Welfare Effects of Commodity Price Volatility

by

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Introduction

- Commodity price volatility has been researched extensively by academics, international organisations such as UNCTAD, FAO and World Bank over many years.
- Evidence shows that for many primary commodities there exists high price volatility.
- Causes of volatility are varied:
  - Endemic supply and demand conditions; production cycles; global value chains; financialisation; natural factors such as weather and harvests.
  - Volatility has been greater in response to market liberalisation (eg end of many ICA’s in the 80’s and 90’s).
Introduction

Market liberalisation of commodity markets in many countries was often accompanied by other macroeconomic reforms such as:

- **Currency adjustments** (usually devaluation or a move to a more flexible currency).
- **Abolition of Marketing Boards** (eg in coffee).
- **Increased role for private suppliers of commodities**.
- This makes analysis of the causes of price volatility complex as these many factors have to be disentangled.
Measuring volatility

- Various ways to measure volatility such as: standard deviation (or variance); coefficient of variation; and more technical tools such as the GARCH method.

- GARCH models provide a framework for analysing the potential for the variance in any time series to be time-varying and to discover whether volatility (measured by the variance) decays or persists over time.

- Has econometric implications, but also important policy implications.

- Firstly, the presentation assesses the price risk faced by coffee producers in two coffee producing countries—India and Ethiopia using the generalised autoregressive conditional heteroskedasticity (GARCH) econometric technique.

- Secondly, it estimates potential welfare gains for producers from eliminating this price risk.

- Thirdly, we ask whether intervention to offset volatility is always desirable and cost-effective.
Coffee in India

- Coffee is an important commercial crop for India, with annual exports varying from 250-300,000 tonnes.
- Production is divided between Robusta and Arabica varieties (60%:40%).
- Circa 90% of India’s coffee is exported and it represents ~4% of world exports of coffee.
- Circa 5 million people depend for their livelihoods on the coffee industry, including nearly 590,000 directly employed workers (Coffee Board of India).
- Classic “Minifundia” structure: 80% of coffee holdings <2 hectares; 98.8% < 10 hectares.
- DATA: Monthly coffee producers’ prices obtained from the International Coffee Organization (ICO) database.
- 458 observations (from 1 January 1973 to 31 December 2011).
- The prices are in US cents/lb and relate to average farm gate price paid to producers.
Figure 1: Percentage change in monthly coffee prices over previous period (January 1973 to December 2011; i.e. months 1-220 pre- and months 221-458 post-liberalisation)
## Table 1: Descriptive Statistics

**Pre-liberalisation period: January 1973 - December 1992**

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>75.47</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>17.49</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.12</td>
</tr>
<tr>
<td>Excess Kurtosis</td>
<td>-0.80</td>
</tr>
<tr>
<td>Coefficient of variation</td>
<td>0.01</td>
</tr>
</tbody>
</table>

**Post-liberalisation period: January 1993 - December 2011**

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>93.60</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>45.82</td>
</tr>
<tr>
<td>Skewness</td>
<td>1.25</td>
</tr>
<tr>
<td>Excess Kurtosis</td>
<td>1.65</td>
</tr>
<tr>
<td>Coefficient of variation</td>
<td>0.49</td>
</tr>
</tbody>
</table>
Coffee in Ethiopia

- The coffee sector accounted for ~35% of merchandise exports and 16%-20% in years 2011 to 2013 (ICO, 2013).
- Over 4 million small farmers are engaged in coffee cultivation but ~15 million people are directly or indirectly dependent on income from coffee production.
- 95% of farmers operate on less than 2 hectares (with low average yield per hectare of ~720kg-in 2013).
- **Data**: Monthly coffee producers’ prices obtained from the International Coffee Organization (ICO) database.
- 444 observations (from 1 January 1976 to 31 December 2012).
- The prices are in US cents/lb and relate to average farm gate price paid to producers.
Data

Coffee Price Volatility

%
Data

Pre - Reform:

Mean = 61 cents/lb
SD = 13.97
CV = 0.23 (23%)

Post - Reform:

Mean = 74.8 cents/lb
SD = 31.7
CV = 0.42 (42%)
Risk Aversion

- Many studies have argued that primary product producers are highly risk averse and apply an Expected Utility approach to their production decisions.

- Key question is whether the average farmer/producer would prefer a high mean price for his/her products but with a high variance.

- OR a low mean price but also low variance. This is an empirical question rather than a theoretical one.

- We assume that the producer prefers certainty equivalence (a form of income (or consumption) smoothing).

