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Welfare effect of eliminating commodity price volatility: Evidence from Tanzania coffee farmers

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This paper investigated the welfare consequences of reducing coffee price volatility in Tanzania. GARCH (1,1) model is fitted with monthly coffee prices from 1998 to 2017 to estimate the conditional and unconditional variance of the residual. The coefficient of relative risk aversion and unconditional variance of GARCH (1,1) model are applied in a typical Lucas-like representative argent model to examine the welfare consequences of eliminating price volatility using the case of coffee farmers in Tanzania. The empirical finding shows that the welfare gain from eliminating price volatility for coffee farmers in Tanzania is small. Taking into account the effects of reforms in coffee industry and economic crisis, the welfare gain remains at 1.139% of revenue from coffee sales per year. Given that coffee market is under oligopoly stage still there is some degree of monopoly in terms of regulations thereby rising a need of "check and balance" to ensure that bureaucratic challenges are addressed. Nonetheless inclusive hedging strategies, improving production and quality of coffee, provide the next step in improving the welfare of the coffee producers where reducing coffee price volatility at a cost might not be a desirable choice.

Key words: Tanzania, coffee price volatility, welfare consequences, and inclusive hedging mechanisms.

INTRODUCTION

Coffee is an important export cash crop in Tanzania. According to coffee board (2011) annual report, coffee accounted for almost 14% of total agricultural exports and 5% of total export value in Tanzania. The estimates of export earnings from coffee have been around USD100 million per annum over the last 30 years. The coffee sector provides direct income to more than 400,000 farmers/households thereby supporting the livelihoods of an estimated 2.5 million individuals. Coffee price volatility not only impinges the welfare of the household involved in coffee farming but also exert uncertainty on environmental degradation especially cutting trees as commodity prices volatility has been higher in 2000s relative to the preceding decades, raising concern among policymakers and various international organizations (FAO et al., 2011). The volatility of coffee prices, like other commodities, is explained by the global market practices (Temu, 1999; Baffes, 2003; Arezki and Bruckner, 2011). The study by Morgan et al. (1999) and FAO (2004) found out that supply surge, macroeconomic

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condition, non-compliance with International Commodity Agreements (ICAs), agricultural subsidies and other supportive policies in developed countries, relatively inelastic demand and poor quality branding among farmers are the key factors explaining commodity price volatility.

Since the great depression in the 1930s, nations all over the universe have implemented a number of policy instruments aimed at stabilizing prices. Newbery and Stiglitz (1981), Reihart and Wickham (1994), Yang et al. (2001), Demeke et al. (2008) and UNCTAD (2011) have summarized the policy tools used by United Nations Agencies, and various government aiming at mitigating the impact of volatile commodity prices. Such interventions[1] include: the establishment of quotas and buffer stock arrangements, reformed pricing within commodity arrangements, outright cartels, stabilization funds, agricultural boards, International Commodity Arrangements, External Compensatory Finance by the IMF and the STABEX by the EU, production restriction measures and the liberalization policies. Other policy instruments are income support programmes, market-based mechanisms (financial instruments), and revenue management, diversification and value addition (Appendices I and II). However, as shown in (Appendix II) these interventions had limited success.

Over time, developing countries including Tanzania have attempted to intervene in the market by separating domestic commodity prices from international price via the Tanzania Coffee Board (TCB), Cooperative Unions, and different reforms in the coffee industry that guaranteed farmers a minimum price for their production (Bryla, 2004). In the case of coffee industry, three laws were enacted namely: the Coffee industry Act (CIA) of 1977, The Coffee Marketing Board Act (CMBA) of 1984 and The Coffee Industry Act (CIA) of 2001 (Appendix III).In addition, from 2001, the World Bank in collaboration with other partners started providing technical assistance and capacity building to allow farmers to access markets in Tanzania. These initiatives were directed at the cooperative unions. Initially, Kilimanjaro Native Cooperative Union (KNCU) attempted to use options in designing a hedging strategy that matched its risk profile. The core objective of these strategies were: to ensure the cooperative maintain and observe an agreed floor price to farmers during trade seasons, and to reduce the cooperative's financial exposure to price volatility and reducing values of stocks of coffee held for curing.

However, this strategy allowed a smoothing-out of price spikes within a marketing year. With the low knowledge on how to use derivative markets, producers have used traditional means such as self-insuring through asset accumulation, savings and access to credits, income diversification and informal insurance arrangements as strategies to mitigate risks emanating from commodity price volatility although each mechanisms have had a number of limitations (Bryla, 2004). As pointed out by Baffes (2003) the coffee board in Tanzania during the liberalization period in early1990s, was no longer guaranteeing farmer's prices, rather than acting as the regulatory authority.

Decision-making in the Tanzanian coffee sector should take into account the knowledge about price behaviour and device appropriate mechanisms to distribute resources in dealing with the impact of price volatility on the welfare of the coffee producers. For instance, how do poor household coffee producers cope with global and domestic risks emanating from price volatility that can jeopardize farm profits and exert uncertainty on income and generally on productivity?

Figure 1 shows the evolution of prices paid to coffee growers and returns of coffee prices. It is clear that coffee prices have not been stable at all. The price series on the right panel are evidently leptokurtic and they are relatively large numbers of observations that are far from average. Coffee prices grew at 55 percent in the year 2011 though in 2017 recorded a negative growth rate of 4.4%. This raises the debate on the welfare impact of volatility emanating from commodity prices. We address this question in the context of coffee farming households in Tanzania.

To take this question into perspective in the notion of expected utility theory we employ the coefficient of relative risk aversion and unconditional variance[2] of GARCH (1,1) model in a typical Lucas-like representative argent model to examine the welfare consequences of eliminating price volatility for the case of coffee farmers in Tanzania. The gist of this approach is that if the resulting coefficient is low, then the costs of interventions to diversify risks or to stabilize prices may outweigh the benefits of these efforts and vice versa is true if the coefficient is high. Evidently, our estimations show that the welfare gains of reducing coffee price volatility for the producers are small.

