Knowing Where Organic Markets Move Next – An Analysis of Developing Countries in the Pineapple Market

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Abstract

As consumers' demand for organic products grows, selling organic products potentially opens up profitable market participation options for farmers in developing countries. This paper studies two aspects of profitability for the producers. It uses hedonic demand theory and empirical analysis to examine the relation between conventional and organic markets using the strongly growing pineapple market as an example. The analysis confirms a nonlinear dependence of the organic market on the conventional one and a non-declining premium. The author concludes that there is a larger potential of the organic market and hence the number of farmers in developing countries who can potentially benefit from growing organic products.

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1 Introduction

Organic market growth rates are around 10%, far higher than those of conventional markets and supermarkets have started offering organic food as part of their usual range of products. Consumer demand for organic products is concentrated in North America and Europe; these two regions comprise 97% of global revenues (Willer and Kilcher, 2009). Organically grown pineapple has also become more popular among consumers. Like other tropical fruit, it is grown almost exclusively in developing countries and 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, requires costly adjustments of production techniques as well as considerable costs for certification, several aspects of organic production need to be considered when trying to determine its profitability. Another important aspect of profitability that has been disregarded in the previous literature so far is the relation between the organic market and the conventional one and its likely future development. Besides a price premium for the organic product this includes the co-movement of the two prices. In this paper we restrict our focus to this price dimension of the profitability of organic production.

The willingness to pay (WTP) a higher price for organic food based on perceived desirable characteristics has been well-documented. The academic literature has shown the existence of a, quite variable, price premium for organic food products (e.g. Boland and Schroeder, 2002; Huang, 1996; Loureiro and Hine, 2002; Thompson, 1998). We take a different approach and deduct dynamic characteristics of the demand functions from price behavior over time. Thereby we are able to provide more general results than by using survey based methods that use cross-section data based on choice experiments rather than on actual buying behavior over time (Huang and Lin, 2007 is an exception). Although our method is indirect it has the advantage of measuring what consumers are actually buying and paying in the marketplace when they have a choice between organic and conventional produce. Despite its importance for the further promotion of organic certification in developing countries, this has not been studied before.

Applying state of the art time series methods, we analyze spatial price transmission between conventional and organic pineapple on the European market

by looking at prices for pineapple from Africa and Latin America respectively. Our observations not only confirm the existence of a non-declining price premium for organic products, the analysis also shows that the conventional market seems to act as a price leader for the organic market while being unaffected by organic price behavior. However, organic prices do not follow conventional prices one by one. Our results show the existence of ranges in which organic prices are unaffected by conventional price changes. These ranges and the corresponding price adjustment behavior do not change over time, even while the organic niche market expands. Theoretically, this observation can be explained when the core demand for organic products expands faster than supply. Hence, one important implication of our analysis is the potential for the scalability of the organic market.

The rest of this paper is organized as follows. First, an introduction to the market for pineapple is given. Then, a theoretical background for the study is presented. Afterwards, the price data for conventional and organic pineapple is described and spatial price transmission between the organic and conventional markets is analyzed using time series techniques such as co-integration and vector error correction models. The paper ends with a conclusion.

2   The Market for Pineapple

Pineapple is well suited for this analysis because it is a relatively homogeneous good, compared to, for instance coffee, where a lot of different varieties and quality grades prevail. This homogeneity is relevant in trade and exists because it is difficult to control for quality of single pineapple at low transaction costs. In the definition of Nelson (1970) pineapple can be seen as an experience good.

The world market for fresh and dried pineapple[1] is dominated by one variety (although this variety may change from time to time) and kilogram prices are relatively uniform across fruit sizes and qualities. In addition, the fresh pineapple market has been recording exceptional growth rates: the European market for fresh and dried pineapple has grown on average by 19% between 2003 and 2007

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[1] Since in market statistics fresh and dried pineapple are generally grouped together, we do so too in this paper.

(FruiTrop, 2008),[2] where world pineapple production totals nearly 16 million metric tons. 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%) and Africa (10–15%, Figure A.1). The market in the United States is completely dominated by Latin American pineapple, complemented by some domestic production. In order to study the price developments of pineapple produced in various world regions, we therefore chose the European market as a case study.

Africa had been Europe's major supplier of fresh pineapples until it was replaced by Central America. Up to the late 1990s, the EU market was dominated by pineapples from West Africa, especially from Côte d'Ivoire. Costa Rica, which was 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%, Costa Rica held a lower market share in Europe than Côte d'Ivoire with 29%, its share of the European market for fresh pineapple has grown from 44% in 2003 to 73% in 2009 (Figure A.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% in 2009 (Figure A.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 (for example Fold and Gough, 2008). In the early 2000s, the wave swept to Europe. The resulting brisk upward trend in MD2 pineapple supply induced a price fall for the MD2 variety (Faure et al., 2009). By today, the price premium on MD2 which was up to 100% at market entry is almost non-existent. The formerly dominant variety, Smooth Cayenne lost market share from over 90%

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

at the end of the 1980s to almost nonexistence today (Loeillet, 2004). The MD2-variety has become the standard variety consumed in the EU.

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 might lead to high entry barriers for small farmer market participation as indicated by many researchers (e.g. Minten et al., 2009). By contrast, organic produce is mostly produced by smallholders and does not yet rely as much on vertically integrated supply chains. For developing countries with a significant share of smallholders in production such as Ghana, the support for diversification of exports towards niche markets (for example organic markets) could therefore increase the profitability of production. In niche markets, which tend to be smaller by definition, farmers 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, 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, up to 40% 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, most importantly to refrain

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[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).

from using synthetic inputs. The rapid growth of the organic food sector with an average growth rate of 13% between 2002 and 2006 creates niche market opportunities. The market value was estimated at US$46 billion in 2007 (double the value of 2000), and is 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% of total food sales. For organic pineapples market growth has been even larger. The permission to use ethylene for flower induction in organic production in 2005 played an important role in the high growth rates in the organic pineapple market. Taken as a whole, Europe is the largest market for organic products. This likely holds for the organic pineapple market as well, although the available data is very imprecise and often out-dated. According to estimations by the Sustainable Markets Intelligence Centre (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 (Willer et al., 2008 amongst others). Hence, it is worthwhile to analyze if switching from conventional to organic production might indeed result in higher profits for farmers. As a starting point, integration of the two markets is evaluated by looking at the price developments for organic compared to conventional pineapple.

3   Conceptual Background

Consumers who buy organic products do so because of their perceived superior attributes. To the best of my knowledge an integrative theory that explains the co-behaviour of two markets for the same product but with different hedonic characteristics is lacking and therefore I apply relevant pieces from various backgrounds. I primarily use hedonic demand theory to formalize the relation between conventional and organic prices in order to provide an analytical framework for the interpretation of empirical results.

