Exploring the effect of crisis on cooperatives: An bayesian performance analysis of French craftsmen cooperatives

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Abstract

This paper aims to understand the economic performance of the craftsmen cooperative during the crisis period. These cooperative have also the distinctive feature to only be supply cooperatives. We use an exhaustive data for the French craftsmen cooperatives (2004-2014). We estimate Bayesian translog econometric models in order to underline the impact of crisis on cooperatives: crisis has a negative effect on turnover, with a mitigation effect of age and sector.

Keywords: Efficiency, cooperatives, production function

JEL Classification: C11, D22, L25, P13

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[1]Results, robustness checks and conclusion to be completed.

1 Introduction

Due to their organizations that promote democracy and transparent management, cooperatives have an important role to play in building a more balanced economy (Stiglitz, 2009; Birchall, 2013). Hannan (2014) explains that cooperatives "'are part of the market economy but possess a multidimensionality that enables them to perform in market economies while providing members with a range of tangible and intangible benefits that have the potential to enhance their socio-economic position and voice"'. The resilience of cooperatives is currently challenged by the economic crisis (Carini and Costa, 2013; Vieta, 2010). Identifying comparative advantages and disadvantages of "'members-owned businesses"', Birchall (2013) states the cooperative model may potentially be stronger than other businesses during economic recessions. In this way, cooperatives must be able to be more resilient than other types of business, since resilience can be defined as "'the ability of the system to withstand either market or environmental shocks without losing the capacity to allocate resources efficiently or to deliver essential services"' (Perrings, 2006)[p. 418]. Several studies show better social and economic performances of cooperatives than other businesses (Cheney et al., 2014; Lambru and Petrescu, 2014; Bentivogli and Viviano, 2012; Zamagni, 2012; Costa and Carini, 2016; Carini and Carpita, 2014), but there are counter examples and the crisis effect may vary by sector and by market context (Birchall, 2013). According to Nunez-Nickel and Moyano-Fuentes (2004); Simons and Ingram (2003, 2004), agricultural cooperatives and kibbutzim are more sensitive to changes in the regulatory environment but have a greater ability to adapt to macroeconomic fluctuations. Staber (1992) pointed out that agricultural marketing cooperatives are highly resistant to recessions. Since academic studies mostly regard cooperatives banks, agricultural and industrial sectors, analysis on other cooperatives activities are lacking. Supply cooperatives are especially not investigated.

One of the main objectives of the cooperative being the social performance, measuring the economic performance of cooperatives is a subject under discussion (Carini

and Costa, 2013). Soboh et al. (2009) present the empirical studies on the performance of the Agricultural Marketing Cooperative in various industries and countries, in particular performance measurements are listed (pp 458-459). They state that due the inaccessibility of data, empirical studies failed to address globally all cooperatives objectives as well as representing stakeholders performance. Empirical literature mostly used financial ratios, mathematical and statistical tools and surveys to evaluate cooperatives efficiency (see the appendix 1, where the table 1 presents the variables and ratios used in recent literature to precisely apprehend multidimensionality performance of cooperatives). Statistical tools aim to apprehend economic and employment dimensions. To compare turnover, total assets, profits, raw materials output and sales (Carini and Carpita, 2014; Costa and Carini, 2016; Delboni and Reggiani, 2013; Jones and Mygind, 2002; Lambru and Petrescu, 2014; Soboh et al., 2012, 2014) is useful to measure economic performance of cooperatives, its evolution regarding a specific period or compared to other firms. Many studies apprehend social performance using statistics regarding employment, reporting the number of workers (Jones and Mygind, 2002; Lambru and Petrescu, 2014; Delboni and Reggiani, 2013; Costa and Carini, 2016), the number of all full time equivalent workers (Arando et al., 2015), or the number of employees according to the type of contract (Carini and Carpita, 2014). Financial ratios are used to characterize the performance of cooperatives, to get the efficiency of the assets, to evaluate the ability to invest or to face shocks. Using financial ratios, (Soboh et al., 2011) show that if cooperatives are less profitable than investor-owned firms, they operate more efficiently and have a stronger financial position. Since the combinations of capital and labor can differ and affect the cooperatives' performance, to observe marginal productivities and elasticities lead to relevant results. Liu and Bailey (2013) found that large cooperatives have an advantage over small cooperatives in terms of economies of scale. Soboh et al. (2014) observe decreasing returns to scale for dairy processing cooperative as well as investor owned firms. In the same way, Fakhfakh et al. (2013) found that labor-managed firms use their inputs as efficiently as conventional firms. This literature globally shows that cooperatives demonstrated a greater reliance

