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Abstract:
As consumers' demand for organic products and especially organic food grows, organic certification for tropical fruit is increasingly promoted in many developing countries. Certified organic pineapple exports only started taking off after 2005 and are rapidly increasing. The organic and conventional fresh pineapple value chains are dominated by certification standards and large multinational companies respectively. The two markets, however, still differ greatly in size. We analyze if this influences the price structure in these markets. Specifically, the paper attempts to single out the existence and direction of causality between the conventional and organic pineapple price using the European pineapple market as an example. We study spatial price transmission, i.e. the difference in prices between the markets for organic and conventional pineapple. The results indicate the dependence of organic market price movements on conventional ones. On the contrary, the conventional market is not affected by this niche market.

Keywords: price transmission, private standards, organic agriculture, organic markets
JEL classification: F14, L11, L15, O13, Q13, Q17

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1. Introduction

The market for fresh pineapple has been growing rapidly during the past years. Like other tropical fruit, pineapple is grown mainly in developing countries. Production of conventional pineapple is mostly dominated by big transnational companies that own large-scale plantations. As a consequence, it might be difficult for small farmers to participate profitably in the market. However, not only did the demand for pineapple in general increase over the past, but organically grown pineapple have also become more popular among consumers. Nevertheless, organic pineapple is still a niche market, which is not controlled by a few big companies, yet. Like other organic products, organic pineapple earns a premium price on the market compared to conventional varieties. Hence, the shift from conventional to organic production might be an opportunity for small and middle-sized farmers to reap higher returns from their investments. Since this change, however, might require costly adjustments of, for example, production techniques as well as considerable costs for certification, several aspects of this market and organic production need to be considered when trying to determine its profitability. One aspect is the size of the price premium and if it can persist over time. Another one is if prices for organic pineapple behave differently from prices for conventional pineapple. For example, one might ask if organic prices are more or less stable than prices for conventional pineapple, and if organic and conventional pineapple can be seen as two different products or if the markets for them are interlinked with each other. Differences between conventional and organic pineapple production that are not related to the price received on the market, such as the unit cost or the depletion of the soil, are also important. In this paper, however, we restrict our focus to the price dimension of the profitability of organic pineapple production. This aspect has not been studied before, despite its importance for the further promotion of organic certification in developing countries. We analyze spatial price transmission between conventional and organic pineapple on the European market by looking at prices for pineapple from Ghana, Côte d'Ivoire and Costa Rica respectively. Our observations suggest that there does not seem to be a trend for a diminishing premium so far. Moreover, our price transmission analysis shows that although price variations for organic pineapple seem to be larger in magnitude over a longer horizon, in the short run organic prices tend to be more stable. Whereas the conventional price seems to be unaffected by the organic price behavior, organic prices follow conventional prices with a lag, which smoothes short-run fluctuations for organic pineapple prices. Such a delayed price transmission also helps forecasting future price movements in the organic market. More stable and predictable prices might be beneficial for farmers in developing countries, as they guarantee more certainty for the producer.

The rest of this paper is organized as follows. First, an introduction to the European market for pineapple will be given. Secondly, the price data and price evolution for conventional and organic pineapple will be presented. Afterwards, the methods used to analyze spatial price transmission will be described, which will be followed by the results of this analysis. Finally, we will conclude.

2. The market for fresh pineapple

Pineapple is well suited for this analysis because the market is relatively homogeneous, compared to, for instance coffee, where a lot of different varieties and quality grades prevail. The world market for fresh pineapple is dominated by one variety (although this variety may change from time to time) and kilogramme prices are relatively uniform across fruit sizes and qualities. In addition, fresh pineapple is a tropical fruit with an exceptional development. The share of fresh pineapple in the whole pineapple market has been rising from 12.5 percent in the early 1960s to 26 percent in 2005 (FruiTrop, 2008)[1], where world pineapple production totals nearly 16 million tonnes. In 2007, the main consumers of fresh pineapples were the US (2.5 kg per capita per year), followed by the EU (2.1 kg per capita per year) and Japan (1.3 kg per capita per year) (FruiTrop, 2008). Measured by volume and value of net imports, the European Union (EU 27) is the world's largest consumer. Fresh pineapple in Europe comes mainly from Latin America (around 80 percent) and Africa (10 - 15 percent, see Figure 1). The market in the United States is completely dominated by Latin American pineapple, complemented by some local production. In order to study

[1] Since the analysis is concerned with prices for fresh pineapple only, figures for processed pineapple are omitted here.

the price developments of pineapple produced in various world regions, we have therefore chosen the European market as a case study. The European market for fresh and dried pineapple has grown on average by 19 percent between 2003 and 2007. The evolution in the geography of pineapple production for the fresh pineapple market is marked by the takeover of Central America from Africa as Europe's major supplier. Up to the late 1990s, the EU market was dominated by pineapples from West Africa, especially from Côte d'Ivoire.

