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Risk and Subsidies in Czech Agriculture - an ex-ante Analysis of Farmers´ Decision-making[1]

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Abstract

This paper deals with the ex-ante analysis of the effects of farm subsidies on farm behaviour. Beside that the risk factor is implemented in the farm model to reflect and quantify potential (negative) impact on farm results. A farm-level optimization model is used to assess the effects of different kind of policies and risk on production structure, income indicators and land use management. It appeared that a reasonable level of risk (via income variation) have impact, but not significant. If liberalisation would have happened (zero direct and disadvantageous payments) production would homogenised, 30% of land would remained abandoned, production and income would clearly decline. Other scenario points out that environmental objectives (here through more extensively managed land) could not be necessarily more costly, but in such a case without accompanying livestock. To increase profitable livestock production requires to provide grassland and animal payments above the current level (obviously in addition to stimulating production economizing) whereas both payments should be conditional to each other.

Key words

Agrarian policy, risk assessment, farm model, direct payments.

Anotace

Příspěvek je zaměřený na ex-ante analýzu možných vlivů zemědělských podpor na chování (rozhodování) zemědělců. Navíc je model obohacen o vliv faktoru rizika při rozhodování a tudíž možnost vyhodnotit případné (negativní) dopady do hospodaření podniku. K analýze je použit optimalizační model na úrovni farmy, který umožňuje vyčíslit dopady různých typů zemědělských politik-scénářů (včetně analýzy rizika) do oblasti výrobní struktury, příjmových ukazatelů a užití půdy. Bylo zjištěno, že při uvažování rizika by bylo částečně hospodaření podniku ovlivněno. Liberální scénář (znamená nulové přímé platby a platby na LFA) by vedl k nižší diverzitě pěstovaných plodin, 30 % půdy by zůstalo neobhospodařovaných a produkce i příjmy by se snížily. Zlepšení péče o půdu prostřednictvím většího podílu extensivně obhospodařovaných ploch nemusí znamenat nutně vyšší náklady; v tomto případě ovšem bez adekvátního zvýšení chovaných zvířat. Ke zvýšení rozsahu chovaných zvířat (přežvýkavců) by bylo zapotřebí u vybrané typové struktury podniku (vedle zvýšení účinnosti vstupů) navýšit podporu travních porostů a platbu na zvíře (top-up) nad současnou úroveň, přičemž obě platby by měly být vzájemně provázané.

Klíčová slova

Zemědělská politika, hodnocení rizika, faremní model, přímé platby.

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Introduction

Decision about land allocation among farm activities is an important aspect in farming businesses with several economic (farm revenues, cash-flow), socio-managerial (input, capital and labour allocation) and environmental (landscape mosaic, soil erosion threat, diversity, etc.) implications. At the same time, nature, climate, developments in markets, technology and societal concerns generate many types of risks. In this paper we look at two phenomena determining decisions: provision of (income) subsidies and the role of risk. Both are highly relevant not only for individual producers but for policy makers as well with regards to: i) allocation of national direct payments to certain targets, ii) directing policies after 2013 – first draft of policy is just communicated, iii) expectation on the increasing fluctuation of farm incomes (changing condition on climate and markets). We implemented the effects resulting from subsidies (area payments plus agroenvironmental payments) into simulation to see the shifts between intensive and extensive land managements. The analysis focuses on a farmers´ possibility to adjust production structure according to economic results. A particular attention is given to incentives that stimulate cattle breeding which is thought be a sector potentially threatened if special support is not provided. An optimization mathematical model FARMA 4 (Foltýn, et. al. 2007) is used. The concepts of risk finds its theoretical justification in the expected utility maximisation decision model (Robinson and Barry, 1987), where the risk of the crop production is usually defined in terms of the levels of income variability associated with different states of nature (lower expected income). This variability results from price (market risk) and yield (production risk) fluctuations.

