The Determinants of Dairy Farming Competitiveness in Ukraine

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Abstract— **WTO accession and the expected free trade agreement with the EU pose significant challenges for Ukrainian agriculture, implying structural changes for the sector as well as adaptations at the farm level to improve efficiency and competitiveness. However, a recent study by von Cramon-Taubadel and Nivievskyi [2] demonstrates a clear lack of competitiveness. This directs attention to the forces that drive competitiveness in Ukrainian agriculture. Dairy farming deserves particular attention in this regard, since it is one of the main income generating sources for the rural population, and of raw material supply for the fast growing dairy processing. In this paper at first we analyze the profile of competitiveness of dairy farming in Ukraine, demonstrating that only about 20% of dairy farms produce at competitive level. Then using a fixed-effect panel regression we analyze the determinants of competitiveness in Ukrainian dairy farming. The size of the farm, productivity and labor intensity have a strong positive effect on competitiveness, while arable land per head has negative effect. Finally, total subsidies received by farms are found to have a negative impact on competitiveness, and this impact does not differ significantly between farms with different herd size.**

Keywords— **Dairy, Ukraine, Competitiveness.**

I. INTRODUCTION

In early February 2008, the WTO General Council by approving the Protocol on Accession gave the green light to Ukraine's membership. WTO accession was set by the EU as the major condition for negotiations on a free trade agreement (FTA) with Ukraine. Both WTO accession and the expected FTA with the EU represent major challenges for Ukrainian agriculture. They imply not only changes in the trade and institutional regime for Ukraine but also structural changes in Ukraine's agriculture and adjustments at the farm level to improve efficiency and competitiveness. However, a recent study [2] demonstrates a clear lack of competitiveness. The authors show that for virtually every product more than half of the farms in Ukraine produce at a non-competitive level. At the same time, for most products a certain share of farms is found to be competitive. This directs attention to the forces that drive competitiveness in Ukrainian agriculture.

In this regard, dairy farming deserves particular attention. It is one of the main sources of income for the rural population, and of raw material supply for dairy processing. The whole dairy sector has been one of the most fast growing branches of the Ukrainian agro-food sector, producing about 4% of the total national output. Although most domestically produced dairy products are sold on the domestic market, approximately one-third of the raw milk processed by dairy plants is exported in the form of cheese, butter, skimmed milk powder etc. The further development of the dairy sector depends on the availability of sufficient, relatively inexpensive and high-quality raw milk, in other words, on the competitiveness of dairy farming. Dairy, together with sugar and fruit and vegetable production, has been highlighted by the Minister of Agriculture Policy of Ukraine as a branch of agriculture that can be expected to face especially difficult challenges as Ukraine opens its agricultural markets[1].

In this paper we analyse the profile and the determinants of competitiveness of dairy farming in Ukraine using farm-level panel data. In the following we begin with a brief description of the dairy farming profile in Ukraine, paying more attention to the perceived current bottlenecks of the sector. Then we proceed with an empirical analysis in which we measure the competitiveness of dairy farming and study the farm-level determinants of this competitiveness. Section 4 closes with conclusions.

1. Interfax-Ukraine news agency, January 31st (www.interfax.com.ua)

II. THE PROFILE OF DAIRY FARMING IN UKRAINE

Ukraine has been producing 13-14 m tons of raw milk annually over the last 6-7 years (see Table 1). The great majority of this milk is produced by households. As Table 1 shows, the share of households in the total raw milk production increased from 24% in 1990 to 81% in 2006. The corresponding rapid contraction of the share of commercial dairy farms ('farms' in the following) was a result of the transformation from the Soviet planned to the market economy [7]. The under- and unemployed rural population, often members of former collective farms, used subsistence production of milk as a 'social buffer' against transformations taking place in the transition period. However, households cannot exploit economies of scale and they make it much more difficult to capture economies of scale up- and -downstream from dairy farming. This adds costs to the value chain, making it less competitive internationally.