Price risk faced by coffee producers

Studies on the impact of commodity price volatility on growth, public finance and welfare in commodity-dependent economies are huge in literature (Reihart and Wickham, 1994; Swaray, 2000, 2005; WB, 2005). In absence of clear hedging mechanisms, producers remained uncertain about the dynamics of prices. The usual conclusion drawn from these studies is that uncertainty arising from commodity price volatility has a

[1] Government interventions refer to any measure related to coffee price risk, market stability, coffee quality and marketing implemented by key organs in the Tanzanian coffee marketing system. These organs include the government, TCB, cooperatives and producer associations. Basically domestic intervention are informs of liberalization policy, regulations, risk management measures, quality improvement, political influences, taxation structures and infrastructure.

[2] As price-takers in global commodity markets, smallholder farm households are often vulnerable to the unpredictable events (Blouin and Macchiavello, 2013)

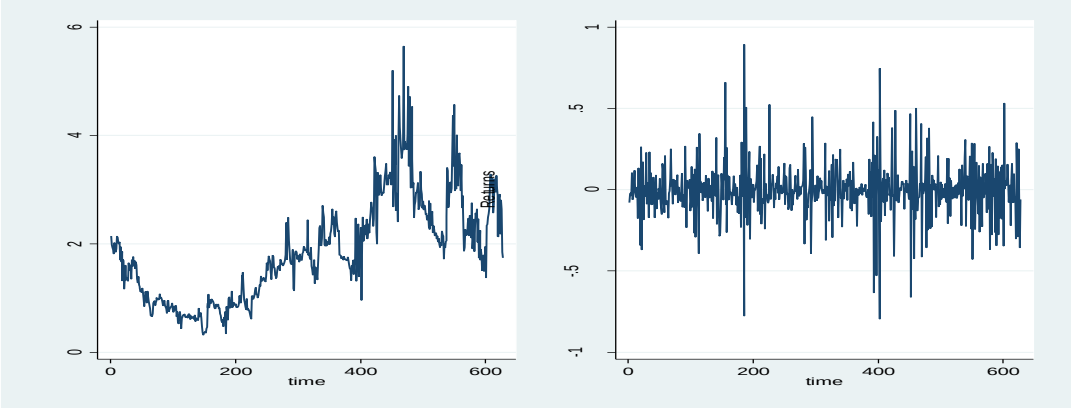

Figure 1. Coffee prices (USD/kg) and returns (%).

detrimental impact at the farm and macroeconomic level. At the farm level, it hampers farmers from the effective allocation of resources, accesses to credit, utilizing advanced production technology; leading to lowering their income.

At the macro level, commodity price volatilities tend to affect government's fiscal revenue, trade balance, exchange rates and creditworthiness. Larson et al. (1998), Chaudhuri (2001) and Rutasitara et al. (2010), argue that the price effect had been the most significant determinant of export earning volatility in most commodity-dependent economies. This implies that commodity price volatility has an impact on economic variables such as GDP growth, development, poverty reduction and debt servicing[3]. In addition, commodity-dependent economies are exposed to a 'specific risk to trade exposure' generated by the volatile world's commodity prices. This is the aggregate risk that affects all the agents in the domestic economy in a perfect correlated way although with different magnitude.

Monitoring African Food and Agricultural Policies (MAFAP) (2011) has cautioned coffee exporters against depressing the welfare of the coffee producers by paying low auction price at the beginning of the year and receive a high premium at the point of exports at the end of the year. For instance, in 2010 prices had escalated by nearly 60 percent by the end of the year benefiting the traders while farmers received a lower price based on low quotation made at the beginning of the year. This entails that prices were far lower than what farmers could have potentially received if they had sold their coffee at the end of the year.

Magnitude of export and import commodity price volatility in Tanzania

Tanzanian export basket involves both traditional and non-traditional crops. It imports a significant share of both intermediate, consumable goods and foodstuffs. The prices of these commodities are historically volatile. For instance, it can be observed that from 1990 to 2014, coffee (Arabica) is more volatile with the standard deviation of 0.47 compared to robusta, which recorded a standard deviation of 0.34 per annum, while the price of tea is more volatile (0.39) than the price of cotton (0.25) and robusta coffee per annum. The price of gold is the least volatile (0.05). The price of oil is the most volatile commodity among all with a standard diversion of 0.62 implying that it can divert from the mean by almost 62% per barrel in USD dollars per annum. Figure 1 in Appendix IV show the monthly volatility of traditional and non-traditional exports, and the volatility of oil imports. Specifically, the price of oil can deviate from the mean by almost 3% per month. Other exported commodities such as tea and cotton have an average volatility of 1% per month although in the year 1998 and 2008/2009 the volatility increased to 2.8 and 3.5 respectively. It appears they were adversely affected by the economic crises of 1998 and 2008/2009. It can be observed from Figure 2 (Appendix V) that Tanzanian export earnings volatility (EEV) is highly irregular. From the year 2000 to 2007 export earnings deviated from the mean by 3 percent per month with lowest records being 2.8 percent. EEV was more volatile in the year 2008/2009 as a result of the economic crisis with the highest point deviation from the mean of about 3.3%. The volatility of export earnings averaged between 3.1% from 2009 to 2010 before reaching 2.9% in the boom that followed thereafter. However, much of the volatility of export earnings was attributed to the volatility of traditional exports as compared to non-traditional exports. The right panel in figure 2 shows that non-traditional export earnings are less volatile that is, about 5 and 2 times compared with traditional export earnings on higher and lower point respectively. On the left panel, we observe that imports are more volatile than export earnings. It is almost 3 times more volatile compared to export earning indicating

[3] Swaray (2005) find that, price volatility has imposed difficulties in commodity dependent economies to service their debt obligation.

more burdens to the balance of payment.

LITERATURE REVIEW

Theoretical literature review

There is a set of literature that relates commodity price volatility and welfare. The common approach used is the compensation of variation especially for food products using household data. Turnovsky et al. (1980) argue that in the scenario of a single commodity price stabilization, the consumer preferences for price volatility depend upon the basic parameters: income elasticity of demand for the commodity, the price elasticity of demand, the share of the budget spent on the commodity and the coefficient of relative risk aversion. All of these parameters enter in an intuitive way and the analysis includes the conventional consumer's approach. However, the basic assumption of the utility maximization and revealed preference theories is that the consumer knows with certainty the prices of all goods and services as well as feasible consumption bundles. In the real world, these assumptions may not reflect the reality. Jehle and Reny (2001) argue that many economic decisions have an uncertainty component and conclude that in a real situation, the operation of economic agents cannot always operate under such lucrative conditions. This is in line Von Neumann (1953) and Morgestern (1944) who state that the ultimate result of a decision taken by the consumer may not be known until it occurs despite the consumer's knowledge of the possible probabilities of the different possible outcome.

