Volatility and stabilization of the price of coffee and cocoa in Côte d'Ivoire

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Abstract: The aim of this paper was to study the coffee and cocoa price volatility in Côte d'Ivoire and to understand the mechanism of price stabilization. Thus, this paper shows that the international prices and the farm gate prices of these two products are strongly dispersed around their respective average, from one year to another and within each year. This paper proposes a model of partial stabilization which makes it possible to highlight an alternate mechanism of the coffee and cocoa price stabilization which is relatively efficient compared to the mechanism which currently exists. It shows that a marketing board in the Ivorian coffee and cocoa sector, which constitutes a buffer stock and uses it in a strategic way, has the advantage of reducing significantly the volatility of the international price and the farm gate price.

Key words: farm gate price, international price, price fluctuation, buffer stock, cocoa and coffee markets

The volatility of free agricultural markets (that is to say, the ones free from intervention, and on which there are only expressed the demand and supply of buyers and sellers) is a common phenomenon. The consequence is that the prices of agricultural raw materials are never equal to marginal costs in the long-term and therefore have no relation to the production costs of farmers (Boussard 2010; Tothova 2011). This instability of agricultural prices causes a serious harm to farmers in the terms of well-being (Matthews 2010; OCDE 2010; FAO et al. 2011; Onour and Sergi 2011; Rapsomanikis and Mugera 2011), but also to the economies of developing countries which depend on agricultural raw materials (Gillson et al. 2004; FAO et al. 2011; Luciani 2011; Rapsomanikis and Mugera 2011; Ehrhart and Guerineau 2012). Then, the storage and marketing boards are sometime used as a solution to stabilize markets and to avoid large fluctuations (Mitra and Boussard 2011, 2012).

The Ivorian coffee and cocoa markets are no exception to the rule. Bogetic et al. (2007) showed that the cocoa and coffee prices shocks affect the growth rates and trade indicators, and they are important sources of volatility in Côte d'Ivoire. Both agricultural export products are very important to the economy of Côte d'Ivoire. Indeed, Côte d'Ivoire is the world's largest producer of cocoa (with a global production of more than 1.3 million tons in 2011) and the 11th largest producer of coffee (about 4% of the global supply). Both products generate over 50% of export earnings and make up 15% of the Ivorian GDP. They are produced on a small-scale by a multitude of farmers whose plantations, for the most part, are less than five hectares. Coffee and cocoa provide a livelihood for almost one quarter of the population (De Lattre-Casquet et al. 1998).

The marketing system of both products has evolved from independence to now. In Côte d'Ivoire, cocoa and coffee production has developed in the context of an administered sector where the Fund for Support and Stabilization of the Prices of Agricultural Products (known as the CSSPPA or the Caistab), founded since 1965, played a central role. It used to set at the beginning of the crop year a guaranteed price to the producer, identical throughout the territory, and to control the external marketing of products through the distribution of export quotas to the approved exporters.

Domestic marketing was carried out by the private sector but the overall costs and marketing margins, from the producer purchase price at the farm gate to the exporter guaranteed price, was set in an administrative scheme called the *barème*[1] (scale).

The objective of the price policy of the Caistab was to maintain a stable producer price. This stabilization was inter-annual, that is to say, over several years and within a crop year, the nominal farm gate

[1]The vertical coordination was built up and strengthened by the stabilization system through an administrative scheme called the *barème* (scale).

prices could remain constant. Thus, between 1980 and 1989, the official farm gate price has evolved as follows: it was set at 300 CFAF/kg[2] between 1980 and 1983, it switched to 350 CFAF in 1984 to 375 CFAF in 1985, to be held at 400 CFAF from 1986 to 1989 (MacIntire and Varangis 1999).

Dawe (2012) discussed both costs and benefits of stabilizing prices of agricultural commodities. He showed that the main cost of price stabilization is the deadweight loss by not allowing market prices to follow the world prices. He also showed that price stabilization serves as a safety net program, although not the most efficient one.