than others forms of enterprise did. However, cooperatives may be less profitable than investor owned firms but operate more efficiently, present a stronger financial position (Soboh et al., 2012, 2014) and have a stabilizing effect on employment with respect to shocks (Delboni and Reggiani, 2013). Global characteristics of a cooperative organization appear as foundations of resilience, members of cooperative building together collective resources for capability building, networks, collective skills, capability to innovate and to be supported by government (Borda-Rodriguez et al., 2016). However, the ability of resilience appear different following the sector of activity, the size of the cooperative and the geographical area (Costa and Carini, 2016; Fakhfakh et al., 2013; Soboh et al., 2014; Borda-Rodriguez et al., 2016).

While most of the literature interests the agricultural and financial sector, as well as workers cooperatives, we study here the case of all French craftsmens cooperatives, which also has the distinctive feature to only be supply cooperatives. This paper aims to understand the economic performance of these cooperatives during the crisis period. Particular attention is paid to the analysis of the age of the cooperative and the differences between sectors of activity. In this paper, we wonder the resilience of the French craftsmens cooperatives. How effective are they at surviving economic recession? We show that crisis negative effect depends on the sector and the date of creation of the cooperative. Economies of scales, estimated with elasticities, also present differences following experience, sector and size of craftsmens cooperatives. These calculations appear important for public policies since they indicate if cooperatives need support on investment or labor expenses to be more resilient. We underline increasing returns to scale. We use Bayesian analysis to compare different models underlying the impact of cooperatives characteristics such as the localization and to fit the performance of cooperatives in the best way. Using state-of-the-art bayesian regression allows us to introduce smoothly sensitivity analysis, robustness check (following Leamer (1983, 1985)) and transparency about the results (thanks to the package shinystan). It is also the first to address this issue on craftsmen cooperative, which is a kind of cooperative largely understudied in the literature. The models are estimated using exhaustive accountancy

data from the AMADEUS data base over the years 2004-2014.

The paper is structured as follows. Next section describes the French context of craftsmens' cooperatives and explains the data. Section 3 presents the empirical analysis and section 4 discusses the main results of the research.

2 Empirical strategy

We estimate a classical translog model, which is a more flexible production function than its special case (cobb-douglas). This production function had already been used for cooperatives: see Fakhfakh et al. (2013) for an application to French workers cooperatives,Maietta and Sena (2008, 2010) for an application to Italian producers cooperatives or Soboh et al. (2012) to dairy cooperatives.

For a cooperative i observed at a moment t, we have

$$\ln(Perf_{i;t}) = \alpha_i + \sum_{k=1}^{K} \beta_k \ln I_{i,t}^k + \sum_{k=1}^{K} \beta_{kk} (\ln I_{i,t}^k)^2 + \sum_{k=1 \neq h}^{K} \beta_{kht} \ln I_{i,t}^k \ln I_{i,t}^h + \gamma_1 A_{i,t} + \gamma_2 C_{i,t} + \gamma_3 S_{i,t} + \gamma_4 A.C_{i,t} + \gamma_5 A.S_{i,t} + \gamma_6 C.S_{i,t} + \gamma_7 A.C.S_{i,t} + \mu_i + \epsilon_{i,t} \quad (1)$$

with A, C and S variables for respectively age, crisis and sector, I a vector of k inputs variables, μ and ϵ two errors terms.

There is no consensus in the literature on what it is the objective function of a cooperative. It can be for example the utility or welfare of the members (as in Fulton and Giannakas (2001) or Giannakas and Fulton (2005)) or its profit with a patronage refunded to its members (as in Agbo et al. (2015)). Soboh et al. (2009) provide a more complete review on the objective functions of cooperatives. In our case the only output available is the total turnover, that is usually used in the literature as an acceptable proxy to economic performance (Fakhfakh et al., 2013; Maietta and Sena, 2008, 2010; Soboh et al., 2012).