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

The hedonic approach disaggregates commodities into characteristics and estimates implicit values for units of the characteristics. The hedonic price function $p(z)$ specifies how the market price (p) of the commodity varies as its characteristics *(z)* vary (Ladd and Suvannunt, 1976) assuming that utility is derived from the properties or characteristics of goods. We focus on one attribute of interest only, the organic nature of a product, which is otherwise homogeneous. Then, the hedonic demand function is derived from standard maximization of a consumers' utility function which results in a vector of implicit prices of each property (Rosen, 1974; Epple, 1987)

Our case is a simple hedonic model, where the number of characteristics is fixed and *z* has only two values; let *z = 1* if a product is organic and *z = 0* otherwise. We add a time dimension for the price, which depends on past prices of the good in both states (organic and conventional) and other hedonic characteristics of the good. Other hedonic characteristics are time invariant. Hence if organic pineapple is on average yellower from the outside in time *t=1*, this is also the case in all other periods. In addition, if information is imperfect, rational consumers gather information about a characteristic if the marginal cost of obtaining the information is smaller than or equal to the marginal utility it generates (Combris et al., 1997). Accordingly consumers may decide to make their choice primarily on the basis of the easily accessible characteristics, for instance size and certification status. This limits the number of relevant characteristics. Since the status of *z,* the variety and the price are easy to assess, we ignore other product characteristics, i.e. we assume that they do not differ systematically between our groups of interest. These simplifications make it easier to estimate the value of the organic attribute, which can then be approximated by the price difference between organic and conventional pineapple of the same variety.[5]

We derive a number of hypotheses from the above described hedonic price theory, but also drawing on other theories such as the goal-based model (van Osselaer et al., 2012).

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[5] Furthermore, we ignore the household budget constraint because, by focusing on the organic pineapple price premium, we touch such a tiny part of the overall household budget that we can safely assume the constraint to be non-binding. Hence, we refer to the case in which households have identical incomes and characteristics, and different tastes.

Hypothesis 1: The organic price moves along with the conventional price, but with a lag.

Unlike in Rosen's (1974) original framework consumers and producers usually do not make their decisions on the basis of perfect information. In our simple example, the wholesaler, when estimating the size of the WTP for the organic product, will use the conventional price as reference. But he might only have knowledge about yesterday's pineapple prices not about pineapple sold at the same time. FOB (free on board) prices may also be pre-fixed with the supplier for a certain shipload (which takes between 10 and 15 days). These two considerations would lead to lags in the dynamic relationship between the observed prices. In addition on the supply side production cost variations are not necessarily the same when organic and conventional pineapple are grown in different places and have different pest and disease challenges.

Hypothesis 2: Cross-price elasticities are low within a certain range of price changes, and high outside this range.

The two sub-markets can be represented by two demand curves that are connected by cross-price elasticities. Imagine the price for the good with $z=0$ falls, while the price stays constant for the good with $z=1$. There is a tolerance range in which consumers do not react to this price change. This range exists due to imperfect information about the price difference between the two regimes and sluggish demand response which can be explained by habits. It is also in line with the goal-based model (van Osselaer et al., 2012) when expectations take time to adjust. Since pineapple is a perishable non-staple food product, small price ranges will not switch, postpone or anticipate buying decisions. This causes low cross-price elasticities within this tolerance range of price changes and considerably higher outside the tolerance range. The threshold above which this happens may not to be the same for all consumers, but again falls within a certain range, and hence a (fuzzy) jump in the elasticity could be possible.

Hypothesis 3: The organic premium and hence the WTP for organic products depends on the relative size of the two markets in a non-linear way.

When the organic market is expanding at a different speed than the conventional market, the premium is likely not constant over time. The supply curves move to

the right as more farmers start to produce pineapple, and the movements of the curves are interrelated, but not perfectly collinear. Using hedonic demand theory helps us to explain the existence of different consumer groups that value the organic attribute differently. These groups can be ranked according to their valuation of the attribute and this explains why the size of the premium depends on the relative size of the two markets. Changes in preferences affect both demand curves, but the size and timing of the effect may differ. To arrive at the nonlinearity we have to add two ingredients. First, supply response to a demand increase is slow, due to a three year conversion period from conventional to organic production. In addition, the length of the production cycle (11–18 months) slows down reaction time. Second, consumer valuations change over time according to empirical observations of markets. When these two effects come together non-simultaneously, this may trigger several countervailing effects and result in non-linear response.

On the one hand, the WTP for the organic attribute may decrease when the size difference between the two markets decreases. The goal of a consumer can be to purchase something special. When a niche market grows it satisfies this goal less and thus consumer valuation decreases (van Osselaer et al., 2012). This also makes sense when we separate the hedonic demand into consumer groups with different marginal monetary values of the organic characteristic (Ladd and Suvannunt, 1976) and assume that the relative WTP between groups is constant. The first consumer group that buys organic products is the one with the highest WTP, the second group has the second highest WTP, and so on. When the market grows beyond the core market (the first consumer group), it can do so only by expanding into consumer groups with lower WTP for organic. On the supply side economies of scale in production, transport (which are included and comprise up to 50% of import prices), distribution and marketing could also lead to decreasing premia due to decreasing costs that affect the supply curve.

On the other hand, if consumer preferences for organic expand fast enough, i.e. when the core market for the organic attribute increases against an inelastic short run supply, the premium rises. In the longer run more producers can start producing organically and the premium will be adjusted downwards.[6]

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[6] The production cycle for pineapple is between 11 and 18 months. Conversion to organic production takes on average three years.

In sum, we can derive information about the hedonic demand forces at work by studying the transmission between organic and conventional prices over time. We have described three different effects: lagged response, a threshold effect, and demand and supply shifts.

4 Descriptive Analysis of Price Data

4.1 Prices for Conventional Pineapple

Average monthly wholesale market prices in € per kg from Europe[7] are used in 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 major importers and wholesalers based in Europe. We distinguish between organic and conventional and focus on sea transported pineapple, hence exclude air transported pineapple.[8] We limit ourselves to the currently dominant MD2 variety. By doing so, we deliberately exclude a number of hedonic characteristics (such as the variety) that might otherwise bias our results.

The data is from the two dominant regions of origin for fresh and dried pineapple in Europe, Latin America and West Africa (Côte d'Ivoire, Ghana and Togo). Due to severe gaps in the data for single destination countries, we averaged the monthly prices for conventional pineapple over all destination countries for each of the two regions of origin. For Latin American pineapple Costa Rica has a dominant market share of over 70%. For African pineapple the data could in principle be split into Côte d'Ivoire and Ghana, which are the main sources

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[7] The countries included in the analysis are the following: Austria, Belgium, Denmark, Finland, France, Germany, Holland, Italy, Spain, Sweden, Switzerland and United Kingdom.

