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Trading-off Volatility and Distortions?

Food Policy During Price Spikes

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Abstract

This paper addresses to what extent governments have traded off price distortions for reduced volatility in intervening in agricultural and food markets during the recent food price spikes. We develop a model to derive how much distortions a government would introduce when it cares about stability in a situation with limited policy options. We show a trade-off and identify the optimal combination of distortions and stability for given international price shocks and interest groups preferences for stability. Empirical evidence shows that several countries have been able to reduce (short run) price volatility in the domestic markets while at the same time allowing structural (medium and long term) price changes to pass through to producers and consumers. However, this is not the general case. For many countries, even when explicitly taking into account the trade-off (and the benefits of reducing volatility) government policies appear far removed from the optimal trade-off and there appears to be much room for policy improvement.

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1. Introduction

A large literature has focused on what Kym Anderson (2009) refers to as “distortions to agricultural incentives”. A key element of these distortions is how government interventions cause prices to diverge from “market prices” or “equilibrium prices” and thus distort incentives for consumers and producers in their respective decisions, causing inefficiencies throughout the economy. The basic model behind the literature on price and market distortions is one with static supply and demand equations where consumption and production adjust in response to long term prices.

However in recent years, much of the discussion on global agricultural and food prices has focused on the, often short-run, volatility of these prices. It is argued that such short-run volatility of prices is causing inefficiencies in consumption and prices as it is difficult for consumers and producers to make optimal decisions in such volatile environments (Barrett et al., 2013). A typical example is the problem of farmers to plan their output if prices are volatile and uncertainty is large.

This is not only an issue for producers and consumers but also for governments. As is well known, all over the world, politicians and governments are regularly under pressure from agricultural producers and food consumers to intervene in agricultural and food markets. In the longer run, this has led to a series of “patterns” of policy distortions in agricultural and food markets (Kreuger et al., 1991; Anderson et al., 2013). In recent years, many governments have intervened in an attempt to reduce short run price fluctuations with global food price spikes (Barrett, 2014; Naylor, 2014; Pinstrup-Andersen 2014)[1]. These government interventions have often been ad hoc -

[1] Government interventions to counter market fluctuations are not unusual. To the contrary, they are a key ‘stylized fact’ of agricultural and food policies (Anderson et al., 2013) and there is much evidence to document this for other periods and regions (e.g. Gardner, 1989; Swinnen, 2009)

resembling what Swinnen (1996) called "*fire brigade policy-making*" when governments are confronted with shocks in the external environment.

Many economists and policy advisors have been critical of these attempts, criticizing governments for (a) being ineffective, (b) causing distortions in the economy, and (c) reinforcing price fluctuations, etc. (Anderson et al., 2013).

However, at the same time many economists and advisors point at the importance of reducing price volatility based on efficiency gains (FAO, 2011; FAO and OECD, 2011; Prakash, 2011; World Bank, 2012). In fact in environments with important market imperfection (e.g. in insurance and other factor markets) government interventions that reduce price instability could be efficiency enhancing. (After all that is why one uses various insurance-type instruments in private markets.) Yet, the basic economic model with static supply and demand equations and perfect markets is not very adequate to capture and measure distortions and inefficiencies in such conditions of market imperfections and volatility[2].

The question therefore can be raised to what extent governments have traded off price distortions for reduced volatility in intervening in agricultural and food markets. This question has both positive *("is this the case? If so, why ?")* and normative *("is this good or bad; and why ?")* aspects. In this paper we analyze how much distortions a welfare maximizing government would introduce when it cares about stability (i.e. if it wants to limit price volatility for domestic producers and consumers) in a situation with limited policy options, and we compare this with empirical evidence.

Key findings of our paper are (a) that several countries have been able to reduce (short run) price volatility in the domestic markets while at the same time allowing

[2] Of course, the more fundamental issue is one of the policy instrument choice and the (transaction) costs and capacity of governments to implement certain policy instruments.

structural (medium and long term) price changes to pass through to producers and consumers; (b) that there is a trade-off between volatility and distortions in situations with limited policy options for welfare maximizing governments; and (c) that even when explicitly taking into account this trade-off (and the benefits of reducing volatility) that many countries (governments) are far removed from the optimal distortion-volatility (DV) combination and that there is, thus, much room for policy improvement.

The paper is organized as follows. Section 2 presents two cases of important staple food markets where governments have significantly reduced (short run) price volatility in the domestic markets while at the same time allowing structural (medium and long term) price changes pass through. Section 3 develops a conceptual model of the trade-off between distortions and volatility for a welfare maximizing government. Section 4 links the theoretical framework to empirical indicators. Section 5 presents empirical indicators of the distortions-volatility (DV) trade-off for staple food markets and develops a single "efficiency" indicator. Section 6 presents the empirical results on distortions in staple food markets in developing and emerging countries. Section 7 concludes.

2. Trading of Volatility and Distortions: Two Examples

To start, we will illustrate the key issue with two cases of government interventions in important food markets over the past decade. The first example is that of rice markets and prices in China; the second example is that of wheat markets and prices in Pakistan.

Figure 1 illustrates the evolution of rice prices on global markets and in China. The graph illustrates two important observations. First, rice prices in China have been much less volatile than on global markets. The sharp global price fluctuations in 2008-2010 have not occurred in China. This was due to important policy interventions by the

Chinese government, including trade policy measures and the strategic use of rice stocks (Yang et al., 2008).

The second observation is that, despite stabilizing prices, the Chinese government allowed rice prices to increase over the 2006-2013, thus passing on (apparently) structural changes in global rice markets (and food markets more general) to Chinese consumers and producers. Rice prices in China were very close to international prices both at the start and at the end of the 2006-2013 period. In fact, prices were close to the international prices throughout 2006 and 2007 and again since 2011. Hence they diverged only during the years of largest volatility on international markets: 2008-2010.

Figure 2 illustrates wheat prices in Pakistan and on global markets. The story here is very similar. Domestic wheat markets have been much less volatile than wheat prices on international markets, due to extensive interventions of the Pakistan government in wheat markets and trade (Dorosh and Salam, 2008; Briones Alonso and Swinnen, 2014). Yet at the same time, the government has allowed structural price changes to be transmitted to its domestic producers and consumers. Also here the domestic prices in Pakistan were very close to international prices both at the beginning and at the end of the 2006-2013 period, and more precisely until mid-2007 and again since 2011. As with rice, in China, wheat prices in Pakistan diverged strongly from international prices only during the most volatile price period: from mid-2007 till end of 2010.

In summary, in their interventions in their most important staple food markets both the Chinese and Pakistani governments appear to have allowed (long run) structural changes in the global food markets to be transmitted to their producers and consumers – avoiding long run distortions – while stabilizing the markets in the presence of large (short run) global price volatility – thus (possibly) avoiding short run inefficiencies due to volatility and uncertainty.

An obvious question is whether these two cases are exceptional or that they represent a larger pattern of government interventions in staple food crops in emerging and developing countries. In this paper we will provide evidence from more countries using quantitative indicators of price distortions and volatility. However, before turning to the empirical indicators of price distortions and volatility, we first develop a conceptual framework to interpret the empirical observations.

3. Conceptual Framework: Social Optimum with Adjustment Costs

The model

Consider a small open economy with one good: "food". The domestic price of food in period t is p_t^D and the price on the world market is p_t^W. Define consumer utility as

$$v(p_t^D) - \frac{\delta}{2}(p_t^D - p_{t-1}^D)^2 + \gamma^C\,(p_t^D - p_t^W)(D(p_t^D) - S(p_t^D)) \qquad (1)$$

where the first term is the consumer's indirect utility of prices[3].

