Information Systems are valuable in helping policy makers to understand factors that cause such shortages and excess supply, together with other current dynamics in the markets.

Differences in farm gate, wholesale and retail prices can be used to make inferences about relationships between farmers, traders and consumers. Market information is a key ingredient in running early warning and food security reserve management (Shepherd, 1997). Also, information is very useful to policy makers in designing better policies and monitoring the impact of various government policies and other actions in the food system. For example, information can be used to measure the impact of free food distribution on prices and demand of food in a given area.

1.1.5 Reduction in Risk and Efficient Allocation of Productive Recourses

In the absence of programs such as marketing boards or minimum price programs, which buy agricultural products from farmers at fixed prices; farmers bear considerable risks associated with their production and marketing decisions and actions. Consumers bear some of the risks transmitted to subsequent production stages in the food system, such as volatile prices for staple food products.

For some agricultural crops, e.g. cassava tubers which can be stored in the ground for a considerable period, market information can help farmers avoid market risks such as harvesting and delivering products to markets at unfavorable prices. Shepherd (1997) argues that farmers can use current market information to decide to postpone harvesting or to store produce up to that period when prices cover their production and marketing costs. In addition, if farmers have an idea of prevailing or future market prices, they can allocate their scarce recourses to inputs such as fertilizers, pesticides and labor in a more productive way (Shepherd, 1997). Thus improved market information can help farmers to spread out risks by diversifying and growing different crops.

1.1.6 Rent Redistribution

In many developing economies, governments may set up policies (e.g. quotas and licenses), that may encourage firms, individuals or organizations to behave in opportunistic and manipulative ways to compete for rents. These actions, which Anne Krueger refers to as “rent seeking,” reduce the social welfare of consumers and producers because they are not backed by trade, production or value addition (Krueger, 1974). For example, there are incidences in which small-scale traders near border points indulge in informal channels of trading agricultural produce across borders just because they do not know that export and or import fees have been eliminated or substantially reduced, to the extent that it would be more profitable for them to use formal channels like other formal traders. Access to market information facilitates the "leveling of the playing field" which enables informal traders to cross to formal trading, leading to rent redistribution among market participants

1.2 Problem Statement and Research Objectives

Using hypothetical price forecasts, observed producer prices, and production data from Mali, this paper utilizes a partial equilibrium model to measure the welfare benefits to society resulting from investing in provision of improved market information to producers and consumers. Specifically, the study:

1. Reviews the theoretical methods used in measuring economic benefits from access to improved information.
2. Modifies and applies a price adjustment model to measure the value of returns to access of improved information in form of accurate price forecast in the Malian cereal production sector.

1.3 Organization of the Paper

This paper consists of 4 chapters. Chapter 2 provides literature review covering some of the theoretical concepts and methods that have been proposed for measuring economic benefits of access to and utilization of improved information and their shortcomings. Chapter 3 presents the Price Adjustment Model and its application using data from Mali. Chapter 4 gives a summary and conclusions of the paper.

CHAPTER 2: METHODS USED TO VALUE INFORMATION

2.0 Introduction

This chapter summarizes some of the methods that have been put forward to measure the value of access to improved information to producers and consumers of goods and services under a competitive setting.

2.1 Role of Information in the Arrow-Debreu World

Information plays an important role in the functioning of the market. When Walras proposed the Walrasian price adjustment, and Marshall the Marshallian quantity adjustment, they assumed that if prices and quantities changed in a market, all buyers and sellers acquired information about the changes, which enabled them to form a new equilibrium almost instantaneously so that the quantity demanded would equal the quantity supplied. In reality, this is not the case because individuals and firms do not behave this way in the market place partly because they do not instantaneously acquire up-to-date information to make such adjustments.

Building on the work of Leon Walrus, Arrow and Debreu proved the existence of equilibrium prices in which agents traded in contingent commodities that accounted for different states of nature, including different locations and time in markets with uncertainty (Arrow and Debreu, 1954). In the process of accounting for both temporal and spatial adjustments in the markets, many fundamental assumptions have to hold, and one of them is that agents have access to complete and symmetric information for the market to be properly defined. When there is imperfect information, the neoclassical partial equilibrium model attributed to Alfred Marshall and Arrow-Debreu's general competitive equilibrium model may not hold, and Pareto efficiency may not be achieved.

For example, Akerlof's "lemon model" for the market for used cars, in which there is asymmetric information about the quality of cars between sellers and potential buyers, attests to the importance of information to the functioning of markets. He was able to show that bad quality cars could drive good quality cars out of the market if buyers were unable to tell the true quality of the cars (Akerlof, 1970). If buyers had sufficient information that the cars they were buying were of high quality, they would be willing to pay more. However, if there was hidden information about the true quality of the cars, buyers would prefer to pay the average market value, which would drive sellers of good quality cars out of the market, since buyers were offering prices below the reservation prices of good quality cars. This phenomenon, referred to as adverse selection in agency theory, results from presence of asymmetric information, and may lead to development of thin or missing markets.

2.2 Value of Information

Stigler (1961) suggested that the value of information is based on the benefits and costs of access to improved information. The benefits of access to information are in the form of savings that sellers and buyers make when they have access to improved information. Stigler indicated that a consumer will search for a minimum price (P) from available stores (n). If $F(p)$ is the cumulative density function of p, the probability that price (P) is the smallest among the searched prices is given by:

$$P_{\min}^{n} = \int_{0}^{\infty} [1 - F(p)]^{n} \, dp \, .$$

The marginal benefit from search $(P_{\min}^{n-1} - P_{\min})$ decreases as n increases, implying diminishing marginal benefits from search, and is given as:

$$\left|\frac{\partial P_{\min}}{\partial_n}\right| = P_{\min}^{n-1} - P_{\min}^{n} = \int_0^{\infty} [1 - F(p)]^{n-1} F(p) dp$$

The Expected Savings, E(S), from an additional unit of information is approximated by quantity purchased times expected reduction in price.

$$E(S) = q * \left|\frac{\partial P_{\min}}{\partial_n}\right| = q * (P_{\min}^{n-1} - P_{\min}^{n})$$, where q=quantity bought.

Stigler suggested that cost of information be based on search costs in terms of money and time spent on communication and travel incurred to obtain improved information. Because there is a cost to search for information, it means that the more a buyer or seller indulges in search, the more costs he or she will incur, resulting in diminishing returns as the number of stores increases (Stigler, 1961).

To maximize returns, one would have to ensure that the marginal cost of search does not exceed the marginal benefit he or she would obtain by searching the next store. Thus the optimal search is obtained when marginal cost of search is equated with the marginal returns from search.

Stigler's concepts have been adapted to provision of public information by Blake et al., (1979), who argue that the benefits of the access to improved information be measured in terms of the private savings made on search costs by farmers and traders by obtaining information from the MIS rather than looking for the information on their own (Blake, et al., 1979). An additional way of looking at benefits of an MIS would be to measure the increase in income that farmers and traders would obtain by making better decisions as a result of obtaining better information from a public information service. In a related approach, (Bonnen, 1986) in (Aldridge, 1992) suggested that value of information be measured as the value of the decision made with information minus the value of the decision made without information, minus the cost of obtaining information.

To be able to implement the above approach, one would need to conduct periodic and regular surveys in order to come up with marginal benefits and marginal costs. This would be expensive in terms of money and time, especially in developing countries with limited budgets. For this reason, this approach is not considered for use in this paper.