As figure 1 shows, the production of raw milk by households follows a pronounced seasonal pattern. Seasonality of raw material supply has a big impact on dairy processors' strategies and costs. In the summer there is sufficient supply, and the quality of this milk can be reasonably controlled. However in the winter supply falls dramatically, so processors are ready to pay more even for the milk of worse quality, just to ensure enough raw material supply.

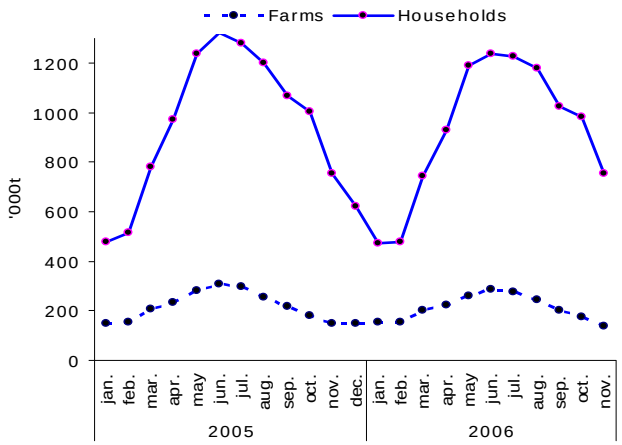
Table 1 Characteristics of raw milk production in Ukraine (1990-2006)

	1990	1995	2001	2002	2003	2004	2005	2006
Cows in milk, mill. head:								
Dairy farms	6.2	4.6	1.7	1.4	1.1	0.9	0.9	0.8
Households	2.2	2.9	3.2	3.3	3.2	3.0	2.8	2.7
Total	8.4	7.5	4.9	4.7	4.3	3.9	3.6	3.4
Yield, t/cow:								
Dairy farms	3.0	1.9	2.1	2.2	2.1	2.5	2.9	3.2
Households	2.7	2.7	3.1	3.2	3.2	3.4	3.6	3.9
Total	2.9	2.2	2.7	2.9	2.9	3.2	3.5	3.6
Fluid Milk, mill. t:								
Dairy farms	18.6	9.4	3.6	3.5	2.7	2.5	2.6	2.5
Households	5.9	7.8	9.8	10.7	11.0	11.2	11.1	10.8
Total	24.5	17.3	13.4	14.1	13.7	13.7	13.7	13.3
Fluid Use Dom. Consum., mill. t			3.2	3.3	3.4	5.1	5.4	6.1
Factory Use Consum., mill. T			8.4	8.8	8.4	7.4	7.0	5.9
Feed Use Dom. Consum., mill. T			1.8	2.1	1.8	1.6	1.3	1.2
Total Dom. Consumption, mill. T			13.4	14.1	13.7	14.1	13.7	13.2

Source: State Statistic Committee of Ukraine

The quality of domestic raw milk has been one of the major problems for the sector. As Table 2 shows, Ukrainian raw milk quality standards are far from Western standards. Milk from households is usually 2nd grade according to Ukrainian system. The EU and USA do not use such milk for food production at all. The situation looks better on dairy farms, which deliver mostly 1st and Extra class milk. Because of incompliance of Ukraine's food safety and quality standards with international standards, Ukraine's export of dairy products has been destined mostly to former Soviet republics. Russia has traditionally been the largest export market, accounting for 64% of Ukraine's total dairy exports in 2005. In that year Ukraine supplied nearly 50% of the Russian cheese market. Since early 2006, when Russia banned imports of Ukrainian livestock products (including dairy), this share decreased considerably. Ukraine's dairy exports to Western countries are limited, and consist mostly of non-fat and skimmed milk powders used for non-human consumption.

