

Full Length Research Paper

Reassessing cotton pricing policy in Burkina Faso: How important is price stabilization?

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This paper focuses on the parastatal marketing of cotton in Burkina Faso. The parastatal companies have bought cotton at a guaranteed price, announced prior to planting, reducing a key element of risk for producers. The cotton sector reforms in the late 1990s and early 2000s have significantly improved the share of international price received by local producers. However, a number of problems must still be solved to improve the living conditions for rural agricultural producers. The purpose of this paper is to reassess parastatal cotton pricing in Burkina Faso by factoring the implicit benefit that producers have obtained from guaranteed prices which reduces the price variability risk. A mean-variance economic risk model was developed to measure the price risk that would have been associated with selling cotton on international markets rather than selling to parastatal companies at a guaranteed price. Results suggest that risk is often a significant factor in producers' decision making, particularly over the past decade, when price volatility would have driven risk averse producers out of international markets. The viability of the parastatal markets, contrary to the prevailing literature which suggests that future policy shifts towards increased privatization, needs to consider price stabilization and the price variability risk associated with the international cotton market.

Key words: Cotton, price risk, mean-variance model, risk premium, certainty equivalent.

INTRODUCTION

Export crops in sub-Saharan Africa (SSA) have traditionally been associated with poor marketing conditions for producers (Diao and Hazell, 2004, Onal, 2012). Export crops have typically been produced within a paternalistic institutional structure, where technology, extension, and marketing are controlled by the parent

company, usually a parastatal or multinational. Under this arrangement, the parent company provides producers with modern technology and inputs at subsidized prices to maximize output, but in exchange for these services, producers have received only a fraction of prevailing international prices, with rents accruing to the parent

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company (Rapsomanikis et al., 2003; Delpuch and Leblois, 2013; Theriault and Tschirley, 2014). This noncompetitive market structure and government ownership creates price distortions that represent an implicit taxation on export crop producers, benefitting urban elites and multinational companies at the expense of the welfare of rural agricultural communities (Kherallah et al., 2000; Baffes, 2007; Delpuch and Leblois, 2013).

The plight of West African cotton producers has drawn considerable international interest over the past few decades. Equity is a primary concern raised by many in the development literature, who argue that West African cotton producers receive an unequal share of the international cotton price and subsequent profit (Baffes, 2005; Baffes et al., 2009; Baquedano et al., 2010). Empirical studies conducted over both the recent and distant past support this claim, which have found a low share of the international price given to West African cotton producers by the national cotton companies operating in the region (Baffes, 2005; Baffes et al., 2009; Baquedano et al., 2010; Delpuch and Vandeplas, 2013). West African cotton producers' share of the international cotton price is generally between 39 and 53% (Badiane et al., 2002). As a consequence of the low share of the international price paid to producers, the cotton companies' rent has been relatively high over the last three decades. When the ginning, transportation and marketing cost are subtracted from the international price, the difference between the domestic price and the adjusted international price approximates the cotton companies' rent. That difference was relatively high in the 1970s and 1980s because the price producers received was abnormally low compared to the international price (Baffes, 2007). In some years, the rent of the cotton companies was as high as 67% of the international cotton price. Following the reforms that took place at the end of the 1980s within most cotton sectors in West Africa, the cotton producer's share of the international price has increased significantly over the last two decades relative to the 1970s and the 1980s. However, even with the reforms, the West African cotton producers' share of international price is still low compared to international standards (Tschirley et al., 2009).

The development literature contains alternative explanations for the plight of the West African smallholder cotton farmer along with potential remedies. Bassett (2010) reported that Fairtrade cotton pilot programs in Burkina Faso and Mali, which aimed at providing transfers from developed country retail markets to smallholder farms, failed since it works within the same conventional commodity chain that impoverishes smallholders. In Burkina Faso and Cote d'Ivoire, international market share that producers ultimately receive depends on price setting mechanism that is highly influenced by inequalities in their economies that highly favor urban areas and government sector (Bassett, 2014). Cotton producers in Benin, Burkina Faso, and Mali

require reducing farmer's financial stress through the establishment of more equitable pricing mechanisms to enable greater on-farm investments in technology and input use, spurring technical efficiency and enhancing profitability (Theriault and Serra, 2014). Other studies have identified alternative reforms such as Nelen (2007), who demonstrates how newly formed farmer's organizations have come to handle complex issues inherent in the cotton sector. This includes the improved bargaining power and partial ownership of the cotton sector in Burkina Faso. Heinisch (2006) showed how developing countries can have advantage in cotton trade when they act as a regional compact. A notable example is how Benin, Burkina Faso, and Mali successfully challenged US cotton subsidies that were blamed on world price declines at the beginning of the 21st century.

Previous cotton market studies have argued that the international market would be more profitable for cotton producers in Burkina Faso (Baffes, 2005; Baffes et al., 2009; Baquedano et al., 2010; Baffes, 2012). Most of these studies support the fact that liberalization in the cotton sectors would improve the producer's share of the international price. However, the pricing mechanism used by West African cotton companies, based on guaranteed prices, insulates producers from uncertainty in the international cotton markets, but transfers the burden to the parastatal. In Burkina Faso, cotton prices are announced by the parastatal cotton companies sometime between March and April, just prior to planting, but cotton is not sold on international markets until the cotton is harvested and ginned, typically eight to twelve months later. International cotton markets are risky since prices can be volatile over the short run, with price collapses occurring frequently between the pre-planting period, when cotton companies announce the guaranteed price, and the post-harvest period, when cotton is sold on international markets (Figure 1). Over the period 1998 to 2009, price collapses had resulted in financial losses for the parastatal cotton companies since the price obtained on international markets had fallen below the price cotton companies were obligated to pay to producers (Estur, 2004). In 2004, there was a 23% fall in the nominal international cotlook 'A' price between May and December, and in 2008 the decline in the international price was 36% over that same seven-month period.

Economic research over the past decades has found that reducing price variability and stabilizing prices has an economic value to producers (Roy, 1952). Risk averse producers prefer, and are willing to pay for, reducing profit variability by choosing alternatives that avoid outcomes considered likely to fall too often below the mean, that is, by reducing variability. Hence, the guaranteed price paid to producers by the parastatal reduces risk and based on current understanding of producer behavior, has an economic value for risk averse producers.

The recent literature on West Africa cotton sector

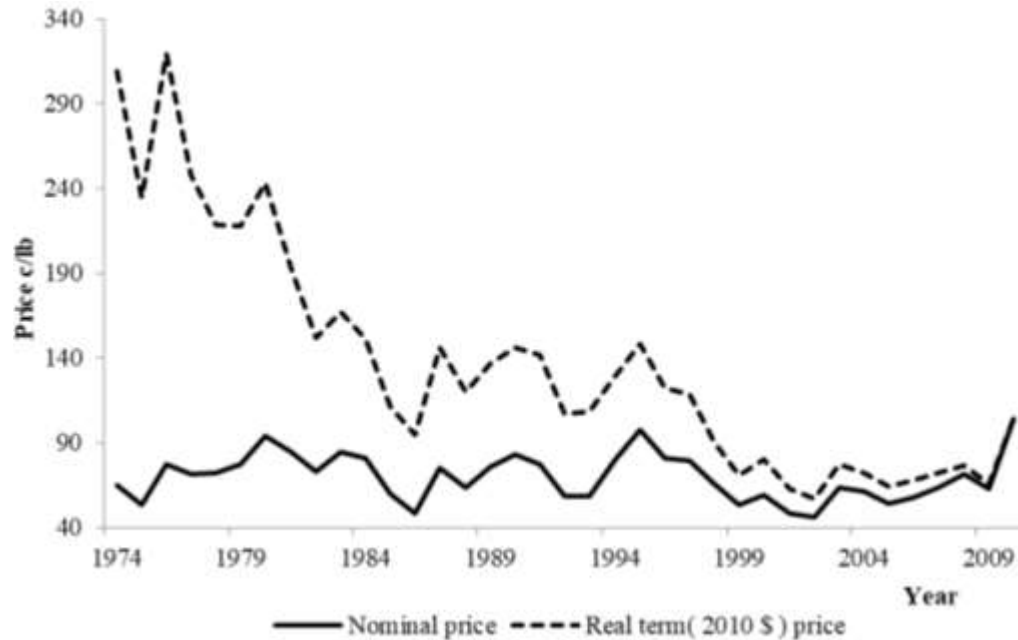


Figure 1. Nominal and real Cotlook 'A' price. The real price is the nominal price adjusted by the GDP deflator for Burkina Faso.
Source: FaoStat.

reform has too often ignored the risk associated with the international market price. Analysis has been based primarily on the post-harvest international cotton price, but for producers the more meaningful cotton price is the expected cotton price, formed prior to planting, when they are making their decisions on how to organize their farm for the upcoming season.

