EX ANTE EVALUATION OF INDEX-BASED CROP INSURANCE EFFECTIVENESS

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Abstract— **The paper evaluates the effectiveness of several index-based crop insurance schemes by comparing results from two alternative evaluation approaches. We apply the common ex post approach from the literature by specifying and evaluating insurance contracts by means of the data for the same historical period. We introduce an ex ante evaluation approach by distinguishing between two consecutive periods in the available time series: the first period is used for determining insurance parameters and optimal number of farmer's insurance contracts; and the subsequent one is considered for the evaluation of the risk reduction due to the insurance contract defined as in the first period. Our empirical results based on the data for 40 grain producers in Kazakhstan indicate that the common ex post approach overestimates the risk reduction substantially for most index insurance schemes. Additionally, the ex post approach seems to cause the overestimation of index-based insurance effectiveness primarily due to differences in the estimates of the optimal insurance contracts' number rather than due to differences in the insurance contract parameters' estimates.**

Keywords— **ex ante analysis, index-based crop insurance, weather-based index insurance, Kazakhstan.**

I. INTRODUCTION

Index-based insurance represents an innovative crop insurance type. It seems to be less vulnerable to information asymmetries than other crop insurance schemes [1], [2], [3]. This feature of index-based insurance explains a great interest for its empirical implementation in last decades.

An important precondition for introducing an index-based insurance is high correlation between farm yields and an area-yield or a weather-based index. The design and effectiveness of area yield insurance schemes was the subject of the investigations by Miranda [1], Smith et al. [4], Mahul and Vermersch [5]. Several studies [6], [7], [8] focused on empirical specifications of weather indices which can be used as a trigger for weather-based index insurance or derivatives. Recently, Vedenov and Barnett [9], Karuaihe et al. [10], and Breustedt, Bokusheva, and Heidelbach [11], investigated the effectiveness of risk management tools based on weather indices in terms of risk reduction. All mentioned studies are based on the principle of the so-called burn-rate method that is often applied in actuarial practice and assumes that future losses will be distributed as in the past ; i.e. they evaluate the insurance effectiveness ex post. With regard to weather-based index and area-yield insurance, this presupposes that the historically determined pattern of farm yield dependence on a weather variable or an area-yield will be maintained in the future. This assumption, however, might be crude, if the relationship between farm yields and weather variables or between farm and area yields, revealed for a period in the past, has changed. In this case, the insurance might be less effective than expected because the estimated relationship between weather and crop yields may differ substantially from the relationship in the years when a farmer actually purchases insurance.

In addition, by applying the ex post evaluation approach, empirical investigations represent an artificial situation when no information uncertainties are there; indeed, employing the same data for the design and evaluation of insurance contracts indirectly assumes situation of perfect information. Consequently, ex post analyses might overestimate the crop insurance effectiveness because they compute a farmer's decision from ex post information. Moreover, they do not consider possible temporary changes in the relationship between a weather or area yield index and farmers' yields.

In this context, the objective of our study is to introduce an ex-ante evaluation concept into the analysis of index-based insurance effectiveness in the

sense that insurance payments and optimal number of insurance contracts are determined based on actually available information before purchasing insurance. In addition to our ex-ante approach, we conduct the common ex post analysis to evaluate empirically the robustness of the results obtained by applying these two different approaches. Additionally, by applying these two approaches we compare the effectiveness of index-based insurance with a farm yield insurance.

The paper proceeds with a review and discussion of the empirical approaches for evaluating index crop insurance schemes' effectiveness. Section 3 presents our data, the insurance products' specifications, and the methodological framework applied in the study. Section 4 proceeds with discussion of our empirical results. Conclusions are drawn in the final section.

II. CONCEPTUAL FRAMEWORK

We divide this section into a presentation of the theoretical framework and into the discussion of empirical problems related to the ex post evaluation of index crop insurance. Based on this we develop an ex ante approach which we describe in more details in section 3.