Estimations are conducted with package Brms for R (Buerkner, 2016), that called

Stan, a C++ program performing Bayesian inference and optimization (Gelman et al., 2015). Bayesian modelling account for uncertainty, sparse data and moderate-sized sample Gelman et al. (2014), especially with weakly informative priors (Gelman et al., 2008). In order to conduct Bayesian model selection, we use WAIC (Widely Applicable Information Criterion) and LOO (Leave-one-out cross-validation). WAIC and LOO (Gelman et al., 2014) are fully Bayesian methods for estimating pointwise out-of-sample prediction accuracy from a fitted Bayesian model using the log-likelihood evaluated at the posterior simulations of the parameter values.

A large set of flexible fonctional form is available to the empirical researcher (Thompson, 1988). Giannakas et al. (2003) show that inappropriate choice of functional form could result in significantly biased efficiency estimates and misleading policy recommendations regarding efficiency improvenments. Their results strongly reject the ad hoc imposition of functional form and underline the importance of specification searches.cobb douglas is a special case of the translog. Less parsimonious function forms such as Generalized Leontieff can also be used, but with our small sample case their clearly lack parsimony. WAIC and LOO reject the Cobb Douglas function that has a slighty worst fit. Another issue is the choice of the addition of an inefficieny error term in the production function regression, that therefore become a stochastic frontier analysis. First analysis allows us to reject such an addition.

3 Data

We use an exhaustive data for the french craftsmen cooperatives (2004-2014), based on Amadeus/ Orbis. Orbis is usually viewed as an untrusted source because of missing data. Authors (Soboh et al., 2011, 2012; Hirsch and Hartmann, 2014) used therefore listewise deletation methods (complete case analysis). Our analysis is not plagued by such problems. Note that all the cooperatives had survived for the whole period, suggesting the absence of non-informative drop-out and the absence of survivor bias.

The dependant variables is the turnover (T) (in K. euros)

The independant variables are :

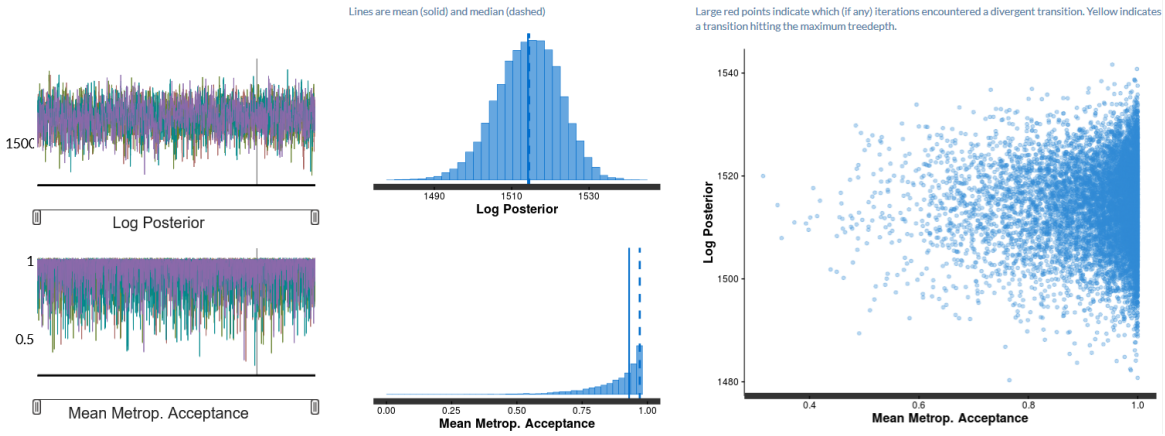
- on one hand the inputs of the production function: intermediate consumption (IC), labor expense (LE) (including wages, salaries, and benefits), intagible assets (IA), tangible assets (TA),
- on the other hand the control variables: age (A) (in year), sector (S) and crisis (C). Sector is a dummy variable : 1 for nace4673 ("Wholesale of wood, construction materials and sanitary equipment") and 0 otherwise[2]. Crisis is also a dummy variable : 1 for 2008 and after and 0 otherwise[3].