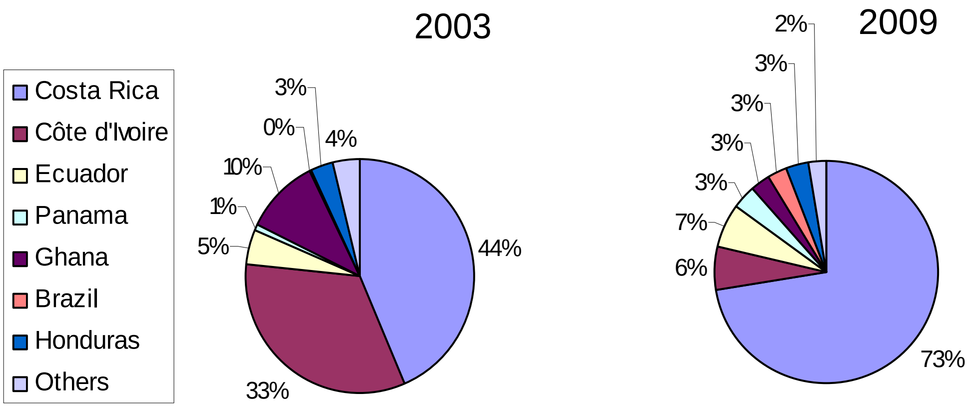
Costa Rica, almost absent from the world market in the late 1980s, is now by far the largest fresh pineapple exporter to Europe and North America. Whereas in 2000, with 24 percent, Costa Rica held a lower market share in Europe than Côte d'Ivoire with 29 percent, its share of the European market for fresh pineapple has grown from 44 percent in 2003 to 73 percent in 2009 (Figure 1). Exports from Côte d'Ivoire have meanwhile developed the opposite way. Being the European market leader in the 1970s, Côte d'Ivoire's market share has been constantly declining since then and was around 6 percent in 2009 (Figure 1). Ghana is the second largest African pineapple exporter to Europe after Côte d'Ivoire and is expected to increase its market share.

The rise of Costa Rica as a market leader for fresh pineapple in Europe is strongly linked to a new pineapple variety called MD2 that was introduced by the company Fresh Del Monte Produce in 1996. This variety, grown exclusively in Latin America at that time, rapidly took over the US market. The success of MD2 has been explained by a combination of the characteristics of this variety and commercial strategy (e.g. Fold and Gough, 2008). After the expiry of patent protection in 2003, the wave quickly swept to Europe. The resulting brisk upward trend in MD2 pineapple supplies in the US and Europe induced a price fall for the MD2 variety[2]. Not only did the entry of a large number of new producers exert a downward pressure on prices, it also translated into greater price volatility (Faure et al., 2009). By today, the price premium on MD2 which was originally up to 100 percent is almost non-existent. Meanwhile, the formerly dominant variety, Smooth Cayenne, slipped to the bottom of the price spectrum for fresh pineapple and lost market share from over 90 percent at the end of the 1980s to

[2] The price development for MD2 is explained in more detail in section 3.1 below and shown in Figure 5.

almost nonexistence today (Loeillet, 2004). The MD2-variety has become the standard variety consumed in the EU.

Figure 1: European Market Shares in Fresh and Dried Pineapple 2003 and 2009



Source: Eurostat Comext

Notes: classification: pineapple fresh or dried, 90percent sea, 10 percent air freight, varieties: Smooth Cayenne, MD2, Victoria

The most globally traded conventional fresh tropical fruits (bananas and pineapples) are primarily produce in large-scale plantations owned by transnational companies who also engage in contractual arrangements with local producers. A few large multinational companies mostly control the supply of pineapples to the large retailers within a tightly structured supply chain. This is not yet the case for organic produce, which is based to a larger extent on smallholders and less on vertically integrated supply chains. The diversification of exports to niche markets could increase profitability especially for developing countries with a strong smallholder share in production such as Ghana, where an estimated 50 percent of pineapple is produced by smallholders. In such smaller markets they can exercise more bargaining power whilst at the same time meeting the latest requirements on quality, traceability, packaging, and standards such as GLOBALGAP[3] or organic might hold the key to good profits (Minot and Ngigi, 2004). Most organic pineapples for the EU market are produced in Ghana with an increasing amount coming from Costa Rica (CBI Market Survey,

[3] GLOBALGAP is a private standard founded in 1997 as EurepGAP by European retailers. It is a business-to-business standard with the aim to establish one standard for Good Agricultural Practices (GAP).Many of the large European retail and food service chains, producers/suppliers are members (www.globalgap.org).

2008). Unfortunately, there are no official trade statistics on organic products and there is no data available that shows the development of volumes and values of the world pineapple market divided according to conventional and organic products. However, it is estimated that up to 40 percent of total pineapple exports from Ghana are organic and/or fair-trade certified.

Trade in organic food products differs from trade in other food commodities due to the organic certification requirement. Certification according to regulation (EC) 834/2007 and (EC) 889/2008 is a prerequisite for any producer wishing to export organic produce to the European market. Organic certification requires producers to adopt certain environmental standards, e.g. to refrain from using synthetic inputs. The rapid growth of the organic food sector with an average growth rate of 13 percent between 2002 and 2006 creates niche market opportunities (US$ 46 billion in 2007 (double the value of 2000), expected to increase to US$ 67 billion by 2012 (UNCTAD, 2008; Willer et al., 2008). In the EU, it is now between 2.5 and 4.5 percent of total food sales. For organic pineapples market growth has been even larger. It is assumed that the permission to use ethylene for flower induction in organic production in 2005 (calcium carbide only in Germany in 2009) played an important role for the high growth rates in the organic pineapple market. Taken as a whole, Europe is the largest market for organic products, and although the available data is very sketchy and often outdated, it is assumed that this holds also for the organic pineapple market. According to estimations by the Sustainable Markets Intelligence Center (CIMS), the European market for organic pineapple was about five times the size of the US market in 2004[4].

However, not only the growing demand makes organic cultivation attractive for producers. Some studies explain the growing interest in organic agriculture in developing countries also by the fact that it requires less financial input and places more reliance on the natural and human resources available (e.g. Willer et al., 2008). Hence, it is worthwhile to analyse if switching from conventional to organic production might indeed result in higher profits for farmers. As a starting

[4] The US National Organic Program allowed the use of ethylene gas for flower induction in pineapple in 2002, the EU only in 2005. It is therefore expected that this difference is even larger today.

point, potential revenues might be evaluated by looking at the price developments for organic compared to conventional pineapple, which is the focus of the next section.

