MARGIN INSURANCE IN AGRICULTURE – A MICRO SIMULATION APPROACH OF WHEAT AND HOG PRODUCTION IN AUSTRIA

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Abstract

To stabilise agricultural markets is one of the central objectives of the Common Agricultural Policies (CAP). After two decades of agricultural policy reforms markets are now only minimally influenced by direct policy interventions. However, prices of many farm commodities have become more volatile. A consequence is that farm incomes have become more volatile, as well. Direct payments are an effective instrument to stabilise incomes by offering a certain minimum level of liquidity. However, such premiums are low for many farmers and therefore a set of income stabilisation instruments was introduced during the Health Check Reform on an optional basis for Member States and certain groups of producers. In order to overcome some of the shortcomings of such approaches, we propose a margin insurance. We present such an insurance programme for EU agriculture and exemplify it using Austrian wheat and hog production as case studies. By referring to existing income insurance systems we identify necessary conditions for such a scheme to work. In order to address adverse selection, a micro simulation approach is proposed that makes granular premium discrimination feasible. Such an approach seems to be better suited for the heterogeneous structural conditions in the EU than a similar scheme for milk producers in the US that is based on a composite index.

Keywords

risk management, hog production, agricultural policy, margin insurance.

1 Motivation and problem statement

To stabilise agricultural markets is one of the five specific objectives of the Common Agricultural Policy (CAP) as laid down in Article 39 of the Treaty on the Functioning of the European Union. However, after introducing a market oriented policy following the Agenda 2000 reform, prices of many farm commodities have become more volatile. The abolition of export subsidies, the abandonment or lowering of intervention prices and the elimination of supply controls like the milk quota brought domestic farm commodity prices in line with international prices. A consequence is that farm incomes have become more volatile as well. Direct payments (an element of the 'First Pillar' of the CAP) were introduced in order to compensate farmers for lower administrative farm commodity prices. Most of them are no longer linked to the production of specific commodities but to land and are therefore an effective instrument to stabilize incomes by offering liquidity even under adverse market conditions. However, direct payments are very low for many farmers, in particular in countries that entered the EU in 2004 and thereafter.

A recent study of the EU Parliament (BARDAJÍ et al., 2016) shows that agricultural policy makers have been aware of farm price and income volatility. Income stabilisation instruments are implemented in a number of EU Member States to help farmers to cope with production risks. However, such tools like mutual funds or revenue/income insurance systems are of limited use for farmers according to BARDAJÍ et al. (2016) because determining the expected or guaranteed and actual revenue or income is extremely difficult.

This paper presents elements of a novel income insurance programme for EU agriculture and exemplifies it using Austrian wheat and hog production as a case study. Austria is chosen as an example because the portfolio of insurance products for agriculture has expanded significantly

during recent years. Insurance against damages due to natural hazards like hail, frost, snow pressure, floods are now available for a large number of crops. Recently two index-based insurances were introduced for crops and grassland to cover losses due to draught and new index products are offered for the 2017 growing season (Lembacher, 2017). The acceptance of new index products on the market shows that farmers actually need such products and are willing to pay for them. The growing market volume indicates that farmers are more actively controlling risks using insurance products.

Representatives of farmers, however, are not yet satisfied with the current product portfolio. Their argument is that a single product that covers both production risk and market price volatility is needed. Currently, separate contracts with different service providers are necessary to cover production losses and to hedge output price risks. From a farmers' perspective, a combined product would reduce transaction costs. A type of revenue insurance would be an improvement compared to the current situation although farmers are mainly concerned about profits and incomes and less about yields or revenues. Therefore, the ideal insurance product would cover not only production risk and product price variation risks but also price risks related to input price variation, e.g. for feed, fuel and fertilizer.

Moreover, many farms in Austria are relatively small and farmers are typically both managing and operating their business simultaneously. They would benefit from a simple insurance product since they are time-constrained, but nevertheless need to make well-informed choices whether to take up the insurance or go along with their current risk management practice.

These considerations and the fact that several index-based products are already well established on the market make it plausible to develop an insurance product that is simple to communicate, robust to massive moral hazard problems associated with income insurance and that can be implemented at low cost. The fact that such a product does not yet exist on the market is an indication that some of the necessary preconditions for a working income insurance product are not yet available. The purpose of our contribution is to demonstrate an approach that may help to make an income insurance product feasible.

