CAP Subsidies and Productivity of EU Farms

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Content

- Introduction
- Estimation approach
- Results – production function estimation
- Subsidies and productivity
- Conclusions

Introduction

- The impact of agricultural subsidies is of high policy and academic interest in the EU and elsewhere
  - EU spends annually € 50 billion on CAP
  - MTR replaced coupled payments with decoupled ones
- There are two arguments on subsidies
  - Within WTO focus is on reducing and decoupling subsidies to minimize distortions
  - Maintaining agricultural support and stimulating investment alleviates food security problems related to recent rise in world commodity prices and economic slowdown

Introduction

- Impact of subsidies on agricultural production, input allocation and income distribution well documented in the literature (e.g., Alston and James, 2002; Ridier and Jacquet, 2002; Lagerkvist, 2005; Goodwin and Mishra, 2006; Serraet al., 2006; Sckokai and Moro, 2009; Vercammen, 2007; Féménia et al., 2010; Carpentier et al., 2012; Weber and Key, 2012)

- **Significantly less attention devoted to impacts of subsidies on productivity**

Introduction

- **Theory does not predict the exact relationship between subsidies and productivity**
  - **Subsidies lead to allocative inefficiency** (higher production of subsidized outputs, higher use of subsidized inputs and slow reallocation of resources between farms) **and technical inefficiency** (slack, lack of effort, soft budget constraint) that reduce productivity
  - **Subsidies stimulate investment** by overcomming credit constraint, affecting risk attitudes, and uncertainty and thus improve productivity

Introduction

- **Coupled subsidies have smaller positive/larger negative impact on productivity relative to decoupled ones**
  - Farms receive decoupled subsidies irrespective of their production decisions, which leads to lower allocative and technical inefficiency effects (Floyd, 1965; Dewbre et al., 2001; Alston and James, 2002; Guyomard et al., 2004; Courleux, et al., 2008).
  - Investment-induced productivity gain through the credit and risk channels is likely smaller for coupled than for decoupled payments (e.g., Ciaian and Swinnen, 2009; Hennessy, 1998) due to higher monitoring costs related to conditionality.

Introduction

- **Empirical literature is inconclusive about the impact of subsidies on productivity**, although negative effects between subsidies and productivity prevail, at least in the EU context (Latruffe et al. (2009), Lakner (2009), Zhu and Oude Lansink (2010), Zhu et al. (2012), Latruffe et al. (2011), Mary (2012), Sauer and Park (2009), Yee et al. (2004) and others)

Introduction

- Existing empirical studies use mainly a two stage approach whereby productivity estimated in the first stage **without controlling for subsidy** effects are regressed on subsidies in the second stage

- Two stage approach does not incorporate subsidies explicitly into a structural estimation algorithm and thus cannot capture their full effect on productivity.

- The two-stage approach therefore may lead to biased estimates of the overall impact of subsidies on productivity.

Estimation approach

- We use structural semi-parametric approach of Olley and Pakes in which we **directly incorporate the effects of subsidies in the model of unobserved productivity**
- OP approach controls for simultaneity bias without relying on instruments and for selection bias
  - **Selection bias**: firms with higher productivity and higher capital are less likely to exit, which leads to biased (downward) capital coefficients in balanced panels
  - **Simultaneity bias:** input choice is correlated with productivity shocks

Estimation approach

- **We extend the Olley and Pakes (1996) algorithm by explicitly allowing farm decisions and market environment (factor markets and demand conditions) to be affected by the CAP subsidies which we directly introduce into the underlying structural model of the farm.**

Estimation approach

- Single period restricted profit and adjustment cost is a function of state variables capital, unobserved productivity, subsidies and environment

$$\pi(k_{jt}, s_{jt}, \omega_{jt}, \vec{e}_{jt}) - c(i_{jt}, s_{jt}, \vec{e}_{jt})$$

Introduction

The incumbent farm maximizes its expected value of both current and future profits according to

$$V(k_{jt}, s_{jt}, \omega_{jt}, \vec{e}_{jt}) = \max \begin{cases} \Phi(k_{jt}, s_{jt}, \omega_{jt}, \vec{e}_{jt}), \\ \max_{i_{jt}} \{\pi(k_{jt}, s_{jt}, \omega_{jt}, \vec{e}_{jt}) - c(i_{jt}, s_{jt}, \vec{e}_{jt}) + \\ \beta E[V(k_{jt+1}, s_{jt+1}, \omega_{jt+1}, \vec{e}_{jt+1}) \mid k_{jt}, s_{jt}, \omega_{jt}, \vec{e}_{jt}, i_{jt}]\}. \end{cases}$$