The primary purpose of the present study is to reassess the equity of parastatal cotton pricing in West Africa by including the implicit benefit producers receive from the guaranteed price. A price forecasting procedure is developed to estimated expected cotton prices at planting. A risk model is then utilized to determine how producers would market their cotton between either a guaranteed price provided by parastatal or a hypothetical marketing strategy, in which producers have the autonomy to sell the cotton directly on international markets. The risk model analyzes a 34 year period, from 1976 to 2009, which provides a robust comparison of how parastatal marketing channels have operated vis-a-vis international markets. The main contribution of this paper is to make transparent the benefits of price stability that smallholder producers implicitly capture in terms of their risk preferences that has largely been ignored by previous research.

Cotton parastatal companies in Burkina Faso

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 producers 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 producers (seeds, fertilizers and pesticides) and a virtual monopsony for the purchase of the seed cotton (Tschirley

et al., 2009). At that time producers 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 international 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).

In the 1980's when most developing countries experienced economic recession including defaulting on their foreign debt, many countries undertook economic reforms such as privatizing most public companies because of economic recession (Anderson and Masters, 2009). In the late 1980s and early 1990s, with an overvalued currency, cotton companies experienced financial difficulties (Baffes, 2007). In 1994, the CFA Franc was devaluated by 50%. The devaluation helped increase the cotton producers' share of the international price (Baffes, 2007). In late 1990s, many West African countries undertook strong reforms in their respective cotton sectors (Tschirley et al., 2009; Kaminski, 2011; Baffes, 2012). However, even with these reforms, numerous issues related to inefficiencies remain in the cotton sectors (Anderson and Masters, 2009).

Liberalizing cotton sectors would grant more marketing autonomy and higher price to cotton producers (Baffes, 2005). West African cotton producers currently benefit from the guaranteed price provided by the national cotton companies, but much of the price stabilization would likely be removed under more liberalized conditions. So, while a greater share of the international cotton price would be transmitted to the farm gate with a liberalized market, producers would also be exposed to an increased level of price risk (Baffes, 2005). The development literature has for the most part focused primarily on the farm gate price and the share of international price paid to producers, while ignoring the economic value of the guaranteed price under the current parastatal pricing system. Other questions also need to be addressed, such as by whom and how would, market uncertainty be managed in a more liberalized marketing chain.

MATERIALS AND METHODS

Data

Monthly cotton prices were collected over a 34 year period (1976-2009) for the international spot markets. The parastatal price was also gathered over the same period. Of the two alternatives, only the international spot market is subject to price variability; the parastatal price is guaranteed (Figure 3). The parastatal price is the national pan-territorial and pan-seasonal price offered to producers by the parastatal cotton companies. In Burkina Faso, since 2006, the parastatal price has been negotiated each year and announced publicly prior to the planting period, sometime around April. Prior to

2006, the price was determined exclusively by the government, but announced in the same manner prior to the planting period in April. The parastatal price has zero variance because it is a guaranteed price, hence, there is no variation associated with the parastatal price over the time between planting and harvest.

The Northern Europe cotton market, represented by price quotations in Liverpool and Rotterdam, is the market where West African cotton, including cotton from Burkina Faso, has primarily been exported. Increasingly, West Africa cotton exports are marketed in Asia and elsewhere as international markets have expanded (Cotlook, 2011). Prices on the international cotton markets are represented by the Cotlook 'A' Index, an average of the five lowest prices from a selection of nineteen price quotations (Cotlook, 2011). In the present study, the cotlook 'A' index was used because the cotlook 'A' index is considered the most representative of international cotton markets that West African cotton producers would utilize. Monthly data on the spot price are published by the UN Commission on Trade and Development (UNCTAD). In the present study, the December spot price is used because December is the month in which producers usually expect to be able to market their cotton, under the assumption that the ginning industry is able to have the cotton lint available by the end of December each year.

When considering spot markets, a major issue for producers is price uncertainty. Producers form price expectations in the spring time, just prior to planting, 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 international markets, there can be significant price movements between the period just prior to planting when price expectations are formed and the period after harvest when cotton is ready to be marketed. Hence, instead of using the actual price in the post-harvest period, an expected price is forecasted based on the historical observations of cotton prices that have evolved up to the time when price expectations are formed. Hence, each year, the December spot price (the harvest period) is forecasted in May (the planting period). This is considered as a more realistic and meaningful price to producers compared to the post-harvest price used in most of the previous studies.

Overall, the trend of parastatal prices and cotton lint yields during our study periods is presented in Figure 2. Cotton yields were obtained from FAOSTAT for the duration of the study period (FAOSTAT, 2017). The introduction of animal traction, modern seed varieties, insecticides, and the presence of extension services from the national cotton companies enabled cotton producers to increase yields over the past few decades. Compared to other crops in the region, cotton is less dependent on rainfall throughout the growing season and varieties have been developed to adapt cotton plants to the higher heat and water stress conditions in the region.

Theory

Parastatal cotton companies purchase cotton from producers at guaranteed prices, insulating producers from market volatility. Policies to transform parastatal control towards privatization, and increased producer autonomy, will require producers to bear a larger share of the uncertainty and fluctuations in international cotton markets. Price uncertainty has generally a strong influence on agricultural producers' decision-making process (Anderson and Dillon, 1992; Moschini, 2001). Resource allocation, whether it is land, labor or capital, is hampered by uncertainty. Because cotton producers do not know how the cotton price will evolve after the sowing date, their planting decisions are based on price expectations that producers form prior to planting, sometime around March or April. Analytically, price expectations are modeled as stochastic processes that producers, acting rationally, determine based on prior outcomes. In economic theory, producers' decision making processes under uncertainty are generally modeled using