The second term represents the price adjustment cost which is zero if prices are stable and increasing and negative otherwise[4]. The costs are a convex function of the difference in prices in period t and the previous period t-1 (with $\delta \geq 0$). Our specification is similar to that of Nickell (1985) and Ivanic and Martin (2014) who assume that consumers face a quadratic cost of deviating from the previous price level. There are several mechanisms through which such adjustments may imply costs for consumers. One is through the need to update and adjust stocks and ingredients for

[3] For simplicity we assume that $v(\cdot)$ is a function of current prices.

[4] In the model we did not include uncertainties of future price changes and the impact of these price risks. How risk in the absence of insurance markets may lead to a solution where free trade is pareto inferior is shown by Newbery and Stiglitz (1984). This could be an alternative conceptual argument for price interventions.

processors and retailers. Menu costs can be an additional source of adjustment costs. Menu costs should be interpreted as the fixed cost related to the price adjustment process: a restaurant has to print new menus, a food processing company has to inform salesmen of the new prices, a company might pay a price for upsetting customers, etc. As shown by Mankiw (1985) these small menu costs can create price rigidities as the producer will not adjust its prices when the menu costs are higher than the additional profits.

The third term is the consumer's share in tax revenue or the share in subsidy expenditures with γ^C representing the share the consumers receive (with $0 \leq \gamma^C \leq 1$) and $(p_t^D - p_t^W)(D(p_t^D) - S(p_t^D))$ representing total budgetary costs or revenues. $D(\cdot)$ and $S(\cdot)$ represent domestic demand and supply and $D(\cdot) - S(\cdot)$ the net imports.

Producer utility is defined as

$$\pi(p_t^D) - \frac{\mu}{2}(p_t^D - p_{t-1}^D)^2 + \gamma^P \left(p_t^D - p_t^W\right)(D\left(p_t^D\right) - S\left(p_t^D\right)) \qquad (2)$$

where $\pi(p_t^D)$ are profits in period t[5]. The second term represents a quadratic cost for producers of deviating from its previous price level, specified similarly as for consumers (with $\mu \geq 0$), and the third term is the producer's share in tax revenue or subsidy expenditures (with $0 \leq \gamma^P \leq 1$). The sum of the shares is equal to one ($\gamma^C + \gamma^P = 1$) as we assume that the total tax revenues or budgetary costs are divided among consumers and producers. With these specifications, price volatility hurts both consumers and producers, but the effect may be different (as δ and μ differ).

The government can influence consumer and producer welfare by intervening in food markets. For simplicity we assume that the government can set the domestic price p_t^D (and that this is the only price that consumers face). We consider the

[5] For simplicity we assume that $\pi(\cdot)$ is a function of current prices.

governments optimal choice under different scenarios of government objectives: maximizing social welfare with and without price volatility.

At time t, the social welfare maximizing domestic price p_t^{D*} is determined by:

$$max_{p_t^D} \left[v(p_t^D) - \frac{\delta}{2}(p_t^D - p_{t-1}^D)^2 + \gamma^C (p_t^D - p_t^W)\left(D(p_t^D) - S(p_t^D)\right)\right] +$$

$$\left[\pi(p_t^D) - \frac{\mu}{2}(p_t^D - p_{t-1}^D)^2 + \gamma^P (p_t^D - p_t^W)(D(p_t^D) - S(p_t^D))\right] \qquad (3)$$

The first order condition is:

$$\begin{bmatrix} v'(p_t^{D*}) - \delta(p_t^{D*} - p_{t-1}^D) + \gamma^C \left(D(p_t^{D*}) - S(p_t^{D*})\right) + \\ \gamma^C (p_t^{D*} - p_t^W)\left(D'(p_t^{D*}) - S'(p_t^{D*})\right) \end{bmatrix} +$$

$$\begin{bmatrix} \pi'(p_t^{D*}) - \mu(p_t^{D*} - p_{t-1}^D) + \gamma^P \left(D(p_t^{D*}) - S(p_t^{D*})\right) \\ +\gamma^P (p_t^{D*} - p_t^W)(D'(p_t^{D*}) - S'(p_t^{D*})) \end{bmatrix} = 0 \qquad (4)$$

Using Roy's identity $v'(p_t^D) = -D(p_t^D)$ and Hotelling's lemma $\pi'(p_t^D) = S(p_t^D)$ the first order condition can be written as[6]:

$$(p_t^{D*} - p_t^W)(D'(p_t^{D*}) - S'(p_t^{D*})) = (\delta + \mu)[(p_t^{D*} - p_{t-1}^D)] \qquad (5)$$

Balancing volatility and distortions in social welfare

As a benchmark let us first consider the optimum without volatility concerns. The optimality condition for $p_t^{D\#}$, the price which maximizes (3) when there is no volatility – or when nobody cares about volatility (i.e. when $\delta = 0$, $\mu = 0$) is:

[6] Using the same specification as in Ivanic and Martin (2014) and Nickell (1985), the equivalent specification would be $(p_t^{D*} - p_t^W)(\beta^c + \beta^p) = -(\delta + \mu)(p_t^{D*} - p_{t-1}^D) - D(p_t^{D*}) + S(p_t^{D*})$. β^C and β^P represents how much consumers and producers care about distortions but unlike our specification they do not sum up to 1. The full derivation of the model with the specification as in Ivanic and Martin (2014) and Nickell (1985) can be requested from the authors.

$$\left(p_t^{D\#} - p_t^W\right)\left(D'\left(p_t^{D\#}\right) - S'\left(p_t^{D\#}\right)\right) = 0 \tag{6}$$

The difference between conditions (5) and (6) is the right hand side term of (5). Without volatility concerns the social welfare maximizing government will set the domestic price where it minimizes distortions, which are captured by the left hand side term of (5) and (6). This is at the world market price. Hence,

$$p_t^{D\#} = p_t^W \tag{7}$$

However with volatility concerns there is a trade-off for the government. Only in the case that $p_t^W = p_{t-1}^D$, i.e. when there is zero volatility, will the government choose $p_t^{D*} = p_t^W$, the non-distortive price. In all other cases, it will chose a different price. More specifically,

$$\text{if } p_t^W > p_{t-1}^D \Rightarrow p_t^W > p_t^{D*} > p_{t-1}^D \tag{8}$$

$$\text{if } p_t^W < p_{t-1}^D \Rightarrow p_t^W < p_t^{D*} < p_{t-1}^D \tag{9}$$

This can also be seen from rewriting condition (5) as follows:

$$p_t^{D*} = \theta\, p_{t-1}^D + (1-\theta)\, p_t^W \tag{10}$$

with $\theta = \frac{\delta+\mu}{\delta+\mu+S\prime-D\prime} > 0$ and $0 \leq \theta \leq 1$. Except in the extreme cases ($\theta = 0$ or 1), the social optimum will be to partially offset the price change. In other words, governments will raise domestic prices in response to global price rises, but because this increases distortions it only does so partially – and similarly for price declines.

This is illustrated in figure 3. Figure 3 shows the optimal price setting for 3 different levels of θ ($\theta = 0,\ \theta = \frac{1}{2}, \theta = 1$). In the extreme cases, the domestic price follows either the world market price (if $\theta = 0$) or the price is set by the government such that there is zero-volatility ($\theta = 1$), i.e. $p_t^{D*} = p_{t-1}^D$. In the case where $\theta = \frac{1}{2}$, the socially optimal domestic price follows the trend of the world market price but is less volatile than the world market price.

The extent of the adjustment will depend on the marginal increase in production and consumption distortions caused by deviations of the price from the world market price (captured by $S' - D'$, which reflect the elasticities of supply and demand) and the preferences for stability ($\delta + \mu$). Only when the preferences for stability are zero ($\theta = 0$) will there be full price adjustments. When the marginal impact on distortions is larger ($S' - D'$ larger and thus θ larger) adjustments will be smaller – and vice versa.