Lack of appropriate/deep insurance markets entails an adverse welfare consequence not only to organisation for economic co-operation and development (OECD) countries but also in developing countries. The situation is perverse in developing countries where insurance markets are underdeveloped and frequently missing (Shiller, 2009). The study by Aizenman and Pinto (2005) and Loayza et al. (2007) corroborates with that of Shiller (2009) in the sense that good times tend not to offset the negative impact of bad times, which leads to permanent negative effects in developing countries. Incomplete markets, sovereign risk, conflict-ridden politics, inefficient taxation, procyclical fiscal policy, and weak financial market institutions signify the reason for such asymmetry.

Empirical literature

Other studies inform that commodity prices are inherently volatile creating instability not only in the global commodity markets but also in price stabilization schemes in local governments (Heifner and Kinoshita, 1994; World Bank, 2000). A strand of empirical literature in favor of this claim relies upon the conversional standard deviation of price or the coefficient of variation as a measure of volatility (Serven, 1996; Acemoglu et al., 2003; Mobarak, 2005; Malik and Temple, 2009; Di Giovanni and Levchenko, 2010).

There exists a rich body of literature that has investigated the determinants of price volatility. Classic macroeconomic reasons such as exchange and interest rate fluctuation, yield and stock levels, climate change, and fuel price variations have been generally cited as the main contributing factors of changes in commodity price volatility (Pindyck and Rotemberg, 1990; Roache, 2010; Apergis and Rezitis, 2011; Karali and Power, 2013). Other studies such as Hnatkovska and Loayza (2005) and Ranciere et al. (2008) identify other source of macroeconomic volatility to be external factors (exports, global prices, terms of trade or international interest rates) and internal factors (such as economic policy, agricultural production, and natural or climatic disasters). Similarly, these studies conclude that it is possible to distinguish between exogenous sources of macroeconomic volatility (related to international trade, agricultural production and natural disasters) and endogenous sources (linked to volatility in economic policy or domestic socio-political conditions).

The literature on the effects of commodity prices on growth is wide. Ramey and Ramey (1995) show that the unpredictability of economic policy caused by volatility[4] in growth rates has a negative effect on the average growth rate of the economy. According to estimates produced by Hnatkovska and Loayza (2005), based on a sample of 79 countries show that increasing the average value of volatility by the value of its standard deviation results in an average loss of 1.3 points for growth in GDP over the period 1960 to 2000, and 2.2 points for the decade 1990 to 2000. Volatility can, indeed, act as an obstacle to economic and social development

Other studies such as Dehn (2000) estimate the impact of shocks in the price of raw materials on investment in developing countries. Similarly, Combes and Guillaumont (2002) show that vulnerability to volatility in global prices has a negative effect on the quality of economic policy and growth. Under imperfect financial markets, the government and individual households are unable to protect themselves fully against risks, which affects their revenue hence adjusts their consumption to the volatile economic activity (Aizenman and Marion, 1999; Wolf, 2005). The study by Aguiar and Gopinath (2007) and Loayza et al. (2007) confirms that volatility is driven by external factors, especially in relation to terms of trade, generates internal volatility in relation to consumption, particularly in developing countries.

In recent years, literature has increasingly focused on the impact of commodity price volatility on public finance

[4] Volatility is associated with risk in that it provides a measure of the possible variation or movement in a particular economic variable (Aizenman and Pinto, 2005)). In quotation of Wolf, (2005), two key connotations of volatility are: Variability (all movements) and uncertainty (unknown movement). Conceptually, volatility at a given time can be decomposed into a predictable and an unpredictable component.

in developing countries. Such studies estimates the impact of commodity prices in public finance mainly based on time series and cross-sectional studies (Kumah and Matovu, 2007; Collier and Gunning, 1999; Medina, 2010; Kaminskky, 2010; Villafuerte et al., 2010; Spatafora and Samake, 2012). The overall conclusion from these studies is that commodity price volatility has detrimental effects on government finance hence making fiscal policy uncertainty.

Other empirical literature focuses on the welfare effect emanating from price changes and volatility. For instance in estimating the welfare impacts of rising food prices in India using compensation of variation approach, Weber (2015) finds a 10% price increase on average causes of welfare loss to 5 to 6% of monthly income in rural areas and 3 to 4% welfare loss in urban areas. The same study concludes that poverty is felt below the poverty line by 4.69 and 2.19%of households in rural and urban regions respectively. The finding by Loayza et al. (2007) show that volatility has a direct welfare cost for risk-averse individuals, as well as an indirect one through its adverse effect on income growth and development.

Analysing the relationship between volatility risk and economic welfare in an analytically tractable growth model in U.S.A. Xu (2017) concludes that in contrast to level risk, which is always welfare reducing for a risk-averse household, volatility risk can increase or decrease welfare depending on model parameters, such as the magnitude of risk aversion. Furthermore, the study shows that the welfare impact of volatility risk is largely negligible. The calibrated model estimates that the welfare cost of volatility risk is equivalent to a 0.0062% decrease in annual consumption. Using general equilibrium set up, Van Campenhout et al. (2013) finds that price movements have real welfare implications in the short run. Changing prices affected welfare predominantly in a negative way, with welfare losses up to 36 percent of initial welfare for people below the poverty line.

Rapsomanikis and Sarris (2006) estimate the impact of international and domestic commodity price volatility on agricultural income instability in Ghana, Peru, and Vietnam using microeconomic approach. They compute household's income variances and coefficients of variation, which allow to indicate the level of income variability and to capture whether it depends on the world or domestic price shocks. The study finds that the influence of international prices on income is small and the main source of income instability is domestic prices.

Using household data, Balié et al. (2016) estimate the effect of cereal price shocks and volatility on farmer's welfare in Sub-Saharan Africa. The study confirm that farmers are likely to benefit more from policy interventions inhibiting cereal price increase which is potential to farmer's welfare gain compared to extremely expensive price stabilization policies. However, targeting the poorest portion of the population is important in order to protect farmers' from substantial welfare loss imposed by price volatility.