Firm makes two decisions. 1. **Exit decision** Φ (if productivity is lower than threshold level assuming profit related to productivity). Exiting firm receives sale value. 2. Remaining firms make **investment decision** which is strictly monotonic in productivity

Estimation approach

- Continuing firms choose variable inputs and investment
- Given monotonicity investment can be inverted to provide productivity function

$$\omega_{jt} = h_t(i_{jt}, k_{jt}, s_{jt}, \vec{e}_{jt})$$

- The productivity and threshold value for exiting are assumed to evolve according to a first-order Markov perfect Nash equilibrium process

Estimation approach

- Semi-parametric estimation methodology based on Olley and Pakes (1996) and extensions by Ackerberg et al. (2007)
  - Deals well with simultaneity and selection biases
  - Is flexible in accommodating various economic situations
- Cobb-Douglas production function

$$y_{jt} = \beta_0 + \beta_k k_{jt} + \beta_m m_{jt} + \beta_l l_{jt} + \omega_{jt} + \eta_{jt}$$

- The model of the unobservable, ω is a non-parametric function

$$\omega_{jt} = h_t(i_{jt}, k_{jt}, s_{jt}, \vec{e}_{jt})$$

Estimation approach

- Two stage estimation algorithm:
  - First stage (semi-parametric OLS)

$$y_{jt} = \beta_m m_{jt} + \beta_l l_{jt} + \phi_t(i_{jt}, k_{jt}, s_{jt}, \vec{e}_{jt}) + \nu_{jt}$$

$$\hat{\omega}_{jt}(\beta_0, \beta_k) = \hat{\phi}_{jt} - \beta_0 - \beta_k k_{jt} \qquad \omega_{jt} = g'(\omega_{jt-1}, \hat{P}_{jt}) + \xi_{jt}$$

;

  - Second stage (semi-parametric NLLS)

$$y_{jt} - \hat{\beta}_m m_{jt} - \hat{\beta}_l l_{jt} = \beta_k k_{jt} + g'(\hat{\phi}_{jt-1} - \beta_k k_{jt-1}, \hat{P}_{jt}) + \varepsilon_{jt},$$

- TFP (residual) obtained as

$$TFP_{jt} = \exp(y_{jt} - \hat{\beta}_k k_{jt} - \hat{\beta}_l l_{jt} - \hat{\beta}_m m_{jt})$$

Data

- The FADN data of Eurostat for the EU-15
- Period 1990–2008, for A, FIN, and SWE 1995-2008
- Data representative of commercial agriculture and 90% of agricultural land used
- Six farm types (field crops, horticulture, diary, pasture, pig and poultry, mixed farms) samples for each country were used for regressions

RESULTS – summary statistics

- Heterogeneity of farms in the EU-15

- GE, DK, NL, and IT have more capital abundant farms, invest and produce more output per farm
- GR, PO have less capital abundant farms, invest less, and have smaller production per farm

- Farm employment variation smaller, farms in NL, UK, G are the largest in terms of employment

- In NORTH subsidies per farm and per person higher than in SOUTH, subsidies per unit of capital are lower in NORTH than in SOUTH

RESULTS – production function estimation

- In total 83 regressions estimated per farm type and country

- Variation across countries in coefficients of production function
  - materials coefficient: between 0.59 and 0.87
  - labour coefficient: between 0.07 and 0.26
  - capital coefficient: between 0.05 and 0.12

- Most countries exhibit constant or slightly increasing Returns to Scale
- More farms in SOUTH exhibit decreasing Returns to Scale

RESULTS - production function estimation

- Within each EU-15 country, we define farm productivity index as

$$TFP_{jt} = tfp_{jt} / \overline{tfp_t}$$

and farm productivity growth as

$$\Delta tfp_{jt} = \log(tfp_{jt} / tfp_{jt-1})$$

- **TFP index** and **TFP growth** are weighted averages of farm-level productivity measures using output shares as weights, within and between farm types, thus capturing the farm and sector composition effects.

