How Green Public Procurement can drive conversion of farmland: An empirical analysis of an organic food policy*

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Abstract: This paper studies a Green Public Procurement (GPP) policy decided by the Swedish government in 2006, stating objectives related to organic farming. The policy aims to increase the public sector's organic food purchases, in order to incentivise Swedish farmers to convert to organic practices, thereby contributing to national environmental quality objectives. We analyse the effect of organic food procurement on organic agricultural land, using panel data from 2003-2016 including information on municipalities' organic food purchases, land use, and direct subsidies aimed at organic production. Based on different specifications and mainly FGLS estimations, we conclude that the 2006 organic food policy is associated with a significant positive impact on organic agricultural land. A significant effect of direct agricultural policy in the form of subsidies is also found.

JEL classification: D44, H57, Q18

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1. Introduction

Promotion of public procurement as a policy instrument – Green Public Procurement (GPP) - is growing stronger. By the use of their purchasing power, public authorities are expected to shape consumption and production trends and thereby increase demand and alter the market structure in favour of more environmentally friendly products (Li and Geiser, 2005). GPP can be understood as a purchasing process where the public authority strives to procure goods, services and works with less environmental impact, based on life cycle costs, compared to the non-green alternative that would otherwise be procured. In 2002, the OECD adopted a recommendation on GPP policies, which have since been launched in member countries like USA, Japan, Australia and South Korea, but also in countries outside the OECD such as China, Thailand, and Philippines (European Commission, 2008).

While concepts of GPP, its adoption, implementation, and barriers thereof, are areas which have largely been explored (see, e.g., Erdmenger (2003a, 2003b); Preuss (2007); Carlsson and Waara (2007); Testa et al., (2016); Michelsen and de Boer (2009)), the effect of GPP as a policy instrument is not evident and currently not extensively researched (Cheng et al., 2018).

As one exception, Lundberg and Marklund (2018) discuss the design of a GPP policy and conclude that its multiple-objective character conflicts with the Tinbergen Rule, which states that the number of policy instruments must equal the number of policy objectives in order to effectively achieve all objectives (Tinbergen, 1952). A series of linked objectives can thus hamper the governing of the intended environmental outcome. Previous work by Marron (1997) and Lundberg et al. (2016) show that the function of public procurement as an environmental policy instrument will differ depending on factors such as product characteristics, market power, and price sensitivities of private and public consumers. Studying the impact of GPP on specific markets is thus, to a large extent, an empirical task, and what this paper aims to explore.

This paper focuses on a GPP policy decided in 2006 by the Swedish Government, stating that the public sector should increase its organic food consumption to 25 percent in order to contribute to a national environmental goal of 20 percent organic farmland by the year 2010 (Government Communication, 2006). In 2017, a more ambitious new version of the policy stated the organic share of the public sector's food consumption to be 60 percent and the share of organic farmland to reach 30 percent by 2030 (Swedish Government, 2017).

The paper's research question stems from the stipulated process of the 2006 GPP policy, where one objective acts as a policy instrument for another objective. Specifically, we empirically explore the relation between public sector organic food purchases and the provision of an organic input factor, i.e., organic agricultural land, while controlling for direct agricultural policy in the form of subsidies for organic production. We use mainly weighted and unweighted feasible generalized least squares (FGLS) estimations, which are performed using panel data on Swedish municipalities and counties for the period 2003-2016. Our findings suggest that an increase in public organic food purchases is positively associated with increases in organic farmland, and that direct agricultural policy in the form of subsidies also has a significant effect on organic farmland.

As such, this paper adds empirical knowledge to this relatively new area of research (Testa et al., 2012; Cheng et al., 2018) and is, to our knowledge, the first to empirically analyse the impact of GPP on organic farmland. The broader relevance of our findings is motivated by a globally increasing trend of using GPP and is thus of potential interest for any local or national government within and outside the European Union (EU) that are using or are considering using public purchasing as a means to pursue green industrial policy.

The paper is structured as follows: Section 2 provides a policy background. Section 3 presents previous literature with a focus on studies of GPP as a policy instrument and studies of policies aiming at incentivising farmers to adopt organic practices. Section 4 outlines the context of public food procurement. In Section 5, data and descriptive statistics are presented. The empirical approach is described in Section 6. Section 7 presents the results of the analysis and Section 8 concludes the analysis.

2. Policy background

A long-term environmental objective of the EU involves sustainable agriculture and increasing organic production. Organic production is recognized by policy makers for its potential to contribute to environmental objectives as well as improve the competitiveness of agricultural practice (European Commission, 2004), with rules on labelling and producing organic food in force in the EU since 1991 (Padel et al., 2009). Organic production is, in brief, farm management and food production while combining best environmental practice, high animal welfare and a high degree of biodiversity and self-reliance. This means, e.g., crop-rotation, livestock fed with organic feed, restricted use of off-farm inputs and in particular chemically synthesized inputs (European Commission 2007). For a product to be labelled and marketed as organic, production needs to be controlled and certified and, to a minimum, comply with council regulation EC 834/2007 (replacing EEC 2092/91). Swedish producers are commonly also certified under the more extensive set of KRAV regulations (Swedish Parliament, 2010).

In order to stimulate the organic food market, EU member states are encouraged to implement GPP, and organic production is central in the 2008 EU criteria for GPP of food and catering services (European Commission, 2014). The Swedish GPP policy from 2006 aimed to increase domestic organic production and thereby contribute to several of the national environmental quality objectives (e.g., “A varied agricultural landscape”, “A rich diversity of plant and animal life", "A non-toxic environment"). The idea was to incentivise farmers to convert to organic production, partly by the increased public purchases and also by the public sector's ability to stimulate private demand for organic products. In this sense, the Swedish GPP policy is market-oriented, aiming to add to the direct agricultural policy by having the market bear a larger share of the costs faced by farmers that convert to organic production (Government Communication, 2006). Public authorities adopting the policy receives no extra funding for costs incurred and can adapt ambition levels to their own preferences. Neither the procurement target nor the target for organic farmland was reached by 2010 (Swedish Parliament, 2010). By 2016, the average share of organic food consumed by the public sector was 33 percent, i.e., well above the targeted level (Ekomatcentrum, 2017), whereas the share of certified organic farmland was still below targeted levels with an area of 15.6 percent (Swedish Board of Agriculture, 2017).

Conversion to organic production entails costs for the individual farmer. These costs typically relate to lower productivity due to, e.g., mandatory agro-chemical reductions, lower livestock density, and increased labour intensity (Tranter et al., 2009). Organic harvests in Sweden are about 50-60 percent of conventional harvests (Swedish University of Agricultural Sciences, 2010) and Treu et al. (2017) estimate an average organic diet in Germany to require about 40 percent more land than a conventional diet. There are also fixed initial costs of investments in production means and knowhow, and larger variations in yield levels which make forecasting (more) difficult in the case of organic production (Jörgensen, 2012).

Direct policies aiming to increase organic production is part of the EU Common Agricultural Policy (CAP) and its Rural Development Programmes (RDP), which are designed and co-financed by the member states according to national level priorities (European Commission, 2017a). A large part of rural development spending is made up by the EU Agro-Environmental Schemes (AES), which were launched in 1992 and provide farmers with area-based compensation for altering agricultural practices in order to improve the environment (Pufahl and Weiss, 2009; European Commission, 2017b). Support aimed at organic production was introduced in Sweden in 1995, with the EU-membership, and received increasingly more focus with the RDP launched in 2000 (Rosenqvist, 2003). Subsidy rates are not constant over the time period studied, but are somewhat stable over the period covered by each RDP (about six years).

Farmers who agree to enter a five-year commitment to organic production can receive organic subsidies. Subsidies are paid annually, per hectare, and differ depending on what is produced and how costly conversion is (Swedish Board of Agriculture, 2008). During the first two years, production is classified as organic, but products are sold as conventional. Prior to 2007, Swedish farmers could receive organic support without fully certifying their production. Since these products were sold as conventional, rules changed in 2007, requiring production to be converted or under conversion in order to receive full compensation (Swedish Parliament, 2010).

Despite the efforts described above, the organic sector in the EU covers only 6.7 percent of the total Utilized Agricultural Area (UAA) in 2016. Sweden's organic sector is comparatively large, with similar numbers found in countries such as Austria and Estonia (European Commission, 2018a). Although several local and/or regional GPP initiatives have been launched within the EU during the last decade, purchasing policies on national level, such as the one studied in this paper, are still relatively scarce (European Commission, 2019; Neto and Gama Caldas, 2018). Thus, studying the effect of the Swedish GPP policy while at the same time controlling for other policy instruments targeting the same objective, would largely contribute to the understanding of the incentives of conversion to organic farming.