3. Descriptive analysis of price data

3.1 Evolution of prices for conventional pineapple

Average monthly wholesale market prices in € per kg from several European destination countries[5] are used for our empirical analysis. As data on organic pineapple prices are neither publicly recorded, nor readily available from the parties involved in the trade, the data collection process was tedious, and we had to use a number of data sources. The data is taken from International Trade Centre's market news service and from several European fruit trading companies. We distinguish between organic and conventional and between air and sea transported pineapple. For conventional pineapple we also distinguish between MD2 and all other pineapple varieties. We do so because of the differences in the markets described above. Data for conventional pineapple could be obtained from three countries of origin, namely Costa Rica, Côte d'Ivoire and Ghana. These countries rather than just one of them have been chosen in order to prevent that the price behaviour observed just reflects the change in the market leader and not a general behaviour in the pineapple market. Monthly prices for conventional pineapple were averaged over all destination countries for each of the three countries of origin. Through this averaging, three time series over the period January 2001 to August 2009 could be obtained[6]. When necessary for the analysis, missing data were imputed. The data for organic pineapple prices could be obtained over the period September 2007 to August 2009. Unfortunately, the data for organic pineapple prices does not allow splitting them up into the new variety (MD2) and other varieties. Moreover, the data for the organic market describes prices for pineapple from Latin America only.

[5] The countries included in the analysis are the following: Austria, Belgium, Denmark, Finland, France, Germany, Holland, Italy, Spain, Sweden, Switzerland and UK.
[6] Due to data constraints, the time series for prices from Ghana only reach until January 2009.

Transport costs constitute an important factor for pineapple pricing in Europe. They account for up to 50 percent of the price for both sea and air transport (0.38 € and 0.83 € respectively). Consequently, the prices for sea- and air-transported pineapple differ greatly and are hardly comparable. Since the majority of pineapple is transported by sea, we focus on pineapple transported by sea.

The evolution of prices over the last 10 years for conventional pineapple from the three sample countries is shown in Figures 2 to 5. Figure 4 shows the development of the MD2 variety from Costa Rica, the other graphs include only other varieties (of which the Smooth Cayenne is the dominant variety). The graph for Costa Rica, where the MD2 variety originated from, shows clearly the high starting point of the MD2 variety and the strong downward trend in its price since 2002. From Figures 4 and 6 it appears that the other varieties have also experienced a downward trend in their prices on the European market. However, this trend is less profound and started later than the decline in the price of MD2. The price development for these other varieties is similar for pineapple from Ghana and Côte d'Ivoire, as can be seen in Figures 3 and 4. The only exception is that the Ghanaian pineapple price, after having reached a record low in 2006-2007, has increased again recently[7]. Up to the year 2000 Ghanaian (Smooth Cayenne) pineapple was highly priced due to a perceived high quality of the fruit[8]. Hence, it seems that the decline in pineapple prices from West Africa is a general trend observed in the market rather than just a result of the market power shift to Latin America.

[7] Since the data for MD2 from Ghana and Côte d'Ivoire are very limited, graphs of the corresponding time series might not be informative and are, therefore, omitted here.
[8] According to information obtained through interviews with fruit importers in Germany in September 2009 and Ghanaian producers, the reason was that Ghanaian producers initially had difficulties with the cultivation, and thus the quality, of the MD2 variety. This depressed the prices for Ghanaian pineapple.

Figure 2: Wholesale prices for conventional pineapple from Ghana

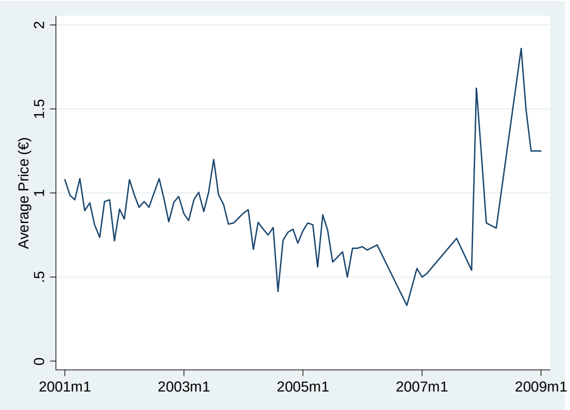


Figure 3: Wholesale prices for conventional pineapple from Côte d'Ivoire

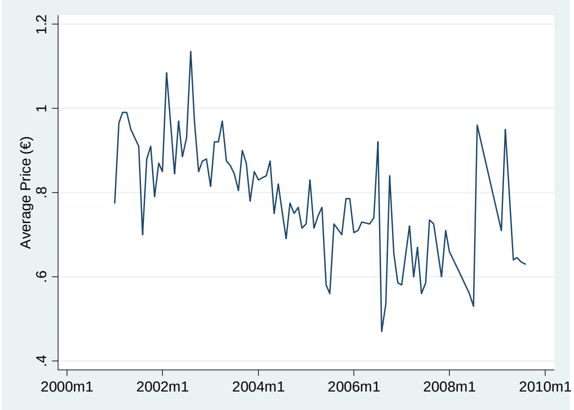


Figure 4: Wholesale prices for conventional pineapple from Costa Rica (only MD2)

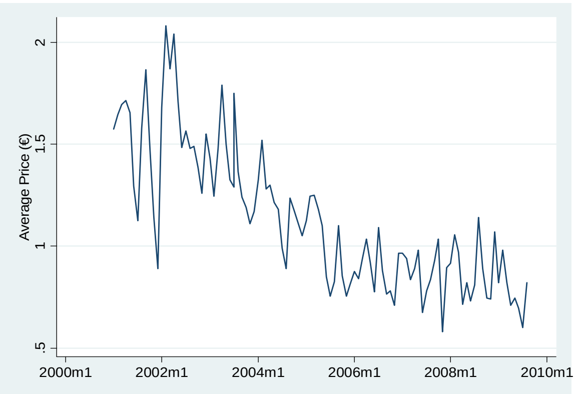
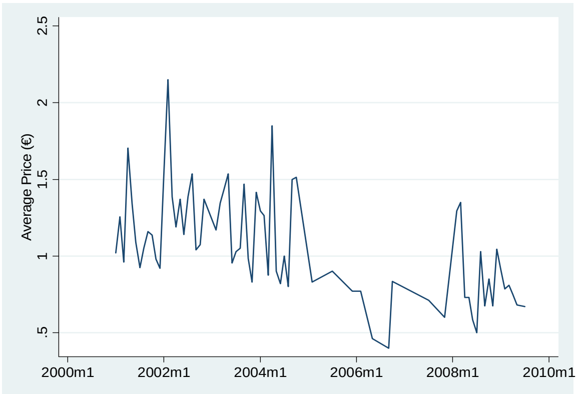


