THE VALUE OF PRICE STABILIZATION POLICY

FOR COTTON PRODUCERS IN BURKINA FASO

By

AMADOU GOUZAYE

INSTITUT AGRONOMIQUE ET VETERINAIRE

HASSAN II

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THE VALUE OF PRICE STABILIZATION POLICY FOR COTTON PRODUCERS IN BURKINA FASO

Thesis Approved:

Dr. Jeffrey Vitale

Dr. Francis Epplin

Dr. Arthur Stoecker

Dr. Brian Adam

Dr. Sheryl A. Tucker

Dean of the Graduate College

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CHAPTER I

INTRODUCTION

Export crops in Sub-Saharan Africa have traditionally been associated with poor marketing conditions for producers (Diao and Hazell, 2004). Producers have often been equipped with modern technology at subsidized price to maximize output, but the prices producers receive are typically only a fraction of world prices (Vitale et al., 2011). Noteworthy examples of poorly marketed export crops in Sub-Saharan Africa include cotton, cocoa, coffee, tobacco, peanuts, and cashew (Dorward et al., 2004). Government intervention and the politicization of agricultural markets has led to noncompetitive and discriminatory marketing outcomes for most of the export crops on the Sub-Saharan Africa sub-continent, favoring urban consumers over rural agricultural communities. Government intervention appears as an implicit taxation of the agricultural sector with poor distribution of the economic surplus and foreign investments (Kherallah et al., 2000).

The noncompetitive market settings and government ownership have led to poor price elasticity transmission between the international market and the farm gate (Rapsomanikis et al., 2003). Several studies have found a low share of the world cotton price given to producers by cotton companies in the West African cotton sectors (Tschirley et al., 2009; Baquedano et al., 2010; Baffes, 2005). Over the past few decades, West African cotton producers have received prices that are only 30% to 40% of world price (Baffes, 2007).

There is a critical need for market reform and "getting prices right" within many economic sectors of developing countries, where government intervention and political economy distort price signals and market outcomes (Timmer, 1986). At the microeconomic level, relative price distortions create allocative inefficiency at the firm level. The allocative inefficiency, results

primary from the lack of producers' self-investment due the market uncertainty (Leibenstein, 1966). At the macroeconomic level, producers need to receive the "right price" because price distortions can create resource misallocations and sub-optimal investment levels (Alston et al., 1988). Price distortions also create inequitable income distributions resulting in non-Pareto optimal outcomes and skewed wealth distribution, leaving rural areas and agriculture underinvested and rural populations mired in cycles of poverty (De Janvry and Sadoulet, 2010). The market distortions due to government intervention are part of the reasons why, in general, investments in the agricultural sector are less than 10% of GDP in Sub-Saharan Africa (Ejeta, 2010).

"Getting prices right" means not only higher prices for producers, but also providing adequate price stability (Timmer, 1986). Producers have a strong preference for stable revenue streams because they fear negative incomes that can result in household welfare deterioration, including difficulties for feeding the family and schooling the children (Abdoulaye and Sanders, 2006). In severe cases, the long-term persistence of low and negative income can force producers to abandon crops similarly to the case of peanuts in the Casamance of Senegal for example (Warning and Key, 2002).

Economists have hypothesized that the decreasing marginal utility of income creates an aversion to uncertain and varied income streams (Greene and Baron, 2001). Stable incomes are important for producers because the marginal utility of consumption or the indirect utility of income decreases as income increases. Economic studies over the past few decades have found that reducing variability and stabilizing prices has an economic value to producers (Newbery and Stiglitz, 1981).

In Burkina Faso, cotton producers, by virtue of the government controlled marketing channel, benefit from the guaranteed price provided by the national cotton companies. If they had the opportunity to sell their production on the international market, as often proposed by proponents of liberalization, they would face international price variability. While they might be

able to obtain a higher share of the world cotton price and a higher farm gate price, they would be exposed to increased risk (Baffes, 2007). Because producers receive the benefit of the risk premium that is theoretically overstated, they should have to "pay" for the guaranteed price. One question is how much benefit has been obtained through the parastatal pricing mechanism that while providing price stability, transmits a disproportionally low share of the world price to producers?

Previous studies (Tschirley et al., 2009; Baquedano et al., 2010; Baffes, 2005) suggested that the international market is better for cotton producers in Burkina Faso because the international spot price is on average higher than the domestic price. However these authors have ignored the risk associated with the international market price. Including risk into the debate may provide a different perspective for the comparison between the two marketing channels. When the international price is adjusted by subtracting the costs beyond the farm gate, the difference between the domestic price and the adjusted international spot price approximates the cotton companies' rent. Because West Africa cotton producers are fully protected against the international price risk by virtue of the guaranteed price, at least a fraction of the "theoretical" rent of the cotton companies' would be the risk premium from which producers derive benefits. This implicit benefit could be significant and deserves empirical testing.

Most countries have agricultural commodity price support programs that include price stabilization and risk-reduction. In the United States, for example, cotton producers have access to cotton revenue support programs financed by the government, as well as access to futures and forward contracts to help stabilize prices in the private sector (Miller, 1986). In West Africa, although usually overlooked, cotton producers have access to price stabilization programs. However, the price stabilization programs are imposed on producers by cotton parastatals and are associated with monopsony pricing and low farm gate prices. Hence, even though these programs reduce risk, producers may still prefer to market their cotton on international markets to obtain a higher price and bear the market risk.

In Burkina Faso, the quasi-parastatal companies are not just state run companies. Two thirds of the investments are held by foreign investors and producers. The foreign investments and producers' participation are based on a profit-seeking model, which likely limits the inefficiencies that surround the parastatals (Kaminski and Serra, 2011).

The pricing mechanism used by many of the West African cotton companies insulates producers from price risk, but transfers the burden to the parastatal, which can create macro level problems (Estur, 2004). In Burkina Faso, for example, guaranteed prices are announced in March-April prior to planting but cotton is not sold until eight-twelve months later. Over the past decade, price movements from the time prices are fixed prior to planting to the post-harvest period when the ginned cotton is available for marketing, has resulted in substantial losses for paratstatal companies since companies are obligated to pay the announced price even when a price collapse occurred.

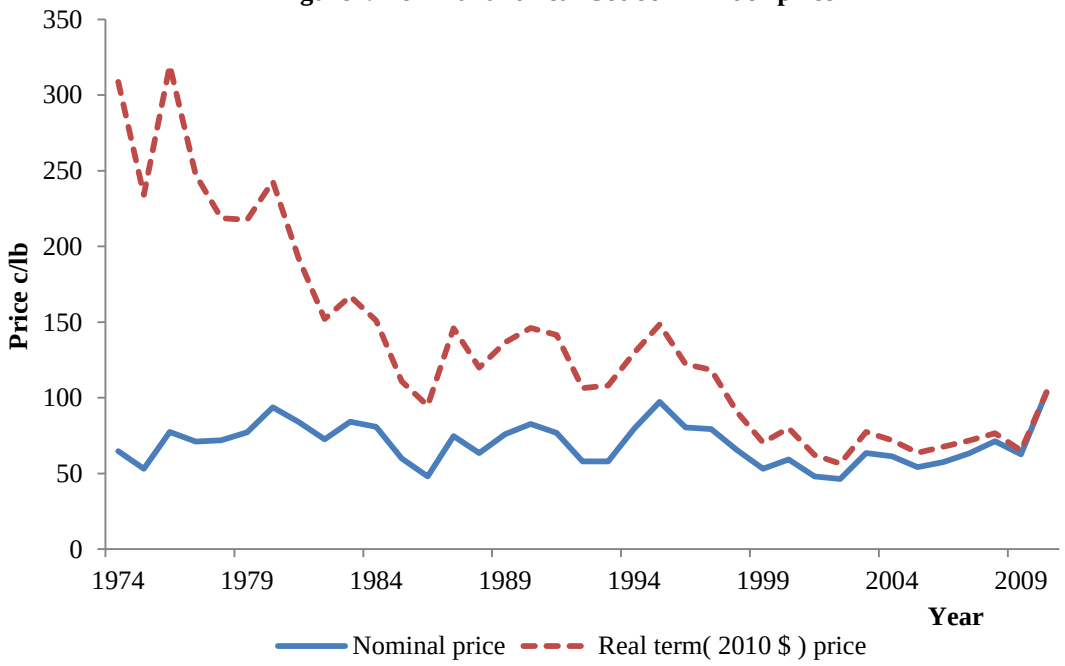
Over the last 30 years, the world cotton price, as with many other primary commodities prices, has been highly volatile and declining in real terms (Figure 1). For example between 1980 and 1986 the nominal Cotlook A- Index price declined from a high of $0.94/lb to a low of $0.48/lb. In 1997, the average annual international nominal price was $0.97/lb. Adjusted to 2010 dollars, the Cotlook A-Index has declined from $3.09/lb in1974 to $1.04/lb in 2010 (Figure 1).

Because of price volatility there is a real need for the cotton sector in Burkina Faso (and the other West African cotton sectors) to have a favorable marketing environment. Risk reduction strategies at both farm and cotton companies' levels are important tools that producers should be able to access. Improved marketing conditions would have two main advantages: increase cotton prices and stabilize farm gate revenue for producers (Vitale et al., 2011).

Another policy question that arises is whether an alternative marketing strategy can be developed for Burkina Faso cotton producers that provides higher and more stable cotton revenue than those generated by the existing parastatal marketing system? In other words, if given the choice to market cotton as they choose, how often would the government's marketing channel be

chosen? According to the literature, the world price would be preferred over the existing government-owned marketing channel, but would including risk result in a different answer?

Figure1: Nominal and real Cotlook A index price



Source: FaoStat

Objectives:

The purpose of the present study is to investigate and analyze some alternative marketing strategies for cotton producers in Burkina Faso.

Specifically this study will:

1.) Compare the potential advantages and disadvantages of three hypothetical marketing channels on Burkina Faso cotton income: the international spot marketing, domestic pricing system, and forward contracting.

2.) Determine the impact of forward contracting and the domestic pricing system on cotton price and risk associated with the international spot marketing.

3.) Estimate the risk premium associated with the guaranteed price provided by domestic cotton companies relative to the international spot and futures markets.

To achieve those objectives we first construct a forecast for the international spot price based on a rational expectation model. After the forecast procedure an E-V model is specified. The E-V model helps to determine the ratio of the production to be sold on each of the three marketing channels used in the study.

The document is structured as follow: Chapter II presents the literature review starting with the history of cotton production in West Africa and in Burkina Faso. After the historical background, the role of alternative price risk mitigating strategies in agricultural commodities marketing is presented. In chapter III the methodological approach is detailed. After the conceptual framework, an empirical model is specified followed by the data description. The findings are presented in chapter IV in which the results of three marketing alternatives are detailed. Finally the conclusion and recommendations are presented in chapter V.

CHAPTER II

REVIEW OF LITERATURE

Evolution of cotton production and marketing in Burkina Faso: Low and stable prices

Cotton commercial production started in Burkina Faso during the French colonization period in the 1920s (Kaminski, 2007). The production of cotton was imposed on local populations by French colonial power to satisfy the French national and European demand with low cost cotton as input to their textile industry (Basset, 2010). Virtually all of the production was export oriented to Europe. With the 1920s economic recession that affected the industrial production, cotton production stopped in Burkina Faso as a consequence of the food shortage induced by the global economic crisis in the colony (Kaminski, 2007).

In 1949, cotton production resumed with the creation of the French Textile Development Company (CFDT). CFDT was a public company that provided inputs and technical assistance to cotton growers during that period. These technical and extension services helped improve cotton production techniques. Cotton quickly became known as “white gold” throughout the West African region. After the independence movement in the early 1960s, cotton production became the main economic activity that attracted foreign investment and generated export earnings for many countries in the region. CFDT continued to own and operate cotton sectors in several West African countries, even after independence.

In Burkina Faso, in the early 1970s the government took a share in the CFDT and a national company (SOFITEX) was created as a subsidiary of CFDT. The public company was a monopoly for inputs supply to farmers (seeds, fertilizers and pesticides) and a virtual monopsony for the purchase of the seed cotton (Tschirley et al., 2009). At that time farmers were organized under village associations which work with the public company. The extension services and improved varieties that the SOFITEX provided lead to a considerable productivity increase for labor and land inputs.

Export earnings from selling cotton on the world market are the primary source of hard currency in these countries and are a vital catalyst to economic development, with cotton's share of GDP being between 2.5 and 6% among the C4 countries (Baghdadli et al., 2007).

The role of forward and future contracts for agricultural commodities price stabilization

In general, agricultural products face more price variability than industrial products (Olson, 1985). Olson (1985) found that there are many factors that contribute to larger price variability in the agricultural sector compared to the industrial sector. The most important factor is the lack of spatial intensification in agriculture. Olson (1985) mentioned that because agricultural production is generally sparsely distributed over space, it is generally difficult for producers to adjust the level of output to price variation. The inelastic nature of demand and supply of agricultural products combined with the weather fluctuations are other reasons for agricultural prices unsteadiness (Schultz, 1954). Cotton market as any agricultural market is affected by the price variability and uncertainty, particularly in developing countries. Several ways have been documented to help farmers face price uncertainty.

Forward contracting is among the strategies that can help producers and investors reduce risk associated with price and even yield variability (Miller, 1986). Davis et al. (2005) found in a survey in Indiana, Nebraska and Mississippi that 65% of corn and soybean producers had used forward contracts for their production in 1999. For cotton production, Miller (1986) described two alternative contracting mechanisms depending on the production system: bales contracting mechanism and acreage contracting. The last contracting practice is more appropriate in situations where cotton is produced with irrigation because with irrigation system yield variability is very low. With non-irrigated production system the bales contracting system is more convenient. Generally, the bales contacting system offers a lower harvest time basis than acreage contracting system.

Forward contracts are often confused with future contracts. However there are substantial differences between the two types of contracts. Nelson (1985) provides some clarification on the

differences between these contracts. He used a theoretical and empirical evaluation of the two types of contracts as hedging instruments for price risk offsetting. His findings suggest that there are basically three main differences between the two types of contracts: the lumpiness, the revenue from intermediate payments, and the basis. He argued that future contracts are more standardized. Nelson (1985) supports also that for small scale producers forwards contracts are preferred than future contracts. He concludes that because future and forward contracts are different in several ways, economists should not use these terms in an interchangeable way without a rigorous analysis of the situation under study. One weakness of Nelson's study is the fact that the risk preference structure is presented without risk aversion coefficient values. The introduction of the producer's risk aversion coefficient would have provided more information about risk preference and would have shown how the two contracts' parameters behave when the risk preference changes.

Another study by Jarrow and Oldfield (1981) addresses the differences between forward and future contracts on the contract's value side. Their work was focused on the theoretical description of the way the two contracts are established and their evolution toward maturity. Their results show that the first difference between forward and future contracts is the intermediary payments. While forward contracts have no payments during the life of the contracts there is a cash flow associated with future contracts. These authors find also that the nature of discount rates is very important in distinguishing between forward and future prices. They argue that when the discount rates change in a stochastic fashion the values of forward and futures prices are not related. When the discount rates are deterministic the value of futures contracts is proportional to the value of forward prices. However their study does not present an empirical evidence of its findings. It is based on a theoretical framework analysis. The results of an empirical model would have given more evidence of the findings if presented in this paper.

Miller (1986) presented a comparison between forward contracting and direct hedging when producers face price and production uncertainty. The methodology used in the study is

based on the mean-variance model under price and yield uncertainty. The study finds that the absence of basis risk associated with forward prices does not imply a higher level of forward contracting than direct hedging. The author provides empirical evidence based on soybean data in the Midwestern US with an objective function that minimizes the risk associated with price variability. Miller's study finds that the optimal level of contracting is not affected by the producers risk aversion coefficients that are higher than one. The study has some strength because it figures out that risk aversion coefficients that are less than one are the range over which the optimal hedging ratio is affected. However this study presents only the forecast error estimation model.