[8] Transport costs constitute an important factor for pineapple pricing in Europe. They account for up to 50% 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. Surprisingly, sea transport costs do not differ greatly between Latin America and West Africa even though the former is further away from European harbors (e.g. Achuonjei, 2003). The difference is negligible in per kilo prices and conventional and organic fruit can be transported in the same container.

recorded and here the prices are highly similar.[9] Through this averaging, a conventional time series over the period January 2001 to July 2011 could be obtained. The data for organic pineapple prices covers the period September 2007 to August 2011. In this section, the time series for organic and conventional prices is analyzed using descriptive and graphical methods separately and jointly. Whenever we examine both prices jointly, we restrict ourselves to the shorter period (2007–2011). Nevertheless showing the longer time series for conventional pineapple allows us to explain some general trends.

The evolution of prices over the last 10 years for conventional pineapple from the three sample countries is shown in Figures 1–3. There is a general trend towards lower pineapple prices observed in the market. The widening gap between volumes and values of EU pineapple imports in Figure 1 makes the fall in prices in general for pineapple clear. Whereas the volume of pineapple imports has more than doubled since 2003, the value of pineapple imports has increased only by about 50%.

We then look at the prices in more detail. Figure 2 shows the evolution of prices over the last 10 years for conventional pineapple from the two major origins. The graph, which includes only sea-freight MD2 pineapple, shows clearly the strong downward trend in its price until 2005.[10] The price development for both regions of origin is similar. However, up to 2007 the price for African pineapple was consistently lower than for Latin American pineapple. According to information obtained through interviews with experts in Europe in September 2009 and Ghanaian producers, this fact is attributed this to the initial difficulties with the cultivation, and thus the quality, of the MD2 variety in West Africa. In addition, Costa Rica had a first mover advantage.

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[9] For destination countries, it is slightly more complicated since wholesalers are often active in several countries and the country recorded is often, but not always the country where the harbor is. We tested for differences in the time series data of different countries and did not find significant differences in the mean prices. There are however some differences in the maxima and minima. I also repeated the analysis several times leaving out various countries without detecting noticeable differences. The raw data is of course available from us.

[10] Compared to other pineapple varieties MD2 had the highest start and the strongest downward development in prices (see Section 2). By today, the difference in prices between varieties has vanished according to International Trade Centre's market news service.

Figure 1: Volumes and values of EU pineapple imports
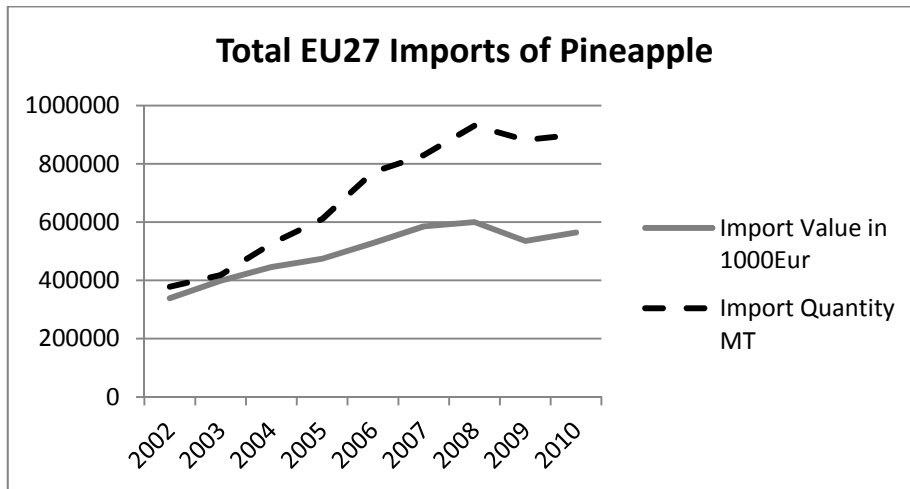
Source: Eurostat Comext 06/06/2011

Figure 2: Wholesale prices for conventional pineapple from different origins
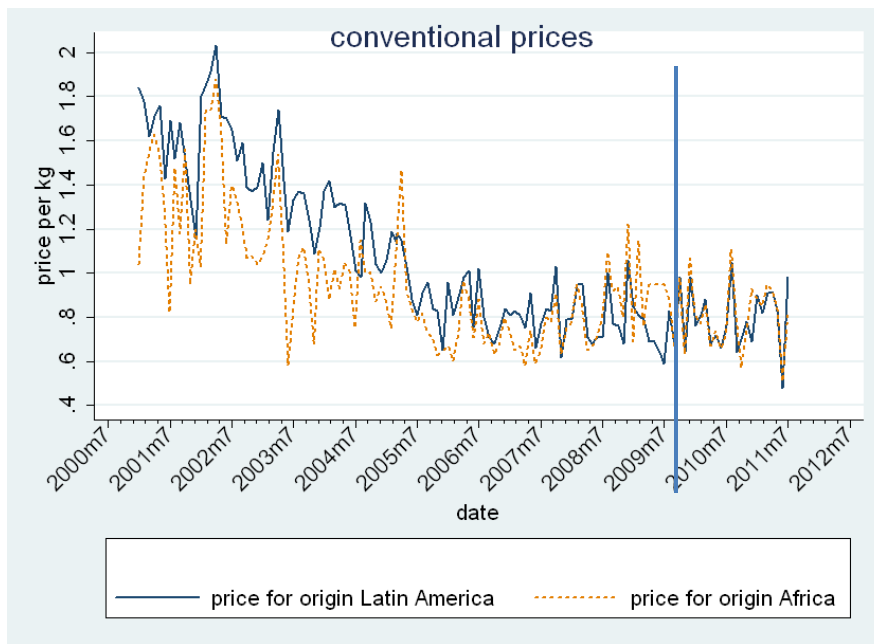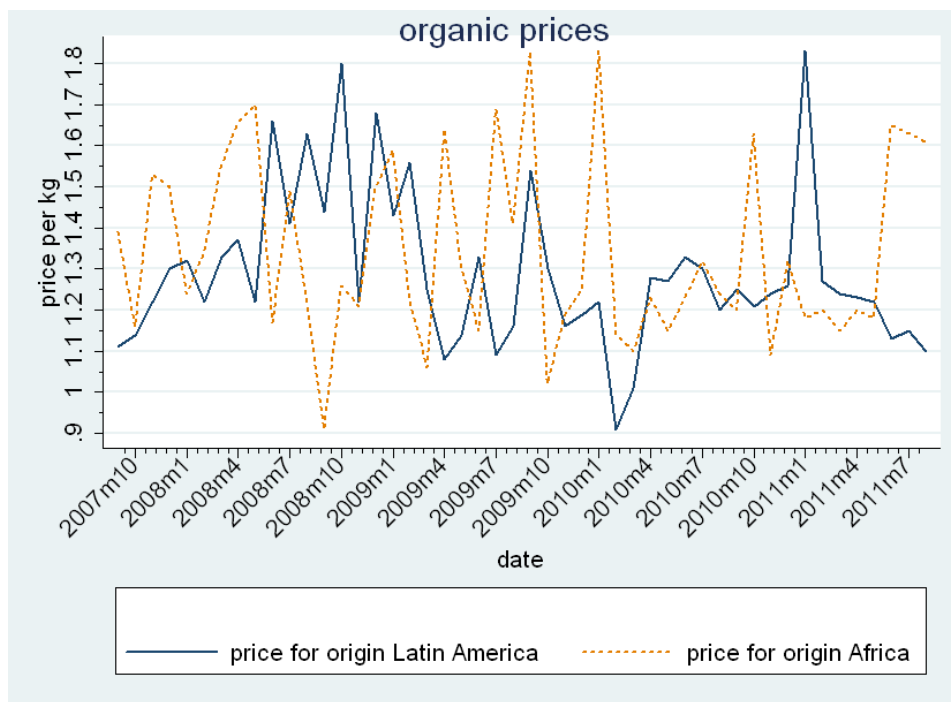
Figure 3: Wholesale prices for organic pineapple from different origins