Figure 5: Wholesale prices for conventional pineapple from Costa Rica



3.2 Organic premiums

Organic certification is a value-addition method. In fact, organic products are usually sold at significantly higher prices than conventional products. According to CBI (2008) organic products generally fetch price premiums of between 15–25 percent and numerous scientific studies have also shown the existence of price premiums for organic products (Teisl et al., 2002; Nimon and Beghin, 1999; Bjorner et al., 2004).

Concerning potential benefits of organic farming for producers, an important question is if such price premiums can be sustained in the long run or if they will also vanish, as in the case of the MD2 variety. The recent development in the banana market shows, for example, that a price premium for organic products cannot be guaranteed over time[9]. Premiums have also been declining for other organic food products due to increasing competition in the organic sector as well as economies of scale in shipping, processing and distribution of some products as a result of increased levels of trade (Didier and Lucie, 2008). Whether this is a temporary development or a long-term trend depends on the value added by the organic certification label. Thus, the answer lies in why these premiums exist in the first place. Price premiums include a reflection of the "value added" by the organic nature of the production of the product (UNCTAD, 2006).

Our analysis shows that, for the period from September 2007 to August 2009, price premiums have fluctuated between 0.00 € and 0.76 € with mean and standard deviation of 0.50 € and 0.20 € respectively. As can be seen from the graph below, a declining trend cannot be observed over this period. The comparison of the price behaviour of conventional pineapple and the price premium shows, however, that the premium and the conventional price moved in opposite directions over the observed time period. This might suggest that either the price for organic pineapple is more stable and has less seasonal fluctuations than the conventional pineapple price, or that prices for organic and conventional pineapple even experience contrary movements. The latter, however, seems to be ruled out, as can be seen in Figure 6. In Figure 7 it seems that, even though organic prices have a larger variation over time, conventional prices vary more frequently and short-term fluctuations are larger for conventional than for organic prices. This might imply that over short periods of time, organic prices are indeed more stable.

There are several possible explanations for this observation. First, niche markets have been reported to have less volatile prices. This is true for current prices for the "old" Smooth Cayenne variety compared to the MD2 (e.g. Paqui, 2007) and

[9] Price premiums for organic bananas have steadily declined. Nowadays, prices for organic bananas can be close to or even the same as for the conventional counterpart (based on data collected by authors in supermarkets in Northern Germany).

could also be true for the organic market compared to the conventional market. Second, the fierce competition between very few companies could make the conventional market more volatile, because it depends completely on the behaviour of very few actors (compared to a less oligopolistic structure in the organic market). Third, for conventional pineapple, the European market is dependent on the Latin American supply position. For organic pineapple, this dependence does not (yet) exist. Hence, for instance weather conditions or new plant diseases in this part of the world do not exert such influence on the organic pineapple market in Europe.

Another possibility, however, is that organic and conventional prices, while not moving together simultaneously, follow each other with some lag. This is further explored in our econometric analysis below.

Figure 6: The Price Premium for Organic Pineapple

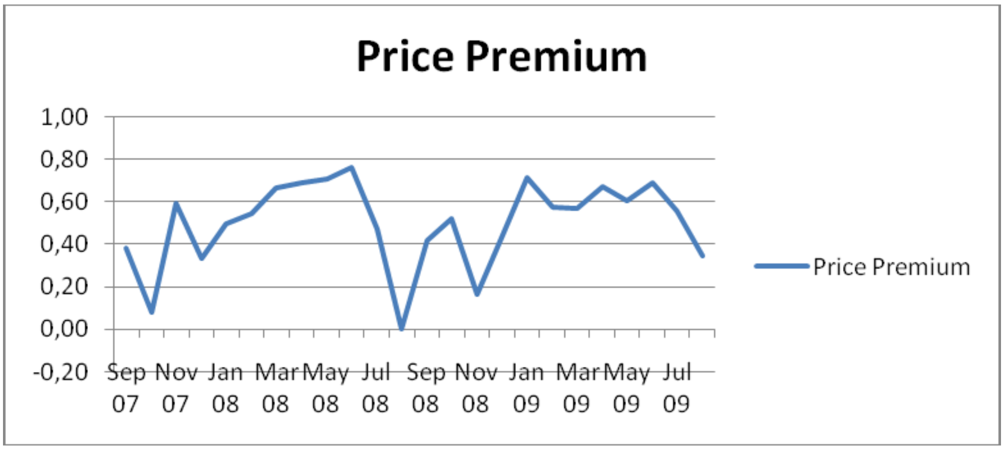


Figure 7: The Price Premium for Organic Pineapple and the Price for Conventional Pineapple