However, a study by Satyanarayan et al. (1993) assumes that if the forward prices are not available because they are scarce, futures prices can be used in model computations. In conclusion even though there are some differences in their evolution toward maturity forward and future contracts have several similarities. They are both instruments for income variability reduction.

Forward and futures contracts in developing countries

Rolfo (1980) presents a study of optimal hedging ratio for four cocoa exporting countries. He considers the London Cocoa Exchange Future contracts because three of the four countries in the study mostly export their Cocoa to Western Europe. Rolfo (1980) assumes that both international price and the national production face variability. The study finds that when production uncertainty is considered within a mean-variance framework, the optimal hedging ratio is less than one. The result is contrary to the findings of previous studies that do not consider production uncertainty. Most of the work consider only price variability and find that the optimal hedging ratio can be one or more. The strength of Rolfo's study is the fact that it uses a forecast model. In hedging evaluation most of the parameters are based on expectation and forecast. The expectation's models accurately take into account the producers' risk preference structure. That's why the author provides the unbiasedness of the forecast in his analysis. One criticism to this

model is the fact that it does not look at other functional forms. The results of a logarithmic function would have given additional value to the study.

Using a mean variance model, Ouatara et al. (1990) found that even though future contracting can reduce the average income of Cocoa producer in Ivory Coast it may also reduce the income variability by 29%. Their study provides a good understanding of how developing countries can use future contracts as a marketing strategy to reduce agricultural income variability. The empirical example of Ivory Coast is a good example of countries whose economy relies heavily on commodity export. In their study they use a range of producers' risk aversion coefficient that goes from near zero to infinity.

Sarassoro and Leuthold (1988) reported that governments and marketing institutions avoid the use of future contracts because future markets are highly unstable and they are considered as speculative. Forward contract are reported to be more suitable for small holders in developing countries because they are less standardized than future contracts and they do not involve higher basis risk (Jarrow and Oldfield, 19981; Miller, 1986). Because the futures contracts need financial provisions (Thompson, 1985) the financial system of the cotton companies in Burkina Faso may fail to support them. Also, due to their high level of standardization it may be difficult for the production system to satisfy all the commitments in futures contracts in some years. Sarassoro and Leuthold (1988) found that the use of forward contracting can significantly reduce the risk associated with price and quantity variability for coffee and cocoa in Ivory Coast. They found a risk reduction (in term of standard deviation) of about 27 to 89% associated with forward contracting.

CHAPTER III

METHODOLOGY

Conceptual framework

Price and yield risk generally has a strong influence on agricultural producers' decision- making process (Moschini, 2001; Anderson and Dillon, 1992). Because cotton growers cannot know how the cotton price will evolve after the sowing date, their planting decisions are based on both expected revenue and its variance. In such case, all the risk is measured with the income variance (Markowitz, 1952). The risk preference structure is an element that determines how the producer reacts when facing risk. Risk preference is generally measured by the risk aversion coefficient (Arrow, 1971). The risk aversion parameter shows producer's willingness to trade-off lower levels of expected income for reduced income variance (Anderson and Dillon, 1992; Jalota et al., 2007). Agricultural producers are assumed to be rational and they seek to maximize their expected utility of income (Mapp et al., 1979). Producers that are less risk averse are less willing to trade expected income for reduced variability. Highly risk averse producers are more willing to trade expected income for reduced variability.

Because the marginal utility of income decreases as income increases, deviations above the mean generate less expected utility than equivalent deviations below the mean reduce the expected utility (Bailey et al., 1980). So in an expected utility framework, it follows that producers will prefer a portfolio with less movement, i.e. variation, about the mean. Freund (1956) suggested that quadratic programming is the best way to include risk into a decision making process. When approximated by a second order Taylor series, the expected utility is a

function of the mean and the variance of the income (Levy and Markowitz, 1979). The quadratic formulation allows minimal assumptions about producer's risk preferences. The assumptions are that the producer's utility function is convex and that the income be normally distributed (Hazell, 1971). The quadratic formulation allows also a balance between expected income and its variance.

Also expected utility maximization problems are well represented in the mean variance framework when a quadratic function can describe the producer's risk preference. Unfortunately, in a quadratic utility function the Arrow-Pratt absolute risk aversion coefficient is increasing with wealth, which is counterintuitive to expectations regarding producers' risk preference (Meyer, 1987). Thus, these assumptions necessary for mean variance to represent producers' expected utility may be violated because income may fail to be normally distributed and producers' risk aversion may decrease with wealth. Nevertheless, Garcia et al. (1994) found that even when the two assumptions do not hold there may not be a big difference empirically. The advantage of the mean variance framework is that it is simple to interpret and it requires less data when compared to the full expected utility maximization problem (Holthausen, 1979).

Empirical Model specification

In the present study, three hypothetical marketing channels are considered for cotton producers: the international spot market, forward contracts and the domestic pricing system of the cotton companies. The international spot market is subject to price variability, while the two other marketing channels do not incur price risk. The Northern Europe cotton market is the one where West African cotton is mainly exported (Cootlook, 2011). We assume that producers can sell part or all of their production on the international markets instead of the local monopsony with the cotton companies.

An E-V model is specified with a quadratic utility function to determine the optimal marketing strategy. The objective function is to maximize the expected utility of income subject to the land constraint. The E-V model is specified as follows:

$$MAX\ \Phi = \sum_{j=1}^{3} X_{(t,j)}\ P_{(t,j)}\ - \frac{\gamma}{2} \sum_{j=1}^{3} X^2{}_{(t,j)}\ Var(t,j) \quad (1)$$

Subject to: $\sum_j X_{(t,j)} = 1$ (2)

$$X_{(t,j)} \geq 0 \quad (3)$$

Where: Φ = the producer's expected utility of income

t = current year time period (year)

J = market channel (domestic, the international spot and Forward contracting)

X(t,j) = decision variable (Fraction of the production for year t sold on market j)

P(t,j) = market price for the j^{th} market in year t

Var(t,j) = variance of market price j in year t

γ = risk aversion parameter.

The E-V model was programmed in GAMS IDE™. The E-V model is a single objective function model with a single constraint, the land constraint. The marketing decision is linked to available land under cultivation. The utility function, Φ, in the model is an approximation of the expected utility of income for producers.

The E-V model was run over three marketing scenarios. In the first scenario, the spot marketing channel was compared to the domestic pricing system to determine in which years cotton producers would have obtained higher utility from selling some or all of the cotton in the spot. In the second scenario, the forward contracting was compared to the spot marketing. The third scenario compares the three marketing channels simultaneously. The impact of the marketing strategies and risk aversion on the level of income and its variability was also examined.

Data description:

Historical price data over 34 years (1976-2009) were collected from various sources for the three marketing channels. The domestic price is the national pan territory price offered to producers by the cotton companies. Since 2006, the domestic producer price has been negotiated each year and announced publicly prior to the planting period, usually in April. Prior to 2006, the price was determined by the government. The domestic price has zero variance because it is a guaranteed price, hence there is no variation associated with it over the time between planting and harvest. The international spot price is the CIF North Europe or Cotlook A Index. Monthly Data on the international spot price are published by the UN Commission on Trade and Development (UNCTAD). In the present study, the December international spot price is used under the assumption that the ginning industry is able to have the cotton lint available for world markets by the end of December each year.

When considering the international spot markets, a major issue for producers is price uncertainty. Producers form price expectations in the springtime to choose the optimal crop portfolio. Since harvest is several months in the future, and further time is required to gin the cotton and ready it for world markets, there can be significant variability between price expectations and received price. Hence, instead of using the actual price an expected price is forecasted based on the historical observations of cotton prices. Each year, the December the international spot price (the harvest period) is forecasted in May (the planting period).

The SAS forecast procedure is used to estimate the predicted December price series. The model behind the procedure uses a linear time trend as given by the equation:

$$P_t = \alpha_1 P_{t-1} + \alpha_2 P_{t-2} + \alpha_3 P_{t-3} + \ldots + \alpha_k P_{t-k} + e \quad (4)$$

P_t = price for the period t

t = current month (May of the current year)

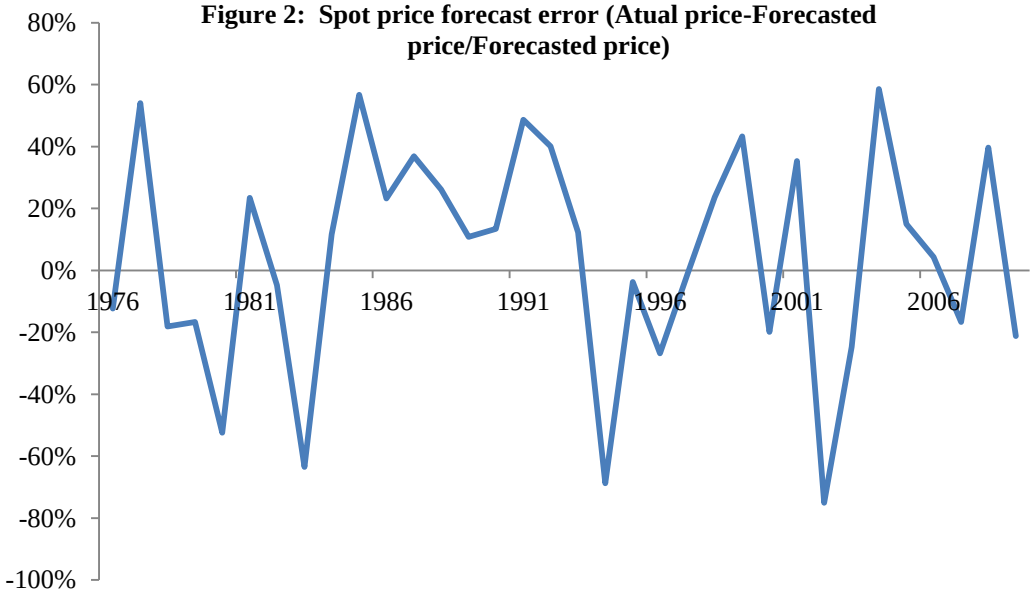
k = time lag index

α_k = estimated parameter.

The forecast procedure generates the mean forecasted December price, the 95% confidence interval, and the standard deviation of the mean (SAS online support). The SAS forecast model was run for each of the 34 years using the previous years' monthly prices prior to May, starting by January 1976 to have the December forecasted price. The standard deviation is squared to give the variance of the international spot price. The variance of the international spot price is the principal component of price variability. Some examples of the forecast results are presented in the appendix.

In general, the SAS forecast model worked relatively well. Most of the years, the forecast error was between 0 and 15% of the actual price (figure 2). However, the forecast procedure tends to overestimate the December world cotton prices rather than underestimating them. Most of the errors components are positive over the time period. In the periods 1976-1984 and 1995-2009 the forecasted international spot price was sometime greater and sometime less than the actual international spot price. Introducing the international spot price variability (standard deviation) shows that there are two periods during which the international spot price can potentially be less than the domestic price. The two periods are 1987- 1994 and 1997-2009.

Figure 2: Spot price forecast error (Atual price-Forecasted price/Forecasted price)



Data for forward contracts prices are difficult to obtain in the present area of study because forward contracts are not common for cotton (Miller, 1986). For this reason the near December NYCE Futures contracts is used. Similarly to the domestic price forward contract price does not involve variability between the planting period and harvest. The reason is because forward contracting does not involve basis risk. The price stays the same from the moment the position is taken with the contract to the contract's maturity.

The domestic pricing mechanism is a farm gate price with which producers do not incur any other marketing costs. With the international spot market, however, producers would need to gin, transport, and market the cotton to London. So, to provide a fair comparison between the domestic pricing mechanism and the two international marketing channels, prices are adjusted by subtracting the ginning, transportation and marketing costs from the international spot market price and forward contracts' price. Data on ginning costs, moving and marketing cotton from the farm gate to London are obtained through the study by Baffes (2007). In the study by Baffes (2007), the average marketing cost, sea freight and ginning cost for the West and Central African cotton producing countries are estimated. Included countries are Benin, Burkina Faso, Cameroon, Mali, the Central African Republic, Chad, Côte d'Ivoire, Guinea, Niger, Madagascar, Senegal, and Togo. The ginning cost for West and Central African countries is compared to the cost in other countries in table 1. Baffes (2007) also estimated domestic transportation costs from gin to sea ports by country. Marketing cost was estimated as 3% of the Cotlook A index for the period between 1976 and 2003. From 2004 to 2006, he assumed that the marketing cost is 2.6% of the Cotlook A index. Exchange rate between US dollar and the local currency (CFA Franc) is obtained from the USDA Economic Research Services. All the data are converted in CFA/Kg (the local currency) of seed cotton using the nominal exchange rate and ginning ratio.

Table1: Ginning cost for selected countries

Country	Ginning cost c/lb (lint)	Ginning CFA/Kg (seed cotton)
Argentina	15.93	58.89
Australia	12.22	45.18
Bolivia	11.63	42.99
China	1.13	4.18
Colombia	11.99	44.33
Cote d'Ivoire	14.84	54.86
Ecuador	11.40	42.14
Spain	24.84	91.83
USA	8.05	29.76
Zimbabwe	16.79	62.07
West and Central Africa	17.34	64.10

Source http://www.icac.org/cotton_info/speeches/Chaudhry/BW97.PDF (converted from c/kg to c/lb)

The sum of the marketing, domestic transportation, ginning, and the sea freight cost is the theoretical difference between the domestic price and the two international markets prices that are the international spot and forward contract prices. These costs are borne by the cotton companies in Burkina Faso. Table 2 shows the additional cost from the farm gate to CIF prices. The cost are converted in local currency that is CFA Franc per kilogram of seed cotton and subtracted from the prices of the two international marketing channels (the international spot and forward contracting) to adjust them to the domestic price. The summary statistics of the non-adjusted and adjusted prices along with the domestic price over the 34 period are given in table 3. The prices evolution over time is shown in figures 4 and 5 respectively for the non-adjusted and the adjusted prices with the domestic price in local currency per Kg of seed cotton.