4 Results

4.1 Estimations

Our benchmark model is based on a convergence of the markov chains (with 4 chains and 10 000 iterations) (see next figure).

Figure 1: Diagnostics



As a transparency check, we made, thanks to shinystan package (Team, 2016), the whole model with all relevant tests available on the website: `https://damienrousseliere.`

[2]The other sector is "Wholesale of hardware, plumbing and heating equipment and supplies".

[3]Note that alternative estimations with other measures for crisis that lead to similary results are available upon request.

`shinyapps.io/craftsmen/`. The stan algorithm is higly efficient as the autocorrelation of the markov chains disappear quickly.

The estimation of the benchmark model are reported in the next table.

Parameter	ESS	mean	sd	se_mean	2.5%	50%	97.5%
lnIC	3293	1.235	0.067	0.001	1.103	1.235	1.364
lnLE	2773	-0.165	0.060	0.001	-0.280	-0.165	-0.048
lnIA	4934	-0.028	0.012	0.000	-0.052	-0.028	-0.005
lnTA	4491	0.003	0.016	0.000	-0.029	0.003	0.035
lnIC2	2600	-0.039	0.011	0.000	-0.060	-0.039	-0.018
lnLE2	3196	-0.013	0.011	0.000	-0.034	-0.013	0.008
lnIA2	10000	0.001	0.001	0.000	-0.000	0.001	0.002
lnTA2	6544	0.002	0.001	0.000	0.000	0.002	0.003
lnIC.lnLE	2701	0.053	0.021	0.000	0.012	0.054	0.094
lnIC.lnIA	3548	0.004	0.003	0.000	-0.003	0.004	0.011
lnIC.lnTA	4369	0.006	0.004	0.000	-0.003	0.006	0.014
lnLE.lnIA	4263	0.000	0.003	0.000	-0.006	0.000	0.007
lnLE.lnTA	5223	-0.011	0.004	0.000	-0.018	-0.011	-0.004
lnIA.lnTA	10000	-0.002	0.001	0.000	-0.004	-0.002	-0.001
S	2564	-0.033	0.008	0.000	-0.050	-0.033	-0.017
C	5210	-0.018	0.005	0.000	-0.027	-0.018	-0.008
A	4285	-0.001	0.000	0.000	-0.002	-0.001	-0.000
S.C	4937	0.019	0.007	0.000	0.006	0.019	0.032
S.A	4214	0.001	0.001	0.000	0.000	0.001	0.002
C.A	5849	0.001	0.000	0.000	0.000	0.001	0.001
S.C.A	5758	-0.001	0.000	0.000	-0.002	-0.001	-0.000
Intercept	5370	-0.190	0.150	0.002	-0.482	-0.189	0.107
sd_id_Intercept	2597	0.014	0.002	0.000	0.011	0.014	0.019
sigma_lnT	10000	0.014	0.001	0.000	0.013	0.014	0.016

Lecture: ESS: Effective Sample Size

Table 1: Results for the benchmark regression

There is a negative effect of crisis on performance. Note also that Age and the sector of "Wholesale of wood, construction materials and sanitary equipment" mitigate this effect. The maginitude of the coefficient of dummy variables can not be interpreted directly in a regression with a log dependant variables as a semi-elasticities (Van Garderen and Shah, 2002). Therefore we choose to interpret them with various prediction of the economies of scale (see next section).

