Price Volatility and Risk Management: The Case of Rice

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Abstract

The paper aims at analysing rice-price volatility over the last five years, and at identifying strengths and weaknesses of financial-risk management tools other than derivatives. In particular, it focuses on innovative insurance products and on their potential use in the EU Mediterranean area, specifically in Italy that is the main rice producer in this area.

Keywords: *Agricultural commodity price volatility, rice price volatility, risk management, revenue insurance*

JEL classification: Q10, Q13, Q14, Q18, G10, G22

1 Introduction

During the last five years, agricultural commodity prices have significantly increased and become more volatile. The reasons of such trends include: economic growth of developing economies, which has increased the global food demand; inadequate and changeable supply caused by climate conditions; financial markets speculation.
Producers are risk-averse and enter into risk management strategies to cope with price risk. Price risk management options can be grouped into three categories: spot-market strategies, such as diversifying the timing of sales of annually produced crops; the use of forward and deferred-pricing contracts or hedging via standardized futures and options contracts; yield or revenue insurance products. The first determines risk retention and exposes farmers to the risk of too much stress on their cash flow; conversely, the second and the third imply risk hedging or risk transfer via financial products.
Among agricultural commodities, rice presents some peculiarities that make its analysis interesting both from an agricultural economics and a financial perspective.
From an agricultural economics point of view, rice is the main staple food for a great part of the population in Asia, especially in China and India, and has important implications for environment; the export is relatively low compared to production and consumption, even if it is growing in recent years. In the EU, rice is cultivated only in the Mediterranean countries, but EU is net importer; moreover, there is a great difference among cultivars.
From a financial point of view, protection against price risks for rice producers faces problems. The trade of rice on futures market started in 1994 and the use of derivatives contracts is still limited in comparison to other important agricultural commodities. Indeed, the volume of rice traded on futures market is smaller than that of relevant agricultural products. Moreover, in the EU countries the production of rice is too small for a worthwhile use of futures contracts in the international trading, and the production can suffer standardization problems. In addition, in the short run domestic market prices can be not strictly linked to world prices, especially for specific cultivars. For all these reasons producers may not be able to utilize existing international commodities exchanges for hedging purposes, while insurance products may assume a relevant role as risk management tools.

Analyzing rice price volatility during the last five years, the paper aims to identify strengths and weaknesses of financial risk management tools other than derivatives. In particular, we focus on innovative insurance products and their potential use in the EU Mediterranean area, specifically in Italy that is the main rice producer country in this area.
The paper is organized as follows. Section 2 analyses the price risk management in agriculture; section 3 describes the main drivers connected to agricultural price volatility, focusing on the rice market; section 4 reports the discussion of the crucial issues on the topic analyzed, whereas section 5 includes the final remarks.

2 Price risk management in agriculture

2.1 General issues

Price risk uncertainty is a relevant problem in all business activities including agricultural commodities, whose price changes have been relevant in the last few years.
Price risk can be defined as the difference between the expected price and the actual price of the commodity; among others, major sources of price risks are inventory levels, weather events, financial commodity markets speculation, imbalance in demand and supply, market imperfections.
Price risk is essentially the result of price uncertainty and affects producers when they make production and marketing decisions regarding application of inputs and labour on the basis of price they expect to receive after harvest, which may be different from the actual price.
Producers are normally concerned about the downside risk, which is the risk that the actual price is lower than the expected price; prices for the products grown may be so uncertain that what appear profitable when planted ends up unprofitable due to price decreases in the following months. However, farmers are also affected by the upside risk: if the actual price is higher than the expected price, they may have lost the opportunity of higher production and higher income. In both cases, price volatility can adversely affect farm profitability (Mohan 2004, Dick 2010, Pasaribu 2010, Wolf 2011). Consequently, for farmers risk management tools are increasingly important. In a food security perspective, agricultural risk management plays an important role indifferent ways: developing agriculture, rising food production, and improving poverty conditions.
Literature is unanimous in considering that while farmers are risk-averse and self-insurance is generally limited since most producers simply have too much stress on their cash flow, price risk management through financial products can benefit farmers with relevant rise in output (Machnes 1992, 1995; Mahul and Vermersch 2000; Mahul 2001; Wong 2002; Machnes and Wong 2003, Hau 2006). Hedging has also a positive impact on access to credit and on the financial cost of the farm's debt, that is the risk premium the producer has to pay to its lenders, i.e. banks (Buhl 2011). Morover, price risk management allows farms to obtain a more sophisticated planning horizon, to plan its expenditures, and to decide on eventual investments (Grinblatt and Titman 2002, Aimin 2010, Buhl 2011).
Financial instruments utilized to hedge commodities price risk can be grouped into two categories:

- derivatives instruments;
- insurance products.

