The Effect of the Single Farm Payment Timing on Production Incentives

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Abstract

This paper contributes to the debate surrounding agricultural policy support for farmers and the potential distortionary effects of area payments. Area payments can affect production decisions via land allocation. I show theoretically how the timing of these payments can weaken the link between area payments and production. The theoretical predictions are supported by the empirical findings.

In 2003, the European Union (EU) introduced the Single Farm Payment (SFP) scheme, a per hectare subsidy that is independent of production level and crop planted. The SFP was primarily motivated as a means to decrease distorted production incentives. The new area payments were expected to fulfill two previously mutually exclusive roles. First, it would continue to augment farmers' income, which is acknowledged as a political dictate. Second, production distortions induced by previous interventions would be reduced, if not eliminated.

If land supply is perfectly inelastic, area payments act as lump-sum transfers to landowners with no distortionary effects (Just, Hueth, and Schmitz (2004)). This remains true even in the presence of uncertainty (Chambers and Voica (2016)). But land supply, although typically inelastic, is not perfectly inelastic. Area payments encourage land use and likely result in increased acreage.

Previous empirical work has found that although area payments are distortionary, the impact is small. Acreage tends to be affected more than the output (see among others, Goodwin and Mishra (2005), Sckokai and Antón (2005), Sckokai and Moro (2006), Bhaskar and Beghin (2009), Weber and Key (2011)). This suggests that the "coupling" link between area payments and production, while present, is small as well.

One possible explanation is that area payments are thoroughly capitalized into land values, benefiting landowners rather than producers. While plausible, previous empirical works suggest that the incidence of subsidy payments favor tenants rather landowners. For example, Kirwan (2009) reports that tenants capture 75% of the subsidy.

Another potential explanation relates to the timing of the area payments. The SFP scheme stipulates that area payments are to be made to farmers between December 1st of the current calendar year and June 30th of the following year (Europe, 2011). That means that farmers receive the payments after all, or at least part, of their production decisions are made. The timing adds an additional intertemporal component to the decision environment producers face. Unless there is no intertemporal discounting and consumption today and consumption tomorrow are perfect substitutes, the timing of the payments may affect production decisions. Area payments create new production incentives. But the timing of those payments could temper those incentives especially if producers have limited ability to transfer income between time periods.

Attempts to measure time preferences have revealed that farmers have average discount rates as high as 34% (Duquette, Higgins, and Horowitz, 2011), which is consistent with discount rates estimates found in other studies (Coller and Williams (1999), Warner and Pleeter (2001), Harrison, Lau, and Williams (2001)). This suggests that delayed area payments may be heavily discounted by producers.

This paper examines theoretically and empirically how the timing of the SFPs affect agricultural production incentives. It is organized as follows. First, a theory of how timing affects the coupling between area payments and production is presented. Then the timing effect is estimated using several years of data from Romanian EU Farm Accountancy Data Network (FADN). A final section concludes.

1 Theoretical Model

There are three time periods. The first period (the decision period), 0, involves no uncertainty. The second and the third periods, 1 and 2, are uncertain. Uncertainty is modeled by a finite state space, described by a finite set, Ω, where each element of Ω, referred to as a state, is a complete and mutually exclusive description of the world. [1] For example, in a two-states representation of the world, a state could be "rain"

[1] The theoretical framework used here is the state-contingent approach to uncertainty. Although most treatments within this framework assume that agents with subjective probability beliefs and Von Neumann-Morgenstern preferences maximize expected utility, additive separability is unnecessary in my application and in many others. Indeed, the classical treatment due to Debreu (1959) makes no use of the expected utility hypothesis and subjective probability. As in my case, an agent's preferences are defined over the vector of dated, state-contingent consumptions. An accessible treatment to the state-contingent approach is Chambers and Quiggin (2000).

and another could be "no rain". Uncertainty is resolved by Nature, choosing from Ω. That choice, however, is only revealed to the farmer after the farmer's choices have been made in period 0. [2]

Farmers are competitive and take input and state-contingent output prices as given. Preferences over consumption in the three periods, $k^0 \in \mathbb{R}_{++}$, $k^1 \in \mathbb{R}^2_{++}$, and $k^2 \in \mathbb{R}^{2S}_{++}$ are continuous and strictly increasing in each argument, and represented by $W(k^0, k^1, k^2)$.[3] [4] The initial wealth endowment, $\omega > 0$, is nonstochastic. In period 0, the farmer can undertake production and financial activities that generate state-contingent income in periods 1 and 2. Production is characterized by a stochastic technology. In period 0, the farmer chooses the level of state-contingent period 2 output $z \in \mathbb{R}^S_+$ and the amount of land devoted to farming, l. The associated variable cost is $c(w, z; l)$ where $w \in \mathbb{R}^N_{++}$ is the vector of variable input prices in period 0.[5] Cost is assumed to be convex in both z and l. There is a rental market for farm land which pays in period 0 the rental rate r. The farmer is endowed with L units of land.

The farmer can also buy and sell assets in financial markets. In period 0, the farmer can purchase two types of financial assets, one that pays off in period 1 and J that pay off in period 2. The asset paying off in period 1 sells for a period 0 price of $v_1 > 0$ and pays off $A \in \mathbb{R}_{++}$ for each unit of the asset purchased. The number of units of this asset purchased in period 0 is denoted h_1. Since the payoff from this asset will be the consumer's only source of income in period 1 whenever the subsidy happens to be delayed, he cannot sell this asset (borrow short term) in period 0 and repay the loan in period 1 since he will lack the wherewithal to pay. Hence, $h_1 > 0$.[6]

[2] To interpret later results in terms of expectations, I assume that agents have well defined subjective probability vectors over the realization of the states of the Nature.

