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Competitive pressure and structural change in agriculture. Are larger farms more resilient? An analysis of Italian Census data

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ABSTRACT

This paper provides an example of application of massive farm-level panel data for agricultural economic studies. We used a panel data of 1,008,310 farms from the V and VI Italian agricultural censuses and we described the adjustment in land use at farm level, in order to observe the changes in the economic and production behavior at individual level.

Changes in market structure, such as the consolidation of downstream and upstream industries, global sourcing, price volatility, increase in reservation wage of family labor increase the socio-economic pressure on farmers and call for adjustment in strategies and operation (Russo, Sabbatini 2010).

The most evident consequence of the severe challenge was the sharp decrease in the number of farms (-32.4% between 2000 and 2010) and the decline of utilized area (-2.5%). The combined result of these trends determined a relevant increase the average size of a farm: from 5.5 to 7.9 hectares. These aggregate data were interpreted at first as a consolidation of the farm system: the selection operated by the competitive pressure made the surviving farms larger and somehow more competitive.

We use our panel data to provide a more in-depth analysis. In particular, we test the hypothesis that larger farms are more likely to survive the competitive pressure.

Keywords: Resilience, Agriculture, Performance

PAPER

1. Introduction

In the decade 2000-2010 Italian (and European) agriculture underwent a process of consolidation (i.e., the growth of farm size aiming at exploiting economies of scale). Census data registered a remarkable decrease in the number of farms and, simultaneously, an increase in the average farm size.

The consolidation process is the result of dramatic changes in farmers' social and economic environment (Sabbatini 2011). A mix of social and economic factors (such as increasing competition, decreasing public intervention, demographic changes, technology, etc.) resulted in a non-negligible 'squeeze' on farming profit margins (van der Ploeg 2006). Facing the increasing pressure, farmers implement a set of strategies defining new paths in rural development (van der Ploeg et al. 2002). Consolidation is often considered the mainstream approach to competitiveness (van der Ploeg et al. 2016), although it is not the only one. The rationale of consolidation is straightforward: given the declining per-unit margins and the increasing fixed costs, farmers must achieve much higher production in order to break-even. A minimum scale is considered a prerequisite for profitable capital investments, and even multi-functional oriented investments are assumed to be fully justified only if the farm is 'large enough' (van der Ploeg et al. 2016).

In this paper, we test if larger farms are more resilient than smaller ones. The study question is relevant because agricultural policy supports farm consolidation and cooperation in order to foster competitiveness and ensure surviving of farm businesses. If farm size proved to be inconsequential, then such policy measures should be reconsidered.

In our study, we measure the farm size with arable land and we use econometric models to link the initial endowment of utilized land (year 2000) to the probability that a farm is still active at the end of the period (year 2010).

In our analysis, we build a panel dataset to identify the surviving farms (i.e., firms from the 2000 Census that are in the 2010 Census). A Logit regression is used to calculate the conditional probability of belonging to the subset of surviving firms. We found a significant and positive impact of farm size on such probability.

2. The dataset

The Database used for this study was obtained combining three independent data sources via statistical matching: the V and VI General Agricultural Censuses and Integrated Administration and Control System (IACS).

The General Agricultural Censuses (Reg. EC 1166/2008) provide complete information based on the structure of the agricultural and livestock system on a national, regional and local level. The dataset of the V Census refers to the year 2000 with 2,396,274 farms and dataset of the VI Census refers to the year 2010 with 1,620,884 farms.

IACS (Reg. EC 73/2009) is the most important system for the management and control of payments to farmers made by the Member States in application of the Common Agricultural Policy.

IACS consists of a number of computerized and interconnected databases that are used to receive and process subsidy applications and respective data. In this study is considered the year 2013 reporting 1,915,560 farms.

We linked the datasets and matched the units having the same person as head of operations from year 2000.,. This approach underestimates the number of surviving farms because units with a passage of an inheritance or a change in legal form have been excluded from the dataset.

In order to integrate the three datasets we applied statistical matching model (also known as data fusion, data merging or synthetic matching) that is a model-based approach for providing joint statistical information based on variables and indicators collected through two or more sources (Leulescu A., Agafitei M., 2013).