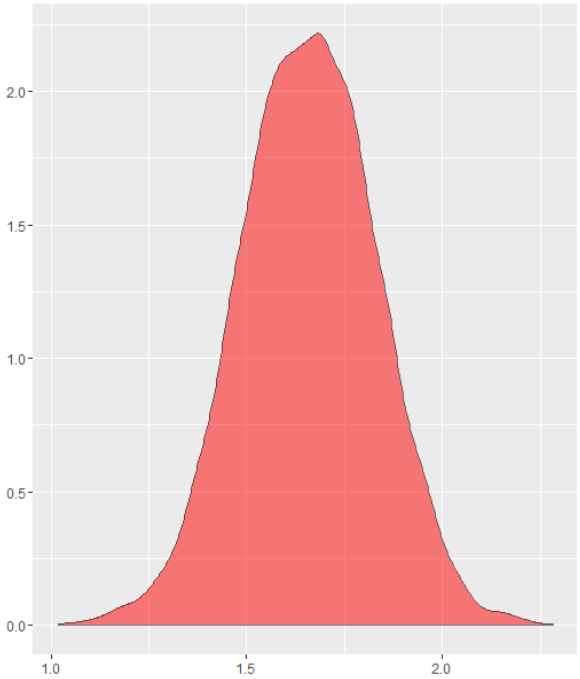
4.2 Economies of scales

Economies of scale and elasticites are calculated at the mean and at various representative values (see (Kumbhakar et al., 2015)) using a Bayesian test which is just the posterior probability under the hypothesis against its alternative Gelman et al. (2014). Economies of scale equals 1.658 with a high contribution of intermediate consumption.

	Estimate	Est.error	l-95% CI	u-95% CI
Elasticities				
intermediate consumption (IC)	1.5197	0.1252	1.2764	1.7619
labor expense (LE)	0.1530	0.0684	0.0173	0.2871
intagible assets (IA)	-0.0019	0.0013	-0.0046	0.0007
tangible assets (TA)	-0.0130	0.0046	-0.0219	-0.0040
Economies of scale	1.6577	0.1726	1.3204	1.9899

Table 2: Economies of scale and elasticies

Figure 2: Economies of scale



Distribution of the 10 000 iterations

In the next table are reported the predictions for various cases of cooperatives according to the dummies crisis and sector, and for various age, with the other independant variables fixed at the mean. The cooperative of the sector of "Wholesale of wood, construction materials and sanitary equipment" suffer less from the crisis than

the cooperative of the other sector ("Wholesale of hardware, plumbing and heating equipment and supplies").

Table 3: Impact of Age, Sector and Crisis on the performance

Age	Sector	Crisis	Impact
Mean	0	0	ref.
Mean	0	1	-0,66%
Mean	1	0	-1,96%
Mean	1	1	-1,93%
Mean - 5 years	0	0	-0,50%
Mean - 5 years	0	1	-0,71%
Mean - 5 years	1	0	-1,92%
Mean - 5 years	1	1	-1,93%
Mean + 5 years	0	0	0,51%
Mean + 5 years	0	1	-0,58%
Mean + 5 years	1	0	-2,00%
Mean + 5 years	1	1	-1,94%

5 Robustness checks

Two additional robustness checks have been made.

The first one is the impact of unoberved heterogeneity. As any production analysis based on longitudinal, our results may suffer from the problem of endogeneity (between the dependant variable and one or many independant variables) or unobserved heterogeneity. We have a sample with small T and small N. Therefore GMM may lead to estimations that are even more biased (Roodman, 2009). A simple and robust approach is to use the Mundlak-Chamberlain correction (Wooldridge, 2010). In production function and efficiency analysis, this method has already been implemented by Emvalomatis (2012) and Griffiths and Hajargasht (2016). We just have to test the joint hypothesis of nullity for the added parameters (a VAT (Variable addition test) (which are the average of each time varying variable). Bayesian test reject this hypothesis.

Another point is to take into account the spatial dimension of data. the craftsmen cooperatives are uneven accross France. A simple first approach is to include regional dummies variables (1). One can also count the number of cooperatives in a given radius

(50, 100 or 200 km) (2). Finaly we can estimate GAMM (Generalized Additive Mixed Models) (Wood, 2006; Santias et al., 2011) (3). Adding the number of cooperatives in a 100 km radius lead to a slightly better fit, but had no impact of other estimated parameters. GAMM model lead to a worst fit.

6 Conclusion

Using an exhaustive database, we underline the presence of high economies of scale for the craftsmen cooperatives. In comparison with agricultural cooperatives (e.g. (Liu and Bailey, 2013; Soboh et al., 2014)), the magnitude of the returns to scale suggest some evidence against the alleged inexorable trade-off between democracy and efficiency (Jones and Kalmi, 2012).