The first reforms of the sector of coffee and cocoa appeared from the early 90s because of the public deficits of the Caistab and that after what the history has remembered as the "cocoa war"[3]. Thus in 1990, the public authorities abandoned the objective of a pluri-annual stabilization of prices in favour of an intra-annual stabilization based on a specific sales program called the *programme of averaged anticipated sales* (known as the PVAM[4]) (Ghoshray 2010; Fry et al. 2011; Maurice and Davis 2011), for the determination of coffee and cocoa prices and the role played by the futures markets). This mechanism should enable to set in advance, for the crop year, the *barème* (scale) determining the unit prices charged by the various operators and farmers in particular.

Following public deficits and the pressure from the World Bank and the IMF, the *Caistab* was removed and the domestic marketing of cocoa has been fully liberalized in August 1999. We noticed then the arrival on that market of large foreign groups, specialized in the grinding of beans, in the confrontation with less efficient local firms and unorganized farmers. These multinationals will therefore strongly dominate the cocoa sector, from the farm gate to the export via the processing, while ousting national operators (Losch 2002).

At the end of 2001, faced with the side effects of that liberalization, the Ivorian State reacted by setting up three regulating organizations (ARCC, BCC, FRC), with very specific roles, responsible for managing both sectors. The ARCC (Coffee and Cocoa Regulatory Authority) was in charge of the administrative regulation of these sectors; the BCC (Coffee and Cocoa Exchange) was responsible for the commercial regulation and the FRC (Regulation and Control Fund) the mission of which was the financial regulation.

Presently, after the post-election crisis, the new authorities returned to a centralized organization for the marketing of coffee and cocoa, with the aim of stabilizing the intra-annual farm gate prices through the PVAM.

Thus the questions that arise are the following: Why are the prices of coffee and cocoa volatile? Why should we reduce the volatility of these prices? What should the relatively efficient policy of price stabilization be?

In this paper, we are going to visit the theory of the agricultural price volatility, to analyze price fluctuations (domestic and international) of coffee and cocoa, and to explore the possibility of establishing a relatively efficient stabilization policy.

To achieve these objectives, the methodology used will firstly consist in calculating the coefficients of variation. As noted by Matošková (2011), the coefficient of variation is the tool used by prestigious global institutions, such as the OECD and the FAO, to evaluate the agricultural prices volatility. It is also the approach used by many other authors like Huchet-Bourdon (2011), Matošková (2011), Tangermann (2011) and Tothova (2011). The data we use to calculate this indicator are both the series of the annual and monthly prices, and the series of international prices and the farm gate prices provided by the UNCTAD, the FAO and the INSEE. Secondly, we will build a model, which takes its source from Newbery and Stiglitz (1979), to understand the price stabilization and to enable us to propose a relatively efficient mechanism for the partial stabilization.

THEORY OF FLUCTUATIONS OF AGRICULTURAL PRICES

Agricultural economists have long been interested in studying the volatility of the prices of agricultural products and Boussard (2010) presents a good synthesis of the theory that emerges.

Deaton and Laroque (1990) published on that subject the characteristics of the prices of some raw materials such as coffee and cocoa. They show that the annual variations of 30% compared to the average

[2]CFAF/kg means CFA franc per kilogram. The CFA franc (in French: *franc CFA*) is the name of two currencies used in Africa which are guaranteed by the French treasury. The two CFA franc currencies are the *West African CFA franc* and the *Central African CFA franc*. Both CFA Francs currently have a fixed exchange rate to the Euro: 1 Euro = 655.957 CFA francs.

[3]For more information on the "cocoa war", see Gombeaud et al. (1990).

[4]For more information on the PVAM, see Bonjean and Chambas (2001).

are "normal" for most agricultural products which are subject to international trade.

The instability of agricultural prices negatively impacts the activity of farmers, because with volatile prices, it is impossible for them to choose the right production techniques or to plan their investments.

According to Boussard (2010), agricultural economists are unanimous on the fact that the immediate explanation of the volatility of prices is the inelasticity of demand with respect to price and income. Indeed, food needs are always satisfied in priority so that higher prices may lead consumers, in the lack of income, to reduce their demand for other commodities, but without significantly reducing their demand for food. Thus, faced with a rigid demand, that is to say not very sensitive to price, small production changes are likely to lead to large price differences.

In a free market, the equilibrium price is determined by the confrontation between supply and demand. The characteristics of this equilibrium point play an important role in the theory of price stability. Thus, equilibrium prices will vary whenever the supply or demand changes.