Utilizing household survey data in Vietnam, Magrini and Montalbano (2012) investigate the welfare impact of people's exposure to risk induced by opening up trade. The study finds a negative welfare effect of "ex-ante" changing behavior induced by risk exposure. Furthermore this study confirms that households that are involved in main "export farm" are more vulnerable than "non-traded non-farms". The conclusion derived from this study is that "economic stabilization policies" should receive more attention even in absence of downside shocks.

Karanja et al. (2003) analyses the effects of market reforms on the evolution and volatility of producer prices in Kenya using monthly producer prices of four commodities including coffee and found that real producer prices for coffee, tea, and maize significantly declined during the reform period. Although producer prices seem to exhibit higher volatilities in general, these volatilities are higher during the reforms period. The argument is that there is limited private sector participation in agricultural markets while international trends in agricultural commodity prices seem to play a major role in influencing high volatilities.

A similar argument relating to market participation is also in line with Ponte (2002) when giving an account of the coffee market in East Africa. Inspired by the major changes in global agricultural markets, it is viewed that liberalization in African countries has led to the substantial involvement of Multinational Corporations (MNCs) in domestic trade and processing hence the consequence has been to hinder independent local traders from accessing the markets. This, eventually, leads to non-competitive behavior among few large-scale actors.

The impact of domestic reforms on agricultural prices is also evident in studies on developed countries. Yang et al. (2001) uses GARCH models to examine the impact of USA agricultural liberalization policy on agricultural commodity prices. The results show that liberalization reforms have an impact on price volatilities on many commodities. However, the impact differs across commodities: that is, whereas liberalization seems to increase price volatility of some commodities, volatility decrease is reported for other commodities. An earlier work by Crain and Lee (1996) on USA farm programmes also confirms that agricultural reforms have the impact on price volatility.

Mofya-Mukuka and Abdulai (2013) confirmed a reduction in the share of Tanzania prices in the world price. The implication is that the reforms in the coffee industry led to more government intervention, which resulted in a negative impact on producer prices. For instance, increasing the government's role in trade, pricing and exports of coffee, and thus resulting in reduced transmission of world-domestic prices. This

could have negative implications on the farmer's welfare because where producer prices do not respond to changes in world prices, the producers are not able to benefit from world price increases.

While the pre-reform policies ensured some price stabilization in the sense that declines in world market prices were not fully and quickly passed on to producers, they also resulted in some delays in passing on price increases to producers. Many studies have documented the concerns about the rate and symmetry of price response that are normally raised if a sector in the marketing channel is highly concentrated and dominated by few firms or marketing agents (White and Leavy, 2001; Abdulai, 2002).

Utilizing Deaton's approach in the application of the coefficient of variation, Leyaro (2009) estimated the effect of commodity price change on consumer welfare in Tanzania using Household Budget Survey (HBS) Data. Accounting for both static and dynamic (second order) effect of commodity price changes, the study confirms that in real term price rises have detriment impact of consumer welfare, especially on poor consumers in the rural compared to non-pour in urban though the scope of the paper was limited to price changes for foodstuffs.

Gemech and Struthers (2014) uses Lucas model to estimate the welfare gain for Ethiopian coffee producers from eliminating coffee price volatility. The study finds that the welfare gains for coffee producers to be very small and cast drought on the efforts to stabilize prices. Mohan et al. (2016) using the same Lucas model came up with contrary results that welfare gains were a bit high and was about 4.8 percent per year for the coffee sales in India.

Reviewed literature has focused on the causes and impact of commodity price change and volatility on growth, public finance and welfare using both macro and micro data. There is a limited case for estimating the welfare gains of eliminating volatility arising from commodity prices. Given this fact has not been investigated in a specific country like Tanzania, this study attempts to bridge this knowledge gap.

METHODOLOGY

Measuring price volatility

GARCH (1,1) model

There are a good number of Autoregressive Conditional heteroskedasticity models (ARCH), first pioneered by Engle (1982) being used in the literature to estimate risk. The extension of ARCH model into the generalized autoregressive conditional heteroskedasticity (GARCH) model is referenced to Bollerslev (1986). These models, common in most financial instruments are increasingly used to capture fluctuations in variance over time compared to the traditional model of the coefficient of variation.

GARCH models have become superior, replacing the common measures of volatility like coefficient of variation and standard deviation, which have the constant range and tend to overstate variability in non-trending series (Engle, 2001). GARCH models are superior to other standard time-series models in the sense that, the conditional variance of a real stochastic process is non-stationary and it varies over time due to the heteroskedastic nature of time series (Bollersleve, 1986).

According to the study of Tomek and Peterson (2001), GARCH model whittles away part of kurtosis in commodity prices. However GARCH (1,1) model can distinguish between the conditional and unconditional innovations potentially for modeling risk (Gemech and Struthers, 2014). The word conditional implies explicit dependence on a past sequence of observations while the word unconditional applies more to long-term behavior of a time series and assumes no explicit knowledge of past information and is termed as a good proxy for risks (Mohan et al., 2016). The practical application of these models is notable with GARCH (1,1) being the most preferable (Engle, 1982; Engle and Victor, 1993; Goodwin and Schnepf, 2000; Rahman et al. 2002; Wang, 2003; Swaray, 2007; Mohan et al., 2016).

More specifically, GARCH (1,1) models have been suitably used in investigating the impact of reforms in agricultural prices. For instance, Yang et al. (2001) employ GARCH model to investigate the effect of liberalization on agricultural price volatility in the United States of America (USA) whereas Engle (2001) proposed the use of Maximum Likelihood (ML) to estimate GARCH models in an environment of a single price variable.