- And this leads to the question: What would the producer be willing to pay for this certainty?

- Producer’s decisions about the appropriate levels of investment to make (eg, inputs such as fertilisers etc ) will be crucially determined by this.

- Producer will be influenced not just by the Expected price (Ep) but also by the variance of (Ep) and the relation between the two.
THE WELFARE GAIN FROM ELIMINATING COFFEE PRICE VOLATILITY

- The Constant Relative Risk Aversion (CRRA) parameter has been used in a number of studies of risk-averse behaviour: Moledina et al (2003); Schechter (2007) and Cardenas and Carpenter (2005);

- \[ \lambda = \frac{1}{2} \gamma \sigma^2 \]

- This is derived from the standard CRRA function:

\[ U(x) = \frac{x^{1-\gamma}}{1-\gamma} \]

- Where \( U(X) \) is the utility of consumption, \( \gamma \epsilon (0,1) \) is the CRRA, \( \lambda \) is the welfare gain if all consumption (production) volatility can be eliminated. This will be a function of two parameters, the risk aversion parameter \( \gamma \) and the amount of risk \( \sigma^2 \); (see Gemech et al, 2014;2016).

- Apply this concept to measure the possible welfare gain from eliminating unpredictable risk for coffee producers.

- Combination of GARCH model and the CRRA concept allows us to determine a value for the Conditional Variance but also the Unconditional (persistent/unpredictable) Variance.

- This then allows us to measure the true welfare effect of the price volatility (at least for this Expected Utility approach).
Table 2: India: Estimates of the welfare gain from eliminating coffee price volatility calculated from equation:

$$\lambda = \frac{1}{2} \gamma \sigma^2$$

Overall variance = 0.095

<table>
<thead>
<tr>
<th>Overall variance</th>
<th>0.095</th>
<th>(\lambda) with (\gamma = 0.6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditional variance</td>
<td>0.015</td>
<td>0.009</td>
</tr>
<tr>
<td>Unconditional variance</td>
<td>0.08</td>
<td>0.0480 (where (\gamma) is the CRRA and the variance has been split between the conditional variance and unconditional variance)</td>
</tr>
</tbody>
</table>
Welfare Gains: Indian Coffee Producers

- The magnitude of the potential gain from eliminating price risk volatility using the unconditional variance of 0.08 and \( \gamma = 0.6 \) is equal to 0.048 (or 4.8 percent of revenue (income)).

- An estimate of the revenue from coffee production is obtained from:
  \[ R = n \times \gamma \times p \] (n=output; p=mean price).

- For the crop year 2010-11, about 400,000 hectares of the Arabica and Robusta varieties were cultivated with an average yield of 852 kg/ha. The mean price of coffee over the sample period was US$2.4/kg.

- This gives \( R = \) US$817 million.

- An estimate of the welfare gain \( W \) is found by using:
  \[ W = R \times \lambda \]

- Giving a welfare gain from eliminating price volatility of approximately US$39.3 million (US$817 million multiplied by 0.048 from Table 1 above) or approximately **US$65 per farm** when spread across 600,000 or so coffee farms.
Welfare Gains: Ethiopian Coffee Producers

- For the crop year 2011-12, about 450,000 hectares of the Arabica varieties were cultivated with an average yield of 720 kg/ha. The mean price of coffee for this period was $0.90/kg (ICO, 2014).
- This gives $R = US$291 million.
- An estimate of the welfare gain $W$ is found by using: $W = R \lambda$
- This gives a welfare gain of approximately **US$6.73 per hectare** (i.e. $\lambda = 0.01039**$ multiplied by US$291).
- ***(The value $\lambda = 0.01039$ has been calculated using the same formula used for India in Table 1 but applied to Ethiopian data).**
Conclusions and policy implications

- In Ethiopia our figures suggest the potential welfare gain for producers from eliminating coffee price volatility is negligible.
- However, potential welfare gain for small Indian coffee producers is quite large.
- Whether government intervention (and associated costs) to deal with price volatility (e.g. providing storage facilities, buffer stock systems etc) is desirable/cost-effective is the key question?
- Are farmers willing to pay for insurance to mitigate price risk? In the short term, providing information to farmers (price discovery) is beneficial.
- Market-based approaches such as those used by the Ethiopian Commodity Exchange may be a better way forward.
- Analysis assumes zero savings.
- Also depends on share of total household income from coffee revenues.
- Empirical findings of course will vary across countries and commodities.
Selected References