3. Previous literature

Theoretical work shows that GPP from a socio-economic perspective is neither cost-effective nor objective-effective. The former means, in brief, that the command and control feature of GPP as a policy instrument leads to the potential suppliers (bidders) not ending up with the same marginal adaption cost to meet the environmental criteria (Lundberg and Marklund, 2013), i.e., the first-order condition for a cost-effective policy instrument is violated (Hanley et al., 2007). The latter means that GPP will not lead to the fulfillment of environmental objectives (Lundberg et al., 2016), the main reason being that participation (and adaption to green criteria) is optional and tendering occurs when potential suppliers find it beneficial (adaption costs are balanced against potential revenues). However, GPP may, under certain conditions contribute to reduced environmental impact. If and to what extent GPP has an impact is contingent on specific market characteristics; (i) the government being a relatively large buyer of the specific good, (ii) supply of the good being considerably elastic, and/or (iii) private demand of the good being considerably inelastic (Marron, 1997, 2003; Lundberg et al., 2016).

In terms of the *first characteristic,* the public sector accounts for about 4 percent of total purchases in the Swedish market for food (Swedish Competition Authority, 2011a). However, the Swedish food market resembles an hour glass with many producers and consumer at each end, respectively, and a few large wholesalers in the middle. Within the market for public sector food and catering services, concentration is even higher, with the two largest wholesalers receiving about 85 percent of disbursements from public authorities in 2017 (Swedish Competition Authority, 2011b, 2018). For these two, the public sector purchases make up about 30 percent of their respective total turnover (Martin & Servera, 2017; Menigo Foodservice, 2017; Swedish Competition Authority, 2018). Public authorities, of which municipalities make up 86 percent of the disbursements, therefore constitute a substantial part of the demand aimed at the market leading wholesalers (Swedish Competition Authority, 2018).

The *second characteristic* is discussed by Jörgensen (2012), who points out that the potential of a Swedish GPP policy in favour of organic food is hampered by short-term in-elasticities in Swedish organic production due to limitations in the supply chain. These limitations include machinery, knowhow, and the arable land itself due to the period of conversion during which products face the market as conventional. Limitations further down the supply chain is indicated by the, above mentioned, hourglass shape of the Swedish market for foods.

Marron’s *third characteristic* is not empirically tested on Swedish data specifically, although studies from other settings indicate a relatively more price elastic demand for organic food than for conventional food (Yiridoe et al., 2005; Bunte et al., 2010).

In an overview of GPP-related literature, Cheng et al. (2018) categorize the literature, based on how the topic relates to GPP according to; (i) *policy and regulation;* (ii) *practices and uptake;* (iii) *environmental aspects;* (iv) *effectiveness.* Their overview shows that while most papers on GPP relates to *GPP practices and uptake,* studies on *GPP’s effectiveness,* in general, are underrepresented, and quantitative empirical studies in particular. Our paper is mainly related to categories (ii) and (iv) and may therefore fill a relevant gap within the existing literature.

Among the few empirical studies on the impact of GPP, Lundberg et al. (2015) study, using bid level data, the Swedish market for cleaning services and the effect of different green criteria on potential suppliers’ entry decision, on the number of bidders, and on the likelihood that a bidder is disqualified. They find that the green criteria are, generally, non-binding, i.e., do not lead to any adoptions, and conclude that GPP’s impact on potential suppliers’ environmental performance is weak at best. In a study on municipal building policies in California, Simcoe and Toffel (2015) find that GPP within the construction sector, where the municipality is a large buyer, promotes and accelerates the diffusion of green building standards within the private sector, thereby solving a problem of coordination. However, these effects are not seen as a result of raised awareness or more competitive pricing.

The current paper also adds to the literature on policies aiming at creating incentives for farmers to adopt organic practices. Daugbjerg et al. (2011) model and compare the impacts of Danish and UK policies aimed at promoting organic production. They find that the policies with significant effect on organic farmland are, in all cases but one, direct supply-side policies involving annual conversion subsidies. Chabé-Ferret and Subervie (2013) study the impacts of the French AESs in 2000-2005 and find that the AES subsidizing conversion to organic farming explains 90 percent of the increase in areas converted and that its windfall effect is low. This result supports the findings in Pietola and Lansink (2001), who show that decreased output prices and increased direct subsidies play a large role in triggering conversion to organic practices in Finland 1994-1997. Both studies highlight the prevalence of adverse selection. Pietola and Lansink find that subsidies for organic farming attract farmers in low-yield regions to a higher degree. Latruffe and Nauges (2013) find similar results for French farms and conclude that high-performance farms are in general less likely to convert to organic farming.

Apart from economic incentives, farmers' individual preferences will also affect the decision to adopt organic practices or not. Läpple and Kelley (2013) stress that farmers must be seen as heterogeneous with regard to, e.g., environmental attitude and that environmentally aware farmers are more influenced by economic incentives than by command and control related policies. By surveying French producers, Mzoughi (2011) finds that social and moral concerns are significant drivers of organic farming, which should be considered when shaping policies.

In summary, there are several factors, economic as well as non-economic, to consider when shaping and evaluating policies that aim to promote organic farming.

4. The context of public food procurement

This section presents the potential outcomes of an indirect GPP policy using public food consumption to incentivise private farms to convert to organic practices. While the GPP policy launched in 2006 states objectives on national level, its implementation is mainly on local level and in accordance with local preferences. Following the general set-up in Bergman and

Lundberg (2013) we therefore assume a representative utility maximising local public authority, e.g., a municipality, procuring a food contract:

$$\max_{Q,C} U(Q,C) = V(Q) + \bar{B} - P \leq V(Q) + \bar{B} - C(Q), P \geq C(Q) \qquad (1)$$

where $V(Q)$ is the authority's monetary valuation of a fixed food basket with quality Q, which increases in Q at a declining rate, $\bar{B}$ is the fixed budget for the entire operations, and P is the winning bid, i.e., the price which the authority pays for the food contract. The winning bidder's cost to deliver a certain quality is denoted $C(Q)$. For simplicity, food quality is characterized as either organic or conventional, meaning that other factors such as appearance (size, shape, color, and texture) and flavor are ignored. The municipality maximises utility for its inhabitants by increasing the quality of its food basket, replacing conventional food with organic alternatives. The quality difference between organic and conventional food is an expression of preferences based on claims of organic food's positive effects on, e.g., health, environment, animal welfare and taste. Although these claims are not undisputed (see e.g., Barański et al., (2017); Smith-Spangler et al., (2012); and Dangour et al., (2009) for organic food's nutritional aspect, and e.g., Tuomisto et al., (2012); and Bahlai et al., (2010) for its environmental aspect), it is undeniably so that organic food entails higher prices than conventional food, ceteris paribus, reflecting higher production costs, smaller packaging sizes, etc., and a perceived or actual quality difference. If this was not the case, the GPP policy from 2006 would be redundant.

Using Swedish public procurement data, Jörgensen (2012) estimates the price of an organic food basket to be on average 66 percent higher than the price of a conventional food basket. The price premium differs among food products. For example, substituting conventional coffee with organic entails a relatively low price premium compared to most vegetables (see Jörgensen (2012) Table 4 for an overview of different price premiums). All in all, this implies there is an opportunity cost associated with increased organic food purchases. The municipality can therefore, in practice, choose to; (i) Stay within its budget and change the composition of the food basket, e.g., replace meat with organic vegetables, favouring food products with relatively low organic price premiums; (ii) Increase its budget and replace conventional food products with its organic equivalents; or (iii) Increase its budget and replace conventional food products, starting with the ones with relatively low organic price premiums.

It follows that merely increasing the share of organic food products does not necessarily imply increased demand for the organic equivalent of the original food basket or domestically produced food. If the increase in demand for organic food includes products produced outside of Sweden, the link between the two goals of public organic food procurement and organic conversion of domestic agricultural land, may appear as non-aligned. However, it cannot be ruled out that producers are affected by a general trend of increased demand for organic food, even if the public demand is pre-dominantly met by imports.

The policy's impact on domestic agricultural land in Sweden is an empirical question, where one must also account for direct subsidies aimed at conversion, as well as control for demographical and geographical factors affecting the propensity of farmers to convert their production (see, e.g., Chabé-Ferret and Subervie (2013) for a model describing a farmer's decision to convert). The data used for this study's purpose is presented in the next section.

5. Data

The empirical approach follows the structure of the policy as it is formulated. We observe the decision to convert to organic production or not, made by an aggregate of individual agricultural households located in the same geographical area. The national policy objectives are expressed in percentages, i.e., share of organic food purchased and share of organic farmland, and one of our empirical specifications are modelled accordingly. Data on organic land is only available on county level for the time period studied. Data on organic food purchases are collected on municipality level, but aggregated to county level in order to match the level of the outcome variable. In addition, we consider that a market power effect is more likely at an aggregate level. The Swedish market for food is integrated across county boarders, and maybe more so in public purchasing, since the EU regulation of public procurement restricts favoring of local businesses. By including other counties' organic food purchases in the set of control variables, we allow for public procurement to impact production decisions beyond the own county.