4. Linking the Theoretical Variables to Empirical Indicators

To relate these theoretical results to empirical indicators, we can express the equilibrium condition as a relationship between price distortions and volatility. Condition (5) can be written as

$$(p_t^{D*} - p_t^W) = \varepsilon\,(p_t^{D*} - p_{t-1}^D) \tag{11}$$

with $p_t^{D*} - p_t^W$ measuring distortions and $p_t^{D*} - p_{t-1}^D$ measuring volatility and $\varepsilon = \frac{\delta+\mu}{D'-S'}\left(= \frac{\theta}{\theta-1}\right) < 0$ measuring the ratio of the preferences for stability over the marginal distortionary effects. The absolute size of ε is increasing with preferences for stability of consumers and producers and decreasing with the distortionary effects of price deviations from the world market price. As we will explain in section 5 we can use data to develop empirical indicators of these variables.

Figure 4 illustrates the government's distortions-volatility (DV) trade-off for three different international price shocks (with $p_{A,t}^W < p_{B,t}^W < p_{C,t}^W$). Notice that figure 4 presents the nominal values of the distortions. The DV(A) line represents equation (11) for a negative price shock, represented by $p_{A,t}^W < p_{t-1}^D$. The DV(A) line represents the optimal combinations of $(p_t^{D*} - p_t^W, p_t^{D*} - p_{t-1}^D)$ for different values of θ (or ε). For $\theta = 1$ ($\varepsilon = -\infty$) the optimal combination is (0, $p_{t-1}^D - p_{A,t}^W$); for $\theta = 0$ ($\varepsilon = 0$), the optimal combination is ($p_{A,t}^W - \ p_{t-1}^D, 0$). The DV(B) and DV(C) lines represent similar trade-off lines but for different price shocks with $p_{t-1}^D < p_{B,t}^W < p_{C,t}^W$. For all the lines the optimal trade-off combination for $\theta = \frac{1}{2}$ ($\varepsilon = -1$) is where the DV lines cross the 45° line.

But as distortions should be measured in absolute values (negative and positive value distortions should be considered equally distortive), figure 5 present the optimal DV combinations of the absolute values of the domestic volatility and distortions for different values of $\theta(\varepsilon)$ for a given price shock. The choice of the government will be more towards the North-West with a higher θ (lower ε). With lower θ (higher ε), i.e. higher marginal distortions and less preference for stability, the choice will be more towards the South-East of the line.

5. Empirical Indicators of the DV Trade-off

We now present empirical indicators of this trade-off for various countries over the past decade. In section 2 we discussed how the Chinese and Pakistani government appeared to have chosen a combination of limited domestic volatility with distortions. We now present comparative evidence from more countries using the conceptual framework we developed in section 3.

Data on staple food prices

Our analysis uses monthly data for wheat, rice, and maize over the period from January 2007 to December 2013 with the price data obtained from the FAO GIEWS food price database[7]. For the selection of the international prices we follow Baltzer (2013) using the same prices of wheat (US Gulf, No. 2 Hard Red Winter, USD/Kg), maize (US Gulf, No. 2, Yellow, USD/Kg) and rice (Bangkok, Rice, Thai 100% B, USD/Kg). The domestic food prices are also based on Baltzer (2013) [8], but we extend his sample to include all the African and Asian countries for which data was available from 2007 to 2013[9].

Measuring volatility

There are different measures of volatility (for an extensive overview see Piot-Lepetit and M'Barek, 2011). These measures can be divided in two kinds of volatility measures (Huchet-Bourdon, 2011): those that measure the historical volatility and those that provide a measure for the implicit future volatility. In this paper, we focus on the measurement of historical volatility.

Within the historical price evaluation literature, several measurements have been proposed. First, volatility can be measured using the coefficient of variation and is defined as the ratio of the standard variation s over the mean μ for a given time period.

$$v = \frac{s}{\mu} \quad (12)$$

There are two disadvantages related to this measure: (1) the measured volatility returns a positive value when the prices remain constant over time (Huchet-Bourdon, 2011)

[7] http://www.fao.org/giews/pricetool/

[8] Baltzer (2013) included the following countries in his analysis: Brazil, India, Egypt and South Africa for wheat; Brazil, Ethiopia, Kenya, Zambia, Nigeria, Mozambique, Malawi and South Africa for maize; and Brazil, China, India, Vietnam, Bangladesh, and Senegal for rice. The wheat prices of Egypt, the maize prices of Malawi, rice prices of Vietnam were not included in our sample because of a lack of data over the period from January 2007 and December 2013.

[9] More details on the countries included and their domestic prices can be found in the Appendix.

and (2) the estimated variability and the standard variation s approaches infinity when the covered time period becomes longer (Minot, 2014).

An alternative measure is the standard variation of returns, where the return can be defined as (1) the percentage change in prices (FAO and OECD, 2011) or similarly (2) as the difference in the logarithm of prices (Gilbert and Morgan, 2010; Minot, 2014). Formally, the volatility measure can be expressed as:

$$v = sd(r) = \left[\sum \frac{1}{T-1}(r_t - \bar{r})^2\right]^{0.5} \qquad (13)$$

where $\bar{r} = \sum \frac{1}{T} r_t$ and r_t can be defined in two ways: either $r_t = \ln(P_t) - \ln(P_{t-1})$ or $r_t = \frac{P_t - P_{t-1}}{P_{t-1}}$.

In contrast to the coefficient of variation, the standard variation of return will be zero when prices follow a constant time trend, but it has the drawback that it does not take into account that most of the agricultural commodity price series exhibit some form of a trend. For example, when the price increase is constant over time the standard deviation of the return will report a positive value. To avoid that trend movements are included in the volatility measure, it is sometimes recommended to use a de-trended series to compute volatility. De-trending, however, requires (strong) assumptions about the nature of the underlying trend. Moreover, the choice of the de-trending technique determines the volatility measure[10].

Gilbert and Morgan (2010) argue that many economists avoid this issue by measuring volatility as the standard deviation of the difference in logarithmic prices. We follow this approach and measure price volatility as the standard deviation of the differences in logarithmic prices.

[10]For example, Cuddy and Della Valle (1978) developed the 'corrected' coefficient of variation which assumes a linear trend $v = CV\sqrt{1 - R^2}$ with CV the coefficient of variation and R^2 the coefficient of determination of the linear trend regression.

Measuring distortions

The price distortions caused by governments is the deviation between the domestic price and the world market price. The measure of distortion is calculated as the average of the absolute difference between the domestic and international price at each point in time.

$$d = \sum_{t=0}^{T} \frac{1}{T} |p_t^D - p_t^w| \quad (14)$$

The distortions-volatility frontier

To evaluate policy choices of the different countries in terms of their real outcomes in volatility and distortions, we will construct the empirical equivalent of the distortions-volatility (DV) trade-off frontier as developed in section 3 (see figure 5). The DV frontier represents the optimal trade-off for the government between different levels of volatility and the degree of distortion in the absence of lobby groups and for a given world market price. If a country's trade-off between volatility and distortions is an element of the frontier, the government's policy is "efficient" from this DV perspective. If not, the distance between the outcome of the government policy and the frontier will represent possible efficiency improvements that can be made by the government.

The empirical DV frontier is constructed as the line between two extreme cases. The first point (on the horizontal axis) represents the volatility of the world market price when there are no distortions. This point is represented by V(D=0) in figures 6 to 8 and is empirical equivalence of the point ($\theta = 0, \varepsilon = 0$) on the theoretical DV line in figure 5. The second point (on the vertical axis) represents the minimum deviation from the world market price when there is no volatility. This point is represented by D(V=0) in figures 6 to 8 and is the empirical equivalence of the point ($\theta = 1, \varepsilon = -\infty$) in figure 5.