Fig. 1 Monthly raw milk production by households and farms (2005-2006)



Source: State Statistic Committee of Ukraine

Table 2 Quality standards for raw cow milk for food production in Ukraine, the EU and the USA

	EU	USA		Ukraine		
		Federal	California	Extra grade	1st grade	2d grade
Plate count 30 °C ('000 per ml)	≤100	≤100	≤50	≤300	≤500	≤3000
Somatic cell count ('000 per ml)	≤400	≤750	≤600	≤400	≤600	≤800

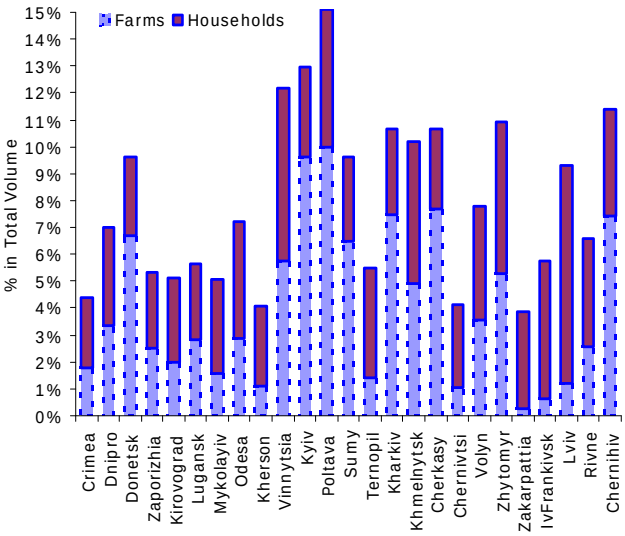
Source: EU Council Directive 92/46/EEC, Chapter IV, A; Grade "A" Pasteurized Milk Ordinance revised 2003, Press releases; DSTU[2] 3662-97;

In terms of geographical location, Figure 2 shows that raw milk production data reveal no clear 'belts' or 'zones' of production. Some Oblasts contribute considerably more than others to total production. A group of 'core' Oblasts consists of Vinnitsa, Kyiv, Poltava, Kharkiv, Chernihiv, Lviv and Cherkassy. These oblasts are located in all three agro-climatic zones of Ukraine – steppe, forest-steppe and forest – which suggests that agro-climatic conditions do not play a major role in the regional distribution of dairy farming in Ukraine.

2. DSTU – abbreviation for the State Standards of Ukraine (Derzhavni Standardty Ukrainy)

Productivity of cows per lactation is very low in Ukraine by Western standards (see Table 1). The average productivity in Germany, for example, is in the range 6-7 tons/year; in Israel it is about 11-12 t/cow. On the other hand, figure 3 shows that some dairy farms in Ukraine are able to reach Western yield levels. Although in 2005 the average cow yield (see Table 1) for dairy farms was 2.9 tons, Figure 3 demonstrates that the modal yield was only 1.7 tons. Also, as Figure 3 demonstrates, productivity grows as herd size increases, making large-scale production more advantageous, on average.