To find coffee price volatility in Tanzania, the GARCH model pioneered by Bollersleve (1986) as an extension of Engle (1982) ARCH model is adopted. The proxy for price risk then becomes the unconditional variance of GARCH (1,1) model. The classic specification of the GARCH methodology is described in the following of equations.

$$\Delta P_t = h + \sum_{t-1}^{n} d_i \Delta P_{t-1} + e_t \quad (1)$$

$$e_t | \Omega_{t-1} \approx N(0, h_t) \quad (2)$$

where

ΔP_t is the first difference of the natural logarithms of coffee price series at time t, and d_i is the respective coefficient for price differences. The white noise term is denoted by e_t, which under the conversional GARCH model, it is rationally assumed to be normally distributed with zero mean and constant variance h_t therefore Ω_{t-1} represents all available information at time $t-1$.

$$h_t = \gamma_0 + \sum_{i=1}^{m} \alpha_i e_{t-i}^2 + \sum_{i=1}^{q} \beta_i h_{t-1} \quad (3)$$

$$h = E(e_t^2) \frac{\gamma_i}{1 - \sum_{i=1}^{m} \alpha_i - \sum_{i=1}^{q} \beta_i} \quad (4)$$

The coefficients in equation (3) and (4) should fulfill the following conditions: $\gamma_i > 0$, $\alpha_i \geq 0$, $i = 1,2\ldots m$, $\beta_i \geq 0, j = 1,2,\ldots q$ and $m, \beta_i \geq 0, j = 1,2,\ldots,q$. The process will be stationary if $\alpha + \beta < 1$ and $\alpha + \beta < 1$ is satisfied. Thus, the conditional

variance will converge towards the unconditional variance of the innovations as expressed in equation (4). To capture all the relevant information contained in $p_t = f(W_{t-1}, X)$ equation (3) can be rewritten as:

$$h_t = y + \sum_{i=1}^{m} a_i h_{t-1} + \sum_{j=1}^{q} b_j e_{t-j}^2 + q_i D \quad (5)$$

Price volatility is accounted for by the conditional variance (h_t), which is specified as a linear function of: past values of conditional variance, past squared errors and a market reforms dummy D. The coefficients a_i and b_i are the ARCH and GARCH parameters respectively.

However, a_i explains how fast the model reacts to news in the market while b_i states how persistent the conditional heteroskedasticity is over time. It is worth to note that if the coefficient b_i is large, effects from economic news in the market will have a tendency to remain. Lag lengths for the conditional variance and squared residuals are denoted by m and q respectively. Equation (5) is purposely designed to mimic the volatility-clustering phenomenon, i.e. large disturbances, positive or negative, become part of the information set used to construct the variance forecast of the next period's disturbances.

Variance of the residuals is decomposed into conditional (predictable) and unconditional (unpredictable) to measure price volatility more precisely (Ramey and Ramey, 1995; Moledina et al., 2003; Gemech and Struthers, 2014). Mohan et al. (2016) uses similar approach to investigate the effect of coffee price volatility on welfare in Ethiopia. The conditional variance has relatively less relevance for measuring risk, as it is predictable by economic agents using past information. On the other hand unconditional variance is unpredictable and therefore is a better measure of the price risk faced by farmers. We then utilizes the unconditional variance as measuring risk to quantify the welfare gains obtained from eliminating price volatility of coffee in Tanzania.

Empirical estimates of the risk aversion parameter

The empirical estimate of the risk aversion parameter (g) is well documented in the literature. The guiding theories on these estimates are the expected utility theory and pricing theory. These theories are knowingly in explaining risky behaviours (Harrison and Rutstrom, 2009; Harrison et al., 2010). An empirical study by Cardenas and carpenter (2005) estimates the value of γ in developed and developing countries and do not support the view that degree of risk aversion is much higher in developing countries than in developed countries. This finding contradict somewhat intuitive perception that poor people in less developed countries are necessarily risk averse than people in developed countries across all income and stakes (that is, gambles and bets). Table 1 provides the summary findings of the value of g.

Empirical model

The coefficient of the CRRA and the expected utility theory are used with the combination of the unconditional variance to estimate the welfare gain for coffee producers from eliminating price volatility. The coefficient of CRRA and the expected utility theory are important aspects because it gives parameters to be used in the Lucas welfare function. The CRRA has been used in developing countries to measure risk (Cardenas and Carpenter, 2005; Schechter, 2007; Harrison and Rutstrom, 2009; Harrison et al., 2010). This measure theorizes that the functional form of the utility functions underlying the attitudes to risk for such people satisfies the condition $dR_u/dq = 0$ resulting into a Luca's CRRA of 1987 as specified in equation 6:

$$U(q) = q^{1-g}/1- g \quad (6)$$

Where

$$g \in (0,1) \text{ and } g = R_u(q)$$

The question is that what are the welfare gains from stabilization would be for the coffee producers if all consumption variability were eliminated. To answer this question we follow the similar approach by Lucas (2003) which basically measures the welfare effect of eliminating overall consumption variability by considering a single consumer who is endowed with a stochastic consumption stream. Considering a single consumer with a stochastic consumption stream with risk aversion, Lucas derives the "*compensation parameter"* (The welfare gains from eliminating consumption risk). Aggregate demand (income) is composed of consumption and saving ($Y = C + S$) (Keynes, 1936). However, it is assumed that producers have negligible savings; therefore consumption is equal to income. The welfare gain f refers to the amount by which the farmer would have to be compensated to be indifferent between the risky and deterministic/certain income streams from coffee's receipt and is given by.

$$f \approx 1/2 g s^2 \quad (7)$$

This study follows the Lucas model specified in equation (7) to estimate the welfare effect of elimination coffee price volatility for the case of coffee farmers in Tanzania. However, the use of equation (7) requires knowledge of the value of risk aversion parameter (g) and the amount of risks (s^2). The value of (g) and (s^2) are summarized in Table 1 and 4 respectively. Moledina et al. (2003), Bellemare et al. (2013) and Mohan, et al. (2016) provide the basic insight in applying Luca (2003) approach in estimating the welfare effects of eliminating price volatility in rice, wheat, and coffee prices in India and Ethiopia respectively.

Data sources and type

The study uses auction coffee prices data from 1998 to 2017 to investigate the welfare effects of eliminating price volatility for coffee in Tanzania. Auction prices are recorded in terms of (Usd/kg). Daily price for coffee is used since is the immediate prices received by the farmers for a transaction carried out at the first point of sale. The first point of sale occurs at the nearest market to the producer's farmer (usually place of production) and therefore is assumed not to include transaction margins (transfer costs) such as transport costs. Tanzanian Coffee Board (TCB) reports coffee farmer's prices on a daily basis based on auction marketing strategies. The price data include three major Tanzanian coffee types by the origin of growing zones (Southern, Northern and western) each with district price paid to the farmers. The weighted average is converted from local currency to US cents at the contemporaneous exchange rate and

Table 1. Estimated value of the risk aversion parameter.