The data set covers Sweden's 290 municipalities and 21 counties over the years 2003-2016. Table 1 presents descriptive statistics for the outcome variable, the main explanatory variables, and the control variables used in the analysis. A more detailed description follows.

Table 1. Summary statistics, 2003-2016.

Variable	Definition	Mean	Std. Dev.	Min	Max	Obs.
Land[1]	Share of agricultural area converted and under conversion (%)	12.8	7.2	1.9	38.6	294
Land_ha[2]	Agricultural area converted and under conversion (1000 ha)	18.3	19.8	0.7	127.2	294
Food_local	Share of organic food procured in county (%)	13.2	10.3	0	45.3	289
Food_others	Share of organic food procured in other counties (%)	14.2	9.7	2.4	33.4	294
TCOcap_local	Organic food expenditures (SEK/capita)[3]	80.6	65.2	0	319.2	289
TCOcap_others	Organic food expenditures in other counties (SEK/capita)	79.0	55.0	14.4	202.8	294
Subsidyveg	Subsidies towards organic vegetable production (SEK/ha)	5138	1060	3425	6031	14
Subsidyanimal	Subsidies towards organic animal production (SEK/ha)	2263	135	2109	2520	14
Farmland	Total agricultural area (1000 ha)	147.6	131.4	35.3	546.6	294
Popdensity	Population/square km	45.8	65.3	2.5	347.8	294
Education	Share of population with three or more years of higher education (%)	15.4	3.3	9.6	27.4	294
Employment	Share of population employed (%)	77.2	2.4	70.0	83.2	294

[1] The method to collect data on organic area changed in 2009. However, numbers on organic area are still comparable over time. (Swedish Board of Agriculture, 2015).
[2] The increase in area-based funding in 2005 led to more registered holdings, although not enough to affect the agricultural area substantially (Swedish Board of Agriculture, 2006). From 2010, EU definitions of UAA applied, which included more holdings. These were predominantly of the size 2 ha or less leaving total agricultural area only marginally affected (Swedish Board of Agriculture, 2012).

[3] SEK 1 ≈ EUR 0.1037.

5.1 Dependent variable – Organic farmland

Sweden's agricultural area amounts to 3 035 920 ha, covering about 7 percent of the total land area (Statistics Sweden, 2018). The variable $Land$ is defined as the county percentage share of agricultural area converted and under conversion to organic status, whereas $Land\_ha$ is the county's amount of organic hectares, in thousands. Data on organic farmland is sourced from the Swedish Board of Agriculture (SBA). For the years 2007 and 2008, values for $Land$ and $Land\_ha$ are linearly interpolated due to missing observations for all counties.

As illustrated in Figure 1, both shares and absolute levels of organic farmland increase between 2003 and 2016, and so do their variation across counties. The mean county share of organic farmland increases from 6.9 percent in 2003 to around 19.8 percent in 2016 (left panel) and absolute levels follow roughly the same trend with a mean amount ranging from 10 800 ha in 2003 to 26 300 ha in 2016 (right panel).

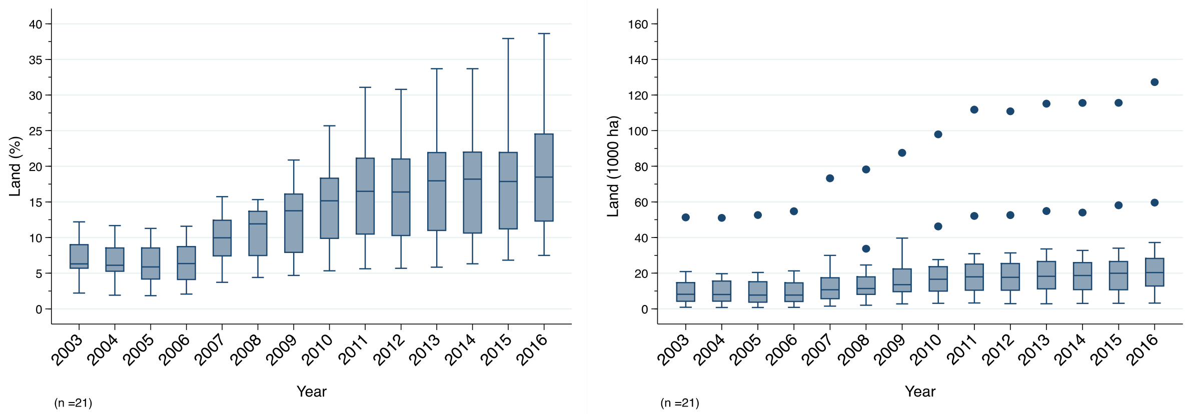

Figure 1. Organic farmland converted and under conversion in Swedish counties, 2003-2016. Left panel shows share of organic farmland (%). Right panel shows organic farmland in thousands of hectares. *Source:* SBA

The increase in the mean share of organic farmland is mainly due to an increase in the nominator, as the agricultural area decreases with 4 percent over the period 2003-2016. The increase in organic farmland is particularly marked between 2006 and 2007. One explanation may be the change in rules regarding organic subsidies in the RDP from 2007, which may have caused non-certified producers to apply for certification in order to maintain their funding, causing an initial surge that levelled out after some years.

5.2 Main explanatory variable - Public organic food procurement

The explanatory variables of main interest are two variables related to the food policy: $Food\_local$ (share of organic food procured in county j) and $Food\_others$ (share of organic food procured in all other counties but j). Both variables are based on measures of the yearly percentage share (in value) of organic food procured by municipalities between 2003-2016. In the empirical analysis the values for $Food\_local$ correspond to the population weighted average of the percentage shares for the municipalities within each county. Values for $Food\_others$ are the corresponding measure of all other counties' shares of organic food procurement.

Due to data limitations, we cannot distinguish the specific *types* of food products procured (e.g., dairy, meat, imported). Although products will likely differ in their impact on domestic organic production, the GPP policy from 2006 does not focus on specific products or countries of origin. We therefore argue that the aggregate percentage share is applicable when studying the impact of the policy as formulated. However, as described in Section 4, an increased share of organic food may not necessarily increase food expenditures. To more explicitly capture the effect of increased expenditures, two alternative variables are considered, namely organic expenditures in Swedish krona (SEK) per capita in county j ($TCOcap\_local$), and in all other counties but j ($TCOcap\_others$). These variables are constructed using survey data on percentage levels and official information from Statistics Sweden (SCB) on total food procurement costs.

A majority of the procurement data comes from the organisation Ekomatcentrum which surveys municipalities yearly on their organic food procurement (the survey questions used for this study's purpose are found in Appendix C). Additional observations come from the national data base Kolada, from The National Association of Swedish Eco-municipalities (Sekom), and from municipalities' official documents. Response rates increase over the years, from 33 percent in 2003 to 96 percent in 2016, with a substantial increase around 2008. The average municipality participates in at least one of the three surveys nine years during 2003-2016. See Appendix C for municipalities' yearly response rates and organic food shares. In 2004, municipalities were not surveyed by Ekomatcentrum which means that observations are missing for most municipalities that year. Therefore, organic food purchases are linearly interpolated for the year 2004, resulting in slightly lower county means, 13.2 percent compared to 13.3, and 57.2 SEK/capita compared to 59.6. Standard deviations are roughly unchanged.

Figure 2 presents organic food purchases at county level during the period 2003-2016. Both shares and expenditures per capita vary across counties, and increasingly so over the years. The mean share of organic foods increases from 2.2 percent in 2003 to around 30 percent in 2016 (left panel) and organic expenditures in SEK/capita follow roughly the same trend with mean values ranging from 14 SEK/capita in 2003 to 192 SEK/capita in 2016 (right panel).

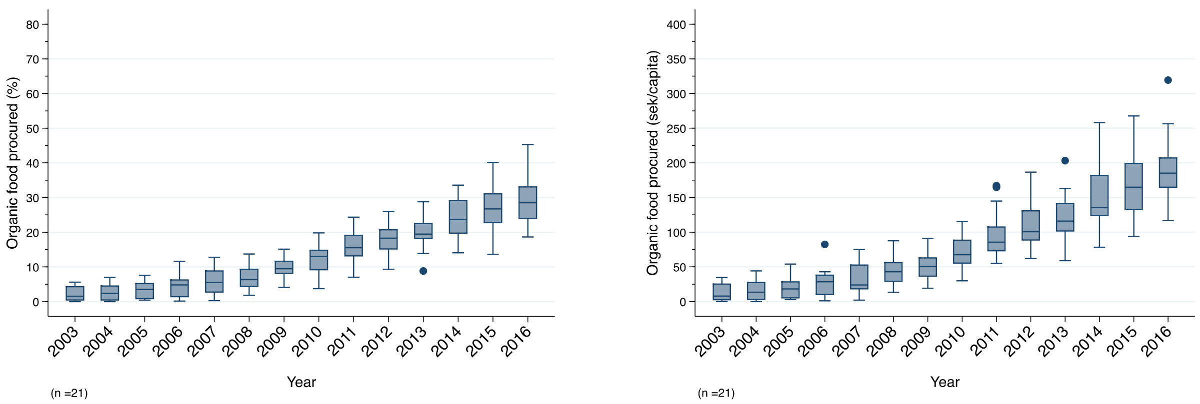

Figure 2. Organic food procured in Swedish counties, 2003-2016. Left panel shows percentage share of organic food. Right panel shows organic expenditures in SEK/capita. *Source: Ekomatcentrum, Sekom, Kolada, and SCB.*

5.3 Other control variables

In addition to the food policy variables the control variables include the national level policy via subsidies aiming for the same objective, and county level characteristics. This data originates from SCB and SBA.