In all markets, there are always variations in supply and demand, and therefore instantaneous variations of the price. Thus the question that arises is that of the amplitude of the variations. Why should they be more important in agriculture than elsewhere?

If the inelasticity of demand is the immediate explanation of the volatility of agricultural prices, there still remains to find out what are the causes of the changes in supply, and this is where the unanimity among economists disappears. On this point, two theories emerged: the theory of exogenous fluctuations and that of endogenous fluctuations.

Theory of exogenous fluctuations

According to this theory, the fluctuations of supply of agricultural raw materials are of a fortuitous origin, caused by events beyond the control of producers (such as climatic disasters, droughts, floods or epizootic diseases, or other similar causes of which producers and/or governments have a little control), hence the term exogenous.

While the market normally (or in average) provides a production close to the "normal" demand, good or bad harvests impede its good functioning. The offer is lower or higher than expected, and the rigidity of demand amplifies these fluctuations.

An essential characteristic of these disturbances is that they are many (each year there are somewhere in the world many droughts, frosts, etc.) and each on a relatively small-scale, at least vis-à-vis the world market.

Theory of endogenous fluctuations

It is based on a dynamic view of markets, on the idea that markets take place over time, and not instantaneously. Therefore, it is less realistic to assume that the operators in a market react immediately to price changes. There is always a certain period of time between the moment a price is noticed and the moment when we notice the corresponding variations of the supply.

The evolution of prices and quantities is then governed by a series of trials and errors, the price of a period leading to changes in supply later, and these ones causing the appearance of new prices. This is what tries to explain the *cobweb* model of Ezekiel (1938) which is based on the idea that the price of the year $n - 1$ is the one which determines the production of the year n.

We can therefore consider that both theories, the exogenous and endogenous one, are complementary in explaining the volatility of agricultural prices. The difficulty is that each of them in practice leads to different solutions, even opposite ones. Thus, our contribution to the literature on the subject is to analyze more efficiently the policy of stabilization of the prices of coffee and cocoa, taking into account the particularities of Côte d'Ivoire.

EVIDENCE OF THE VOLATILITY OF PRICES ON THE MARKETS OF COFFEE AND COCOA

The volatility measures the magnitude and speed of the evolution of the price of an asset over a given period, such as the price of an agricultural product. In economic theory, the volatility is related to two concepts: variability and uncertainty. Variability describes the overall variations of price while uncertainty refers to the unpredictable variations.

Price volatility in one market can be demonstrated through the calculation of the indicators of dispersion of which the most used is the coefficient of variation. The coefficient of variation (CV) is the ratio of the standard deviation to the average. The higher the value of the coefficient of variation is the greater is the dispersion around the average. We have:

$$CV = \frac{\sqrt{\frac{\sum_{i=1}^{n}(p_i - \bar{p})^2}{n}}}{\bar{p}}$$

Table 1. Characteristics of the trend of the series of world prices

	Average (in US$/T)	Standard deviation	CV
Cocoa beans	1 835	712.86	38.85
Raw coffee	1 512.8	647.5	42.80

Source: Our calculations were based on the data from the INSEE Statistical Bulletin and the ICO

where p_i and $\bar{p}$ are respectively the price at the date i and the average of the series of price studied.

We are very aware that the relevance of this indicator is disputed by some specialists who consider that small fluctuations around the average price are not important. They think that only the most extreme values (that the price can take at the increase or decrease) should count. They propose alternative measures of volatility usually used to analyze the prices in financial markets. However, further in this paper, we will opt for the coefficient of variation because it is the most used in the analysis of the agricultural price volatility.

International price volatility

The calculation of the coefficients of variation for two series of monthly average prices over the period January 1998–June 2012 for coffee and cocoa gave the results in Table 1. The high values of the coefficients of variation reflect a strong dispersion of the monthly international prices around the average prices for coffee and cocoa, over the period considered.

These results are highlighted in Figure 1, which shows the evolution of the monthly average international price of the Robusta coffee and that of the cocoa bean over the periods above. This chart shows an uneven evolution of international prices of both products, which reflects the volatility of these prices.

We notice then that, from January 1998 to June 2012, the international price of the Robusta coffee did not follow a constant evolution. It is the same for the international price of cocoa beans.