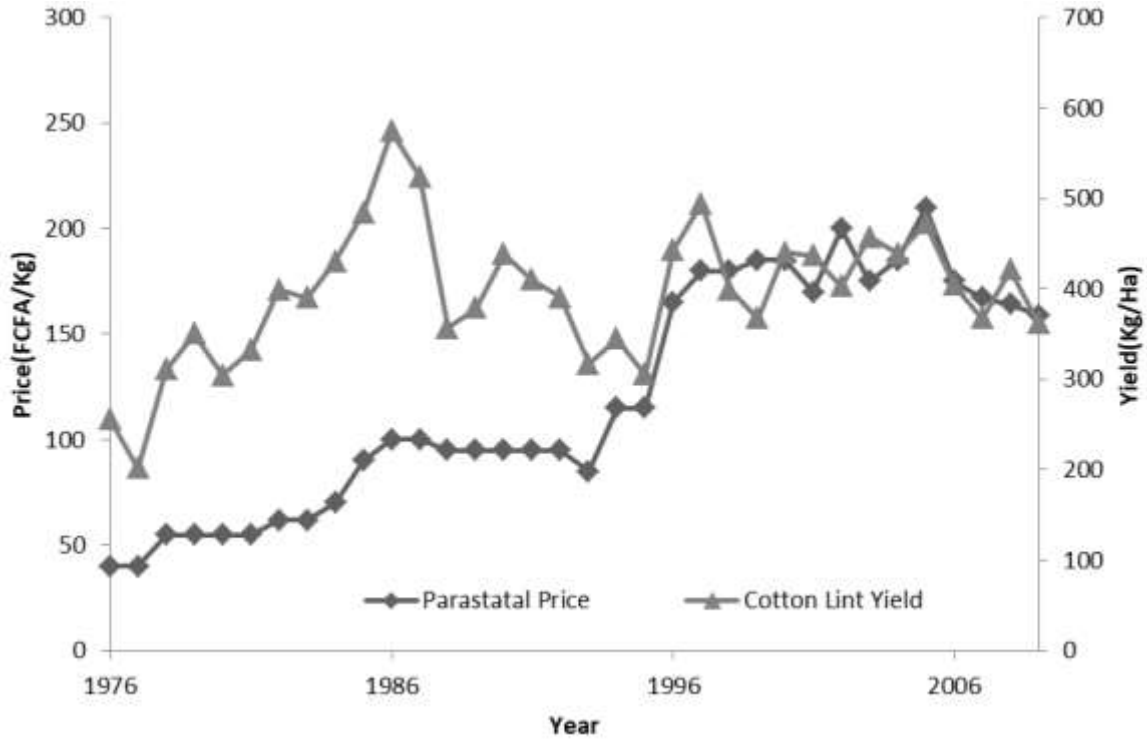


Figure 2. Parastatal price and cotton lint yield, 1978-2009. Source: FaoStat.



Figure 3. Forecasted international spot and the parastatal prices in Burkina Faso. *Data sources: parastatal price (International Bank), Spot price (UNCTAD). **The parastatal price is the national producer's price at the farm gate. The forecasted spot price is the December expected price forecasted with a simple linear time series model. The errors bars represent one standard deviation above the mean and one standard deviation below the mean for the spot price.

the expected utility maximization framework (Markowitz, 1952). Producers are presumed to assess their utility in each of the outcomes (or states) and an expected value is determined based on the probability of the outcomes (or states). For this study, cotton producers expected utility maximization problem, when choosing between the international spot market and the parastatal pricing system, is written as:

$$\underset{\theta}{\text{Max}} EU(x_1, x_2, \theta) = \theta EU(x_1) + (1 - \theta) EU(x_2) \quad (1)$$

where $EU(x_1, x_2, \theta)$ is the overall expected utility from the two marketing channels, x_1 is the stochastic distribution of the international cotton price and x_2 is the parastatal cotton price, θ is the decision variable, the proportion of the production sold on the international market, $EU(x_1)$ and $EU(x_2)$ are expected utility from the international and parastatal marketing channels, respectively.

The expected utility for selling cotton on the international markets is given by:

$$EU(x_1) = \int_{x_1=0}^{\infty} U(x_1) f(x_1) dx \quad (2)$$

where x_1 represents the stochastic choice variable, $f(x_1)$ is the probability density function of the stochastic process that represents how the distribution of international cotton price, x_1 , is formed prior to planting around March and April, and

$$EU(x_2) = U(x_2) \quad (3)$$

is the expected utility from the guaranteed parastatal pricing system, x_2 , which requires no expectation since the price is guaranteed prior to planting.

Because the marginal utility, $dU(l)/dl$, decreases as profit, l , increases for risk averse individuals, deviations above the mean profit, that is, when prices are higher than expected, generate less expected utility than equal deviations below the mean reduce expected utility, when prices fall short of expectations (Bailey et al., 1980). In an expected utility framework, it thus follows that risk averse producers will prefer a portfolio that reduces stochastic variation about the mean even if it requires accepting a lower expected mean income. Because the expected utility framework requires integrating a utility function, methods have been developed to approximate the formulation given by Equation 1 into more computationally tractable formats. Freund (1956) suggests that the quadratic programming, a Taylor series approximation based on the mean and variance of the support function used in Equation 1, is often the best way to include risk in a decision making process.

Empirical model

In the present study, two marketing channels are considered, the international spot market and the parastatal pricing system of the cotton companies. The international spot market is a hypothetical alternative since all producers have been under contract, through village level farmer cooperatives, to sell all of their cotton to the parastatal cotton company operating in their region. The expected utility given by Equation 1 in the theory section, when expanded using a second order Taylor series, is approximated as a function of the mean and the variance of the stochastic price distribution, that is, the mean variance (or E-V) formulation (Levy and Markowitz, 1979). The quadratic formulation is used in situations where the exact risk preferences of the producers are not available or not

required, since the quadratic formulation requires minimal assumptions about producer's risk preferences (Hazell, 1971). The main assumption for the quadratic utility approximation is the stochastic process is normally distributed. When the quadratic formulation is valid, risk is measured by the variance, and higher order moments such as skewness or Kurtosis can be ignored, making the quadratic formulation relatively straightforward to solve (Markowitz, 1952). When the cotton price is normally distributed, the E-V model is an exact representation of the expected utility problem discussed previously (Levy and Markowitz, 1979).

The objective function of the E-V model, Φ , maximizes the expected cotton profit but penalizes deviations around the mean using the variance, that is, the squared distance from the mean. The E-V model maximizes the objective function subject to a land constraint, mandating that all of the cotton is either marketed in the parastatal or international spot market, which operates the same as θ in Equation 1. The E-V model is specified as follows:

$$\underset{A}{\text{max}} \Phi = \sum_{j=1}^2 A_{(t,j)} Y_t P_{(t,j)} - \frac{\gamma}{2} \sum_{j=1}^2 A_{(t,j)}^2 Y_t \text{Var}(t, j) \quad (4)$$

Subject to:

$$\sum_{j=1}^2 A_{(t,j)} \leq 1 \quad (5)$$

$$A_{(t,j)} \geq 0 \quad (6)$$

where Φ is the producer's E-V objective function, that is producer's expected cotton profit, t is the current year (time period), j is the marketing channel ($j=1$ for parastatal price and $j=2$ for the Cotlook 'A' market price), $A_{(t, j)}$ is the decision variable or the solution of the E-V model, that is, the fraction of the production for year t sold on market j , Y_t is the cotton yield in year t and $P_{(t, j)}$ is the market price for the j^{th} marketing channel in year t , $\text{Var}(t, j)$ is the variance of market price j in year t , and γ is the producer's risk aversion parameter, which is varied using sensitivity analysis.

Risk preferences are generally measured by the risk aversion coefficient (Arrow, 1971). The risk aversion parameter shows producer's willingness to trade-off lower levels of expected profit for reduced variance (Jalota et al., 2007). Agricultural producers are assumed to be rational and they seek to maximize their expected utility of profit (Mapp et al., 1979). Producers that are less risk averse are less willing to trade-off expected profit and variance (or variability). Highly risk averse producers are more willing to trade-off expected profit for reduced variance (or variability). Since risk aversion is an individual preference, sensitivity analysis is used to vary γ to account for risk aversion ranging from risk neutrality ($\gamma = 0$) to high risk aversion. The magnitude of the producer's risk aversion parameter was varied using sensitivity analysis and a constant absolute risk aversion preference over income, following the approach of Rolfo (1980), who also investigated agricultural export marketing in the sub-Saharan Africa.

