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# Decoupled Single Farm Payments of the CAP and Land Rental Prices

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**Abstract:**

This paper contributes to the discussion on the extent of the capitalization of decoupled direct payments into land rental prices. Based on a dynamic panel model and an extensive dataset for Bavaria for 2005 to 2011, we show that a significant number of Single Farm Payments (SFPs) of the European Union (EU) Common Agricultural Policy (CAP) are captured by landowners rather than by active farmers. However, the degree of capitalization varies considerably among regions, from almost 0 to 56 cents per each additional Euro paid.

**Key words:** Capitalization, decoupled subsidies, Common Agricultural Policy, land rental prices

**JEL codes:** H22, Q15, Q18

Throughout its history, the European Union (EU) has devoted a considerable share of its budget to supporting farmers through the Common Agricultural Policy (CAP). After decades of price support followed by coupled direct payments related to farmed areas and to the number of animals kept, the Fischler Reform passed in 2003 introduced profound changes by switching to decoupled Single Farm Payments (SFPs). Given the considerable amount of money spent on this policy, it is crucial to comprehensively understand the effects of these measures on input and output markets, farm development, and rent distribution.[1] One important question in this regard concerns the extent to which CAP payments capitalize into land rental prices. This is particularly important because rental shares are relatively high and are still increasing in a number of EU member countries. For example, Swinnen et al. (2009) reported that rented farmland accounted for at least 60% of the total utilized agricultural area

(UAA) in eight EU member countries (Slovakia, the Czech Republic, France, Malta, Belgium, Germany, Hungary and Estonia in descending order) in 2005. With capitalization, at least some transfers represent windfall profits to landowners rather than support for active farmers. This clearly contradicts the objective of the CAP to direct its “support exclusively to active farmers” (European Commission 2010, p. 3).

Ricardo (1817) was the first to show that government interventions can increase land rental and sales prices. However, different government programs capitalize into agricultural land values to varying extents (Floyd 1965; Hertel 1989; Gardner 1990; Debrew et al. 2001; Alston and James 2002; Guyomard et al. 2004; Latruffe and Le Mouël 2009). Courleux et al. (2008), Ciaian et al. (2008), and Kilian and Salhofer (2008) theoretically show that SFPs under some circumstances have strong effects on land rental prices. However, questions regarding the exact capitalization ratio, i.e. by how many cents rental prices increase per each additional Euro paid, remain empirical. Recently, a number of researchers have attempted to estimate the capitalization ratio of SFPs (Kilian et al. 2012; O’Neill and Hanrahan 2013; Guastella et al. 2013; Michalek et al. 2014). Interestingly, estimated effects vary considerably and range from zero to almost one Euro per each additional Euro paid.

The aim of this paper is to contribute to this ongoing discussion by examining a comprehensive dataset of more than 3,000 Bavarian farms for 2005 to 2011. While find a significant capitalization effect on average, we also show that this effect can vary considerably even within a relatively small and homogenous area, such as Bavaria.

We proceed with our analysis as follows. The next section discusses policy changes of the 2003 CAP Reform. The third section provides a short review of theoretical and empirical findings of the literature on the capitalization of SFPs. The fourth section introduces our empirical model. The fifth section presents our results, and the final section concludes our discussion.

## The Fischler Reform of the CAP

Between 1992 and 2003, the European Union converted the CAP in two reforms (the MacSharry Reform in 1992 and the AGENDA 2000 Reform) from an intervention price system, whereby farmers received a price above the world market price, to a coupled payments system largely based on hectares farmed and on the number of animals kept.

In 2003, the European Union (EU) enacted the Single Payment Scheme (SPS), which came into effect in 2005 (and in 2006 in some countries). At the starting point, all active farmers received as many payment entitlements as the number of hectares they farmed on average in the reference period. From 2005 onward, a farmer could activate these entitlements each year and receive SFPs equal to the number of entitlements times their face value. When a farmer does not activate an entitlement for more than two years, it reverts to the "national reserve," and the administration can allocate them to other farmers under specific conditions. Land can be rented and sold with or without entitlements. Entitlements can be sold with or without land but only rented out with land. To receive SFPs, farmers are no longer obliged to plant anything or keep animals, but rather to simply keep their land in “good agricultural and environmental condition” (European Union 2013).[2]