Theoretical background

There is considerable literature on assessing the effectiveness of different index crop insurance schemes prior to their market launch. For a crop insurance, the indemnity payment n (per one area unit) is defined as $n = p \, Max[x_s - x, 0]$, where x is an area (farm) yield in the case of area (farm) yield insurance, and a weather index in the case of weather-based index insurance. The indemnity is paid every time if actual values of x are less than the strike or trigger value x_s and is defined as their difference $x_s - x$ times a monetary factor p. If x is based on another variable than the farm yield[1] we call such an insurance index-based insurance. A farmer is free to choose the number of insurance contracts z he wants to purchase for index insurance. For farm yield insurance z is restricted not to exceed one to reduce moral hazard.

Under this general setting Miranda [1], Smith, Chouinard, and Baquet [4], as well as Mahul and

Vermersch [5] evaluate the effectiveness of area yield insurance in terms of (relative) revenue variance reduction for a farmer. Skees, Gober, Varangis, Lester, and Kalavakonda [6] look at the reduction of the coefficient of variation for a portfolio of different crops due to weather-based index insurance while Vedenov and Barnett [9] use two risk measures – the semi-variance of insured revenue and the concept of Value-at-Risk (VaR) – to measure weather derivatives' effectiveness. In addition, to determine demand for weather-based index risk management tools, Vedenov and Barnett [9] as well as Karuaihe, Wang, and Young [10] apply Expected Utility models based on explicit utility functions, including an assumption about the farmer's level of risk aversion. The theoretical frameworks of the cited empirical studies are consistent in the sense that they either maximize Expected Utility (EU) or minimize a risk measure (RM) for one harvesting year with respect to the number of insurance contracts z. In the following, for simplicity, we refer only to minimizing an RM such as variance or coefficient of variation. The (absolute) effectiveness of an index insurance is measured by the decrease of the RM if the optimal number of contracts z* is chosen RM(z*) compared to the RM without insurance, i.e. z = 0, RM(0). More formally, the difference in a risk measure (R M) is defined as follows:

$$\Delta RM = RM\left(0\right) - RM\left(z^{*}\right) \qquad (1)$$

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Ex post and ex ante evaluation concepts

To define an insurance contract and assess its effectiveness for a farmer historical data on farm yields and of (hypothetical) indemnity payments are needed for an empirical analysis. Most of the above-mentioned studies estimate the optimal number of insurance contracts by

$$\min_{z} RM_{t0}^{T} \Big| \Omega_{t0}^{T} \qquad (2)$$

where Ω_{t0}^{T} is the information, i.e. yields and indemnities, from the period t_0 to T. In this case the RM minimisation is conditioned on all information available for the period from $t0$ to T. Thus, the minimization is done ex post with z^* being optimal

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1.[1] More general, we should say if x is not perfectly correlated to the variable whose risk should be reduced by the insurance.

number of insurance contracts.[2] Accordingly, the ex-post effectiveness of an insurance contract is computed as the following:

$$\Delta RM_{t0}^{T} = RM_{t0}^{T}(0)\big|\Omega_{t0}^{T} - RM_{t0}^{T}(z_{t0,T}^{*})\big|\Omega_{t0}^{T} \quad (3)$$

However, to measure effectiveness of an insurance contract ex ante, the evaluation has to be done by employing information from the period which starts after T. Thus, ex ante effectiveness of an insurance contract is to evaluate by means of

$$\Delta RM_{t=T+1}^{T+L} = RM_{t=T+1}^{T+L}(0)\big|\Omega_{t0}^{T}$$
$$- RM_{t=T+1}^{T+L}(z_{t0,T}^{*})\big|\Omega_{to}^{T} \quad (4)$$

In this case evaluation of insurance contract is done for the period of length L, which follows the period from $t0$ to T, conditioned on the information available for the period from $t0$ to T.

As no information from future periods is available, empirical studies extensively apply ex post evaluation framework. Yet, if sufficiently long historical time series are available, the ex ante approach can be adapted by separating historical data into two sub-samples or sub-periods. Consequently, the first sub-period can be used to specify parameters of insurance contracts and to determine optimal number of contracts to purchase. The data from the second sub-period provide a basis for the ex ante evaluation of the specified insurance contracts. To this end, equation (4) has to be adjusted in the following way:

$$\Delta RM_{t=T-L+1}^{T} = RM_{t=T-L+1}^{T}(0)\big|\Omega_{t0}^{T-L}$$
$$- RM_{t=T-L+1}^{T}(z_{t0,T-L}^{*})\big|\Omega_{t0}^{T-L} \quad (5)$$

where L represents now the length of the second sub-period of the whole historical period.