Cotton

A price forecast model was also developed using the SAS Forecast procedure (SAS Institute, 2008) to estimate the predicted cotton price in December, when cotton can be marketed, based on expectations formed several months earlier in May just prior to planting when cropping decisions are made, $P_{\text{Dec}}|P_{\text{May}}$. The price

forecast model used in the procedure combines a time trend and an autoregressive process that are given by the following equations:

$$P_t = a + b_1 t + b_2 t^2 + u_t \quad (7)$$

$$u_t = a_1 u_{t-1} + a_2 u_{t-2} + \dots + a_p u_{t-p} + \varepsilon_t \quad (8)$$

In Equation 7, P_t is the expected price of cotton in December based on a seven month forecast where a , b_1 , and b_2 , are trend parameters, t is the monthly time trend, and u_t is the error component. In Equation 8, a_i 's are autoregressive parameters, t represents the time period that is the month considered, and ε_t is the random error term. The forecast procedure includes only the parameters for the time lags that are statistically significant in the autoregressive process (SAS Institute, 2008). The forecast procedure generated the mean forecasted December price, the 95% confidence interval, and the standard deviation of the mean, which is used in the E-V model formulation (SAS Institute, 2008).

The SAS forecast model was run consecutively for each of the 34 years using the previous years' monthly prices, prior to May, starting in January 1976, to forecast the December price. The price forecast model is able to use all prior information known up to the current year when expectations are formed in May.

To compare the parastatal price (the price paid for raw cotton at the farm gate) to the international price, the price received on the international market for cotton fiber, the marketing, parastatal transportation, ginning, and the sea freight costs are subtracted from the spot market price. Additional data on these costs as well as the ginning ratio were obtained from the literature (Tschirley et al., 2009; Baffes, 2007). This step was necessary since the parastatal price paid to producers did not factor in any of the costs required to ship, market, or transform the raw cotton purchased at the farm gate into the cotton fiber sold on international markets. The parastatal and international cotton prices series are presented in Figure 3. The price series trend shows that the difference between the two prices and the variability of the international cotton price were not constant over the time period. In the 1970's and early 1980's, the international cotton price was substantially higher than the parastatal price. The variability was relatively low compared to the mean price. Over the 2000 decade, the international price was highly volatile and the levels of two price series were relatively in the same range (Figure 3).

After solving the E-V model that gave us the fraction of which market the cotton to be sold (the value A in Equation 9), the gross profit is calculated as well as its variance for a hypothetical 1 ha farm, using Equations 9 and 10 as follows:

$$\bar{R} = \sum_{j=1}^3 A_{jt} P_{jt} Y_t \quad (9)$$

$$V_t = Y_t^2 A_t^2 \text{var}_t \quad (10)$$

where \bar{R} is the average expected profit, A_{jt} , is the proportion of cotton sold in market j for year t given by the solution of the E-V model, P_{jt} is the cotton price on market j for year t , Y_t is the cotton yield for year t , V_t is the expected variance of profit, Y_t is the cotton yield for year t , A_t is the proportion of cotton to be sold on the international market ratio given by the solution of the E-V model, and var_t is the expected variance of the international market price obtained from the SAS price forecast model.

The cotton companies' rent is calculated as the difference between the profit with the adjusted international spot price and the

profit with the parastatal price. The rent is given by the following equation:

$$R_t = Y_t (P_s - P_d) \quad (11)$$

In Equation 11, R_t represents the annual rent earned by the parastatal cotton companies, Y_t is the yield for each year, t is the year. P_s is the adjusted international spot price and P_d is the parastatal price.

The risk premium is the amount of money, measured in terms of expected profit, which a risk averse decision maker is willing to pay to reduce profit variability as determined by their level of risk aversion. By definition, the risk premium is zero for risk neutral producers. For a risk averse producer, the risk premium is defined as the difference between the expected profit obtained for their level of risk aversion and the expected profit of the risk neutral producer. Risk premiums grow larger as risk aversion is increased. In the E-V model, as risk aversion is increased, producers will forgo expected profit by selling a larger share of their cotton to the parastatal to reduce variability. In this paper, the risk premium measures the implicit benefit that risk averse producers would have derived from having access to the parastatal marketing channel, even when given the opportunity to sell their cotton on international markets. The risk premium indicates the extent to which risk averse producers would be willing to pay to reduce price variability. The parastatal market provides a price stabilization mechanism, resulting in a mixed marketing strategy in which the international market provides benefits from a higher expected price and the parastatal enables producers to manage risk. The following equation is used for the risk premium calculations:

$$R_p = R_{RNP} - R_{RAP} \quad (12)$$

In Equation 12, R_p is the risk premium, R_{RNP} is the profit of the risk neutral producer and R_{RAP} the profit of risk averse producer.

The certainty equivalent is another measure of risk. For a risk averse producer, the certainty equivalent (CE) is defined as the minimum amount, they would be willing to accept, with certainty, to avoid facing an uncertain (risky) alternative (Hardaker, 2004). The CE is calculated using the following equation:

$$U(CE + R_{PRN}) = U(R_W) \quad (13)$$

where CE is the certainty equivalent, R_W the potential profit from international market, R_{PRN} is the profit of a risk averse producer when marketing only through the parastatal market from Equation 4 and U is the expected utility function defined in Equation 1.

The international market functions as the uncertain alternative since it contains substantial price variability. So for this study, the CE is the amount that a risk averse producer would pay to avoid having to market exclusively in the international market, and instead markets only with the parastatal company, where profit is certain. Profit from the parastatal market is included with the CE in Equation 13 since it already provides a guaranteed outcome. Hence, the CE as measured by Equation 13, indicates the additional amount, above and beyond the certainty provided by the parastatal pricing, to make producers accept the certain outcome rather than face the uncertainty. Risk neutral producers have a CE equal to the expected profit in the international market since they do not discount variance. Risk averse producers would accept less than the expected profit in the international market. Given the definition used in Equation 13, negative CE values are possible, indicating that the parastatal market exceeded the minimum amount of profit that was needed to pay producers to forgo the risky alternative and accept a certain outcome. Negative CE values are interpreted as a

Table 1. Comparison between the International European spot market and the parastatal pricing system over the period 1976-2009.

γ	Parastatal pricing ratio*	International spot ratio*	Average profit** (\$US.ha ⁻¹)	STDEV of profit (\$US.ha ⁻¹)	Certainty equivalent*** (\$US.ha ⁻¹)	Risk premium# (\$US.ha ⁻¹)
0	0.15	0.85	377.45	70.18	87.41	-
0.001	0.20	0.80	377.43	65.48	87.41	0.02
0.1	0.61	0.39	340.05	23.79	41.93	37.40
1	0.92	0.08	294.21	3.31	-226.78	83.24
5	0.98	0.02	285.15	0.68	-268.38	92.30
50	0.99	0.001	282.09	0.02	-280.62	95.36
100	1.00	0.00	281.97	0	-281.30	95.54

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

benefit since they provide risk averse producers benefits with additional risk management that they would have received from the parastatal.

RESULTS

The international spot market price represented by the cotlook 'A' index was compared to parastatal pricing mechanism using the E-V (mean variance) model to determine the most profitable marketing channel for producers. The international market was not always the optimal marketing strategy selected by the E-V model, even though the international market offers a higher expected price, on average, than the parastatal over the period from 1976 to 2009 (Table 1). Risk neutral producers would have marketed a substantial majority of their production, 85%, in international markets over the 34-year period between 1976 and 2009, with the remaining 15% marketed to the parastatal (Table 1). Since risk neutral producers do not discount variance, in 15% of the years the parastatal market gave producers a higher price than they would have expected to receive on international markets, based on price expectations formed just prior to planting. Previous literature would not have found this result because they were too focused on the actual international spot price at post-harvest, rather than the more appropriate expected price just prior to planting (Baffes, 2005; Baffes et al., 2009; Baquedano et al., 2010). For risk neutral producers, however, the results found from the E-V model are generally consistent with previous studies that indicate producer welfare would be significantly increased if they had greater marketing autonomy.