Importantly, to activate entitlements, a farmer needs a corresponding number of hectares of eligible land that she owns or rents. In calculating initial entitlement values, EU member states were allowed to select among three different models: 1) In the *regional model* (Malta and Slovenia), all payments received by farmers of a certain region during the reference period were summed and divided by the number of eligible hectares. Therefore, entitlement values were equal within a region but different between regions. 2) In the *historical model* (Austria, Belgium, France, Greece, Ireland, Italy, Portugal, Scotland, Spain, the Netherlands and Wales), all payments received by a farm during the reference period were summed and divided by the number of hectares farmed. Thus, entitlement values varied between farms. 3) The *hybrid model* (Luxembourg, Northern Ireland and Sweden) includes regional and historical components. Thus, entitlement values are also different between farms but not as much as those under the historical model. Some countries initially adopted a hybrid model (Denmark, Finland, Germany and England) but used its dynamic form, i.e., they gradually adapted to a regional model. Moreover, countries were given the option to retain parts of payments coupled, e.g., up to 25% of arable crop payments and up to 75% of the special beef premium. As a consequence of the different implementation models and coupling options used, the CAP now differs to some extent between countries and thus its effects may vary as well.

Germany introduced a dynamic, fully decoupled and regionalized hybrid model in 2005. Initial entitlement values were based on regional and historical (farm specific) components. The regional part of the payments was the same for each farmer but varied between 13 defined regions, which are basically the German "Länder". Moreover, different values were assigned for cropland and grassland. For example, for Bavaria, 299 €/ha were assigned to cropland, and 89 €/ha were assigned to grassland. The historical part involved "top-ups" based on former animal payments, the dairy premium as allocated in 2005, and some premiums for special products, received by farms received between 2000 and 2002. In 2005, average values for these "top-ups" for Bavaria were 111 €/ha for cropland and 155 €/ha for grassland.

## Literature Review

Payments made under the SPS are clearly decoupled from direct production decisions, but since one hectare of eligible area is required for an entitlement to be activated, they are not decoupled from land. Based on different theoretical models Ciaian et al. (2008), Courleux et al. (2008), and Kilian and Salhofer (2008) analyzed the effects of SFPs on land rental prices. All three studies showed that the degree of capitalization is crucially dependent on the ratio between the number of entitlements distributed and hectares of eligible area available to activate them. In accordance with standard welfare economic analysis, the rent of this policy is mainly captured by the scarcest production factor. When available hectares of an eligible area exceed the number of entitlements in a region, there is no capitalization of payments into land values. Rent in the form of entitlement values goes to the holder of the entitlement, who is usually the active farmer. In the opposite case of an entitlement surplus, at least some SFPs capitalize into land rental or sales prices.

While the exact ratio between allocated entitlements and eligible area is unknown, Ciaian et al. (2014) showed that for at least half of the old member states including Germany, the ratio between activated entitlements and utilized agricultural area (UAA) is close to 1. Although there might be differences between allocated and activated entitlements and between eligible area and UAA, this is an indication of strong competition for land, which is necessary to activate entitlements. In addition, Swinnen et al. (2009) reported an entitlement surplus in Finland and reasonably balanced ratios in Belgium, France, Germany, Northern Ireland and Scotland. Moreover, they found a share of inactivated entitlements of between 0.9% and 6.8% for all countries examined in their study. The fact that not all entitlements are activated denotes the existence of a surplus. Salhofer et al. (2009) found a small entitlement surplus for Germany.

In the case of an entitlement surplus, the degree of capitalization is dependent on the implemented model. With all other things equal, capitalization is higher in the regional model than in the historical model, with the hybrid model somewhere in between (Kilian et al. 2012; Michalek et al. 2014). The main argument is that rental prices are determined at the margins. When high and low entitlement values exist, as in the case of the historical model, and when owners of these entitlements compete for the same scarce eligible hectares, the maximum willingness to pay of the low entitlement owner will determine the rental price in the market.

Hence, values exceeding the marginal entitlement value will not be capitalized into land prices and will instead stay with the holder of the entitlement. Full capitalization is never possible. In contrast, the capitalization effects of SFPs in the regional model are equivalent to area payments. Under some assumptions discussed below, full capitalization is possible. The results of the hybrid model always fall between those of the regional and historical models.

The ratios between entitlements and eligible area and the implementation model are only two determinants of the capitalization ratio. Under entitlement surplus and the regional model, full capitalization occurs only with a perfectly inelastic land supply and zero elasticity of substitution between other input factors and land and/or a perfectly elastic supply of other inputs (Latruffe and Le Mouël 2009; Kilian et al. 2012). In all other cases, SFPs will either shift land demand upward by less than the payments associated with land (due to input factor substitutions) or increase the price by less than the demand shift (due to increased land supply).