Fig. 2 Oblast's share in the national raw milk production, 2006

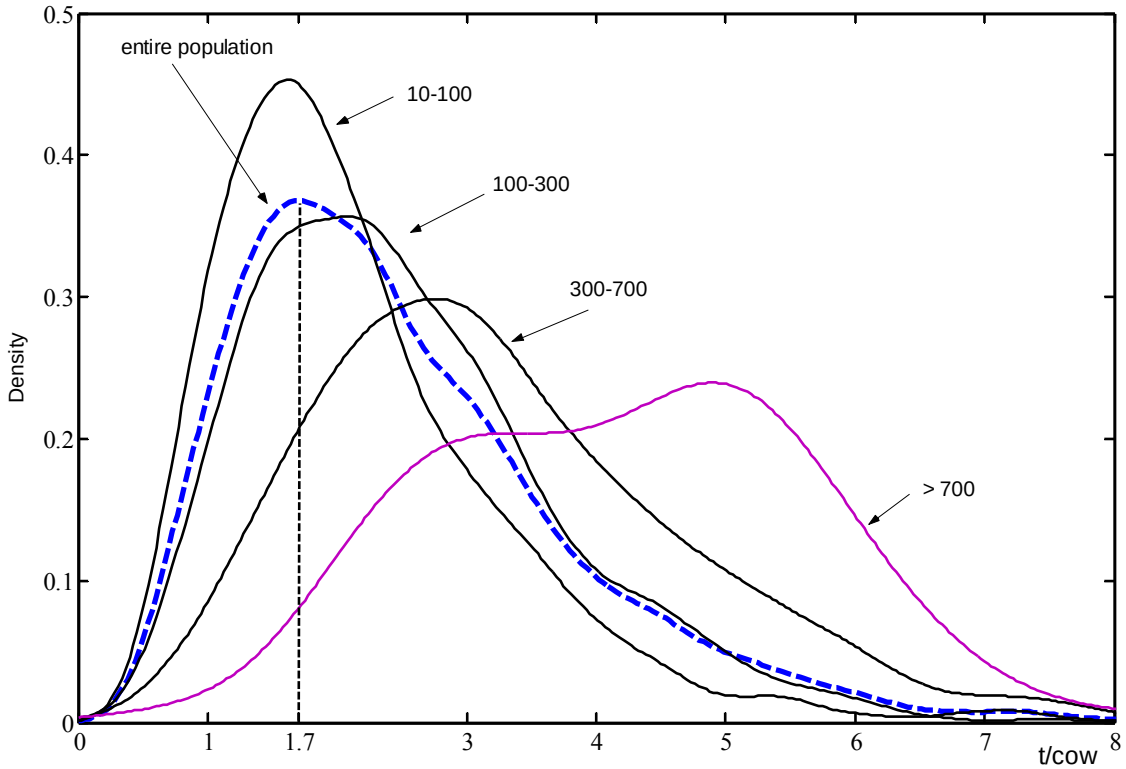


Source: State Statistic Committee of Ukraine

Feed makes up a biggest share (50-70%) in milk production costs, and farms mostly produce their own feed. However, Lischka [4] argues that feed production for dairy cows on Ukrainian farms generally takes place on a very extensive basis. Optimising feed production for dairy cows could reduce land requirements by 30-50% and decrease feed costs correspondingly. Furthermore, Ukraine's dairy farms have much less capital equipment than farms in Central and Western Europe. This implies a lack of investments in dairy farming. There are different reasons for that, but the most important are taxation of inputs (seeds, agrochemicals, machinery etc) via tariff and tariff import barriers, excessive

regulation (e.g. certification), a lack of a market for farm land, a lack of market and marketing information and infrastructure, and a glaring shortage of human capital [2, 3]. These barriers do not allow farmers to boost productivity thus decrease production costs.

Fig. 3 The distribution of milk yields by herd size on dairy farms in Ukraine (2005)



Source: State Statistic Committee of Ukraine; Note: figures in the figure refer to the range of the herd size for the corresponding group. For example, "> 700" refers to dairy farms with more than 700 cows.

A possible additional source of uncompetitveness is subsidies. Dairy farms receive subsidies based on the quantity of milk delivered to dairy plants, so they do not comply with WTO requirements. The study [1] has shown that these subsidies limit the ability of dairy farms to adjust their behavior and operate more efficiently, as well as to employ more advanced technologies or to improve the implementation of the existing technologies. In the empirical analysis below we also study the impact of subsidies on competitiveness.

Having briefly described the main characteristics and shortcomings of dairy farming in Ukraine, we proceed with an empirical analysis of the barriers to competitiveness in milk production.