S/N	Authors	Approach	Country	Value of γ
1	Harrison et al. (2010)	Bets and Lotteries	Rural Households in Ethiopia, India and Uganda	0.536
2	Schechter (2007)	Bets and Lotteries	Rural Paraguayan	1.92
3	Cardenas and Carpenter,(2005)	Bets and gamble	DCs	Less than 1
4	Binswanger (1980), Nielsen (2001) and Barr (2003)	Bets and Lotteries	DC	Less than 1
5	Barr (2003)	Two stage experiment	Rural villages in Zimbabwe	0.65
6	Mohan et al. (2016) benchmark uses	Applied	Ethiopia	0.6 to 1
7	Moledina et al. (2003) benchmark uses	Applied	Thailand, Argentina USA	0.6 to 1

Source: Compiled from various authors.

Table 2. Descriptive statistics.

Statistics	Coffee	Log differences of coffee
Mean	1.843	-0.000
Variance	0.879	0.026
Standard deviation	0.938	0.163
Skewness	0.704	0.083
Kurtosis	3.279	8.060

Source: author's computation.

supplied to the International Coffee Organization by the TCB. The dummy variable is set equal to one from January 1993 to December 2007 when market liberalization was implemented and zero otherwise. If Dummy turns out to be positive and statistically significant, then reform policy would have had an impact in increasing price volatility and vice versa.

Estimation results for coffee in Tanzania

Descriptive statistics of data

The standard deviation is viewed as a measure of volatility. Log difference in Coffee prices appears to be volatile with the standard deviation of 0.16. Skewness is a positive and statistical difference between zeros, and indicates that there are more values above the zero mean than below. It is also evidenced that coffee prices portray fat tails (excess kurtosis) for the log differences of coffee prices since they all above the normal distribution. When is abnormally high, might be probably due to regulated markets in the country during most of the period under consideration (Table 2).

Estimation results GARCH (1,1)

To be more precise, we tested the ARCH effects and took into consideration all the diagnostic tests (autocorrelation, normality test) for robust results. These tests confirmed that the squared residuals are truly heteroskedastic, autocorrelated and with ARCH-effect. All the tests rejected the null hypothesis at 5 percent level. The coefficient of the ARCH specification was positive and significant warranting the next procedures of fitting GARCH (1,1) model of coffee price volatility.

However, to ensure unbiased results, stationarity tests are carried out using Augmented Dickey-Fuller Test (ADF) and Zivot and Andrews (1992). Zivot and Andrews (1992) unit root test is important as it takes into account structural break in the intercept and trend of the series. Moreover, it searches all over the possible single breakpoints. Since the objective of this study is to get the appropriate measure of risk by taking into account all the policy reforms, a search for a single structural break was appropriate. ADF and Zivot Andrews test confirms that coffee price series have unit root in level but stationary at first difference. Table 3 shows the results for ARCH (1) and GARCH (1,1) model. Table 3 show that the sum of the estimated coefficients satisfies the boundary constraints that is, $a_i + b_i < 1$. These coefficients are positive and statistically significant at 5% level implying that, volatility is persistence and it is measured by the sum ($a_i + b_i$).

This suggests that the current volatility (measured by the variance of the error term) depends on both the past period's news about volatility and the last period's volatility. The coefficient for dummy variable is positive though not significant, while that take into account the effect of economic crisis has a negative sign and insignificant. The immediate impression is that the effect of reforms and world economic crisis on producer auction price volatility is almost negligible.

To estimate the welfare gains of eliminating coffee price volatility using a Lucas (2003) model requires the calculation of the amount of risks herein referred as the "annualized unconditional variance"[5]. Then we regenerate unconditional Variance utilizing equation (4). Table 4 show the results for annualize variances. We then use the regenerated unconditional variance and the parameter of risk aversion to estimate the welfare gains of eliminating coffee price volatility in Tanzania. Table 5 provides the summary results.

DISCUSSION

The aim of this paper is to estimate the welfare gains of eliminating coffee price volatility. Owing to the notion of expected utility theory, we employ the coefficient of relative risk aversion and the unconditional variance of GARCH (1,1) model in a typical Lucas-like representative argent model of 2003 to examine the welfare consequences of eliminating price volatility for the case of coffee farmers in Tanzania. The gist of this approach is

[5] Annualized variance = $\sqrt{12}$

Table 3. Summary results for GARCH (1, 1) model of Coffee prices.

Parameter	No reforms and crisis	With reforms	With crisis
y	0.004*** (-0.00)	0.004*** (-0.000)	0.004*** (-0.000)
a	0.353*** (-0.050)	0.353*** (-0.050)	0.353*** (-0.050)
b	0.564** (-0.034)	0.564** (-0.034)	0.564*** (-0.034)

Standard errors in parentheses * p<0.05, ** p<0.01, *** p<0.001.

Table 4. Annualized variance.

Variable	Annualized variance		
	No reforms and crisis	With reforms	With crisis
Unconditional	0.038	0.038	0.038
Conditional	0.001	0.001	0.001
Total	0.039	0.039	0.039

Source: Author's computation.

Table 5. Estimates of welfare gains from eliminating coffee price volatility in Tanzania.

Risk aversion parameter	No reforms and crisis (%)	With reforms (%)	With crisis (%)
0.6	1.139	1.133	1.139
0.8	1.519	1.511	1.519
1	1.899	1.889	1.899
2	3.798	3.778	3.798

Welfare Gain $I \approx \frac{1}{2}\gamma\sigma^2$ where γ ranges from 0.6 to 2 and σ^2 is the variance.

Source: Author's computation.

that, if the resulting coefficient is low, then the costs of interventions to diversify risks or to stabilize prices may outweigh the benefits of these efforts.

Evidently, the study estimations show that the welfare gains of reducing coffee price volatility for the producers are small. Table 5 shows the magnitude of the potential gain from reducing coffee price volatility (risks) using conditional and unconditional variance. We make an inference based on unconditional variance (the unpredictable component of the residual), which is the accepted standard measure of risks. We then proceed using a benchmark value of risk γ=0.6 and annualized unconditional variance to estimate the welfare gains from eliminating coffee price volatility in the spirit of Gemech and Struthers (2014) and Mohan et al. (2016). As shown in Table 5, the welfare gains is 1.139% of the income derived from coffee sales per year which are small thereby raising a debate about the efficacy of price stabilization policies enacted by both international and state economies. A similar conclusion is made by Gemech and Struthers (2014) for the case of coffee producers in Ethiopia. Mohan et al. (2016) came up with contrary results that welfare gains were about 4.8% per year for the coffee producer in India.