2.3 Information and Increase in Social Welfare

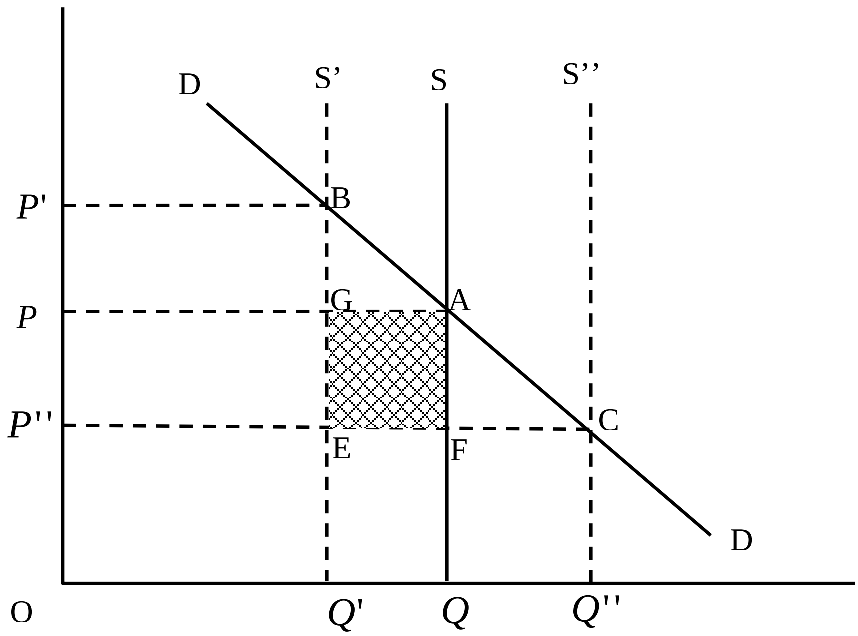
Hayami and Peterson (1972) developed a social welfare model to estimate the social returns to the private sector from investing in improved forecasts. They obtained the increase in social welfare as a result of increased accuracy or reducing sampling errors, which change the quantity produced, and compared these with the costs of conducting sample surveys to obtain the cost-benefit ratios. Since this paper will use a modified version of Hayami and Peterson's model, more details of this model are given below.

2.3.1 Inventory Adjustment Model

The first model presented in figure 1 was applied in short-run situations where production could not be adjusted significantly and the supply curve (S) is considered to be perfectly inelastic. In such a situation, inventory holders adjust release of stocks to the market depending on whether a public agency, e.g., United States Department of Agriculture (USDA), predicts more or less than normal crop output in the following year.

In the model, the difference between the predicted and actual output is referred to sampling error. For example, if USDA predicted a far-below-average crop (Q') in the following year, the inventory holders would expect higher prices and reduce the rate at which they deplete their inventories. This induces a shift of the supply curve to the left (Q') leading to high consumer prices (P') and reduction in quantity demanded to OQ'. This leads to a reduction in total social welfare (producer and consumer surplus) by $\mathrm{ABQ'Q}$. The gain in producer surplus to inventory holders will depend on the elasticity of demand (Hayami and Peterson, 1972). If demand is inelastic, the producer surplus will be higher since an increase in prices will not lead to a more than proportional reduction in quantity consumed. When demand is elastic, the producer surplus will be less because an increase in price will result in a more than proportional reduction in quantity consumed.

Figure 1: Inventory Adjustment Model



From Hayami and Peterson, 1972

In the next period, Hayami and Peterson argue that there would be a carry-over $Q'Q$ which in addition to the normal production OQ would total to OQ''. At this point there would be a reduction in consumer prices to P'' (below P which would prevail if there was no reporting error). This leads to an increase in social welfare by ACQ''Q.

The net loss to society from inaccurate statistical reporting (i.e., initially underestimating the size of the harvest, leading to a reduction in the drawdown on inventories in period 1) would equal the losses when prices rise minus gains when prices fall, which is given by $\text{ABQ'Q - ACQ''Q = AGEF}$. The value of improved information (i.e., more accurate forecasts) is considered to be the reduction in the welfare loss to consumers and producers as a result of reducing the error in forecasting by the forecasting agency, which Hayami and Peterson estimated as:

$$\text{AGEF=AG*GE} = \Delta Q * \Delta P = eQ * \frac{eP}{E_d} = \frac{e^2 QP}{E_d} \qquad (2.1)$$

Where:

Q = the quantity of the commodity produced

P = the producer price of the commodity

e = the sampling error which is a percentage of the true quantity Q

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

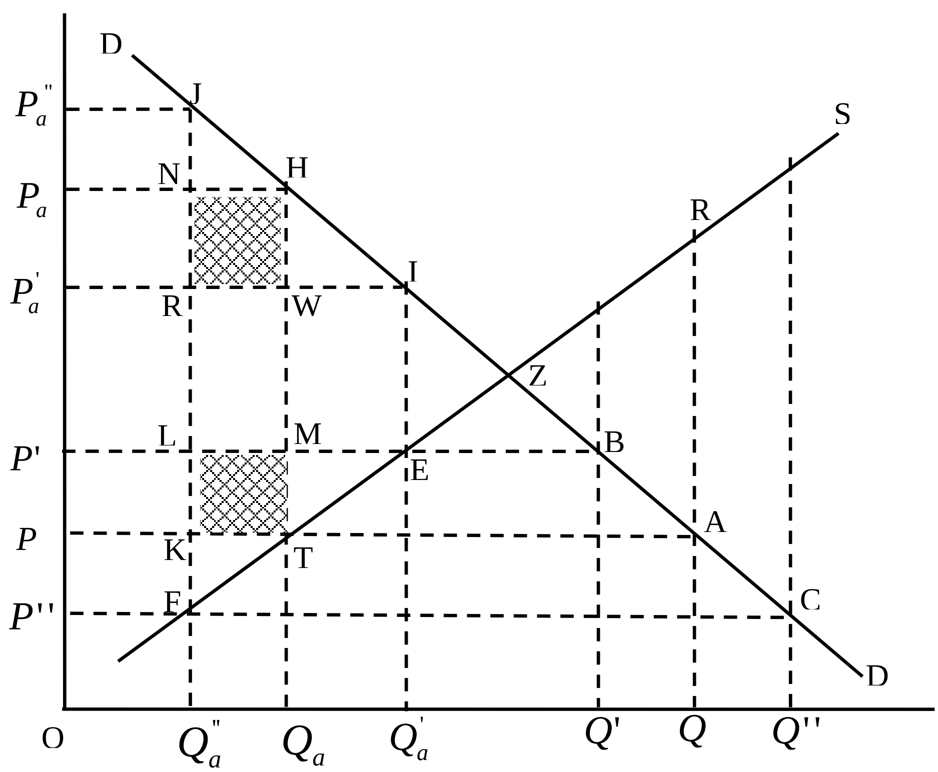
The assumptions in the model are that (1) the demand is linear, and that (2) price elasticity of demand is known. Equation (2.1) suggests that the payoffs to market information (in the form of better production forecasts) are greater where: (a) the sampling error, which shows previous uncertainty regarding quantity produced, is large; (b) the value of inventories, as reflected in the price, is high; and (c) the own-price elasticity of demand is low.

2.3.2 Production Adjustment Model

In the Production Adjustment Model, it is assumed that producers can adjust output in response to additional information from the reporting agency, i.e., there is an upward-sloping supply curve (S), as shown in figure 2. The assumptions are: (1) that price expectations change because of new information from the statistical reporting agency, (2) producers adjust production along the supply curve, and (3) the supply and demand curves are linear and their elasticities are known. Because this is a production adjustment model, based on rational expectations, it works like a cobweb model, and requires that the elasticity of supply be less than the elasticity of demand to ensure stability and convergence to equilibrium.

Hayami and Peterson's model starts by assuming the producers are unaware that their true production level would be at OQ (which is not the traditional equilibrium location on the graph, possibly because of various market failures such as externalities, public-goods and incomplete and asymmetric information) if their production plans materialized. If a production survey could correctly predict that production would be OQ, and the demand is known, then the predicted price in the next period would be OP. This would induce producers to cut production so as to put output OQ_a on the market.

Figure 2: Production Adjustment Model



From Hayami and Peterson, 1972

At quantity OQ_a, the consumer price would be OP_a implying that the marginal benefit of an extra unit (P_a) is more than the marginal cost (P), and that society would benefit if more were to be produced. Under competition, and in the absence of externalities, at output Q_a, there is misallocation leading to a dead-weight loss to society given by area ZHT.