Table 2: Beyond farm-gate-costs

Year	Ginning costs (cts/lb lint) (A)	Nominal Domestic transportation cost (cts/lb lint) (B)	Sea freight Cost (cts/lb lint) (C)	Marketing costs (cts/lb lint) (D)	Total costs (cts/lb lint) (A+B+C+D)	Total Costs (CFA/Kg seed cotton)
1976	12.93	3.58	2.72	1.95	21.18	41.70
1977	13.72	3.66	2.72	2.49	22.59	43.69
1978	15.31	4.59	2.95	1.95	24.80	43.11
1979	18.90	5.46	3.18	2.27	29.80	49.48
1980	21.81	6.11	3.40	2.54	33.86	63.07
1981	20.53	5.79	3.63	2.81	32.76	76.99
1982	18.08	5.27	3.86	2.22	29.44	83.66
1983	16.43	4.67	4.08	2.31	27.50	96.79
1984	15.34	4.38	4.99	2.63	27.34	108.48
1985	13.93	4.04	5.44	2.09	25.50	84.39
1986	18.00	4.92	4.99	1.45	29.36	84.28
1987	21.53	5.74	4.54	1.86	33.67	81.79
1988	20.76	6.15	4.31	2.18	33.39	87.41
1989	17.67	5.74	4.31	2.00	29.72	78.50
1990	18.59	5.80	4.31	2.40	31.10	71.22
1991	19.94	6.65	4.08	2.45	33.12	79.77
1992	18.56	6.46	4.08	2.04	31.14	76.65
1993	20.23	6.74	4.08	1.77	32.83	89.74
1994	16.55	4.97	4.08	2.04	27.64	143.87
1995	15.21	4.78	4.08	2.77	26.84	128.92
1996	17.24	5.26	4.08	2.59	29.17	142.92
1997	16.86	4.89	3.63	2.40	27.78	153.45
1998	15.93	4.40	3.40	2.22	25.95	132.97
1999	17.21	4.44	3.18	1.81	26.64	159.26
2000	16.07	4.19	2.95	1.63	24.85	171.88
2001	15.20	4.03	2.72	1.72	23.68	161.19
2002	13.96	4.34	2.49	1.32	22.12	131.32
2003	15.40	4.97	2.72	1.59	24.68	122.27
2004	17.57	5.88	2.49	1.72	27.67	126.26
2005	19.04	6.32	2.49	1.45	29.31	149.80
2006	19.08	6.36	2.72	1.45	29.61	135.79
2007	17.97	6.01	2.75	1.57	28.30	129.79
2008	17.00	5.65	2.77	1.61	27.03	123.98
2009	16.71	5.44	2.78	1.61	26.54	121.69

Sources: Baffes (2007)

Table 3: Prices summary statistics (CFA/kg seed cotton)

Statistics	Domestic price	Forecasted international Spot	Adjusted Forecasted international spot price**	Forward Price	Adjusted forward price***
Mean	119.82	268.08	158.96	245.95	140.77
Standard Deviation	-	84.95	53.30	-	-
Kurtosis	-1.51	-1.07	-0.49	-1.14	-0.81
Skewness	0.11	-0.02	0.25	0.395	0.69
Minimum	40	125.56	74.77	97.41	53.72
Maximum	210	427.39	282.99	449.26	288.70
Number of observations	34	34	34	34	34

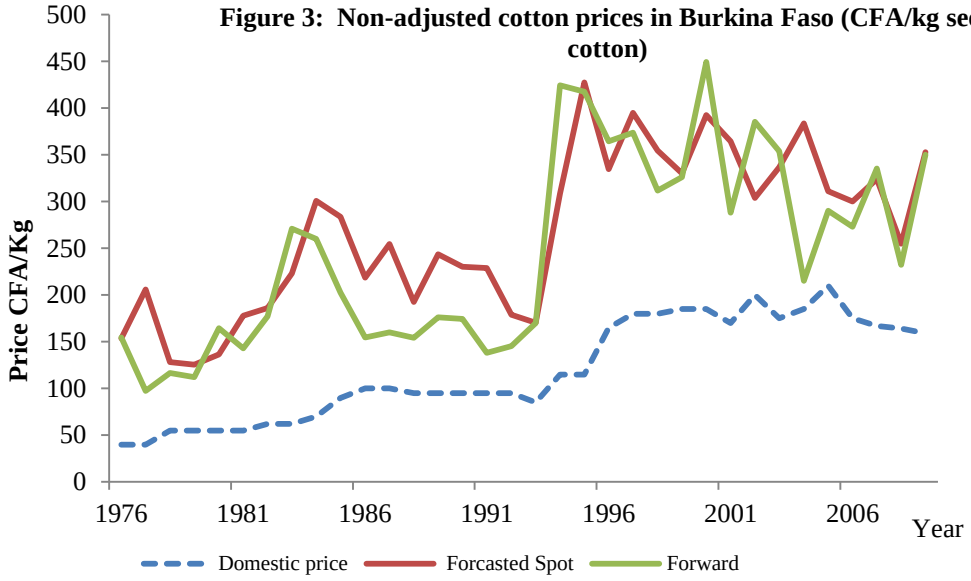
Data sources: Domestic price (World Bank), International spot price (UNCTAD), Forward price (NCCA).

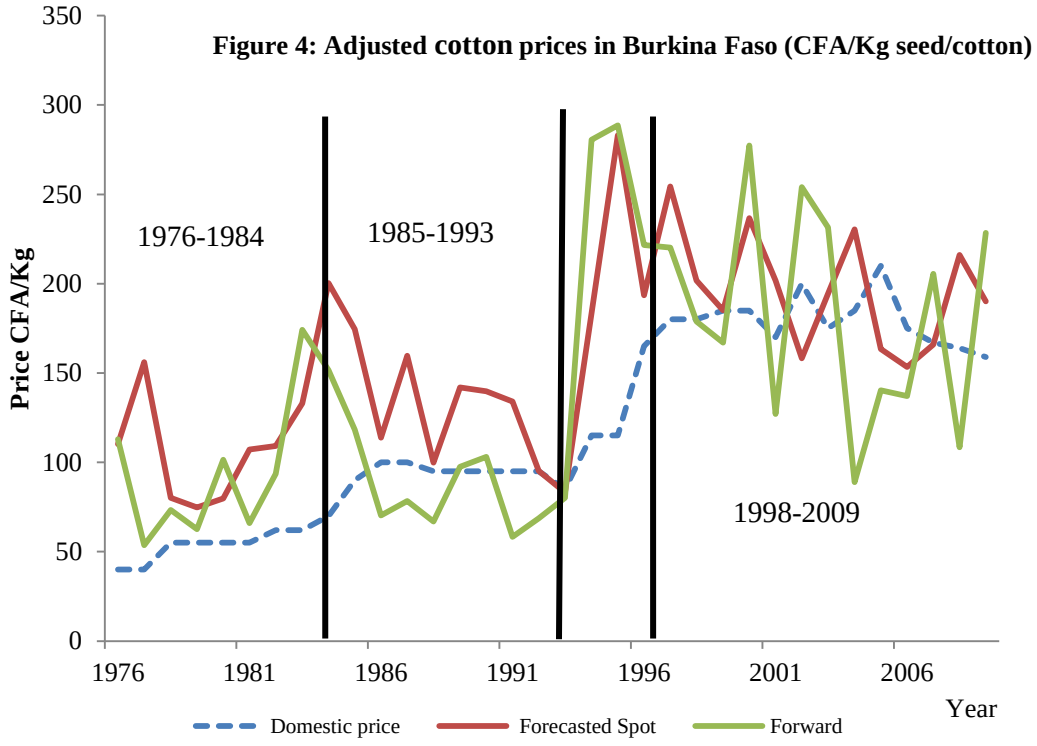
**The domestic price is the national unique producer price . **The adjusted forecasted international spot is obtained by subtracting the beyond farm gate costs from the international spot price. ***The adjusted forward price is obtained by subtracting the beyond farm gate cost from the forward December price.*

Table 3 gives the summary statistics of the three prices series. On average the forecasted December international spot price is higher than forward price. Both the forecasted international spot and forward contracts prices are higher than the domestic price, even when discounted by the transportation, ginning and marketing costs. The average domestic price is 119.82 CFA per Kg of seed cotton. The domestic price is 25% lower than the forecasted international spot price and 15% lower than the forward contracting price.

On average, the forecasted international spot price is 268.08 CFA/Kg seed cotton corresponding to a price of 0.63$/lb of seed cotton. When discounted by the additional marketing costs, the average international spot price is 158.96 CFA/Kg, corresponding to 0.37$/lb of seed cotton. The average forward price was 245.95 CFA/kg (0.57$/lb.). Adjusted average forward price is 140.77 CFA/Kg of seed cotton (0.33$/lb.). The forecasted international spot price is subject to variation with a standard deviation of 53.30 CFA/Kg.

All the three price series have a negative Kurtosis meaning that their distributions are relatively flat with fat tails. The skewness is positive for the domestic and the forward price. The international spot price has a negative skewness. The skewness of the forecasted international spot price can create skewed outcomes.





Figures 4 and 5 present the evolution of prices over the time scope of the present study.

The non-adjusted international prices are obviously higher than the domestic price. When the

prices are adjusted the gap between the prices is largely reduced. The gap between the international prices and the domestic price is ineterpreted as the additional costs borne by the cotton companies. Even though those costs are variable over time, the adjustment did not change the general trend of the prices.

Over the time scope of the study there are four distinct periods in wich the price series' evolution presents different characteristics (table 4).

Table 4: Average domestic and international spot price in selected periods (CFA/Kg seed cotton)

Period	Mean domestic price	Mean forecasted international spot price	Spot STDEV
1976-1983	54.89	116.75	18.09
1985-1993	94.44	126.88	31.35
1994-1997	118.06	169.20	26.27
1998-2009	179.58	191.46	30.27

Between 1976 and 1984 cotton international prices increased significantly from 150 to 300 CFA per kilogram of seed cotton after a sudden drop in 1977. The domestic price was largely below the international prices. Baffes (2007) reports that the resaon for the relatively low producer price was the tax to which to cotton sector was subject during the late 1970s and early 1980s. From 1985 to 1993 the price decreased from 300 to 169 CFA/kg (Seed cotton). With the 50% devaluation of the CFA Franc, the international price doubled from 169 in 1993 to 424.48CFA/Kg in 1994.

Between 1994 and 1997 the international price was again higher than the domestic price. From 1998 to 2009 the difference between the international prices and the domestic price was reduced with the domestic price being even higher than the international price in some years. In these years, producers were given a relatively higher price. The domestic pricing system had helped producers by protecting them against the low international price during the 2000's when

the cotton market price was low. Over the period between 1976 and 2009 the domestic price variation had been smoother than the variation of the international prices.

The estimation with forecast procedure uses the following equation to predict the next December price depending on the trends identified from the times series. The forecast equation is:

$$P_t = (a + b_t)\, s(t) + \varepsilon_t \tag{5}$$

In equation (5), P_t is the next December forecasted price, a and b are trend parameters, t is the trend and ε the error term.

After running the E-V model the gross revenue is calculated as well as its variance for a hypothetical one hectare farm using equation (6) and equation (7) as:

$$\bar{R} = \sum_{j=1}^{3} X_{jt} P_{jt}\, Y_t \tag{6}$$

where R is the average expected revenue, X_{jt} the ratio of market j for the year t, P_{jt} price on the market J for the year t and Y_t the cotton yield for year t.

$$V_t = Y_t^2 X_t^2 var_t. \tag{7}$$

In equation (7) V_t is the expected variance of revenue, Y_t is the yield for year t, X_t is the international spot market ratio given by the E-V model and var_t is the expected variance of the international spot market price.

The cotton companies' rent is calculated as the difference between the revenue with the adjusted international spot price and the revenue with the domestic price. The rent is given by the flowing equation:

$$R_t = Y_t(P_s - P_D). \tag{8}$$

In equation (8) R_t represents the annual rent earned by the cotton companies, Y_t is the yield, t is the year. P_s is the adjusted international spot price and P_d is the domestic price.

In the present study, the risk premium is defined as the difference between the expected revenue of the risk neutral producer and the expected revenue of the risk averse producer. The risk premium is defined within the context of the risky international spot market and the domestic

guaranteed price and therefore increasing with the producer's risk aversion. The risk premium reaches its maximum with extreme risk aversion for which producers' expected revenue is at its minimum.

The following equation is used to calculate the risk premium:

$$R_p = R_{RNP} - R_{RAP.} \tag{9}$$

In equation (9) R_p is the risk premium, R_{RNP} is the revenue of the risk neutral producer and R_{RAP} the revenue of risk averse producer.

The certainty equivalent is the difference between the revenue of the risk neutral producer and the risk premium. It is calculated using:

$$CE = R_{RNP} - R_p \tag{10}$$

where CE represents the certainty equivalent, R_{RNP} the revenue of the risk neutral producer and $R_{p,}$ the risk premium.

CHAPTER IV

FINDINGS

Comparison between spot market and domestic pricing system

The international spot marketing on the northern Europe market is compared to the domestic pricing mechanism using the mean variance model to determine the most profitable marketing channel for producers. The northern Europe spot market is used because the West African cotton is more likely to be marketed on European markets (Tschirley et al., 2009).

The international spot market was not always the optimal marketing strategy selected by the E-V model even though the international spot market offers the higher price on average over the period 1976-2009 (table 5). Because of price risk and uncertainty, risk neutral producers would have marketed 15% of their production on the domestic pricing system to maximize their expected income (table 5). With the risk neutral preference, the average cotton revenue can fluctuate by 20% because its standard deviation is \$77.18 ha^{-1} for a mean of \$377.45 ha^{-1} (table 5).

Risk averse producers prefer to use the domestic pricing system that protects them against price uncertainty. However, risk averse producers lose part of their expected revenue as they sell an increasing part of their production with the domestic pricing system. As producers sell more of their production with the domestic pricing system their certainty equivalent decreases. The decreasing certainty equivalent as risk aversion increases, can be interpreted as if less risk averse producers are willing to accept more than highly risk averse ones to maintain a certain level of certainty for their expected income. The certainty equivalent can also be interpreted as the minimum price that the cotton companies should offer producers to maintain

them in the program. Conversely, the risk premium that is the difference between the expected revenue of the risk neutral producer and the revenue of another producer who has a higher level of risk aversion, increases as the risk aversion increases (table 5). For the period between 1976 and 2009, a producer with a risk aversion parameter of 0.1 has a risk premium around \$37.40 ha^{-1} for an expected revenue that is around \$340.05 ha^{-1} while a producer whose risk aversion parameter is 50 has a risk premium that is about \$95.36 ha^{-1} for a \$282.09 ha^{-1} expected revenue (Table 5).

For values of the risk aversion parameter greater than or equal to 100, all the production should be sold with the domestic pricing system to minimize income variance. At this level of risk aversion, the annual expected revenue is around \$281.97 ha^{-1} (table 5). This represents a 25.3% reduction in the expected revenue compared to the average revenue of risk neutral producers across the period 1976-2009. Meanwhile, the risk averse producer reduces the standard deviation of the expected revenue to zero. The risk-variance trade-off represented by the ratio of income reduction over variance reduction is about 0.233 or 23.3%.

Combining the international spot marketing and the domestic pricing system would generally help producers increase their revenue compared to the prevailing (parastatal) marketing practices. The only exception is the highly risk averse producers. As far as they can bear a certain level of risk, producers can improve their expected revenue and minimize income variability. For example, for risk neutral preference cotton revenue increases by 36% compared to the domestic pricing system over the 1976-2009 period (table 5). The expected revenue of highly risk averse producers is the same as with the domestic pricing system because they sell 100% of their production on the domestic market to significantly reduce the variability associated with the international spot price.

Baquedano (2009) and Tschirley et al. (2009) argue that producers would have earned an average revenue of \$377.45 ha^{-1} across the time horizon 1976-2009. Because these studies did not consider risk, their assumption is that the international spot market is not associated with risk.

This revenue would be about $100 per ha higher than the domestic marketing system. In the present study however, we find that for the medium to highly risk averse producers, the domestic marketing system actually has benefits by reducing income variability.

If cotton producers have had the opportunity to sell their production with the international spot market as recommended by previous studies they would have earned higher revenue in some periods. However, the present study found that in other periods the actual revenue on the international spot market is lower compared to the revenue with the domestic pricing system. Because the international spot price incurs risk it is not always the best marketing channel. The direct implication of the findings in the present study is that there is a positive value for the price stabilization role of the domestic guaranteed price supported by the public companies. The value evaluated as the risk premium that risk averse producers are willing to pay is on average 41 cents/lb. or an average of 119 CFA/kg (seed cotton).

It seems reasonable and consistent with other studies (Ouatara et al. 1990, Patillo and Soderbom, 2000) that producers would be willing to reduce their expected revenue by 20% to significantly reduce variability, including avoiding low and negative incomes. Ouatara et al. (1990) found a reduction of 26% for the expected revenue for cocoa producers in Ivory Coast to reduce the income variability by 11%. In the present study the income reduction ranges between 5 and 20%. Importantly, with the expectation model presented here the variability of revenue is reduced to zero at high levels of risk aversion.