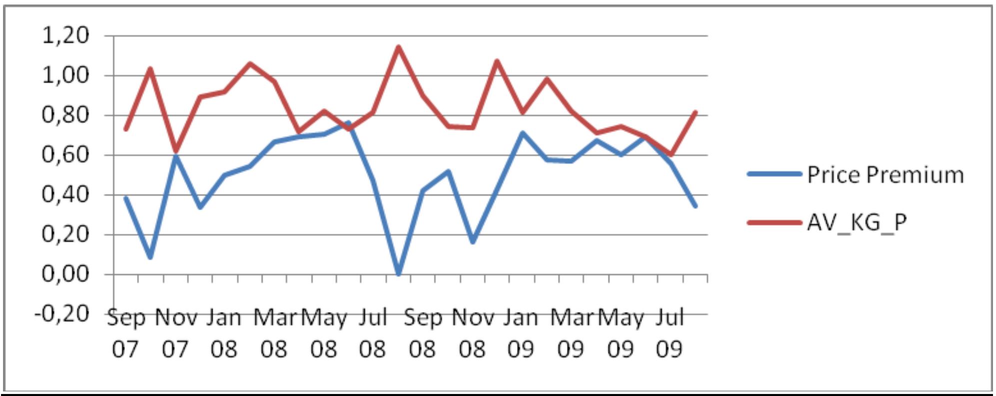
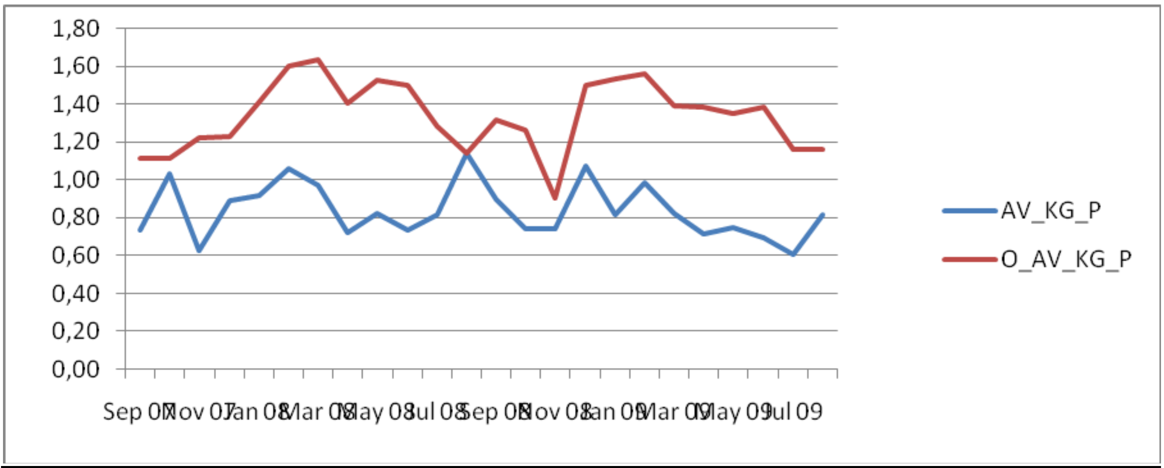


Figure 8: The Prices for Organic and Conventional Pineapple



Notes on Figures 6-8: AV_KG_P is the average monthly European wholesale price for pineapple per kilogram. O_AV_KG_P is the average monthly European wholesale price for organic pineapple per kilogram.

4. Econometric analysis of spatial price transmission

The notion of price transmission is used in different contexts in the literature. First of all, some authors test for price transmission within the value chain of a product. For example, it is analyzed if the world price of some commodity is transmitted to the domestic producers. Other authors are rather interested in the difference of prices between different markets within one country, for example, the so-called spatial price transmission. In this paper, we study spatial price transmission between the markets for organic and conventional pineapple from Ghana, Côte d'Ivoire and Ghana in the European market.

When analyzing price transmission different price series are usually regressed on each other in order to find a possible relationship between them. For, example, in their study of vertical price transmission in different agricultural markets in Brazil, Aguiar and Santanta (2002) regress the log of retail prices on the log of farm prices. However, if the time series are non-stationary, it might be the case that a relationship is established even though the series are independent from each other as shown by Cramer and Newbold (1974). In order to avoid these spurious regressions in case of non-stationarity, many authors have used conintegration techniques to study price transmission and long-run relations between different prices (e.g. Meyer & Cramon-Taubadel, 2004). Abdulai (2000), for example, employing threshold cointegration tests finds a long-run relation between wholesale and retail prices in the Ghanaian maize market. Rapsomanikis et al. (2003) also use cointegration methods and error-correction models, and develop a comprehensive framework to test for the price transmission between local coffee markets of Ethiopia, Rwanda and Uganda and the international market. They suggest starting by testing for integration of each single price series utilizing the Augmented Dickey-Fuller and the Phillips and Peron tests. In case the different time series do not have the same order of integration, the authors suggest that prices cannot be cointegrated and hence simpler methods, as employed for example by Aguiar and Santana (2002), can be applied.

4.1 Unit root tests for conventional pineapple prices

Given these arguments, we start our analysis by testing prices in the organic and conventional markets for unit roots. As explained above, this is important in order to avoid spurious regressions when studying spatial price transmission. For conventional prices, the time series of the three countries of origin are tested separately. In addition, panel unit root tests are conducted. For Côte d'Ivoire, several destination countries had enough data to form monthly time series over the period 2001 to 2006. These countries are Germany, Sweden, Holland and France.

For the individual time series unit root tests, the traditionally employed Augmented Dickey Fuller (ADF) proposed by Dickey and Fuller (1979) has been used. However, it has recently been documented that this test performs badly in the presence of small samples as the ones used in this paper. In addition, the ADF test has low power in distinguishing highly persistent stationary processes from nonstationary processes and the power of these unit root tests diminishes as deterministic terms are added to the test regressions. Elliot, Rothenberg and Stock (1996) have proposed an alternative test that addresses the above shortcomings. Consequently, this test has also been used to test for unit roots in the variables.