Risk averse producers ($\gamma > 0$), because of the uncertainty in forecasting prices between planting and harvest, would have more of an incentive to sell in the parastatal market, where price is guaranteed, than would risk neutral producers. In doing so, however, risk averse producers must trade-off a portion of their expected profit

since the expected price of cotton on the international market typically is higher than the parastatal price (Figure 3).

With low risk aversion ($\gamma = 0.001$) producers would have marketed 20% of their production with the parastatal and 80% on the international market (Table 1). At higher levels of risk aversion, producers would market a greater proportion of their production in the parastatal marketing channel, with its guaranteed price, than in the international market, where price variability can be significant (Table 1). Over the 34-year period, producers with modest risk aversion ($\gamma = 1$) would have continued to sell an average of 92% of their production with the parastatal marketing system. Producers with a higher risk aversion parameter ($\gamma = 50$) would continue to sell nearly all of their production, 99%, in the parastatal market (Table 1).

The E-V model thus suggests that international cotton market uncertainty could have been an influential factor on producer's decision making over the past few decades. The marketing decision was very sensitive to risk aversion, as even a slight change in risk aversion resulted in producers shifting a substantial portion of their cotton to the parastatal marketing channel. Hence, when risk is included in the analysis, the results of the E-V model are much less consistent with the literature since the parastatal marketing alternative provides greater economic benefit due to its price certainty.

Risk averse producers, by utilizing the parastatal market to reduce variability, accept lower expected income. The average expected profit of producers with risk aversion parameter of $\gamma = 1$ was \$294.21 ha⁻¹ over the period of 1976 to 2009, which represents a 22% reduction compared to the average profit for the risk neutral producer which was \$377.45 ha⁻¹ over the same period (Table 1). For the more extreme risk averse producer ($\gamma = 50$), the average expected profit was \$282.09 ha⁻¹ (Table 1), suggesting a 25% reduction compared to the risk neutral producer's expected profit.

The E-V trade-offs are summarized in the risk premium and certainty equivalent measures (Table 1). Modestly risk averse producers ($\gamma=0.1$) would give up only 11% (\$37.40/\$340.05) of their expected profit as risk premium to reduce variability (Table 1). As more risk averse producers are considered, the risk premium increases. For a highly risk averse producer ($\gamma=50$), for example, the risk premium is \$95.36 ha⁻¹ (Table 1). The highly risk averse producer would be willing to forgo 25% of their expected profit to reduce the standard deviation of profit by nearly 100%, from \$70.18 ha⁻¹ to \$0.02 ha⁻¹ (Table 1).

The risk premiums and E-V trade-offs found in this study are consistent with the results from other studies that risk averse producers would be willing to give up 25% of their expected profit to significantly reduce variability, which includes avoiding low and negative incomes (Ouatarra et al., 1992; Patillo and Soderbom, 2000). Ouatarra et al. (1992) found cocoa producers in Ivory Coast would be willing to accept a 26% loss in expected profit to reduce the profit variance by 11%. Patillo and Soderbom (2000) found a trade-off that was between 80 and 100% for extreme risk aversion in the manufacturing industries in Ghana. The risk premium were higher because by leaving the risky marketing channel in the international market, risk averse producers give up a substantial portion of their expected profit with international price that was high. In the present study, the profit reduction ranges between 5 and 25% and given the presence of guaranteed prices in the parastatal markets the variability of profit is reduced to zero at high levels of risk aversion.

The certainty equivalent measures the amount that a producer would pay to avoid having to face the uncertainty in the international market by marketing their cotton in the parastatal marketing channel, where the guaranteed prices provide certain market outcomes. With low risk aversion ($\gamma=0.001$), the certainty equivalent was the same compared to risk neutral producers ($\gamma=0$) because there was not a significant change in the proportion of the production that would have been sold on the international market when risk preferences change. For a modestly risk averse producer ($\gamma=0.1$), the certainty equivalent averaged \$41.93 ha⁻¹ over the period from 1976 to 2009 (Table 1). Extremely risk averse producers ($\gamma=100$), those who would have sold all their production on parastatal market, had a negative certainty equivalent (Table 1). This is interpreted as a benefit provided by the parastatal pricing to highly risk averse producers, who would have been willing to pay a higher amount to avoid selling on the international markets.

Because the use of parastatal marketing system was found to be much greater over the past decade, a deeper look was taken at different time periods. Four distinct periods are identified based on the study by Baffes (2007). Baffes (2007) identifies four distinct periods in West African cotton sector policy reforms and the difference between the international price and the

domestic prices in the West and Central African region. For the periods of 1976 to 1984 and 1994 to 1997, the use of parastatal marketing would have been low except for highly risk averse producers, while for the periods of 1985 to 1993 and 1998 to 2009, the parastatal marketing system would have been utilized to a much higher extent than the previous periods, contrary to what the development literature has been reporting.

1976-1984 Period

The Burkina Faso parastatal cotton price was significantly lower ($P=0.005$) compared to the international spot price over the period of 1976 to 1984 (Figure 3). The parastatal cotton price represented, on average, only 47% of the expected international price of cotton in December, forecasted in May just prior to planting, $P_{Dec}|P_{May}$. The December forecasted international price variability was also modest in the 1976 to 1984 period, with a coefficient of variation of 15% (Figure 3). For all the 9 years, the expected international price in December ($P_{Dec}|P_{May}$) was at least one standard deviation above the parastatal price (Figure 3). Given the significantly higher price and correspondingly low variability, marketing cotton on the international markets was the best marketing channel over the period for both risk neutral ($\gamma=0$) and modestly risk averse producers ($\gamma=0.1$), which is both evident from the data and also confirmed by the E-V model (Table 2). Over the 9 years from 1976 through 1984, even if producers lose one standard deviation with the spot price, they would have higher price compared to the price offered by the parastatal company.

A risk neutral producer ($\gamma=0$) would have sold all of their cotton on the international cotton market in each of the 9 years since the expected international price in December ($P_{Dec}|P_{May}$) was always higher than the parastatal price (Figure 4a). The expected profit would have averaged \$354.94 ha⁻¹ over the 9 years for risk neutral ($\gamma=0$) producers (Table 2). Modestly risk averse producers ($\gamma=0.001$) also would have sold their cotton only on the international market, indicating that although there was variability in forecasting international prices, the variability (or STDEV) was not large enough to have any influence on their marketing decisions (Table 2). With identical marketing choices, modestly risk averse producers ($\gamma=0.001$) would have earned the same expected profit as risk neutral producers ($\gamma=0$), \$354.94 ha⁻¹ (Table 2). The highly risk averse producers would not have used the international markets even in this period of high international because of their extreme aversion to risk.

Over the 1976 to 1984 period, highly risk averse producers would have used the parastatal marketing in lower proportion compared to the 34-year period between 1976 and 2009 (Table 1). For example, producers with a risk aversion parameter $\gamma = 0.1$, would have sold 61% of

Table 2. Comparison between the international European spot market and the parastatal pricing system over the period 1976-1984.