Moreover, the exact capitalization ratio is also dependent on several other factors. Michalek et al. (2014) discuss how the fact that SFPs are conditional on farmers fulfilling cross-compliance obligations may decrease the capitalization ratio, as this implies additional costs. Ciaian and Swinnen (2006) discuss the impacts of transaction costs and imperfect competition in land markets on effects of payments on rental prices. Similarly, based on a spatial competition model, Graubner (2016) showed that payment capitalization varies with the competitiveness of the land rental market. Ciaian et al. (2014) found asymmetric information on entitlement values between landowners and farmers in the historical and hybrid models as a source of incomplete capitalization. Moreover, several other region-specific aspects of formal and informal market institutions may affect the functioning of the land rental markets and the pass-through of payments to land owners. Therefore, the exact capitalization ratio remains empirically unknown.

The effects of SFPs on land rental prices have recently be examined by various authors.[3] Kilian et al. (2012) used cross-sectional data at the municipality level for Bavaria and found that 61 cents per each additional Euro spent on SFPs will capitalize into land rental prices. O'Neill and Hanrahan (2013) used a dynamic panel model and a farm level dataset for Ireland and estimated a capitalization effect of 21 to 53 cents per Euro spent on SFP for different farming systems (e.g., dairy, cattle, sheep, etc.). Michalek et al. (2014) used a generalized propensity score matching approach and applied it to an extensive farm-level dataset on all EU member countries to find comparably low average capitalization ratios of between 0.04 (Greece) and 0.18 (Portugal). However, these capitalization ratios vary considerably from 0.03 to 0.94 for different SFP levels and among different EU member states. Based on farm-level data, Guastella et al. (2013) were not able to identify any significant effects of SFPs on Italian land rental prices.

## Empirical Model

We model rental prices ($r$) determined from expected net returns from the market and different expected government payments. It can be argued that changes in returns and government payments do not instantaneously change the rental price $r$ because of multiple-year rental contracts and/or other transaction costs causing inertia (Hendricks et al. 2012). This can be modeled simply through Nerlove's (1958) partial adjustment model: $r_t - r_{t-1} = \rho(r_t^* - r_{t-1})$, with $r_t^*$ being the equilibrium rental price and $\rho$ being the adjustment coefficient; $\rho$ = 1 represents a full (instantaneous) adjustment, whereas 0 < $\rho$ < 1 implies a partial adjustment. With this in mind, we define a dynamic panel data model as,

$$r_{it} = \gamma + \theta r_{it-1} + \gamma_m m_{it} + \sum_{l=1}^{L} \gamma_l \, s_{lit} + \sum_{e=1}^{E} \lambda_e \, x_{eit} + \sum_{t=1}^{T-1} \mu_t \, d_t + u_{it} \tag{1}$$

with $u_{it} = +v_i + \varepsilon_{it}$

where $r_{it}$ is the average per-hectare rental price farm *i* pays during time period *t*, $r_{it-1}$ is the rental price paid in the previous time period $t-1$, $m_{it}$ denotes expected net returns from the market, $s_{lit}$ denotes expected per-hectare averages of *L* for different CAP payments a farm receives, $x_{eit}$ denotes *E* covariates that control for observed farm specific conditions, $d_t$ denotes $T-1$ time dummies absorbing year specific shocks (e.g., weather, key interest rates, etc.) that affect all farm operations, and $u_{it}$ is an error term. The two components of this error term, the unobserved heterogeneity $v_i \sim IID(0, \delta_v^2)$ and the idiosyncratic portion $\varepsilon_{it} \sim IID(0, \delta_\varepsilon^2)$, are assumed to be independent of one another and among themselves (Baltagi 2013). $\theta = (1-\rho)$, and all $\gamma$s, $\lambda$s, and $\mu$s are coefficients to be estimated. Whereas these coefficients capture short-run effects, long-run effects are calculated by dividing the respective coefficient by the adjustment coefficient $\rho = (1-\theta)$.

The inclusion of the lagged rental price ($r_{it-1}$) in combination with unobserved heterogeneity ($v_i$) introduces two problems. First, due to the presence of the lagged dependent variable, we have autocorrelation, as $r_{it-1}$ is correlated with $\varepsilon_{it-1}$, $\varepsilon_{it-2}$, etc. Second, $r_{it}$ is a function of $v_i$, and because the same is true for $r_{it-1}$, it is also correlated with $\varepsilon_{it}$. Therefore, the OLS estimator is inconsistent and upward biased (Bond 2002). Furthermore, Nickell (1981) showed that the within transformation does not solve the problem for the fixed-effects (FE) estimator. $r_{it-1}$ remains correlated with $\bar{\varepsilon}_i$ because it includes $\varepsilon_{it-1}$. The estimator remains inconsistent as the number of individuals *N* increases, but it becomes consistent as the number of time periods *T* increases (Roodman 2009a). The FE estimator is typically downward biased.