Farmers´ decision is not static but rather it is inter-linked: economists often assume that risk consideration has been related to the existence of safety net: obviously such safety net may not be provided only by governmental payments but also off-farm revenues (or other types of income). Yet, not only the existence of certain support is crucial for decision but also the type or criteria the payment is distributed or whether it is tied to production or not. In this sense Bhaskar and Beghin (2010) state that in the presence of uncertainty, decoupled payments reduce the coefficient of risk aversion (they call it as wealth effect) and income variability (as insurance effect). OECD (2008) view decoupled payments rather as providing compensation and adjustment assistance, rather than as a fundamental policy of income support to farmers. In fact, that has impact on the way how payments are spent: more progressive farmers declared they tend to invest them what basically confirms the existence of production linkage.

The aim of this contribution is: i) to ex-ante estimate production and income effect of direct payments reduction (full liberalization as an extreme scenario); ii) how risk-averse behaviour might influence farmers results and iii) to simulate (calculate) a sort of compensation payment when shift in production intensity is followed on a selected typical Czech farm.

Risk behaviour in the literature

Omitting risk and uncertainty in decision has been criticised in the neoclassical theory of the firm since the 1960s. Over the last decades, better insight has been developed about risk assessment, risk preferences and value of information. Harwood et al. (1999) offer specific definition of risk. They define risk as uncertainty that "matters" and may involve the probability of losing money, possible harm to human health, repercussions that affect resources (irrigation, credit), and other types of events that affect a person's welfare. Uncertainty (a situation in which a person does not know for sure what will happen) is necessary for risk to occur, but uncertainty need not lead to a risky situation. In this paper we concentrate on pure risk which is considered as downside risk[2] only, although the business risk usually incorporates both downside and upside risk[3].

The literature on farmers' risk exposure usually covers either price risk or yield risk. A closer look at price risk provided e.g. OECD (1993), Ray et al. (1998), Harwood et al. (1999) and Goodwin, Roberts, Coble (2000). They focused on the variability and estimation of the probability distribution of agricultural output prices. Studies differ in the length of the measured period, locality,

[2] *Downside risk means the likelihood of only negative deviation of the critical variable (i. e. negative consequences if risk occurs).*
[3] *Upside risk refers to the positive features of risk (e. g. the probability of plan excess).*

type of price (future price, spot price, export price), method of adjustment of the time series (deflating, detrending, using nominal prices) and time scale (usually average annual price or average monthly price). Most of authors have used the coefficient of variation as the tool for the assessment of price volatility. The regional aspect is very important for the interpretation of results because market interventions and market price support vary widely across the world.

Yield risk is the second essential part of the income risk of agricultural enterprises. Many authors have tried to estimate the probability distribution of natural yields of various crops but there is no clear evidence of the kind of skewness (Day, 1965 vs. Ramirez, 1997 or Harwood et. al, 1999). For the purpose of this paper it is necessary to point out the influence of spatial aggregation of yield data on the distortion of yield variance. Regional average data reflects the regional randomness or risk factors which are common to all farmers in the region. On the other hand, individual variability of natural yield can be caused by management failures or local weather conditions. Hence using spatially aggregated data is not suitable for the estimation of individual farmers risk exposure (Harwood et al, 1999, Popp, Rudstrom, Manning, 2005). Furthermore, the results of these empirical studies revealed a different nature of yield and price risks in agriculture. The natural yields are low spatially correlated and the rate of yield risk depends on the climate and weather features, soil properties, technology of production and other predominantly natural variables. Estimates of yield probability distribution require the most individualized data.

In connection with natural risks, some research teams have been dealing with specific underlying risks faced by farmers, such as epidemic diseases or climate change (e.g. publications of LEI Wageningen).

The correlation between price and yield volatility has been considered in risk analysis as well. From the results of empirical studies (e.g. Weisensel, Shoney, 1989, Coble, Heifner, Zuniga, 2000) implicitly follows the assumption that open economies (markets) show lower correlation between output prices and natural yields than more isolated economies. Correlation coefficients also depend on the crop, growing conditions, access to storage capacities and the level of contracting.

The agrarian policy is another significant factor determining the level of farm income and farmers' behaviour. Since discussions on the topic of suitable risk management schemes have taken place at a global level, some studies of risk management tools in agriculture have been published. The OECD publications (2000, 2009) may be considered as significant and relatively comprehensive studies of income risk management in agriculture. The overview of the European agricultural risk management schemes was introduced in the common research project EC-JRC Ispra Italy with data contributed from European countries (Bielza et al., 2006). This study constituted the basis for analyzing strategies to integrate risk management tools within the Common Agricultural Policy (CAP). The strategic objective of the parallel research projects was to analyze the potential of different risk management tools for stabilizing farm household incomes in the EU (Meuwissen et al., 2008).