5.3.1 Direct subsidies – national policy

It seems reasonable to also control for other types of policy instruments aiming at the same objective as the GPP policy. We control for direct supply-side agricultural policy on national level by including yearly subsidies available to those who convert to organic production. The subsidy rates are measured in SEK/ha and vary across different types of organic production where the most common ones include grass, crops, livestock, grazing, and vegetables. As seen in the left panel of Figure 3, rates vary relatively little over time, and some types are, by policy intensions, bound to correlate (See Table B1 in Appendix B for correlation coefficients).

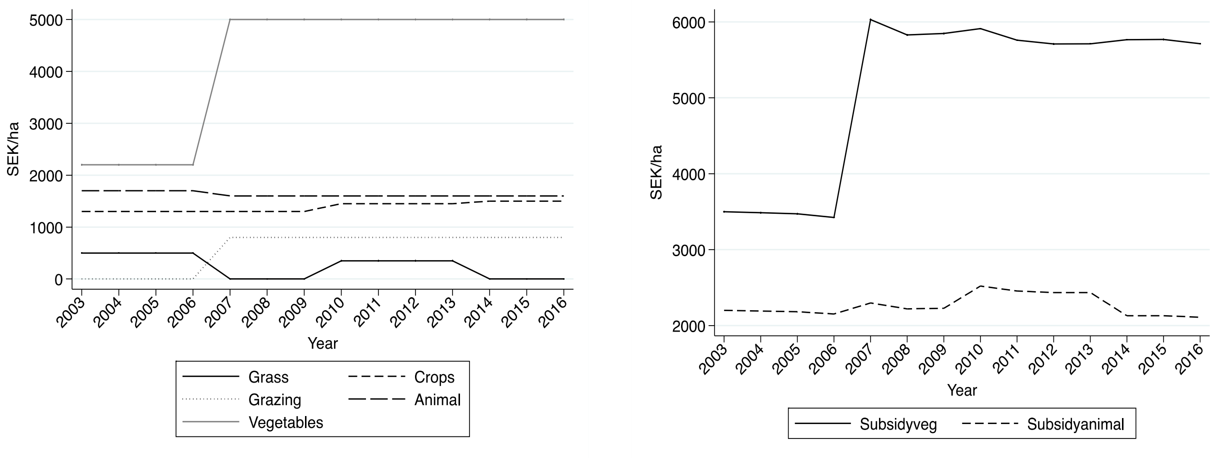

Figure 3. Annual subsidy rates for organic production, 2003-2016. Left panel shows individual subsidy rates. Right panel shows grouped subsidy rates. Source: SBA.

To avoid multi-collinearity, the different subsidies are grouped into two main types. Subsidies for organic production of grass, grazing area and livestock, all aimed towards animal production, constitutes the group $Subsidyanimal$, and subsidies for organic production of crops and vegetables, i.e., subsidies aimed at non-animal production, are in a group labelled $Subsidyveg$. The rates are inflation adjusted using consumer price index as reference with 2003 as base year. The right panel of Figure 3 presents the grouped subsidy levels.

Another potential control variable is the private consumption. In Sweden, private consumption constitutes about 86 percent of the total food consumption (Jörgensen, 2012) and the public sector is, in the political argumentation in favour of GPP, expected to lead the way and inspire private consumers to follow. However, including the private organic food consumption in the specifications can make it difficult to identify the effect of public consumption, should this effect go via the private consumption. While both the public and the private sector consume organic food, the main empirical analysis will therefore focus on the consumption of the former. An alternative specification includes private organic consumption.

A description of the development of private organic food consumption is, however warranted. Organic food (imported and domestically produced) purchases among private consumers did, de facto, increase during the time period, from 1.9 percent in 2004 to 7.9 percent in 2016. These numbers do not reflect changes in the relative prices of organic and conventional food. According to Ekoweb (2014), one third of sales increases in organic food in 2013 can be explained by price increases and two thirds by volume increases. During the period 2003-2016, total food sales and population have similar growth rates, whereas organic food sales grow at a considerably higher and more varying rate.

Another factor of potential interest is the trade pattern of organic food. Unfortunately, official, periodical data on imports of organic food, specifically, is not available. However, estimates suggest that the share of organic food consumption stemming from imports increased from 20 percent in 2003 to 57 percent in 2016 with 1 percent of exported food being organic (Jörgensen, 2012; KRAV, 2016). Thus, Sweden is a net importer of organic food and increasingly reliant on imports, similar to most EU countries (European Commission, 2010). This is illustrated in Figure 4 which shows private consumers' share of the organic alternatives and the net export of five large product groups from 2003 to 2016.

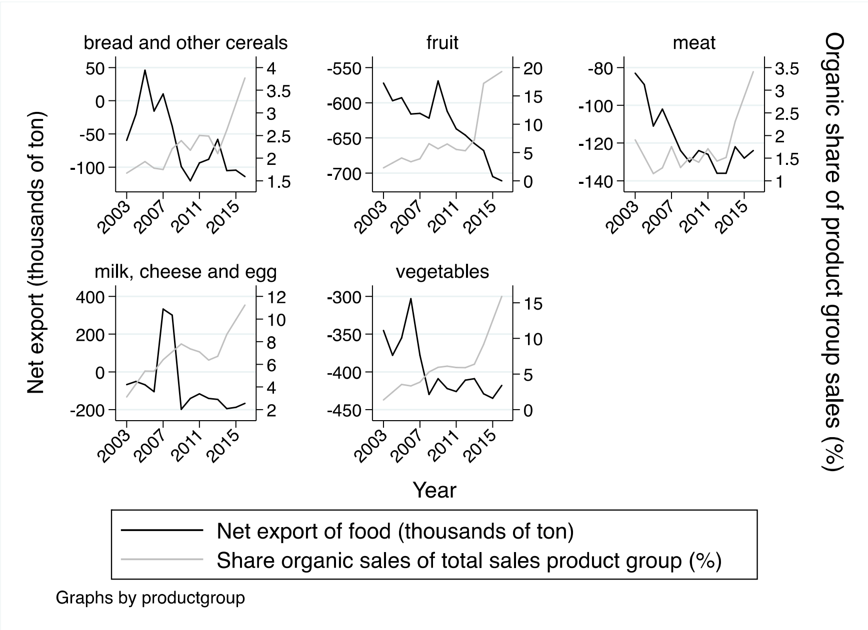

Figure 4. Net export and organic share of sales for five large product groups, 2003-2016.
Source: SCB.

As shown in the figure, the organic share of private consumption has increased for all product groups, especially around 2012 and for *fruit* and *vegetables.* During the same period, net exports (including both organic and conventional products) have decreased for all product groups, except for in the initial years for *bread and other cereals; milk, cheese and egg,* and *vegetables.*

5.3.2 County level characteristics *(CC)*

Since organic farming is, generally, less resource efficient and requires more land to maintain the same output level as conventional farming, we control for the variation in land availability using population density ($Popdensity$). Since land is used for many purposes besides farming, we further control for land availability by including the amount of agricultural land in the county ($Farmland$) in some of the regressions.

Numerous studies show that pro-environment attitudes are positively correlated with education and income levels (Baudry et al., 2015; Nordlund et al., 2013; Gowindsamy and Italia, 1999). We control for the effect of local organic preferences, using the proxy variable $Education$ which is the share of the county population, aged 16-74 years, with three or more years of higher education. Additional variables to capture organic preferences were considered, e.g., median income, share of environmentally friendly cars and environmental party voting shares, but were left out of the analysis due to multi-collinearity (see Table B2 in Appendix B). To further control for socio-demographic factors influencing the supply of organic land, we include the variable $Employment$, which is the share of the county population, aged 20-64 years, with employment.

The natural conditions for organic farming, such as soil and climate, vary across Sweden. Both Swedish and European data show that regions with large shares of grassland, or production based on grassland, have relatively large shares of organic farmland compared to regions dominated by arable crops. Large shares of grassland are commonly found in areas of more barren and less mild climate (European Commission, 2010; Swedish University of Agricultural Sciences, 2010). We control for the time-invariant factor of belonging to one out of seven vegetation zones in Sweden, by including zone fixed effects in some of the regressions instead of county fixed effects.