In order to evaluate the feasibility of such a solution, we first describe the market for insurance products for agricultural production risks and income risks for non-farmers in order to identify reasons why such a product is not yet on the market. We identify necessary characteristics an income insurance product must have in order to be of value for farmers and operational for an insurer. We develop a prototype of such an insurance which focusses on the margin of an agricultural activity. It is therefore not an income insurance but comes as close to it as possible. We exemplify the margin insurance for a typical wheat and hog producer in Austria based on microsimulated farm revenues and costs which indicate the occurrence of a loss. The purpose is to identify the elements that are necessary for developing a marketable product that deals with production and market price variation risks and that offers advantages over existing approaches.

2 The state of agricultural production risk management in Austria

The market of Austrian disaster risk management is characterized by the fact that private firms and the public are active but not well co-ordinated (Url and Sinabell, 2008). With respect to agriculture, the situation is different: a single company offers a wide range of insurance products to mitigate agricultural production risks. The Austrian Hail Insurance Company (Österreichische Hagelversicherung) is a mutual insurer, founded by the Austrian insurance industry in 1947. As a mutual insurer it is not profit-oriented and thus costs can be kept low. The national government subsidizes the hail-insurance premium for all crops since 1995 and the frost-insurance premium for vine-cultures and insurable crops since 1997. The subsidy is

shared equally between the federal and the Länder governments and amounts to 50% of the total premium.

An overview of the product portfolio offered by this insurer shows that insurance products are available for almost all relevant production activities. Statistics (Table 1) show that the market has grown significantly during the last decade and that public support has grown in a likewise manner. The annual total value of agricultural production in Austria was € 6.7 bn over the last five years. The sum insured was € 3.7 bn and shows the high degree of market penetration (output of agricultural products was € 6.0 bn in 2016).

Drought is a severe production risk in Austria. Recently introduced innovation are drought insurances for grassland and maize. The new index insurances rely on big data meteorological applications. Frost and flood insurance products that were not covered so far have been introduced in 2017 as well (Lembacher, 2017).

Table 1: Key data on the market for production related risks in Austrian agriculture

	2000	2005	2014
clients	71,897	67,866	n.a.
area, 1,000 ha	913	1,079	1,209
premium volume, mn €	45.9	53.1	96.3
farmer's losses, mn €	64.3	23.3	n.a.
premium subsidy, mn €	22	24	40
sum insured, bn €	n.a.	n.a.	3.7

Hint: The decreasing number of clients is mainly due to structural change.
Source: Österreichische Hagelversicherung, VVaG; BMF various years.

For production related risks there is a broad portfolio of insurance products available and the rate of innovation is satisfying from the farmers' perspective (e.g. index-based insurances). Nevertheless, since price volatility has increased significantly from 2005 onwards, farmers are nowadays concerned about price risks as well.

Until recently there were no financial products available that a typical Austrian farmer would use to reduce output price-related risks. Only few farmers employ brokers for hedging of futures contracts. Several years ago grain trade companies started to introduce price hedging products as a service for their suppliers and some grain farmers have made good experience with such services recently.

Futures contracts for agricultural products are available only for a few crops (wheat, rapeseed, corn) in Austria and many producers of piglets, pigs or milk have become interested in price hedging products for livestock, as well. Additionally, the recent decline of prices for these products has raised the awareness among farmers further.

Eventually, Austrian farmers are interested in stable incomes (Larcher et al., 2015). Therefore, alleviating production-related risks like frost, hail or drought is improving the situation for those exposed to these risks. But many more are confronted with highly volatile income streams during the last years like milk or pig producers. Income stabilisation tools like mutual funds or revenue insurance systems have not yet been established successfully in Austria.

3 Elements of income insurance schemes in Austria

Income insurance schemes are widely used in the Austrian economy but only few of them are offered by private insurers. Private insurance products cover the payment of daily allowances

in the case of sickness or of the payment of annuities if a permanent reduction in the individual's earnings capacity occurred. In both cases potentially severe moral hazard problems with income insurance are solved by requiring medical examinations.