Some papers also examined the relationship between the farmers' operating risk and current subsidies. Based on the simulation at the commodity level the results revealed that partially or fully decoupled payments extend the farmers' decision-making possibilities. The current subsidies (in Czech agriculture) are a suitable complement to other commonly used risk management tools primarily designed to reduce the farmers' income volatility and farm income volatility (Špička et al., 2009).

Data and methods

Prices (and variations) were collected from Czech Statistical Office and calculated for a period between 1991 – 2009[4.] Cost structure of characteristic farm types was taken from an annual survey carried out by IAEI (Poláčková, et. al., 2009). It provides a standard costs assignment for each commodity included in a survey in a regional classification (maize, sugar-beet, potatoes, potatoes-

[4] *For some commodities the period had to be shortened due to incomplete time series. If monthly data were used spot (current) prices for some commodities had to be avoided due to extreme drops recorded.*

oats, mountainous). Data on yields (and monthly variations) were calculated for time period 2007-2010.

We use a mathematical static farm optimization model (FARMA 4, Foltýn et. al., 2007) which simulate behaviour of selected farm types. An optimization function is

$$\max\pi = TR + TS - TC ,$$

where π is a farm profit[5], TR is total revenue (from crop and livestock activities), TS is total subsidies. Production (and revenues) are endogenously determined based on the area and number of animals calculated, respectively. Unit payments are exogenously given either as area payments or commodity payments (if applicable). TC is total costs including labour and fixed costs. Costs are linear[6] and thus do not assume scale efficiencies. Beside factor (and nutrients) restrictions there are also "agro-environmental" options which allow simulating more "environmental" sensitive behaviour and related economic effects. This is e.g. positive balance of organic fertilizers, elimination of erosion threats, balance of nutrients. Model simulates both crop and livestock activities whereas there are possible two management strategies for crops: intensive and extensive. Extensive management is usually given a subsidy as stimulus. It enables to assess the trade-offs between more profitable intensive scenario against more environmental sensitive extensive one.

Risk is taken into account through subtraction of the variation in yield[7] (income-variance criterion) as follows:

$$Y_{ex} = Y_{av} - \phi\lambda ,$$

where Yup is expected yield, Yav is the average yield, ϕ is an exogenously determined risk-averse coefficient indicating to what extent the farmer avoids risk (parameter close to zero indicates risk neutrality and the value close to one implies risk-averse behaviour) and λ is the variance of yield, respectively. Yields are endogenous parameters depending on the management. Yield variation is not provided for livestock commodities and for some crops (this assumption substitutes agronomic limits in the crop rotation). Extensively cultivated crops are supposed to exhibit large yield variation and that is reflected in the model as well. Precise data for yield and variations are given in the appendix (Table A1).

For the analysis a typical farm representing "average conditions" of the Czech Republic (half of territory designed as LFA) was selected. The farm represents corresponding production and cost structure for such territory (although the size is rather normative).

The following assumptions have been applied between crop and animal production: i) the farm is assumed to be self-sufficient in forage and straw via required energy intake, ii) animals receive the required amount of feed and roughage, which satisfies the ingredient and nutrient restrictions, iii) animal transactions (buying and selling) are made at the start of the planning period and these transactions are restricted, iv) animals are categorised into calves, heifers (dairy and suckler), suckler cows, dairy cows, fattening beef, v) all crops produced are sold or used as animal feed or seeds. No storage costs are assumed.