For the augmented Dickey-Fuller test the model looks as follows:

$$\Delta y_t = \alpha + p\, y_{t-1} + \sum_{i=1}^{\tau} \beta_i \Delta y_{t-i} + \gamma t + \varepsilon_t$$

where α is a constant, y_t indicates the respective price, t is a trend, ε_t is the error term, and ρ, β_i and γ are the regression coefficients. The null hypothesis claims that $\rho=0$, i.e. the prices experience a unit root. In order to employ this test, it is necessary to determine the optimal number of lags of the prices to be included. One approach often employed is to use the Schwartz criterion or the AIC criterion. However, as shown by Perron and Ng (2001), in the presence of large negative moving-average components of the error term, these information criteria usually choose a lag length that is too short. This in turn leads to size distortions and hence overrejection of the null hypothesis. Perron and Ng (2001) propose a modified version of the AIC (MAIC) that improves on these problems. In the analysis below both the Schwartz criterion as well as the MAIC are employed.

As already described shortly above, Elliot, Rothenberg and Stock (1996), propose a modification to the ADF test (DF-GLS), which increases the power of the general ADF test. The authors propose to first detrend the data using the generalized-least-squares method. The following equation is then estimated to test for a unit root:

$$\Delta y_t^d = \alpha + p\, y_{t-1}^d + \sum_{i=1}^{\tau} \beta_i \Delta y_{t-i}^d + \gamma t + \varepsilon_t$$

where y_t^t now denotes the generalised-least-square detrended variable. The null hypothesis is the same as for the general ADF. To determine the optimal lag length, the same criteria as above have been employed[10]. For inference on the detrended data, the critical values tabulated in Elliott, Rothenberg and Stock (1996) have been used. Some selected results are presented below.

[10] In contrast to the general ADF test, using the DF-GLS requires a balanced panel. Therefore, missing values have been imputed when necessary for this test.

The time series for conventional prices of MD2 and other varieties were tested separately. As it is visible from Tables 1 and 2, the time series for the prices of conventional pineapple other than MD2 seem to be stationary or trend stationary for all three countries of origin using the Schwartz criterion for lag length selection. The same is true for MD2 prices from Costa Rica. Since data for MD2 from Côte d'Ivoire and Ghana is very limited, it might not be representative and is therefore omitted here. The trend stationarity of the data is largely supported by both the standard ADF test as well as the modified DF-GLS test. However, using the MAIC criterion, the null hypothesis of a unit root in the data can mostly not be rejected at any significance level. This result might reflect the problem of overrejection of the null hypothesis when using the Schwartz criterion, as explained above[11].

Table 1: T-statistics of ADF-test for conventional prices

	Lags by Schwartz criterion		Lags by MAIC	
	no trend	trend	no trend	trend
Côte d'Ivoire	-1.146	-4.052**	-1.097	-1.810
Ghana	-5.203***	-5.577***	-0.810	-2.369
Costa Rica	-3.566**	-5.819***	0.394	-3.503**
Costa Rica/MD2	-3.128**	-6.410***	-0.329	-1.451

Note: (***) indicates a rejection of the null hypothesis at the 1percent significance level, (**) at the 5percent significance level, (*) at the 10percent significance level.

[11] The unit root tests in first differences clearly indicate that the time series of conventional prices are at maximum I(1). The results of these tests are omitted here, but are available from the authors upon request.

Table 2: Test statistics of DF-GLS test for conventional prices [a]

	Lags by Schwartz criterion	Lags by MAIC
Côte d'Ivoire	-3.093**	-1.363
Ghana	-4.549***	-0.810
Costa Rica	-5.554***	-1.725
Costa Rica/MD2	-5.045***	-1.261

Note: (***) indicates a rejection of the null hypothesis at the 1percent significance level, (**) at the 5percent significance level, (*) at the 10percent significance level.

[a] By default, the test includes a trend.

Although the tests above are frequently used when testing for unit roots in time series data, they are known to have fairly little power. Pooling individual time series and applying panel unit root tests, however, can significantly improve the power compared to simple tests (Maddala and Wu, 1999). Therefore, in addition to the time series tests above, different panel unit root tests for non-MD2 pineapple prices from Côte d'Ivoire have been employed in order to exploit the panel structure of our data set. Instead of just testing prices averaged over all destination countries, four single time series from Germany, Holland, Sweden and France have been pooled together.

The Fisher test as developed by Maddala and Wu (1999) with the null hypothesis of a unit root in every individual time series and the alternative hypothesis of at least one stationary series has the test statistic $\lambda = \sum_{i=1}^{N} \log \pi_i$ with a χ^2_{2N} distribution. Here N is the number of separate time series in the panel and π_i is the p-value from a simple augmented Dickey-Fuller test on the i^{th} series. As suggested by tables 3 the test rejects the null hypothesis.

Table 3: Fisher Test

	τ=0	τ=1	τ=2	τ=2 with trend
λ	41.9235***	22.4705***	26.6692***	20.9889***

Note: (***) indicates a rejection of the null hypothesis at the 1percent significance level, (**) at the 5percent significance level, (*) at the 10 percent significance level.

A second test has been suggested by Levin, Lin and Chu (2002). Contrary to the Fisher test, the alternative hypothesis states that all individual time series in the panel are stationary. Moreover, the test restricts the AR(1) coefficient p to be the same across all series and estimates the following model:

$$\Delta y_{i,t} = \alpha_i + p\, y_{i,t-1} + \sum_{j=1}^{\tau} \beta_{i,j} \Delta y_{i,t-j} + \gamma t + \varepsilon_{i,t}$$

The null hypothesis hence states that in a pooled regression p=0. As can be seen in table 4, in accordance with the results above, this test also rejects the null hypothesis in favour of the alternative.

Table 4: Levin Lin Chu Test

	τ=0	τ=1	τ=2	τ=2 with trend
Test-statistic	-11.260***	-8.070***	-6.896***	-7.147***

Note: (***) indicates a rejection of the null hypothesis at the 1 percent significance level, (**) at the 5percent significance level, (*) at the 10 percent significance level.