Hayami and Peterson assumed that sampling errors occur randomly with a probability 0.5 that they are more or less than the true parameter. For example, if the quantity predicted is OQ', then the total loss to society would be ZIE, a reduction in social loss of IHTE. On the other hand, if the sampling error resulted in an overestimate of production to OQ'', then the dead-weight loss would be ZJF, an increase in social loss of HJFT. The difference between these two areas (HJFT- IHTE) equals the two shaded areas.

The expected value of net social loss to society is given as half the sum of the shaded areas, which takes care of the fact that the sampling error might be larger or smaller than the true estimate. The estimated social loss due to random sampling errors is:

$$\text{E (SL)} = 0.5\ (\text{TMLK + HNRW}) = \frac{1}{2}e^2 PQ\left(\frac{E_s}{E_d^2} + \frac{E_s^2}{E_d^3}\right) \qquad (2.2)$$

Where:

Q = the quantity of the commodity produced

P = the price of the commodity

e = the sampling error which is a percentage of the true quantity Q

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

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

Again, in this model, the value of information is considered to be the reduction in the welfare loss to consumers and producers as a result of reducing the error in forecasting by the forecasting agency. The data requirements for estimating benefits to improved information using Hayami and Peterson's models are the crop forecasting error, value of crop production and demand and supply elasticities.

Just like in equation (2.1), the model assumes linear demand and supply, and known own-price elasticity of demand and supply. Equation (2.2) suggests that the payoffs to market information are greater where (a) the sampling error is large (b) the value of farm production is large (c) the own-price elasticity of demand is small and (d) the own-price elasticity of supply is high.

This paper modifies this approach by assuming that the public information service supplies improved information in terms of a better price forecast to producers and small scale traders. The benefits of improved information from the reduction of welfare loss due to a better price forecast from Market Information Systems. This is appealing because the concept is simple to understand by policy and decision makers who may not be familiar with more complex models. Secondly, the data requirements are few and reasonable, unlike Stigler's method in 2.2, and the decision-theoretic approach discussed below.

2.4 Decision-Theoretic Approach

This approach presented by Eisgruber (1978) measures the benefit of providing improved information as the difference in expected utility given a prevailing state of nature and the cost of obtaining the information. The prevailing states of nature are assumed to be known with varying probabilities. This method demonstrates that those consumers who alter their decisions on how to allocate their resources as a result of access to improved information obtain better payoffs than those who do not have such information. To demonstrate this approach, assume there are two states of the world (these can be generalized to many, say n, but for simplicity, only two are considered). Then the decision theoretic-approach is such that:

$$\mathrm{E(U)} = \pi_g U(W_g) + \pi_b U(W_b) - C(I) \qquad (2.3)$$

Where

E(U) =expected utility from a decision or action

π_g =probability of "good times" when consumers have information about prices

π_b =probability of "bad times" when consumers have no information about prices

W =wealth of an individual

$U(W)$ = von Neumann-Morgenstern utility index which is concave

C(I)=cost of obtaining information

Equation (2.3) suggests that expected utility from improved information depends on subjective probabilities, the nature of the utility function assumed, the wealth of consumers of information and the cost of attaining the information. The presence of market information enables the consumer to alter the probabilities of good and bad times.

In the good times, when π_g is approaching or equal to one, consumers have information on the source of lower priced goods, and attain higher payoffs. In the bad times, π_b is tending to one, implying a state of total uncertainty, and consumers pay more for a good that they would otherwise have obtained at a cheaper price. If the cost of attaining information is low, then the expected utility from access to improved information is higher. Assuming that information can be measured in some form of units, say m , e.g. number of messages from a radio programs, number of telephone calls, or short message service (SMS) requests, each with a unit cost of P_m to the farmer, the cost may take the form $C(I) = P_m m$. Another assumption is that consumers of information, in this case farmers and small scale traders, are risk averse with a concave utility function.

In this approach, the states of nature are represented by subjective probabilities, π_g and π_b, which can range anywhere between zero and one. Obtaining probabilities, the utility functions and the form of the cost function is a difficult task. Thus this approach of estimating value of information is limited to small problems with a few discrete probability choices (Eisgruber, 1978, Nicholson, 2002). For these reasons, this approach is not considered of reasonable applicability to the problem at hand.

2.5 Complementarities with other Reforms

In some African countries, such as Mali and Uganda, provision of market information was part of the reforms in the agricultural markets that were implemented by governments as part of the Structural Adjustment Programs (SAPs) supported by the World Bank and IMF. For example, in Mali, MIS activities were part of the 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 neighboring countries (Dembélé, et al., 2003, Dembélé and Staatz., 1999). Such programs also 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.

CHAPTER 3: APPLICATION OF THE PRICE ADJUSTMENT MODEL

3.0 Introduction

In this chapter, Hayami and Peterson's Production Adjustment model for measuring the returns to access to improved information is modified, to come up with a Price Adjustment Model. It is assumed that public information services provide improved information in the form of better price forecasts to producers and small scale traders, disseminated through urban and rural radios, television and other channels. Using production and producer price data on four major cereals (millet, maize, sorghum and rice) released by the Agricultural Market Watch (OMA[1]) in Mali, and hypothetical price forecasts, the benefits of access to improved information are modeled as the reduction of social welfare loss due to better price forecast from Market Information Systems. 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 out off equilibrium price and quantity. 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 price adjustment model is based on a partial equilibrium model, assuming a closed economy with no international trade. In reality, some agricultural crops are exported from Mali, but no adjustments are made for purposes of keeping this model simple. In reality, for landlocked countries like Mali and Uganda, facing high transport costs, most bulky commodities like cereals are only semi-tradables, so the general conclusions from a closed-economy model like this one should be similar in the general direction, if not the magnitude, for these countries. Another assumption is that producers

[1] OMA -*Observatoire du Marché Agricole- by its French acronym*

adjust their production outputs based on new information, such as price forecasts from the public information agencies, in this case OMA.

In the model, it is assumed that producers have or form rational expectations about quantity demanded if they know future prices. It is assumed that producers make decisions in such a way that they produce more when they expect future prices to be higher than the current price and less when they expect future prices to be lower than the current prices. The model is developed assuming a single homogenous commodity, but at the estimation stage, it is replicated to cover four separate commodities which are sold on the market.

Another important assumption is that users of market information are able 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. For example in Mali, apart from expectations based of future prices, marketed surplus also depends on expected production, which is also influenced by climatic conditions such as expected rain in the next season (Aldridge, 1999).

The benefits of access to improved information are in form of reduction in net social welfare loss by producers and consumers as a result of reduction in price forecasting errors. This could be also viewed as the reduction in the cost of being out of equilibrium. In the model, it is assumed that the farmers are the producers, and the merchants, or small-scale traders, are the consumers. In reality, both farmers and small-scale traders will take on the role of producer and consumers interchangeably.