Y	Parastatal pricing ratio*	International spot ratio*	Average profit** (\$US.ha ⁻¹)	STDEV of profit (\$US.ha ⁻¹)	Certainty equivalent*** (\$US.ha ⁻¹)	Risk premium# (\$US.ha ⁻¹)
0	0	1	354.94	56.07	184.93	-
0.001	0	1	354.94	56.07	184.93	0
0.1	0.1	0.9	346.90	49.14	184.93	8.04
1	0.7	0.3	221.34	8.10	-37.50	133.60
5	0.9	0.1	184.62	2.33	-129.68	170.33
50	0.99	0.0	171.02	0.10	-165.98	183.93
100	1.00	0.0	170.02	0	-168.00	184.93

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

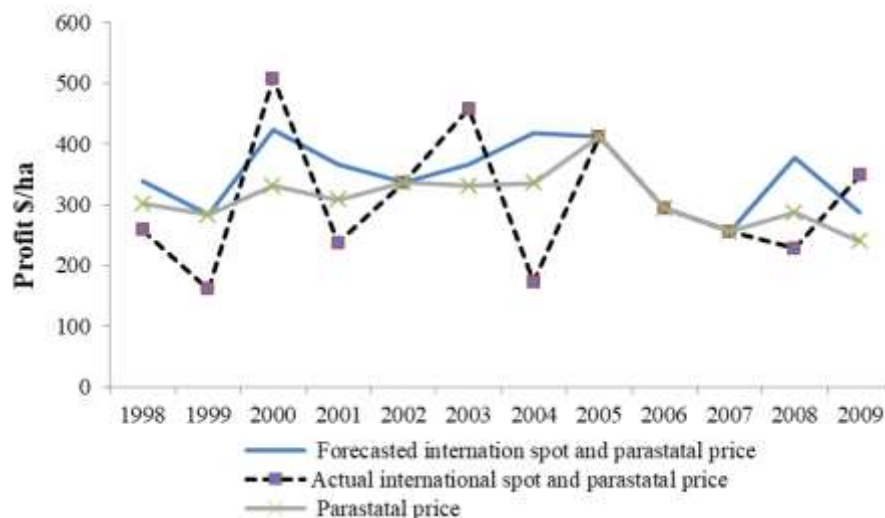
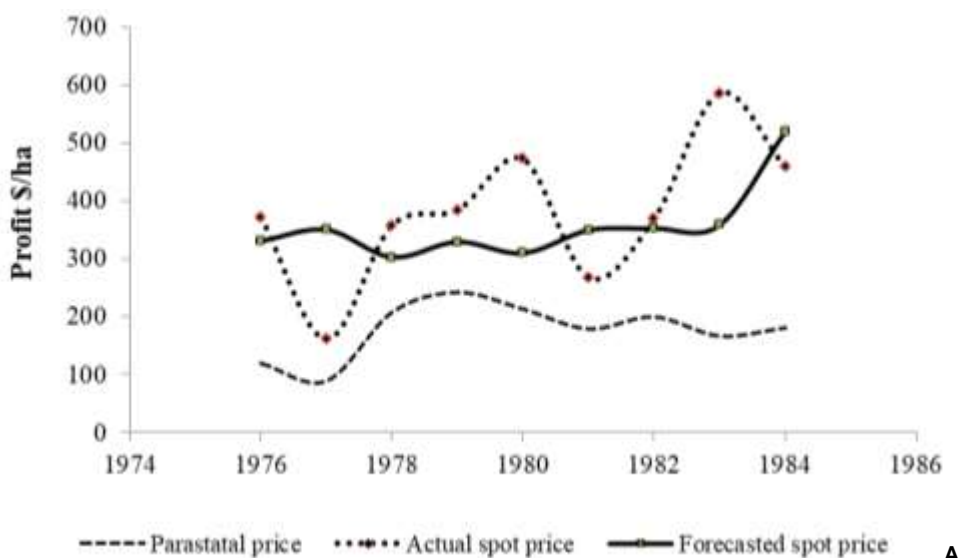


Figure 4. (A) Actual earnings for a risk neutral producer for 1976-1984 period. **(B)** Actual earnings for a risk neutral producer for 1998-2009 period. *The profit with the parastatal price is the actual profit for producers in Burkina Faso.

Table 3. Comparison between the international European spot market and the parastatal pricing system for the period between 1985 and 1993.

Γ	Parastatal Pricing ratio*	International Spot ratio*	Average profit** (\$US.ha ⁻¹)	STDEV of profit (\$US.ha ⁻¹)	Certainty equivalent*** (\$US.ha ⁻¹)	Risk premium# (\$US.ha ⁻¹)
0	0.10	0.90	468.87	103.23	126.44	-
0.001	0.21	0.79	468.83	93.00	126.90	0.04
0.1	0.70	0.30	421.72	39.16	115.97	47.15
1	0.96	0.0	351.22	4.15	-270.01	117.64
5	0.99	0.0	343.89	0.86	-327.54	124.98
50	1.00	0.0	341.93	0.00	-340.49	126.94
100	1.00	0.0	341.93	0.00	-341.21	126.94

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

their production, on average, for the longer period with the parastatal marketing system, whereas only 10% would have been marketed over the period 1976 to 1984 (Table 2). For the highly risk averse producers ($\gamma=50$), 99% of the production would have been sold on the parastatal marketing meaning that they would sell all their production with the parastatal marketing system.

The risk premiums were higher for the period 1976 through 1984 compared to the overall period, 1976-2009 (Tables 1 and 2). The risk premium was high, because by leaving the risky international market, risk averse producers give up a substantial portion of their expected profit with the international market price that was high over the 1976-1984 period. The certainty equivalent was also higher over the period of 1976 to 1984 compared to the period of 1976 to 2009 overall. The risk averse producer's certainty equivalent that was \$87.41 ha⁻¹ over the longer period was \$184.93 ha⁻¹ for the 1976 to 1984 period. The certainty equivalent of modestly risk averse producer ($\gamma = 1$) was \$-37.49 ha⁻¹ which is higher compared to \$-226.78 ha⁻¹ over the period 1976 to 2009. Highly risk averse producers ($\gamma = 50$) have a certainty equivalent of \$-165.98 ha⁻¹ compared to \$-280.62 ha⁻¹ over the longer period.

The E-V model results reveal that producers had been given greater marketing autonomy, the use of the international market would have had a positive effect on producers' profit between 1976 and 1984. The E-V model findings are consistent with the development literature, which has consistently argued that the international cotton price is poorly transmitted to smallholder producers by rent seeking parastatals. The risk neutral producer's profit would have increased by more than 100% on average over the 9-year period compared to the current marketing practices. The risk neutral producer would sell all their production on the international market over the 9-year period compared to 85% over the longer period from 1976 to 2009. The modestly risk averse

producers ($\gamma = 0.1$) would have also increased their expected profit by 2.3% (\$8.04) on average over this period. These producers would have sold all their production on the international market compared to only 39% over the longer period. However, the highly risk averse producers ($\gamma = 100$) would always use the parastatal marketing channel and therefore their expected profit is always the same compared to the actual marketing practices.

1985-1993 and 1993-1997 periods

From 1985 to 1993 the forecasted December international price was low proportionally to the parastatal price given the stable parastatal pricing during this period, resulting in a substantially better transmission of the international cotton price to producers (Figure 3). The parastatal price was 25% lower than the December international price forecasted at May ($P_{Dec}|P_{May}$) during the 1985 to 1993 period, a marked improvement for producers compared to the 1976 to 1984 period, when the parastatal price was 53% lower than the expected international price of December cotton ($P_{Dec}|P_{May}$). Producers profited during the period (1985-1993) with a relatively higher parastatal price offered by the parastatal cotton company. Risk neutral producers ($\gamma=0$) would have sold 10% of their production within the parastatal marketing system, with the remaining 90% sold on international markets (Table 3).

The period 1994 through 1997 had a price structure and price trend similar to the period from 1976 through 1984 (Figure 3). In each of the four years, the expected international price ($P_{Dec}|P_{May}$) was at least two standard deviations higher than the parastatal price and on average was 60% higher over the four-year period (Figure 3). The variability associated with the expected international price, as it transitions from planting to post-

Table 4. Comparison between the international European spot market and the parastatal pricing system for the period between 1994 and 1997.