Another way to evaluate the revenue and price risk trade-off is to compute the ratio $\Delta E(Y)/ \Delta\sigma$, with $E(Y)$ being the expected income and σ the standard deviation of income (Patillo and Soderbom, 2000). In their study on the manufacturing sector in Ghana these authors found a ratio between 0.8 and 1 for extreme risk aversion, between 0.67 and 0.8 for severe risk aversion, 0.5 to 0.33 for moderate risk aversion. Their ratio was between 0 and 0.33 for slight to neutral risk aversion. In the present study the ratio of the expected income variation over the risk variation is always greater than one for highly risk averse producers. For the study by Ouatara et

al, (1990) the ratio is 0.5. A study by Patrick et al. (1984), found a ratio of 1.5. The ratio for another study by Schurle and Erven (1979) is around 1.4.

Table 5: Comparison between spot marketing and the domestic pricing system, 1976-2009

γ	Domestic Pricing ratio*	Spot ratio*	Average revenue ($US/ha)**	STDEV of revenue ($US/ha)	Revenue difference ($US/ha)	Certainty equivalent*** ($US/ha)	Risk premium‡ ($US/ha)
0	0.15	0.85	377.45	70.18	95.54	-	-
0.0001	0.16	0.84	377.44	68.96	95.54	377.44	0.00
0.001	0.20	0.80	377.43	65.48	95.26	377.16	0.02
0.008	0.22	0.78	377.16	63.84	95.53	377.43	0.28
0.01	0.23	0.77	376.74	62.62	94.83	376.74	0.71
0.1	0.61	0.39	340.05	23.79	58.15	340.05	37.40
0.2	0.73	0.27	324.98	14.92	43.08	324.98	52.46
0.5	0.86	0.14	303.14	6.47	21.24	303.14	74.31
0.6	0.88	0.12	300.11	5.36	18.20	300.11	77.34
0.7	0.89	0.11	297.99	4.69	16.08	297.99	79.46
1	0.92	0.08	294.21	3.31	12.31	294.21	83.24
2	0.94	0.06	289.82	1.82	7.91	289.82	87.63
5	0.98	0.02	285.15	0.68	3.25	285.15	92.30
50	0.99	0.001	282.09	0.02	0.18	282.09	95.36
100	1.00	0.00	281.97	0.00	0.00	281.97	95.54

***The ratios are obtained through the E-V model using the data for the period between 1976 and 2009.*
***The revenue is computed using the ratios, the prices of the two marketing channels and adding them up.*
**** The certainty equivalent is equivalent to the income that risk averse producer is willing to accept rather than a higher revenue that is subject to risk.* ‡*The risk premium is the difference between the certainty equivalent and the revenue of the risk neutral producer.*

Over the 34-year period from 1976 to 2009, the cotton companies' annual rent averaged around $21 million. The companies kept their rent without investments in rural areas. The lack of rent redistribution through investments is the reason why critics are abundant about the parastatal companies' management over the whole cotton sector. Because there was a clear difference in the price discrepancy over the time scope of the present study (Figure 5), the two marketing channels are compared for the periods in which the same trend of the price distribution is identified.

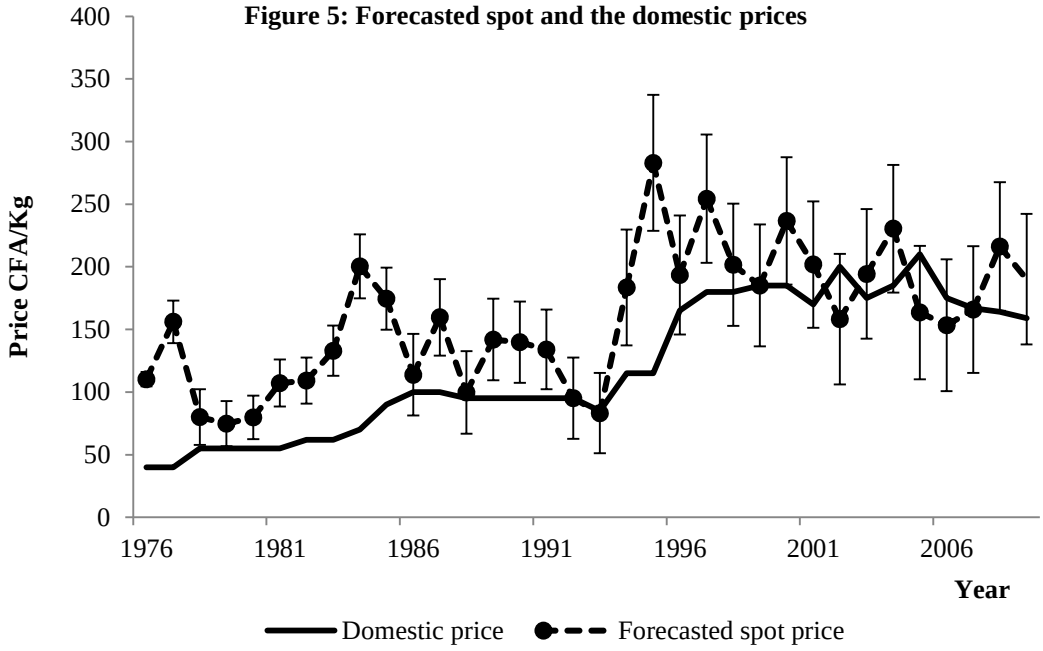


Figure 5: Forecasted spot and the domestic prices

1976-1984 Period:

During the period 1976-1984, the domestic cotton price was substantially lower compared to the international spot price. The domestic price represented 47% of the spot price on average (table 6). The spot price variability was also modest over the period (with a coefficient of variation of about 15%). In all of the years the spot price was at least one standard deviation above the domestic price. It is obvious that the spot market was the best marketing channel for the period and this is confirmed by the model (table 6). Over the 9 years from 1976 through 1984 there were six years during which even if the spot price went down by one standard deviation producers would have a higher price with the spot compared to the price offered by the national company. Hence, the spot price was exclusively the best marketing option for risk neutral and modestly risk averse producers for all the 9 years (table 6).

The expected revenue was \$354.94 ha^{-1} for risk neutral preference (Table 6). The certainty equivalent for risk neutral producers is \$354.94 ha^{-1} and their risk premium is zero. For more risk averse producers, the domestic pricing system is more utilized. When the producer's risk aversion coefficient is 100, the total production is sold with the domestic pricing system

giving an expected income of \$170.02 ha^{-1}. Producers would sacrifice a larger part of their income (52%) to reduce price variability to zero. The ratio of the income reduction to the reduction of the standard deviation of revenue is about 3.3. This ratio is reasonably acceptable when compared to other studies (Musser and Stamoulis, 1981) where the ratio is greater than 10. Highly risk averse producers have a certainty equivalent of \$170.0.2 ha^{-1} and a risk premium of about \$184.92 ha^{-1}. It clearly appears that the use of spot market would have had a positive effect on producers' income between 1976 and 1984. Their revenue can increase by more than 100% on average over the 9-year period.

Table 6: Comparison between spot marketing and the domestic pricing system, 1976-1984

γ	Domestic Pricing ratio*	Spot ratio*	Average revenue (\$US/ha)**	STDEV of revenue (\$US/ha)	Income difference (\$US/ha)	Certainty equivalent (\$US/ha)**	Risk premium (\$US/ha) ‡
0	0	1	354.94	56.07	184.93	-	-
0.0001	0	1	354.94	56.07	184.93	354.94	0.00
0.001	0	1	354.94	56.07	184.93	354.94	0.00
0.008	0	1	354.94	56.07	184.93	354.94	0.00
0.01	0	1	354.94	56.07	184.93	354.94	0.00
0.1	0.1	0.9	346.90	49.14	176.89	346.90	8.04
0.2	0.3	0.7	326.58	38.60	156.56	326.58	28.36
0.5	0.6	0.4	253.94	17.79	83.92	253.94	101.00
0.6	0.7	0.3	242.96	15.09	72.94	242.96	111.99
0.7	0.7	0.3	234.89	13.06	64.87	234.89	120.05
1	0.7	0.3	221.34	8.10	51.32	221.34	133.60
2	0.8	0.2	205.11	5.61	35.10	205.11	149.83
5	0.9	0.1	184.62	2.33	14.60	184.62	170.33
50	0.99	0.0	171.02	0.10	1.00	171.02	183.93
100	1.00	0.0	170.02	0.00	0.00	170.02	184.93

The ratios are obtained through the E-V model using the data for the period between 1976 and 1984.
The revenue is computed using the ratios, the prices of the two marketing channels and adding them up.
**** The certainty equivalent is equivalent to the income that risk averse producer is willing to accept rather than a higher revenue that is subject to risk. ‡The risk premium is the difference between the certainty equivalent and the revenue of the risk neutral producer.***

1985-1993 period:

From 1985 to 1993 the international price was low. The domestic price was 74% of the spot price. The standard deviation of spot price was large (25%). Producers profited with a relatively higher domestic price offered by the cotton company. The expected gross revenue was \$468.87 ha^{-1} for risk neutral producers. Its represents a 37% increase compared to revenue obtained with domestic pricing system alone. For highly risk averse producers the expected revenue was \$341.93 ha^{-1}. It is 28% lower than the expected revenue of risk neutral producers. When the international prices are low, the domestic pricing system (or a combination of it with other strategies) would offer a better marketing opportunity for producers.

1994-1997 period:

From 1994 to 1997 the price structure and trend was similar to the period between 1976 and 1984. For all four years the spot price was at least two standard deviations higher than the domestic price. The spot price was 60% higher than the domestic price on average over the four-year period. The variability associated with the spot price was also small (with a coefficient of variation of 15 %). The expected revenue for modest risk aversion was \$390.06 ha^{-1}. This represents an increase of 34% compared to revenue with the monopsony system only. The magnitude of the difference in gross revenue between the combination of international marketing with the domestic pricing system and the revenue with the actual pricing system only was relatively high in this period. Highly risk averse producers would give up 34% of their expected income with spot market in order to reduce revenue variability to zero. The expected revenue with high risk aversion was \$256.73 ha^{-1} with zero standard deviation. The 34% loss is the risk premium that producers would be willing to pay in order to get risk free revenue.

1998-2009 period:

The period from 1998 to 2009 is another period of low international prices. The domestic price was higher than the forecasted spot price in four years over the period, i.e. in one year out of three the domestic price was actually higher than the forecasted spot price. During this most recent

period, risk neutral producers would sell 33% of their production with the domestic pricing system (table 7). The expected revenue of risk neutral producers was \$346.7 ha^{-1} with a standard deviation of \$33.85 ha^{-1}. The expected revenue of highly risk averse producers was \$309.7 ha^{-1}. It is 10% lower than the expected revenue of risk neutral producer. However, the revenue of risk averse producers is risk free because its standard deviation is zero. The certainly equivalent of the risk averse producer is 309.7 ha^{-1} and the risk premium is \$37.1 ha^{-1}. Compared to the domestic pricing system, the increase of the expected income with the combination of spot and domestic prices was only 11% for risk neutral producers. The 1998 -2009 period was a period of progressive decline in the cotton world price. The national companies were probably using the Stabilization Fund to insure a higher price to producers.

Table 7: Comparison between spot marketing and the domestic pricing system, 1998-2009

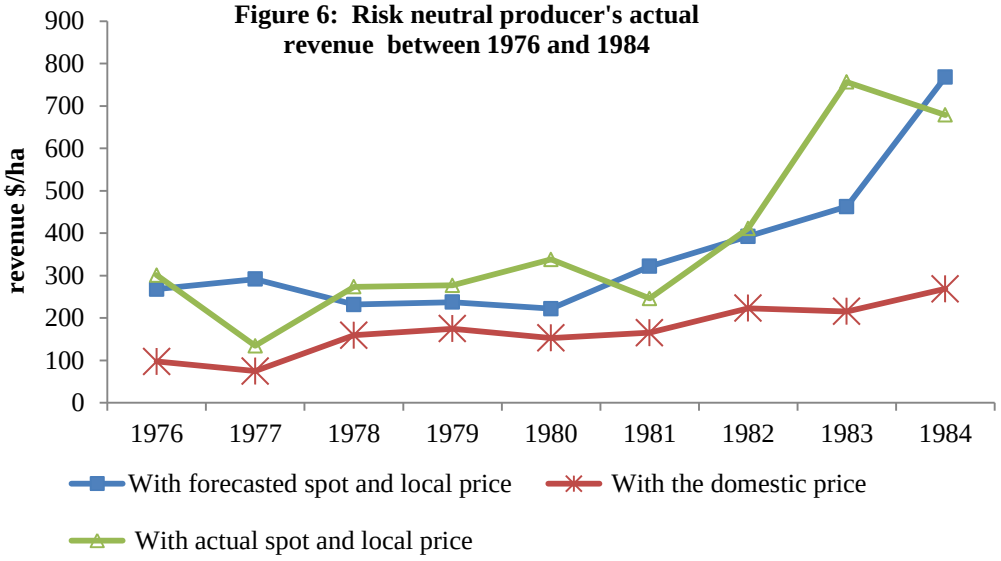
γ	Domestic Pricing ratio*	Spot ratio*	Average revenue (\$US/ha)**	STDEV of revenue (\$US/ha)	Income difference (\$US/ha)	Certainty equivalent (\$US/ha)***	Risk premium (\$US/ha) ‡
0	0.33	0.67	346.7	33.85	37.0	-	-
0.0001	0.37	0.63	346.7	32.50	37.0	346.7	0.0
0.001	0.41	0.59	346.7	30.76	37.0	346.7	0.0
0.008	0.42	0.58	346.4	30.18	36.7	346.4	0.3
0.01	0.45	0.55	345.6	29.02	35.9	345.6	1.1
0.1	0.92	0.08	315.6	4.33	5.8	315.6	31.2
0.2	0.96	0.04	312.7	2.21	2.9	312.7	34.1
0.5	0.98	0.02	310.9	0.88	1.2	310.9	35.8
0.6	0.99	0.01	310.7	0.70	0.9	310.7	36.1
0.7	0.99	0.01	310.6	0.67	0.9	310.6	36.1
1	0.99	0.01	310.3	0.44	0.6	310.3	36.4
2	1	0	310.0	0.00	0.0	309.7	37.0
5	1	0	309.7	0.00	0.0	309.7	37.0
50	1	0	309.7	0.00	0.0	309.7	37.0
100	1	0	309.7	0.00	0.0	309.7	37.0

The ratios are obtained through the E-V model using the data for the period between 19986 and 2009.
****The revenue is computed using the ratios, the prices of the two marketing channels and adding them up.***
***** The certainty equivalent is equivalent to the income that risk averse producer is willing to accept rather than a higher revenue that is subject to risk.* ‡*The risk premium is the difference between the certainty equivalent and the revenue of the risk neutral producer.***

Over the last twelve years, if producers had implemented the model's results, risk neutral producers would have earned higher revenue with the domestic price (table 8). For 4 years risk

neutral producers would have the same revenue in both channels and they would have had higher revenue only in three years (Figure 6). The risk averse producers might have used either of the two channels and made approximately the same level of revenue. However, for the periods during which the international price was high (for example 1976-1984) risk neutral producers would use the spot price for all the years and made higher revenue. Because the domestic price was dominated in first order dominance by the international price, the domestic marketing option was not chosen in these periods for risk neutral producers.