III. THE COMPETITIVENESS OF UKRAINE'S MILK PRODUCTION

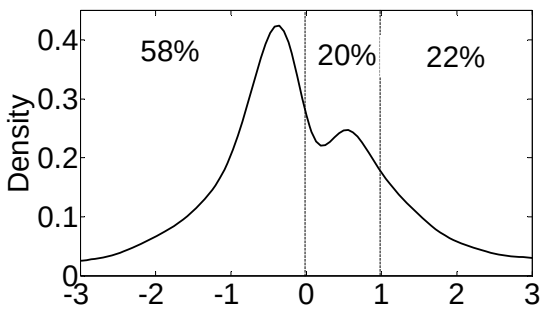
A. Describing the competitiveness of milk production in Ukraine

To measure the competitiveness of dairy farming we employ Domestic Resource Cost (DRC) and Social

Costs Benefit ratio analysis (SCB: [6]). The DRC and SCB are two of many indicators that can be calculated using the Policy Analysis Matrix (PAM) framework developed by Monke and Pearson [5]. The DRC compares the cost of domestic resources measured at social prices (in the numerator) with value added measured at social prices (in the denominator). The use of social prices throughout ensures that the DRC measures whether employing scarce domestic inputs in the production of a good generates a positive return for the country in question. $0 < DRC < 1$ indicates comparative advantage: the social opportunity cost of domestic resources used is smaller than the corresponding social gain (value added). The opposite is true for the $DRC > 1$. If the DRC is smaller than 0, then the denominator must be negative, in which case revenue does not even suffice to cover tradable input costs, let alone domestic inputs. In this case, production of the good in question is clearly not competitive.

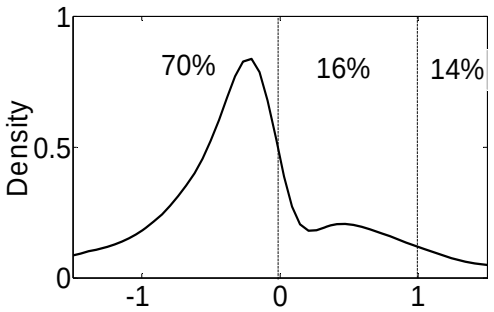
The SCB is defined as the ratio of the sum of tradable and domestic input costs to the price of the good in question. The SCB is always greater than 0, and a SCB less than (greater than) 1 indicates that total input costs are less than (greater than) revenue and that production is (is not) competitive. Unlike the DRC, the SCB does not distinguish between uncompetitive production that is merely unable to cover the opportunity costs of domestic factors ($DRC > 1$) and uncompetitive production that is not even able to cover the costs of tradable inputs ($DRC < 0$). However, SCB is robust to the classification of inputs bias [6].