Statistical matching relies on certain pre-requisites of harmonization and coherence of data sources to be matched, in particular the choice of matching keys.

For the linkage of the two Censuses three variable which identify the farms are chosen:

1. Unique Code Farm (UCF).
2. Address of the headquarter.
3. Name of the farm.

UCF is represented by the personal code in the individual companies and the Value Added Tax (VAT) in the companies, it is a stable variable along the time and allows a deterministic linkage of the two universes. In both censuses, this variable was not subject to control procedures, so it was applied a standardization procedure before the linking activities.

Related to the addresses a fundamental issue is related to the existence of multiple ways to express the location qualifiers, (e.g. Piazza and P.zza) or parts of the proper name of the street (such as Santa, or S. or S or S.ta). To validate the addresses was used a software to validate the addresses and standardize them to the official format (www.egon.com).

The farm name or the holder name (depend on the UCF) is the variable potentially wrong for the presence of transcription errors and for the possibility that during the period each farm might changed its name.

The first step of the matching model selected for the linkage was linking the Unique Code applying a deterministic model of equality, combining the frame of V and VI agricultural censuses. In this way has been obtained a panel of 816,319 farms existing at 2000 Census and still active at 2010 Agricultural Census. We excluded approximately 20,000 farms existent in the lists of both censuses, because they result inactive in 2010 year.

804,565 farms detected at VI census and 1,579,955 farms of 2000 census result un-matched. A comparison function1 is used to compute the distance between records on the values of the chosen matching variables, name and address. It is requested to choose a threshold, between 0 and 1. The higher distance for two strings is, the more similar the strings are. The threshold chosen is 0.69 for both variables. The distance function was used combined with a deterministic merge.

With the deterministic merge with variable name 130,455 farms have coupled. According to the threshold of distance function applied on the address of these farms, just 783 have similar addresses.

The same procedure was applied on residuals, making a deterministic match on the variable address combining to the comparison function on the variable name. 47,657 have the same address, but only 6,669 also the same name.

The result was a panel of 823,771 farms that are present in the censuses of 2000 and 2010.

We checked the residual 2000 census farms with IACS. It was done a deterministic linkage between IACS database and 2000 census residual farms using the Unique Code as merge key. In this way it was been identify other 184,539 of 2000 Census still "alive" based on IACS source.

Totally we can considered 1,008,310 farms detected at V General Agricultural Censuses still-existing after 10 years.

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[1] The function distance calculated is $d(\delta, \theta) = \begin{cases} 1 & se\ \delta = \theta \\ 0 & or \end{cases}$