Measuring inefficiency in a DV trade-off framework

To get one single estimator to measure the distance to the DV frontier, we will estimate the "efficiency" of each observed government policy combination using a technique known as data envelopment analysis (DEA)[11]. The data envelopment analysis is a non-parametric method that estimates the efficiency E of the different countries' policies using the following linear programming calculation:

$$min_{\theta,\tau}\theta \quad (15)$$

subject to

$$\tau_i \, v_i \leq \theta v_j \quad (16)$$

$$\tau_i \, d_i \leq \theta d_j \quad (17)$$

$$\tau_i \, DV_i \geq \theta DV_j \quad (18)$$

$$\tau_i \geq 0 \quad (19)$$

where v denotes the observed volatility in a country (as measured in equation 21), d is the observed distortion (as measured in equation 22) and *DV* the distance to the DV frontier.

6. DV Trade-off and Inefficiency in Staple Food Markets in Developing and Emerging countries

DV trade-off and classification of countries

Figures 6 to 8 illustrate the empirically measured trade-off between price distortions and volatility for wheat, rice and maize. Each point represents a country's choice between efficiency and stability.

There are also two additional points in each figure : (a) the zero distortion point "V(D=0)" on the horizontal axis that represents the volatility of the international price

[11] The Data Envelopment Analysis was first developed by Farrell (1957) and has been widely applied in estimating efficiency in agricultural production (e.g. Mathijs and Swinnen, 2001; Brümmer, 2001; Latruffe et al., 2004; Piesse et al., 1996)

and (b) the zero volatility point "D(V=0)" on the vertical axis which is the minimum distortion of the domestic price when there is no volatility. The line that connects both points in figures 6 to 8 is the empirical equivalent of the theoretical DV line in figure 5. The dotted vertical and horizontal lines on the figures go through the zero distortions and zero volatility points such that we get four quadrants.

The countries in the South-West quadrant have done better than the zero distortions point in terms of volatility and better than the zero volatility point in terms of distortions. The cost of the distortion caused by their divergence from the international price to reduce volatility is rather limited as it is lower than the world price with no volatility. Figures 6 to 8 show that several countries are in (or close to) the (best) South-West quadrant. This is the case for China, Sri Lanka and Pakistan for rice; for Pakistan, Bangladesh, India, and Brazil for wheat; for Thailand, Brazil and South Africa for maize. However it is also obvious that the majority of the countries is in the other quadrants.

In the North-West quadrant countries perform better in terms of volatility relative to the world market price but with higher distortionary costs than the efficiency trade-off when there is no volatility. In this case, it seems that countries value stability more than the distortionary costs. From figures 6 to 8 it appears that there are only few countries in the North-West quadrant for wheat and maize and that each of these countries are located close to the South-West quadrant. For rice, on the contrary, there are a significant number of countries located in the North-West quadrant with some of them close to the South-West quadrant (Djibouti, Nepal and India) and others much further away (Ghana, Gabon and Mongolia).

Governments of countries in the South-East have followed a price policy that kept the price distortion between the domestic and the international price limited, but volatility was higher than volatility in the international market. In this quadrant countries value the cost of the distortionary effects more than the adjustment costs for consumers and producers resulting from higher volatility. Figures 6 to 8 show that there are only two countries in this quadrant: Thailand in the case of rice and South Africa for maize.

The worst situation is in the North-East quadrant where countries have performed worse both in terms of volatility and efficiency. In these countries it should be possible to simultaneously reduce distortions and reduce volatility. There is a significant number of countries that is in the worst quadrant. It appears that especially African countries are in the North-East quadrant, in particular for rice and maize for which we have the most observations.

Measuring inefficiency

To get a better perspective on the extent of the inefficiencies, we now calculate an indicator of inefficiency in this DV trade-off framework, with the methodology as explained in Section 5. Figure 9 presents the calculated efficiency in observations of the government policy compared to the distortion and volatility trade-off. The countries with the lowest scores on the efficiency indicator are located in the North–East quadrant in figures 6 to 8. While the countries in the South-West quadrant are the countries with the highest efficiency scores.

China's policy intervention in the rice market has the highest efficiency indicator (74%) which means 26 per cent lower in terms of increased volatility and increased distortions compared to the (theoretically) best outcome. Similarly, the best performer in the wheat market is Pakistan with 70 per cent, i.e. 30 per cent lower than the best possible in terms of a reduction of volatility and distortions over the 2007-2013 period. For the maize market the best performer (Thailand) is at 60 per cent.

The efficiency indicators in figure 9 confirm that there are a lot of countries with very low performance levels compared to the DV frontier. In fact the average efficiency indicator is 31 per cent for rice, 49 per cent for wheat, and 32 per cent for maize.

In summary, our analysis indicates a large heterogeneity in the performance of countries in this DV trade-off framework. Some seem to have done well in this trade-off but other could have had much lower distortions, even when intervening to reduce volatility on the domestic markets. In fact several countries have done worse in both distortions and volatility than could have been possible. Political concerns in these countries may have caused unnecessary distortions in the face of volatile markets.

7. Conclusion and Future Extensions

The question addressed in this paper is to what extent governments may have traded off price distortions for reduced volatility in intervening in agricultural and food markets. We developed a model to derive how much distortions a government would introduce when it cares about stability (i.e. if it wants to limit price volatility for domestic producers and consumers) in a situation with limited policy options. We showed that there is a trade-off between volatility and distortions in situations with limited policy options; and we identified a DV frontier as the optimal combination of distortions and stability for given international price shocks and various preferences.

We also showed that several countries have been able to reduce (short run) price volatility in the domestic markets while at the same time allowing structural (medium and long term) price changes to pass through to producers and consumers. One case is the Chinese rice market.

However, this is not the general (or average) case. The average “DV efficiency” is rather low. For many countries, even when explicitly taking into account this trade-off (and the benefits of reducing volatility) government policies appear far removed from the optimal distortion-volatility (DV) combination and that there appears to be, thus, much room for policy improvement.

There are several ways in which this analysis can be further refined, and several issues need to be taken into consideration when interpreting the results. One is to improve the empirical indicators by better correcting for differences in transportation costs. A second is related to the conceptual model and the availability and costs of using alternative instruments. Our assumption was that to address the volatility governments would intervene in markets and did not have other instruments, such as income support as an alternative option. A more elaborate model with multiple policy instruments (and their respective implementation costs and distortions) would improve the conceptual analysis. Finally, an issue we ignored is the spillover effects (and potentially secondary price effects) of domestic policies on international markets, an issue emphasized by e.g. Martin and Ivanic (2014). Our analysis and results are complementary to the findings of these studies.