Alternative transformations that address unobserved individual effects include first-differences, $\Delta r_{it} = r_{it} - r_{it-1}$ (Anderson and Hsiao 1982; Holtz-Eakin et al. 1988; Arellano and Bond 1991), and forward orthogonal deviations, $\tilde{r}_{it} = r_{it} - \frac{1}{T-t}\sum_{t+1}^{T} r_{it}$ (Arellano 1988;

Arellano and Bover 1995). We focus here on first-differences but find that the results for forward orthogonal deviations are not significantly different.[4] The transformed model can be written as,

$$\Delta r_{it} = \theta \Delta r_{it-1} + \gamma_m \Delta m_{it} + \sum_{l=1}^{L} \gamma_l \Delta s_{lit} + \sum_{e=1}^{E} \lambda_e \Delta x_{eit} + \sum_{t=1}^{T-1} \mu_t d_t + \Delta \varepsilon_{it} \qquad (2)$$

It is important to note that the lagged dependent variable, $\Delta r_{it-1} = r_{it-1} - r_{it-2}$, and the error term, $\Delta\varepsilon_{it}$, after this transformation remain correlated because $r_{it-1}$ is correlated with $\varepsilon_{it-1}$. However, as was suggested by Anderson and Hsiao (1982), we can use $\Delta r_{it-2}$ or $r_{it-2}$ as instruments for $\Delta r_{it-1}$ because they are not correlated with $\Delta\varepsilon_{it}$. Using instruments at their levels saves one time period. Anderson and Hsiao's (1982) two-stage least squares (2SLS) estimator is consistent, as $N \to \infty$, but it is only efficient when $T = 3$. In all cases of T > 3, efficiency can be improved. Although $r_{it-2}$ is the only instrument available for period $t = 3$, the number of available instruments increases dynamically. Hence, $r_{it-2}, \ldots, r_{iT-2}$ can be utilized as instruments for period $T$. Holtz-Eakin et al. (1988) and Arellano and Bond (1991) applied the generalized method of moments (GMM) approach developed by Hansen (1982) to exploit this additional information in dynamic panel data problems. In our analysis, we apply Arellano and Bond's (1991) two-step GMM estimation approach, which accounts for a heteroskedastic error structure.

By dynamically increasing the instruments, the model becomes overidentified. The basic specification test used in this regard is the $J$ statistic test developed by Hansen (1982), which can also be applied in this context (Arellano and Bond 1991). Roodman (2009b) discusses how the large number of instruments included in the Arellano and Bond estimator can overfit endogenous variables and weakens the Hansen test. He suggests overcoming this problem by limiting the number of lacks and using a collapsed instrument matrix. We follow these suggestions.

In obtaining a consistent estimator, Arellano and Bond (1991) stress the importance of having no serial correlations in levels and proposed a test for the lack of serial correlation based on the GMM residuals. First-order serial correlation is apparent in estimations in differences by construction because $\varepsilon_{it-1}$ is part of $\Delta\varepsilon_{it}$ and of $\Delta\varepsilon_{it-1}$. Therefore, the assumption that there is no serial correlation in the disturbances $\varepsilon_{it}$ can also be confirmed by testing for the absence of second-order serial correlations in the first differenced residuals (Bond 2002).

Apart from those discussed above, other potential sources of endogeneity remain. In particular, Kirwan (2009), Breustedt and Habermann (2011), Hendricks et al. (2012) and others stress the importance of expectation errors when conducting land rental price analyses. Essentially, as one form of measurement error, an expectation error arises when rental prices are negotiated before the growing season. Tenants must form some expectations about future market returns and CAP payments. As expectations are not observable, the researcher must use actual values in their estimations. When actual values differ from expected values, biased coefficient estimates are made. As the value of SFP entitlements was precisely given and known upfront for 2005 to 2013, we do not anticipate any expectation error in this regard. However, the result may be different for market returns. Therefore, we use the same dynamic instrument procedure applied for $r_{it-1}$ in the case of market returns $m_{it}$.

## Data

Our empirical model is applied to a comprehensive dataset of bookkeeping records for more than 3,000 Bavarian farms. In addition to accounting data, the dataset includes information on land uses, production, farm structures and socio-economic factors of the persons involved in the farm operation. The sample is stratified with respect to legal form, farm type (agriculture, viniculture, horticulture and forestry), farm size and geographic region. However, very small farms and part-time farms are underrepresented. The reporting period is the financial year, which starts July 1st and ends June 30th of the following year. We refer to the financial year 2005/06, for example, as the year 2005.