Figure 6: Risk neutral producer's actual revenue between 1976 and 1984



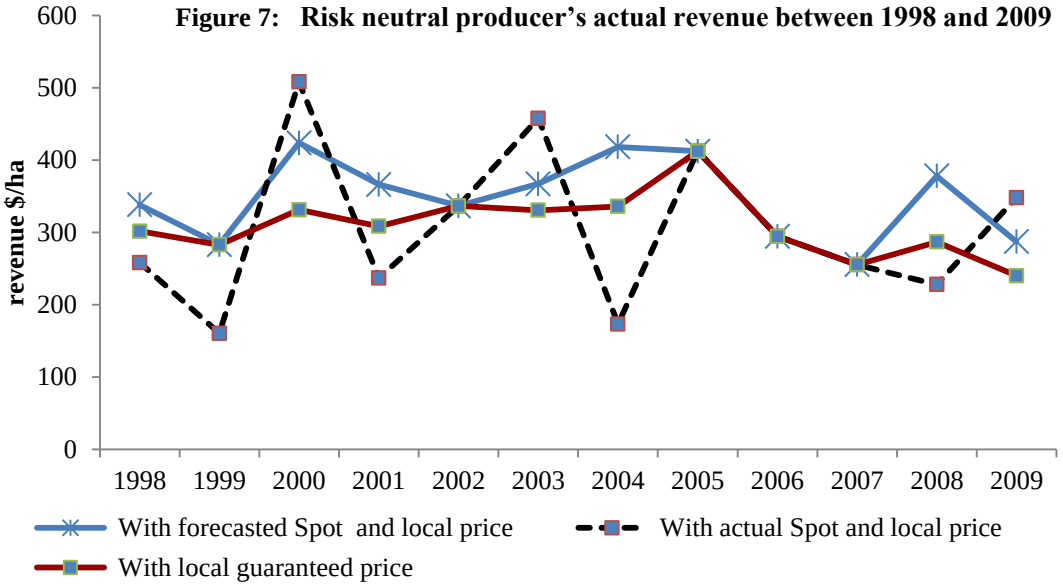


Figure 7: Risk neutral producer's actual revenue between 1998 and 2009

Figure 7 shows that it is typical that forecasts are optimistic over the last twelve years. In most of the years (except three) the forecasts were for higher spot price but this did not always lead to higher actual price in December. The forecasted revenue was equal to the revenue with the revenue with the domestic price four years over the twelve years. The years in which the forecasted revenue is the same as the revenue with the domestic price, are the years for which the risk neutral producers would sell all the production with the domestic pricing system. For three years (2000, 2003 and 2009) the actual spot price was higher than the forecasted spot price. Finally for five years the actual spot price was lower than the forecasted spot price. Over the period 1998-2009 the average revenue with the actual spot price was \$304.50 ha^{-1} with a standard deviation of \$115.90 ha^{-1}. The average revenue with the domestic price was \$309.72 ha^{-1} with a standard deviation of \$44.86 ha^{-1}. The t-test shows that the two mean revenues are significantly different at 5% level. It clearly appears that there is, coincidentally, a value in the domestic guaranteed price during the last decade. Because the SAS forecast procedure overestimates the spot price, the expected revenue with the combination of the forecasted spot price and the domestic price is higher than the expected revenue with the two other combinations (table 8). The

annual average expected revenue over the last twelve –year period was \$346.73 ha^{-1} with a standard deviation around \$57.15 ha^{-1}. The revenue of risk neutral producers with the combination of the actual spot and the domestic price was lower (\$305.86 ha^{-1}) compared to the revenue of risk averse producers (\$309.89). The reason why the risk neutral producer may have lower actual revenue is because by using the ratio given by the E-V model the expectation was to earn more. However, because the forecast was not perfectly accurate the average income is low (tables 8 and 9).

Table 8: Actual and expected revenue for risk neutral producer (\$US/ha)

Year	Forecasted spot price Combination*	Actual spot price** Combination	Domestic market only	Actual spot price only
1998	338.14	258.33	301.73	258.33
1999	283.03	160.63	282.81	160.63
2000	423.71	507.93	331.18	507.93
2001	366.18	237.01	308.47	237.01
2002	336.59	336.59	336.59	466.24
2003	367.17	457.87	330.60	457.88
2004	418.26	173.30	335.81	173.30
2005	412.32	412.32	412.32	273.16
2006	294.63	294.63	294.63	247.17
2007	255.46	255.46	255.46	296.18
2008	378.01	228.07	286.82	228.07
2009	287.30	348.19	240.26	348.19
Average	346.73	305.86	309.72	304.51
STDEV	57.15	109.71	44.86	115.90

The ratios given by the E-V model are used to combine the forecasted spot price and the domestic market to maximize producer's expected revenue. The combination in this case used the actual December spot price instead of the forecasted spot one.*

Highly risk averse producers would have a higher actual income because the model's output suggest that they should use the domestic pricing system. It turned out that the domestic price was higher than the actual spot price. So the actual revenue of risk averse producers is relatively higher than the actual revenue of the risk neutral producers.

Table 9: Actual and expected revenue for highly risk averse producer ($US/ha)

Year	Forecasted spot price Combination*	Actual spot price Combination**	Domestic market only	Actual spot market only
1998	305.01	297.83	301.73	258.33
1999	282.81	282.81	282.81	160.63
2000	349.68	366.53	331.18	507.93
2001	315.97	299.18	308.47	237.01
2002	336.59	336.59	336.59	466.24
2003	333.16	339.51	330.60	457.88
2004	350.65	306.56	335.81	173.30
2005	412.32	412.32	412.32	273.16
2006	294.63	294.63	294.63	247.17
2007	255.46	255.46	255.46	296.18
2008	305.06	275.07	286.82	228.07
2009	245.43	252.13	240.26	348.19
Average	315.57	309.89	309.72	304.51
STDEV	45.50	46.75	44.86	115.90

The ratios given by the E-V model are used to combine the forecasted spot price and the domestic market to maximize producer's expected revenue. the combination in this case used the actual December spot price instead of the forecasted spot one.*

Spot marketing versus forward contracting

The northern Europe spot market is compared to forward contracting in a second scenario. For neutral and modest risk aversion the use of forward contracting is lower compared to spot marketing (table 10). The reason is because in general the spot price is higher than the forward contract price. Risk neutral producers would sell 68% of their production on the spot market and 32% with forward contracting (table 10). By combining forward contracts with spot marketing, risk neutral producers can significantly improve their income compared to the domestic pricing system. The expected average annual income could reach as high as $398.21 ha^{-1}, which represents a 41% increase compared to the revenue with the domestic pricing system. For risk neutral producers, the difference between the expected revenue with the combination of the two international marketing channels and the domestic pricing system would be around $116 ha^{-1} and

the average standard deviation of their expected revenue is about \$17.82 ha^{-1} that is 14% of the average revenue. The certainty equivalent of the risk neutral producer is \$398.21 ha^{-1}.

The standard deviation of the expected revenue decreases as the risk aversion increases. With a risk aversion parameter of 50, cotton growers would produce 100% of the cotton area under forward contracting. By producing all the area under contracts the variability of the producers' expected revenue is zero. The producers' revenue expectation in May would stay the same over the period between the planting period and the contract's maturity at harvest time (December). A highly risk averse producer's expected revenue is about \$297.45 ha^{-1}, which is 25% lower than the expected revenue of risk neutral producer. So if risk preferences change from neutral to extreme risk aversion, producers would choose to give up 25% of their expected revenue in order to reduce the income variability by 100%. The risk premium of risk averse producers is \$100 ha^{-1}.

The standard deviation of revenues becomes zero when producers are highly risk averse. The reason for the decrease in the standard deviation is because as the risk aversion increases, forward contracting becomes the best marketing channel each year.

Table 10: Forward contracting and spot market ratios between 1976 and 2009

γ	Forward contracting ratio*	Spot market ratio*	Average revenue ($US/ha)**	STDEV Of revenue ($US/ha)	Difference of revenue ($US/ha)***
0	0.32	0.68	398.21	57.56	116.31
0.0001	0.32	0.68	366.04	57.56	84.14
0.001	0.32	0.68	365.61	57.56	83.70
0.008	0.35	0.65	366.04	55.43	84.14
0.01	0.37	0.63	364.83	53.35	82.93
0.1	0.71	0.29	336.55	21.13	54.65
0.2	0.84	0.16	319.03	10.93	37.13
0.5	0.93	0.07	307.30	4.61	25.40
0.7	0.95	0.05	304.55	3.28	22.64
1	0.96	0.04	302.35	2.28	20.45
2	0.98	0.02	299.94	1.12	18.04
5	0.99	0.01	298.46	0.46	16.55
50	1.00	0.00	297.49	0.00	15.58
100	1.00	0.00	297.45	0.00	15.54

***The ratios are obtained through the E-V model using the data for the period between 1976 and 2009.*
***The revenue is computed using the ratios, the prices of the two marketing channels and adding them up.*
****The revenue difference is the difference between the revenue with the combination of the ratios given by the E-V model and the revenue with the current domestic pricing system.*

For the two periods 1985-1993 and 1998-2009 in which the international prices were low, the expected revenue with the combination of spot market and forward contracts might be less than the attainable revenue with the local companies (table 11). The reason is because at certain level of risk aversion producers would choose forward contracts rather than spot market. Since the forward contract price was often lower than the domestic price during these two periods, producers' revenue is lower than the revenue with the domestic price. For this reason the combination of the three marketing channels should be examined.

Table 11: Comparison between forward contracts and spot market between 1985 and 1993

γ	Spot ratio*	Forward contract ratio*	Average revenue ($US/ha)**	STDEV ($US/ha)	Difference of revenue ($US/ha)***
0	1.00	0.00	468.37	112.22	126.44
0.0001	1.00	0.00	468.37	112.22	126.44
0.001	1.00	0.00	468.37	112.22	126.44
0.008	0.93	0.07	467.83	106.56	125.90
0.01	0.92	0.08	467.77	106.56	125.84
0.1	0.48	0.5	405.79	105.93	63.86
0.2	0.24	0.76	351.65	55.73	9.72
0.5	0.094	0.91	319.57	27.59	-22.35
0.6	0.078	0.92	315.98	10.99	-25.95
0.7	0.068	0.93	313.72	9.10	-28.20
1	0.047	0.95	309.06	7.92	-32.87
2	0.024	0.98	303.92	5.46	-38.00
5	0.011	0.99	300.84	2.84	-41.09
50	0.00	1.00	298.48	0.00	-43.44
100	0.00	1.00	298.48	0.00	-43.44

***The ratios are obtained through the E-V model using the data for the period between 1985 and 1993.*
***The revenue is computed using the ratios, the prices of the two marketing channels and adding them up.*
****The revenue difference is the difference between the revenue with the combination of the ratio given by the E-V model and the revenue with the current domestic pricing system.*

Comparison between the three marketing channels

The three marketing channels (domestic, spot and forward) are compared in the last scenario. As one may expect the spot market is mostly used by risk neutral and modestly risk averse producers over the 34-year period. For risk neutral preferences 59% of the production should be sold on the spot market on average, 32% with forward contracting and 9% with domestic pricing system on average (table 12). As risk aversion increases the ratio of spot marketing decreases. Meanwhile the ratio of forward contracting and domestic pricing increases. One interesting aspect to note here is that even though both forward contracting and local monopoly pricing do not involve price risk, the forward contracting ratio is higher than the domestic pricing ratio for the 34-year period. This finding implies that over time the local companies had been paying producers less than they should and they had been generating a rent that stayed at their level.

The use of forward contracting is interesting in this case because it offers producers the opportunity to sell their production with a relatively higher price compared to the domestic price and at the same time it reduces the effect of the international market price variability. If the risk aversion parameter changed from zero to 50 the expected revenue changes from \$412.78 ha^{-1} to \$351.90 ha^{-1}, corresponding to a 15% reduction in revenue. By giving up 15% of their expected revenue, highly risk averse producers reduce all the uncertainty associated with price variability (table 12).

Table12: Comparison between the three marketing channels between 1976-2009

γ	Domestic market ratio*	Spot market ratio*	Forward contracts ratio*	Average revenue (\$US/ha)**	STDEV of revenue (\$US/ha)	Difference of revenue (\$US/ha)***	Certainty equivalent (\$US/ha)++	Risk premium (\$US/ha) ǂ
0	0.09	0.59	0.32	412.78	67.68	121.50	412.78	-
0.0001	0.10	0.58	0.32	412.78	66.22	121.49	412.78	0.00
0.001	0.14	0.53	0.32	412.63	63.44	121.34	412.63	0.15
0.008	0.16	0.52	0.32	412.76	64.26	121.48	412.76	0.02
0.01	0.17	0.51	0.32	412.46	62.82	121.18	412.46	0.32
0.1	0.33	0.22	0.45	375.76	23.11	83.07	375.76	37.01
0.2	0.36	0.13	0.52	366.00	12.17	72.29	366.00	46.78
0.5	0.37	0.06	0.57	358.79	5.39	64.42	358.79	53.99
0.6	0.37	0.05	0.58	344.92	4.42	755.14	344.92	67.86
0.7	0.37	0.04	0.58	356.83	3.88	62.32	356.83	55.95
1	0.38	0.03	0.59	355.20	2.62	60.57	355.20	57.57
2	0.38	0.02	0.61	353.71	1.40	58.96	353.71	59.06
5	0.38	0.01	0.61	352.47	0.50	57.64	352.47	60.31
50	0.38	0.00	0.62	351.94	0.04	57.06	351.94	60.84
100	0.38	0.00	0.62	351.90	0.00	57.02	351.90	60.87

***The ratios are obtained through the E-V model using the data for the period between 1976 and 2009.*
***The revenue is computed using the ratios, the prices of the two marketing channels and adding them up.*
****The revenue difference is the difference between the revenue with the combination of the ratio given by the E-V model and the revenue with the current domestic pricing system.* ++ *The certainty equivalent is equivalent to the income that risk averse producer is willing to accept rather than a higher revenue that is subject to risk.* ǂ*The risk premium is the difference between the certainty equivalent and the revenue of the risk neutral producer.*

Comparison between the three marketing channels over the1976-1984 and 1994-1997 periods

The comparisons for different price trend periods show that for the periods between 1976 and 1984 and from 1994 to 1997 (when the domestic price was particularly low), the domestic pricing system was never the best marketing option (Table 13). For these two periods, the problem of utility maximization is finally treated as if there were only two markets available (Spot and Forward). The expected revenue is around \$440 ha^{-1} for risk neutral producers with a standard deviation of \$28 ha^{-1} for the 94-97 period. The difference of revenue between the combination of the three marketing channels and the domestic pricing system is \$184 ha^{-1} for the risk neutral producer. For highly risk averse producers, the expected income is around \$303 ha^{-1} with a standard deviation of zero and a difference of revenue around \$46 ha^{-1} compared to the domestic pricing system. Risk averse producers give up 31% of their income to reduce the variance to zero.

Table13: Comparison between the three marketing channels between 1994 and 1997

γ	Domestic price ratio*	Spot market ratio*	Forward Contracts ratio*	Average revenue ($US/ha)**	STDEV of revenue ($US/ha)	Revenue difference ($US/ha)***	Certainty equivalent ($US/ha)++	Risk premium ($US/ha) ‡
0	0.00	0.25	0.75	441.04	27.81	184.31	441.04	-
0.0001	0.00	0.25	0.75	441.04	27.81	184.31	441.04	0.00
0.001	0.00	0.25	0.75	441.04	27.81	175.88	441.04	0.00
0.008	0.00	0.25	0.75	441.04	27.81	184.31	441.04	0.00
0.01	0.00	0.25	0.75	441.04	27.81	184.31	441.04	0.00
0.1	0.00	0.03	0.97	528.13	3.61	64.14	320.87	120.17
0.2	0.00	0.02	0.98	312.58	1.95	55.86	312.58	128.46
0.5	0.00	0.001	0.99	307.06	0.83	50.33	307.06	133.98
0.6	0.00	0.00	1.00	305.68	0.00	48.95	305.68	135.36
0.7	0.00	0.00	1.00	305.68	0.00	48.95	305.68	135.36
1	0.00	0.00	1.00	304.29	0.00	47.57	304.29	136.74
2	0.00	0.00	1.00	304.29	0.00	47.57	304.29	136.74
5	0.00	0.00	1.00	302.91	0.00	46.19	302.91	138.12
50	0.00	0.00	1.00	302.91	0.00	46.19	302.91	138.12
100	0.00	0.00	1.00	302.91	0.00	46.19	302.91	138.12

***The ratios are obtained through the E-V model using the data for the period between 1994 and 1997.*
***The revenue is computed using the ratios, the prices of the two marketing channels and adding them up.*
****The revenue difference is the difference between the revenue with the combination of the ratio given by the E-V model and the revenue with the current domestic pricing system.* ++ *The certainty equivalent is equivalent to the income that risk averse producer is willing to accept rather than a higher revenue that is subject to risk.* ‡*The risk premium is the difference between the certainty equivalent and the revenue of the risk neutral producer.*

Comparison between the three marketing channels over the 1985-1993 and 1998-2009 periods

For the two periods 1985-1993 and 1998-2009, the domestic pricing system was the best marketing channel for highly risk averse producers. However, the fraction of the production that should be sold to the domestic companies was never one. With extreme risk aversion, the domestic pricing system has always to be combined with forward contracting to maximize the expected revenue. The difference of expected revenue compared to the domestic price was small in these periods. The small difference of expected revenue means that the domestic pricing system was relatively good for producers. For the period between 1998 and 2009 the expected revenue was \$376 ha^{-1} with a standard deviation of \$28 ha^{-1} and a difference of \$66 ha^{-1} compared

to the price offered by the local company (table 14). The income reduction between the risk neutral and the highly risk averse producers is just 6%. The spot market is always chosen less by highly risk averse producers. In all four periods the spot market ratio is zero for risk aversion parameter greater or equal to 50.