The first category includes forward contracts, futures contracts, and options[1].

[1] For a deep analysis of derivatives see Hull (2006)

Forward and futures contracts are an agreement between two parties to buy or sell the underlying asset, i.e. the commodity, at a certain time in the future for a certain price. Hedging via forward and futures market can control price risk; however, while it ensures the producer against price reduction, it does not allow enjoying price increases. Conversely, options allow the producer insuring prices against declines (put option) while taking advantage of price increases. Indeed, the buyer of the option has the opportunity, but not the obligation, to exercise the agreement; the strike price of the put guarantees a price insurance to producers in the form of a minimum price floor. The main cost involved in the purchase of put options is the price of the options premium, which is paid up-front. The value of the premium depends on the strike price relative to the underlying value of the options futures contract, the duration of the contract and the volatility of the underlying commodity market prices.

The largest exchanges on which commodities futures and option contracts are traded are the Chicago Board of Trade (CBOT) and the Chicago Mercantile Exchange (CME). As far as "soft commodities" - among which is rice - the China's Dalian Commodity Exchange and Shanghai Futures Exchange are at the moment the largest commodities exchanges. Open interests and volumes have increased considerably in the past decade and even more in recent years, likely reflecting the desire of both sellers and buyers to mitigate price risk.

Insurance works as an option as well, and allows the producer to transfer risk to a third party - private company or government institution – versus the payment of a premium. The underlying principle of insurance lies in the law of large numbers, where the incidence of risk is distributed over individuals. In crop insurance, the losses suffered by farmers in a particular locality are borne by farmers in other areas and the reserves accumulated through premium in good years are used to pay the claims in bad years (Pasaribu 2010).

Several papers on price risk management and financial products have appeared in the agricultural economics literature. Knight and Coble (1997) analyze the drivers for farmers' insurance demand, Turvey and Amanor-Boadu (1989) examine premium setting for revenue insurance, Babcock and Hennessy (1996) focus on the issue of moral hazard with revenue insurance and Hart et al. (2000) investigate the cost and structure of several possible livestock revenue insurance products.

More recently, Mahul and Stutley (2010) provide insight into the extent of agricultural insurance penetration in different countries, while Dick and Wand (2010) analyze the effect of government interventions in agricultural insurance. Sai et al (2010) investigate the factors that affect demand of agricultural insurance and Wolf (2011) focuses on dairy farmer use of price risk management tools, specifically futures contracts and options. A specific study on rice insurance products and price risk management is Pasaribu (2010) who analyzes suitable rice farm insurance schemes for the Indonesian market.

2.2 Rice revenue guarantees

For the specific purpose of our paper we focus only on insurance products and the reasons are as follows.

When enter a forward contract the two parties fix at time t_0 the price at which buy and sell the harvest at time t_t. However, since forward contracts are not standardized but traded over-the-counter, the parties may fail to agree on such a price. In addition, the buyer of the forwards (i.e. the buyer of the rice) normally requires a guarantee of actual delivery of the agreed quantity. Consequently, in the case in which at the end of the period the crop is lower than expected the seller of the forward must buy the missing quantity of commodity