6. Empirical approach

The effect of the GPP policy on domestic organic farmland is estimated using data on the 21 counties in Sweden between 2003-2016. The main specifications used for this purpose are:

$$Land_{jt} = \beta_0 + \sum_{i=0}^{2} \alpha_i \, Food\_local_{jt-i} + \sum_{i=0}^{2} \delta_i \, Food\_others_{jt-i} + \beta_1 Subsidyveg_t + \beta_2 Subsidyanimal_t + \beta_3' CC_{jt} + \beta_4' T_t + \gamma_j + \varepsilon_{jt} \tag{2}$$

$$Land\_ha_{jt} = \beta_0 + \sum_{i=0}^{2} \alpha_i \, TCOcap\_local_{jt-i} + \sum_{i=0}^{2} \delta_i \, TCOcap\_others_{jt-i} + \beta_1 Subsidyveg_t + \beta_2 Subsidyanimal_t + \beta_3' CC_{jt} + \beta_4' T_t + \gamma_j + \varepsilon_{jt} \tag{3}$$

$$Diff_{jt} = \beta_0 + \beta_1 D.TCOcap\_local_{jt} + \beta_2 D.TCOcap\_others_{jt} + \beta_3 D.Subsidyveg_t + \beta_4 D.Subsidyanimal_t + \beta_5' CC_{jt} + \beta_6' T_t + \gamma_j + \varepsilon_{jt} \tag{4}$$

The dependent variable in Expression (2), $Land_{jt}$, corresponds to percentage shares of organic agricultural land in county *j* in year *t*. The explanatory variables of main interest are $Food\_local_{jt-i}$ and $Food\_others_{jt-i}$, corresponding to the population weighted average share of organic food procured in year *t-i* in county *j*, and in all other counties, respectively.

While Expression (2) mimics the way the policy is stipulated, Expression (3) employs organic hectares in absolute terms as dependent variable, thereby avoiding the pitfalls of a dependent variable potentially varying in both nominator and denominator. Since municipalities can increase the share of organic foods purchased without increasing expenditures as such, the main explanatory variables in Expression (3) are public organic food purchases (SEK/capita) in county *j* ($TCOcap\_local_{jt-i}$) and in all other counties ($TCOcap\_others_{jt-i}$), respectively.

In Expression (4), we consider only the influx of *new* organic hectares in a county as the dependent variable, which is constructed by taking the yearly difference in organic hectares (converted and under conversion). The explanatory variables prefixed with D. in Expression (4) are also yearly differences.

In Expressions (2) and (3), we use up to two-year lagged values due to the assumption that the potential impact of public procurement on agricultural households' decision to convert to organic production may not be instantaneous. As subsidy levels are observed beforehand by the producers, $Subsidyveg$ and $Subsidyanimal$ are both measured in year *t*. The vector CC refers to county level control variables, including population density, total amount of farmland, education levels and employment intensity.

All three specifications include a within-sample time trend (T_t) with a linear and a quadratic component that controls for an underlying trend in purchasing behaviour and agricultural production which may show non-linear features. The variable γ_{cc} represents time invariant fixed effects with estimations performed using county fixed effects and zone fixed effects, respectively. While county fixed effects are likely to control for any within county trend not captured by the control variables, the inclusion of zone fixed effects reduce the number of estimated parameters and may, as mentioned above, more explicitly control for variation in natural conditions for (organic) agricultural production. The parameter ε_{jt} is a random term, capturing unobserved factors affecting the share of organic farmland. All continuous variables in Expression (2) and (3) are logarithmic. In Expression (4), all variables are non-logarithmic due to observations with zero and negative values.

Addressing concerns about endogeneity is warranted if we suspect that organic food purchases are correlated with the error term through, e.g., unobserved consumer preferences or production costs affecting the farmer's decision to convert. As stated earlier, severe multi-collinearity arise when including more control variables to capture organic preferences on county level. By including education levels to control for organic preferences, and subsidy rates which to some extent capture changes in production costs, we argue that the risk of endogeneity due to omitted variable bias is reduced. The case of endogeneity due to reversed causality could be suspected if authorities are able to source food locally and choose to do so to a large extent, maybe in an attempt to support local agricultural businesses. However, according to non-discrimination principles laid out in the Council Directive 2014/24/EU, the public sector is prohibited to explicitly favour local businesses. The directive applies to all contracts above a certain threshold value, which is currently at EUR 221 000 (European Commission, 2018b).

The south of Sweden has typically more and larger agricultural holdings than the north of Sweden. We therefore perform a weighted analysis for Expression (2), where the square root of the number of agricultural holdings in each county is used as an analytical weight. This weight is used since we expect organic conversion rates to be less susceptible to shocks in counties with a large number of agricultural holdings. For Expression (3) and (4), we include the control variable $Farmland$ instead of analytical weights, thereby controlling for the total amount of farmland available in the county.

All three specifications above indicate panel level heteroskedasticity when performing a likelihood-ratio test. A Wooldridge test (2002), as implemented by Drukker (2003), indicates serial correlation. A Pesaran test, as described by De Hoyos and Sarafidis (2006), indicates no cross-sectional dependence when including year dummies. With a time trend, T_t, the hypothesis of no cross-sectional dependence is rejected for all Expressions (2) to (4).

We handle the issues of heteroskedasticity and serial correlation by estimating Expression (2) to (4) using the FGLS estimator (see, e.g., Wooldridge, 2002). FGLS, as proposed by Parks (1967), typically requires a “large T, small N” panel data set in order to correct for contemporaneous correlation across units and unit-specific serial correlation. According to Beck and Katz (1995), unit-specific serial correlation is theoretically unlikely in many cases of cross-sectional time series, which is why we assume a common auto-regressive parameter. In order to fit a model with cross-sectional dependence, panels must be balanced and the number of observations per panel must exceed the number of panels. Our case meets neither of these requirements. By ignoring the cross-sectional dependence and only estimating panel specific variances, we accept the tradeoff of estimating a covariance matrix using the FGLS estimator. FGLS estimates are, supposable efficient, but possibly biased, while ordinary least squares (OLS) estimates are, supposable unbiased, but possibly inefficient (Lewis and Linzer 2005). As a robustness check, estimations are also carried out using OLS with robust standard errors.

7. Results

This section presents the results from our three main specifications, estimated with FGLS. Results are presented from estimations including county fixed effects and zone fixed effects, respectively. Full-length tables, A1 to A3, are found in Appendix A.

7.1 Dependent variable share organic hectares

Table 2 presents the results from estimating the equation as specified by Expression (2). The results show that the coefficient of organic food procurement within the county, $Food\_local_{t-i}$, is statistically, albeit weakly, significant in about half of the specifications. However, the coefficient of $Food\_others_{t-0}$ is statistically significant and positive in all specifications. As can be seen in Table 2, 1 percent increase in the weighted average share of other counties' procurement is associated with an increase in the share of organic land in county *j* ranging from around 0.4 percent up to around 0.6 percent.

The coefficients of the lagged variables of $Food\_others$ are statistically significant and positive in the two-year lagged case, but non-significant in the one-year lagged case. A possible explanation to the difference in significance and magnitude between the coefficients of $Food\_local$ and $Food\_others$ is that public organic food consumption within the individual county provides none, or small, incentives for local producers to convert to organic production. This may be a result of municipalities (in county *j*) demanding too little organic products, or municipalities (in county *j*) demanding products that are primarily grown and produced elsewhere. The comparatively large, significant positive coefficient of $Food\_others$ suggests that producers within a county are more likely to react to the aggregated purchasing behavior of the public sector as a whole. A quantification of the coefficients of $Food\_others_{t-0}$ is as follows: The average size of a county's organic farmland during the period studied amounts to 12.8 percent or 18 000 hectares. Coefficient estimates show that an increase by 1 percent in the weighted average share of other counties' organic food procurement in year *t* is thus associated with an average increase in the organic farmland in county *j* in the same year, corresponding to around 72 to 108 hectares.

Table 2. Results from weighted FGLS estimations. Dependent variable log percentage share organic farmland in Swedish counties, 2003-2016.