Regarding cocoa, we noticed a low fluctuation of the international price between January 1998 and January 2001, with a downward trend over this period. However, from January 2001 to June 2012, the price fluctuations were very strong with very significant price differentials, but this time, with an upward trend of the international price.

Concerning coffee, we noticed low fluctuations of the international price with a downward trend from January 1998 to January 2002. After this period, price fluctuations became stronger with, this time, a strong upward trend until January 2008. This cycle of upward and downward fluctuations of the international price of coffee resumed again until June 2012.

The volatility of the international prices of coffee and cocoa can also easily be observed when using the annual series of prices. Figure 2 shows the evolution of prices and the global cocoa production from 1961 to 2010. It shows a non-monotonic shape of the international price of cocoa, thus confirming the results of the monthly series of international prices. We can therefore conclude that from one year to another, and within each year, the international prices of coffee and cocoa are widely dispersed around the average of the period considered.

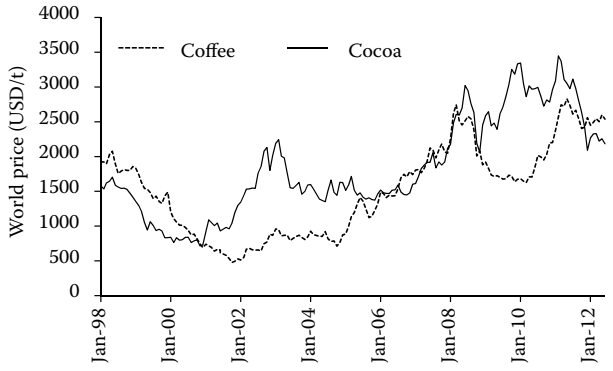

Figure 1. Average monthly international prices of the Robusta coffee and cocoa

Source: Based on data from the ICO (for coffee) and the INSEE Statistical Bulletin (for cocoa)

Farm gate price volatility

The coefficient of the variation of annual prices was calculated for coffee and cocoa. Table 2 gives the value of this indicator for two series of farm-gate prices over the period 1966–2009. It therefore

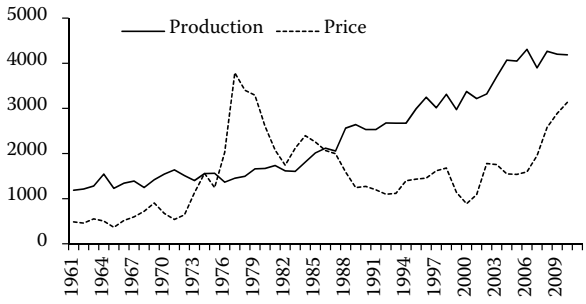

Figure 2. Evolution of the price and the global cocoa production (1961–2010)

Source: Based on data from the UNCTAD, www.unctad.org

Table 2. Trend characteristics of the series of farm gate price

	Average (in CFAF/T)	Standard deviation	CV
Cocoa beans	287 829.73	147 033.92	51.08
Raw coffee	313 242.15	169 208.91	54.02

Source: Our calculations based on the FAO data

highlights the farm gate price fluctuations from one year to another. Indeed, the values of the coefficient of variation were high for both products (51.08% for cocoa and 54.02% for coffee). We can therefore conclude that there was a wide dispersion of the annual average farm gate prices around the average farm gate price (which value is 287.8 CFAF/kg for the cocoa bean and 313.2 CFAF/kg for coffee) between 1966 and 2009.

As Figure 3 shows, the volatility of the average farm gate price over the period considered has increased from the 1990s, a period during which the Ivorian government has planned to implement the PVAM, giving up then the pluri-annual stabilization of the farm gate prices for an intra-annual stabilization. Thus, between 1993 and 2004, the kilogram of cocoa bean and that of coffee ranged between 200 CFAF (minimum value) and 700 CFAF (maximum value). However, from 1966 to 1990, the average farm gate price has little fluctuated. Instead, it gradually increased over this period, respectively starting from 65 CFAF/kg and 75 CFAF/kg for cocoa bean and coffee, to 400 CFAF/kg for both.

We can learn from this analysis that the international prices of coffee and cocoa are volatile and the fluctuations of those prices are transmitted to the farm gate, as shown by Malan (2009). In that case, what would the relatively efficient price stabilization policy be for these products?