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Figures

Figure 1: Rice markets and prices in China (2006-2013)

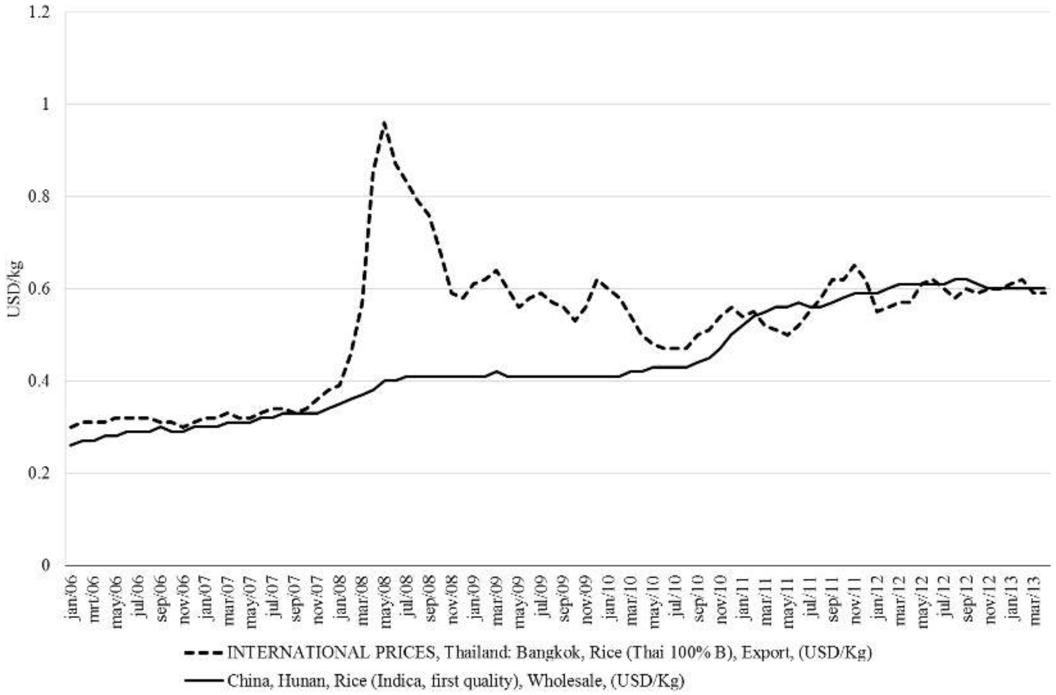


Figure 2: **Wheat markets and prices Pakistan (2006-2013)**

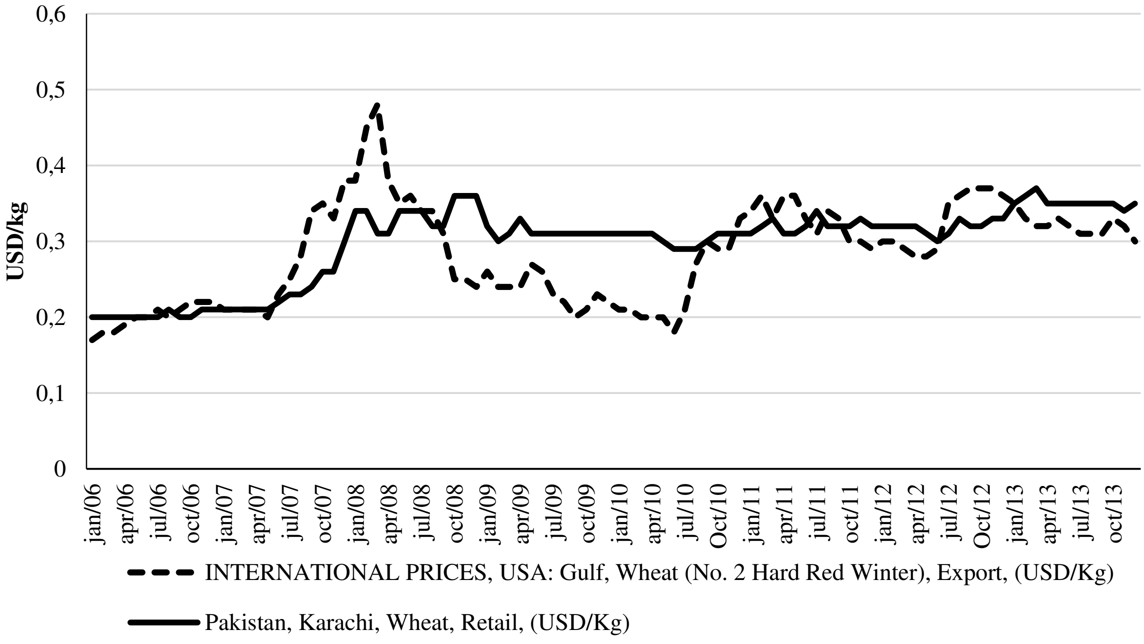


Figure 3: Social optimum for different θ

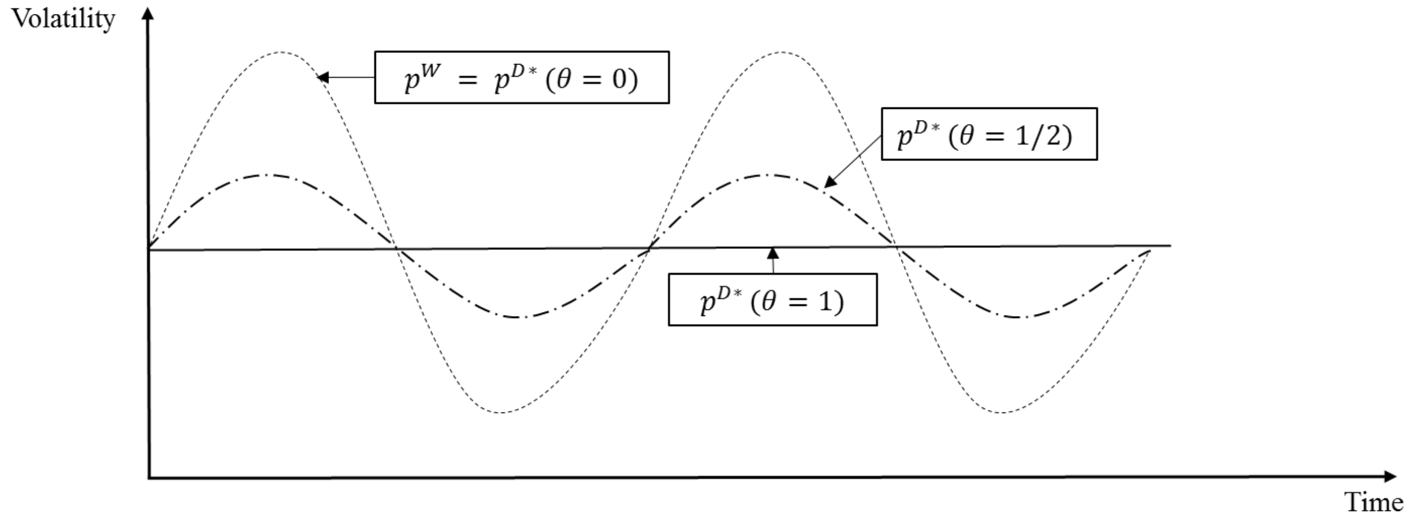


Figure 4: International price shocks and trade-off between distortions and volatility.