Further on, in the above-presented ex ante evaluation approach the optimal number of insurance contracts remains the same over all years of the second sub-period (which is used for evaluation). However, in reality a farmer has to decide about purchasing insurance contracts at the beginning of every growing year[3]. Thus, he can purchase different numbers of

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2. [2] Due to short farm yield records – in general not exceeding 15 years – econometricians seem to have no alternative to this procedure.
3. [3] Except for the case of long-term (perennial) insurance contracts.

insurance contracts in different years. Regarding this, the farmer's decision problem at the beginning of each year k is to find the optimal number of insurance contracts z_k^{*}:

$$\min_{z_k} E\left[RM^{k}\right]\big|\Omega_{t0}^{k-1} \quad (6)$$

Equation (6) expresses that the farmer wants to minimize his risk, in the year $k = t$ for all $t > T-L$ by purchasing insurance contracts conditioned on the information which he has received from the period prior to year k. We call z_k^{*} the ex ante optimal number of insurance contracts for year k. We introduce the subscript k to indicate those years for which the analysis is done ex ante.

The optimal number of insurance contracts and thus the (expected) risk reduction may differ subject to, whether one computes the ex post or the ex ante optimal number of insurance contracts. The solution for optimal number of insurance contracts $z_{t0,T}^{*}$ derived in the literature (as being a constant for the whole considered period) may change from year to year because important information about the joint distribution of farm yields and / or indemnities may not be known until $k-1$. Thus, the ex ante framework seems to be more realistic, since it represents appropriately the actual amount of information which a farmer can use to make a decision about the number of insurance contracts to purchase, and an insurer uses to determine insurance contract's parameters before selling the contract.

Vedenov and Barnett [9] develop a methodological framework to analyse so called *out-of-sample* effectiveness of weather derivatives. They estimate an optimal $z_{t0,T-L}^{*}$ by solving

$$\min_{z} RM_{t0}^{T-L}\big|\Omega_{t0}^{T-L} \quad (7)$$

According to that, the optimal number of insurance contracts is derived based on the information of a sub-period from t_0 to $T-L < T$. In the next step, the risk reduction is computed for the second sub-period from $T-L+1$ to T assuming that the number of insurance contracts $z_{t0,T-L}^{*}$ is constant in every single year of the second sub-period; i.e. their evaluation approach can be described as in (5).

Finally, up to now we have assumed that the farm yield data and the data for the indices underlying the insurance schemes are free from any time trend and their relationship stays constant over time. If there is a

time trend the expected yield or insurance index has to be adjusted for that trend. Yet detrending has to be consistent with the procedure which determines the optimal number of insurance contracts. This is assured, if the same information amount is used for the detrending procedure as for assessing the optimal number of insurance contracts. Then, detrending in the ex post and in the ex ante approaches differ because different information amounts Ω are employed. The same applies to the insurance parameters' specification, e.g. for parameterisation of a weather index.

III. EMPIRICAL ANALYSIS

Data

Yield data was collected by means of farm surveys and covers 54 large grain producers in five *rayons* (administrative units similar to counties) in Kazakhstan from 1980 to 2002.[4] In addition to farm data, the study employs statistics at the national [12] and rayon level as well as data from a weather station in each rayon.

The expected farm yields for 2002 vary between 0.31 t/ha in north-west Kazakhstan (rayon 4) and 2.37 t/ha in eastern Kazakhstan (rayon 5). In 1998, a year of a severe drought, the weighted average yield of all sample farms amounted to only 0.38 t/ha, which is 40% of the average observed yield from 1980 to 2002. The average cumulative precipitation during the summer months of June to August ranges from 153 mm (SD=61 mm) to 88 mm (SD=33 mm). Table A1 in the Appendix presents expected yields, average values of weather variables, and variations of yields as well as weather variables for selected farms.

Empirical procedures

Our empirical analysis has to two major aims. First, we want to compare the risk reduction due to the ex ante approach and due to the ex post approach. Second, we want to separate the effect of the ex post detrending and insurance parameters determining from

the effect of the ex post-estimated number of insurance contracts. To this end, we introduce an additional procedure called mixed approach with an ex ante detrending, ex ante insurance parameters specification, and an ex post optimal number of contracts. In our empirical analysis we distinguish between the ex post and the ex ante approaches by employing two different procedures for each step of analysis: determining the optimal number of insurance contracts and detrending yields.