As previously outlined an objective is to see the possible effects of introducing certain types of policies (coupled or decoupled payments) on production structure, crop management, livestock density and economic results. We applied 6 scenarios, in more details are presented in the table below. The first one serves as a "Baseline" scenario (without risk consideration), the remaining ones simulates either more liberalised conditions or provision of environmental or livestock payments: the "Current policy" scenario explores the effects of risk implementation and other parameters are the same as in "Baseline", the next scenario ("Liberalized") is used to look at on the extreme effects resulting from complete subsidy cut. The

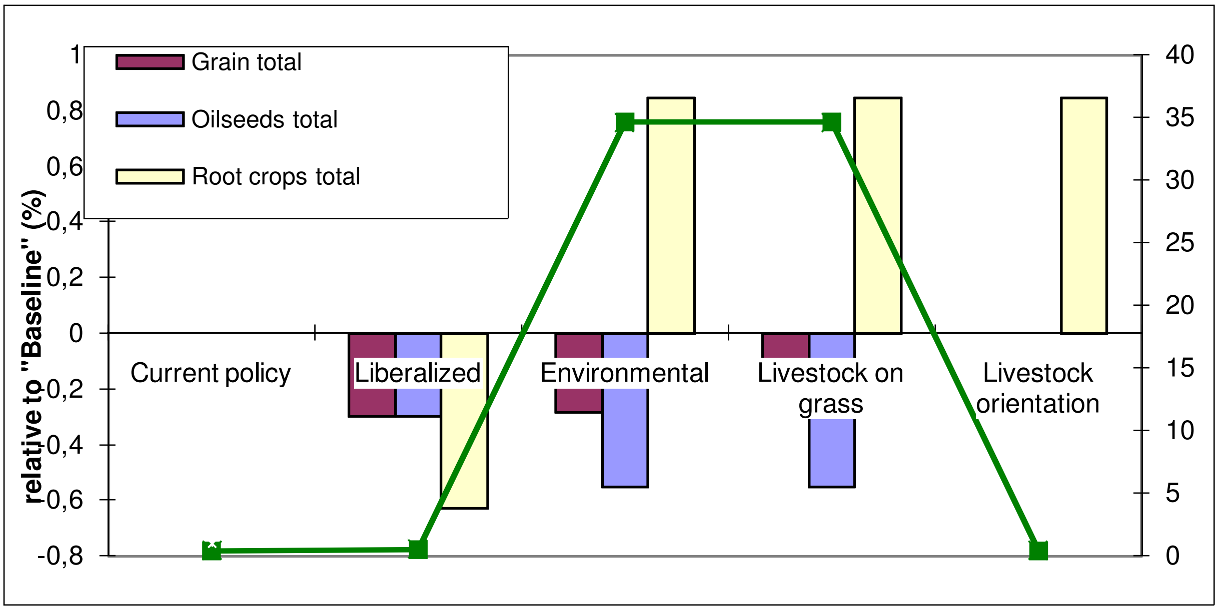
[5] *Alternatively it can be altered to value added (external factors are not deducted from revenues) or gross margin objective function.*

[6] *In the version applied here. By using positive mathematical programming algorithm (e.g. Howit, 2005) it allows cost function to be non-linear and thus reducing the need for further production constraints.*

[7] *Model enable also to implement price variation. For this simulation this option was off.*

Scenario	Description	Risk
“Baseline”	Policy as for 2009: no difference in subsidies between intensive and extensive management, area payment 188 €/ha (SAPS+top-up 2009), no payment for livestock; Agro-envi programmes do not apply; production limits max 200% of initial level.	No
“Current policy”	Policy and production limits applied as in “Baseline”, risk implemented.	Yes
“Liberalized”	No subsidies for any crop and management; Agro-envi programmes do not apply as well, production limits as in “Baseline”.	Yes
“Environmental”	Intensive management is not supported, crops with extensive management receive 282 €/ha, extensive grassland 564 €/ha, in fact zero crop limits, livestock maximum 200% of initial level.	Yes
“Livestock on grass”	=”Environemtnal” scenario, beside that livestock subsidy 392 €/LU (coupled payment).	Yes
“Livestock oriented”	=”Livestock on grass”, extensive grass management do not receive subsidy.	Yes

Table 1. Description of scenarios applied in the model FARMA 4.



Graph A1. Land use in scenario break down (in % relation to “Baseline”).

“Environmental” assumes support provision for extensive management and do not limit maximum of individual crop area. In addition to this “Livestock on grass” provides additional payment for each livestock unit (LU) and its aim is to envisage potential to increase livestock ruminants on grassland. The last scenario “Livestock oriented” relates to the previous one but does not provide support for grassland to see potential livestock restructuralization.