There is a mitigate effect of crisis on the turnover, with the sector of the sector of "Wholesale of wood, construction materials and sanitary equipment" suffering less from the crisis than the other sector. However this effect is low, showing therefore a highly resilience of these cooperatives in comparison with other components of the social economy (Bouchard and Rousselière, 2016; Pape et al., 2016).

References

Agbo, M., D. Rousselière, and J. Salanié (2015). Agricultural Marketing Cooperatives with Direct Selling: A Cooperative Non Cooperative Game. *Journal of Economic Behavior and Organization 109*, 56–71.

Arando, S., M. Gogo, and D. Jones (2015). Efficiency in employee-owned enterprises: An econometric case study of mondragon. *ILR Review 68*(2), 328–425.

Bentivogli, C. and E. Viviano (2012). Changes in the italian economy: The cooperatives. *Bank of Italy Occasional Paper* (113).

Birchall, J. (2013). The potential of cooperatives during the current recession; theo-

rizing comparative advantage. *Journal of Entrepreneurial and Organizational Diversity 2*(1), 1–22.

Borda-Rodriguez, A., H. Johnson, L. Shwa, and S. Vicari (2016). What makes rural co-operatives resilient in developing countries? *Journal of International Development 28*, 89–111.

Bouchard, M. J. and D. Rousselière (2016). Do hybrid organizational forms of the social economy have a greater chance of surviving? an examination of the case of montreal. *VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations 27*(4), 1894–1922.

Buerkner, P.-C. (2016). *brms: Bayesian Regression Models using Stan*. R package version 0.8.0.

Carini, C. and M. Carpita (2014). The impact of the economic crisis on italian cooperatives in the industrial sector. *Journal of Co-operative Organization and Management 2*, 14–23.

Carini, C. and E. Costa (2013). Exploring the performance of social cooperatives during the economic crisis: The italian case. *Euricse Working Paper* (59).

Cheney, G., I. Cruz, A. Peredo, and E. Nazareno (2014). Worker cooperatives as an organizational alternative: challenges, achievements and promise in business governance and ownership. *Organization 21*(5), 591–603.

Costa, E. and C. Carini (2016). Northern and southern italian socail coopeartives during the economic crisis: A multiple factor analysis. *Service Business*.

Delboni, F. and C. Reggiani (2013). Cooperative firms and the crisis: Evidence from some italian mixed oligopolies. *Annals of Public and Cooperative Economics 84*(4), 383–397.

Emvalomatis, G. (2012). Adjustement and unobserved heterogeneity in dynamic stochastic frontier models. *Journal of Productivity Analysis 37*, 7–16.

Fakhfakh, F., V. Perotin, and M. Gago (2013). Productivity, capital, and labor in labor-managed and conventional firms: An investigation on french data. *Industrial and Labor Relations Review 65*(4), 847–879.

Fulton, M. and K. Giannakas (2001). Organizational commitment in a mixed oligopoly: agricultural cooperatives and investor-owned firms. *American Journal of Agricultural Economics 83*, 1258–1265.

Gelman, A., J. Carlin, H. Stern, D. Dunson, A. Vehtari, and D. Rubin (2014). *Bayesian Data Analysis, Third Edition*. Boca Raton: CRC Press.

Gelman, A., J. Hwang, and A. Vehtari (2014). Understanding predictive information criteria for bayesian models. *Statistics and Computing 24*, 997–1016.

Gelman, A., A. Jakulin, M. Pittau, and Y. Su (2008). A weakly informative default prior distribution for logistic and other regression models. *The Annals of Applied Statistics 2*(4), 1360–1383.

Gelman, A., D. Lee, and J. Guo (2015). Stan: A probabilistic program for bayesian inference and optimization. *Journal of Educational and Behavioral Statistics 40*(5), 530–543.

Giannakas, K. and M. Fulton (2005). Process innovation activity in mixed oligopoly: The role of cooperatives. *American Journal of Agricultural Economics 87*(2), 406–422.

Giannakas, K., K. Tran, and V. Tzouvelekas (2003). On the choice of functional form in stochastic frontier modeling. *Empirical Economics 28*, 75–100.

Griffiths, W. and G. Hajargasht (2016). Some models for stochastic frontiers with endogeneity. *Journal of Econometrics 190*, 341–348.