The two tests mentioned described above are so-called first generation panel unit root tests. They rely on the assumption of cross-sectional independence of the individual time series. In the presence of dependence, however, these tests might experience large size biases (O'Connell, 1998). In order to take cross-sectional dependence into account, second-generation panel unit root tests were developed. Since it is plausible that the price of pineapple from Côte d'Ivoire are correlated across destination countries, especially since the countries in our sample are all members of the common European market, a second-generation test proposed by Pesaran (2003) is analyzed. The test is based on the following model:

$$\Delta y_{i,t} = \alpha_i + p_i \; y_{i,t-1} + \varepsilon_{i,t} ,$$

with $\varepsilon_{i,t} = \lambda_i f_t + u_{i,t}$, where f_t is an unobserved common effect of the individual series in the panel and $u_{i,t}$ is an idiosyncratic error. In order to estimate the model, a cross-sectional augmented Dickey Fuller (CADF) regression is employed, where the common factor f_t is proxied by the cross-sectional average $\bar{y}_t$ of $y_{i,t}$, and its lagged values:

$$\Delta y_{i,t} = \alpha_i + p_i \; y_{i,t-1} + c_i \bar{y}_{i,t} + d_i \Delta \bar{y}_t + \gamma t + v_{i,t} .$$

The Pesaran test statistic, also called Cross-Sectionally Augmented IPS (CIPS), is given by

$$\text{CIPS} = \frac{1}{N} \sum_{i=1}^{N} CADF_i ,$$

where $CADF_i$ is the t-statistic from an augmented Dickey-Fuller test on the i^{th} series of the panel. As table 5 shows, even when controlling for potential cross-sectional correlation among the individual series, the null of a unit root is rejected. Hence, all panel unit root tests analyzed here lead to the conclusion that pineapple prices from Côte d'Ivoire do not experience a unit root.

Table 5: Pesaran CADF Test

	τ=0	τ=1	τ=2	τ=2 with trend
Test-statistic	-5.480***	-4.102***	-3.412***	-3.434***

Note: (***) indicates a rejection of the null hypothesis at the 1 percent significance level, (**) at the 5percent significance level, (*) at the 10 percent significance level.

These results are in contrast to the above findings for individual time series data when the MAIC criterion is employed. However, the main reason for using panel unit root tests is to increase the power of the test, which means to increase the probability of rejecting the null hypothesis when it is in fact false. Hence, the contradicting results might suggest that given the low power of normal unit root tests, they might not reject the null hypothesis even though the data is stationary. Hence, the results from the panel unit root tests might be more accurate. We, therefore, might conclude that the price data for pineapple from Côte d'Ivoire is indeed (trend) stationary even if normal unit root tests are unable to show this. Since due to data limitations, the panel tests could only be used in the analysis of prices from Côte d'Ivoire, the same conclusion can unfortunately not be drawn for Costa Rica or Ghana. However, from the graphical analysis above, we assume that prices from these two countries could also be trend stationary. Figures 3 to 6 above show that prices for the old varieties fell rapidly after the introduction of the MD2 variety and only recently stabilized. Similarly prices for the MD2 variety started at a very high level and then gradually fell over several years and reached the level of other varieties recently.

4.2 Unit root tests for organic pineapple prices

In contrast to the prices of conventional pineapple, the price for organic pineapple does not seem to be stationary even when the Schwartz criterion is used to determine the optimal lag length. As can be seen from tables 6 and 7 below, the general Dickey-Fuller and DF-GLS tests either reject the null hypothesis of a unit root only at a low level of significance or do not reject it at all. Moreover, the test specifications including a trend suggest that the prices are non-stationary. Hence, the evidence against stationarity of the data seems to be more evident for organic than for conventional prices. Given these results, unit-root tests in first differences have been conducted. As Tables 6 and 7 show, it seems that similar to the conventional prices, the conclusion about stationarity depends on the lag length specified. Whereas the null hypothesis is rejected according to the Schwartz criterion, using the MAIC points towards non-stationarity even after differencing the data. Panel unit root tests for organic prices were not possible due to limited data on these prices.

Table 6: T-statistics of ADF-test for organic prices

	Lags by Schwartz criterion		Lags by MAIC	
	no trend	trend	no trend	trend
Non-differenced	-2.741*	-2.598	-2.741*	-2.598
First-differenced	-4.137***	-4.262**	-1.825	-1.843

Note: (***) indicates a rejection of the null hypothesis at the 1percent significance level, (**) at the 5percent significance level, (*) at the 10percent significance level.

Table 7: Test statistics of DF-GLS test for organic prices[a]

	Lags by Schwartz criterion	Lags by MAIC
Non-differenced	-2.650	-2.650
First-differenced	-3.724**	-1.593

Note: (***) indicates a rejection of the null hypothesis at the 1percent significance level, (**) at the 5percent significance level, (*) at the 10percent significance level.

[a] By default, the test includes a trend.

4.3 Analysis in First-Differences

According to Rapsomanikis et al. (2003), if one of the two prices, in this case the conventional market prices for pineapple, is I(0) and the other one I(1), the prices in the cannot be cointegrated over time. However, if both prices are integrated of order one, we have to test for cointegration. Even though we might conjecture from the unit root tests in association with the graphical analysis above that conventional prices for pineapple are rather stationary whereas organic prices are not, the results are not strong enough to reject cointegration of the two prices immediately. Therefore, results from the Johannsen cointegration test are shown in table 8 below.

Table 8: Johannsen Cointegration Test

rank	Trace statistic	5% critical value
0	15.18**)***)	15.41
1	5.27	3.76
2		

Note: **) indicates the rank selected by a sequence of trace statistics at 5% level.
***) indicates the rank selected by a sequence of trace statistics at 1% level.

From the table it is clear, that the null hypothesis of no cointegrating vector cannot be rejected. It might therefore be concluded that the prices in the conventional and organic market for pineapple are not cointegrated over time.