Results - production function estimation

- TFP index ranges between 0.73 in Greece and 1.67 in Finland
- Higher index suggests that relatively more productive farms and farm sectors dominate, i.e., they have larger market shares
- NORTH has more productive farm sectors, i.e. more productive farms dominate

Results - production function estimation

- Average annual growth of TFP ranges between -0.78% in Finland and +2.05% in Italy.

- Six small, north European countries show negative productivity growth

- Germany, France and the UK show small but positive productivity growth.

- The highest average annual productivity growth is recorded by the south European countries, Italy, Portugal and Spain.

Production function coefficients and TFP estimates

Country	b_m (s.e.)	b_l (s.e.)	b_k (s.e.)	Adj. R^2 (No. obs.)	*TFP* index (*TFP* growth)
(1)	(2)	(3)	(4)	(5)	(6)
Belgium	**0.68**	**0.24**	**0.08**	**0.98**	**1.10**
	(0.03)	**(0.04)**	**(0.02)**	**(10693)**	**(-0.63)**
Denmark	**0.72**	**0.26**	**0.08**	**0.97**	**1.02**
	(0.02)	**(0.02)**	**(0.02)**	**(10697)**	**(-0.06)**
Germany	**0.84**	**0.17**	**0.07**	**0.93**	**1.05**
	(0.01)	**(0.01)**	**(0.01)**	**(54037)**	**(+0.63)**
Greece	**0.59**	**0.22**	**0.07**	**0.99**	**0.73**
	(0.02)	**(0.02)**	**(0.02)**	**(11957)**	**(+0.43)**
Spain	**0.60**	**0.26**	**0.07**	**0.98**	**1.09**
	(0.01)	**(0.02)**	**(0.01)**	**(32121)**	**(+1.98)**
France	**0.74**	**0.21**	**0.08**	**0.97**	**1.01**
	(0.01)	**(0.01)**	**(0.01)**	**(71274)**	**(+0.24)**
Ireland	**0.80**	**0.07**	**0.05**	**0.98**	**1.23**
	(0.02)	**(0.02)**	**(0.02)**	**(6088)**	**(-0.59)**

Notes: *TFP* index is an aggregate productivity measure in levels; *TFP* growth is the aggregate annual percentage growth. The total number of observations (No. obs.) reported is from the second-step estimated sample.

Production function coefficients and TFP estimates

Country	b_m (s.e.)	b_l (s.e.)	b_k (s.e.)	Adj. R^2 (No. obs.)	*TFP* index (*TFP* growth)
(1)	(2)	(3)	(4)	(5)	(6)
Italy	0.62	0.20	0.07	0.98	1.10
	(0.01)	(0.01)	(0.01)	(56977)	(+2.05)
Luxembourg	0.68	0.24	0.10	0.99	0.99
	(0.03)	(0.03)	(0.02)	(3799)	(+0.63)
Netherlands	0.70	0.27	0.11	0.98	1.04
	(0.01)	(0.02)	(0.01)	(12800)	(-0.61)
Austria	0.62	0.20	0.12	0.99	1.36
	(0.02)	(0.02)	(0.02)	(13228)	(+1.44)
Portugal	0.64	0.20	0.07	0.97	0.96
	(0.02)	(0.03)	(0.01)	(8341)	(+1.89)
Finland	0.68	0.16	0.11	0.93	1.67
	(0.03)	(0.02)	(0.02)	(5364)	(-0.78)
Sweden	0.87	0.11	0.06	0.95	1.20
	(0.03)	(0.02)	(0.01)	(4626)	(-0.47)
UK	0.80	0.22	0.08	0.94	0.99
	(0.01)	(0.02)	(0.01)	(27680)	(+0.18)

Subsidies and productivity

- Almost all EU farms receive some subsidies
- No natural treatment and control groups exist
- **Since subsidies used in estimating productivity to test the link between subsidies and productivity we use simple correlation analysis**
- Spearman correlation coefficient computed to identify whether two variables relate in a monotonic function

Subsidies and productivity

- Results of correlation analysis reported by country for
  - Full samples before and after decoupling
  - Subsamples, we drop from samples farms that received other types of coupled subsidies which were not decoupled by the reform (RDP), size of subsamples is between 43 and 76 per cent of the size of full samples

- Effect of decoupling expected to be stronger in subsamples as other subsidies not affected by decoupling could bias the results

Subsidies and productivity

BEFORE DECOUPLING

- In both full and subsamples, **negative link between subsidies and the level of productivity** (DK and POR exceptions)
- **Correlation between subsidies and productivity growth is also negative** for most countries, for 4 countries it is positive but statistically insignificant.
- These results are consistent with findings by previous productivity studies which employ two-stage approaches to identify the CAP subsidy impact on farm technical efficiency (e.g., Latruffe et al.,2009; Lakner, 2009; Zhu and Oude Lansink, 2010, Mary, 2012).