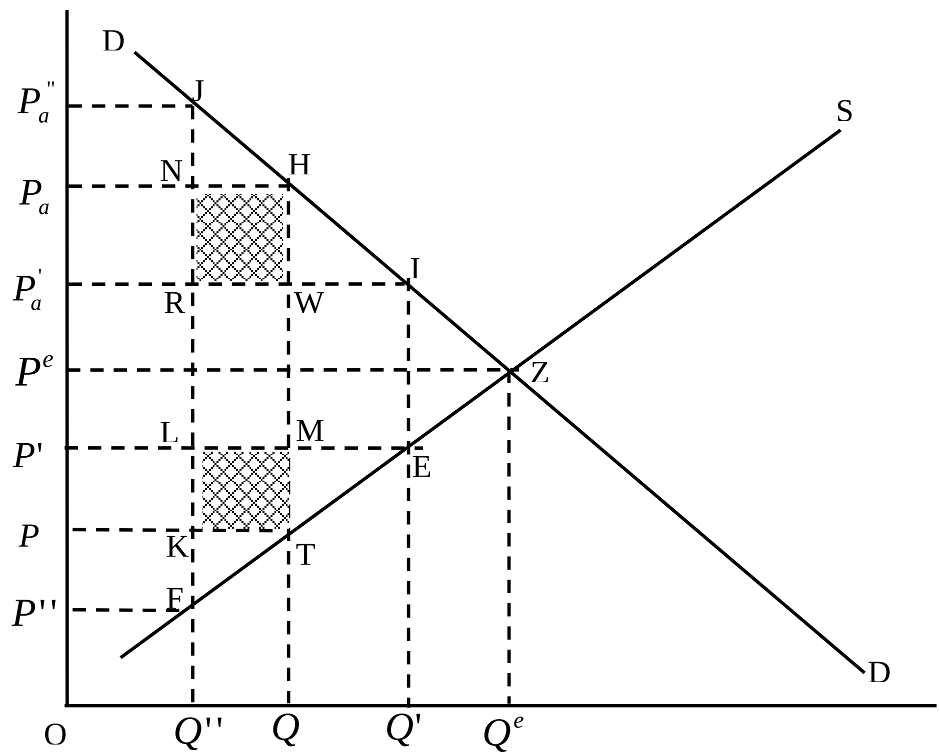
This model is appealing for evaluating benefits of MIS's in Africa since they have not developed the capacity to forecast quantities but find it easier to collect and disseminate price information. The assumptions made can significantly influence the nature of the results. The parameters used in the analysis are conservative as much as possible so that the estimates reflect the “lower bound” of social welfare loss due to price forecasting errors.

3.1 The Price Adjustment Model

The graphical form of the price adjustment model is given in figure 3 below. The model uses linear demand and supply curves, and assumes that farmers adjust their production along an upward sloping supply curve (S). Price P^e and quantity Q^e would be the theoretical competitive equilibrium if there were no market imperfections such as lack of complete and symmetric information, presence of externalities and or public goods. At this point, there would be no dead-weight loss and thus no welfare loss (i.e., the cost of being off the equilibrium price and quantity is zero). However, as expected, due to market imperfections, assume that the true price in the next period (maybe a year or production season of a crop) would be OP, and at that price, the true expected quantity supplied would be OQ, and the loss in social welfare would be represented by the dead-weight loss (ZHT). The role of forecasting is to try to reduce this loss of social welfare. The analysis in the model is based on a price forecasts that are below the competitive equilibrium price.

Suppose a public information agency forecasts a higher price $\mathrm{OP'}$ in the next period above the true market price P that would prevail. Then the production strategy of the producers would be to produce more in order to benefit from the higher producer price $\mathrm{OP'}$. Assuming that producers adopt the forecast, based on the expectations of the price OP', producers increase output to quantity OQ' on the market. At quantity OQ' and based on the demand schedule, consumers pay OP_a' leading to a loss in welfare to society equal to (ZIE). This means that this higher forecast of OP' instead of the expected price OP saves society welfare losses equal to HIET.

Figure 3: Price Adjustment Model



Adopted from Hayami and Peterson, 1972

If, however, the public information agency forecasts a lower price OP'' in the next period, producers would expect a lower price and adjust their production to OQ''. This leads to a higher consumer price, OP_a'', leading to an increase in loss of total social welfare to ZJF. This means that a lower price forecast increases society's welfare losses by JHTF.

Adopting Hayami and Peterson's assumption that sampling errors are higher or lower with a probability of 0.5, the expected value of net social loss to society, E (SL) due to forecasting error would be half the difference between areas HIET and JHTF, given as the two shaded areas.

E (SL) =0.5(area MLKT+ area HNRW).

These areas on the partial equilibrium model can be computed using the sets of equations below, using the following notation:

Let:

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

P = producer price of the commodity.

$\hat{P}$ = forecast producer price of the commodity

Q = the quantity of the commodity produced

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

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

Then:

Area MLKT=LK*KT:

Change in price resulting from the forecast or sampling error:

$$\mathrm{LK} = \mathrm{MT} = \Delta P = e_p P \qquad (3.1)$$

Expected change in quantity supplied when price changes from P to P'' is:

$$KT = \text{LM} = \Delta Q = \Delta P * E_s * \frac{Q}{P} = e_p Q E_s \tag{3.2}$$

Therefore MLKT= $e_p^2 PQE_s$ (3.3)

Area HNRW=NR*RW:

Expected change in consumer prices:

NR=HW is the expected change in consumer prices from P_a to $P_a^{'}$ when there is a change in quantity demanded from Q to $Q^{'}$.

$$NR = \Delta P = \frac{\Delta Q}{E_d} * \frac{P}{Q} = \frac{e_p Q E_s}{E_d} * \frac{P}{Q} = \frac{e_p P E_s}{E_d} \tag{3.4}$$

Expected change in quantity demanded:

RW=NH is the expected change in quantity demanded from Q to $Q^{''}$.when the expected price changes from P_a to $P_a^{''}$. It is the same as KT=LM, which is the expected change in quantity supplied when price changes from P to P'' and from equation (3.2),

RW= $e_p Q E_s$ (3.5)

Therefore HNRW=NR*RW= $\dfrac{e_p^2 PQE_s^2}{E_d}$ (3.6)

Using equation (3.3) and (3.6), the expected value of net social loss, E (SL) resulting from sampling errors committed while forecasting the “true” future price P is given as:

$$\text{E (SL)} = \frac{1}{2} e_p^2 PQ \left(\frac{E_s^2}{E_d} + E_s \right) \tag{3.7}$$

To calculate the expected net social loss, or the cost of being off the equilibrium price and quantity, requires the price forecasting error, the value of crop production, and demand and supply elasticities. The expected value of information to producers and consumers in a single period is approximated by the reduction in the net social loss resulting from reducing price forecast errors (i.e. the reduction in the cost of being off the equilibrium price and quantity). The comparative statics in this model are similar to those of Hayami and Peterson (1972) discussed in section 2.3.1 and 2.3.2. Equation (3.7) suggests that the payoffs to providing improved agricultural market information to both producing and consuming households are greater where:

(a) There is higher previous uncertainty regarding the true future price, i.e. where the price forecast error, (e_p), is large. Indeed, the cost of being off the equilibrium price and quantity goes up exponentially with the price forecast error. The intuition here 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 dead-weight loss resulting from an excess shortage 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 dead-weight loss to society. In terms of social welfare redistribution, and holding other factors constant, an underestimate of the true future price hurts consumers through higher food prices, and an overestimation of the true future price benefits consumers through lower food prices. Overall, as the price forecast error becomes smaller, society benefits through the reduction in the dead-weight loss (reduction in the cost of being off the equilibrium price and quantity) resulting from better price forecast from the market information service.

(b) The own-price elasticity of demand, (E_d), is inelastic. If supply increases because of a higher price forecast, the welfare loss is larger when demand is inelastic than when elastic. Also, if supply decreases because of a lower price forecast, the welfare loss is larger when demand is inelastic, than when it is elastic. The intuition is that when the production decisions of the producers respond to price forecasts, but the consumption decisions (quantity demanded) do not, then there is a misallocation of resources because consumers want a relatively fixed amount of production but production is varying due to "mistaken" price forecasts. Thus, there is a higher expected social welfare loss, or the cost of being off the equilibrium price and quantity is higher the more inelastic is demand.

(c) The own-price elasticity of supply, (E_s) is high. The intuition behind this 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 more than 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.

(d) The value of farm production (PQ) is large. The larger the value of production 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 of being off the equilibrium price and quantity, unless the lack of information is a major reason why farmers don't produce the crop in high volumes.