Source: International Trade Centre's market news service and European fruit trading companies.

Figure 3 shows the development of organic pineapple prices. The graph right of the vertical line in Figure 2 corresponds to the period that organic pineapple data was available data for. During this period the price for conventional pineapple stabilized around a mean of 0.83 (0.15) €/kg for African and 0.79 (0.13) for Latin American pineapple and 1.34 (0.23) €/kg for African organic and 1.29 (0.19) for Latin American organic pineapple. Standard deviations are in parenthesis and the differences between the origins are not statistically significant. There are seasonal fluctuations in pineapple prices with usually low prices early in the year and in (European) summer and high prices around Christmas and Easter.

4.2   Organic Premia

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 premia of between 15 and 25% and numerous scientific studies have also shown the existence of price premiums for organic products (e.g. Teisl et al., 2002; Nimon and Beghin, 1999; Bjorner et al., 2004).

With regard to the potential benefits of organic farming for producers, an important question is if such price premia can be sustained in the long run or if they will vanish, as in the case of the MD2 variety. The recent developments in typical agricultural commodities like wheat or milk show that the price premium for organic products seems to be relatively constant.[11] Whether this is a temporary development or a long-term trend depends on changes in supply characteristics and in consumers' perception about the value added by the organic certification label (Hypothesis 3).

The data shows that, for the period from September 2007 to July 2011, price premia fluctuated between €0.14 and €1.02 with mean (standard deviation) of €0.51 (0.20) respectively on average (Figure 4).[12] A declining trend cannot be observed over this period. This might tell us which forces are at work with respect to Hypothesis 3.[13] The comparison of the price behavior in Figure 4 also shows that the premium is far from stable over the observed time period. Obviously the two curves are interdependent. In this context we should take note of a particularity of the pineapple market. The supply of conventional pineapple is highly dependent on harvests in Latin America, especially in Costa Rica (see Section 2 above), whereas organic pineapples are reported to come from a variety of source countries. Hence, for instance weather conditions or new plant diseases in Latin America would influence the two markets differently. This is unobservable without information about such supply shocks. However apart from

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[11] Information from AMI for Germany: http://www.ami-informiert.de/.

[12] Means and standard deviations for Africa are 0.50 (0.31) and for Latin America 0.50 (0.22) respectively.

[13] However, since the available time series is short and we do not have sufficient data about the development of the size of the two markets, our conclusions have to be taken with care.

Figure 4: The price premium for organic pineapple
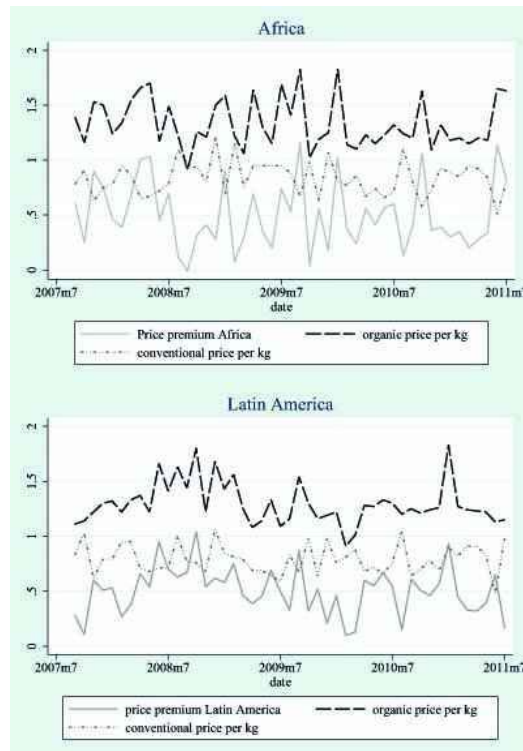
Notes: Prices are average monthly European wholesale prices in €/kg.

Source: International Trade Centre's market news service and European fruit trading companies.

this, there are potentially market inherent explanations for these fluctuations, which will be studied in the next section, the econometric study of price transmission.

5   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. They test, for instance, whether the world market price of a commodity is

transmitted to domestic producers. Other authors are interested in the difference of prices between different markets within one country, the so-called spatial price transmission. In this paper however, we study spatial price transmission between the markets for organic and conventional pineapple from Latin America and Africa in the European market.

We test the hypothesis that prices in the organic market are dependent on prices in the conventional market due to its dominance in size (Hypothesis 1). Secondly, we analyze if small and large price changes have different effects on the respective other price (Hypothesis 2). Finally, we explore if such a possible integration between the two markets decreases or increases over time as a result of the growth of the organic market and possible supply and demand shifts (Hypothesis 3).

When analyzing price transmission, different price series are usually regressed on each other in order to find a possible relationship between them. 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 Granger and Newbold (1974). In order to avoid these spurious regressions in case of non-stationarity, many authors have used cointegration techniques to study price transmission and long-run relations between different prices (for example Meyer and von Cramon-Taubadel, 2004 and Abdulai, 2000). 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.

5.1   Unit Root Tests

As in Rapsomanikis et al.'s framework, 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. The time series of the two regions of origin are tested separately and the different price series separately and as panel.

For the individual time series unit root tests, the traditionally employed Augmented Dickey Fuller (ADF) test has been used. However, due to its weak performance in small samples as the ones used in this paper and its low power in distinguishing highly persistent stationary processes from non-stationary processes

Elliot, Rothenberg and Stock (1996) proposed an alternative test that addresses the above shortcomings. For this DF-GLS test the data is first de-trended using generalized least squares. In order to employ the tests, it is necessary to determine the optimal number of lags of the prices to be included. We use the Schwartz and the MAIC criterion, a modified version of the AIC. In the presence of large negative moving-average components of the error term, the MAIC avoids too short lag lengths that result size distortions and hence overrejection of the null hypothesis (Ng and Perron, 2001).[14]

As is visible from Tables A.1 and A.2, the time series for the prices of conventional pineapple from Latin America are clearly I(1). This is supported by both the standard ADF test as well as the modified DF-GLS test. For African conventional pineapple the case is less clear. Only when using the MAIC criterion for lag length selection the time series might be I(1), but the results of the tests point generally toward stationarity.[15] The unit root test results for organic prices are similar but clearer. Latin American pineapple prices have one unit root and African pineapple prices seem to be stationary.