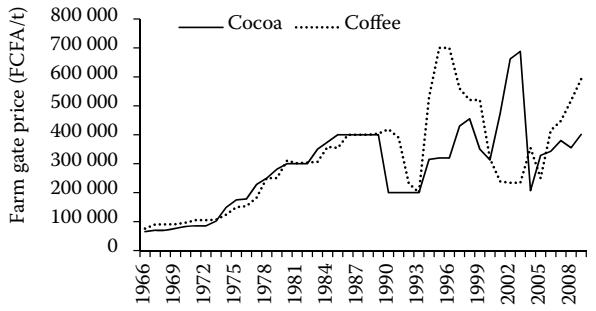

Figure 3. Evolution of the farm gate price of coffee and cocoa (1966–2009)

Source: Based on data from the FAO

PARTIAL PRICE STABILIZATION POLICY

A price stabilization system is any mechanism which leads to a reduction of price volatility. In this section, we set up a model which has its source in Newbery and Stiglitz (1979), to analyze and explain the stabilization of prices drawing our inspiration from the Ivorian context to compare the mechanism currently used to a more active alternative mechanism of stabilization.

Three key entities are involved in the stabilization of prices of agricultural products: farmers (producers of the agricultural raw material), the stabilization body (which may also represent all the traders, the international trading companies) and firms (which demand for agricultural raw materials is driven by the demand for the consumer derivative products). We ignore here the activity of collecting and processing of firms so as to consider simply and therefore isolate the effects of stabilization.

Without a loss of generality, the functioning of the stabilization mechanism can be schematized as follows: Farmers after the harvest deliver their production to the stabilization body which, according to whether the international price from one period to another is low or high (depending on the supply of farmers and the demand of firms), keeps in stock or keeps out of stock a certain amount of agricultural product it has.

Let us set p_i the international price at the date i when we cross the demand for raw materials of the firms at the date i with the offer at the date i.

Let us set $p_1 > p_2$. Assuming that demand is inelastic, let us consider the price series generated by the distribution below, which indicates the amount of raw material put in the market by the stabilization body at different times:

$$\text{(I)}\ Q_i^{Is} = \begin{cases} Q_i^s & i \neq 1,2 \\ Q_1^s & i = 1 \\ Q_2^s & i = 2 \end{cases} \quad (1)$$

Q_i^s is the supply of agricultural products at the date i.

In a free market where the price is determined by supply and demand, distribution (I), which determines the series of international prices p_i, it enables to generate the series of farm gate prices as follows:

$$w_i^I = p_i - Cs \quad (2)$$

Cs represents the overall expenses that require the collection and carriage of the raw material, from the farm gate to the warehouses of the stabilization body (or the approved firms) via the packing plants, as well as the costs incurred by the activity of stabilization. These expenses are contained in a pricing

structure previously determined by the stabilization body through the *barème*.

The distribution above reflects, in a very simplified way, the behaviour of a "passive" stabilization body, of which the centralized management mechanism implemented currently in the Cote d'Ivoire is an example.

Let us consider now a stabilization body which acts strategically ("active" stabilization body), that is to say, which has a storage capacity and uses its buffer stock to transfer a small part δQ of the supply (quantity for sale) from the period 2 towards date 1. Such behaviour modifies the distribution (I) into a new distribution (II) of the supply of raw material defined as follows:

$$\text{(II)}\ Q_i^{IIs} = \begin{cases} Q_i^s & i \neq 1,2 \\ Q_1^s + \delta Q & i = 1 \\ Q_2^s - \delta Q & i = 2 \end{cases} \quad (3)$$

Assuming that δQ is small enough and that the offer at the date i is independent of the price at the date j, this distribution generates the respective price series (international and farm gate) p_i^{II} and

$$w_i^{II} = p_i^{II} - Cs \quad (4)$$

We easily show that the different series of prices (international and farm gate) generated by distributions (I) and (II) have the same average. We also show that:

$$p_1 > p_1^{II} \text{ and } p_2^{II} > p_2 \quad (5)$$

Therefore, we have:

$$w_1^I > w_1^{II} \text{ and } w_2^{II} > w_2^I \quad (6)$$

These results are summarized in the Figure 4 to highlight the reduction of price volatility when we switch from distribution (I) to distribution (II). We notice that the difference between prices (international and farm gate) of periods 1 and 2 is greater in distribution (I) than in distribution (II).