3. Farmland distribution a comparison between 2000 and 2010 Censuses

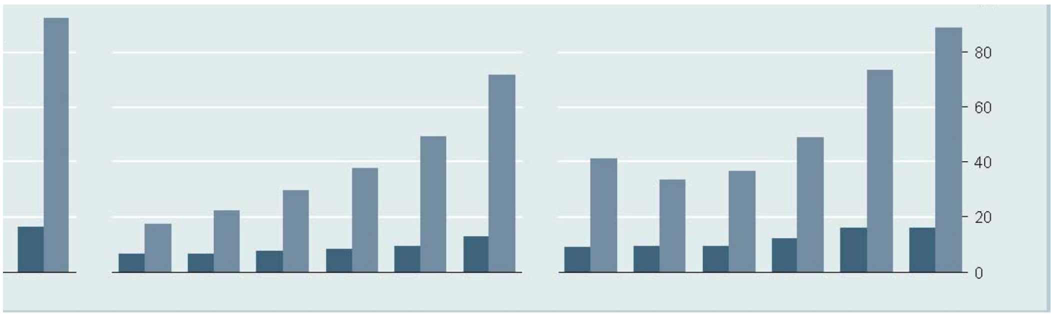
Aggregate descriptive statistics from the two Censuses show that, the agricultural sector has been characterized by a deep restructuring due to competitive pressure (Spinelli, Fanfani 2012; Sotte, Arzeni 2013). Between 2000 and 2010 the number of farms declined by 32.4% while the average tillable area increased by 30.4%. More than half of the farms in the panel is located in the hills, about a third in the plains and the rest in the mountain. In terms of Utilized Agricultural Area (UAA) the farms in the panel registered an increase of 22%, but they have values slightly higher than the total number of farms in 2010, with an average UAA of 8.9 hectares against 7.9 hectares of the total, and an average Total Agricultural Area (TAA) of 12 hectares against 10.5. However the distribution and the increase in the UAA varies across regions, indeed the average values vary from less than 2.5 hectares of Liguria to more than 20 hectares in Lombardy and Sardinia. Almost all regions recorded an increase in the area, the highest value is recorded in the Province of Trento (+70%), followed by Abruzzo (+42%) and Lazio (+33%), the lowest values in Molise and Liguria (+12% and +10%, respectively), the only region that recorded a decrease is the Valle d'Aosta (-11%). Average size varies with altitude. The value reaches 12.4 hectares in mountainous areas, generally characterized by the presence of large area of pasture and meadows, 9.3 hectares in the plains and 7.6 hectares in hilly areas. Also the change in UAA is affected by altitude. Censuses registers an increase of the UAA in the mountainous part of the country (+34.2%) followed by about 20% in the plain area while in the hilly the rise were smaller (+17.3%).

At national level the most common form of land tenure is still the property, with 66% of the UAA, although it is down compared to 2000 (70%), while the rented area slightly increases (from 25% to 27%) and even more the area used for free, that is almost doubled, although it remains marginal (from 4.6 to 7.2%). This situation varies across Regions, in fact, even if the property remains the most prevalent form of tenures, the percentages vary from region to region.

4. Farm size and resilience

The panel data described in section 2 can be used to address the first study question: are larger farms more resilient? The question has theoretical implications. The hypothesis that larger farms are more resilient implies that the incentive to selling out operation decreases with farm size. The Figure 1 summarizes the problem. From an economic standpoint, a farmer should sell his/her farm if the present value of future cash flows (the thick line in Figure 1.) is lower than the sum of the sale price of land (and operations) plus the value of any alternative revenue (e.g., a reservation salary).

Figure 1 - Farm size and the decision of selling operations out



The Figure 1 presents two illustrative examples of the comparison between the Present value of future cash flows (PVFC) and sale price plus outside option (SPOO). In the graph, we depicted two SPOO lines: one refers to the outside option (reservation salary) for the farmer, the other refers to the outside option for the family member who can take charge of operation after the farmer's retirement (for example, a son or daughter), which has been assumed to be greater than farmers' one (for example, because of more education, etc.). The graph identifies three areas: when PVFC is lower than farmer's SPOO, the rational behavior is Competitive pressure and structural change in agriculture. Are larger farms more resilient? An analysis of Italian Census data to sell operation immediately. If PVFC is lower than family's SPOO but higher than farmer's SPOO, the rational decision is to sell after the farmer's retirement. Finally if PVFC is greater than any SPOO, the optimal behavior is to keep farming and the family member should take over at farmer's retirement.

The two panels in Figure 1 depict opposite cases. In case a) small farms are more likely to be sold; in case b) large farmers are more likely to be sold. The difference between the two panels is in the curvature of the PVFC curve. If the PVFC increases faster than SPOO, then large farms are more likely to survive. In this case, our simple framework suggests that the price of land is not able to capture the increase in PVFC. Such result might be due to scale economies: the marginal value product of land changes depending the amount of factor. Vice-versa, case b) suggests the presence of declining marginal value product of land (scale diseconomies).

In order to test the hypothesis, we developed an econometric model assessing if farm size (measured as hectares of utilized agricultural area) is a statistically significant variable affecting the probability of surviving in the competitive agro-food sector. The test is structured as a logit regression estimating the probability that a farmer detected in the 2000 census is still active in 2010. We built a binary variable yr that is equal to 1 if a given farmer belongs to the panel of 1,008,310 surviving farms (described in section 2) and it is equal to zero otherwise. The logit regression of yr on a set of explanatory variables, including farm size, can provide an answer to the study question.