A coverage of income losses is also offered by the public and obligatory unemployment insurance scheme for employees and a recently introduced scheme for self-employed persons which operates on a voluntary basis. The unemployment insurance for employees uses several constraints to control moral hazard. There is a minimum waiting period during which premiums are paid but the insured have no right to claim benefits. Furthermore, the payment period is limited to six months and the benefits cover the previous working income only partially. Employees quitting their job on their own initiative and self-employed persons who stop their activity are subject to short period without benefit payment. During the unemployment period the insured are legally obliged to actively search for a new job or attend training programs. The refusal of cooperation with the labour market service results in temporary forfeiture of the benefit. Finally, after resumption of active work another waiting period starts before repeated claims can be made.

Adverse selection is limited by mandatory insurance for employees. The self-employed have to stay in the system for at least eight years and must have paid into the system a certain period before they qualify for benefits. The income insurance for self-employed persons was introduced only a few years ago. Since no evaluation has been published so far, it is not known whether adverse selection and moral hazard can be effectively controlled by the requirements. The system seems to be vulnerable to adverse selection because self-employed persons in sectors with a strong seasonal pattern (tourist guides, gardeners, etc.) are more likely to buy coverage than others.

Contrary to employees and the self-employed population, an income insurance does not yet exist for Austrian farmers. However, lessons learned from the other schemes can be used to identify necessary conditions that must be met in order to get it working:

- *Costs of administration*: In order to keep premiums low, administrative processes have to be highly automated, information has to be transparent and available swiftly at low costs to all involved parties.
- *Moral hazard*: The farmers' behavior should not impact on the payout of the insurance, easily observable variables not under the control of the farmer should trigger indemnities automatically.
- *Adverse selection*: Mandatory insurance or external examinations are the instruments used in existing income insurance products described above. Another well known instrument to limit adverse selection is premium discrimination among identifiable groups of the insured (Dionne and Lasserre, 1985). In this case, the characteristics of potential buyers of a gross margin insurance have to be well known. Contracts need to be designed such that identification or self selection supports a smooth operation of the insurance system.
- *Concentration risks*: Livestock production (e.g. milk and pig production) uses similar inputs and farmers sells their product at the same competitive market. Farms are therefore subject to the same sort of unexpected variation in input and output prices. If an insurance company underwrites Austrian dairy farms it would be subject to substantial concentration risk because all dairy farms will be adversely affected by the same unfavourable price developments. A reasonable remedy of this concentration risk is to underwrite several – preferably unrelated – agricultural products because this helps to spread the risk across the insured pool.
- *Trends in agricultural prices and input costs*: An income insurance scheme should not impact on structural change rather it is supposed to smooth out unexpected changes in market conditions. Due to the recognition lag for structural developments the insurance scheme may

as a by-product help farmers to adjust to new situations without worrying about income losses too much. But a series of bad years may drive the insurer into insolvency. Short-run insurance contracts, e.g. for one year, would reduce the probability of bankruptcy for the insurer because premiums can be regularly adjusted. A public reinsurance scheme would reduce the need for solvency capital. Alternatively, one may close the scheme until market developments become clear.

A product that is placed on the market and successful over long periods has to have finely-tuned features that address all the elements listed above. For a prototype of a farm income insurance in Austria which is presented in more detail in the next section these features have not yet been fully developed. The concept presented in the next chapter addresses the three elements: cost of administration, moral hazard, and adverse selection. It is based on well known data sources that are maintained for other purposes and therefore most of the data are available at low costs. It uses wheat and hog production in Austria as an example but the method is developed for all major crops, and for milk production. The concept can therefore be expanded to reduce concentration risks as well.

4 The concept of an index based margin insurance

The core of the new product is a calculation of standard gross margins that is based on observed data and farm characteristics. Effectively it is a technical data set that is not specific to observed farms but describing synthetic farms with special features. Almost every Austrian farmer is familiar with this method and farm advisory services offer sophisticated online tools that implement this concept (BAWI, 2016). In addition, many farmers are organized in working groups promoted by the Chamber of Agriculture where they meet in order to compare the gross margin results and cost break downs of their farm and learn from the peers performing above average.

In order to calculate the premiums, the volatility of input prices (fuel, fertilizer, feed), of output prices, of yields and the cost structure needs to be known. Volatility of output prices and input prices can be observed on the market and detailed statistics are readily available. To deal with the production risk is the core business of any crop insurance and therefore is well known to the incumbent insurance company.