Table14: Comparison between the three marketing channels between 1998 and 2009

γ	Domestic price ratio*	Spot market ratio*	Forward Contracts ratio*	Average revenue ($US/ha)**	STDEV of revenue ($US/ha)	Revenue difference ($US/ha)***	Certainty equivalent ($US/ha)++	Risk premium ($US/ha)ǂ
0	0.16	0.42	0.42	376.0	35.83	66.2	376	-
0.0001	0.20	0.38	0.42	375.9	33.28	66.2	376	0.0
0.001	0.25	0.34	0.42	375.9	30.00	66.2	376	0.0
0.008	0.25	0.33	0.42	375.9	29.69	66.2	376	0.0
0.01	0.26	0.33	0.42	375.7	29.07	65.9	376	0.3
0.1	0.53	0.05	0.42	357.3	4.49	47.6	357	18.7
0.2	0.56	0.03	0.42	355.4	2.24	45.7	355	20.5
0.5	0.57	0.011	0.42	354.4	0.97	44.7	354	21.5
0.6	0.58	0.00	0.42	354.2	0.74	44.5	354	21.7
0.7	0.58	0.00	0.42	354.2	0.68	44.5	354	21.8
1	0.58	0.00	0.42	354.0	0.45	44.3	354	22.0
2	0.58	0.00	0.42	353.8	0.23	44.1	354	22.1
5	0.58	0.00	0.42	353.6	0.00	43.9	354	22.3
50	0.58	0.00	0.42	353.6	0.00	43.9	354	22.3
100	0.58	0.00	0.42	353.6	0.00	43.9	354	22.3

***The ratios are obtained through the E-V model using the data for the period between 1998 and 2009.*
***The revenue is computed using the ratios, the prices of the two marketing channels and adding them up.*
****The revenue difference is the difference between the revenue with the combination of the ratio given by the E-V model and the revenue with the current domestic pricing system.* ++ *The certainty equivalent is equivalent to the income that risk averse producer is willing to accept rather than a higher revenue that is subject to risk.* ǂ*The risk premium is the difference between the certainty equivalent and the revenue of the risk neutral producer.*

Overall the use of the international markets offers a great opportunity for cotton producers in Burkina Faso. By combining the three marketing channels (spot marketing, the domestic pricing system and forward contracting) producers would improve their expected revenue compared to the local monopsony pricing system. Compared to situations in which they use the spot market exclusively their income is reduced at some risk aversion levels if they used the combination of the three marketing channels. However the combination always reduces the variability of revenue compared to spot marketing alone.

CHAPTER V

CONCLUSION AND DISCUSSION

Summary of main findings:

The present study investigated the potential benefit of three hypothetical marketing channels for cotton producers in Burkina Faso in the face of world price uncertainty using historical price data. The 34-year period between 1976 and 2009 is covered in the study. An E-V model was specified with a quadratic utility function to approximate producer's expected utility of income. The single equation and single constraint model was based on a producer's decision variable that is the ratio of the production to be allocated to each marketing channel.

Three scenarios or marketing alternatives are considered. In the first scenario, the domestic pricing system was compared to the Northern Europe spot market. In the second scenario the spot market was compared to forward contracting on the European market. The third scenario was a simultaneous comparison of the three marketing channels.

The first scenario suggests that, contrary to what one may expect, Burkina Faso's domestic pricing system was not always the inferior marketing channel when compared to international prices using spot marketing. During the periods of high international cotton prices the spot marketing is the best marketing channel to be used by producers, even though the spot market price incurs risk. Spot marketing was better than the domestic pricing system between 1976 and 1984 and between 1994 and 1997. For the periods between 1985 and 1993 and between 1998 and 2009, the international cotton prices were low. Because of the magnitude of the difference between the two prices over these two periods and due to the fact that the spot price was subject to variability, the domestic pricing system was better than the spot market for highly risk averse producers.

The comparison between the spot market and forward contracting showed that for risk neutral producers, the spot market is better than forward contracting because the spot price were generally higher than the forward contract price. For risk averse producers, as one may expect, forward contracting was the best marketing option when compared to spot market because it does not incur risk. Because the forward contracts price was lower than the domestic price in some years, the overall expected revenue with the combination of spot and forward contracting was lower than the expected revenue with the combination of the spot and the domestic price for highly risk averse producers.

The combination of the three marketing channels is the best way to reduce the risk of price variability and maintain higher revenue. The use of forward contracts on international markets is the best way to reduce the risk of price collapse. Depending on time periods and the producers risk aversion level, the domestic pricing system may be the best marketing option for cotton producers. This was particularly the case for the periods in which the international prices were low. During the periods between 1985 and 1993 and the period between 1998 and 2009 the domestic price had certainly provided benefits for producers. For the periods between 1976 and 1984 and between 1994 and 1997 the international prices were relatively high. The spot market or the forward contracting on the Northern Europe cotton market would have offered farmers higher gross revenue during these two periods.

For the periods in which the international cotton prices are high, the findings of the present study are in accordance with the findings of Ouatara et al. (1990). Ouatara et al. (1990) found that the use of international markets for hedging can help the Ivory Coast cocoa producers reduce risk associated with price and exchange rate variability. However the results of the present study are not in accordance with Wang and Chidmi (2011) who found that the use of price risk mitigation strategies (future contracts) cannot benefit West African cotton producing countries.

Risk averse producers have profited the most from the price stabilization policy in Burkina Faso. The value of the policy for the risk averse producers is represented by the risk

premium that they are willing to pay to get the guaranteed price. However, the producers do not pay a risk premium to get the guaranteed price. The risk neutral producer would have earned a higher income during the periods of high international cotton price. For the periods during which the international cotton price was low, the risk neutral producer have also profited from the domestic price that protected all the producers against international price collapse.

The results of the present study are surprising because the common view of practitioners and specialists is that the domestic pricing system in Burkina Faso has always been negative for producers and the cotton sector in general. The present study found that the domestic pricing system has a positive value particularly during the last decade when the international price collapsed. Previous studies did not consider international price variability and therefore most of time these studies were misleading.

Policy implications:

The present study suggests a rationale for maintaining a price stabilization policy in the Burkina Faso cotton sector. A vertically integrated cotton company may not be the best way to provide price stabilization. An alternative solution could be to utilize the government, perhaps a ministry of agriculture, to establish a stabilization fund that would operate over the long-run to set aside surplus revenue in good years of marketing and production, which could then be accessed in subsequent years when prices and/or production are below expectations. Other price stabilization policies such as price insurance or crop insurance may provide another income support system for the cotton sector in Burkina Faso.

The result suggests that the combination of different marketing channels is the optimal marketing strategy for cotton producers in Burkina Faso. Because the price offered by the local cotton companies is chosen at some level of risk aversion (even when it is compared to the two international marketing channels), the result of the third scenario implies that the domestic pricing structure should be combined with international marketing to obtain an optimal marketing setting.

However, practically it can be difficult for cotton producers to combine different marketing channels. Having cotton producers to operate alone on the international markets may be difficult because of the complexity (intellectual background requirements) of these markets. It might be possible for cotton producers to use international markets by using the model of fish and ornamental flowers producers in Kenya where small holders sell their production on the very competitive European markets. It is possible to overcome these challenges and take advantage from the opportunities that the international markets offer. One way to do so might be to start by educating producers' organizations on the requirements of the international market mechanism (Nyangweso and Odhiambo, 2004). The example of cotton sectors in East African countries provides also insight because the Eastern African cotton sectors are more liberalized than the West and Central African ones (Tschirley et al., 2009). The competiveness of the cotton sectors of Eastern African countries is principally due the increased competition in marketing in these sectors (Poulton and Maro, 2007).

The combination of different marketing channels was used to show the upper limit of the theoretical marketing possibilities. Because the domestic pricing system has some additional benefits, such as providing inputs and technology that were ignored in the E-V model, it could be the best alternative for cotton marketing. However, the government control over the production system should be limited (Vitale and Sanders, 2005).

For the last ten years the cotton prices were low compared to their historic values. This fact was not an aberration and it is likely to continue because the low prices were in part due to subsidies from developed countries notably the U.S cotton price support program (Baffes, 2005). The previous studies were correct for the period prior to 1990. Over the 10 last years, the domestic price was as good as the international spot price. The local price isolates producers from the international price variability and the cotton companies provide support for research and development, ginning and transportation logistics. If Burkina Faso cotton producers sold on the

international spot market they themselves would need to provide most of the services that the cotton companies currently provide.

In Burkina Faso the parastatal companies have helped improve production by providing adequate and needed technology for producers (Vitale et al., 2011). A comparison with the Eastern African countries cotton sectors shows that the production systems in Eastern African countries are not as efficient as those in West African countries. Eastern African cotton producing countries have lower yield and input use compared to West African countries (FAOStat, 2011). These countries need to provide more support and investment to acquire modern technologies.

Because of the lack of support from foreign investors and governments for research and development, the East African countries struggle to get a higher cotton yield. FAOStat (2011) shows that the East African regional average yield was 646 kg ha^{-1} compared to 1,008 kg ha^{-1} in the West Africa region over the period between 1998 and 2008. East Africa cotton producing countries might consider a closer collaboration between governments and the private sector. Additional investments by the private sector would bring new varieties, extensions services and input provision in East Africa (Poulton and Maro, 2009).

Another policy implication for the cotton sector in Burkina Faso is that the marketing operations should be liberalized in the cotton sector of Burkina Faso. Liberalizing the sector would allow producers to use different marketing options based on their choice. Based on the results of third scenario, combining different marketing channels would allow producers to maximize their revenue and lower the risk associated with the international price.

The role of the producers over the past few years should not be understated. Today with the internet and more access to the media, producers are more aware of the world markets. They are more organized and have more bargaining power (Courcelle et al., 2004). For the last 10 years with lower international prices and greater uncertainty the domestic price was competitive compared to the international spot price. One of the reasons why the domestic price was relatively

high over the last decade is the new price negotiation mechanism established since 2005-2006 in which producers have a stronger voice (Tschirley et al., 2009).

Recommendations:

Because there is coincidentally a positive value, represented by the risk premium, for the price stabilization policy in Burkina Faso, there is need for a clear and defined price stabilization scheme. The current guaranteed price policy does not have clear objectives. Defining a set of objectives would make the price stabilization policy more effective. The cotton companies may not be the optimal way to provide a guaranteed price to producers. A guarantee fund inspired by other experience such as the cocoa sector in Ivory Cost that provided a floor price may be the best alternative. The positive aspect of the price stabilization is that it would increase producer's self-investment in capital and effort to optimize the production. Lack of investment negatively affects national production, producers' income and overall welfare (Hayes, et al., 1997).

The present study suggests that a hybrid parastatal model with foreign investment, producers' participation, and government oversight can be an effective working model. Bringing producers into the sector appears to have made pricing more fair, and foreign investment has provided the needed technology (Vitale and Sanders, 2005). Government legal frameworks and other functioning have also been beneficial. Despite these benefits, the role of the government needs to be carefully monitored. In Burkina Faso the primary role of the government should be to provide a legal framework that protects foreign investors (Delpeuch, 2011). Another role of the government could be to coordinate the price negotiation mechanism between the cotton companies and producers. However, the government should not control the price between the two main actors (Delpeuch, 2011).

Future research:

Because the present study did not consider yield variability, it can be extended by introducing yield risk in the model so that producer's yield expectation is taken into account. However this additional step would require more field data such as weather conditions and input use. Another

way to strengthen the present study is to empirically estimate producers risk aversion with respect to wealth. Empirical estimation of a producer's risk aversion involves conducting experiment among the producers.

The transportation cost used in the present study can be better estimated. For example the sea freight cost is an average for all the West and Central African countries. If the cost from Abidjan or Tema, the two mainly used sea ports by the Burkina Faso cotton companies, can be obtained, the price adjustments would be more accurate. Including the inputs cost from the cotton companies on a per hectare basis would also provide a better estimation of the cotton companies' rent.