The independent variable yr is subject to measurement error due to the construction of the panel data. The linkage procedure is designed to minimize the probability of including non-surviving firms in the panel (type I error). Yet among the set of excluded firms might still include surviving firms that for several reasons (data collection errors, changes in management or in address, etc.) have not been identified in the 2010 census (type II error). The low power of the linkage procedure might introduce a bias in the estimation of significant variables affecting the surviving probability, because the control group (i.e., the non-surviving firms) might include unidentified surviving firms. We run our analysis under the assumption that misidentification of surviving firms depends on non-systematic, random factors so that model still provides unbiased estimates.

In order to assess the statistical significance of farmland size on the surviving probability of a farm, we regressed yr on a set of variables describing the structural characteristics of the farm, the social and demographic characteristics of the farmer and his/her family, and the marketing approach. This reduced model approach is based on the assumption that the surviving probability is somehow affected by four drivers: the resource endowment (measured in terms of land, livestock, and machinery), the working effort of the farming family (measured in terms of farmer's age, working days, number of family members working on farm), human capital (measured by farmer's education) and market opportunities (measured in terms of share of self-consumed products, presence of value-added productions, differentiation and horizontal coordination). In theory, we expect a positive pairwise-correlation between each driver and the probability of surviving. Table 1 reports the regression results. The odds ratio in the logistic regression output summarizes the relationship between the explanatory and the dependent variables: an odds value ratio greater than 1 means that an increase in the explanatory variable is associated with an increase in the probability that the observation belongs to the panel of surviving farms, holding everything else constant (i.e., the regression coefficient is positive). A lower-than-1 odds ratio indicates a negative association (i.e., the regression coefficient is negative). The z-score and the p-value of a t-test on the statistical significance of the regression coefficients are also investigated.

The sign of the regression coefficients is consistent with expectations. Market access, participation to associations (such as cooperatives or producer associations), and processing activities are associated with higher probability of belonging to the surviving panel. The variables are associated with higher PVFC, while have a weak link with SPOO. Consequently, we expect that the probability of selling the operations is smaller.

The share of rented land has a positive impact (although the confidence level is only 10%). Land rental is profitable only if the farming activities are profitable enough to pay the rent. Therefore, we expect that land rental is a proxy of high PVFC. The association with SPOO is weak, because the value of rented land usually is not captured in the sale value of operations.

Multi-functional activities, measured with the presence of agri-tourism and the location in a natural park, are not statistically significant. However, the complexity of multifunctional agriculture is hardly captured by the available variables and measurement errors might reduce the efficiency of estimates.

The personal characteristics of the farmer are expected to affect both the PVFC (because of higher farming profits) and the SPOO value (because of better outside working opportunities). The regression results support the conclusion that better human capital increases the probability of being in the panel of surviving firms. Such conclusions are consistent with a wide literature about human capital in agriculture (e.g., Idda and Pulina 2011). Young, educated and full-time farmers have higher probability of being in the panel of surviving farms than otherwise. Noticeably, female gender is positively associated with yr. This result might be explained by the lower value of the outside option for women in agriculture (e.g., Sabbatini et al. 2011).

The role of family members is ambiguous. On one hand, the presence of 'family members working on farm' increases the probability of being in the surviving panel. The presence of family workers is associated to the ability to sustain the family with farm profits. Both factors are associated to higher PVCF. Furthermore, family members are assumed to be working on farm because the value of outside options is low, depressing the SPOO value. The combined effect of the two drivers results in higher probability of yr =1.

On the other hand, when an additional variable discriminating the presence of full time family members, a negative effect emerges. The interaction of the two variables results in a negative and statistically significant coefficient (the 2(2) test statistic is 65,443, which allows us to reject the null hypothesis of no joint significance at 1% confidence level). The result might be explained considering that a full time position by a family member might be associated to a planned turnover in management (e.g., Cardillo et al. 2010). In this case, the full-time member might act as apprentice, learning specific skills, with the objective of taking over.