on the market to fulfill the forward contract, at a price probably higher than the forward price at which the farmer agreed to sell the harvest.
As far as futures and options, actual use is limited because of many reasons such as access to trading facilities and expertise required. Moreover, rice is traded on futures market since 1994 and the trading volume is low relative to futures contracts on other major agricultural products, domestic prices are often not strongly related to world market prices, and trading is costly in terms of margins and option premium. In addition, compared to US, in EU farmers produce smaller quantities of rice to make participation in futures markets worthwhile and, even if aggregated across farmers, production is subject to problems of standardization and quality.
At the beginning of 90s, revenue insurance products started to be offered in the US markets[2]. Revenue insurance products combine yield and price insurance: they offer protection against the farmer's loss of revenue both due to declines in the price of the commodity during the crop's growing season, and due to loss of harvests caused by natural disasters. Thus, revenue insurance products insure the gross revenue of the insured crop and provide farmers with payment if the production falls below a threshold, it does not matter whether it is yield or price or both that cause the revenue at harvest to be below the guaranteed revenue. They ultimate goal is to reduce year-to-year income variability (Coble 2003).
The revenue guarantee is computed like an option. If the actual price multiplied by the realized yield at harvest is lower than the expected price multiplied by the expected yield at planting, the farmer receives the difference; zero otherwise. The result is then multiplied by the chosen coverage level, usually from 50 to 85 percent.
The indemnity equation for the revenue protection (RP) can be written as:

$$RP = max\,[p_0 * y_0 - p_t * y_t;\, 0] * lc_0$$

Where p_0 is the expected price, y_0 is the expected farm yield at planting, p_t is the actual price, y_t is the realized yield at harvest, lc_0 is the chosen coverage level.
Reference prices come from futures markets: the expected price is the preseason price for the harvest month contract, while the harvest market price is the cash settlement price in the future market. The expected farm yield at planting depends on the actual production history of the farm.
The net revenue protection (NRP) is obtained by subtracting from RP the insurance cost, that is the amount of the premium paid to the insurance company:

$$NRP = max\,[p_0 * y_0 - p_t * y_t;\, 0] * lc_0 - ip_0$$

where ip_0 is the insurance premium. Figure 1 shows graphically the relation expressed in the equation.

[2] Long time before 90s, the first type of insurance product offered to farmers has been the yield insurance product, that offers protection against the loss of crops due to meteorological events and natural disasters, such as floods, drought, hail. Yield insurance products are generally offered in the form of multi-peril crop insurance (MPCI) and cover different types of natural disasters bundled together to form a combined package. Those products do not offer protection against price volatility, thus are not the object of our study.

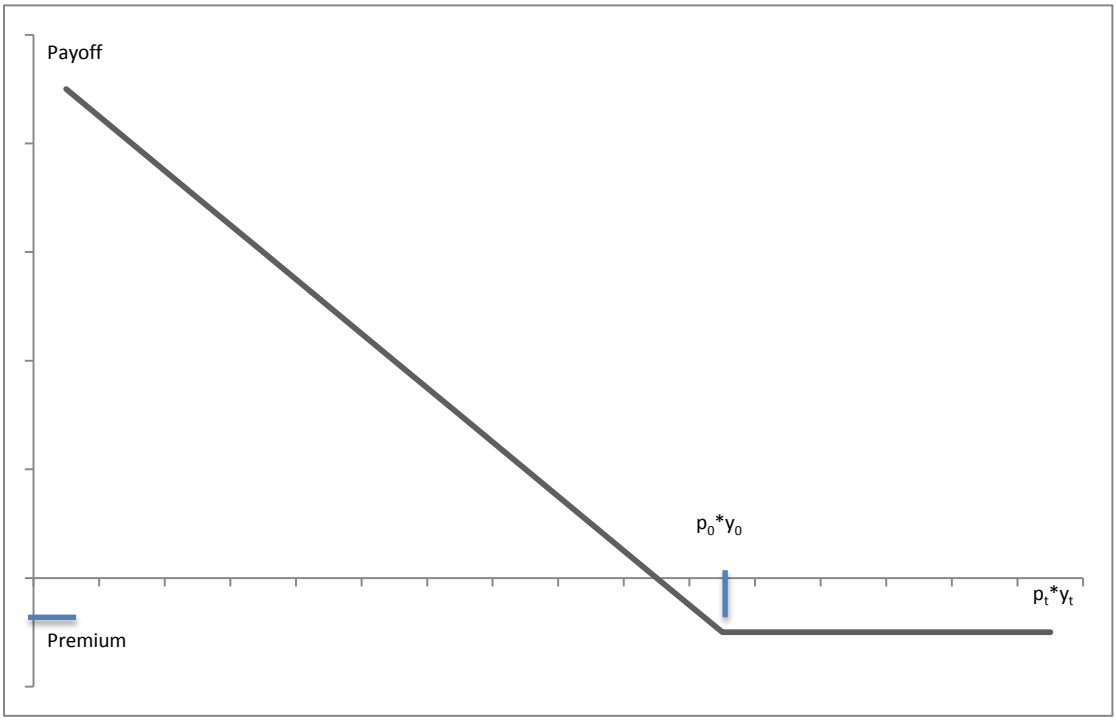

Figure 1. The payoff (NRP)