	County fixed effects			Zone fixed effects		
	No lag	1-year lag	2-year lag	No lag	1-year lag	2-year lag
$lnfood\_local_{t-0}$	0.003	0.016	0.026*	0.012	0.019*	0.025**
	(0.010)	(0.011)	(0.013)	(0.010)	(0.010)	(0.013)
$lnfood\_local_{t-1}$		0.004	0.008		0.010	0.018
		(0.010)	(0.012)		(0.010)	(0.011)
$lnfood\_local_{t-2}$			0.012			0.028***
			(0.010)			(0.010)
$lnfood\_others_{t-0}$	0.526***	0.461***	0.561***	0.480***	0.356***	0.624***
	(0.091)	(0.112)	(0.205)	(0.086)	(0.104)	(0.218)
$lnfood\_others_{t-1}$		0.053	0.026		0.113	0.083
		(0.095)	(0.090)		(0.092)	(0.091)
$lnfood\_others_{t-2}$			0.300**			0.404***
			(0.133)			(0.139)
lnsubsidyveg	0.443***	0.429***	0.427***	0.433***	0.406***	0.445***
	(0.037)	(0.046)	(0.052)	(0.038)	(0.046)	(0.052)
lnsubsidyanimal	0.738***	0.684***	0.603***	0.683***	0.586***	0.538***
	(0.105)	(0.114)	(0.122)	(0.106)	(0.113)	(0.128)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	No	No	No
Zone FE	No	No	No	Yes	Yes	Yes
N	286	264	242	286	264	242
df	29	31	33	14	16	18
chi2	3465.716	3637.742	3879.215	1100.818	1136.680	1108.338

Note: All models control for common auto-regressive parameter and panel level heteroscedasticity. Coefficients with standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

Direct agricultural policy in the form of organic subsidies has a significant positive impact on the share of organic farmland, as shown by the coefficient estimates of $Subsidyveg$ and $Subsidyanimal$. This signal effect is stable across specifications and in line with previous studies by, e.g., Pietola and Lansink (2001) and Chabé-Ferret and Subervie (2013). Bearing in mind that subsidy rates do not differ across counties, the size of the coefficients implies that 1 percent increase in organic subsidies is associated with an increase in the share of organic farmland of about 0.4 percent in the case of $Subsidyveg$ and ranging from 0.5 to 0.7 percent in the case of $Subsidyanimal$. Since one of the subsidies included in $Subsidyanimal$ targets grass production, which is relatively easy to convert, it is intuitive that grass producers are more responsive to increases in their relevant subsidies, relative to crops and vegetables producers.

F-tests are performed to test whether the coefficients of organic food purchases and organic subsidies differ. Results show that coefficients of $Food\_others_{t-0}$ and $Subsidyveg$ are not statistically different from each other, whereas the coefficient of $Subsidyanimal$ is of a statistically larger magnitude than $Food\_others_{t-0}$ in a majority of the estimations in Table 2.

7.2 Dependent variable organic hectares

With Expression (3), absolute hectares of organic land are regressed on per capita expenditures of public organic food purchases. The results obtained from unweighted FGLS estimations are found in Table 3 and generally confirm the results above.

A noteworthy difference is the significant negative coefficient of local organic food purchases, $TCOcap\_local_{t-1}$, in one of the specifications. One explanation to this could be that organic food within the public sector is predominantly purchased in counties where farmers are less likely to switch to organic production, due to factors such as vegetation zones, soil type and other fixed factors which are included in the error term and/or the county fixed effects, and not properly controlled for. When turning to the estimates using zone fixed effects in Table 3, the significant negative coefficient is in fact gone, and replaced by a significant positive one in the specification with two lags. The coefficients of $TCOcap\_others_{t-i}$ are mainly significant positive, in line with results above. Estimates indicate that 1 percent increase in per capita organic food purchases in other counties is associated with an increase in organic hectares in county j, corresponding to 0.5 percent with the no-lag specification using zone fixed effects and to 1 percent when allowing for a lagged effect.

Table 3. Results from unweighted FGLS estimations. Dependent variable log hectares of organic farmland in Swedish counties, 2003-2016.

	County fixed effects			Zone fixed effects		
	No lag	1-year lag	2-year lag	No lag	1-year lag	2-year lag
$lnTCOcap\_local_{t-0}$	-0.007	0.003	0.013	0.009	0.014	0.021
	(0.009)	(0.012)	(0.015)	(0.010)	(0.011)	(0.013)
$lnTCOcap\_local_{t-1}$		-0.025**	-0.012		0.004	0.008
		(0.011)	(0.013)		(0.010)	(0.011)
$lnTCOcap\_local_{t-2}$			-0.006			0.027***
			(0.011)			(0.010)
$lnTCOcap\_others_{t-0}$	0.244***	0.235**	0.847***	0.495***	0.410***	1.051***
	(0.083)	(0.092)	(0.204)	(0.082)	(0.086)	(0.225)
$lnTCOcap\_others_{t-1}$		0.028	-0.038		0.133*	0.112
		(0.076)	(0.074)		(0.080)	(0.078)
$lnTCOcap\_others_{t-2}$			0.457***			0.648***
			(0.144)			(0.159)
lnsubsidyveg	0.422***	0.392***	0.521***	0.433***	0.384***	0.530***
	(0.035)	(0.044)	(0.059)	(0.040)	(0.048)	(0.065)
lnsubsidyanimal	0.761***	0.788***	1.007***	0.702***	0.612***	0.615***
	(0.096)	(0.105)	(0.115)	(0.109)	(0.110)	(0.120)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	No	No	No
Zone FE	No	No	No	Yes	Yes	Yes
N	286	264	242	286	264	242
df	30	32	34	15	17	19
chi2	7623.869	9562.854	10686.810	1734.046	1859.714	2015.130

Note: All models control for common auto-regressive parameter and panel level hetero-scedasticity. Coefficients with standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

F-tests results show, in line with previous specification, that the coefficient of $Subsidyanimal$ is generally larger than that of $TCOcap\_others_{t-0}$, whereas the coefficient of $Subsidyanimal$ is either slightly smaller than or not statistically different from that of $TCOcap\_others_{t-0}$.

7.3 Dependent variable differences in organic hectares

Expression (4) employs yearly differences in organic hectares as dependent variable, and yearly differences in organic expenditures in SEK/capita as main explanatory variable. Results are presented below in Table 4, with a full-length table presented in Table A3 in Appendix A.

Table 4. Results from non-weighted FGLS estimations – Difference in hectares of organic farmland in Swedish counties between 2003-2016.

	County fixed effects	Zone fixed effects
D.TCOcap_local	0.003	0.003
	(0.004)	(0.004)
D.TCOcap_others	0.038***	0.033**
	(0.014)	(0.014)
D.subsidyveg	0.001***	0.001***
	(0.000)	(0.000)
D.subsidyanimal	0.004***	0.003***
	(0.001)	(0.001)
Controls	Yes	Yes
Time trend	Yes	Yes
County FE	Yes	No
Zone FE	No	Yes
N	267	267
df	30	15
chi2/R2 adjusted	371.520	200.174

Note: All models control for common auto-regressive parameter and panel level heteroscedasticity. Coefficients with standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

The results largely follow the same pattern as earlier with differences in organic food purchases having a non-significant effect on "new" organic land on the local level, but a significant positive effect, when aggregated. Coefficient estimates indicates that a one unit increase in the difference from previous year's organic food purchases per capita is associated with an increase in the amount of new organic hectares corresponding to about 0.03 hectares.

7.4 Alternative specifications

Expressions (2) to (4) are also estimated using year fixed effects instead of a time trend, in order to mitigate the risk of contemporaneous correlation across panels. These estimations exclude panel-invariant variables $Subsidyveg$ and $Subsidyanimal$. Results are found in Tables A4 to A6 in Appendix A and mainly confirm previous results, although it appears as if much of the statistical significance of organic food purchases are captured by the year fixed effects. Results from OLS estimations are also in line with the results presented above. Due to space constraints, OLS estimates can be found in the Online Appendix.

Expressions (2) and (3) are also estimated including the (logarithmic) share of private organic food consumption, $Private$ in year t. Although the inclusion of private consumption may hamper identification if the effect of public consumption of organic food works through private consumers, excluding private consumption may cause omitted variable bias. Results show that the coefficients representing public organic food consumption are in line with those presented in Table 2 and 3 above, and that the coefficients representing private food consumption are, in general, significant and positive. Results are available in the Online Appendix.

7.5 Addressing non-response bias

According to, e.g., Ochoa and Erdmenger (2003) and Jörgensen (2012), surveys on green procurement will likely have higher response rates among more environmentally committed responders. If the decision of non-response is related to the survey outcome of interest, survey results may be biased (Manski, 1989; Heckman, 1979), i.e., missing values in our case represent shares that would entail a lower mean of public organic food purchases. When interpreting the findings of the current study, it is thus important to note that a positive policy impact may be subject to overestimation. Although it would be informative to explore whether the data on organic food purchases suffer from non-response bias, it is beyond the scope of this study.

8. Discussion and conclusions

In this paper, we empirically study the effect of a GPP policy implemented by the Swedish Government in 2006. The policy aims at increasing the public sector's organic food purchases with an expected positive effect on the share of domestic organic farmland. The effect of public procurement as a policy instrument is an empirical question which is determined by market specifics and also contingent on the agricultural household's preferences on organic production, and other policies aiming at the same objective, e.g., agricultural subsidies.

Estimations are carried out using panel data for the years 2003 - 2016, including data on organic food purchases, organic farmland and subsidy rates. Based on mainly weighted and unweighted FGLS with different specifications, we conclude that public organic food purchases can be associated with a significant positive impact on organic farmland. This effect is mainly found on aggregated level and attributed to the joint market power of the Swedish municipalities. That is, although the Swedish public sector only accounts for about 4 percent of the Swedish market for foods, it appears as if uncoordinated public authorities as a whole make up a sufficiently large buyer to reach market power via a coordination effect of the oligopolistic wholesalers.