Hannan, R. (2014). Good co-operative governance: the elephant in the room with rural poverty reduction. *Journal of International Development 26*(5), 701–712.

Hirsch, S. and M. Hartmann (2014). Persistence of firm-level profitability in the european dairy processing industry. *Agricultural Economics 45*, 53–63.

Jones, D. and P. Kalmi (2012). Economies of scale versus participation: A co-operative dilemma? *Journal of Entrepreneurial and Organizational Diversity 1*(1), 37–64.

Jones, D. C. and N. Mygind (2002). Ownership and productive effiency: Evidence from estonia. *Review of Development Economics 6*(2), 284–301.

Kumbhakar, S. C., H.-J. Wang, and A. Horncastle (2015). *A Practitioner's Guide to Stochastic Frontier Analysis Using Stata*. Cambridge University Press.

Lambru, M. and C. Petrescu (2014). Surviving the crisis: Worker cooperatives in romania. *Organization 21*(5), 730–745.

Leamer, E. (1983). Let's take the con out of econometrics. *American Economic Review 73*(1), 31–43.

Leamer, E. (1985). Sensitivity analyses would help. *American Economic Review 75*(3), 308–313.

Liu, J. and D. Bailey (2013). Examining economies of scale for farmer cooperatives in china's shanxi province. *Journal of Rural Cooperation 41*(2), 147–175.

Maietta, O. W. and V. Sena (2008). Is competition really bad news for cooperatives? some empirical evidence for italian producers' cooperatives. *Journal of Productivity Analysis 29*, 221–233.

Maietta, O. W. and V. Sena (2010). Financial constraints and technical efficiency: Some empirical evidence for italian producers' cooperatives. *Annals of Public and Cooperative Economics 81*(1), 21–38.

Nunez-Nickel, M. and J. Moyano-Fuentes (2004). Ownership structure of cooperatives as an environmental buffer. *Journal of Management Studies 41*(7), 1131–1152.

Pape, U., R. Chaves-Avila, J. Pahl, F. Petrella, B. Pielinski, and T. Savall-Morera (2016). Working under pressure: Economic recession and third sector development in europe. *International Journal of Sociology and Social Policy 36*(7/8), 547–566.

Perrings, C. (2006). Resilience and sustainable development. *Environment and Development Economics 11*, 417–427.

Roodman, D. (2009). A note on the theme of too many instruments. *Oxford Bulletin of Economics and Statistics 71*(1), 135–158.

Santias, F. R., C. Cadrso-Suarez, and M. X. Rodriguez-Alvarez (2011). Estimating hospital production functions through flexible regression models. *Mathematical and Computer Modelling 54*, 1760–1764.

Simons, T. and P. Ingram (2003). Enemies of the state: Interdependence between institutional forms and the ecology of the kibbutz, 1910-1997. *Administrative Science Quarterly 44*, 592–621.

Simons, T. and P. Ingram (2004). An ecology of ideology: Theory and evidence from four populations. *Industrial and Corporate Change 13*(1), 33–59.

Soboh, R., L. A.O., and van Dijk A. (2011). Distinguishing dairy cooperatives from investor-owned firms in europe using financial indicators. *Agribusiness 27*(1), 34–46.

Soboh, R., L. A.O., and van Dijk A. (2012). Efficiency of cooperatives and investor owned firms revisited. *Journal of Agricultural Economics 63*(1), 142–157.

Soboh, R., L. A.O., and van Dijk A. (2014). Efficiency of european dairy processing firms. *NJAS - Wageningen Journal of Life Sciences 70-71*, 53–59.

Soboh, R. A. M. E., A. O. Lansink, G. Giesen, and G. van Dijk (2009). Performance Measurement of the Agricultural Marketing Cooperatives: The Gap between Theory and Practice. *Review of Agricultural Economics 31*(3), 446–469.

Staber, U. (1992). Organizational interdependence and organizational mortality in the cooperative sector: A community ecology perspective. *Human Relations 45*(11), 1191–1211.

Stiglitz, J. (2009). Moving beyond market fundamentalism to a more balanced economy. *Annals of Public and Cooperative Economics 80*(3), 345–360.