3 Price volatility in the rice market

3.1 Commodity price volatility drivers

Recently, in the international market of agricultural commodities a strong price volatility has occurred, in particular in the period 2007-2010, with a high growth of prices in the years 2007-2008- 2009 and a decrease in the following years.

A number of different and complex elements affect the trends of agricultural commodity prices that act both on the demand side and on the supply side (Headey, 2011). On the last one, the drivers of such trends include the followings:

- technical innovation in the agricultural sector, that in the long-run allows a growth of the global production; on the other hand, the reduction of research and development expenditures declines the diffusion of innovation yield-increasing;
- climate conditions during the crop production period, especially in the major exporting countries, like Unites States, Canada, Australia, Russia for wheat and Asian countries for rice; these conditions determine the increase or the reduction of production (for example connected to droughts) , affecting the price dynamics;
- agricultural policies, especially in the exporting countries; in particular, the US and EU support to bio-fuels led to a growth of demand for non-food agricultural commodities, determining a reduction of the global agricultural supply traded in the international markets;
- export restrictions in exporting countries;
- raising oil prices, that affect the production costs of agricultural products;
- financial speculation.

On the demand side, the increasing GDP per capita in emerging national economies, like BRICS countries, and the evolving consumer diets, especially in India and China, have led to a

growth of the food demand connected to animal proteins, supporting the demand for cereal at world level.
In the EU market, besides the world trends, demand and supply dynamics in the different countries can have a strong influence on the price volatility. Another driver that can affect the price evolution is connected to the agent relationships within the supply chain. In particular, the type of link between agricultural sector and food industry is crucial for the price transmission in the supply chain. Farmers are price takers, as most of the agricultural products are commodities. On the other side, most of the processed products are differentiated and processors can be price makers. Therefore, the market power of food industry is definitively stronger that agriculture, and this affects the way in which prices move, leading to an asymmetric price transmission along the supply chain.
In the case of rice, the drivers described above explain just one part of the story of the price volatility, since there are specific factors connected to the particular characteristics of the rice supply chain.

3.2 Price volatility drivers for rice

In the international market of the agricultural products the different commodity exchanges show a specific importance for certain products. In the case of rice the most important commodity exchange, that is considered representative for the world price trends, is the market of Bangkok (Thailand).
The drivers of world price volatility for rice can be classified in three main groups (Headey, 2011):

1. motivations in line with other agricultural commodities; these include oil price increase, climate conditions, financial speculation;
2. close relation between wheat and rice price trends;
3. trade measures especially concerning export restrictions.

Regarding the second point, some studies have underlined the link between the price volatility of wheat and that of rice. This fact is due to a possible switching of importing countries from wheat to rice when the level of price of wheat is particularly high. This implies a possible “substitution” between the two commodities, whose effect could be the increase of demand for rice and, consequently, of price.
With regards to trade measures, the export restrictions implemented by some countries in periods of strong volatility affect the world market, determining a reduction of available supply. Therefore, the price tends to increase. In the last five years many trade measures of this kind occurred. For example, in autumn 2007 Vietnam and India applied an export restriction; the same happened in January 2008 for Egypt and China; on the opposite, Saudi Arabia and Nigeria implemented import subsidy and tariff exemptions between February and May 2008 (Headey, 2011).
The effects of price volatility are very strong on importing developing countries, as well as exporting countries, creating worst conditions in terms of poverty.
Figure 2 reports rice price trend over the period 1990-2012, taking into account an average price calculated by FAO. The graph shows the strong volatility in the last five years and the sharp price increase in 2008.
Figure 3 shows rice price trends at national level considering the major exporting countries where the prices are calculated as a ratio between value exported and quantity. The graph confirms the strong volatility in the last five years at national level too.