We also used the Johansen multivariate procedure to test for unit roots for both conventional and organic prices, which test the null hypothesis that at least one of the system variables under consideration is a unit-root process against the alternative that all system variables are stationary processes (Taylor and Sarno, 1998). As shown in Table A.3, it confirms the results from the univariate tests, and so do the panel unit root tests by Fisher and Levin-Lin (not shown). Hence, we test Latin American pineapple for cointegration next. Since African pineapple prices are presumably stationary there is no need to test for cointegration.[16]

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[14] The unit root tests are reported in levels, but results do not change if done in logarithms.

[15] This result might reflect the problem of over-rejection of the null hypothesis when using the Schwartz criterion, as explained above. The larger number of lags is also able to account for seasonality in the price data. On the other hand the large number of lags might reduce the significance of the results.

[16] All I(1) prices are borderline cases in terms of stationarity. If there were longer time series or higher frequency data available we could test whether the unit root results hold for different time periods. However, due to the data limitations and because we do not want to run the risk of estimating spurious relationships we assume that the test results indicating non-stationarity are correct.

5.2   Analysis of Cointegration and Price Dynamics between Markets

Since both Latin American price series are integrated of order one we test for cointegration. If the linear combination of the two time series is stationary, it would describe the long-run relation between the two variables. The number of cointegrating vectors in the system is determined using the Johansen test. We consider the cases without a constant or trend and with a constant in the cointegrating relationship (over the period 2007 to 2011, see Figure 4). The results are illustrated in Table A.4. There is clearly one cointegrating vector. We then test for granger causality. Table A.5 shows that Latin American conventional prices granger cause organic prices, that is lags of conventional prices improve the forecast of organic prices but not vice versa. We expected the conventional market to act as a leader due to its dominance in size; hence this result confirms our a priori expectations. The results on cointegration mean that there exists a long-run relation between the conventional and organic Latin American pineapple prices and a linear combination of the two prices that is stationary.

For African pineapple prices, since they are stationary, we do not test for cointegration. Even though we would be able to analyze the data on African pineapple in levels, for reasons of comparability we use the same models as for Latin American pineapple.

Let $p = (p_c\ p_o)$ where p_c and p_o are the conventional and organic prices respectively. Then there exists β such that βp is stationary. Then, the long-run relation between the two prices has to be taken into account by a cointegrated version of the VAR. Therefore, we apply the following vector error correction model (VEC) in our analysis:

$$\begin{pmatrix} \Delta p_{ct} \\ \Delta p_{ot} \end{pmatrix} = c + \sum_i \Gamma_i \begin{pmatrix} \Delta p_{ct-i} \\ \Delta p_{ot-i} \end{pmatrix} + \Pi \begin{pmatrix} p_{ct-1} \\ p_{ot-1} \end{pmatrix} + u_t \qquad (1)$$

Δ is the difference operator, c indicates a constant, p_{ct-i} *and* p_{ot-i} indicate the ith lag of p_{ct}, *and* p_{ot}, Γ_i describes the short-run relation among p_t and the ith lag, and $\Pi = \alpha\beta$, where β is the cointegrating vector defined above and α measures the speed of adjustment of the two prices to deviations from their long-run relation. All variables are transformed into natural logarithms. In order to employ this approach, the optimal lag length for the differenced price vector has to be determined. We used Akaike and Schwarz's Bayesian and Hannan and Quinn

information criteria to determine the optimal number of lags to include in the cointegrated VAR. All of them suggested that estimating the model by using one lag was optimal. Therefore, the model above with only one lag has been estimated. Results are reported in Table 1. The long-run relation between Latin American prices (cointegration equation) is given by:

$$p_o = 0.273 + 0.089\,p_c \tag{2}$$

For African prices, the long-run relation is:

$$p_o = 0.283 + 0.017\,p_c \tag{3}$$

Estimating the VEC model indicates that the organic market is responsive to a deviation from the long-run equilibrium whereas the conventional market is not. We see asymmetric transmission of price changes between the two markets in the sense that organic prices do not respond in the same way to changes in market prices as conventional prices to changes in market prices.[17]

Considering the short-run dynamics, Δp_{c-1} has significant effects on both Δp_c and Δp_o. The cross-price elasticity of current organic prices with respect to lagged conventional prices is 0.36 for Latin America and 0.38 for Africa (i.e. a one percentage change in conventional prices changes organic prices by 0.38%).18

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[17] We could extend the model to incorporate asymmetries in the transmission of positive price changes in contrast to negative ones. Apart from data constraints (short time series), this is also questionable for other reasons in this case. Since it would mean that price increases in conventional prices are transmitted more rapidly or slowly to organic prices than price decreases, the rationale behind different adjustment speeds for price increases and price decreases are according literature usually market power. In our case this would mean that wholesalers in the organic market would have the market power to asymmetrically transmit prices changes in the conventional pineapple market to their customers (retailers and specialty shops). As retailers often also engage in wholesales, this is not very plausible on aggregate level. Alternatively exporters in developing countries would have the market power to asymmetrically adjust organic prices when conventional ones change. This is even more unlikely because pineapple is a perishable fruit so exporters are dependent on selling fast. In such cases actors at the beginning of the value chain usually have relatively little power. The second possibility would be information asymmetries, that is exporters or importers having different information about market prices than wholesalers and retailers, which is quite unlikely in this case at least when regarding monthly data. It might be more relevant with price data of higher frequency.

[18] The coefficient of the lagged difference of conventional prices in the conventional price equation indeed points to model instability considering only the short-run effects. I acknowledge this problem

Table 1: Estimation results for VEC

	LATIN AMERICA		AFRICA	
	Δp_c	Δp_o	Δp_c	Δp_o
Δp_{c-1}	–1.191***	0.361***	–1.07***	0.382**
	(0.153)	(0.153)	(0.16)	(0.196)
Δp_{o-1}	–0.084	–0.084	0.120	0.283*
	(0.149)	(0.149)	(0.215)	(0.155)
c	–0.001	0.005	0.001	0.003
	(0.025)	(0.025)	(0.029)	(0.035)
α	0.073	–0.580***	0.150	–0.497***
	(0.323)	(0.172)	(0.236)	(0.197)
Test results				
R^2	0.428	0.174	0.428	0.174
F-statistic	6.988**	3.181*	6.988**	3.181*
Log Likelihood	30.87		16.57	
LM-Test (p-values) for				
autocorrelation, lag 1	0.252	0.511		
lag 2	0.413	0.508		

Notes: p_c is the conventional price, p_o is the organic price in natural logarithms.