Because of lack of cointegration, only the short run relationship using the data in first differences can be analysed. We test two different hypotheses. The first one states that price movements in one market (Δp_{1t}) in time t are dependent on current (Δp_{2t}) and past price movements ($\Delta p_{2t-1},...,\Delta p_{2t-T}$) in other markets. We would like to know in particular if the conventional market acts as a price leader due to its dominance in size. The second hypothesis is that price movements are a function of past price movements in the same market (equation 2). This would imply that price dynamics in this market can be predicted on the basis of past prices.

Equation 1: $$\Delta p_{1t} = \beta_1 \Delta p_{2t} + \beta_2 \Delta p_{2t-1} + ... + \beta_T \Delta p_{2t-T} + \varepsilon$$

Equation 2: $\Delta p_{1t} = \beta_1 \Delta p_{1t-1} + \beta_2 \Delta p_{1t-2} + ... + \beta_T \Delta p_{1t-T} + \varepsilon$

where β_i indicates the responsiveness of one price movement to other price movements, and ε is the error term.

We used organic and conventional prices in first differences to test these hypotheses. Tables 9 and 10 show the regression results.

Table 9: Regression Results for Organic Prices

Variable explanations	Variables	Do_av_kg_p
		Δp_{2t}
Δp_{1t}	Dav_kg_p	0.463*
		(0.223)
Δp_{1t-1}	L_Dav_kg_p	0.450*
		(0.218)
	Observations	22
	Prob > F	0.079
	R-squared	0.224

Notes: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

p_1 is the conventional price, p_2 is the organic price.

Table 10: Regression Results for Conventional Prices

Variable explanations	Variables	Dav_kg_p
		Δp_{1t}
Δp_{1t-1}	L_Dav_kg_p	-0.492***
		(0.143)
Δp_{1t-2}	LL_Dav_kg_p	-0.224
		(0.179)
	Observations	21
	Prob > F	0.01
	R-squared	0.217

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

p_1 is the conventional price, p_2 is the organic price.

We conducted several different specifications, including different price variables, and also including more lags and a constant. Price differentials in prior periods (more than one period) did not seem to influence current price differentials. We also tried to account for seasonal variations by including a dummy for high and low seasons in one of the specifications. The ones reported here are the most parsimonious ones. In the first model (Table 9) past organic prices were not significant and are therefore left out here. In the second model (Table 10), present and past organic prices were not significant and are therefore left out here. After testing for heteroscedasticity robust standard errors are used for the second model (Table 10). We did not find heteroscedasticity in the organic specification (Table 9). We also test for serial correlation and regression specification (using Ramsey's (1969) regression specification-error test (RESET) for omitted variables)[12].Although the explanatory power of the models is not very strong they still tell us what we want to know[13].

Firstly, organic price differentials are caused by current and past conventional price movements, thus confirming the first hypothesis. This indicates the

[12] The detailed results are available from the authors upon request.
[13] Prices are also dependent on other factors, such as quality or market imperfections, which are not included here.

dependence of organic market prices on conventional ones. Past and present movements of the organic price are not significantly different from zero. Furthermore, an increase in conventional price differences leads to an increase in organic price differences now and in the next period. This pattern can also be observed in Figure 8 in section 3.2, where organic price movements seem to follow conventional ones with a lag. The fact that present and lagged Δp_{1t} have a similar effect in size helps to explain why organic prices have less frequent fluctuations (see section 3.2). When conventional prices move up and down rapidly, there are periods where Δp_{1t} is positive and Δp_{1t-1} is negative. Then the effect on Δp_{2t} is small or even zero, compared to the situation where both Δp_{1t} and Δp_{1t-1} move in the same direction. Only when Δp_{1t} and Δp_{1t-1} have the same sign, there is a strong reaction. This means that organic prices smooth fast fluctuations by conventional prices, confirming hypothesis 2 for the market for conventional pineapple. Past and present movements of the organic price are not significantly different from zero in any of the regressions that we conducted. This means that the conventional market is not affected by this niche market. On the conventional market, an increase in conventional price differences decreases price differentials in the future. This can be interpreted as a stabilizing effect on the market price and also explains the frequent and short-term fluctuations for conventional prices observed in section 3.2. It has to be further noted that the size of effects is similar in both models. An increase in price differentials of 1 € leads to an increase/decrease of 0.4-0.5 € in the same/the next period.

5. Conclusion

As the demand for organic products is growing, this paper has tried to shed light on the profitability of organic production in the pineapple sector. In particular, we have focused on spatial price transmission between organic and conventional pineapple on the European market. The analysis is set up with a development perspective since organic products in general and organic pineapple in particular are still niche markets not yet dominated by large multinationals. Hence, organic production might be a valuable alternative for developing countries with many smallholders. Our results suggest that while prices for conventional pineapple are independent of organic prices, organic price movements are responding to their conventional counterparts. This means that the conventional market development can be used to forecast the developments of the organic market. Moreover, as organic prices react to conventional price changes not only immediately but also with a lag, high-frequency fluctuations in the conventional market are smoothed out for organic prices. These results suggest that organic prices are more stable in the short-run compared to conventional ones. This is an important factor when considering organic production, since more stable prices mean less risk and more certainty in production plans especially for smaller farmers. This suggests that organic production could indeed be a profitable and more certain alternative for small farmers in developing countries. This however assumes that the price premium on organic pineapple will continue to exist. Our observations above do not show a clear trend for the price premium in the pineapple market so far. However, to understand price premiums and their behaviour in more detail, future research might investigate what part of the price premium can be attributed to the organic nature and what part to other product characteristics such as quality. This would also help to make predictions about the development of the organic premium on the producer level in the future and hence its sustainability over time. Although these questions are still to be analyzed, our results suggest already a positive effect on the price received, as well as the price stability, of switching from conventional to organic production when competing on the global market for pineapple.

6. References

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