Table 1 presents descriptive statistics for 2005 – 2011. The dependent variable is constructed in the following manner. Our dataset includes information on farmed and owned land for each farm. We first subtract owned from farmed hectares to obtain a measure of net rented land. We then divide the total expenditures of a farm dedicated to renting land by net rented hectares.

To control for outliers and data problems, we exclude observations indicating specific farming or rental situations and unexplainably high or low values. In particular, we exclude farms specialized in viniculture, horticulture and forestry and those with negative rental prices and average rental prices of more than 3,000 €/ha. We also exclude farms with revenues exceeding 12,000 €/ha. Moreover, we exclude farms with CAP payments exceeding 1,000 €/ha for SFPs, 2,500 €/ha for agri-environmental payments and 250 EUR/ha for disadvantaged area payments. Finally, we do not consider smallholder farms of less than five hectares of agricultural land or farms renting less than one hectare. To avoid gaps in our panel dataset, we completely exclude a specific  farms from all estimations if one criterion listed above is met for a particular year. Our final dataset is an unbalanced panel of 18,367 observations on 3,010 farms. Thus, the average farm reports data for 6.1 out of 7 years.

The average rental price is 255 €/ha. As a proxy for market returns, we use market revenues with an average value of 2,943 €/ha. As market revenues fluctuate instantaneously from year to year with price variations, we normalize the revenue of each farm by the sample average for each year. While the values in Table 1 depict absolute values, the variable used in the estimations describes relative farm revenues. In our GMM estimations, we also utilize rental prices and market revenues for 2002 to 2004 as instruments. In addition to SFPs, we also consider agri-environmental payments and disadvantaged area payments. The former are paid to farmers who participate in agri-environmental programs. In most cases, participation involves additional costs, e.g., in the form of constraints on input usage. To qualify for disadvantaged area payments, farms are usually located at higher altitudes and/or in hilly areas. Farms considered in our sample received an average of 350 €/ha in SFPs, 61 €/ha in agri-environmental payments and 40 €/ha in disadvantaged area payments.

We consider two types of variables to account for farm heterogeneity. Ratios of cash crops (sugar beet, potato, corn, wheat and rapeseed) are used to describe the specific natural production conditions of the farm to some extent. In addition, we use the log of the farmed area to account for different farm sizes. We first estimate the capitalization effect for the entire sample. We then include dummy variables for twelve defined agricultural production regions in Bavaria and interact those with the SFP variable. Agricultural production regions are demarcated in Wittmann (1983) and LfB (1984) based on natural conditions (e.g., soil quality, altitude and climate) for farming in a specific area (Figure 1).

**Results**

The results of the OLS, FE and two-step dynamic GMM (Arellano-Bond) estimator are shown in Table 2. As was expected, the Arellano-Bond test rejects the null hypothesis of no first-order serial correlation, but not the hypothesis of no second-order serial correlation. We use the second to sixth lagged levels of rent and revenues as instruments. The Hansen test fails to reject the hypothesis of jointly valid instruments.

As was expected, the OLS estimate of the lagged variable is biased upward. The results found for the FE and GMM estimators are similar. This corresponds with a relatively small coefficient of 0.067 found for the lagged variable. This indicates relatively fast rental price adjustments to changes in market conditions or subsidies. In fact, our adjustment coefficient of $\rho = (1 - 0.067) = 0.933$ is considerably higher than the value of 0.33 found by Hendricks et al. (2012) for Kansas and the values ranging between 0.30 and 0.49 estimated by O'Neill and Hanrahan (2013) for Ireland. Rental prices per hectare increase in the short-run on average by 4.50 Euro when market revenues deviate by 100 Euro from the average value. The long-run equilibrium effect is only slightly higher, at 4.5/(1 - 0.933) ≈ 4.79 Euro.

We find that land rental prices are significantly influenced by CAP payments. According to our results, every additional Euro given as an SFP to a farmer increases land rental prices by 35 (33) cents in the long-run (short-run). With 5 cents per each Euro of payment, agri-environmental payments capitalize to a much lower extent than SFPs in the long-run. By contrast, capitalization effects for disadvantaged area payments are considerably greater at 46 cents per additional Euro over the long run.

We use several crop ratios to describe differences in land productivity. As expected, all these variables have positive coefficients, because these crops are typically planted on relatively productive soil in climatically and topographically advantaged regions. Apart from that, our results reveal that paid rental prices vary with farm size. Larger farms seem to be able to pay higher rents per hectare because of economies of scale.

Finally, we investigate if capitalization effects vary between different regions. To do so, we use interaction terms between SFPs per hectare and twelve dummies for the agricultural production areas in Bavaria. Corresponding results are reported in Table 3. While the results for all other coefficients do not change very much, the interaction dummies exhibit considerable differences in capitalization ratios between areas. Estimated short-run coefficients vary from 1 cent to 52 cents.