Lagged organic price changes are not significant in any regression except at 10% level for African organic prices, whereas the corresponding conventional price changes are in all cases significant at higher levels. Hence, in the short-run organic prices are strongly influenced by conventional price movements, whereas this is not true in the opposite direction. This confirms our Hypothesis 1 that the conventional market acts as a price leader for the organic one.

Although our results suggest that organic prices follow prices in the conventional market, it may be that this relation is nonlinear. Niche markets might change at a different speed than the main market for various reasons (see Hypothesis 3). The following section investigates the possibility of a non-linear relation with a threshold autoregressive (TAR) and a smooth transition autoregressive (STAR) model and thereby tests hypotheses 2 and 3.

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and at the same time argue that the paper does not focus on the stability of the model, and that the long-run relationship is not affected by the short run parameters.

5.3 Testing for Nonlinear Price Dynamics between Conventional and Organic Markets

Previous studies explained non-linearities by transaction costs of spatially separated markets for the same good (e.g. Baulch, 1997; Fafchamps, 1992; Sexton et al., 1991). Unlike in these studies, in our example transaction costs are not the result of costs and risks associated with trade between such separated markets and the speed of adjustment is not necessarily dependent on the traders' access to market information. At the wholesale level information about prices in conventional markets is readily available. And we have found out that organic prices follow the price in the main market (that is the conventional market) and not vice versa.

In our case, thresholds may exist when consumers see conventional and organic pineapple as two different products. This may happen when there is a physical separation - still a considerable part of organic pineapple is traded by way of organic specialty markets as opposed to mainstream food multinationals - or when marketing and branding efforts of companies are successful. Nonlinearity may also exist due to the switching behavior of consumers: when the price difference between the organic and the conventional pineapple increases beyond the willingness to pay for an organic pineapple, then the consumer may switch and buy a conventional pineapple instead, and vice versa.

The organic premium is not constant over time (Figure 2). If Hypothesis 2 is correct, it is possible that due to a certain willingness to pay for organic products *relative* to conventional goods, organic prices only respond to movements in conventional prices when the difference between these two prices exceeds a certain threshold. On the supply side, both thresholds and non-immediate adjustment can be caused by menu costs and differences in competitive structures: a small number of fiercely competing food multinationals in the conventional market versus a larger number of smaller competitors and limited possibilities consumers to compare prices in the niche market. In addition, if conventional prices vary as a result of changing supply conditions from Costa Rica, organic prices might not adjust or not as much.

In addition, nonlinearities in the form of thresholds may vary over time with the relative WTP of consumers for organic over conventional products. As stated

in Hypothesis 3, the threshold may vary when cross-price elasticities change over time.

In this paper, we first follow the analysis by Van Campenhout (2007) who uses a threshold autoregressive model to test for integration of several Tanzanian maize markets over time and then use a smooth transition autoregressive (STAR) model, which should work better if there is no one-for-all threshold. As explained by the author, the threshold autoregressive (TAR) model can be preferred over a parity bounds model (PBM) because the TAR model allows separating the two market components of transaction costs and speed of adjustment of prices. Moreover, it allows for time-varying thresholds. To analyze possible non-linearities in the relation between organic and conventional prices, we estimate the following TAR model:

$$\Delta m_t = \begin{cases} \rho_{out}\, m_{t-1} + \varepsilon_t & m_{t-1} > \theta \\ \rho_{in}\, m_{t-1} + \varepsilon_t & -\theta \leq m_{t-1} \leq \theta \\ \rho_{out}\, m_{t-1} + \varepsilon_t & m_{t-1} < -\theta \end{cases} \tag{4}$$

where $m_t = p_{c,t} - p_{o,t}$ is the difference between the conventional and the organic price in period t, $\varepsilon_t \sim N(0, \sigma^2)$. ρ_{in} and ρ_{out} measure the adjustment speed, the change in the price difference as result of the previous difference itself, within the band created by the threshold θ and outside this band respectively. If the hypothesis of a threshold was wrong, these two parameters should be the same.

It is possible that the threshold is not constant but changing over time. To incorporate this possibility, the threshold θ can be modeled as a function of time:

$$\theta_t = \theta_0 + \frac{(\theta_t - \theta_0)}{T} t \tag{5}$$

where $t \in (0,T)$.

In addition, we will allow for a time trend in the adjustment parameters ρ_{in} and ρ_{out}. These two extensions can be expressed by the following second model:

$$\Delta m_t = \begin{cases} \rho_{out}\, m_{t-1} + \rho'_{out}\, t\, m_{t-1} + \varepsilon_t & m_{t-1} > \theta_t \\ \rho_{in}\, m_{t-1} + \rho'_{in}\, t\, m_{t-1} + \varepsilon_t & -\theta_t \leq m_{t-1} \leq \theta_t \\ \rho_{out}\, m_{t-1} + \rho'_{out}\, t\, m_{t-1} + \varepsilon_t & m_{t-1} < -\theta_t \end{cases} \tag{6}$$

To estimate these two models, the data was converted into first differences. Data in this form was stationary for all the time series. To determine the threshold parameters θ, θ_o and θ_T, a grid search over all possible values has been performed. Furthermore, according to the hypothesis that prices only respond if the difference between them is large enough, ρ_{in} is set to zero in the analysis.

In the STAR model, a piecewise linear autoregressive model with smooth transition among the regimes, the binary threshold is replaced by a smooth transition function $G(z_t)$. Switching smoothly means that both regimes may have an impact on the dynamics of the dependent variable at the same time but with different weights. Logistic and exponential functions are the most common transition functions resulting in LSTAR and ESTAR:

$$LSTAR: \qquad G(z_t; \gamma, c) = \frac{1}{1 + e^{-\gamma(z_t - c)}} \; ; \gamma > 0 \tag{7}$$

$$ESTAR: \qquad G(z_t; \gamma, c) = 1 - e^{-\gamma(z_t - c)^2} \; ; \gamma > 0 \tag{8}$$

where z_t is the transition variable, c can be interpreted as the threshold, and γ determines the transition speed (van Dijk et al., 2002). We use the autoregressive order one, i.e. STAR(1) as in the previous regressions. The ESTAR model reduces to a TAR model for very large γ, hence we use this model for comparison reasons (van Dijk et al., 2002). Following van Dijk et al. (2002) the ESTAR model is estimated by non-linear least squares.