Fig. 4 DRC distribution for dairy farms, 2005



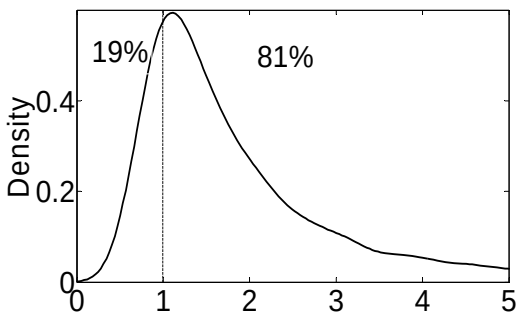
Source: Own calculations

Fig. 5 DRC distributions for dairy farms, 2004



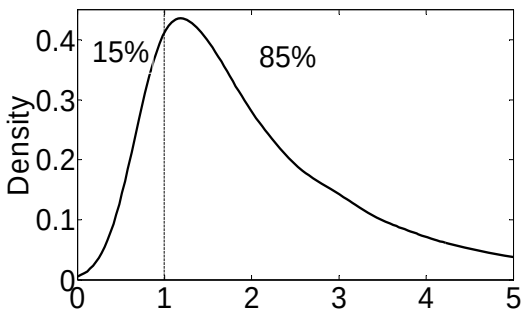
Source: Own calculations

Fig. 6 SCB distribution for dairy farms, 2005



Source: Own calculations

Fig. 7 SCB distribution for dairy farms, 2004



Source: Own calculations

The DRC and SCB analysis presented here is carried out using Ukraine-wide farm-level accounting data provided by the State Statistics Committee of Ukraine. This dataset is an unbalanced panel of 17906 observations, including 11131 farms producing raw milk, over the period 2004-2005. Estimates of univariate DRC and SCB density functions across all relevant farms are calculated using the kernel-based estimate proposed by Rosenblatt [8]. Note, however, that there is an inherent discontinuity in the DRC distribution at 0, with values slightly greater than 0 reflecting very competitive farms, and values slightly below reflecting very uncompetitive farms. The kernel-based algorithm used to estimate the DRC distributions presented in this paper smooths this discontinuity and, hence, creates the false impression of a relatively high frequency of observations close to and equal to 0. For more detailed description of methodology and results for other than milk products please refer to von Cramon-Taubadel and Nivievskyi [2].

Results of the DRC and SCB analysis for dairy products in 2005 and 2004 are presented in Figures 4 - 7, and the key results are summarised in Table 3. The distributions of DRCs reveal that 20% of dairy farms produced milk competitively in 2005, compared with 16% in 2004. These 20% and 16% of all dairy farms produced about 49% and 42% of the total production volume, respectively. Hence, these dairy farms are relatively large-scale. SCB distributions are consistent with DRC distributions (slight differences in the shares of competitive farms are caused by smoothing.

Table 3 Summary of DRC results for dairy farms in Ukraine

	2004			2005		
	DRC<0	0<DRC<1	DRC>1	DRC<0	0<DRC<1	DRC>1
Weighted average DRC	-1.24	0.46	2.48	-1.70	0.49	2.49
Share of the group in total production volume	42.4%	42.0%	15.6%	28.3%	49.1%	22.6%
Share of the group in total number of farms	70%	16%	14%	58%	20%	22%

Source*:* Own calculations

B. The determinants of competitiveness in Ukrainian milk production

As a next step we explore the determinants of the dairy farming competitiveness. We continue working with the unbalanced panel data for 2004 and 2005, with a total of 11131 observations on competitiveness and other relevant variables (see Table 4 for more detailed description and summary statistics). Prior to further analysis, we removed outliers from the data. For example, if a farm reports a milk yield of 0.001 or 20t/cow, if its SCB score is 100 or its labor intensity factor is 0, the corresponding observation was removed. This left 10043 observations (farms). Eliminated farms turned out to be marginal farms, in the sense that their total raw milk output accounted for only roughly 2% of the total sector output.

The basic model we employ is a fixed effects panel regression in which a farm's SCB score is the dependent variable.

Table 4 Variable definitions and summary statistics

Variable	***Definition***	***Mean***	***Std. dev.***	***Min***	***Max***
SCB	Social cost benefit ratio	2.29	.66	.19	14.90
Herd size	Number of cows	163.88	23.13	2	2705
Labor intensity	Labor per cow, in '000 man-hours per cow	.29	.08	.01	3.6
Productivity	Milk yield, t/cow	2.36	.41	.56	10.76
Feed	Land cultivated per cow, ha/head	8.51	4.27	.0003	284.4
Subsidies	Total subsidies, 000 UAH	59.64	37.49	0	3653.7

Source: Own presentation

As was mentioned in the previous section, larger values of the SCB imply less competitiveness. Since the DRC is discontinuous, estimation and inference based on DRC scores would be problematic. Since the SCB scale is not easy to interpret, we transform it into the *standardized SCB*, which makes it possible to measure changes in the SCB in standard deviations from the mean. Independent variables (see Table 4) are chosen based on theoretical considerations (see the discussion in the previous section) and data availability. The labor intensity variable also was standardized to ease interpretation.

Table 5 shows the results of the fixed-effects regression. Random effects are considered unlikely, because unobservable factors that influence competitiveness – such as as management quality – are probably correlated with yields and other independent variables in the model. This is confirmed by the Hausman test, which rejects the hypothesis of orthogonally of the random effects and the regressors at the 1% significance level. Therefore, we proceed with the fixed-effect model.