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APPPENDICES

Appendix 1: SAS forecast procedure code

```
PROC IMPORT OUT= Period1
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1976.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period1 interval= month lead=7
    out=pred1 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred1 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1976";
RUN;
PROC IMPORT OUT= Period2
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1977.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period2 interval= month lead=7
    out=pred2 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred2 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
          DBMS=  EXCEL2007 REPLACE;SHEET="1977";
RUN;
```

```
PROC IMPORT OUT= Period3
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1978.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period3 interval= month lead=7
    out=pred3 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred3 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1978";
RUN;
PROC IMPORT OUT= Period4
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1979.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period4 interval= month lead=7
    out=pred4 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred4 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1979";
RUN;
PROC IMPORT OUT= Period5
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1980.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period5 interval= month lead=7
    out=pred5 outfull outSTD;
    id Month;
    var Price;
    run;

PROC export Data= pred5 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1980";
RUN;
PROC IMPORT OUT= Period6
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1981.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
```

```
proc forecast data=period6 interval= month lead=7
    out=pred6 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred6 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1981";
RUN;
PROC IMPORT OUT= Period7
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1982.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period7 interval= month lead=7
    out=pred7 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred7 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1982";
RUN;
PROC IMPORT OUT= Period8
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1983.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period8 interval= month lead=7
    out=pred8 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred8 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1983";
RUN;
PROC IMPORT OUT= Period9
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1984.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period9 interval= month lead=7
    out=pred9 outfull outSTD;
    id Month;
    var Price;
    run;

PROC export Data= pred9 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1984";
RUN;
```

```
PROC IMPORT OUT= Period10
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1985.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period10 interval= month lead=7
    out=pred10 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred10 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1985";
RUN;
PROC IMPORT OUT= Period11
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1986.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period11 interval= month lead=7
    out=pred11 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred11 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1986";
RUN;
PROC IMPORT OUT= Period12
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1987.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period12 interval= month lead=7
    out=pred12 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred12 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1987";
RUN;
PROC IMPORT OUT= Period13
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1988.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period13 interval= month lead=7
```

```
    out=pred13 outfull outSTD;
    id Month;
    var Price;
    run;

PROC export Data= pred13 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1988";
RUN;
PROC IMPORT OUT= Period14
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1989.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period14 interval= month lead=7
    out=pred14 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred14 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1989";
RUN;
PROC IMPORT OUT= Period15
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1990.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period15 interval= month lead=7
    out=pred15 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred15 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1990";
RUN;
PROC IMPORT OUT= Period16
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1991.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period16 interval= month lead=7
    out=pred16 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred16 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1991";
RUN;
PROC IMPORT OUT= Period17
```

```
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1992.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period17 interval= month lead=7
    out=pred17 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred17 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1992";
RUN;
PROC IMPORT OUT= Period18
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1993.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period18 interval= month lead=7
    out=pred18 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred18 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1993";
RUN;
PROC IMPORT OUT= Period19
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1994.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period19 interval= month lead=7
    out=pred19 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred19 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1994";
RUN;
PROC IMPORT OUT= Period20
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1995.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;

proc forecast data=period20 interval= month lead=7
```

```
    out=pred20 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred20 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1995";
RUN;
PROC IMPORT OUT= Period21
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1996.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period21 interval= month lead=7
    out=pred21 outfull outSTD;
    id Month;
    var Price;
    run;

PROC export Data= pred21 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1996";
RUN;
PROC IMPORT OUT= Period22
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1997.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period22 interval= month lead=7
    out=pred22 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred22 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1997";
RUN;
PROC IMPORT OUT= Period23
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1998.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period23 interval= month lead=7
    out=pred23 outfull outSTD;
    id Month;
    var Price;
    run;

PROC export Data= pred23 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1998";
RUN;
```

```
PROC IMPORT OUT= Period24
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\1999.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period24 interval= month lead=7
    out=pred24 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred24 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="1999";
RUN;
PROC IMPORT OUT= Period25
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\2000.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period25 interval= month lead=7
    out=pred25 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred25 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="2000";
RUN;
PROC IMPORT OUT= Period26
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\2001.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period26 interval= month lead=7
    out=pred26 outfull outSTD;
    id Month;
    var Price;
    run;

PROC export Data= pred26 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="2001";
RUN;
PROC IMPORT OUT= Period27
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\2002.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
```

```
proc forecast data=period27 interval= month lead=7
    out=pred27 outfull outSTD;
    id Month;
    var Price;
    run;

PROC export Data= pred27 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="2002";
RUN;
PROC IMPORT OUT= Period28
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\2003.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period28 interval= month lead=7
    out=pred28 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred28 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="2003";
RUN;
PROC IMPORT OUT= Period29
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\2004.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;

proc forecast data=period29 interval= month lead=7
    out=pred29 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred29 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="2004";
RUN;
PROC IMPORT OUT= Period30
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\2005.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period30 interval= month lead=7
    out=pred30 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred30 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="2005";
```

```
RUN;
PROC IMPORT OUT= Period31
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\2006.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period31 interval= month lead=7
    out=pred31 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred31 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="2006";
RUN;
PROC IMPORT OUT= Period32
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\2007.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period32 interval= month lead=7
    out=pred32 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred32 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="2007";
RUN;
PROC IMPORT OUT= Period33
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\2008.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
proc forecast data=period33 interval= month lead=7
    out=pred33 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred33 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="2008";
RUN;
PROC IMPORT OUT= Period34
DATAFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS Model\Data for GAMS
model\Model  in CFA\Second CFA Data\2009.xlsx"
DBMS=EXCEL REPLACE;
GETNAMES=YES;
MIXED=NO;
SCANTEXT=YES;
USEDATE=YES;
SCANTIME=YES;
run;
```

```
proc forecast data=period34 interval= month lead=7
    out=pred34 outfull outSTD;
    id Month;
    var Price;
    run;
PROC export Data= pred34 OUTFILE= "C:\Users\Amadou\Documents\Documents\MS\Cotton\GAMS
Model\Data for GAMS model\Model  in CFA\Second CFA Data\Pred.xlsx"
            DBMS=  EXCEL2007 REPLACE;
     SHEET="2009";
RUN;
```

Appendix 2: Some results for the forecast procedure

1976

Month	_TYPE_	_LEAD_	Price
1/1/1976	ACTUAL	0	77.92633
1/1/1976	FORECAST	0	76.64191
2/1/1976	ACTUAL	0	78.97462
2/1/1976	FORECAST	0	79.70173
3/1/1976	ACTUAL	0	82.33586
3/1/1976	FORECAST	0	82.76155
4/1/1976	ACTUAL	0	83.71636
4/1/1976	FORECAST	0	85.82137
5/1/1976	ACTUAL	0	90.85457
5/1/1976	FORECAST	0	88.8812
6/1/1976	FORECAST	1	91.94102
6/1/1976	L95	1	86.58079
6/1/1976	STD	1	2.734859
6/1/1976	U95	1	97.30124
7/1/1976	FORECAST	2	95.00084
7/1/1976	L95	2	88.81139
7/1/1976	STD	2	3.157943
7/1/1976	U95	2	101.1903
8/1/1976	FORECAST	3	98.06066
8/1/1976	L95	3	90.94567
8/1/1976	STD	3	3.630163
8/1/1976	U95	3	105.1757
9/1/1976	FORECAST	4	101.1205
9/1/1976	L95	4	93.01659
9/1/1976	STD	4	4.134718
9/1/1976	U95	4	109.2244
10/1/1976	FORECAST	5	104.1803
10/1/1976	L95	5	95.04468
10/1/1976	STD	5	4.661119
10/1/1976	U95	5	113.3159
11/1/1976	FORECAST	6	107.2401
11/1/1976	L95	6	97.04295

11/1/1976	STD	6	5.202739
11/1/1976	U95	6	117.4373
12/1/1976	FORECAST	7	110.3
12/1/1976	L95	7	99.0198
12/1/1976	STD	7	5.755284
12/1/1976	U95	7	121.5801

1983

Month	_TYPE_	_LEAD_	Price
1/1/1976	ACTUAL	0	77.92633
1/1/1976	FORECAST	0	86.8161
2/1/1976	ACTUAL	0	78.97462
2/1/1976	FORECAST	0	76.7238
3/1/1976	ACTUAL	0	82.33586
3/1/1976	FORECAST	0	80.76309
4/1/1976	ACTUAL	0	83.71636
4/1/1976	FORECAST	0	84.44198
5/1/1976	ACTUAL	0	90.85457
5/1/1976	FORECAST	0	85.03878
6/1/1976	ACTUAL	0	111.1616
6/1/1976	FORECAST	0	93.06222
7/1/1976	ACTUAL	0	130.2599
7/1/1976	FORECAST	0	114.7471
8/1/1976	ACTUAL	0	125.1718
8/1/1976	FORECAST	0	130.7519
9/1/1976	ACTUAL	0	121.6589
9/1/1976	FORECAST	0	118.6389
10/1/1976	ACTUAL	0	128.7728
10/1/1976	FORECAST	0	116.1983
11/1/1976	ACTUAL	0	129.4262
11/1/1976	FORECAST	0	125.7743
12/1/1976	ACTUAL	0	124.234
12/1/1976	FORECAST	0	124.3014
1/1/1977	ACTUAL	0	113.2672
1/1/1977	FORECAST	0	118.026
2/1/1977	ACTUAL	0	123.1466
2/1/1977	FORECAST	0	106.833
3/1/1977	ACTUAL	0	128.6504
3/1/1977	FORECAST	0	122.0775
4/1/1977	ACTUAL	0	126.3091
4/1/1977	FORECAST	0	125.4281
5/1/1977	ACTUAL	0	117.0906
5/1/1977	FORECAST	0	120.9456

6/1/1977	ACTUAL	0	98.70781
6/1/1977	FORECAST	0	110.8921
7/1/1977	ACTUAL	0	88.98408
7/1/1977	FORECAST	0	92.25909
8/1/1977	ACTUAL	0	79.53626
8/1/1977	FORECAST	0	86.79375
9/1/1977	ACTUAL	0	74.16629
9/1/1977	FORECAST	0	78.85556
10/1/1977	ACTUAL	0	71.94261
10/1/1977	FORECAST	0	75.63474
11/1/1977	ACTUAL	0	69.40888
11/1/1977	FORECAST	0	74.80473
12/1/1977	ACTUAL	0	72.03765
12/1/1977	FORECAST	0	72.59256
1/1/1978	ACTUAL	0	74.66627
1/1/1978	FORECAST	0	76.56558
2/1/1978	ACTUAL	0	81.1839
2/1/1978	FORECAST	0	78.87023
3/1/1978	ACTUAL	0	82.88229
3/1/1978	FORECAST	0	85.75888
4/1/1978	ACTUAL	0	82.28177
4/1/1978	FORECAST	0	85.7104
5/1/1978	ACTUAL	0	86.09604
5/1/1978	FORECAST	0	84.5095
6/1/1978	ACTUAL	0	86.482
6/1/1978	FORECAST	0	89.25519
7/1/1978	ACTUAL	0	82.26117
7/1/1978	FORECAST	0	88.53332
8/1/1978	ACTUAL	0	84.93744
8/1/1978	FORECAST	0	83.48929
9/1/1978	ACTUAL	0	86.90384
9/1/1978	FORECAST	0	88.06349
10/1/1978	ACTUAL	0	88.57976
10/1/1978	FORECAST	0	89.57223
11/1/1978	ACTUAL	0	96.03026
11/1/1978	FORECAST	0	90.96796
12/1/1978	ACTUAL	0	94.78329
12/1/1978	FORECAST	0	99.26403
1/1/1979	ACTUAL	0	82.41698
1/1/1979	FORECAST	0	95.44242
2/1/1979	ACTUAL	0	81.77524
2/1/1979	FORECAST	0	81.32502
3/1/1979	ACTUAL	0	80.57949

3/1/1979	FORECAST	0	84.62044
4/1/1979	ACTUAL	0	78.26682
4/1/1979	FORECAST	0	83.47414
5/1/1979	ACTUAL	0	82.28599
5/1/1979	FORECAST	0	81.19036
6/1/1979	ACTUAL	0	83.4734
6/1/1979	FORECAST	0	86.73083
7/1/1979	ACTUAL	0	82.22063
7/1/1979	FORECAST	0	86.88741
8/1/1979	ACTUAL	0	83.6969
8/1/1979	FORECAST	0	85.08284
9/1/1979	ACTUAL	0	83.35143
9/1/1979	FORECAST	0	87.2835
10/1/1979	ACTUAL	0	83.45295
10/1/1979	FORECAST	0	86.455
11/1/1979	ACTUAL	0	86.25666
11/1/1979	FORECAST	0	86.74207
12/1/1979	ACTUAL	0	88.06207
12/1/1979	FORECAST	0	90.06974
1/1/1980	ACTUAL	0	89.22855
1/1/1980	FORECAST	0	91.34754
2/1/1980	ACTUAL	0	105.3998
2/1/1980	FORECAST	0	92.19482
3/1/1980	ACTUAL	0	104.9255
3/1/1980	FORECAST	0	110.9346
4/1/1980	ACTUAL	0	100.5662
4/1/1980	FORECAST	0	105.2058
5/1/1980	ACTUAL	0	93.15756
5/1/1980	FORECAST	0	100.2765
6/1/1980	ACTUAL	0	84.40308
6/1/1980	FORECAST	0	93.00837
7/1/1980	ACTUAL	0	89.85288
7/1/1980	FORECAST	0	85.13929
8/1/1980	ACTUAL	0	105.1929
8/1/1980	FORECAST	0	94.44766
9/1/1980	ACTUAL	0	113.9976
9/1/1980	FORECAST	0	110.8236
10/1/1980	ACTUAL	0	112.652
10/1/1980	FORECAST	0	116.3004
11/1/1980	ACTUAL	0	116.9501
11/1/1980	FORECAST	0	111.9249
12/1/1980	ACTUAL	0	121.8365
12/1/1980	FORECAST	0	117.4817

1/1/1981	ACTUAL	0	128.1468
1/1/1981	FORECAST	0	121.9081
2/1/1981	ACTUAL	0	129.7013
2/1/1981	FORECAST	0	127.8228
3/1/1981	ACTUAL	0	121.0423
3/1/1981	FORECAST	0	127.6717
4/1/1981	ACTUAL	0	117.8213
4/1/1981	FORECAST	0	117.0189
5/1/1981	ACTUAL	0	124.0673
5/1/1981	FORECAST	0	116.0761
6/1/1981	ACTUAL	0	126.9095
6/1/1981	FORECAST	0	124.5348
7/1/1981	ACTUAL	0	127.6173
7/1/1981	FORECAST	0	125.9223
8/1/1981	ACTUAL	0	119.0531
8/1/1981	FORECAST	0	125.8939
9/1/1981	ACTUAL	0	102.1054
9/1/1981	FORECAST	0	115.6264
10/1/1981	ACTUAL	0	97.9256
10/1/1981	FORECAST	0	98.47348
11/1/1981	ACTUAL	0	90.92455
11/1/1981	FORECAST	0	99.07898
12/1/1981	ACTUAL	0	82.19148
12/1/1981	FORECAST	0	92.2333
1/1/1982	ACTUAL	0	97.5704
1/1/1982	FORECAST	0	84.25777
2/1/1982	ACTUAL	0	101.5397
2/1/1982	FORECAST	0	105.2626
3/1/1982	ACTUAL	0	104.6664
3/1/1982	FORECAST	0	105.0274
4/1/1982	ACTUAL	0	109.374
4/1/1982	FORECAST	0	107.486
5/1/1982	ACTUAL	0	118.0908
5/1/1982	FORECAST	0	112.0802
6/1/1982	ACTUAL	0	126.8742
6/1/1982	FORECAST	0	120.8892
7/1/1982	ACTUAL	0	139.8249
7/1/1982	FORECAST	0	128.4811
8/1/1982	ACTUAL	0	135.2368
8/1/1982	FORECAST	0	140.9635
9/1/1982	ACTUAL	0	127.8622
9/1/1982	FORECAST	0	131.4265
10/1/1982	ACTUAL	0	121.2017

10/1/1982	FORECAST	0	124.2723
11/1/1982	ACTUAL	0	118.8974
11/1/1982	FORECAST	0	118.8604
12/1/1982	ACTUAL	0	114.717
12/1/1982	FORECAST	0	118.3524
1/1/1983	ACTUAL	0	126.692
1/1/1983	FORECAST	0	114.2254
2/1/1983	ACTUAL	0	135.4593
2/1/1983	FORECAST	0	129.7469
3/1/1983	ACTUAL	0	150.8422
3/1/1983	FORECAST	0	136.2671
4/1/1983	ACTUAL	0	162.4998
4/1/1983	FORECAST	0	151.6215
5/1/1983	ACTUAL	0	170.6489
5/1/1983	FORECAST	0	160.4471
6/1/1983	FORECAST	1	166.3411
6/1/1983	L95	1	148.8497
6/1/1983	STD	1	8.924362
6/1/1983	U95	1	183.8325
7/1/1983	FORECAST	2	158.686
7/1/1983	L95	2	132.0238
7/1/1983	STD	2	13.60344
7/1/1983	U95	2	185.3483
8/1/1983	FORECAST	3	151.1108
8/1/1983	L95	3	118.8263
8/1/1983	STD	3	16.47199
8/1/1983	U95	3	183.3953
9/1/1983	FORECAST	4	144.7113
9/1/1983	L95	4	109.129
9/1/1983	STD	4	18.15457
9/1/1983	U95	4	180.2936
10/1/1983	FORECAST	5	139.6719
10/1/1983	L95	5	102.1974
10/1/1983	STD	5	19.12002
10/1/1983	U95	5	177.1465
11/1/1983	FORECAST	6	135.8557
11/1/1983	L95	6	97.30775
11/1/1983	STD	6	19.66769
11/1/1983	U95	6	174.4037
12/1/1983	FORECAST	7	133.0418
12/1/1983	L95	7	93.88801
12/1/1983	STD	7	19.97677
12/1/1983	U95	7	172.1955