## Conclusions

The objective of this paper was to investigate the effects of SFPs and other CAP payments on land rental prices. According to our empirical results for Bavaria, on average 35 cents per additional Euro spent on SFPs capitalize into land rental prices. Bearing in mind that about 42% of all Bavarian agricultural land was rented in 2010 (StMELF, 2012), a considerable share of support is received by landlords rather than by active farmers. This clearly contradicts the objective of the CAP to direct “support exclusively to active farmers” (European Commission 2010, p. 3). Our results are in line with two studies employing similar estimation methods and comparable datasets but for different countries. In reference to Ireland, O’Neill and Hanrahan (2013) estimated a range of 21 to 53 cents for the long-run by farm type. In reference to decoupled payments made in Kansas, Hendricks et al. (2012) estimated a magnitude of 37 cents. Our results also correspond with estimates of 38 cents per additional Euro dedicated to coupled area payments made prior to the Fischler Reform by Breustedt and Habermann (2011) for crop land in Germany. These results, theoretical findings of Kilian et al. (2012), and the empirical findings of Feichtinger and Salhofer (2016) for land sales prices suggest that the capitalization of decoupled payments is at least not smaller to that for coupled payments made before the reform.

However, we also show considerable regional variations in our results. By dividing our sample according to the twelve defined production areas in Bavaria, we find estimates of capitalization effects between 1 cent and 54 cents per additional Euro of SFP. It is not clear at this point what drives this pattern. However, the three production areas with the highest average land quality (4, 5, 6) and the highest average rents show above average capitalization ratios of 0.45, 0.54, and 0.36, respectively. Therefore, one could hypothesize that with high demand and low supplies of quality land, landowners may be able to exert some market power and capture a higher proportion of the rent. On the other hand, production area 12 has the lowest average land quality but the highest capitalization ratio of 0.56. This suggests that factors other land quality may play an important role.

As discussed above, the rate of capitalization can vary based on the different ways that countries have implemented the SPS. This may be one reason why Michalek et al. (2014) found varying capitalization ratios for different countries. However, in our dataset, the broader institutional setting is applied in all of the investigated areas. Therefore, our results may suggest the presence of formal and informal regional institutional differences in the land market at work.

We find a very low capitalization effect (5 cents per additional Euro) for agri-environmental payments. This can be rationalized by the fact that the main purpose of these payments is to compensate for additional costs that arise while delivering environmental services or decreasing negative externalities from production. This result is consistent with results obtained in other studies. For example, Lence and Mishra (2001) did not confirm that the US Conservation Reserve Program payments influence cash rental rates in Iowa. Kilian et al. (2012) found a negative effect of agri-environmental payments on land rental prices. O'Neill and Hanrahan (2013) obtained coefficient estimates of close to zero for EU second pillar payments. Our results also suggest that only moderate windfall profits are generated from these programs.

By contrast, the capitalization effect for disadvantaged area payments is considerable at 46 cents per additional Euro spent. We attribute this to the fact that no significant obligations are tied to such payments. Moreover, the exact value of payments is not only evident to farmers but also to landowners, potentially improving their bargaining position. Our results are somewhat higher than the 19 – 29 cent range found by Kilian et al. (2012) but are much lower than that of Patton et al. (2008), who report a full capitalization of disadvantaged area payments.

Our study also presents some limitations. In contrast to Breustedt and Habermann (2011) and Feichtinger and Salhofer (2016), we do not consider spatial interdependency. Although we know where the district a specific farm is located, our dataset lacks information on respective municipalities or on exact coordinates. As we only consider farms renting more than 1 ha and exclude farmers limiting themselves to operating exclusively on their own land, we run the risk of generating nonrandom sample selection biases. However, Kirwan (2009) and Ciaian and Kancs (2012) did not find significant sample selection biases in their land rental price analyses.

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**Footnotes**

[1] In 2014, almost € 39 billion or 79% of the agricultural budget of the EU was used for decoupled payments (European Commission, 2016).

[2] In 2004, twelve countries joined the EU. With the exception of Slovenia and Malta, all of them opted not to implement the SPS and instead adopt for a Single Area Payments (SAPs) system. SAPs are a simpler version of the SPS with no entitlements established. Rather, farmers receive a specific payment per hectare.