The farm's factor endowment is associated with a negative impact on the probability of belonging in the surviving panel. Capital investments in irrigation, machinery and livestock present negative coefficients (although significance is at 10% confidence level). In part, this result might be due to the crisis of cattle farming that struck Italy after the 2003 dairy quota reform. Nevertheless, the data suggest that markets are efficient in capturing the value of investments in the sale price of the farm.

Finally, land size shows a positive and statistically significant coefficient. Data support the conclusion that larger farms have higher probability of being in the surviving panel. Yet, the quadratic term in the regression shows that the relationship is not linear and the impact of land increase is decreasing. This conclusion might explain why empirical studies have reached mixed conclusion when looking at the relationship between land size and farm surviving.

6. Conclusions

In this paper we tested the hypothesis that larger farms are more successful in surviving the increasing competitive pressure. This assumption is the rationale for agricultural policies fostering consolidation in the agricultural sector as a key driver for competitiveness. Yet, academic literature has not reached a consensus about the link between size and resilience.

We contributed to the debate using a unique dataset composed of observation from two censuses (2000 and 2010). The comparison between the two censuses allowed us to identify the subset of farms that are in both surveys. We considered this set as the group of 'surviving farms'. A Competitive pressure and structural change in agriculture. Are larger farms more resilient? An analysis of Italian Census data simple logit regression allowed us to establish that larger farms have higher probability of being in the surviving group. We conclude that large farm, holding everything else constant, are more likely to survive the competitive pressure.

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Table 1 - Regression results

Dependent variable: y_r (observation belongs to the panel of surviving farms) Log-likelihood: -736.532 Area under the receiver operating curve (AROC): 0,7639 N. of observations: 2.396.274 Unconditional probability of y_r: 0,42						
Variable	Description	Type	Odds ratio	Std. error	z-score	p-value
RentS	Rented land/arable land	Continuous	1,001	0,000	1,896	0,058
SALES	Value of market production /total production	Discrete				0,000
SALES1	*0<SALES<0,5*		2,393	0,192	10,873	0,000
SALES2	*0,5≤SALES*		2,980	0,262	12,405	0,000
SALES3	*SALES=0 (base)*		1,	0,		
ORG	participation to associations	Binary	1,705	0,056	16,138	0,000
PARK	farm is located in a natural park	Binary	0,983	0,043	-0,395	0,693
LIVES	livestock	Continuous	1,000	0,000	-1,661	0,097
AGTUR	Agri-tourism activities	Binary	0,972	0,042	-0,653	0,514
PROCES	processing activities	Binary	1,175	0,051	3,695	0,000
WFAM	Family members working on farm	Binary	1,144	0,03	5,204	0,000
WFAM_FT	Family members working on farm full time	Binary	0,793	0,027	-6,792	0,000
GEND	Farmer's gender is female	Binary	1,145	0,037	4,169	0,000
WD	On farm working days of farmer	Continuous	1,042	0,001	41,458	0,000
YEAR	Farmer's year of birth	Continuous	1,004	0,000	25,54	0,000
EDUC	Farmer's education	Discrete				0,000
HE	*Higher education degree*		1,143	0,053	2,901	0,004
HS	*High school diploma*		1,070	0,030	2,433	0,015
MS	*Middle school diploma*		1,189	0,028	7,406	0,000
ES	*Elementary school*		1,291	0,024	13,487	0,000
N	*None (base)*		1,	0,		0,000
HP_AL	Machinery hp/arable land	Continuous	1,000	0,000	-1,677	0,094
SO_AL	Standard output / arable land	Continuous	1,000	0,000	-0,827	0,408
ALT	Altitude	Discrete				0,000
M	*Mountain*		0,704	0,058	-4,289	0,000
H	*Hill*		0,888	0,052	-2,011	0,044
P	*Plains (base)*		1,	0,		
UAA	Utilized agricultural area	Continuous	1,005	0,001	5,263	0,000
UAA²	Utilized agricultural area squared	Continuous	1,000	0,000	-3,048	0,002
IRR	Presence of irrigated land	Binary	0,981	0,032	-0,594	0,000