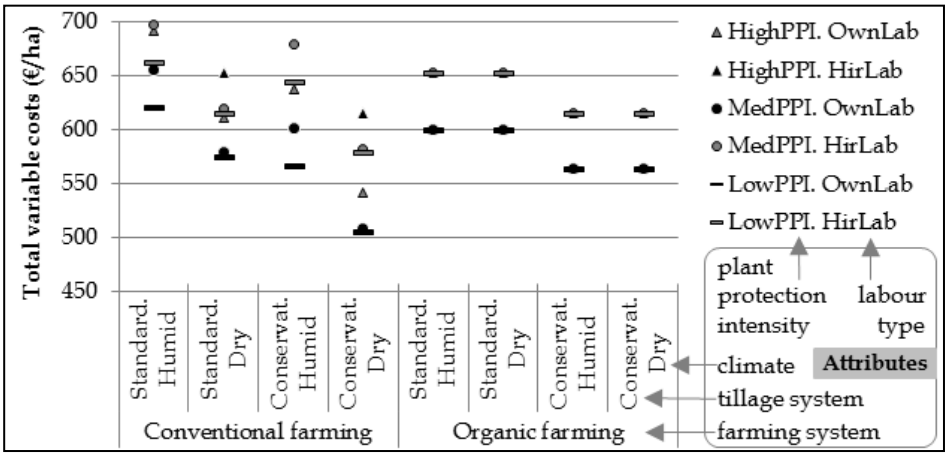
The cost structure and the relative weight of each cost item is very heterogeneous in Austrian farms because many of them are not specialized but produce multiple outputs (Figure 1). To account for farm heterogeneity, INCAP (index-based costs of agricultural production) was developed. The INCAP data set is designed to make such analyses possible by covering all relevant production activities of the Austrian agricultural sector (Heinschink et al., 2016a,b). Data derived from INCAP can be used as a tool for examining risks in Austrian agriculture, such as fluctuations of activity-specific gross margins. It can also be used to evaluate farm-specific incomes or incomes at sector level (Sinabell, Heinschink, Tribl, 2016).

The data used for INCAP are not based on cost accounting data of farms but are derived from many sources. The quality of the results and their validity is scrutinized using data from farmers in accounting working groups from a major production region (Heinschink et al., 2016a).

Figure 1 shows selected results derived from INCAP, the variable cost calculations of wheat production over a period of three years. INCAP represents various technologies explicitly and captures most production conditions in Austrian farming. In order to highlight some of the features, two types of wheat production (organic and non-organic milk), two tillage systems (standard tillage and conservative tillage), variants of hired/own labour, plant protection intensity and two climatic conditions (homid and dry) are shown in Figure 1. Cost and revenue

information for major agricultural activities in Austria similar to the one presented in Figure 1 are available for the most important products and production systems in Austria. The calculation scheme is transparent and available over long periods using indices mainly from official sources. Currently the coefficients that represent the technology are fixed and not time varying therefore technical change has to be accounted explicitly if this is needed.

Figure 1: Variable costs for 48 combinations of quality wheat production (no straw recovery, cropland, field size: 2 ha, tax excluded) in the baseline period (avg 2011-2013), €/ha



Source: own figure

5 Micro-simulation of a margin insurance scheme for milk producers

INCAP is very detailed it can be used in a micro-simulation tool for a wide range of insurance schemes. An example for wheat and hog production is presented in this section. It is inspired by the margin protection programme for dairy which was introduced in the 2014 US farm bill (Orden and Zulauf, 2015). Key elements of this programme are applied in the Austrian context and our examples shows how it would have worked for two specific activities had it been in operation in the past.

In the remainder of this section it is important to keep in mind that the term "margin" is defined in a specific way and must not be confused with the term "gross margin" (GM) presented in the previous section and shown in Figure 2. "Margin" is revenue minus feed cost in the case of livestock products and “margin” is revenue minus variable costs in case of crop products. Feed cost are the sum of forage cost/farm-produced feed, concentrates, and other feed costs.