These results raise debate about the efficiency, effectiveness and sustainability of the policy measures to stabilize prices. Wright and Williams (1988) support the claim that in reality commodity policies can achieve price stabilization by stabilizing quantities but not prices. Welfare assessment implies that governments should avoid price stabilization policies and focus resources on policies that promote increased productivity. As pointed out by Mohan et al. (2016) that intervention are normally associated with a high implementation, monitoring and other regulatory costs. Thus, any attempt to eliminate coffee price volatility at a cost might not be the desirable choice for coffee producers. The usual conclusion is that stabilization is not feasible and feasible stabilization policies are costly.

Conclusion

Decision-making in Tanzanian coffee sector cannot

isolate the knowledge of price behaviour and appropriate mechanisms to distribute resources in dealing with the impact of price volatility on the welfare of the coffee producers. This aspect not only requires appropriate hedging mechanism such as futures and options but also calls for strict strategies to revamp agriculture sector given its potential in the economy.

In an environment of the failure of the international commodity agreements and the high cost and mixed record of domestic stabilization policies, countries should rely on the market -based risk management instruments and safety nets. As the second-best policies for stabilization, market-based risk management instruments are supposed to provide farmers, traders, food agencies and even individuals with access to instruments that allow the sharing of price and weather risks and the smoothing of income variations. Simply, these instruments should help to complete markets. Also increasing production and income stream across the entire value chain requires among others re-planting the uprooted coffee trees and plant new coffee varieties, expansion of farm land, organization reforms, increase fertilizer usage, and control of coffee diseases and pests, ensure sustainable irrigation system as well as frequent monitoring of the coffee quality are imperative.

In addition, the strategic choice to produce and export high-quality coffee for a well-explored niche markets requires proactive government action to cooperate with other coffee stakeholders and co-operatives societies for the aim of increasing quality of coffee production, particularly in relation to coffee processing, financing and market access. Deliberate efforts to support private sector associations and enterprises in accessing technology, innovation in breeding species and appropriate financial packages will eventually ensure standard and quality coffee products. Promote tools such as value chain analysis, will helps entrepreneurs to see what problem and challenges need to be addressed within and beyond the borders as well as increasing market networks. Nonetheless, there must be appropriate mechanisms such as “check and balance” of any stabilizing funds to ensure bureaucratic challenges are addressed. Clearly, given that price volatility has intimate effects of the welfare of the farmers, a study to investigate the extent to which farmers are willing to pay as one of the strategies to stabilize prices at a mean remains the area for further research.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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Appendix I

Table 1. Trade based policies measures commonly adopted after the 2008/2009 economic crisis.

Countries surveyed	Africa	Asia	Latin America	Total
	33	26	22	81
Market interventions-trade policy				
Reduction of tariffs and customs fee in imports	18	13	12	43
Restrictive or banned export	8	13	4	25
Domestic market interventions				
Suspension/reduction of VAT or other taxes	14	5	4	23
Released stocks at subsidized prices	13	15	7	35
Administered prices	10	6	5	21
Production support				
Production support	12	11	12	35
Production safety nets	6	4	5	15
Fertilizer and seeds programs	4	2	5	9
Market interventions	4	9	2	15
Consumer safety nets				
Cash transfers	4	8	4	12

Source: Constructed from Demeke et al. (2008).

Appendix II

Table 2. Stabilization policies since 1970s.

A: Supply management schemes	Aim	Failures
A1: Integrated Programme for Commodities (IPC) (UCTAD)-(1976-1980)	Finance buffer stock-reduce price fluctuations	Some commodities such as tin, sugar, coffee and cotton were dropped (global recession (1980s) and depressed prices)
Reinhart and Wickham (1994)	Stabilize prices at levels remunerative to producers	Difficulties of influencing prices via output management
A2: Common Fund for Commodities (CFC)- Gilbert and Wickham (1994)	-	Un unanimous agreement on price changes that would equitable to producers
Cashin; McDermott and Scott (2002)	-	Lack of enforcement mechanisms and the problem of free-riding
Rangarajan (1983)	-	Insufficient resource
A3: Establishment of Market Boards	Stabilization of prices via stockpiles and buffer stock facilities	Dismantled in 1980s and 1990s under SAP
-	Providing ancillary extension services	Bureaucracy and rent-seeking
B: Oil Supply Management -OPEC	Stabilization of prices in international oil markets	Rent seeking and challenges in quotas enforcement
C: Income Support Programmes	-	-
C1: Compensatory Financing Facilities (CFF)	Designed to compensate shortfalls in income and short-term price shocks	Yet 2008/2009 crises occurred with secular price declines
C2: Contingency and Compensatory Finance Facility (IMF)-(1988)- UCTAD (2003)	To smooth the effects of a temporary, exogenously caused shortfalls in merchandise export receipts	-

Table 2. Stabilization Contd.

-	Deals with countries with willingness to cooperate with IMF to address the problem	-
-	Help country with BOP problems	-
C3: The European Union's Stabilization of Export earnings (STABEX) -STABEX (Lome 1 Conversion)-(1975-1979)	It was part of comprehensive international commodity policy	It was observed to be cumbersome, pro-cyclical or too expensive to use
C4: EU's System for Safeguarding and Developing Mineral Production (SYSMIN) and Swiss Compensatory Programmes	Address the shortfalls in export earnings due to fluctuations in world price	-
-	Address domestic supply of agricultural commodities for ACP countries.	-
C6: (htt: www.rma.usd.gov/.) Risk management Agency (USA)-(1996)	Administer federal crop insurance Corporation (FCIC)	Diseases, droughts and flood
-	Non-Insurance-related risk management that help support agriculture	-
-	Sales of crops via licensed private contractual brokers	-
-	Provide insurance facilities (subsidies)	-
D: Market -based Mechanism- financial instrument	Rely on hedging programmes to mitigate the exposure to price volatility	Hedging is limited to developing countries event though risk is very high
-	Forward contracts, futures options to complex combinations e.g. collars, over-the -counter and tools.	-
E: Revenue management	Sovereign Wealth Fund	-
F: Stabilization Fund	Reduce the fluctuations in budgetary revenue for CDDCs	-
G: Diversification	Horizontal diversification into agricultural products and processes that capture proportion of the value chain	Structural barriers in international trade (tariff and standard escalation)
-	Diversification into non-agricultural activities that exploit comparative advantages	Scarce resources to invest in the sector-cost related to infrastructure and storage
-	Horizontal diversification into alternative crops.	Lack of skills in producing and marketing alternative products

Sources: Compiled from Deegon (2011) United Nations on Trade and Development.