Thus, the price series (international and farm gate) generated by distribution (II) are less dispersed around their respective average than those generated by distribution (I). Distribution (II) therefore enables to reduce volatility and it therefore enables a partial stabilization of prices compared to distribution (I).

The question which arises is then: How, concretely, can we transfer a part of the supply of period 2 towards period 1?

The transfer of the supply of period 2 (when the international price is low) towards period 1 (when the price is high) consists, for the regulation body, in using strategically its buffer stock to stock out a certain quantity of products when the price is high and stock in when the price is low. This way of acting has a double advantage: on the one hand, you can take advantage of periods when the prices are high, and on the other hand, anticipate so as impacting the prices when they are low.

This behaviour is essentially what the trading firms have, with the difference that, concerning the markets of coffee and cocoa in Côte d'Ivoire, the stabilization body is state-controlled and has the advantage of controlling approximately 50% of the global supply of agricultural raw materials (concerning cocoa) and perfectly mastering the information relating to supply in those markets.

At the international level, there is for coffee and cocoa a fairly significant number of trading firms, which individually have a low market share concerning the storage of products, but they play a significant role of intermediation. These trading firms in their "selfish" behaviour of profit research (through stocking out or storage, depending on whether the price is high or low), indirectly enable a significant

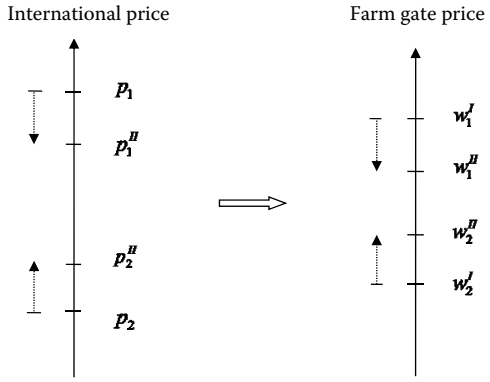

Figure 4. Reduction of price volatility

Source: The author

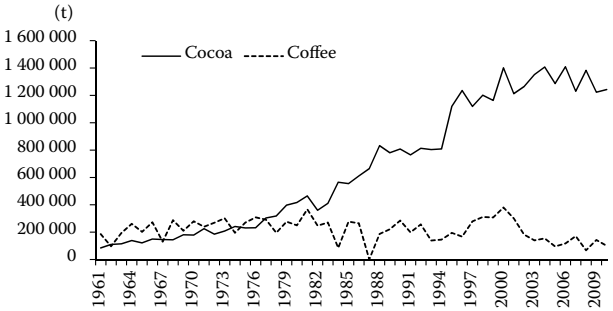

Figure 5. Evolution of the production of cocoa and coffee in Côte d'Ivoire (1961–2009)

Source: Based on the FAO data

reduction of fluctuations of the international prices of agricultural products. Indeed, the demand for storage is added to the demand of firms for the purchase of raw materials and thus enables to reduce the inelasticity of the global demand, and to compensate for this characteristic of agricultural goods which generates the price volatility.

CONCLUSION

This study allowed us to visit the theory of the agricultural price volatility, to analyze price fluctuations of coffee and cocoa, to study the possibility of a relatively efficient stabilization policy.

It appears from this study that the immediate cause of price volatility is the inelasticity of demand with respect to the price. Thus, faced with an inelastic demand, any fluctuation of the supply (as small as it is) causes a fluctuation of the price (the price is the result of the equalization of supply and demand). The debate of the economists is then about the causes of the fluctuations of supply; some evoking exogenous fluctuations and the others endogenous fluctuations.

The market analysis of coffee and cocoa helped to highlight the volatility of prices of these two products. We showed that the series of the international prices and the farm gate prices are highly dispersed around their respective average, and that volatility affects the series of the monthly average prices as well as the annual ones.

The construction of a model of partial stabilization has enabled to highlight an "active" stabilization mechanism of the prices of coffee and cocoa which is relatively efficient compared to the mechanism which currently exists. Indeed, we show that a stabilization body in the Ivorian coffee and cocoa sector, which sets up a buffer stock and strategically uses this stock has the advantage of significantly reducing the volatility of international prices and the farm gate prices.

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Received: 18th December 2012
Accepted: 14th March 2013

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