Determining the optimal number of insurance contracts

We start by dividing our sample into two sub-samples: the first one from 1980 to 1991 and the second one from 1992 to 2002 and set $k \in \{1992, 1993, \ldots, 2002\}$. The latter sub-period is used for comparing the risk reduction due to the ex post and the ex ante approach, respectively. The relative variance reduction of the uninsured farm wheat revenue assuming a known and constant wheat price is applied as the risk measure.

In the ex post approach, we measure the risk reduction over the period 1992 to 2002, i.e. $t0 = 1992$, and $T = 2002$ in (2). Determining the ex post optimal number of insurance contracts follows the standard literature (e.g. [1]). We define the insured revenue π_k for a year k as:

$$\pi_k = py_k - z_{1992,2002} n_k - z_{1992,2002} E[n] \qquad (8)$$

Then, we determine optimal number of insurance contracts as the variance minimising number of insurance contracts $z_{1992,2002}^* = -Cov[py,n] / Var[n]$ based on the data from 1992 to 2002.

In the ex ante approach, we use the data from years 1980 to $k-1$ to estimate the ex ante optimal number of insurance contracts z_k^* for year k (following equation (9)). $t0$ is set to 1980, $T = 2002$, $L=11$ ($T-L = 1991$), and $t \in \{1980, \ldots, 2002\}$. We compute the optimal number of insurance contracts z_k^* separately for each year k based on the data for the period from 1980 to $k-1$. The ex ante solution z_k^* is derived in the same manner as in the ex post approach but by applying the data from 1980 to $k-1$ only. Accordingly, the insured revenue π_t is defined as follows:

$$\pi_t = py_t - z_k n_t - z_k E[n] \qquad (9)$$

4.[4] The initial sample contained the data on 84 farms from seven rayons. However, we skipped 30 farms from the initial sample in view of structural breaks which were found in the rayon and farm yield time series by applying the Chow-test and assuming third degree polynomial trend over the 1980-2002 period.

with $t \in \{1980, 1981, \ldots, k-1\}$.

The variance minimising number of insurance contracts $z_k^* = -Cov[py, n] / Var[n]$ is determined over the whole period 1980 to $k-1$ and, thus, the procedure is applied for each year k, i.e. L times in total. Then the variance of insured revenue var_{ins}^{ante} is computed for the whole sub-period considered for the evaluation, i.e. from 1992 to 2002 as described by:

$$\text{var}_{ins\ 1992}^{ante\,2002} = (11-1)^{-1} \sum_{k=1992}^{2002} \left(py_k + z_k^* n_k - 11^{-1} \sum_{k=1992}^{2002} \left(py_k - z_k^* n_k \right) \right)^2$$

(10)

Subsequently, we assess the relative ex ante risk reduction over the period 1992 to 2002 by

$$\Delta_{1992}^{ante\,2002} = \frac{\text{var}_{without1992}^{ante\ 2002} - \text{var}_{ins\ 1992}^{ante\,2002}}{\text{var}_{without1992}^{ante\ 2002}} \quad (11)$$

where $\text{var}_{without1992}^{ante\ 2002}$ is the revenue variance without insurance over the period from 1992 to 2002 computed analogously to (10) with $z_k = 0$.

Detrending

The general detrending procedure employed in the study includes the following steps. First, we test the yield data for a time trend by employing second-degree polynomial and linear time trends, alternatively. If estimated trend parameter(s) in the respective regression model is (are) not found to be significantly different from zero according to an F-test, no de-trending is applied. Otherwise, we employ the estimated trend parameter(s) from the respective regression. Then, farms with either autocorrelated residuals or negative yields after detrending are excluded from the sample. Thus, after detrending our sample contains 40 farms from 5 rayons.

There are only small differences in the detrending procedure between the ex ante and the ex post approaches (further ex ante and ex post detrending, respectively). For the ex post analysis we employed yield time series from 1992 to 2002. For the ex ante detrending we estimate the trend parameters for 11 different periods, i.e. for every period $\{1980, 1981, \ldots, k-1\}$ with $k \in \{1992, 1993, \ldots, 2002\}$.[5]

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5. [5] In doing so, we replicate situations actually observed in the insurance practice, when the length of available time series increases with every succeeding year.