5.1 The US Margin Protection Programme for Dairy

The Margin Protection Program for Dairy Producers (MPP-Dairy will be effective through 2018.[1] It offers dairy producers: (1) catastrophic coverage, at *no* cost to the producer, other than an annual $100 administrative fee; and (2) various levels of buy-up coverage. Catastrophic coverage provides payments when the national dairy production margin is less than $4.00 per cwt (0.088 $/kg).[2] The national dairy production margin is the difference between the all-milk price and average feed costs, computed from a formula using national benchmark prices of

[1] The following section is based on http://www.nmpf.org/margin-protection-program-2014-farm-bill (retrieved 15 Sept 2016).

[2] In the U.S., dairy farmers are paid per cwt (1 cwt = 100 lb). 100 lb (=1 cwt) is 45.359237 kg or 44.038 l with a conversion factor of 1.03 per kg milk.

corn, soybean meal and alfalfa hay. A national average margin is used for the calculation, not the farm specific margin.

Producers may purchase buy-up coverage that provides payments when margins are between $4.00 (0.088 $/kg) and $8.00 per cwt (0.176 $/kg). To participate in buy-up coverage, a producer must pay a premium that varies with the level of protection chosen by the producer. The Margin Protection Program pays indemnities when the average margin for specific, two-month periods is below the level selected by the producer. The volume covered in this period is one-sixth of the annual total and not the milk produced in these two months.

The quantity covered is limited by observed production levels prior to the farm bill. Producers can protect between 25% to 90% of their production history. If production is expanded more than the national average, the surplus milk is not insured.

Premiums for buy-up coverage start at $ 0.01 at the $ 4.50/cwt level and increase to $ 0.475 (9.92 cent/kg) for $ 8.00/cwt (0.176 $/kg). Farmers producing more than 40,000 cwt (1,814 t) have to pay higher premiums for production exceeding this threshold. For a typical dairy herd of 100 cows with a production history of 892 t (of which 90% are covered) the annual premium for a margin protection coverage of $ 4.5/cwt (0.992 $/kg) is $ 177. The premium for the herd of 100 cows is $ 8,411 for a $ 8.00/cwt (0.176 $/kg) coverage. A recent report of Mark et al. (2016) gives a detailed overview of the operation of the programme so far.

5.2 A micro-simulation of a wheat margin insurance scheme in Austria

To exemplify an ex-post calculation of an index-based margin insurance in the EU, we present results of a margin insurance for wheat in Austria. It guarantees a minimum margin of 120 € per hectare.

In Figure 2, all types of wheat are aggregated and numbers represent weighted averages. The upper (solid) line is the average price of wheat in Austria over a period of 16 years. The lower (short-) dashed line indicates the standard production costs (i.e. seed, fertiliser, machinery, energy, plant protection). The light-coloured area, assuming positive and negative values, represents the margin prior to deducting premiums for the 'margin insurance'. The dark area, capped at the determined level of insurance, represents the insurance payout that accrue when the margins fall below 120 € /ha. In order to keep things simple, the assumption was made that a public fund is sponsoring the insurance by covering administrative costs and re-insurance premiums (together approximately 20%). The premium accrued during the chosen period (indicated by the long-dashed line) therefore equals the indemnities that are used to compensate any shortfall of margins below 120 € per hectare. If the government in addition fully supported the premium, the total cost would be 59 € per hectare in this example. For comparison, the average direct payment in Austria per hectare of utilised agricultural land was 258 € in 2015. It is important to bear in mind trends in output and input prices as well as covariance between the time series.

Figure 2 shows that such a product may impose severe concentration risk for an insurer over several years. Declining margins over a period of four years are likely unbearable if an insurer can not offset the losses with revenues from other products that are negatively correlated. From an insurers point of view it may therefore be necessary to have several margin insurance products in the portfolio along with other products.