Appendix III.

Table 3. Major reforms in coffee industry in Tanzania

Year	Major events in coffee market
1994	The beginning of major reforms, but under inherited CMBA of 1984;Poorly performing cooperative unions with inability to pay producers for their coffee; new players entered the market; private traders allowed to trade domestically, all coffee was cured at cooperative or government owned processing plants; establishment of Tanzanian Coffee Association to solve disputes between cooperative and private traders
1995	Poor performance of the cooperative system led into the emergence of Vertically Integrated Exporters (VIEs). This affected the auction delivery by having two types of coffee delivery (captive and non-captive coffee). There was also indication of uncompetitive behaviours in the marketing systems.
1996	Establishment of National Input Voucher System (NIVS). The NIVS operates a special input fund whereby licensed parchment buyers issue a specified portion of farmers' coffee payments in the form of input vouchers. This aimed at improving the deteriorating quality of coffee
1997-2000	Remarkable deterioration of coffee quality. This seems to be related to the declining share of cooperatives in traded coffee
2001	Emergence of organized producer groups for coffee marketing purposes: The World bank and other partners initiate market-based approaches for price hedging strategies based on cooperative systems; Re-establishment of TCB, replacing TCMB
2000-2002	The coffee board revoked buying licenses of private traders in order to protect cooperatives that secured loans from the government. The aim was to ensure the loan repayment
2002	The CIA of 2001 was assented; Coffee 'repossession' at the auction was abolished (i.e. no captive coffee at the auction
2002	Cooperatives and producer groups start participating in Fair trade arrangements. This only account for a small portion of the coffee traded
2003	Export regulations amended to allow producers to export coffee directly without passing the auction market
2004-2005	-
2006-2010	The Government abolished deduction of levy from growers to run TCB. The Government will now run TCB 100%
2010-2015	Crop Laws Miscellaneous Amendment Act number 9 of 2009 established among others the following; Shared functions to be covered by the stakeholders (research, extension, production, promotion, etc), stakeholders meetings/forums and contract farming
2016 -date	2018 the Government banned the private buyers purchasing coffee directly from growers. All farmers be organized into AMCOS

Appendix IV

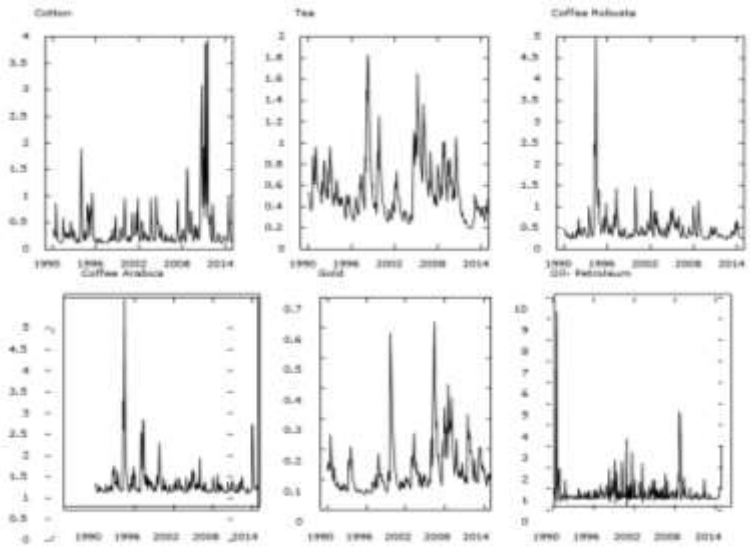

Figure 1. Monthly commodity price index volatility of cotton, coffee, gold, tee, and oil petroleum (%).
Source: Own computation from World Bank datasets (2014).

Appendix V

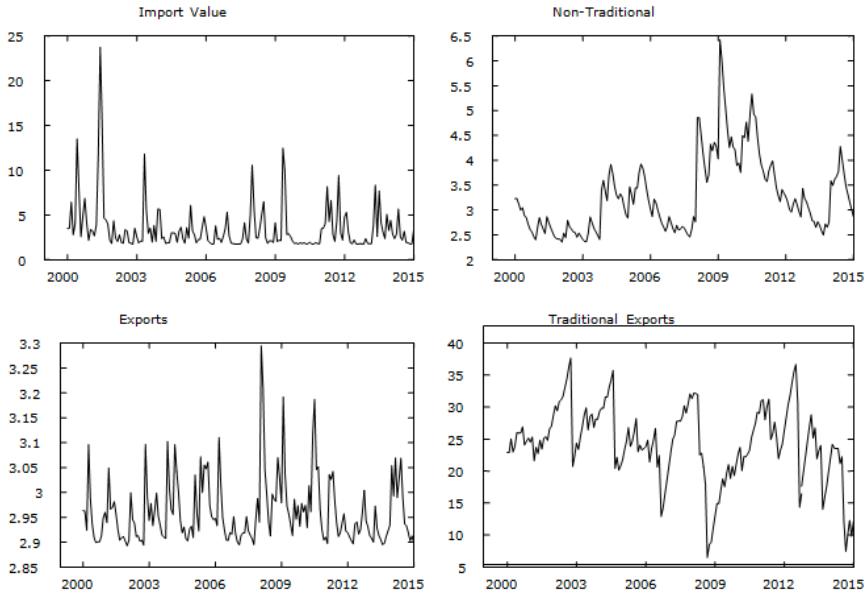

Figure 2. Monthly Export earnings volatility, traditional and no-traditional export volatility and import value volatility.
Source: Own computation from Bank of Tanzania datasets (2015).