Insurance schemes

We evaluate two main groups of index insurance products: weather-based index insurance (WBII) and area yield insurance (AYI). In addition, we use farm yield insurance (FYI) as a reference, which is the equivalent to the U.S. standard farm yield insurance. The analysis considers WBII products based on two drought indices developed for Kazakhstan by Selyaninov [13] and Ped [14] (quoted in [14]). Area yield insurance is defined at the national and *rayon* level.

In general, we construct our insurance premiums and indemnity payments as described in the theoretical framework. The indemnity is denoted $z^* n$ where z is the number of insurance contracts chosen by the farmer and n is defined as $p^* \text{Max}[x_s - x, 0]$ where x is the detrended yield or the weather-based index in an individual year and x_s is the strike or trigger value, p represents a monetary factor. The strike value for all index insurance schemes is the expected value. For the farm yield insurance, the trigger value is set to 75% of the expected farm yield, which equals the maximum strike yield in the U.S. farm yield insurance in most U.S. regions. The insurance premium is assumed to be fair, i.e. it amounts to $z^* E[n]$.

In our study, we analyse two groups of weather-based indices: *farm yield tailored* and *meteorological weather indices*.

The *farm yield-tailored weather indices* are described in equations (12) and (13). The *farm yield-tailored* Selyaninov index is defined as

$$Sel_t^{tailored} = w_{May} P_t^{May} + w_{June} \frac{P_t^{June}}{Temp_t^{June}} +$$

$$w_{July} \frac{P_t^{July}}{Temp_t^{July}} + w_{Aug} \frac{P_t^{Aug}}{Temp_t^{Aug}} + w_{Sept-April} P_t^{Sept-April}$$

(12)

The *farm yield-tailored* Ped index is computed by

$$Ped_t^{tailored} = w_{June} \frac{\Delta P_t^{June}}{\sigma_{P^{June}}} + w_{July} \frac{\Delta P_t^{July}}{\sigma_{P^{July}}} + w_{Aug} \frac{\Delta P_t^{Aug}}{\sigma_{P^{Aug}}}$$

$$- w_{Temp^{June-Aug}} \frac{\Delta Temp_t^{June-Aug}}{\sigma_{Temp^{June-Aug}}} + w_{Sept-May} \frac{\Delta P_t^{Sept-May}}{\sigma_{P^{Sept-May}}}$$

(13)

where *P* is the cumulative precipitation in a particular sub-period, *Temp* is the average daily temperature in an indicated sub-period, *t* is a year index, σ stands for the long-term standard deviation of a particular weather parameter, Δ corresponds to the difference between long-term average and the level of a respective weather parameter in year *t*, and *w* represents a sub-period's weight, obtained from regressions of farm yields on the right-hand side variables. The regression ensures that the indemnity payments of the weather-based index insurance schemes are scaled similarly to the area and farm yield insurance schemes.

The *meteorological* Selyaninov and Ped *weather indices* are described in (14) and (15), respectively, following [13] and Ped [14] (quoted in [15]).

$$Sel_t^{meteo} = \frac{P_t^{June-Aug}}{Temp_t^{June-Aug}} + P_t^{Sept-May} \qquad (14)$$

$$Ped_t^{meteo} = \frac{\Delta P_t^{June-Aug}}{\sigma_{P^{Jun-Aug}}} + \frac{\Delta P_t^{Sept-May}}{\sigma_{P^{Sept-May}}} - \frac{\Delta Temp_t^{June-Aug}}{\sigma_{Temp^{June-Aug}}} \qquad (15)$$

To ensure a similar scale for the latter two indices they were multiplied with a factor which was determined for a respective rayon.

Similarly to the procedure employed for yield detrending, the insurance parameters are specified differently in the ex ante and in the ex post analysis. For the ex post analysis we estimate respective insurance parameters, e.g. *w* in (12) and (13), by employing weather and yield time series from the 1992 to 2002 period. The insurance parameters are estimated for every of the 11 considered sub-periods separately in the ex ante approach, i.e. 1980 to *k* − 1.