Model 1 in the Table 5 demonstrates that, as one might expect, average cow milk yield has a statistically significant positive impact on the competitiveness of raw milk production. The results indicate that increasing the average milk yield on a dairy farm by 1t/cow increases competitiveness by 0.25 standard deviations. With the variable herd size we test whether competitiveness increases with the scale of the farm operation, and with herd size squared we test whether this relationship is non-linear. Both variables are significant at the 1% level, implying the existence of a non-linear impact. Increasing the herd size by 1 cow increases competitiveness by only 0.0047 standard deviations, which is much weaker than the impact of productivity increases. Combining the estimated coefficients suggests that the largest positive impact on competitiveness is reached for a herd size of roughly 900 cows. However, this result should be interpreted carefully, since in our model we allow for the interaction between total subsidy and herd size variables. With this interaction term we test the impact of subsidies on the competitiveness of dairy farms at different herd sizes. The underlying hypothesis is that subsidies have different impacts on farms with different herd size. Taking the interaction term into account, the effect of the herd size on competitiveness discussed just above only applies to farms that receive no subsidies. However, as the model 2 in Table 5 the shows the effect of the herd size at mean subsidy is almost identical. In fact, the subsidy variable (significant at 1%) alone turns out to have a negative impact on competitiveness. At the mean herd size, every thousand hryvnas pumped into a farm increase the competitiveness score (i.e. reduce competitivemess) by 0.00078 standard deviations.

The variable 'Labor intensity' reflects the level of technological equipment on dairy farms. It is included in a standardized form into the model. The assumption is that the more labor is spent per cow, the less equipped a farm is. As expected, the impact is negative and statistically significant. Each additional standard deviation of labor intensity reduces competitiveness by 0.037 standard deviations.

In the previous section we pointed out that dairy farms in Ukraine mostly produce their own feed. However, they allocate too much land for feed crops, thereby increasing costs of feed production and decreasing competitiveness. To test this we include land per cow in the regression. However, the records in our dataset do not allow us to distinguish between land allocated to feed production and other land. We therefore assume that all grain produced on the farm that was not sold was fed to animals, and use the share of this unsold grain to calculate the share of land used for feed production. The regression results confirm our hypothesis. Each additional hectare of arable (feed) land per cow decreases competitiveness by 0.0095 standard deviations from the mean SCB. Decreasing this ratio would have the opposite effect, as extension specialists suggest [4].

Lastly we test the impact of subsidies at different levels of the herd size. Results (see Other Models column of the Table 5) show no statistically significant differences. Although the impact of subsidies at herd size 10 is almost 3 times larger than for herd size 700, inspection of the 95% confidence intervals for these coefficients show that this difference is statistically insignificant. The key result is that subsidies appear to have the above-mentioned negative impact on competitiveness across all herd sizes.

Table 5 Fixed-effect panel regression estimates

	Dependent variable is standardized SCB score (standard errors in brackets)		
	Model 1	Model 2	Other models
Herd size*	-.0046755 (.0004119)	-.0047243 (.00042)	-.0047243 (.00042)
Herd size squared*	2.55e-06 (4.36e-07)	2.55e-06 (4.36e-07)	2.55e-06 (4.36e-07)
Productivity (t/cow)*	-.2527053 (.0155216)	-.2527053 (.0155216)	-.2527053 (.0155216)
Labor intensity (standardized)*	.0374786 (.0134001)	.0374786 (.0134001)	.0374786 (.0134001)
Total subsidy (thd. UAH)	.0007756 (.000224)	.0007756 (.000224)	-
Subsidy×Herd size (at the mean) *	-8.19e-07 (2.52e-07)	-	-
Subsidy (at the mean) ×Herd size (at the mean) *	-	-8.19e-07 (2.52e-07)	-
Total subsidy (thd. UAH) (at herd size = 10 cows) *	-	-	.0009014 [.000403 .0013998]
Total subsidy (thd. UAH) (at herd size = 50 cows) *	-	-	.0008686 [.0003861 .0013511]
Total subsidy (thd. UAH) (at herd size = 100 cows) *	-	-	.0008276 [.0003645 .0012908]
Total subsidy (thd. UAH) (at herd size = 300 cows) *	-	-	.0006638 [.0002723 .0010553]
Total subsidy (thd. UAH) (at herd size = 700 cows) *	-	-	.0003361 [.0000373 .000635]
Feed land (ha/cow)*	.0094993 (.0012311)	.0094993 (.0012311)	.0094993 (.0012311)
Intercept*	1.101987 (.0710471)	1.101987 (.0710471)	1.101987 (.0710471)
Number of obs: 10043 corr(ui, Xb): -0.2501	Log likelihood: -3056.9108	Prob > F: 0.0000	R-sq: overall = 0.2149