Appendix 3: GAMS models

```
GAMS Rev 235  WEX-WEI 23.5.1 x86_64/MS Windows          03/05/12 09:10:54 Page 1
G e n e r a l   A l g e b r a i c   M o d e l i n g   S y s t e m
C o m p i l a t i o n
   1  *the expeted utility model for forward contracts
   2  set J The 2 different markets
   3  /Local, Spot/
   4
   5  Set T year
   6  /1976*2009/
   7  ;
   8  set M Month
   9  /jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec/
  10  *the time period is 31 years: 1976 t0 2006
  11  I input
  12  /land/  ;
  13
  14  Table P(T, J) Price on different markets
  15              Local     Spot
  16  1976        40        110.30
  17  1977        40        156.15
  18  1978        55        80.06
  19  1979        55        74.77
  20  1980        55        79.76
  21  1981        55        107.15
  22  1982        62        109.18
  23  1983        62        133.04
  24  1984        70        200.31
  25  1985        90        174.49
  26  1986        100       113.87
  27  1987        100       159.69
  28  1988        95        99.79
  29  1989        95        141.98
  30  1990        95        139.77
  31  1991        95        134.00
  32  1992        95        95.12
  33  1993        85        83.21
  34  1994        115       183.56
  35  1995        115       282.99
  36  1996        165       193.49
  37  1997        180       254.34
  38  1998        180       201.72
  39  1999        185       185.14
  40  2000        185       236.69
  41  2001        170       201.80
  42  2002        200       158.29
  43  2003        175       194.36
  44  2004        185       230.42
  45  2005        210       163.51
  46  2006        175       153.36
  47  2007        167       165.91
  48  2008        164       216.14
  49  2009        159       190.13
  50  ;
;
 131  Table Var(T,J) variance of spot price
 132           Local     spot
```

```
133  1976               5.76
134  1977               16.96
135  1978               22.17
136  1979               17.93
137  1980               17.40
138  1981               18.80
139  1982               18.27
140  1983               19.98
141  1984               25.57
142  1985               24.77
143  1986               32.64
144  1987               30.59
145  1988               32.93
146  1989               32.50
147  1990               32.41
148  1991               31.78
149  1992               32.50
150  1993               32.05
151  1994               46.27
152  1995               54.27
153  1996               47.48
154  1997               51.20
155  1998               48.80
156  1999               48.67
157  2000               50.76
158  2001               50.39
159  2002               52.16
160  2003               51.66
161  2004               50.91
162  2005               53.26
163  2006               52.59
164  2007               50.52
165  2008               51.37
166  2009               52.19
167  ;
168  set L /run1*run19/;
169  Parameter Gamma(L) risk aversion coefficient
170  /run1   0
171  run2    0.0001
172  run3    0.001
173  run4    0.008
174  run5    0.01
175  run6    0.1
176  run7    0.2
177  run8    0.5
178  run9    0.6
179  run10   0.7
180  run11   1
181  run12   2
182  run13   5
183  run14   50
184  run15   100
185  run16   300
186  run17   500
187  run18   700
188  run19   1000/
189  ;
190  Scalar CurGamma Curent value for Gamma (controlled by loop);
191  ;
 195  196  Price_A(J)
197  Var_A(J)
198  ;
```

```
 199  variables
 200  Utility      objective function value ;
 201  *Eincome(T)   Expected Income
 202  positive variable X(J);
 203  Equations
 204  OBJ      Objective Function
 205  Supply   Resources constraints;
 206  OBJ.. Utility =E= Sum(J,X(J)* Price_A(J)) - Sum(J, X(J)*X(J)*(CurGamma/2)*
Var_A(J)*Var_A(J));
 207  Supply.. Sum(J,X(J))=E= 1;
 208  Model Amadou Cotton marketing /ALL/;
 209  Parameter Report (*,*,*);
 210  Loop(T,
 211  Loop(L,
 212  CurGamma = Gamma(L);
 213  Price_A(J) = P(T,J);
 214  Var_A(J) = Var(T,J);
 215  Solve Amadou using NLP maximizing Utility;
 216  Report(L, T, J) = X.L(J);
 217  );
 218  );
 219  Display Report;
 220  Option decimals=5;
 221  display Utility.L;
 222  FILE result /"C:\Ok_State\Journals\Amadou\Gams\Output\Result.dat"/;
 223  224  Loop (L,
 225  Put result; Put "    "; Put "    ";
 226  );
 227  Put result;
 228  Loop (L,
 229   put @40  '.......Risk parameter value.....'; put/;
 230   Put @50  put;
 231   Put Gamma(L),
 232  put/;
234   Loop(T,
 235  Put Result; Put "X.L (T,J)"; Put "    ";  Put T.Tl;
 236  loop (J,
 237   PUT Result;  Put "   "; Put report(L,T,J);
 238   );
 239   Put /;
 240
 241   );
 242   Put /;
 243  );
);
```

```
GAMS Rev 235  WEX-WEI 23.5.1 x86_64/MS Windows          03/05/12 09:41:21 Page 1
G e n e r a l   A l g e b r a i c   M o d e l i n g   S y s t e m
C o m p i l a t i o n
   1  *the expeted utility model for forward contracts
   2  Option LIMROW=0, LIMCOL=0;
   3  set J The 3 different markets
   4  /Spot, Forward/
   5  Set T year
   6  /1976*2009/
   7  ;
   8  set M Month
   9  /jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec/
  10  *the time period is 31 years: 1976 t0 2006
  11  I input
  12  /land/  ;
  13
  14  Table P(T, J) Price on different markets
  15              Spot          Forward
  16  1976        110.30        112.85
  17  1977        156.15        53.72
  18  1978        80.06         73.33
  19  1979        74.77         62.54
  20  1980        79.76         101.40
  21  1981        107.15        65.92
  22  1982        109.18        93.63
  23  1983        133.04        174.16
  24  1984        200.31        151.63
  25  1985        174.49        118.22
  26  1986        113.87        70.35
  27  1987        159.69        78.39
  28  1988        99.79         66.87
  29  1989        141.98        97.51
  30  1990        139.77        103.08
  31  1991        134.00        58.38
  32  1992        95.12         68.63
  33  1993        83.21         80.17
  34  1994        183.56        280.60
  35  1995        282.99        288.70
  36  1996        193.49        221.66
  37  1997        254.34        220.16
  38  1998        201.72        178.75
  39  1999        185.14        167.02
  40  2000        236.69        277.37
  41  2001        201.80        127.01
  42  2002        158.29        254.00
  43  2003        194.36        231.47
  44  2004        230.42        88.95
  45  2005        163.51        140.30
  46  2006        153.36        137.18
  47  2007        165.91        205.45
  48  2008        216.14        108.39
  49  2009        190.13        228.50
  50  ;
  51  Table Var(T,J) variance of spot price
  52              Spot        Forward
  53  1976        5.76
  54  1977        16.96
  55  1978        22.17
  56  1979        17.93
```

```
 1980        17.40
 1981        18.80
 1982        18.27
 1983        19.98
 1984        25.57
 1985        24.77
 1986        32.64
 1987        30.59
 1988        32.93
 1989        32.50
 1990        32.41
 1991        31.78
 1992        32.50
 1993        32.05
 1994        46.27
 1995        54.27
 1996        47.48
 1997        51.20
 1998        48.80
 1999        48.67
 2000        50.76
 2001        50.39
 2002        52.16
 2003        51.66
 2004        50.91
 2005        53.26
 2006        52.59
 2007        50.52
 2008        51.37
 2009        52.19
;
set L /run1*run19/;
Parameter Gamma(L) risk aversion coefficient
/run1   0
run2    0.0001
run3    0.001
run4    0.008
run5    0.01
run6    0.1
 run7   0.2
run8    0.5
run9    0.6
run10   0.7
run11   1
run12   2
run13   5
run14   50
run15   100
run16   300
run17   500
run18   700
run19   1000/
;
Scalar CurGamma Curent value for Gamma (controlled by loop);

Parameter
A(J) Use of land
/Spot     1
Forward  1/
Price_A(J)
Var_A(J)
;
```

```
 119  variables
 120  Utility   objective function value ;
 121
 122  *Eincome(T)   Expected Income
 123  positive variable X(J);
 124  Equations
 125  OBJ      Objective Function
 126  Supply   Resources constraints;
 127  OBJ.. Utility =E= Sum(J,X(J)* Price_A(J)) - Sum(J, X(J)*X(J)*(CurGamma/2)*
      Var_A(J)*Var_A(J));
 128  Supply.. Sum(J,A(J)*X(J))=E= 1;
 129  Model Amadou Cotton marketing /ALL/;
 130  Parameter Report (*,*,*);
 131  Loop(T,
 132    Loop(L,
 133    CurGamma = Gamma(L);
 134    Price_A(J) = P(T,J);
 135    Var_A(J) = Var(T,J);
 136  Solve Amadou using NLP maximizing Utility;
 137  Report(L, T, J) = X.L(J);
 138    );
 139  );
 140  Display Report;
 141  Option decimals=5;
 142  display Utility.L;
 143  FILE result /"C:\Ok_State\Journals\Amadou\Gams\Output\Result.dat"/;
 144  Loop (L,
 145     Put result; Put "    "; Put "    ";
 146  );
 147  Put result;
 148  Loop (L,
 149     put @40  '.......Risk parameter value.....'; put/;
 150     Put @50  put;
 151        Put Gamma(L),
 152  put/;
 153
 154      Loop(T,
 155          Put Result; Put "X.L (T,J)"; Put "    ";  Put T.Tl;
 156            loop (J,
 157     PUT Result;  Put "   "; Put report(L,T,J);
 158     );
 159     Put /;
 160
 161       );
 162      Put /;
 163  );
```

```
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G e n e r a l   A l g e b r a i c   M o d e l i n g   S y s t e m
C o m p i l a t i o n
```

```
   1  *the expeted utility model for forward contracts
   2  set J The 3 different markets
   3  /Local, Spot, Forward/
   4
   5  Set T year
   6  /1976*2009/
   7  ;
   8  set M Month
   9  /jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec/
  10
  11  I input
```

```
/land/  ;

Table P(T, J) Price on different markets
            Local      Spot       Forward
1976         40        110.30     112.85
1977         40        156.15     53.72
1978         55        80.06      73.33
1979         55        74.77      62.54
1980         55        79.76      101.40
1981         55        107.15     65.92
1982         62        109.18     93.63
1983         62        133.04     174.16
1984         70        200.31     151.63
1985         90        174.49     118.22
1986         100       113.87     70.35
1987         100       159.69     78.39
1988         95        99.79      66.87
1989         95        141.98     97.51
1990         95        139.77     103.08
1991         95        134.00     58.38
1992         95        95.12      68.63
1993         85        83.21      80.17
1994         115       183.56     280.60
1995         115       282.99     288.70
1996         165       193.49     221.66
1997         180       254.34     220.16
1998         180       201.72     178.75
1999         185       185.14     167.02
2000         185       236.69     277.37
2001         170       201.80     127.01
2002         200       158.29     254.00
2003         175       194.36     231.47
2004         185       230.42     88.95
2005         210       163.51     140.30
2006         175       153.36     137.18
2007         167       165.91     205.45
2008         164       216.14     108.39
2009         159       190.13     228.50
;
Table Var(T,J) variance of spot price
          Local      spot        Forward
1976                 5.76
1977                 16.96
1978                 22.17
1979                 17.93
1980                 17.40
1981                 18.80
1982                 18.27
1983                 19.98
1984                 25.57
1985                 24.77
1986                 32.64
1987                 30.59
1988                 32.93
1989                 32.50
1990                 32.41
1991                 31.78
1992                 32.50
1993                 32.05
1994                 46.27
1995                 54.27
1996                 47.48
```

```
 74  1997                51.20
 75  1998                48.80
 76  1999                48.67
 77  2000                50.76
 78  2001                50.39
 79  2002                52.16
 80  2003                51.66
 81  2004                50.91
 82  2005                53.26
 83  2006                52.59
 84  2007                50.52
 85  2008                51.37
 86  2009                52.19
 87  ;
 88  set L /run1*run19/;
 89
 90  Parameter Gamma(L) risk aversion coefficient
 91  /run1   0
 92  run2    0.0001
 93  run3    0.001
 94  run4    0.008
 95  run5    0.01
 96  run6    0.1
 97   run7   0.2
 98  run8    0.5
 99  run9    0.6
100  run10   0.7
101  run11   1
102  run12   2
103  run13   5
104  run14   50
105  run15   100
106  run16   300
107  run17   500
108  run18   700
109  run19   1000/
110  ;
111  Scalar CurGamma Curent value for Gamma (controlled by loop);
112
113  Parameter
114  A(J) Use of land
115  /Local   1
116  Spot     1
117  Forward  1/
118  Price_A(J)
119  Var_A(J)
120  ;
121  variables
122  Utility   objective function value ;
123
124  *Eincome(T)   Expected Income
125  positive variable X(J);
126  Equations
127  OBJ      Objective Function
128  Supply   Resources constraints;
129  OBJ.. Utility =E= Sum(J,X(J)* Price_A(J)) - Sum(J, X(J)*X(J)*(CurGamma/2)*
     Var_A(J)*Var_A(J));
130  Supply.. Sum(J,A(J)*X(J))=E= 1;
131  Model Amadou Cotton marketing /ALL/;
132  Parameter Report (*,*,*);
133  Loop(T,
134    Loop(L,
```

```
135    CurGamma = Gamma(L);
136    Price_A(J) = P(T,J);
137    Var_A(J) = Var(T,J);
138  Solve Amadou using NLP maximizing Utility;
139  Report(L, T, J) = X.L(J);
140    );
141  );
142  Display Report;
143  Option decimals=5;
144  display Utility.L;
145  FILE result /"C:\Ok_State\Journals\Amadou\Gams\Output\Result.dat"/;
146  Loop (L,
147     Put result; Put "    "; Put "    ";
148  );
149  Put result;
150  Loop (L,
151     put @40  '.......Risk parameter value.....'; put/;
152     Put @50  put;
153        Put Gamma(L),
154  put/;
155
156      Loop(T,
157          Put Result; Put "X.L (T,J)"; Put "    ";  Put T.Tl;
158            loop (J,
```

VITA

AMADOU GOUZAYE

Candidate for the Degree of

Master of Science

Thesis: The value of price stabilization policy for cotton producers in Burkina Faso

Major Field: Agricultural Economics

Biographical:

Education:

Completed the requirements for the Master of Science in your major at Oklahoma State University, Stillwater, Oklahoma in December, July, 2012.

Completed the requirements for the Bachelor of Science in Agricultural sciences at INSTITUT AGRONOMIQUE ET VETERINAIRE HASSAN II /Morocco July, 2003.

Experience:

Professional Memberships:

Name: AMADOU GOUZAYE Date of Degree: July, 2012

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: The value of price stabilization policy for cotton producers in Burkina Faso

Pages in Study: 81 Candidate for the Degree of Master of Science

Major Field: Agricultural Economics.

Scope and Method of Study: Advantages of three marketing channels for cotton producers in Burkina Faso using a mean variance (E-V) model.

Findings and Conclusions: The common view of some specialists and practitioners is that the domestic pricing system in Burkina Faso discriminates against the cotton producer. However, the present study found that the local pricing system in the cotton sector of Burkina Faso was not always the inferior marketing channel when compared to the spot market and forward contracting. For the years during which the international cotton price was low, the local pricing system offers the best marketing alternative compared to international markets. During the years of high international cotton price if producers are less risk averse, the spot marketing is the best marketing channel. For some years even though the spot is on average higher than the local price it was not the best marketing option because it incurs risk. In other years the spot price was higher than the local price so that even if it goes down by one standard deviation it is still the best marketing option. However, for highly risk averse producers the local pricing system is always the best marketing alternative. Overall, the combination of the local pricing system with the international market (Spot and forward) is the best marketing choice for the cotton sector producers in Burkina Faso. The combination of different marketing channels was considered primarily for theoretical results. In practice, the local pricing system might be the best alternative because the domestic production model provides additional benefits that are not accounted for in the E-V model. Such benefits encompass technological support and foreign investments.

ADVISER'S APPROVAL: Jeffrey Vitale