IV. RESULTS

Table 1 presents the relative variance reductions of the analysed insurance schemes under three employed approaches. In the first row the average variance reduction of the common literature approach − the ex post approach (with ex post detrending and ex post estimation of the optimal number of insurance contracts) − ranges from 24 to nearly 44 per cent.

Table 1 Variance reduction from different empirical approaches[*)]

40 farms	farm yield isurance	national yield isurance	rayon yield insurance	Sel meteo	Ped meteo	Sel tailored	Ped taylored
ex post approach							
average variance reduction	24.2	26.7	43.6	24.8	30.3	26.8	42.5
positive variance reduction	36	38	40	39	40	40	40
mixed approach							
average variance reduction	21.3	33.8	41.4	23.2	24.2	24.6	24.6
positive variance reduction	36	39	39	37	37	37	37
ex ante approach							
average variance reduction	23.4	10.3	31	19.7	8.1	8.6	11.3
positive variance reduction	1	8	2	4	15	12	10

Notes: [*)] - Insurance purchased in each year for the harvests between 1992 to 2002.

Source: Authors' own estimations.

The number of farms with a positive variance reduction according to the ex post approach varies between 36 and 40. The last two rows show the results for our ex ante approach. The results differ considerably for some insurance schemes, e.g. the average variance reduction reduces by more than one half for the area yield insurance based on the national yield (second column), the exogenous Ped drought index insurance, and both farm tailored weather insurance contracts (three last columns). For the rayon yield insurance and the exogenous Selyaninov index the average variance reduction decreases by one third and by one fourth, respectively. Only, the average variance reduction due to the farm yield insurance is nearly

unchanged between the ex post and the ex ante approach. This suggests, that (I) overestimation of the index-based insurance effectiveness by the ex post approach can be substantial.

To distinguish between two effects: the effect of ex ante detrending. insurance parameters' specification, and ex ante contract parameters' specification we use the mixed approach for which the yield detrending and insurance parameters specification are done as in the ex ante approach but the number of insurance contracts is determined ex post. Thus, in the mixed approach and in the ex ante approach the data on yields and insurance payments are the same but the optimal number of contracts is determined differently, i.e. ex post and ex ante, respectively. The results of the mixed approach are presented in the two middle rows. For the farm yield insurance (first column) again, we cannot state substantial differences in the results of different empirical approaches. The variance reduction through the farm yield insurance from the mixed approach is 21.3% and thus does not differ substantially from the results of the ex post (24.2% reduction) and the ex ante (23.4% reduction) approaches. Obviously, there is not any distinctive over- or underestimating through the ex post determination of the optimal number of the farm yield insurance contracts. Consequently, neither the ex post choice of contracts nor the ex post detrending seem to overestimate substantially the variance reduction of the farm yield insurance. In other words, the ex post approach seems to deliver empirical results which are not less appropriate than results from the ex ante approach for the farm yield insurance.

The results for the index-based insurance schemes are less robust regarding the evaluation approaches applied. In general, the average variance reduction is substantially lower for the number of insurance contracts in the ex ante anaylsis than for the number of insurance contracts in the ex post analysis by applying them

to the ex ante assessed insurance payments and ex ante detrended yields (middle and bottom rows in Table 1). This conclusion holds for nearly every individual farm (see fig. 1). Contrarily, the difference between the ex post number of contracts applied to the ex ante determined insurance payments and detrended yields and the ex post determined insurance payments and yield data is small in general (middle and top rows). Consequently, the ex post approach employed in the literature seems to cause the overestimation of average variance reduction for index insurance schemes in our empirical analysis primarily due to differences in the estimated number of insurance contracts compared to the ex ante approach.
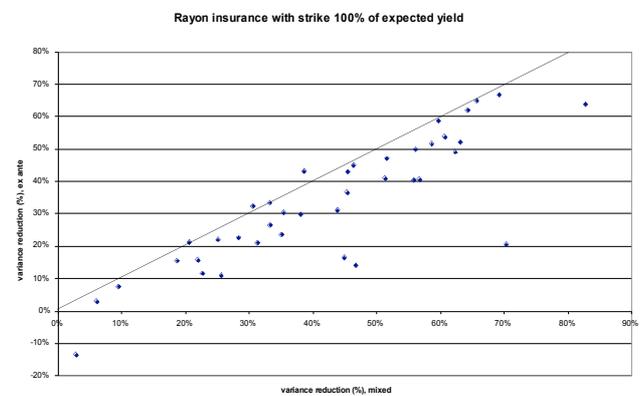

Figure 1 Variance reduction for rayon insurance in the mixed and in the ex ante approach*)

Notes: *) - One farm, that increases its revenue variance in the ex ante approach by 67%, is not displayed

Source: Authors' own estimation.