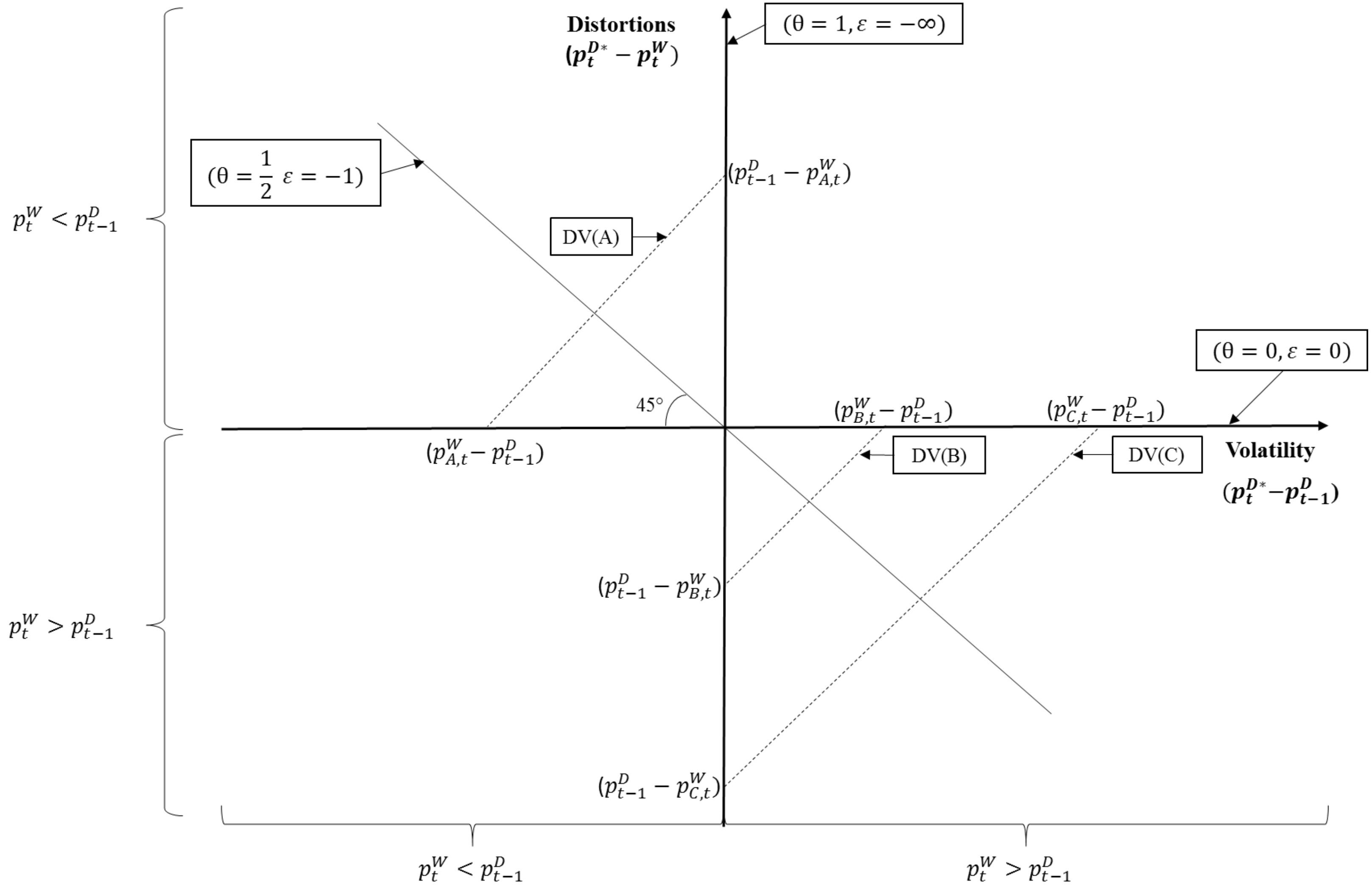


Figure 5: Optimal combinations of observed volatility and distortions for a given price shock

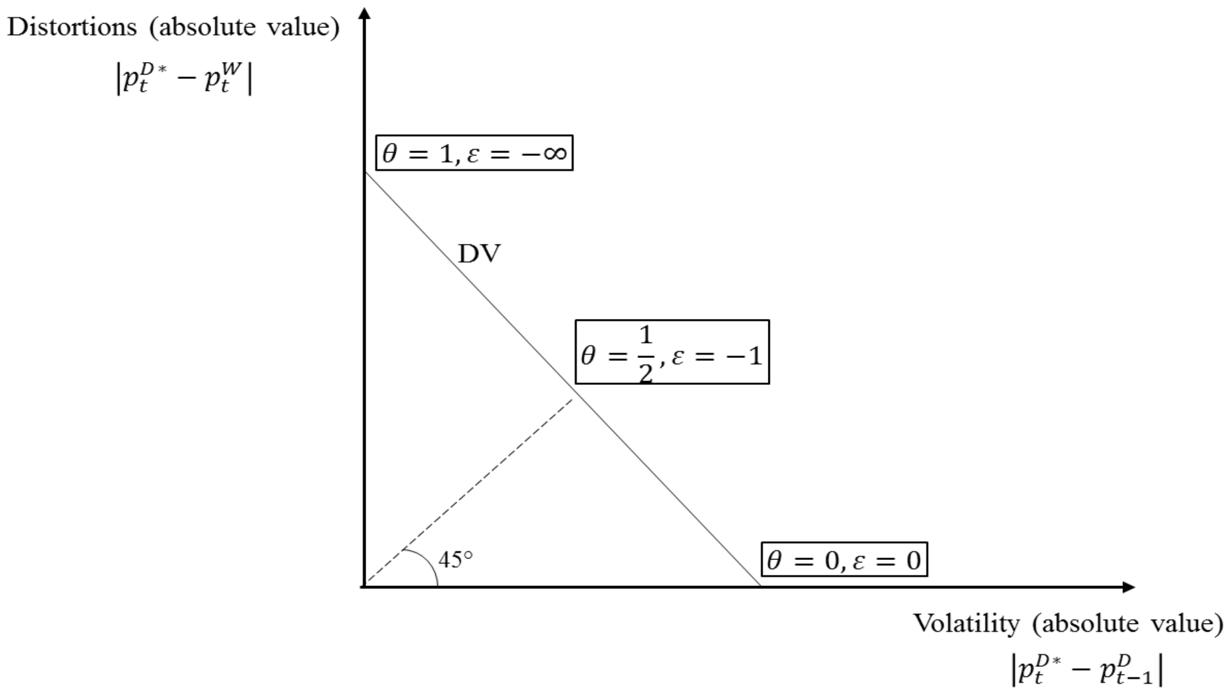
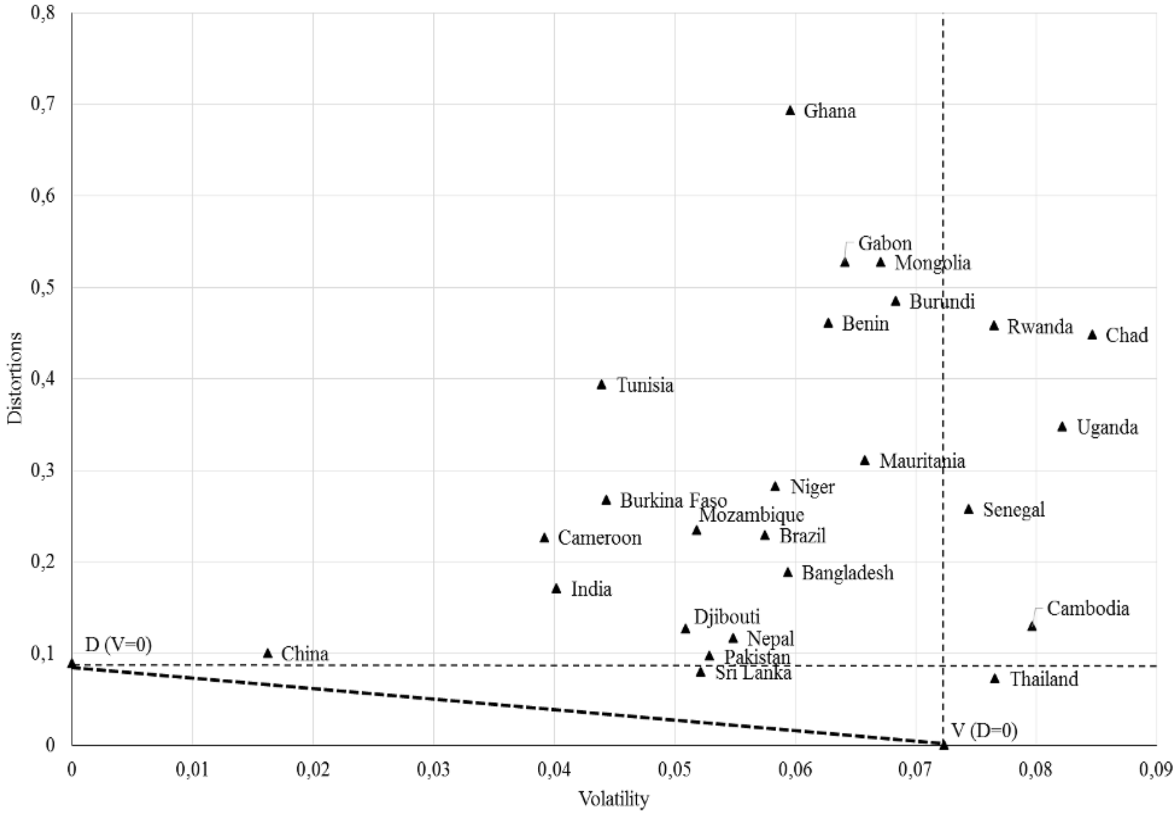
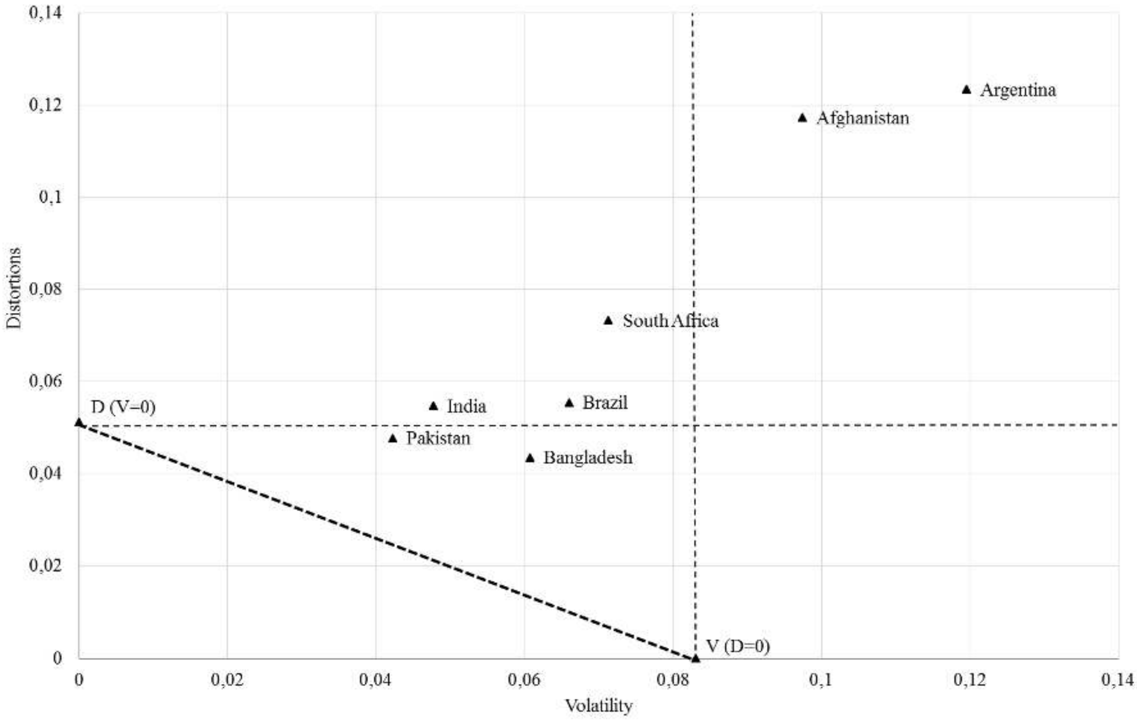