The results are shown in Table 2. For the TAR model, the threshold is at 63% (Latin America) and 53% (Africa) of the average differenced price in the simple TAR model, thus confirming Hypothesis 2. This number is quite high, but one should remember that the price changes are rather small compared to the absolute value of the price. When including time trends, thresholds for Latin American pineapple stay the same and thresholds for African pineapple increase from 46% to 61%. On the other hand, above the thresholds, adjustment speeds (ρ) are almost unaffected by the inclusion of a trend and the coefficients that measure the interaction between adjustment and time are not statistically significantly different from zero. The adjustment speeds in the model without time trends outside the band formed by theta are -0.335 (Latin America) and –0.479 (Africa), which imply

Table 2: Estimation results for TAR, TAR with trend and STAR

	LATIN AMERICA		AFRICA		LATIN AMERICA	AFRICA
	TAR	**TAR with trend**	**TAR**	**TAR with trend**	**STAR**	**STAR**
θ	0.630		0.530		$m_t = -0.291 m_{t-1} + (-0.101 m_{t-1})$	$m_t = -0.326 m_{t-1} + (-0.086 m_{t-1})$
$\theta(t=1)$		0.630		0.460	(0.123) (0.043)	(0.187) (0.056)
$\theta(t=34)$		0.630		0.610		
ρ	−0.335***	−0.365*	−0.479***	−0.350*	$*\left[1 - e^{-8.208(m_{t-1}-0.601)} / \hat{\sigma}_t^2\right] + \widehat{u_t}$	$*\left[1 - e^{-7.923(m_{t-1}-0.498)} / \hat{\sigma}_t^2\right] + \widehat{u_t}$
	(0.095)	(0.197)	(0.102)	(0.194)		
$\rho * t$		−0.012		−0.007	(2.082) (0.519)	(3.681) (0.388)
		(0.008)		(0.008)		
half-live	1.697	1.350	1.064	1.609	1.439	1.823
N	46	46	46	46	46	46
R²	0.217	0.258	0.330	0.352	0.331	0.216
F-statistic	12.47***	7.65***	22.13***	11.93***	$\widehat{\sigma_{STAR}}/\widehat{\sigma_{TAR}} = 0.201$	$\widehat{\sigma_{STAR}}/\widehat{\sigma_{TAR}} = 0.119$
AIC	1.287	0.917	1.328	0.989	1.069	1.168
Skewness	0.210	0.216	0.191	0.206	0.267	0.228
Excess kurtosis	2.389	3.265	3.573	4.447	2.054	2.621
LJB	0.005	0.007	0.001	0.003	0.009	0.006
LM_{ARCH}	0.001	0.001	0.000	0.000	0.003	0.002
LM_1	0.546	0.582	0.642	0.654	0.663	0.684
LM_2	0.654	0.348	0.354	0.345	0.437	0.341

Notes on the TAR models: Dependent variable is the change between two periods in the price difference between the two market prices. All models are estimated without a constant. Rho (ρ) denotes the adjustment parameter on the lagged price difference expressed as the percentage of mean price in the two markets, theta (θ) is the threshold expressed again as the percentage of mean price in the two markets and t is a time trend. The TAR models are three regime symmetric models with unit root behavior imposed within the band formed by the thresholds. The thresholds are identified through a grid search over candidate thresholds with as model selection criterion the minimal sum of squared residuals. As starting values for the thresholds, at least 20% of the observations were either within or outside the band formed by the thresholds. Half-lives are expressed in months and in brackets when they are based on a coefficient that was estimated not significantly different from zero. Standard errors are in brackets. *, ** and *** denote parameter estimates significantly different from zero at the 10%, 5% and 1% significance, respectively. N is the number of observations used in the estimation. AIC is Akaike information criterion.

Additional notes on the STAR models: Asymptotic standard errors are given below parameter estimates in parentheses; ^"t denotes the model's residual at time t; $\widehat{\sigma_{STAR}}/\widehat{\sigma_{TAR}}$ denotes the ratio of STAR model's residual versus the TAR model's residual standard error. LJB is the Lomnicki–Jarque–Bera test of normality of residuals; reported are asymptotic p–values. LM_{ARCH} is the LM test for ARCH–type heteroscedasticity based on one lag. Similarly, LM_1 is the Eitrheim and Teräsvirta's (1996) LM test of no remaining autocorrelation in the residuals based on one lag, represented as F-Test., and LM_2 is the same for Eitrheim and Teräsvirta's (1996) LM test for remaining nonlinearity.

a half-life of 1–2 months. In the model with time trends the adjustment speeds outside the band are -0.365 (Latin America) and –0.350 (Africa), which imply a half-life of 1.350 (Latin America) and 1.609 (Africa) months, not very different from the regression without trend. Hence, there is no evidence for an overestimation of half-lives and underestimation of adjustment speeds by simple TAR models as stated by Van Campenhout (2007). The results indicate that over time there is not much change in thresholds below which no adjustment of organic prices to conventional price changes takes place. This implies that these markets do not become more integrated and cross-price elasticities remain indeed constant over time. Adjustment speeds also remain unchanged, which suggests that neither market information nor competitive structures change. Hence, Hypothesis 3 cannot be confirmed. There is also no indication that the premium on organic pineapple is bound to decrease. However, since our database covers only four years, this rather indicates that more research should be done to answer this question when more data is available than a strong rejection of the hypothesis. As reported in Table 2, the results of the ESTAR models are fairly similar to the ones of the TAR models. The ESTAR has a similar AIC than its counterpart. The estimated standard error for the ESTAR model is slightly smaller than that for the respective TAR model with trend. We therefore conclude that the difference in fit is not large. We also computed regime-dependent half-lives as in Goodwin et al. (2011) also shown in Table 2. These are again fairly similar to those computed from the TAR model.

The test results in Table 2 indicate that there is no evidence of skewness in the residuals but considerable excess kurtosis, which is not surprising given the data structure. The Lomnicki–Jarque–Bera (LJB) test rejects the null hypothesis of normality in residuals and finds ARCH-type heteroscedasticity. For remaining autocorrelation and nonlinearity we use the test developed by Eitrheim and Teräsvirta (1996). As in Goodwin et al. (2011) we implemented these tests as F–test versions of the respective Lagrange Multiplier (LM) tests. There is little evidence of remaining autocorrelation and nonlinearity.

Overall these results indicate the regime behavior in price responses did not change significantly over the past four years, and there is also no significant difference in regions of origin. These results may help farmers, traders, retailers, and agencies promoting organic certification to better understand the market and predict future price movements. The availability of more data over time will improve the results.