Although, the average variance reduction is similar in the mixed and in the ex post approach for most index insurance schemes figure 2 shows that the relationship between the variance reductions of the rayon insurance under both approaches differs substantially among farms. It seems that the variance reduction of an index-based insurance for an individual farm may

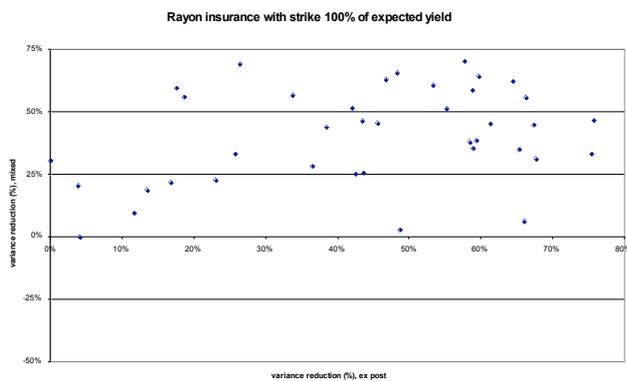depend substantially on the detrending procedure applied.

Figure 2 Variance reduction for rayon insurance in the ex post and in the mixed approach.

Source: Authors' own estimation.

V. CONCLUSIONS

Previous analyses on weather-based index insurance apply the ex post evaluation framework and thus do not consider possible temporary changes in yield and weather variables' distributions that may seriously affect insurance effectiveness. In our study we introduce an ex ante evaluation approach to test effectiveness of index-based insurance contracts. We do this by distinguishing between two consecutive periods: the first period is used for determining insurance parameters and optimal number of contracts; and the subsequent one is considered for the evaluation of the insurance contract defined in the first period. The study also employs the common ex post approach by specifying and evaluating the insurance contracts for the same period.

Our estimation results show that the effectiveness of weather-based insurance may change seriously over time. That means forecasting the relationship between weather variables and farm yields seems to be uncertain, at least for short time series of somewhat ten years. Both statistics: the number of farms with positive variance reduction and the average variance reduction are substantially lower according to the ex ante analysis than in the ex post case. Moreover, approximately one third of all considered farms realise a negative variance reduction which means that the weather-based index insurance may increase farmers' risks.

The considered farm yield insurance demonstrates quite moderate variance reduction, however its results seem to be more robust to the choice of approaches. Though the effectiveness of the area yield insurance based on rayon yields reduces seriously in the ex ante analysis, it provides the highest average variance reduction according to both applied empirical approaches. According to our empirical results overestimation by the ex post evaluation approach can be substantial. Thus, previous studies based on the ex post approach probably overestimate the effectiveness of index-based crop insurance.

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Appendix A

Rayon number	Farm*)	Expected yield (2002) in 0.1t/ha**)	Yield STD	Cumulative precipitation in mm (June-August)		Average daily temperature in °C (June-August)	
				Mean	STD	Mean	STD
1	a)	9.16	3.42	117	49	19.1	1.2
1	b)	6.97	4.66	117	49	19.1	1.2
2	a)	11.27	2.95	103	45	19.6	1.3
2	b)	8.53	4.61	103	45	19.6	1.3
3	a)	6.32	3.09	118	49	19.6	1.1
3	b)	10.17	4.21	118	49	19.6	1.1
4	a)	9.80	4.00	153	61	18.9	1.5
4	b)	11.04	5.39	153	61	18.9	1.5
5	a)	17.44	3.91	134	41	19.0	0.7
5	b)	16.46	6.17	134	41	19.0	0.7

Table A1: Descriptive statistics for selected farms (1980-2002)

Notes: *) farm a) is the farm with the lowest, farm b) with the highest standard deviation in the respective rayon; **) after de-trending by employing ex post approach and by including weather effect.

Source: Own calculations.