Model results

The following section describes the outcomes of the model for selected scenarios. All scenarios are expressed relative to “Baseline” scenario until otherwise stated. Three areas are of high interest: land use changes, animal structures (animal density), economic results.

Land use

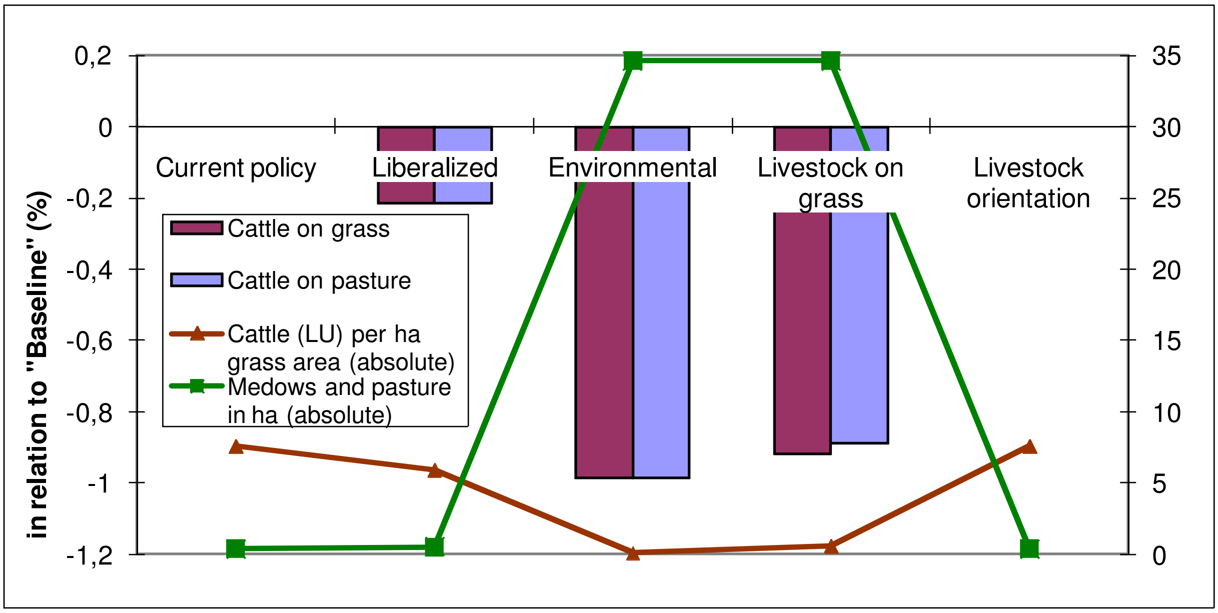
Czech agriculture applies Common Agricultural Policy (CAP) since 2004. Pillar one consists, beside market interventions, of direct payments paid as single area payments (SAPS), national financed direct payments for area and for certain crops and animals (top-ups), payment for sugar-beet growers, and payments for dairy cows. In the model we therefore implemented SAPS and top-ups crop area payments. In respective scenario top-up payment for livestock unit is applicable as well. Pillar two consists of structural assistance payments (not applicable here), agro-environmental payments (payment to compensate either income loss or higher costs due to specific management application, usually on grassland) and payments for less favourite areas. We implemented agri-environmental subsidies via area payments for extensive management and for grassland management.

Total utilised agricultural area was used completely in all scenarios except the "Liberalised" one. Here, some 30% of UAA remained abandoned (a few individual crop area limits were fulfilled). Land abandonment used to be often placed as a threat by professional groups which, as simulation shows, is not be so dramatic under current policies.