Our findings do not detect stark evidence of a positive local effect on the own county. That is, based on the geographical organization of Swedish production and public consumption of organic food, we conclude that the public organic food consumption within an individual county generally creates none, or small, incentives for producers within that county to convert to organic production. This is not surprising given that producers are more likely to react to the purchasing behaviour of the aggregated market as a whole, private consumers included, and that the public sector is largely prohibited to favour local suppliers. In line with expectations and previous literature, direct organic subsidies have a significant positive effect on organic farmland, and compared to organic food purchases, this effect is generally somewhat larger.

It is important to address some caveats of the present study. There is, theoretically, a possibility that increases in organic food purchases are met by proportional increases in organic agricultural land by all, or a majority of the counties. In that case, the policy would indeed have an effect, but given this study's reduced form approach, we would not detect a significant impact. This scenario is, however, unlikely given the variation in, e.g., climate, soil and locality, to which Swedish agricultural production is exposed.

The organic expenditure levels depend on the composition of the food basket, which can be adapted by the public authorities according to local preferences. While the policy's impact is largely contingent on the origin of the food product, public authorities are, to a large extent, unable to mandate food to be sourced locally. Due to the policy's multi-objective nature, a local authority may then reach its goal of organic food procurement without contributing as such to the overarching goal of increased domestic organic farmland. A more in-depth analysis of this type of GPP policy would use time-series data on food contract level to study substitution patterns within food baskets as the share and/or expenditures of organic food purchases change.

Future studies could also address the way in which public authorities choose to implement a food policy of this type, as its adoption allows for certain degrees of freedom. In addition to studying what factors determine the uptake of this sort of voluntary policy, key questions relate to contract design, technical specifications, supplier selection methods, and award criteria in the specific procurement. Studying the rationale behind the choices made, and the distributional and welfare effects thereof would provide a deeper understanding of the implications of EU policies on public procurement and how they are being carried out in practice.

This study has mentioned the potential role of intermediaries in the production chain where wholesalers seem to be an important link between the public sector and the producers, by exerting pressure upward in the supply chain. However, more research is warranted on the dynamics between private and public organic food consumption and of the intermediaries (food processors, wholesalers and retailers) in relation to, e.g., supply elasticities and market shares. These studies would largely contribute to an understanding of the possibilities and pitfalls of using public procurement as an instrument of environmental policy.

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Appendix A. Full-length tables and results from alternative specifications

Table A1. Results from weighted FGLS estimations. Dependent variable log percentage share organic land in Swedish counties, 2003-2016

	County fixed effects			Zone fixed effects		
	No lag	1-year lag	2-year lag	No lag	1-year lag	2-year lag
$lnfood\_local_{t-0}$	0.003	0.016	0.026*	0.012	0.019*	0.025**
	(0.010)	(0.011)	(0.013)	(0.010)	(0.010)	(0.013)
$lnfood\_local_{t-1}$		0.004	0.008		0.010	0.018
		(0.010)	(0.012)		(0.010)	(0.011)
$lnfood\_local_{t-2}$			0.012			0.028***
			(0.010)			(0.010)
$lnfood\_others_{t-0}$	0.526***	0.461***	0.561***	0.480***	0.356***	0.624***
	(0.091)	(0.112)	(0.205)	(0.086)	(0.104)	(0.218)
$lnfood\_others_{t-1}$		0.053	0.026		0.113	0.083
		(0.095)	(0.090)		(0.092)	(0.091)
$lnfood\_others_{t-2}$			0.300**			0.404***
			(0.133)			(0.139)
lnsubsidyveg	0.443***	0.429***	0.427***	0.433***	0.406***	0.445***
	(0.037)	(0.046)	(0.052)	(0.038)	(0.046)	(0.052)
lnsubsidyanimal	0.738***	0.684***	0.603***	0.683***	0.586***	0.538***
	(0.105)	(0.114)	(0.122)	(0.106)	(0.113)	(0.128)
lnpopdensity	-2.370***	-2.550***	-2.411***	-0.015	-0.034	-0.033
	(0.390)	(0.409)	(0.426)	(0.054)	(0.054)	(0.053)
lneducation	-0.207	0.366	1.182	-0.437**	-0.374	-0.389*
	(0.699)	(0.767)	(0.913)	(0.219)	(0.228)	(0.219)
lnemployment	-3.090***	-2.697***	-2.117***	-2.332***	-1.661***	-1.611***
	(0.409)	(0.497)	(0.573)	(0.390)	(0.478)	(0.579)
T	-0.069	-0.075	-0.205*	-0.058**	-0.034	-0.241**
	(0.046)	(0.056)	(0.111)	(0.026)	(0.038)	(0.113)
T^2	0.004***	0.004***	0.005**	0.003***	0.002	0.006**
	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.003)
Constant	19.672***	17.791***	12.557***	3.291**	1.223	0.882
	(3.546)	(3.913)	(4.532)	(1.635)	(1.841)	(1.953)
N	286	264	242	286	264	242
df	29	31	33	14	16	18
chi2	3465.716	3637.742	3879.215	1100.818	1136.680	1108.338

Note: All models control for common auto-regressive parameter and panel level hetero-scedasticity. Coefficients with standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

Table A2. Results from unweighted FGLS estimations. Dependent variable log organic hectares in Swedish counties, 2003-2016

	County fixed effects			Zone fixed effects		
	No lag	1-year lag	2-year lag	No lag	1-year lag	2-year lag
lnTCOcap_local$_{t-0}$	-0.007	0.003	0.013	0.009	0.014	0.021
	(0.009)	(0.012)	(0.015)	(0.010)	(0.011)	(0.013)
lnTCOcap_local$_{t-1}$		-0.025**	-0.012		0.004	0.008
		(0.011)	(0.013)		(0.010)	(0.011)
lnTCOcap_local$_{t-2}$			-0.006			0.027***
			(0.011)			(0.010)
lnTCOcap_others$_{t-0}$	0.244***	0.235**	0.847***	0.495***	0.410***	1.051***
	(0.083)	(0.092)	(0.204)	(0.082)	(0.086)	(0.225)
lnTCOcap_others$_{t-1}$		0.028	-0.038		0.133*	0.112
		(0.076)	(0.074)		(0.080)	(0.078)
lnTCOcap_others$_{t-2}$			0.457***			0.648***
			(0.144)			(0.159)
lnsubsidyveg	0.422***	0.392***	0.521***	0.433***	0.384***	0.530***
	(0.035)	(0.044)	(0.059)	(0.040)	(0.048)	(0.065)
lnsubsidyanimal	0.761***	0.788***	1.007***	0.702***	0.612***	0.615***
	(0.096)	(0.105)	(0.115)	(0.109)	(0.110)	(0.120)
lnfarmland	-2.468***	-2.676***	-3.923***	1.048***	1.076***	1.116***
	(0.403)	(0.450)	(0.494)	(0.045)	(0.045)	(0.042)
lnpopdensity	-4.082***	-4.504***	-5.059***	0.002	-0.011	-0.009
	(0.406)	(0.421)	(0.425)	(0.055)	(0.056)	(0.052)
lneducation	-0.033	0.593	0.288	-0.508**	-0.515**	-0.663***
	(0.641)	(0.718)	(0.824)	(0.232)	(0.243)	(0.228)
lnemployment	-2.387***	-2.377***	-3.284***	-2.799***	-2.174***	-2.492***
	(0.386)	(0.440)	(0.540)	(0.408)	(0.457)	(0.559)
T	-0.013	-0.023	-0.373***	-0.040	-0.014	-0.405***
	(0.040)	(0.047)	(0.111)	(0.024)	(0.032)	(0.116)
T^2	0.004***	0.004***	0.012***	0.002***	0.000	0.008***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.003)
Constant	37.002***	38.462***	47.474***	6.497***	4.555**	2.170
	(4.116)	(4.613)	(5.443)	(1.702)	(1.838)	(1.941)
N	286	264	242	286	264	242
df	30	32	34	15	17	19
chi2	10738.515	10371.995	16243.048	1734.046	1859.714	2015.130

Note: All models control for common auto-regressive parameter and panel level hetero-scedasticity. Coefficients with standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

Table A3. Results from non-weighted FGLS estimations – Difference in hectares of organic land in counties between 2003-2016