Source: Own calculations. Notes: * denote significance at 1%; Hausman test rejected the hypothesis of the random effect model at 1%. For Other Models column 95% confidence intervals are in squared brackets.

IV. CONCLUSIONS

The successful completion of WTO negotiations, combined with expected FTA negotiations with the EU, will take Ukraine's agriculture into a new phase of its development. These two big challenges imply not only change in the trade regime for Ukraine but also significant structural changes in Ukraine's agriculture sector as well as adjustments at the farm level to achieve greater efficiency and competitiveness. Therefore Ukrainian policy makers need a better understanding of the determinants of agricultural competitiveness in their country. In this paper we study the determinants of competitiveness in milk production, a major part of Ukraine's livestock sector, and a branch of agriculture that is likely to come under intense competitive pressure as Ukraine opens its markets.

First we measure the competitiveness of the dairy farming using DRC and SCB analysis and Ukraine-wide farm-level accounting data provided by the State Statistics Committee of Ukraine. This dataset is an unbalanced panel of 17906 observations, including 11131 farms producing raw milk, over the period 2004-2005. Estimates of the univariate DRC and SCB density functions across all relevant farms are calculated using kernel methods. The DRC and SCB analysis reveals that 20% of dairy farms produced milk competitively in 2005, compared with 16% in 2004. These 20% and 16% produced about 49% and 42% of the total production, respectively. Hence, these dairy farms are relatively large-scale.

Using a fixed-effect panel regression we then analyze the determinants of competitiveness in Ukrainian dairy farming. As expected, the size of the farm has a strong positive and non-linear effect on competitiveness. Combining the estimated coefficients suggests that the largest positive impact on competitiveness is reached for a herd size of roughly 900 cows. However, the impact of productivity (milk yields) on competitiveness is found to be much stronger. One additional ton of milk per cow and year increases competitiveness by over 50 times as much as increasing the herd size by one cow does. Labor intensity has a negative effect on competitiveness. Since dairy farms produce most of their feed themselves, it is important to keep arable land per animal equivalent as low as possible to increase competitiveness. Our analysis confirms this. Finally, total subsidies received by farms are found to have a negative impact on competitiveness. This impact does not differ significantly between farms with different herd size.

From the policy making point of view these results suggest termination of the current subsidy mechanism for the dairy farming of Ukraine to improve the sector's competitiveness. Instead, the developing of technology promotion (e.g. avoid taxation of inputs and excessive regulation procedures, etc) and human capacity building policies would have a positive impact on productivity, herd size and labor-to-capital ratios thus improving the competitiveness.

A further research step would be to utilize the advantage of DRC over SCB distinguishing the effects of determinants between three categories of dairy farms: with competitive production ($0 < DRC < 1$), uncompetitive production that is merely unable to cover the opportunity costs of domestic factors ($DRC > 1$), and with uncompetitive production that is not even able to cover the costs of tradable inputs ($DRC < 0$). This might give an additional insight to understanding of the forces that drive the competitiveness of dairy farming in Ukraine.

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