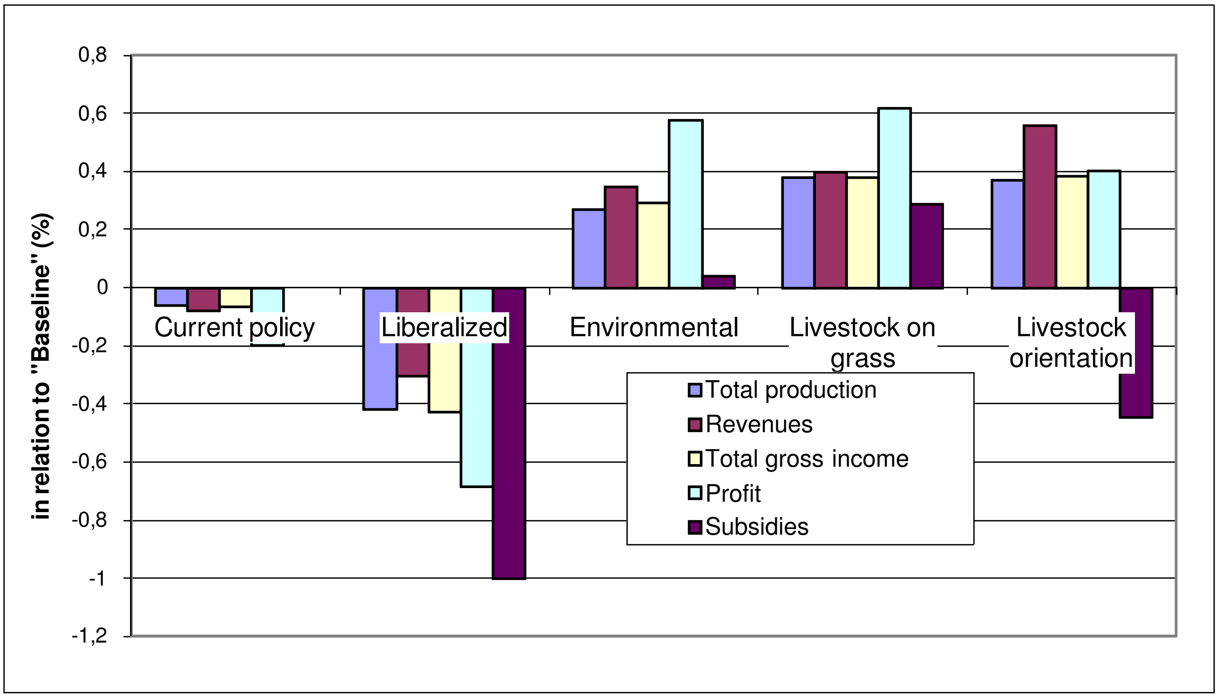
Implementation of risk into model does not change production structure significantly (only small changes are observed inside intensive or extensive commodity groups; variation in livestock was not considered), see graph A1 in the Appendix. Notably, extensively cultivated wheat got more attention if risk was implemented (though yield variation in extensive scenario was higher than in intensive). Yet the opposite is true for barley – its profitability in extensive management was outweighed by winter wheat which has lower variation than barley. "Liberalized" scenario leads to reduction of most cash crops (particularly roots), grassland remains unchanged at the end (intensive grass disappeared in favour of extensive management on pasture). Hence extensive crop production did not expanded on the expense of intensive crops (partially due to larger variation for extensive crops than for intensive management). The next two scenarios ("Enviromental" and "Livestock on grass", recalling that extensive crops and grassland get more supports compared to the previous ones) exhibit decrease in some cash crops, except potatoes, but increase of maize and particularly grassland (solely extensively managed grass due to higher supports; it contributed also to sharp drop in cattle density on grass). However, in the "Environmental" scenario livestock remained unchanged in absolute figures (graph A2 in the Appendix). Scenario ("Livestock orientation") due to zero grassland support (only ruminants are supported) indirectly allowed cash crops (grains and oilseeds) to be allocated on land (and even root crops raised up). In this scenario livestock surprisingly did not get maximum possible level (grassland area was reduced due to diminished subsidy) although largely supported (392 € per LU). It follows that even payment which is 3 times higher than the real current level still does not make a sufficient incentive for increasing beef cattle stock. In this scenario ("Livestock orientation"), cattle density on grass remained on the "Baseline" level due to drop in total grass and relative increase of cattle stock. The largest expansion of livestock was recorded in "Livestock on grass" scenario where both – LU and extensive grassland management – is largely supported. Results regarding livestock clearly suggest that only strong impetus (animal and area support) is capable to increase animal breeding. Under simulated conditions suckler cows - eligible to be supported - are getting the attention when receiving as much as around 390 € per LU plus support for grassland 3 times higher than area payment in 2009. Notably milk production did not increase across any scenario even despite setting the prices on pre-recession level. Non-ruminants (this category were not directly supported in the model) still remained on the minimum level allowed by the model.