Figure 6: Rice: distortions and volatility (2007-2013)



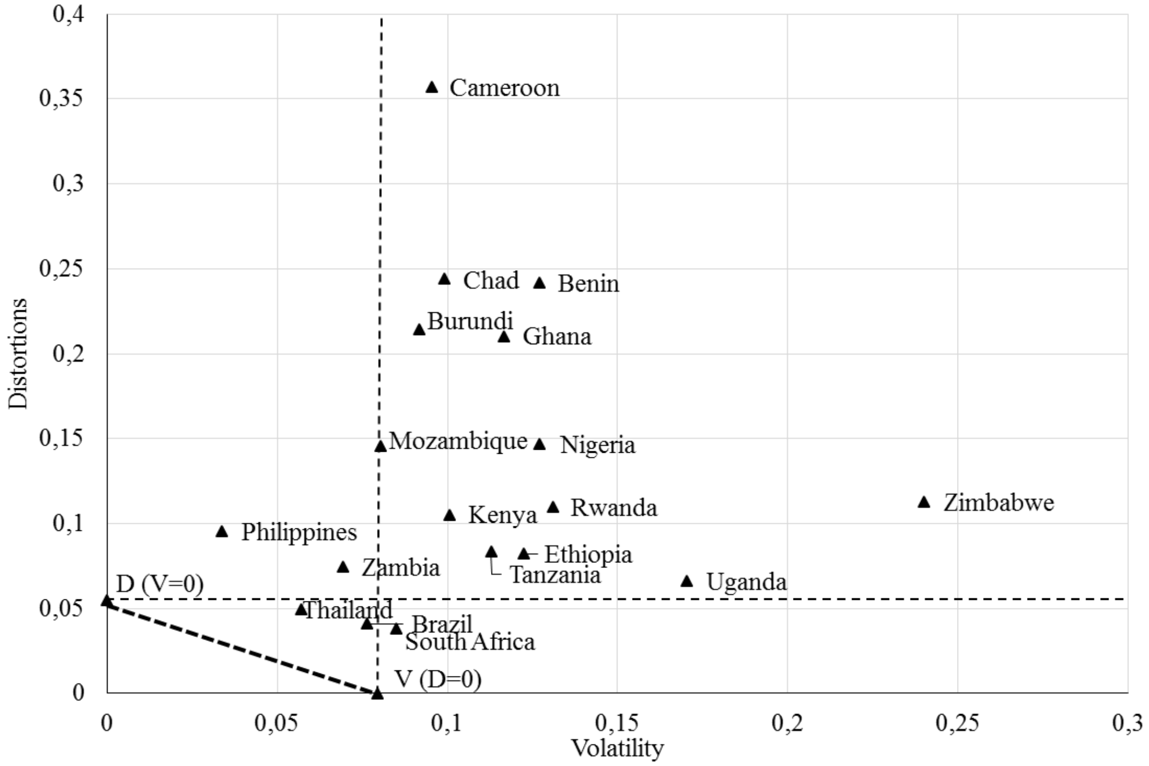
Note: D (V=0): Minimum distortions at zero volatility
V (D=0): Volatility at zero distortions (= world market price volatility)

Figure 7: Wheat: distortions and volatility (2007-2013)



Note: D (V=0): Minimum distortions at zero volatility
V (D=0): Volatility at zero distortions (= world market price volatility)

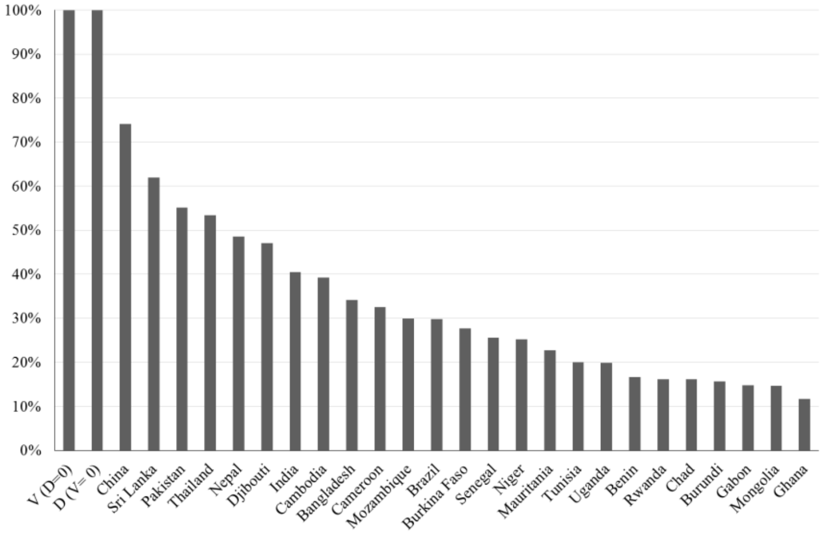
Figure 8: Maize: distortions and volatility (2007-2013)