	County fixed effects	Zone fixed effects
D.TCOcap_local	0.003	0.003
	(0.004)	(0.004)
D.TCOcap_others	0.038***	0.033**
	(0.014)	(0.014)
D.subsidyveg	0.001***	0.001***
	(0.000)	(0.000)
D.subsidyanimal	0.004***	0.003***
	(0.001)	(0.001)
D.farmland	-0.008	0.006
	(0.037)	(0.037)
D.popdensity	-0.149	-0.128*
	(0.108)	(0.078)
D.education	-1.158*	-0.549
	(0.667)	(0.756)
D.employment	-0.283***	-0.245***
	(0.064)	(0.067)
T	0.247***	0.323***
	(0.082)	(0.096)
T^2	-0.016***	-0.020***
	(0.005)	(0.005)
Constant	0.417	-0.530
	(0.721)	(0.565)
N	267	267
df	30	15
chi2	371.520	200.174

Note: All models control for common auto-regressive parameter and panel level hetero-scedasticity. Coefficients with standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

Table A4. Results from weighted FGLS estimations with year fixed effects. Dependent variable log percentage share organic farmland in Swedish counties, 2003-2016

	County fixed effects			Zone fixed effects		
	1-year lag	2-year lag	3-year lag	1-year lag	2-year lag	3-year lag
$lnfood\_local_{t-0}$	-0.013	-0.003	0.006	-0.001	0.004	0.016
	(0.009)	(0.011)	(0.012)	(0.009)	(0.011)	(0.012)
$lnfood\_local_{t-1}$		0.005	0.002		0.004	0.011
		(0.010)	(0.010)		(0.010)	(0.011)
$lnfood\_local_{t-2}$			0.011			0.022**
			(0.009)			(0.009)
$lnfood\_others_{t-0}$	-0.087	0.056	-0.253	0.272	0.265	0.023
	(0.305)	(0.340)	(0.450)	(0.307)	(0.344)	(0.447)
$lnfood\_others_{t-1}$		-0.500	-0.336		-0.235	-0.090
		(0.307)	(0.328)		(0.317)	(0.328)
$lnfood\_others_{t-2}$			-0.093			0.158
			(0.302)			(0.306)
lnpopdensity	-1.515***	-1.716***	-1.681***	-0.059	-0.078	-0.061
	(0.369)	(0.392)	(0.415)	(0.064)	(0.062)	(0.061)
lneducation	1.040	1.861**	2.140**	-0.231	-0.162	-0.220
	(0.764)	(0.853)	(0.959)	(0.262)	(0.258)	(0.250)
lnemployment	1.270	1.387	1.687*	1.473*	1.858**	1.694**
	(0.971)	(1.002)	(0.931)	(0.808)	(0.849)	(0.844)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Constant	2.085	0.527	-1.526	-4.511	-6.114*	-5.343
	(5.627)	(6.143)	(6.228)	(3.557)	(3.714)	(3.685)
N	286	264	242	286	264	242
df	38	39	40	23	24	25
chi2	3546.249	4083.990	4768.465	1457.493	1394.400	1296.195

Note: All models control for common auto-regressive parameter and panel level hetero-scedasticity. Coefficients with standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

Table A5. Results from unweighted FGLS estimations with year fixed effects. Dependent variable log hectares of organic farmland in Swedish counties, 2003-2016

	County fixed effects			Zone fixed effects		
	1-year lag	2-year lag	3-year lag	1-year lag	2-year lag	3-year lag
$lnTCOcap\_local_{t-0}$	-0.018**	-0.007	-0.005	-0.006	0.001	0.008
	(0.009)	(0.011)	(0.015)	(0.010)	(0.013)	(0.013)
$lnTCOcap\_local_{t-1}$		-0.015	-0.015		0.005	0.009
		(0.010)	(0.013)		(0.011)	(0.011)
$lnTCOcap\_local_{t-2}$			-0.007			0.020**
			(0.010)			(0.010)
$lnTCOcap\_others_{t-0}$	0.033	0.337	0.294	0.322	0.487	0.262
	(0.321)	(0.367)	(0.462)	(0.383)	(0.434)	(0.507)
$lnTCOcap\_others_{t-1}$		-0.091	-0.051		0.286	0.326
		(0.338)	(0.368)		(0.406)	(0.405)
$lnTCOcap\_others_{t-2}$			0.297			0.358
			(0.350)			(0.380)
lnfarmland	-2.201***	-2.671***	-3.751***	1.077***	1.107***	1.137***
	(0.393)	(0.443)	(0.472)	(0.050)	(0.049)	(0.046)
lnpopdensity	-3.554***	-4.071***	-4.531***	-0.053	-0.049	-0.027
	(0.400)	(0.426)	(0.435)	(0.063)	(0.062)	(0.061)
lneducation	0.493	1.349*	1.159	-0.471*	-0.535**	-0.647**
	(0.681)	(0.784)	(0.866)	(0.269)	(0.269)	(0.268)
lnemployment	1.883**	1.834*	1.460*	0.933	0.944	0.919
	(0.849)	(0.941)	(0.856)	(0.842)	(0.911)	(0.894)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Constant	29.520***	31.580***	40.565***	-0.315	-1.760	-2.161
	(5.775)	(6.534)	(6.825)	(3.759)	(4.066)	(4.164)
N	286	264	242	286	264	242
df	39	40	41	24	25	26
chi2	9879.263	11499.846	13948.823	1884.909	1822.971	2009.003

Note: All models control for common auto-regressive parameter and panel level hetero-scedasticity. Coefficients with standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

Table A6. Results from non-weighted FGLS estimations with year fixed effects – Difference in hectares of organic land in counties between 2003-2016

	County fixed effects	Zone fixed effects
D.TCOcap_local	-0.002	-0.001
	(0.005)	(0.006)
D.TCOcap_others	-0.088	-0.120
	(0.152)	(0.149)
D.farmland	0.032	0.021
	(0.041)	(0.037)
D.popdensity	-0.024	-0.053
	(0.130)	(0.097)
D.education	0.069	0.663
	(0.864)	(0.936)
D.employment	0.283	0.297
	(0.189)	(0.198)
Year FE	Yes	Yes
Constant	-0.737	-0.659
	(1.080)	(0.782)
N	267	267
df	38	23
chi2/R2 adjusted	458.444	285.424

Note: All models control for common auto-regressive parameter and panel level hetero-scedasticity. Coefficients with standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

Appendix B –Correlation tables

Table B1. Correlation coefficients between organic subsidies, 2003-2016

	Grass	Crops	Grazing	Animal	Vegetables
Grass	1.000				
Crops	-0.505	1.000			
Grazing	-0.733	0.714	1.000		
Animal	0.903	-0.684	-0.872	1.000	
Vegetables	-0.803	0.724	0.990	-0.933	1.000

Table B2. Correlation coefficients

	food	food_others	TCOcap	TCOcap_others	education	greencar	Mppercent	employment	income	popdensity	farmland	subsidyanimal	subsidyveg
food	1.000												
food_others	0.879	1.000											
TCOcap	0.979	0.881	1.000										
TCOcap_others	0.882	0.999	0.877	1.000									
education	0.514	0.579	0.480	0.586	1.000								
greencar	0.864	0.901	0.829	0.906	0.681	1.000							
Mppercent	0.623	0.595	0.574	0.607	0.671	0.653	1.000						
employment	0.171	0.326	0.222	0.323	0.016	0.185	-0.017	1.000					
income	0.684	0.822	0.653	0.829	0.675	0.840	0.530	0.361	1.000				
popdensity	0.149	0.030	0.074	0.041	0.428	0.307	0.296	-0.203	0.245	1.000			
farmland	-0.019	-0.121	-0.081	-0.120	0.136	0.030	0.136	-0.278	-0.098	0.578	1.000		
subsidyanimal	-0.117	-0.136	-0.114	-0.135	-0.069	-0.004	-0.000	-0.105	-0.173	-0.028	-0.007	1.000	
subsidyveg	0.254	0.327	0.251	0.327	0.194	0.345	0.141	0.115	0.314	-0.003	-0.061	0.328	1.000

Appendix C - Survey questions and participation

Survey questions on organic food procurement. Example from Ekomatcentrum (2014):

How large was the total cost of purchasing food for the entire municipality's/region's departments year 2013?

How large was the organic share of food procurement?

Table C1. Response rates and organic food shares in municipalities, 2003-2016

Year	Share (%) of 290 municipalities reporting organic food shares in at least one survey	Share (%) of organic food procured		
		Mean	Min	Max
2003	33	2.2	0.0	19.7
2004	11	2.6	0.0	20.4
2005	43	3.2	0.0	16.6
2006	51	3.6	0.0	19.1
2007	49	4.5	0.0	20.0
2008	64	5.8	0.0	25.1
2009	81	6.9	0.0	33.7
2010	81	9.5	0.0	34.6
2011	83	12.9	0.0	43.3
2012	85	14.9	0.0	46.0
2013	90	16.8	0.0	48.7
2014	93	20.6	0.0	57.1
2015	93	24.2	0.0	72.0
2016	96	26.1	0.0	80.0

Note: No survey performed by Ekomatcentrum in 2004. All responses this year are from Sekom survey. *Source:* Ekomatcentrum, Kolada and Sekom.