Economic results

The interpretation of economic results needs to be done in relation to the assumptions and often to strict rules existing in the model. However, many production specificities (eg. costs of structural adjustment) will still remain outside the model consideration. As expected the most visible drop of production and income indicators took place in "Liberalized" scenario followed by "Current policy". Contrary to other scenarios, profit declined in these two scenarios by more than 60% and 20%, respectively. This is also due to the fact that scenario without subsidies do not exploited even all land available. Moreover if production limits on certain crops would not be restricted the abandoned land could be possibly even larger. Hence, intensive management dominates in subsidy-zero scenario (but still total production would drop by more than 40% in "Liberalized" scenario). Production do not decline as fast as profit. It needs to have in mind that if risky expectation yields would not have finally realized production would not differ as much. Looking at "Current policy" scenario it confirms that area-based payment is partially capable of stimulating extensively cultivated cash crops (even with higher yield variation). This



Graph A2. Cattle density according to scenarios break down (in % relation to "Baseline")



Graph A3. Farm economic results according to scenarios break down (in % relation to "Baseline").

scenario could be also a proxy simulation for extreme weather conditions when yields drop down. It shows that though production would diminished by 6% profit would be down by some 20%. "Environmental" and "Livestock on grass" scenarios lead to profit increase; it is caused by increasing supports for both intensive and extensive land management and setting the crop production limits less strict (resulting in reallocation of land even into more profitable crops). Although production and profit do not differ significantly, the "Livestock on grass" is "more costly" for taxpayers: increase in subsidies (+ 29%), in the "Environmental" scenario (+ 4%), both in comparison with the "Baseline". Such trend is also visible as for "Livestock orientation" where production neither gross income do not decline but total subsidies dropped by more than 40% in relation to base situation. Nevertheless, difference between these two last scenarios is caused by various revenue sources: "Livestock orientation" generates more revenues from cash crops than in the "Livestock on grass" scenario. Hence from policy perspective this is relatively cheapest option but does not contribute to animal production change (both categories - ruminant and non-ruminant). From environmental perspective there is a clear lost of extensively farmed grass in favour of arable land (cash crops and fodder on arable land) in "Livestock orientation" scenario. Unit subsidies (per ha UAA) are approximately 239 Euro in the scenario with the largest share of grassland ("Livestock on grass") but without any effect on cattle density.

Conclusions

The paper tries to contribute to the discussion about direction of Czech agriculture while the political relevance for these projections is twofold: to anticipate the effects of changes after 2013 (though specific policy is not considered in this period) and to support decision about direction of national policies (including the application of an article 68 of Council Direction 1782/2003) in 2011- 2013. Model implemented market parameters (prices) according to OECD projections (but without incorporating significant drops related to global recession to avoid extreme model solutions). Typical farm represented average agro-ecological production conditions. Based on that, the following observations can be drawn:

– Only highly profitable crop commodities would be produced (eg. rape seed) if direct payments completely vanish. Livestock production is mostly not profitable even under current conditions. Therefore liberalized conditions (abolished direct and compensatory payments) would likely lead to land abandonment, livestock breeding would cease. That would obviously cause several negative effects, for example on the soil fertility deterioration due to organic matter lost.

– If environmental compensatory payments are introduced in less favourite areas their total profitability is ensured even under risk consideration (meaning smooth reduction in yield variation) that guarantees their production.

– Under current conditions in livestock sector, certain beef breeding can be guaranteed either by administrative rules that require minimum livestock density or by introducing coupled animal payment which however has to be higher than currently applied (50 €/LU).

– If yield variation in intensive areas (land management) is considered it may easily reduce revenue to the level currently achieved by extensive management. In such a case that would impose certain income threat on those farms operating in intensive areas as compensatory payments are unlikely to be introduced here.

The concept of risk was defined in this paper in terms of income variability and to some extent "normalised" for a decision-making; it is clear that perception of risk is very specific. However the risk-attitude (here only as a prevention against price and yield deviations) also mirrors the institutional conditions surrounding farmers (access to external financing, market transparency, access to information, etc.). In this sense one may assume the more developed and flexile environment the more likely farmers will be willing to accept higher risk.

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