[3] In addition to the literature for the EU cited herein, there are also empirical studies regarding the effects of US farm policies on land rental prices (e.g., Roberts et al. 2003; Lence and Mishra 2003; Kirwan 2009; Qiu et al. 2010; Goodwin et al. 2011 and Hendricks et al. 2012). Moreover, there is also literature addressing the effects of agricultural policies on land sales prices. Latruffe and Le Mouël (2009) and Feichtinger and Salhofer (2013) provide comprehensive reviews of this issue.

[4] Results are available from the authors upon request.

**Table 1** Descriptive statistics for the total sample N = 18,367

| Variable | Mean | SD | Min | Max |
|---|---:|---:|---:|---:|
| Rent (€/ha) | 255.00 | 163.72 | 1.65 | 2,983.86 |
| Market revenues (€/ha) | 2943.47 | 1639.559 | 0.00 | 11816.4 |
| Single farm payments (€/ha) | 349.98 | 94.94 | 0.00 | 997.31 |
| Agri-environmental payments (€/ha) | 61.30 | 80.95 | 0.00 | 699.27 |
| Disadvantaged area payments (€/ha) | 39.67 | 42.59 | 0.00 | 228.93 |
| Ratio of sugar beet area | 0.02 | 0.05 | 0.00 | 0.49 |
| Ratio of potato area | 0.01 | 0.05 | 0.00 | 0.57 |
| Ratio of corn area | 0.04 | 0.10 | 0.00 | 0.97 |
| Ratio of wheat area | 0.15 | 0.15 | 0.00 | 0.94 |
| Ratio rapeseed | 0.05 | 0.08 | 0.00 | 0.90 |
| Farm size | 58.60 | 38.74 | 6.17 | 518.44 |

Source: Authors‘ calculations.

**Table 2** Dynamic GMM (Arellano-Bond), fixed effects and OLS coefficient estimates

| | **dynamic GMM** | | **fixed effects** | | **OLS** | |
|---|---|---|---|---|---|---|
| Variable | coeff. | | coeff. | | coeff. | |
| Constant | | | -364.554 | *** | 9.763 | |
| | | | (72.782) | | (10.507) | |
| Lagged rent (€/ha) | 0.067 | *** | 0.075 | ** | 0.641 | *** |
| | (0.031) | | (0.034) | | (0.031) | |
| Market revenues (€/ha) | 0.045 | *** | 0.015 | *** | 0.010 | *** |
| | (0.015) | | (0.002) | | (0.001) | |
| Single farm payments (€/ha) | 0.326 | *** | 0.400 | *** | 0.141 | *** |
| | (0.052) | | (0.036) | | (0.014) | |
| Agri-env. payments (€/ha) | 0.049 | * | 0.089 | *** | 0.112 | *** |
| | (0.031) | | (0.024) | | (0.013) | |
| Disadv. area payments (€/ha) | 0.426 | *** | 0.632 | *** | -0.075 | ** |
| | (0.133) | | (0.093) | | (0.032) | |
| Ratio of sugar beet area | 499.197 | *** | 539.671 | *** | 233.779 | *** |
| | (124.866) | | (118.932) | | (35.815) | |
| Ratio of potato area | 367.190 | *** | 304.257 | ** | 100.180 | *** |
| | (125.501) | | (108.696) | | (18.389) | |
| Ratio of corn area | 120.736 | *** | 138.441 | *** | 155.835 | *** |
| | (42.853) | | (31.246) | | (16.795) | |
| Ratio of wheat area | 106.445 | *** | 142.066 | *** | 68.171 | *** |
| | (23.716) | | (20.877) | | (11.215) | |
| Ratio rapeseed | 73.090 | *** | 103.758 | *** | 64.887 | *** |
| | (28.500) | | (21.377) | | (14.120) | |
| ln(Farm size) | 235.607 | *** | 98.759 | *** | 1.243 | |
| | (38.323) | | (18.303) | | (1.495) | |
| Observations | 15625 | | 18367 | | 18367 | |
| Cross-section fixed effects | First differences | | Within transformation | | | |
| Period fixed effects | Dummies | | Dummies | | Dummies | |
| Adjusted R-squared | | | 0.730 | | 0.609 | |
| Instrument rank for J-statistic | 27.00 | | | | | |
| Hansen test – Prob. (J-statistic) | 0.317 | | | | | |
| Arellano-Bond test – Prob. AR(1) | 0.000 | | | | | |
| Arellano-Bond test – Prob. AR(2) | 0.571 | | | | | |