Correlation between subsidies and productivity, full samples

Country	TFP index		TFP growth	
	Pre-reform	Post-reform	Pre-reform	Post-reform
(1)	(2)	(3)	(4)	(5)
Belgium	-0.272 (0.000)	-0.250 (0.000)	-0.015 (0.024)	+0.024 (0.032)
Denmark	+0.160 (0.000)	+0.206 (0.000)	+0.018 (0.087)	+0.024 (0.055)
Germany	-0.526 (0.000)	-0.477 (0.000)	+0.014 (0.079)	+0.027 (0.000)
Greece	-0.068 (0.000)	-0.034 (0.000)	-0.081 (0.000)	-0.015 (0.183)
Spain	-0.471 (0.000)	-0.402 (0.000)	-0.022 (0.000)	+0.022 (0.028)
France	-0.539 (0.000)	-0.507 (0.000)	-0.027 (0.000)	+0.013 (0.000)
Ireland	-0.502 (0.000)	-0.278 (0.000)	-0.029 (0.059)	+0.025 (0.041)
Italy	-0.324 (0.000)	-0.304 (0.000)	+0.013 (0.129)	+0.026 (0.000)

Correlation between subsidies and productivity, full samples

Country	TFP index		TFP growth	
	Pre-reform	Post-reform	Pre-reform	Post-reform
(1)	(2)	(3)	(4)	(5)
Luxembourg	-0.175 (0.000)	-0.032 (0.246)	-0.047 (0.001)	+0.057 (0.059)
Netherlands	-0.648 (0.000)	-0.504 (0.000)	-0.015 (0.143)	+0.018 (0.375)
Austria	-0.060 (0.000)	+0.080 (0.000)	-0.022 (0.045)	+0.028 (0.063)
Portugal	+0.253 (0.000)	+0.266 (0.000)	-0.047 (0.002)	+0.001 (0.063)
Finland	-0.162 (0.000)	+0.049 (0.023)	+0.003 (0.868)	+0.070 (0.004)
Sweden	-0.222 (0.000)	+0.006 (0.766)	-0.011 (0.572)	+0.016 (0.500)
UK	-0.337 (0.000)	-0.206 (0.000)	-0.038 (0.000)	+0.041 (0.001)

Subsidies and productivity

AFTER DECOUPLING

- In full samples, **correlation between subsidies and the level of productivity became less negative and turned positive for additional countries** (A, F, SW)

- In full samples, **correlation between subsidies and productivity growth turned positive and statistically signficant**

Correlation between subsidies and productivity, full samples

Country	TFP index		TFP growth	
	Pre-reform	Post-reform	Pre-reform	Post-reform
(1)	(2)	(3)	(4)	(5)
Belgium	-0.272 (0.000)	-0.250 (0.000)	-0.015 (0.024)	+0.024 (0.032)
Denmark	+0.160 (0.000)	+0.206 (0.000)	+0.018 (0.087)	+0.024 (0.055)
Germany	-0.526 (0.000)	-0.477 (0.000)	+0.014 (0.079)	+0.027 (0.000)
Greece	-0.068 (0.000)	-0.034 (0.000)	-0.081 (0.000)	-0.015 (0.183)
Spain	-0.471 (0.000)	-0.402 (0.000)	-0.022 (0.000)	+0.022 (0.028)
France	-0.539 (0.000)	-0.507 (0.000)	-0.027 (0.000)	+0.013 (0.000)
Ireland	-0.502 (0.000)	-0.278 (0.000)	-0.029 (0.059)	+0.025 (0.041)
Italy	-0.324 (0.000)	-0.304 (0.000)	+0.013 (0.129)	+0.026 (0.000)