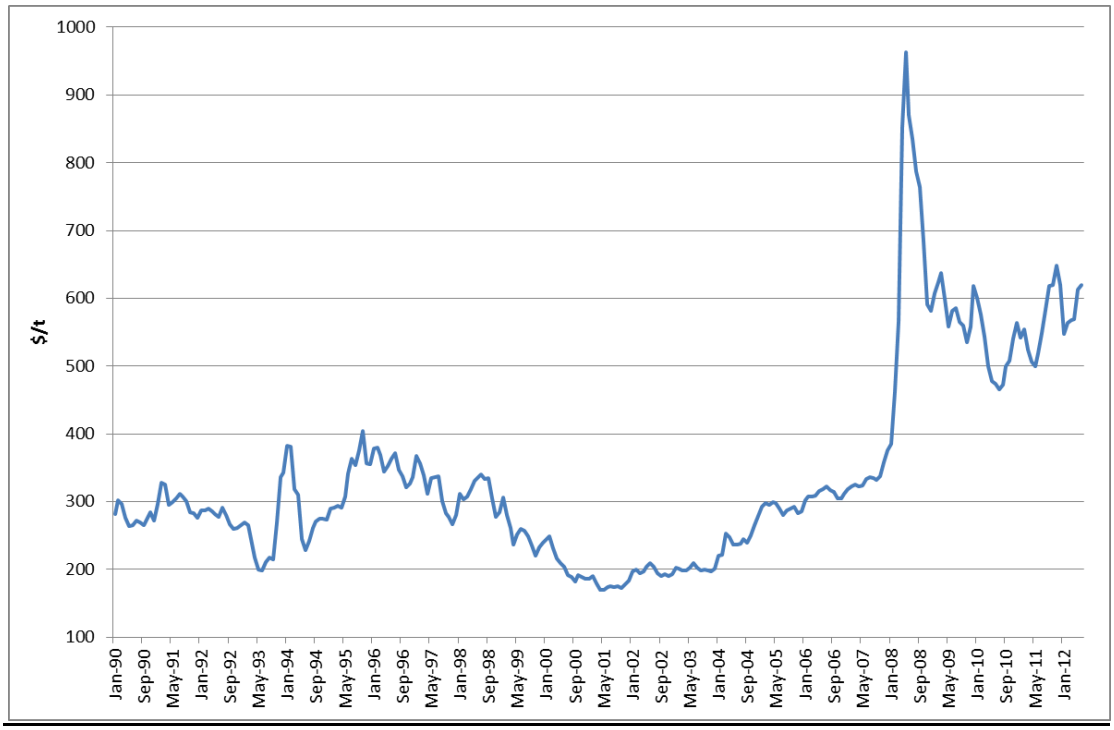

Figure 2. Rice price trend at world level
Source: FAO data

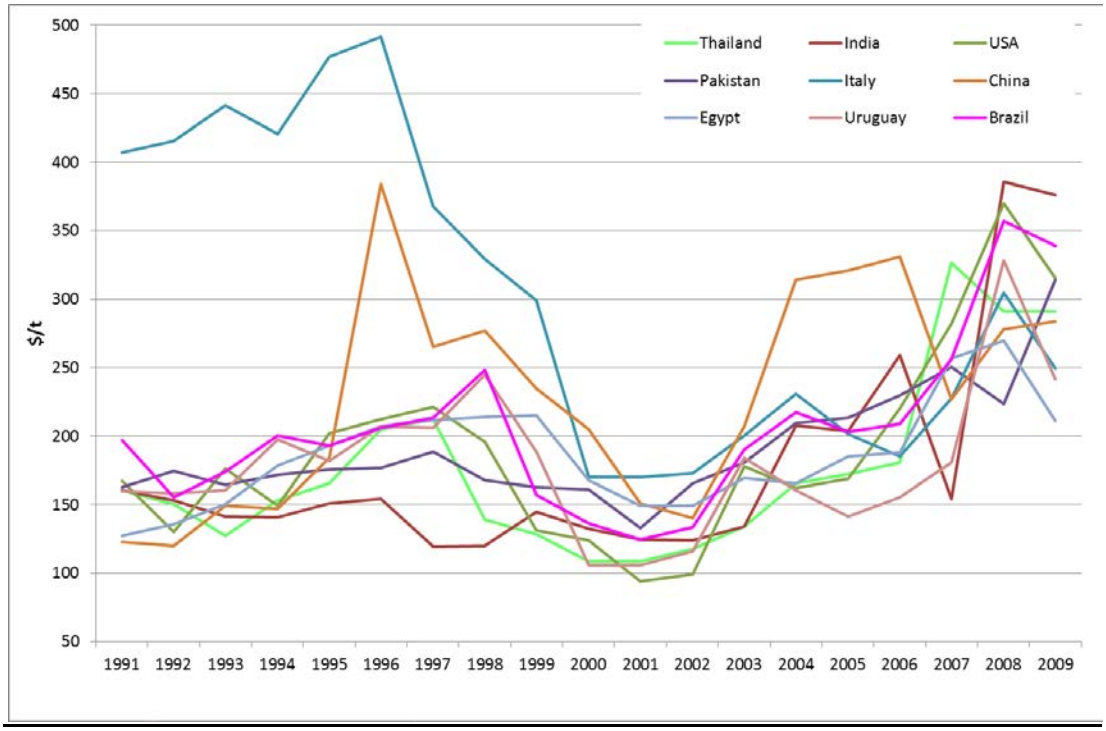

Figure 3. Rice prices at world level
Source: FAO data

In the EU, the rice price trends have been strongly affected by the price policy of the Common Agricultural Policy (CAP). Until 2003-2004, the common market organization for rice (Regulation 372/95) fixed the intervention price at 298,35 Euro/t, providing a direct

payment equal to 318,01 Euro/he. A maximum surface was established for each European country. In Italy, for example, it was 239,259 he.
In 2003, the new regulations 1782 and 1785 strongly reduced the intervention price to 150 Euro/t lowering the European price to the same level of the world one. Moreover, the maximum surface was reduced too (in Italy, 219,588 he). To compensate rice farmers for the profitability reduction a direct payment has been introduced, divided in a decoupled aid (in Italy, 616 Euro/he) and a coupled aid (453 Euro/he).
With the health check of the CAP the decoupled aid has been incorporated into the overall farm payment, and in 2012 also the coupled aid has been included. Therefore, from 2004 the intervention price does not influence anymore in a strong way the price rice trends in the EU. Figure 4 shows the rice price trends in Italy from 2000 to 2012. Again, the graph remarks the high volatility during the last five years. These trends are in line with the world one, but some specificities linked to the rice Italian market add even more volatility.
Figure 5 reports the price trends in Italy for milled rice, showing also in this case a strong volatility in the last five years.