***p<0,01, **p<0,05, *p<0,10, standard errors in parenthesis

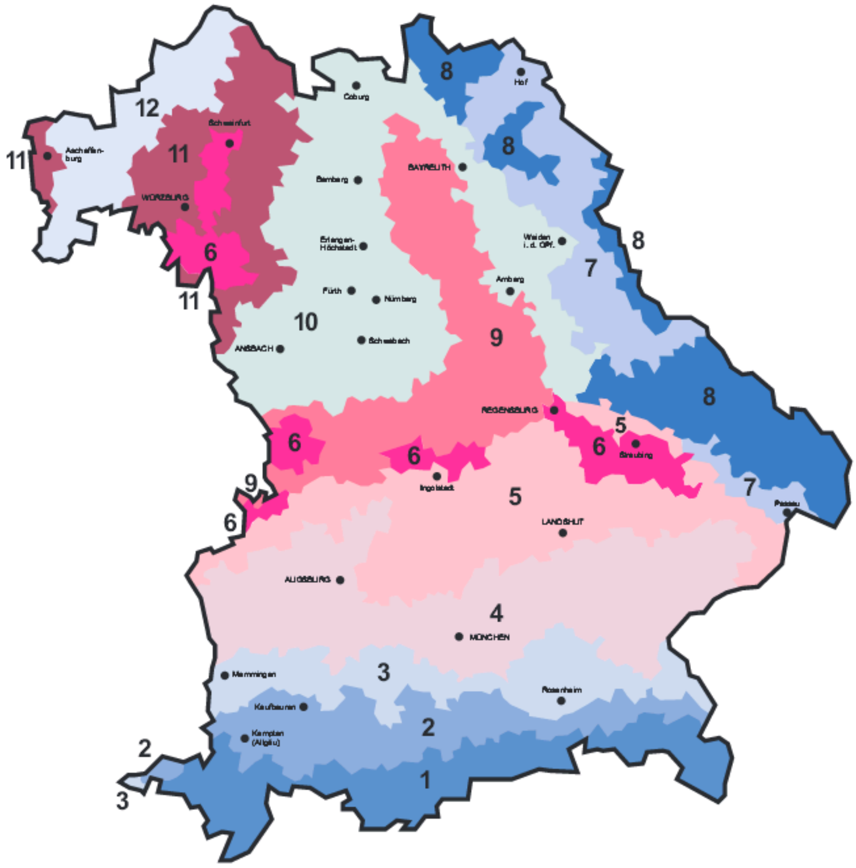
Source: Authors‘ calculations.

**Table 3** Dynamic GMM (Arellano-Bond) with regional interaction dummies

| Variable | coeff. | | Std. err. |
|---|---|---|---|
| Lagged rent (€/ha) | 0.077 | ** | 0.032 |
| Market revenues (€/ha) | 0.043 | *** | 0.014 |
| SFPs (€/ha)*Region 1 | 0.125 | ** | 0.053 |
| SFPs (€/ha)*Region 2 | 0.125 | * | 0.075 |
| SFPs (€/ha)*Region 3 | 0.197 | | 0.156 |
| SFPs (€/ha)*Region 4 | 0.454 | *** | 0.092 |
| SFPs (€/ha)*Region 5 | 0.543 | ** | 0.237 |
| SFPs (€/ha)*Region 6 | 0.360 | *** | 0.116 |
| SFPs (€/ha)*Region 7 | 0.563 | *** | 0.174 |
| SFPs (€/ha)*Region 8 | 0.021 | ** | 0.047 |
| SFPs (€/ha)*Region 9 | 0.416 | *** | 0.112 |
| SFPs (€/ha)*Region 10 | 0.260 | *** | 0.076 |
| SFPs (€/ha)*Region 11 | 0.279 | ** | 0.114 |
| SFPs (€/ha)*Region 12 | 0.014 | | 0.043 |
| Agri-env. payments (€/ha) | 0.053 | * | 0.031 |
| Disadv. area payments (€/ha) | 0.528 | *** | 0.120 |
| Ratio of sugar beet area | 488.912 | *** | 125.461 |
| Ratio of potato area | 332.992 | ** | 130.545 |
| Ratio of corn area | 113.839 | *** | 40.728 |
| Ratio of wheat area | 99.483 | *** | 23.601 |
| Ratio rapeseed | 66.934 | ** | 27.503 |
| ln(Farm size) | 229.821 | *** | 38.217 |
| Observations | 15,625 | | |
| Cross-section fixed effects | First differences | | |
| Period fixed effects | Dummy variables | | |
| Instrument rank for J-statistic | 38.00 | | |
| Hansen test – Prob. (J-statistic) | 0.247 | | |
| Arellano-Bond test – Prob. AR(1) | 0.000 | | |
| Arellano-Bond test – Prob. AR(2) | 0.354 | | |

Source: Authors‘ calculations.

**Figure 1** Bavarian agricultural regions according to Wittmann (1983) and LfB (1984)




Source: StMELF (2012)

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