Γ	Parastatal pricing ratio*	International spot ratio*	Average profit** (\$US.ha ⁻¹)	STDEV of profit (\$US.ha ⁻¹)	Certainty equivalent*** (\$US.ha ⁻¹)	Risk premium# (\$US.ha ⁻¹)
0	0	1	390.06	45.40	133.33	-
0.001	0	1	390.06	45.40	133.33	0.00
0.1	0.68	0.33	308.68	13.54	102.80	81.38
1	0.97	0.03	262.07	1.35	-220.77	127.99
5	0.99	0.01	257.92	0.32	-249.53	132.14
50	1	0	256.73	0	-256.01	133.33
100	1	0	256.73	0	-256.37	133.33

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

Table 5. Comparison between the International European spot market and the parastatal pricing system from 1998 to 2009.

γ	Parastatal Pricing ratio*	International Spot ratio*	Average profit** (\$US.ha ⁻¹)	STDEV of profit (\$US.ha ⁻¹)	Certainty equivalent (\$US.ha ⁻¹)***	Risk premium# (\$US.ha ⁻¹)
0	0.33	0.67	346.70	33.85	20.4	-
0.001	0.41	0.59	346.70	30.76	37.0	0.00
0.1	0.92	0.08	315.60	4.33	-60.9	31.20
1	0.99	0.01	310.30	0.44	-284.8	36.40
5	1	0	309.70	0	-304.75	37.00
50	1	0	309.70	0	-309.23	37.00
100	1	0	309.70	0	-309.48	37.00

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

harvest, was low compared to the other periods, with a coefficient of variation 15% (Figure 3). The risk neutral producers ($\gamma=0$) and producers with low risk aversion ($\gamma = 0.001$) would have sold all of their production on the international market (Table 4).

1998-2009 period

The period between 1998 and 2009 is another period of low international prices, similar to the period of 1995 and 1993 period. The parastatal price was higher than the forecasted international spot price in four years over the period, that is, in one year out of three the parastatal price was actually higher than the expected international cotton price ($P_{Dec}|P_{May}$). During this most recent period, risk neutral producers ($\gamma=0$) would have continued to sell 33% of their production with the parastatal cotton companies compared to 15% over the longer period from 1976 to 2009 (Table 5). The expected profit of risk neutral producers was \$346.70 ha⁻¹ with a standard deviation of

\$33.85 ha⁻¹ (Table 5). For the period from 1976 to 1984 also all the risk neutral producers production would have been sold on the international market. From 1985 to 1993, the fraction was 90% and all production would have been sold on international market for the period from 1994 to 1997. For low risk aversion ($\gamma= 0.001$) 41% of the production would have been sold on the parastatal market and 59% on the international markets if producers had the opportunity to market as they wish. The low risk averse producers would have the same expected profit as the risk neutral producers. Modestly risk averse producers ($\gamma=1$) would have sold almost all of their production on the parastatal marketing system and would have earned an expected profit of \$310.30 ha⁻¹ with a standard deviation of \$0.44 ha⁻¹. Their risk premium is \$36.40 ha⁻¹. The expected profit of highly risk averse producers ($\gamma=50$), who would have sold all (100%) of their production with the parastatal, was \$309.70 ha⁻¹, which is 11% lower than the expected profit of risk neutral ($\gamma=0$) producer (Table 5). The profit of highly risk averse producers ($\gamma=50$) is risk free because its standard

Table 6. Actual and expected profit for risk neutral producer (\$US/ha).

Year	Forecasted spot price* combination	Actual spot price** combination	Parastatal price only	Actual international spot 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 forecasted spot price is combined with the parastatal market using the proportion suggested by the E-V model. ** The actual spot price is combined with the parastatal market using the proportion suggested by the E-V model.

deviation is zero. The certainly equivalent of highly risk averse producer is $-\$309.23 \text{ ha}^{-1}$ and the risk premium is $\$37 \text{ ha}^{-1}$ (Table 5). Compared to the parastatal pricing system, the increase of the expected profit, with the combination of the international and parastatal market, was only 11% for risk neutral ($\gamma=0$) producers (Table 5).

The 1998 to 2009 period was a period of progressive decline in the international cotton price. The parastatal companies often fell into financial distress during this period, particularly as the increased bargaining power of the producers pushed up the price, they were obligated to pay producers even when the international price collapsed. Over the last twelve years, if producers had implemented the E-V model's results, risk neutral producers ($\gamma=0$) would have earned lower profit on the international market compared to the profit from the parastatal. For four years, risk neutral producers ($\gamma=0$) would have the same profit in both the international and parastatal marketing channels, and they would have had higher profit only in three of the twelve years (Table 5). The risk averse producers ($\gamma>0$) who used combinations of the two marketing channels yet would have made approximately the same level of profit as they would if they had remained only in the parastatal channel (Table 5).

The most recent period is perhaps the most illustrative example of how the prevailing view of parastatal pricing should be reconsidered. It was the only period when both the risk neutral and risk averse producers would have benefitted more from the parastatal than the international markets. The expected international price of cotton in December was not significantly different ($P>0.05$) than the parastatal price, resulting in risk averse producers

preferring the parastatal market in most of the years, while in other years when cotton was sold on international markets the profit difference was not significantly different than it would have been through marketing with the parastatal. Risk averse producers have even greater incentives to use the parastatal markets given the high level of variability during this period.

Actual price outcomes

Table 6 presents a comparison between the E_V model's marketing choices for risk neutral producers, based on the forecasted international cotton price ($P_{\text{Dec}}|P_{\text{May}}$), with the actual international price in December, over the period of 1998 to 2009. The comparison shows that the planting-to-post harvest price forecasts ($P_{\text{Dec}}|P_{\text{May}}$) would often have been overly optimistic over the last twelve years (Figure 4b). In most of the years, the forecasts were for higher price movements between planting and post-harvest than actually occurred (Figure 4b). For three of the twelve years, 2000, 2003, and 2009, the actual spot price was higher than the forecasted spot price (Figure 4b). On 4 years, the price is exactly equal and in the remaining 5 years, the actual spot price was lower than the forecasted spot price (Figure 4b).

The forecasted profit was equal to the profit with the parastatal price in four out of the twelve years (Figure 4b). The years in which the forecasted profit is the same as the parastatal profit are the years for which the risk neutral producers would sell all the production with the parastatal pricing system, these years are 1999, 2002, 2005, and 2007 (Figure 4b). Over the period of 1998 to

2009, the average profit with the actual spot price was \$305.86 ha⁻¹ with a standard deviation of \$109.71 ha⁻¹. The average profit with the parastatal price was \$309.72 ha⁻¹ with a standard deviation of \$44.86 ha⁻¹ (Table 6). The E-V model clearly suggests that there is a positive economic value in the guaranteed parastatal price over the last decade, providing a greater benefit to producers than in any of the other periods. Because the forecast procedure overestimates the spot price, the expected profit with the combination of the forecasted spot price and the parastatal price was higher than the expected profit with the combination of the actual price and the parastatal price (Table 6). With the forecasted international price ($P_{Dec}|P_{May}$), the average annual expected profit over the last 12-year period was \$346.73 ha⁻¹ (Table 6) for the risk neutral producers. The standard deviation of the expected profit was around \$57.15. The profit with the combination of actual spot and parastatal price was lower (\$305.86ha⁻¹) for risk neutral producers ($\gamma=0$) compared to risk averse producers ($\gamma>0$), \$309.72 ha⁻¹ (Table 6). The reason why the risk neutral producer had lower actual profit is because the price expectations were too high, resulting in a marketing ratio, from the E-V model, that sold too much cotton on the international market (Table 6).