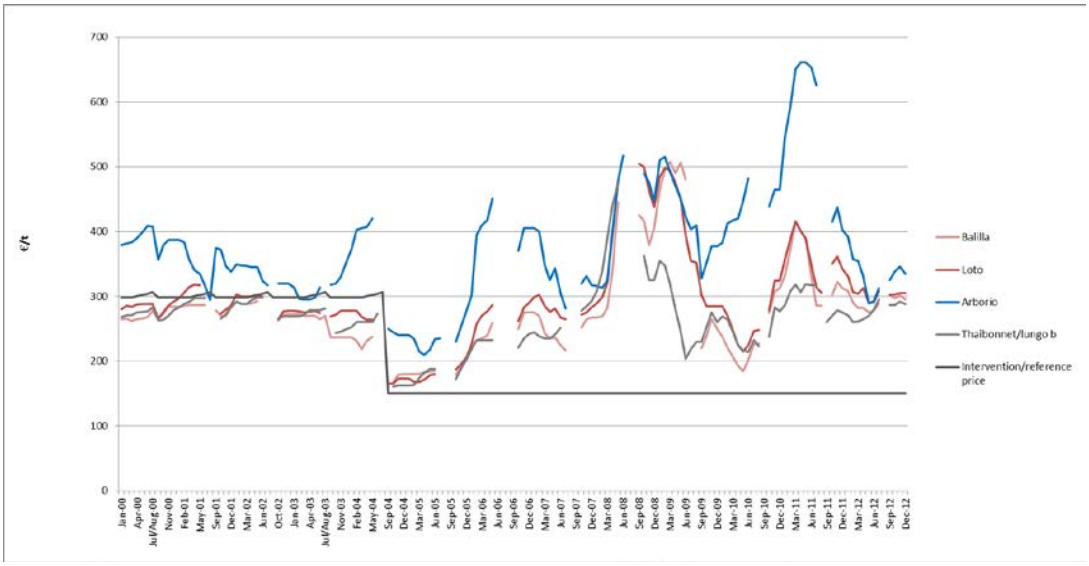

Figure 4. Price trend in Italy for paddy rice
Source: Chamber of commerce of Vercelli data

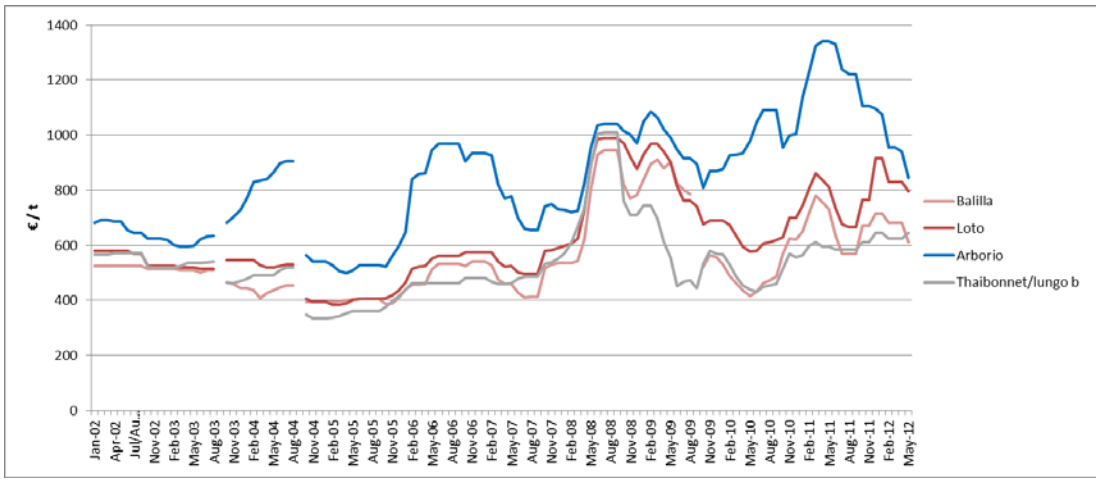

Figure 5. Price trend in Italy for milled rice
Source: Chamber of commerce of Vercelli and Pavia data

4 Discussion

In Europe, revenue insurance products are still not widespread. To the best of our knowledge, the first revenue insurance product was launched in the UK in 1999 (Mahul and Wright 2003, Harwood et al. 2000), while in France private insurers are trying to establish a pilot product, but without any government support. In Italy, although public intervention has a long tradition, the market for agricultural insurance products offers only yields coverage[3].

At the moment the only country offering a comprehensive crop revenue insurance at a market level is the US, where the Risk Management Agency introduced the first revenue insurance product in 1996. Although a variety of coverage options are available, the three standard revenue insurance products, which mainly differ in rate setting procedures, are Crop Revenue Coverage (CRC), Income protection (IP), Revenue Assurance (RA).

Those products are offered both at firm-level and at area-level. In the first case, the threshold under which the insurance pays is defined with regards to the characteristics of the farmer's insured crop. In the second case, the threshold is selected for an area yield/revenue: if the gross revenue of a crop in a certain area is below a certain threshold, all farmers are compensated, that is all of the crops in a county are insured as a single unit[4].

The US insurance system for agricultural commodities is public-private and is administered by the Risk Management Agency (RMA), a division of the USDA. The public sector subsidies 60% of premiums and co-finances losses in proportion to the severity of losses. Public reinsurance assumes between 35% and 100% of losses; the larger the losses, the more co-financing are provided. According to literature, the most crucial success factors for US revenue insurance are: co-financing of premium rates, large database of historical yields and prices, transparent and highly liquid commodity-price discovery mechanism (Munich RE, 2011).