3.2 Price Forecast Errors

A forecast error (e_t), at period (t) is defined as the difference between the true price (P) and the predicted or forecast price ($\hat{P}$). i.e., $e_t = \hat{P}_t - P_t$. The forecast error is expressed as a percentage of the true price and is used to obtain the change in prices, i.e.,

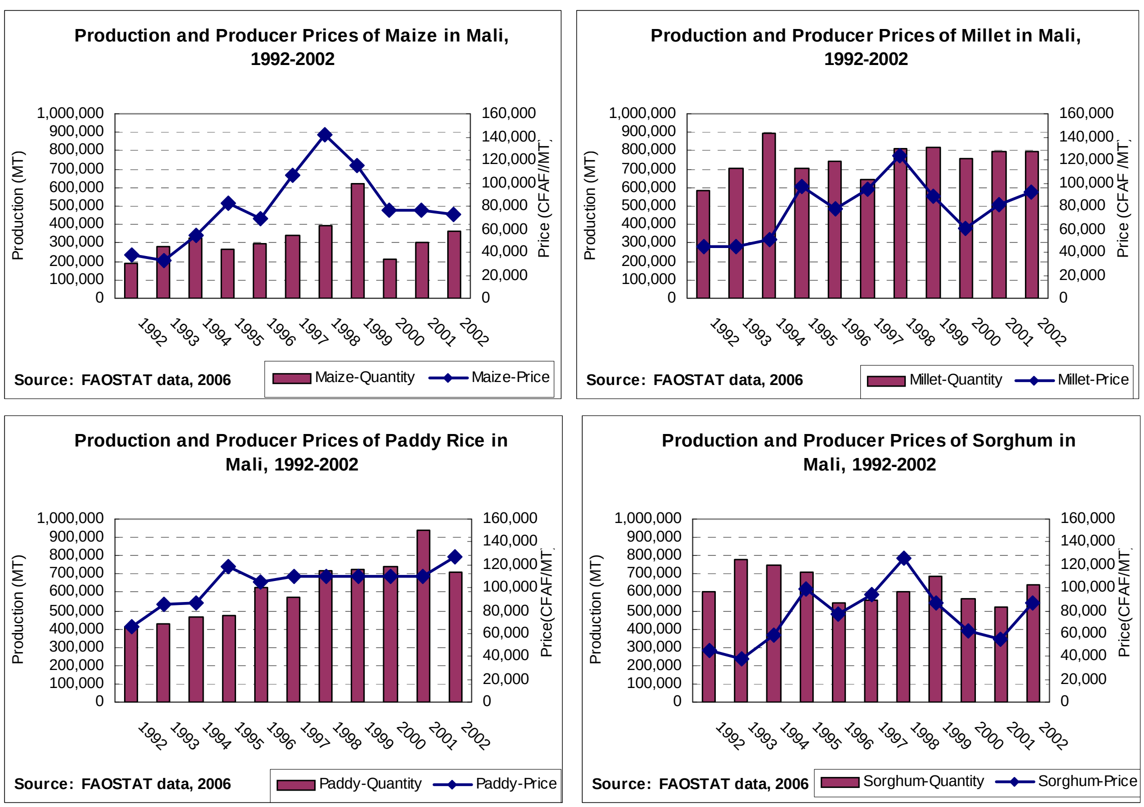
$$e_p = \frac{(\hat{P}_t - P_t)}{P_t} \text{ and } \Delta P = e_p P.$$

Forecast error can be estimated using many methods, a topic which is beyond the scope of this paper. However, availability of data, skills of analysis, costs involved, simplicity of understanding by decision makers, and the level of accuracy needed determine which forecasting method is adopted (Aldridge, 1999). For example, because of limited data, Aldridge (1999) used time series instead of structural methods to forecast cereal prices in Mali. The study found that Autoregressive Integrated Moving Average (ARIMA) and Vector Error Correction (VEC) models evaluated by statistical tests such as the Root Mean Square Error (RMSE) and the Mean Absolute Percentage Error (MAPE) performed well in estimating cereal prices in Mali. The forecast errors used in this study are differences between observed prices released by the MIS and hypothetical price forecasts. To facilitate sensitivity analysis, the hypothetical forecast errors range from 40% (an extremely poor forecast) to 0% (extremely accurate) forecast error.

3.3 Value of Farm Production

Value of agricultural production is obtained as the product of quantity produced and producer prices obtained from FAOSTAT data 2006 (http://faostat.fao.org/). The study uses data spanning a period of ten years from 1992, before the 1994 devaluation of the CFA franc, to 2002. Figures 4 show the quantities produced in metric tons and the nominal producer prices of the four cereals in CFA francs.

Figure 4: Production and Producer Prices of Maize, Millet, Sorghum and Rice, 1992-2002



3.4 Demand and Supply Elasticities

The elasticities of demand and supply used in this paper are obtained from numerous studies that have been conducted in Mali and other West African countries. A careful review of the elasticities was done before selecting the ones used in this paper. Using the double log model with data from urban Mali between 1985/86, Rogers and Lowdermilk (1991) estimated the own-price elasticity of sorghum and millet to be -0.53 and the own price elasticity of rice was -0.68 (Rogers and Lowdermilk, 1991) In another study by Coulibaly, the own-price elasticity of demand for millet and sorghum were estimated to be -0.24 before 1994 and -0.63 after the devaluation of the CFA franc ((Coulibaly, 1999) in (Vitale and Sanders, 2005)). Using an Almost Ideal Demand System (AIDS) on panel data from 2000-2001, Camara (2004) estimated Marshallian (uncompensated) own-price elasticities of demand for sorghum and millet of -0.691, rice of -0.767 and maize of -1.968. This study uses the estimates from the Rogers and Lowdermilk study for 1992 and the Camara study estimates for 2002. Sensitivity analysis is done for 2002 only, using elasticities estimated by Camara because: (1) they are complete in a sense that they cover all the crops of interest in this study, and (2) they are computed using the AIDS model, which is superior to its predecessors in demand analysis (Camara, 2004). The Marshallian (uncompensated), and not the Hicksian (compensated) own-price elasticities of demand are used because the model uses consumer surplus to approximate the changes in welfare of farmers and small-scale traders in this study. This is justifiable because the Hicksian demand function is based on utility, which is not directly observable while the Marshallian uses the ordinary market demand function based on prices and income (Mas-Colell, et al., 1995, Varian, 1992).

On the supply side, 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. These are 0.18 for rice, 0.17 for maize and 0.14 for millet and sorghum (Rosegrant, et al., 2001). These elasticities of supply are close to those from a previous study in (Sadoulet and Janvry, 1992). Using an integrated CGE-Multi-market approach, the elasticity of output supply for food crops was estimated to be 0.20 (Sadoulet and Janvry, 1992). There is a potential problem of how one would estimate the elasticities of supply when farmers are uncertain about the future price. The methodological answer to this question would be beyond the scope of this paper. However, to take care of the potential variations in the elasticities of demand and supply used, a sensitivity analysis within a 100% range is done for the elasticities used.

3.5 Results

The results from this method of estimating the benefits from access to improved information are summarized in table 1 below. Two periods are covered, 1992 (before the 1994 devaluation of the CFA franc) and in 2002 (after the devaluation). Part 1 of table 1 contains elasticities of demand and supply, and hypothetical forecast errors in the range of zero to forty percent of the true observed prices.

Part 2 of table 1 contains production and producer price data for 1992 and 2002 respectively. The value of farm production is obtained by multiplying quantity produced by producer prices for the four crops. This value is converted into US dollar equivalent using the average exchange rate between the CFA franc and the USD for the corresponding year. For example in 1992, the value of farm production is estimated to be

$27 million for maize, $97 million for millet, $100 million for paddy rice and $100 million for sorghum. In 2002, 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. From part 1 and part 2 of table 1, the value of improved information to society in the model depends on the elasticity of demand, elasticity of supply, and the price forecasting errors, and the value of crop output.