6   Conclusions

As the demand for organic products is growing, this paper has tried to shed light on the longer-term profitability of organic production. Taking hedonic demand theory as basis, we empirically analyzed spatial price transmission between organic and conventional pineapple on the world's largest organic market Europe as a case study. The analysis is set up with a development perspective since organic products in general and organic pineapple in particular are niche markets that exhibit premium prices. As a result, organic production is currently promoted as a valuable agricultural alternative for developing countries. Our results imply that the conventional market acts as a price leader for the organic one. While prices for conventional pineapple are independent of organic prices, organic price movements are responding to their conventional counterparts. However, our analysis indicates that organic prices only react to changes in conventional prices if these changes are sufficiently large, outside a tolerance range. In addition, this range does not change over time. Hence, despite an expanding organic niche, market integration does not increase. Our observations also do not show an upward or downward trend for the organic price premium in the pineapple market. When there is neither more integration, nor a declining price premium to be observed, while the organic market is expanding faster than the main market, this happens, according to theory, only when the core market expands faster than supply. One important implication of this observation is the potential for the scalability of the organic market. Accordingly, these results suggest that organic production can indeed be a profitable alternative for small farmers in developing countries, and it is likely to remain so in the near future. Furthermore, being founded in hedonic demand theory allows this analysis to be applied to other similar niche-main market situations. Other environmental or ethical certifications such as Fair trade may provide a very similar context.

However, some questions remain to be analyzed. In order to understand price premia and their behavior 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 using hedonic demand models. We deliberately chose a relatively homogeneous experience good for our analysis. Nevertheless, this is relevant for search goods as well. However this remains to be shown. In addition, longer time series data would help to strengthen the analysis of

the sustainability of the organic premium on the producer and retail level and may be able to show when the current dynamics of demand and supply shifts are likely to change in the future.

Appendix

Figure A.1: European market shares in fresh and dried pineapple 2003 and 2009
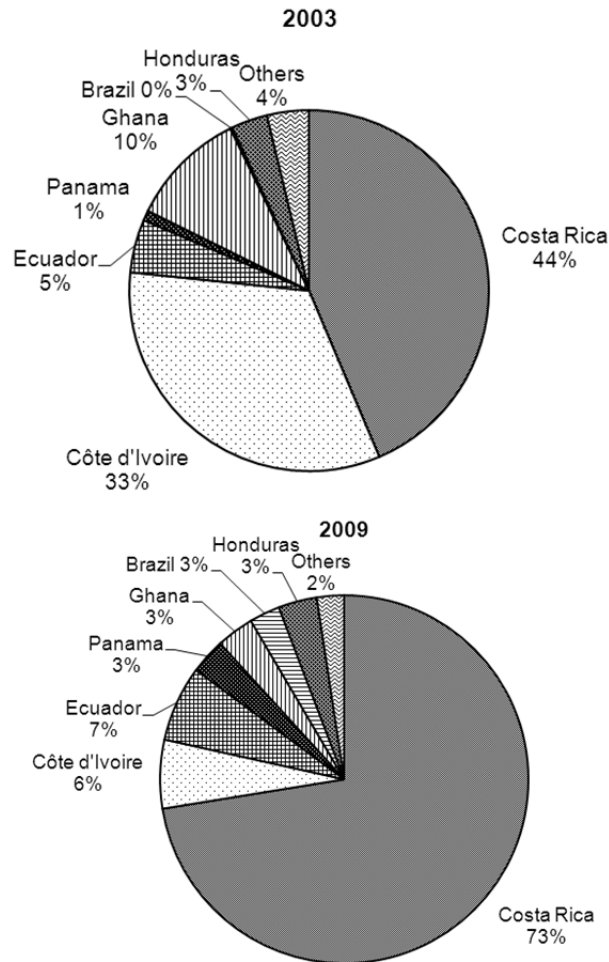
Source: Eurostat Comext

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

Table A.1: T-statistics of ADF-tests

	Conventional prices				Organic prices			
	Lags by Schwartz criterion		Lags by MAIC		Lags by Schwartz criterion		Lags by MAIC	
Levels	no trend	trend	no trend	trend	no trend	trend	no trend	trend
Latin America[a]	-2.476 (1)	-3.922** (1)	-1.558 (11)	0.224 (11)	-2.915* (1)	-3.272* (1)	-1.954 (3)	-2.389 (3)
Africa[a]	-3.617*** (1)	-4.787*** (1)	-3.501** (11)	-3.031* (11)	-4.502*** (1)	-4.545*** (1)	-4.502*** (1)	-4.545*** (1)
First Differences								
Latin America[a]	-11.06*** (1)	-11.05*** (1)	-6.300*** (6)	-6.433*** (6)	-6.743*** (1)	-6.740*** (1)	-6.743*** (1)	-6.740*** (1)
Africa[a]	-9.856*** (3)	-9.878*** (3)	-9.856*** (3)	-9.878*** (3)	-7.570*** (1)	-7.535*** (1)	-7.570*** (1)	-7.535*** (1)

Note: (***) indicates a rejection of the null hypothesis at the 1% significance level, (**) at the 5% significance level, (*) at the 10% significance level. [a] In brackets are the number of lags by Schwartz/ MAIC criterion.

Table A.2: Test statistics of DF-GLS tests[a]

	Conventional prices		Organic prices	
	Lags by Schwartz criterion	Lags by MAIC	Lags by Schwartz criterion	Lags by MAIC
Levels				
Latin America[b]	-2.927 (1)	-0.378 (11)	-2.685 (1)	-1.911 (3)
Africa	-4.455*** (1)	-1.420 (11)	-3.990*** (1)	-3.990*** (1)
First Differences				
Latin America[b]	-8.662*** (1)	-2.543* (6)	-6.080*** (1)	-6.080*** (1)
Africa	-3.174** (3)	-3.174** (3)	-6.843*** (1)	-6.843*** (1)

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

[a] By default, the test includes a trend. [b] In brackets are the number of lags by Schwartz/ MAIC criterion.

Table A.3: Johansen likelihood ratio test statistics

	Lags		
Origins	1	2	3
Latin America	3.824	3.832	4.325
Africa	6.341	6.883	9.581
Critical values	4.081	4.353	4.664

Note: The Vector Error Correction Model (VECM) is estimated for 1, 2 and 3 lags (k) as in the previous tables. The asymptotic distribution for the Johansen test is $\chi^2(1)$. We follow Barkoulas et al. (2003) and adjust the critical value for finite-sample bias, which is given by $\chi^2(1) {}^T\!/_{T-pk}$, where T is the number of observations and p is the number of system variables (dimension of the system).

Table A.4: Johansen cointegration test for Latin American prices

rank	Trace statistic (5% critical value)	Max. eigenvalue (5% critical value)
	Intercept in CE, trend in series	Intercept in CE, trend in series
0	33.51 (12.53)	33.34 (11.44)
1	0.17*** (3.84)	0.17*** (3.84)
	Intercept in series	Intercept in series
0	50.62 (19.96)	41.83 (15.67)
1	8.80** (9.24)	8.80** (9.24)

Note: ** indicates the rank selected by a trace statistics test at 5% level.

*** indicates the rank selected by maximum eigenvalue statistic test at 5% level.

Table A.5: Granger causality test (p-values)

Latin America	p_c	0.67
	p_o	0.07
Africa	p_c	0.86
	p_o	0.08

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