Team, S. D. (2016). *ShinyStan: Interactive Visual and Numerical Diagnostics and Posterior Analysis for Bayesian Models*. R package version 2.2.0.

Thompson, G. (1988). Choice of flexible functional forms:review and appraisal. *Western Journal of Agricultural Economics 13*(2), 169–183.

Van Garderen, K. and C. Shah (2002). Exact interpretation of dummy variables in semilogarithmic equations. *The Econometrics Journal 5*(1), 149–159.

Vieta, M. (2010). The social innovations of autogestion in argentina's worker-recuperated enterprises: Cooperatively reorganizing productive life in hard times. *Labor Studies Journal 35*(3), 295–321.

Wood, S. (2006). *Generalized Additive Models*. Boca Raton: CRC Press.

Wooldridge, J. (2010). *Econometric Analysis of Cross Section and Panel Data*. Cambridge: MIT Press.

Zamagni, V. (2012). Interpreting the roles and economic importance of cooperative enterprises in a historical perspective. *Journal of Entrepreneurial and Organizational Diversity 1*(1), 21–36.

7 Appendix

7.1 Variables and ratios used to apprehend cooperatives performance

	Statistical Tools			Mathematical Tools	
Reference	**Economic dimensions**	**Employment dimensions**	**Financial Ratios**	**Survey**	**Sector**
				Other dimensions	
Arando et al., 2015	Real Sales of Stores Market Index of the area served by store	Number of all full time equivalent workers Employee Attitude Index			Worker Cooperatives (Eroki and Gespa Stores)
	Turnover Profits	Employees according to the type of contract Temporary workers		Survey: Investments internationalization	
Carini, Carpita, 2014		Changes in employment by sector of activity Forecast about employment		Innovation and RD	Industry
Costa, Carini, 2016	Turnover Total Assets	Permanent and fixed-term employees Employees per coop	Turnover/Operating Cost -Profit (loss) / Turnover Equity/Total Assets Fixed Assets/Total Assets	Multiple Factor Analysis	Social Cooperatives
Delbono and Reggiani, 2013	Sales Profits Equity	Employment			Production Cooperatives Focus on constructions industry
Fakhfakh et al., 2012	Value-Added of Firm Profits		Returns to Scale		Workers Cooperatives
Jones and Mygind, 2002	Sales Assets Output	Employment No of workers	Elasticity of output with respect to capital and labor		660 Estonian Firms (by ownership)
Lambru and Petrecu, 2014	Income Surplus Deficit	Employees	% Worker Cooperative in profit	Number of Coop Numbers of Members	-Workers Cooperatives
Liu and DeeVon Bailey, 2013			Growth rate (year-over-year growth in the cooperative's assets)		
Nuñez-Nickel Moyano Fuentes, 2004			Economies of scale	Firm Failure	Agricultural Cooperatives (Olive oil)
Soboh et al., 2011			Profit before interest and taxes / total assets Material cost / Total asset Total debt / total asset Long-term debt / total equity Currents assets / current liabilities Turnover / fixed assets Turnover / inventories [NonissuedEquity(y+1)- NonissuedEquity(y)] / NonissuedEquity(y)		Dairy Firms
Soboh et al., 2012	Total Turnover Fixed Assets Raw Materials Labour				-Dairy Processing Firms
Soboh et al., 2014	Total Turnover Output Fixed Assets Raw Materials Labor		Efficiency relative to production frontiers Elasticity of scale		Dairy Cooperatives

7.2 Descriptive statistics

Table 4: Summary statistics

Variable	Mean	Std. Dev.	N
lnT	9.061	0.974	490
lnIC	8.855	0.978	490
lnLE	6.68	0.98	490
lnIA	1.378	1.422	490
lnTA	6.182	1.838	490
crisis	0.594	0.492	490
age	12.622	11.536	490
year	2009.439	2.927	490
latitude2	46.994	1.474	490
longitude2	0.817	2.655	490
nace4673	0.49	0.5	490
coop_100km	4.959	2.951	490
coop_50km	1.939	0.999	490
coop_200km	1.414	0.700	490

7.3 Goodness of fit plots

See `https://damienrousseliere.shinyapps.io/craftsmen/`