Table 1: Estimates of Social Returns from Access to Improved Market Information

Part 1: Elasticities of demand and supply and hypothetical percentage forecast errors

	1992					2002				
Elasticities	**Maize**	**Millet**	**Rice, Paddy**	**Sorghum**	**Total**	**Maize**	**Millet**	**Rice, Paddy**	**Sorghum**	**Total**
Elasticity of demand	-0.53	-0.53	-0.68	-0.53		-1.968	-0.691	-0.767	-0.691	
Elasticity of supply	0.17	0.14	0.18	0.14		0.17	0.14	0.18	0.14	
Hypothetical Price Forecast Errors										
High (40%)	0.40	0.40	0.40	0.40		0.40	0.40	0.40	0.40	
35%	0.35	0.35	0.35	0.35		0.35	0.35	0.35	0.35	
30%	0.30	0.30	0.30	0.30		0.30	0.30	0.30	0.30	
25%	0.25	0.25	0.25	0.25		0.25	0.25	0.25	0.25	
20%	0.20	0.20	0.20	0.20		0.20	0.20	0.20	0.20	
15%	0.15	0.15	0.15	0.15		0.15	0.15	0.15	0.15	
10%	0.10	0.10	0.10	0.10		0.10	0.10	0.10	0.10	
5%	0.05	0.05	0.05	0.05		0.05	0.05	0.05	0.05	
0%	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	

Part 2: Production, prices and value of farm production in '000 CFA francs and USD, 1992 and 2002

Crop Production and Prices	**Maize**	**Millet**	**Rice, Paddy**	**Sorghum**		**Maize**	**Millet**	**Rice, Paddy**	**Sorghum**	
Production (MT)	192,530	582,296	410,018	602,254		363,629	795,146	710,446	641,695	
Price CFA Franc/MT	38,000	45,000	66,000	45,000		72,200	92,100	127,600	87,000	
Value of Farm Production (CFAF)*	7,316,140	26,203,320	27,061,188	27,101,430		26,254,014	73,232,947	90,652,910	55,827,465	
Value of Farm Production (USD)**	27,196,535	97,406,490	100,595,472	100,745,065		37,667,705	105,070,297	130,063,429	80,097,943	

Part 3: Social loss corresponding to percentage of forecasting error for 1992 and 2002

Price Forecast Error	**Maize**	**Millet**	**Rice, Paddy**	**Sorghum**	**Total**	**Maize**	**Millet**	**Rice, Paddy**	**Sorghum**	**Total**
High (40%)	488,511	1,379,129	1,832,021	1,426,398	5,126,059	556,533	1,415,210	2,312,450	1,078,853	5,363,046
35%	374,017	1,055,896	1,402,641	1,092,086	3,924,639	426,095	1,083,520	1,770,469	825,997	4,106,082
30%	274,788	775,760	1,030,512	802,349	2,883,408	313,050	796,056	1,300,753	606,855	3,016,713
25%	190,825	538,722	715,633	557,187	2,002,367	217,396	552,816	903,301	421,427	2,094,940
20%	122,128	344,782	458,005	356,600	1,281,515	139,133	353,803	578,112	269,713	1,340,761
15%	68,697	193,940	257,628	200,587	720,852	78,262	199,014	325,188	151,714	754,178
10%	30,532	86,196	114,501	89,150	320,379	34,783	88,451	144,528	67,428	335,190
5%	7,633	21,549	28,625	22,287	80,095	8,696	22,113	36,132	16,857	83,798
0%	0	0	0	0	0	0	0	0	0	0

Part 4: Marginal social returns from reduction of price forecasting error in dollars from

Price Forecast Error of	**Maize**	**Millet**	**Rice, Paddy**	**Sorghum**	**Total**	**Maize**	**Millet**	**Rice, Paddy**	**Sorghum**	**Total**
40% to 35%	114,495	323,233	429,380	334,312	1,201,420	130,437	331,690	541,980	252,856	1,256,964
35% to 30%	99,229	280,136	372,129	289,737	1,041,231	113,046	287,465	469,716	219,142	1,089,369
30% to 25%	83,963	237,038	314,879	245,162	881,041	95,654	243,239	397,452	185,428	921,774
25% to 20%	68,697	193,940	257,628	200,587	720,852	78,262	199,014	325,188	151,714	754,178
20% to 15%	53,431	150,842	200,377	156,012	560,663	60,871	154,789	252,924	118,000	586,583
15% to 10%	38,165	107,744	143,127	111,437	400,473	43,479	110,563	180,660	84,285	418,988
10% to 5%	22,899	64,647	85,876	66,862	240,284	26,087	66,338	108,396	50,571	251,393
5% to 0%	7,633	21,549	28,625	22,287	80,095	8,696	22,113	36,132	16,857	83,798

* Value of Farm Production in '000 CFAF

** 1992 Exchange rate 1 USD=269.01 CFAF, 2002 Exchange rate 1 USD=696.99 CFA, source: CIA World Fact Book

3.6 Loss of Social Welfare

The loss of welfare to society resulting from price forecast errors is computed in part 3 of table 1 for the periods 1992 and 2002. 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 with an error rate of 40%, the error is decreased in a discrete descending order in intervals of 5%, up to 0% error, which would depict a perfect forecast. For example, in part 3 for the year 1992 for sorghum, when the price forecast error is 40%, society losses $ 1.4 million, and if this forecasting error is reduced to 35%, society looses $1.1 million. If 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.

3.7 Benefits of MIS through Improved 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 dead-weight loss when farmers with rational expectations respond to improved price forecasts provided by market information systems. 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 $0.1 million dollars worth in social welfare. For all the four cereal crops, reducing the price forecast error in 2002 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.

As a caveat, it should be noted that 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. Summing up across all changes in social welfare from MIS-forecasts of each crop individually will likely not give the same result than if all crops faced the same poor forecast at the same time because: (a) the elasticity of supply of all cereals in the aggregate is likely to be less elastic than 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. (b) On the other hand, the price elasticity of demand for all grains in aggregate is likely to be lower than for the grains taken individually, as there is less scope for substitution between grains and other foods as there is among grains. So this would tend to under-estimate the effect of a poor price forecast for all grains in the aggregate. Whether the aggregation error leads to an under-estimate or an over-estimate of the total cost of poor price forecasts for all grain crops at once depends on the relative balance of these two effects and can't be answered a-priori.

3.8 Sensitivity Analysis of the Benefits to Elasticity of Demand and Supply

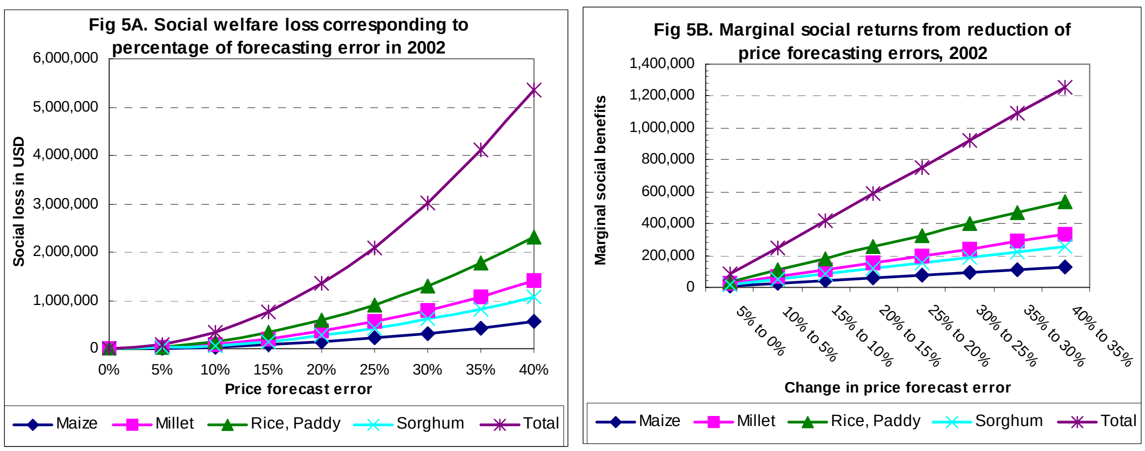
This section analyzes the sensitive of the model is to changes in key parameters used. These are the price forecasting errors, the elasticity of demand and elasticity of supply for the four cereal crops. This is done for 2002, but can be applied to any year without loss of generality. Many scenarios can be made, but only four are considered in this section.