DISCUSSION

If cotton producers had been granted the opportunity to sell their production with the international spot market as recommended by previous studies; over the past few decades, they would have earned higher expected profit only in certain periods (Baffes et al., 2009; Baquedano et al., 2010). Previous studies in the development literature have not considered the risk associated with the uncertainty from selling cotton on international markets as prices trend between planting and post-harvest. This study provides suggestive evidence that previous claims against parastatal pricing, and concerns over the equity of parastatal pricing, could be overstated when risk is included. Because the international price incurs risk, the parastatal market would often have provided risk averse producers with a marketing alternative to better manage risk. In addition, there were several years in which the parastatal price offered to producers prior to planting was equal or higher than the expected price of cotton on international markets over the last few decades.

Risk neutral producers would have benefitted from market liberalization, particularly during the periods of high international cotton prices, 1976-1984 and 1994-1997. This finding is consistent with the previous literature, which by ignoring risk implicitly limited their scope to risk neutral producers. Risk averse producers have profited the most from the parastatal pricing that has been in place over the past few decades, 1976-2009. Large risk premiums were found by our E-V model,

indicating that international cotton markets contain substantial variability, as price trends from planting to post harvest are highly uncertain. Risk averse producers would have been willing to accept a lower price in the parastatal market, with its guaranteed price, rather than sell their cotton in international markets. However, the present study found that in other periods such as the period between 1998 and 2009, the actual profit of risk neutral producers with the expected spot price at planting, is often lower than the profit with the parastatal pricing system.

For the last 12 years in the present study, 1998 to 2009, international cotton prices were low compared to their historic levels, but also contained significant variability. Those trends are expected to continue, as subsidies from developed countries, notably the U.S but the European Union countries, and increased production from Asia and Africa, are likely to impact markets in unpredictable ways (Baffes, 2005). Over the last twelve years, with the low and highly variable prices the parastatal price was, in general, as good as the international spot price, largely due to the price stabilization effect. The parastatal price isolates producers from the international price variability, so policy makers should expect to plan based primarily on the outcomes from the more recent period of 1998 to 2009, rather than the previous periods when there was less need for price stabilization.

The benefits of the parastatal would likely have been higher if the co-benefits of the parastatal marketing system had been included in the E-V model. Throughout the analysis period of 1976 to 2009, parastatal cotton companies provided producers with access to new technology, extension services, credit for input, and invested in rural infrastructure including roads, water, and electricity. While it was beyond the purpose of this paper to quantify those benefits, policies to shift producers away from parastatal control must include careful consideration of how those services would be delivered to producers under more liberalized conditions. It is not clear that parastatal could be justified on their own merits or even as necessary, but evidence from other countries have shown that the private sector has had difficulty in developing the necessary markets for delivering adequate processing, access to new technology, and extension services (Poulton and Wilbald, 2007).

Over the 34 year period from 1976 to 2009, the cotton companies' annual rent averaged around \$21 million representing the producer's surplus. Normally, the surplus should be invested in rural areas. However, the cotton companies do not have transparent plan to redistribute the surplus in rural areas on an on-going basis. Most of the investments have been largely self-serving, e.g. providing roads, electricity and water to facilitate the movement and ginning of cotton that has left non-producing cotton area severely lagging. The lack of equitable rent distribution through investments is the

reason why critics have voiced concerns over how the parastatals have managed cotton's economic surplus.

Conclusion

The present study investigated the potential benefit of two marketing channels for cotton producers in Burkina Faso in face of international price uncertainty. Historical cotton price data over the 34-year period between 1976 and 2009 are used in the present 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 decision variable that allocates cotton production in a marketing scenario where producers are given the opportunity to sell cotton to either the existing parastatal company or on international markets. The combination of different marketing channels was used to show the upper limit of the theoretical marketing possibilities.

Our result suggests that, contrary to the conventional wisdom in the development literature, the parastatal pricing system was often a preferred marketing channel compared to international markets. During the periods of high international cotton price, the spot market is the best marketing channel to be used by producers, even though spot market price incurs risk. The periods over which the spot marketing was better than the parastatal pricing system are the period between 1976 and 1984 and the period from 1994 to 1997. For the periods between 1985 and 1993 and 1998 and 2009, the international cotton price was low. Because of the magnitude of the difference between the two prices and due to the fact that spot price was subject to variability, the parastatal pricing system was better than the spot market for risk averse producers.

The results of the present study suggest that policy makers should consider maintaining for producers some type of guaranteed pricing mechanism that could be combined with the opportunity to market cotton on international markets. The guaranteed price could be provided by either parastatal cotton companies or perhaps through producer's associations. Another alternative would be a guaranteed fund administered through the Ministry of Agriculture, similar to U.S and European farmer support programs. Other price stabilization policies, such as price insurance mechanism or more traditional alternatives such as futures and options may also provide alternative price support system for the cotton sector in Burkina Faso.

While shifting to a policy that encourages cotton producers to operate independently on the international markets may be difficult because of the complexity and competitiveness of international markets, there is evidence that producers in sub-Saharan Africa can be successful in penetrating international markets. West

African cotton producers could follow the model of fish and ornamental flowers producers in Kenya, where small holders have been successful in selling their production on the very competitive European markets. One way to do so might be to start by educating producers' organizations on the requirements of the international market mechanism (Nyangweso and Odhianbo, 2004).

Cotton has often been one of the most important cash crops in developing economies, providing needed export earnings that can be used to generate economic growth in industrial and service sectors. The recent "cotton problem" and depressed world prices has plagued West African cotton producers and left them at a crossroads, deciding whether incentives are adequate to invest in new technology to improve productivity. This is a critical decision since yields are an equally important determinant of profits as price. During 34 years in our study periods, cotton yields have fluctuated without showing any long-run upward trend. The highest yield was 574 kg per hectare in 1986, followed by 494 kg in 1997, after which yields have primarily decreased while cotton prices in real terms have fallen. In Burkina Faso, genetically modified (GM) cotton has already illustrated how introducing modern technology can increase yields by reducing insect damage. Further productivity gains can be achieved by introducing "stacked" GM varieties that are herbicide tolerant. Granting cotton producers higher farm-gate prices will enable producers to invest in new technology such as Bt cotton. With improved pest management, producers would likely make greater investments in fertilizers and other crop amendments, including herbicides, insecticides, and lime.

Another technological advancement that would be beneficial to the West African cotton sector is mechanization, which would significantly increase labor productivity. At the aggregate level, West African cotton sectors made successful investments in the 1970's and 1980's when animal traction, along with improved varieties, were introduced and quickly diffused. This enabled farmers to expand acreage and improve land and labor efficiency that fostered a successful cotton-cereal rotation that improved food security. Those gains have plateaued and a new labor paradigm has emerged. Rural labor is continually being pulled into urban areas. Today's millennial generation, with greater access to urban areas, is less likely to stay on-farm earning agricultural wages of US\$2 per day, especially when confronted by labor-intensive activities like cotton picking and hand weeding. Greater use of mechanical power, even based on small 25 HP tractors, is expected to be an alternative that will be increasingly used on Burkinabe cotton farms. Mechanization could also be combined with complementary investments in irrigation infrastructure that would further improve cotton productivity and continue to close the yield gap with more developed countries. The southwest production zone of Burkina Faso in particular contains possibilities for improved

water management and irrigation.

Technological advancement of the industry would also benefit from significant investments in human capital and research institutions. These investments would strengthen the sector's productive capacity and meet the challenges it faces over the coming decades by fostering technological breakthroughs to cut production costs and improve labor productivity. To achieve these goals, a well-educated and trained corps of agricultural scientists to prescribe agronomic and entomologic treatments is needed. In this context, particular emphasis should be placed on Burkina scientists attaining advanced degrees needed to develop GM crops, which will require developing and monitoring phytosanitary and biosafety protocols and other legal statutes.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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