Correlation between subsidies and productivity, full samples

Country	TFP index		TFP growth	
	Pre-reform	Post-reform	Pre-reform	Post-reform
(1)	(2)	(3)	(4)	(5)
Luxembourg	-0.175 (0.000)	-0.032 (0.246)	-0.047 (0.001)	+0.057 (0.059)
Netherlands	-0.648 (0.000)	-0.504 (0.000)	-0.015 (0.143)	+0.018 (0.375)
Austria	-0.060 (0.000)	+0.080 (0.000)	-0.022 (0.045)	+0.028 (0.063)
Portugal	+0.253 (0.000)	+0.266 (0.000)	-0.047 (0.002)	+0.001 (0.063)
Finland	-0.162 (0.000)	+0.049 (0.023)	+0.003 (0.868)	+0.070 (0.004)
Sweden	-0.222 (0.000)	+0.006 (0.766)	-0.011 (0.572)	+0.016 (0.500)
UK	-0.337 (0.000)	-0.206 (0.000)	-0.038 (0.000)	+0.041 (0.001)

Subsidies and productivity

AFTER DECOUPLING

- In subsamples, the magnitudes of change are larger compared to those in the full samples.
- In subsamples, productivity growth rates and subsidies are positively correlated in every country.

- The effects in the subsamples compared to the full samples clearly suggest that indeed **decoupling had an impact on productivity**.
- Our findings are consistent with Zhu et al. (2012) and Mary (2012),which investigate the impact of partial decupling (e.g., the introduction of the Agenda 2000).

Correlation between subsidies and productivity, subsamples

Country	TFP index		TFP growth	
	Pre-reform	Post-reform	Pre-reform	Post-reform
(1)	(2)	(3)	(4)	(5)
Belgium	-0.294 (0.000)	+0.063 (0.011)	-0.031 (0.106)	+0.076 (0.010)
Denmark	+0.167 (0.000)	+0.251 (0.000)	-0.016 (0.181)	+0.049 (0.019)
Germany	-0.592 (0.000)	-0.447 (0.000)	-0.031 (0.000)	+0.037 (0.017)
Greece	-0.081 (0.000)	+0.055 (0.107)	-0.128 (0.002)	+0.017 (0.107)
Spain	-0.482 (0.000)	-0.144 (0.000)	-0.026 (0.015)	+0.024 (0.028)
France	-0.565 (0.000)	+0.010 (0.135)	-0.034 (0.000)	+0.051 (0.019)
Ireland	-0.542 (0.000)	-0.153 (0.005)	-0.031 (0.022)	+0.030 (0.061)
Italy	-0.337 (0.000)	-0.258 (0.000)	-0.008 (0.302)	+0.028 (0.000)

Correlation between subsidies and productivity, subsamples

Country	TFP index		TFP growth	
	Pre-reform	Post-reform	Pre-reform	Post-reform
(1)	(2)	(3)	(4)	(5)
Luxembourg	-0.186 (0.087)	+0.069 (0.055)	-0.111 (0.012)	+0.068 (0.032)
Netherlands	-0.654 (0.000)	-0.324 (0.000)	-0.026 (0.038)	+0.020 (0.093)
Austria	-0.108 (0.000)	+0.178 (0.030)	-0.028 (0.022)	+0.048 (0.056)
Portugal	+0.225 (0.000)	+0.290 (0.000)	-0.041 (0.009)	+0.100 (0.062)
Finland	-0.238 (0.000)	+0.111 (0.041)	-0.005 (0.370)	+0.032 (0.051)
Sweden	-0.247 (0.000)	+0.191 (0.016)	-0.032 (0.139)	+0.035 (0.472)
UK	-0.372 (0.000)	-0.180 (0.000)	-0.055 (0.072)	+0.067 (0.018)

Subsidies and productivity

- Link between subsidies and productivity depends on the type of subsidies

- Our indirect evidence is consistent with:
  - Coupled subsidies distort farm behaviour and lead to productivity loss,
  - Coupled subsidies stimulate less credit and enhance less investment compared to decoupled payments
  - Coupled subsidies have higher leakages

Conclusions

- We build a structural model of the unobserved productivity incorporating directly the effect of farm subsidies
- We find some evidence that aggregate productivity levels and growth rates systematically differ between the north and south European MS

Conclusions

- Subsidies impact negatively farm productivity in the period before the decoupling; after that the effect is more nuanced as in several MS it turned positive
- Our findings are consistent with the literature emphasising the inefficiencies of public subsidisation of production and at the same time lend support to the EU policy for decoupling of CAP subsidies

Thank you

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