The importance of government support is commonly recognized in literature as a reason of failure of agricultural insurance markets (Tang, 2010). Indeed, agriculture is a high risk industry, with frequent and highly covariate agricultural production risks and the persistence of moral hazard and adverse selection problems, and insurance companies have little economic interest in engaging in it. Specifically, insurance companies face specific problems when identifying the input data to determine the level of the coverage and the amount of the premium. As far as the yield component, in order to identify the expected farm yield at planting, it is essential to have a sufficiently long time series of data, both at firm-level and at area-level. The same holds for measuring the expected variations of futures prices between planting and harvest.

A time series of at least 20 years is only available for a few markets, like CBOT in the US. Regional markets, such as the Italian, in theory could use global markets as a proxy, but this works only if there is a high correlation of local and global commodity prices.

[3] Every year the Ministry of Agriculture issues an Annual Insurance Plan that determines which crops are insurable and for which damages; this crop/damage are entitled to a subsidy of around 40% of the premiums (Enjolras et al. , 2012).

[4] The most widespread area-based insurance product is the Group Risk Income Protection (GRIP). According to Deng (2007), some believe that the area-based insurance product provide farmers with a valuable, and less expensive, alternative to the farm-level insurance products; other thinks that the basis risk associated with area-based products makes them unattractive for most farmers. From a farmer's perspective, the choice between the area-based and farm-level insurance products typically comes down to a trade-off between higher basis risk (with the area-based products) and higher premium cost (with the farm-level products).

Without government subsidies or public reinsurance insurers would not offer revenue insurance products or would offer them at a very expensive risk premium (Mahul 2001).

6 Conclusions

Results show that revenue insurance products seem a dynamic field of research. They provide protection against declines in price during the crop growing season, measuring price variability with reference to a specific market benchmark.

At the moment in Italy there are no revenue insurance products available. In general, major concerns in creating such a market are: high production costs in creating single-farm insurance products, data availability, information asymmetries, high premium requiring public intervention.

Our analysis is a first attempt to highlight the most relevant issues in creating revenue insurance products for rice farmers in Italy.

The localization of rice production in Italy is characterized by a strong geographical concentration in the North-West area of the country, where more than 85% of rice farms are located. In the same area, rice millers and retailers are located, allowing reducing transportation costs. This geographical specificity of rice production determines favorable conditions to develop an area-based revenue insurance product. In this way, it is possible to overcome the constrain of high production costs connected to single-farm insurance, as the farms located in this area are quite similar in terms of structural and production conditions (i.e. farm size, level of mechanization, high innovation attitude, type of soil, irrigation systems).

Concerning data availability, in Italy there are no futures contracts with rice as underlying asset. This means that it is not possible to evaluate the insurance premium based on the difference between spot and futures price trends. However, there are long time series data regarding paddy and milled rice prices deriving from local commodity exchange markets. Time series data on paddy production yields are also available. Indeed, since many years a public institution has been established to collect data for rice and to support supply chain relationship (“Ente Nazionale Risi”) which provides databases on rice market. Therefore, a deep amount of data is available to design an area-insurance revenue contract based on rice farming specificities.

As far as information asymmetries, the characteristics of the Italian rice market may help to overcome such criticalities. In particular, adverse selection problems are pre-contractual and regard the propensity of high risky agents to subscribe insurance products. For rice the level of risk connected to price volatility is almost the same for all producers; what may differ are the production yields as they can vary due to sub-areas climatic and soil conditions. This problem can be solved by applying different premium rates accordingly to the sub-area specificities. Regarding moral hazard, farmers are price takers and therefore they have not the possibility to behave in opportunistic way in case of price volatility. When prices and yields are low, the market incentive for producers could low too, but still exists, as the producers normally have long-run and valuable relationship with their customers in the supply chain. Therefore, even in this case moral hazard behaviors should be limited.

The most critical issue remains the high level of the premium for insurers. Public intervention can help in reducing its level, providing a specific framework in which support is provided to farmers. In this direction, new opportunities can be opened by the reform of the CAP and thanks to the new coming program for rural development. In particular, the latter policy can include specific measures concerning public support for revenue insurance.

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