3.8.1 Effect of Changes in Price Forecast Errors.

Figure 5A shows that the losses in social welfare increase with price forecast errors, keeping elasticities of demand and supply constant. In other words, the cost of being off the equilibrium price and quantity increases as the forecast error increases. The smooth increase in the losses is partly because of the linear nature of the demand and supply functions used in the model. The results are a graphical representation in part 3 of table 1 for 2002. 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 5B, 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 reduce, the marginal benefits also reduce.

Figure 5: Social Welfare Loss and Marginal Social Returns Associated with Reduction in Forecast Errors for Maize, Millet, Paddy Rice and Sorghum in Mali, 2002



Keeping the three other parameters constant (demand and supply elasticities and value of production), any price forecast different from the prevailing market price will lead to a loss in social welfare. The magnitude of the loss of social welfare increases with the size of the forecasting errors. This means farmers, small-scale traders, and consumers lose more when they produce and consume a crop when there is high uncertainty regarding future prices. Here, uncertainty is manifested in the forecast error which increases the loss 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's forecast and disseminated information to farmers using mostly radio, mobile telephones, television, bill boards, 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, 2001a, Shepherd, 2001b).

In Uganda, the overall costs of setting up and running a localized micro information service serving a population of about one million households growing maize and beans was estimated to be US$30,000 per annum. Using anecdotal information and assuming that MIS contributed an additional 10% (27 Uganda shillings /= or $0.015 USD) increase of farm gate price per kilogram of maize produced by 1 million small scale households, each with an estimated production of 200 kilograms per year, the gains from a localized Market Information Systems were estimated to be 100 times more than investment required to setting up and run the service (Muganga, et al., 2000). This study, done 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.

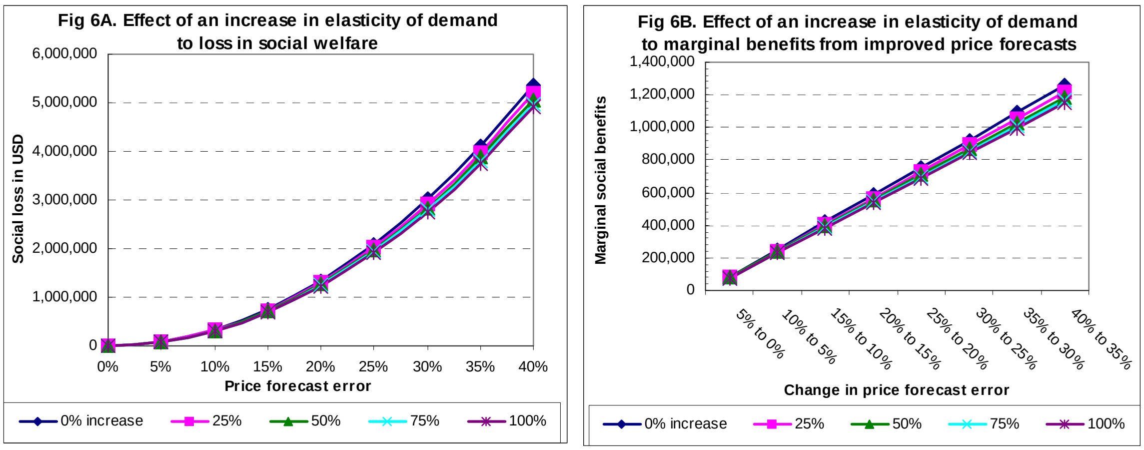
Currently, the cost of running the market information service in Mali is estimated at $0.35 million per year (Staatz, 2006). Given that this figure covers many crops and the whole country, and that the estimates in part 3 and 4 of table 1 cover only four commodities, it is reasonable to state that the benefit of providing market information which results into reducing price forecast errors within a 10% to 15% range are more than 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 Market Information Systems to farmers and small-scale traders.

As a caveat, it should be noted that these figures are obtained from a partial equilibrium model and therefore face an aggregation problem due to summing up the estimated benefits for all the four commodities. In addition, in a general equilibrium setting, one would expect the gains to either increase or decrease depending on the magnitude of the complementary and supplementary relationships of the four commodities in the model. Figure 5A shows that the loss of social welfare increase exponentially when there is high uncertainty about future prices and high elasticities of supply, as will be discussed below.

3.8.2 Effect of Changes in Elasticity of Demand

In the model, it is observed that as elasticity of demand increases, holding other factors constant, the expected loss in social welfare reduces. To solve the potential problem of overestimating the social loss, sensitivity analysis is done by increasing the elasticity of demand up to 100%, holding elasticity of supply constant. Figure 6A and table 2, part 1 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 is supply elasticities as will be seen in the next section. Sensitivity analysis on the elasticity of demand was not done for smaller elasticities than those found in the literature review because it would overestimate expected social loss which in turn would overestimate the expected marginal benefits from access to improved forecasts.

Figure 6: Effect of an Increase in Elasticity of Demand to Loss in Social Welfare and Marginal Returns from Access to Improved Price Forecasts for Maize, Millet, Paddy Rice and Sorghum in Mali, 2002



For example, in 2002, if a 40% forecast error is committed, at the elasticities of demand and supply in table 1, part 1, (i.e. the default elasticities); 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.

Table 2: Sensitivity Analysis of Effect of an Increase in Elasticity of Demand to Loss in Social Welfare and Marginal Social Returns to Access to Improved Price Forecasts for Maize, Millet, Paddy Rice and Sorghum in Mali, 2002

Part 1: Senstivity of Loss in Social Welfare to Increase in Elasticity of Demand

	Percentage Increase in Elastisity of Demand				
Price Forecast Error	**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: Sensitivty of Marginal Social Returns to Increase in Elasticity of Demand

	Percentage Increase in Elastisity of Demand				
Price Forecast Error fr	**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

This suggests that the model is not very sensitive to changes in elasticity of demand as compared to elasticity of supply (shown in the next section). That is why the social welfare loss curves show less dispersion from each other as the elasticity of demand increases for any given level of price forecast errors. Figure 6B and table 2, part 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. This low sensitivity implies that investment in MIS should focus more in areas where quantity supplied adjusts significantly to information about future prices (market information forecasts) more than focusing on crops where demand is price-elastic.

3.8.3 Effect of Changes in Supply Elasticities

From the model in equation 3.7, as the own-price elasticity of supply increases, the loss in social welfare increases. This implies that lowering the supply elasticities has an effect of reducing the estimated social loss, thus favoring the objective of being conservative in estimating the benefits of access to improved information so as to obtain lower bound figures. Thus, the sensitivity analysis done in this section is to reduce the elasticity of supply, holding elasticity of demand constant, such that benefits from improved price forecasts are not overestimated. The elasticity of supply is reduced in the intervals of 25% up to 100%, reduction, i.e. up to where the elasticity of supply tends to zero.

Figure 7: Effect of a Decrease in Elasticity of Supply to Loss in Social Welfare and Marginal Returns from Access to Improved Price Forecasts for Maize, Millet, Paddy Rice and Sorghum in Mali, 2002

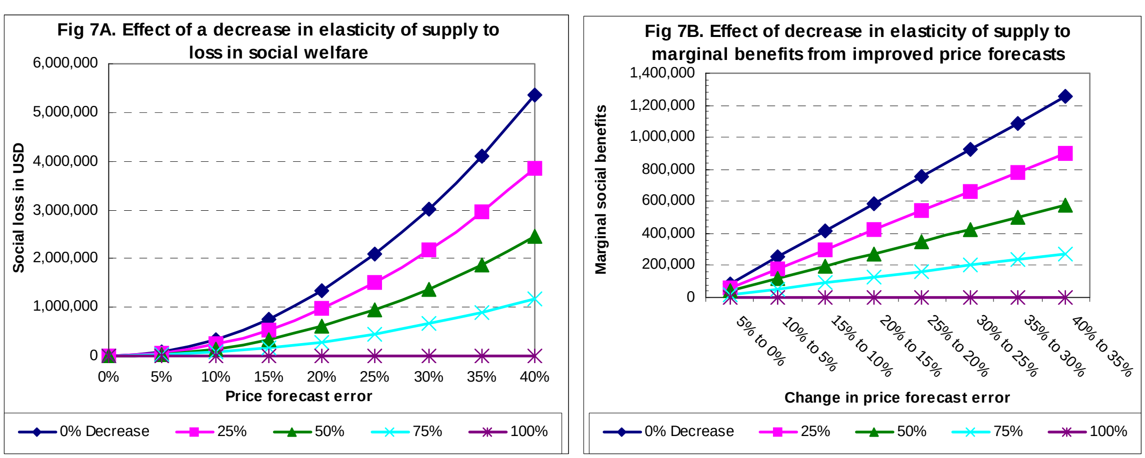


Figure 7A and table 3, part 1 show that for any given level of forecast error, as the elasticity of supply reduces, the loss of social welfare declines more rapidly than in the case of elasticity of supply in Figure 6A. For example, in 2002, if a 40% forecast error is committed, at the base-case elasticities 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.