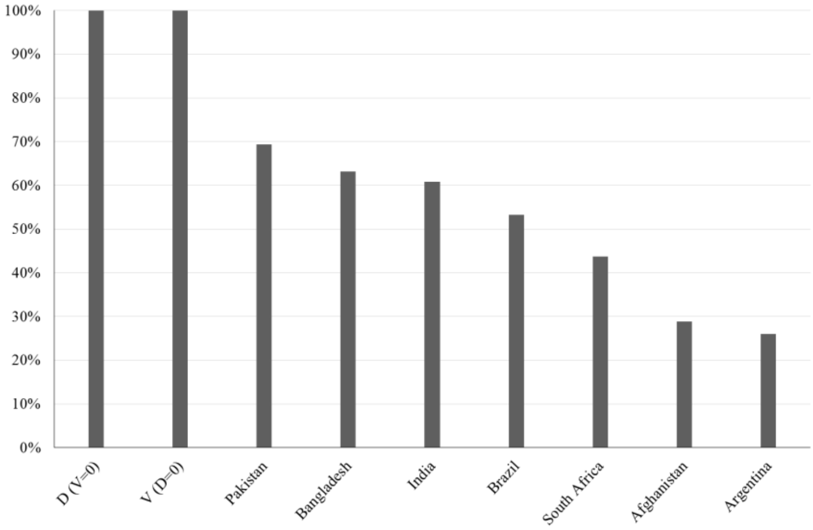
Note: D (V=0): Minimum distortions at zero volatility
V (D=0): Volatility at zero distortions (= world market price volatility)

Figure 9: Efficiency relative to the DV frontier

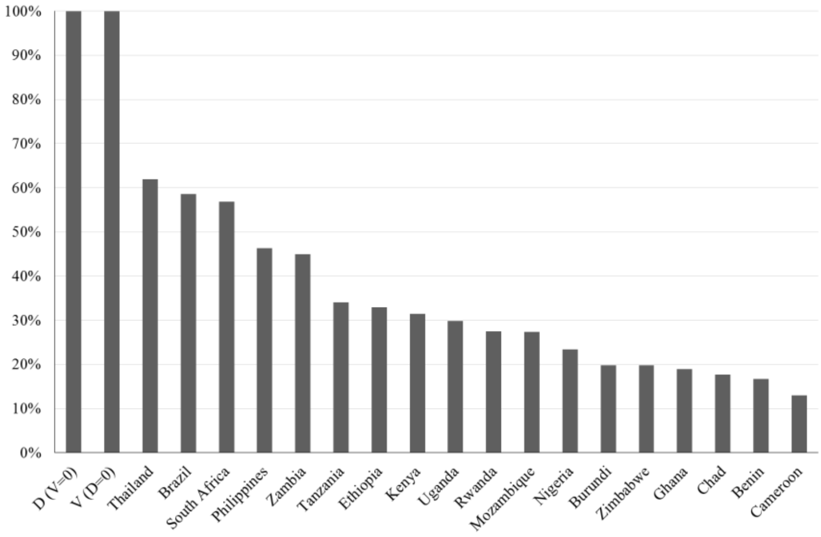
a. Rice



b. Wheat



c. Maize



Appendix

Rice	Domestic price
Bangladesh	Dhaka, Rice (coarse), Wholesale, (USD/Kg)
Benin	Cotonou, Rice (imported), Retail, (USD/Kg)
Brazil	National Average, Rice (paddy), Wholesale, (USD/Kg)
Burkina Faso	Dori, Rice (imported), Wholesale, (USD/Kg)
Burundi	Bujumbura, Rice, Retail, (USD/Kg)
Cambodia	Phnom Penh, Rice (Mix), Wholesale, (USD/Kg)
Cameroon	Douala, Rice, Retail, (USD/Kg)
Chad	N'Djamena, Rice (imported), Retail, (USD/Kg)
China	Hunan, Rice (Indica, first quality), Wholesale, (USD/Kg)
Djibouti	Djibouti, Rice (Belem), Wholesale, (USD/Kg)
Gabon	Libreville, Rice, Retail, (USD/Kg)
Ghana	Accra, Rice (imported), Wholesale, (USD/Kg)
India	New Delhi, Rice, Wholesale, (USD/Kg)
Mauritania	Nouakchott, Rice (imported), Retail, (USD/Kg)
Mongolia	Ulaanbaatar, Rice, Retail, (USD/Kg)
Mozambique	Maputo, Rice, Retail, (USD/Kg)
Nepal	Kathmandu, Rice (coarse), Retail, (USD/Kg)
Niger	Niamey, Rice (imported), Wholesale, (USD/Kg)
Pakistan	Karachi, Rice (basmati), Retail, (USD/Kg)
Rwanda	Kigali, Rice, Wholesale, (USD/Kg)
Senegal	Dakar, Rice (imported), Retail, (USD/Kg)
Sri Lanka	Colombo, Rice (white), Retail, (USD/Kg)
Thailand	Bangkok, Rice (5% broken), Wholesale, (USD/Kg)
Togo	Lomé, Rice (imported), Retail, (USD/Kg)
Tunisia	National Average, Rice, Retail, (USD/Kg)
Uganda	Kampala, Rice, Wholesale, (USD/Kg)

Wheat	Domestic price
Afghanistan	Kabul, Wheat, Retail, (USD/Kg)
Argentina	Buenos Aires, Wheat, Wholesale, (USD/Kg)
Bangladesh	National Average, Wheat, Wholesale, (USD/Kg)
Brazil	National Average, Wheat, Wholesale, (USD/Kg)
India	New Delhi, Wheat, Wholesale, (USD/Kg)
Pakistan	Karachi, Wheat, Retail, (USD/Kg)
South Africa	Randfontein, Wheat, Wholesale, (USD/Kg)

Maize	**Domestic price**
Benin	Cotonou, Maize (white), Retail, (USD/Kg)
Brazil	National Average, Maize (yellow), Wholesale, (USD/Kg)
Burundi	Bujumbura, Maize, Retail, (USD/Kg)
Cameroon	Douala, Maize, Retail, (USD/Kg)
Chad	N'Djamena, Maize, Retail, (USD/Kg)
Ethiopia	Addis Ababa, Maize, Wholesale, (USD/Kg)
Ghana	Accra, Maize, Wholesale, (USD/Kg)
Kenya	Nairobi, Maize, Wholesale, (USD/Kg)
Mozambique	Maputo, Maize (white), Wholesale, (USD/Kg)
Nigeria	Kano, Maize, Wholesale, (USD/Kg)
Philippines	National Average, Maize (yellow), Wholesale, (USD/Kg)
Rwanda	Kigali, Maize, Wholesale, (USD/Kg)
South Africa	Randfontein, Maize (white), Wholesale, (USD/Kg)
Thailand	Bangkok, Maize, Wholesale, (USD/Kg)
Uganda	Kampala, Maize, Wholesale, (USD/Kg)
United Republic of Tanzania	Dar es Salaam, Maize, Wholesale, (USD/Kg)
Zambia	National Average, Maize (white), Retail, (USD/Kg)
Zimbabwe	Harare, Maize, Retail, (USD/Kg)