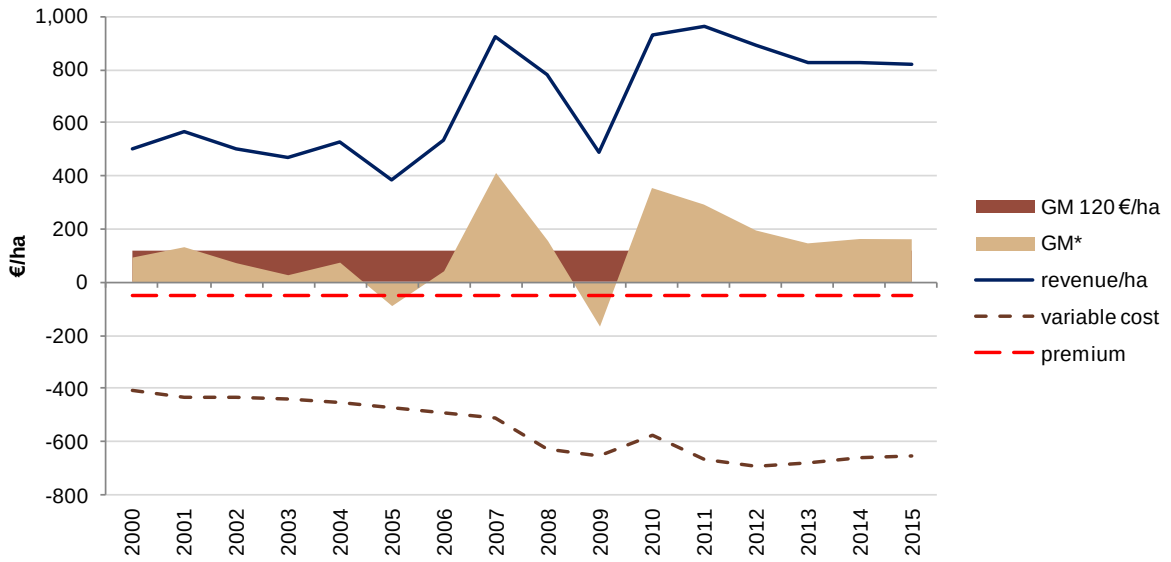


Figure 2: An ex-post calculation of an index-based margin insurance scheme (€/ha) with minimum margin of 120 € hectare.

Remark: The assumption was made that administrative costs and re-insurance are covered by a farm programme. If the government in addition fully supported the premium, the total cost would be 59 € per hectare. The average direct payment in Austria per hectare utilised agricultural land was 258 € in 2015.

Source: Own figure

5.3 A micro-simulation of margins in hog production in Austria

In the US Milk Margin Protection programme a period of two month is taken in order to calculate average margins. The period can even be shortened to one month as shown in Figure 3 using the example of hog production in Austria. Because crops are harvested only once a year it is not meaningful to differentiate between shorter periods than a year in the case of crop production - but in the case of livestock products it makes sense.

Figure 3 does not show all the elements of the margin calculation as in the previous examples but just the margin and two levels of minimum coverage at 10€ and 20 € per hog. The figure clearly shows the large variance of margins over time. The figure also shows that margin volatility seems to have become smaller after the period of the financial crisis in 2008/2009. Whereas price volatility has generally increased in Austria during recent years, the same can not be observed in the case of margins in hog production (for the specific type shown in Figure 2).

Over the period of 204 month the frequency of margins lower than indicated by the two lower bounds was 11 for the case of 10€/hog and 59 times for the case of 20 €/hog. The fair premiums for such a margin insurance scheme would have been 0.16 or 1.65 €/hog (assuming that the premiums are not deducted from the revenues).

Compared to the previous example of wheat production a margin insurance for hog production seems to be easier to manage from an insurers' point of view because there are no long sequences of margins below the thresholds. However, the question is whether hog farmers actually would buy such an insurance product because those who are still in the market obviously have found effective ways to manage income risks in the past