Table 3: Sensitivity Analysis of Effect of a Decrease in Elasticity of Supply to Loss in Social Welfare and Marginal Social Returns to Access to Improved Price Forecasts for Maize, Millet, Paddy Rice and Sorghum in Mali, 2002

Part 1: Senstivity of Loss in Social Welfare to Decrease in Elasticity of Supply

	Percentage Decrease in Elastisity of Supply				
Price Forecast Error	**0% Decrease**	**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: Sensitivty of Marginal Social Returns to Decrease in Elasticity of Supply

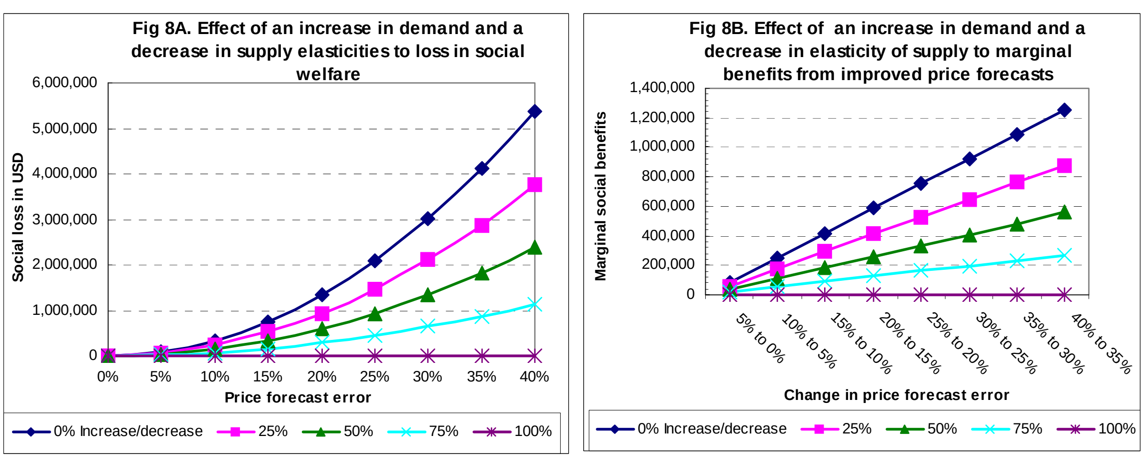
	Percentage Decrease in Elastisity of Supply				
Price Forecast Error fr	**0% Decrease**	**25%**	**50%**	**75%**	**100%**
5% to 0%	83,798	60,200	38,368	18,301	-
10% to 5%	251,393	180,600	115,103	54,903	-
15% to 10%	418,988	300,999	191,838	91,505	-
20% to 15%	586,583	421,399	268,574	128,107	-
25% to 20%	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	-

These results suggest that investment in MIS should focus more in areas where quantity supplied does adjust to price forecast errors more than on how quantity demanded adjusts.

3.8.4 Effect of Joint Changes in Elasticities of Demand and Supply

In this section, both elasticities are adjusted simultaneously. The elasticity of demand is increased by 25% intervals up to 100% while the elasticity of supply is reduced in the intervals of 25% up to 100%. A comparison of Figures 6, 7 and 8 shows that elasticity of demand does not cause a lot of variability in both social welfare loss and marginal benefits to access to improved forecast compared to changes in the elasticity of supply.

Figure 8: Joint Effect of an Increase in Elasticity of Demand and a Decrease in Elasticity of Supply to Loss in Social Welfare and Marginal Returns from Access to Improved Price Forecasts for Maize, Millet, Paddy Rice and Sorghum in Mali, 2002



Once again, this suggests that investments in access to improved information would give higher returns when there is a larger supply response than a demand response to price forecast. One of the implications of this is that there would be higher returns, ceteris paribus, to decentralized information provision, where targeting is based to crops with a higher elasticity of supply in any given agro-ecological zone or regional administrative area.

Lastly, the value of farm production matters. Intuitively, there would no need for an MIS if there was no production and marketing of produce. It follows that MIS activities should be established in areas where substantial quantities of commodities are produced or have the capacity to be produced.

Table 4: Sensitivity Analysis of Effect of Increase in Elasticity of Demand and Decrease in Elasticity of Supply to Loss in Social Welfare and Marginal Social Returns to Access to Improved Price Forecasts for Maize, Millet, Paddy Rice and Sorghum in Mali, 2002

Part 1: Senstivity of Loss in Social Welfare to Increase in Elasticity of Demand and Decrease in Elasticity of Supply.

	Percentage Increase in Elasticity of Demand and Decrease in Elastisity of Supply				
Price Forecast Error	**0% Increase/decrease**	**25%**	**50%**	**75%**	**100%**
40%	5,363,046	3,751,094	2,380,200	1,147,054	-
35%	4,106,082	2,871,931	1,822,341	878,213	-
30%	3,016,713	2,109,990	1,338,863	645,218	-
25%	2,094,940	1,465,271	929,766	448,068	-
20%	1,340,761	937,774	595,050	286,764	-
15%	754,178	527,498	334,716	161,304	-
10%	335,190	234,443	148,763	71,691	-
5%	83,798	58,611	37,191	17,923	-
0%	-	-	-	-	-

Part 2: Sensitivty of Marginal Social Returns to Increase in Elasticity of Demand and Decrease in Elasticity of Supply.

	Percentage Increase in Elasticity of Demand and Decrease in Elastisity of Supply				
Price Forecast Error from	0% Increase/decrease	25%	50%	75%	100%
5% to 0%	83,798	58,611	37,191	17,923	-
10% to 5%	251,393	175,833	111,572	53,768	-
15% to 10%	418,988	293,054	185,953	89,614	-
20% to 15%	586,583	410,276	260,334	125,459	-
25% to 20%	754,178	527,498	334,716	161,304	-
30% to 25%	921,774	644,719	409,097	197,150	-
35% to 30%	1,089,369	761,941	483,478	232,995	-
40% to 35%	1,256,964	879,163	557,859	268,841	-

CHAPTER 4: SUMMARY AND CONCLUSIONS

In this paper, a partial equilibrium model is used to evaluate the impact of access to improved information to farmers and small-scale traders. 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 behavior in response to improved information from the Market Information Systems. 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:

(1) The level of uncertainty about future market price in the market is high.

(2) The own-price elasticity of demand for agricultural commodity is low.

(3) The own-price elasticity of supply for the agricultural commodity is high.

(4) The value of farm production of the crop is high.

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 decentralized, localized, crop-specific information services, targeted based on the above criterion, may have more returns than large centralized and uniformly distributed information services. Here decentralization refers to collection, analysis and dissemination of market information on few crops in a given agro-ecological, market or administrative area or region. Decentralization of MIS's does not mean that each localized MIS is fully autonomous. Other organizational structures such as administration and financing can remain centralized. Uniformity refers to the tendency of national MIS to collect a wide range of information on all crops in a country. The criteria of identifying the crops would be based on the four parameters above (elasticities of supply and demand, level of future price uncertainty and value of crop production).

Though the analysis in this study was not done on a regional basis, the results suggest that provision of information services be targeted such that crop-specific information is collected, analyzed 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 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 into higher benefits to society.

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