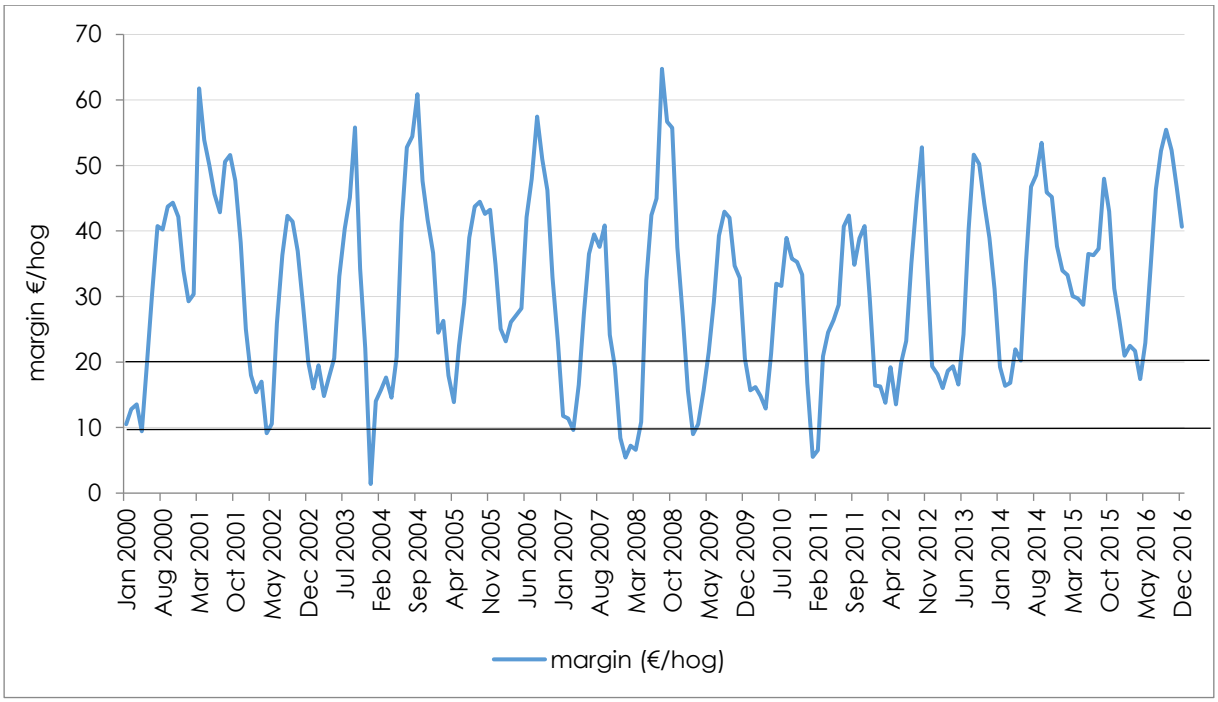


Figure 3: Margins (€/hog) in Austria

Remark: CCM based feed with self mixed grain / soy been complement. Including tax. Weight of piglet 31.5 kg, slaughter weight of hog depending on market conditions (91.8-98.4kg).

Source: Own figure; based on http://www.awi.bmlfuw.gv.at/idb/schweinemastkonv.html.

6 Discussion and outlook

Income insurances are frequently used in economies of the EU. Using Austria as an example we show that private income insurances exist parallel to compulsory and voluntary public ones. An income insurance for farmers does not exist, though. A reason may be that income stability in agriculture was traditionally attained by price control or supply control measures. Because many of such instruments were abandoned during the last two decades many farmers have become exposed to high income volatility. This paper presents core elements of a new insurance product that allows farmers to insure against income risks.

Using milk production in Austria as an example, a micro-simulation approach is presented that can be used to capture many farm specific characteristics. To account for farm heterogeneity is important for two reasons. Farmers need to see the benefit of an insurance product and premium discrimination is essential to cope with adverse selection.

At the moment, there is not yet a margin insurance product that can be placed on the market in Austria. Several additional steps need to be made before such a product can be placed on the market. After concluding the data validation phase it is necessary to define the details of the sub-indices that enter the micro-simulation model, the details of premium calculation and the specification of the product that shall be placed on the market. To evaluate the acceptance on the market for such a product is probably the most important step before its launch. The European Innovation Partnership offers a chance to support the development of such a product because it promotes cooperation between science, industry and farmers in order to develop innovative products like the one presented in this paper.

A noteworthy advantage of a margin insurance like the one presented here is that it can be easily combined with any other production risk insurance. Very risk averse farmers therefore have the

opportunity to fine tune their risk mitigating measures by combining different insurances. This seems to be important in case of region specific perils like hail or flood.

The results shown in this paper were based on the assumption that technology (e.g. yield per cow and feed/milk ratios) did not change. Such an assumption may be justified for short periods but is certainly inadequate for longer ones. In order to account for technological change, technical parameters need to be modelled explicit and an exploration of their change over time is necessary.

Finally, it will be important to check whether the information on which the micro-simulation system is based, is actually well suited for deployment in the practice. Currently farmers do not have a strategic interest when they report hay prices to statistical authorities. If premiums of an insurance product depend on hay price indices and farmers are aware of it, this may change. In order to prevent moral hazard it is therefore important to identify well designed triggers.

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