[3] Readers are free to specialize W to additively separable (following Von Neumann-Morgenstern) scaling functions weighted by subjective probabilities. They can further restrict the scaling functions to concave functions reflecting risk aversion; but such assumptions are unnecessary for my results.

[4] S is a subset of Ω. As such, S represents uncertainty corresponding to period 2, while Ω represents uncertainty corresponding to periods 1 and 2.

[5] For an axiomatic study of cost functions see Chambers and Quiggin (2000).

[6] To preserve simplicity, I model the period 1 financial market as riskless. A more complex financial market for period 1 could be modeled, but this would bring notational clutter without substantially

The period 2 payoffs for the J assets are given by the payoff matrix $D \in \mathbb{R}^{S \times J}$ and the period 0 price of the jth asset is denoted v_{2j}. The portfolio vector for the assets paying off in period 2 is denoted $h_2 \in \mathbb{R}^J$. The agent can *sell* asset j in period 0 in exchange for his making state-contingent payments in period 2. It is assumed that D is of full column rank and that $J < S$.

The government pays the farmer a fixed subsidy a per unit of land l either in the second period, or in the third period, but not in both. The timing of this payment is only revealed to the farmer in the second period, after the farmer has made the land-allocation decision. Thus, from the farmer's perspective in period 0 its timing is stochastic.

Figure 1 - inserted here.

In the second period, the farmer receives the payoff Ah_1 plus the subsidy al, if the subsidy is paid in period 1 and Ah_1 if the subsidy is paid in period 2. Thus, the farmer state-contingent consumption is either $k_E^1 = Ah_1 + al$ or $k_L^1 = Ah_1$, where subscript E denotes an "early" subsidy payoff and L a "late" subsidy payoff.

In the third period, the farmer receives the revenue from farming $p_s z_s$, where p_s is the output price in state $s \in S$, the revenue from financial markets participation, $D_s h_2$, where $D_s \in \mathbb{R}^J$ is the vector of assets payoffs in state s, and the subsidy al if the subsidy was not paid in period 1.[7]

Because there are S possible realizations of the output z (i.e. $z_s \in \mathbb{R}_{++}, s \in \{1, \ldots, S\}$), and two possible realizations of subsidy payments (i.e. late or early), the total number of states of Nature in the third period is $2S$ (i.e. the dimension of Ω is $2S$). [8] For example, $k_{sE}^2 = p_s z_s + D_s h_2$ is the consumption in state s given the

changing results.

[7]The row vector $D_s = (D_{s1}, D_{s2}, \ldots, D_{sJ})^T$, where D_{sj} is the payoff of j-th asset in state s. Later, I introduce the column payoffs vector $D_j \in \mathbb{R}^S$, the payoffs vector of the j-th asset, where $D_j = (D_{1j}, D_{2j}, \ldots, D_{sj})$.

[8]With a slight abuse of notation S is used to denote both the set of states of nature associated with the production uncertainty, but also the state S. As such, $S = \{s : 1 \leq s \leq S\}$.

subsidy is paid in the second period, and $k^2_{2L} = p_s z_s + D_s h_2 + al$ is the consumption in state s given the subsidy is paid in the third period. Figure 2, illustrates the timing of the subsidy payments to the farmer.

Figure 2 - inserted here.

The farmer's period 0 problem is to choose $k^0 \in \mathbb{R}_{++}$, $k^1 = (k^1_E, k^1_L) \in \mathbb{R}^2_{++}$, $k^2 = (k^2_{1E}, \ldots, k^2_{SE}, k^2_{1L}, \ldots, k^2_{SL}) \in \mathbb{R}^{2S}_{++}$, $z \in \mathbb{R}^S_+$, $l \in \mathbb{R}_{++}$, $h_1 \in \mathbb{R}^2_{++}$ and $h_2 \in \mathbb{R}^J$ to[9]

$$\begin{aligned} \max \Big\{ W\Big(k^0, k^1, k^2\Big) : & \qquad\qquad (1) \\ & k^0 \leq \omega - c(w, z; l) + r(L - l) - v_1 h_1 - v_2^T h_2, \\ & k^1_E \leq Ah_1 + al,\ k^1_L \leq Ah_1, \\ & k^2_E \leq pz + Dh_2 \text{ and } k^2_L \leq pz + Dh_2 + al1^S \Big\} \end{aligned}$$

where $v_2^\top = (v_{21}, \ldots, v_{2J})$ and 1^S is a S dimensional vector with each entry equal to 1.

The farmer faces three sets of budget constraints. Period 0 consumption can be no larger than the difference between initial wealth ω plus the income from renting out farm land $r(L-l)$ and the costs of production and operating in financial markets, $c(w, z; l)$, $v_1 h_1$, and $v_2^T h_2$, respectively. The consumption in period 1 is bounded by the revenue generated in the financial market, Ah_1, plus the subsidy, al, if the subsidy is paid on time. While period 2 consumption in the state of nature s, conditional on the subsidy payment being made late, can be no larger than the agricultural revenue in that state, $p_s z_s$, plus the return in the financial markets, $D_s h_2$, and the subsidy al.

[9] With a slight abuse of notation S is used to denote both the set of states of nature associated with the production uncertainty, but also the state S. As such, $S = \{s : 1 \leq s \leq S\}$.

Strict monotonicity of W ensures that at the optimum:[10][11]

$$k^0 = \omega - c(w, z; l) + r(L - l) - v_1 h_1 - v_2^T h_2 \tag{2}$$

$$Ah_1 = k_E^1 - al, \; Ah_1 = k_L^1 \tag{3}$$

$$Dh_2 = k_E^2 - pz \text{ and } Dh_2 = k_L^2 - pz - al1^S \tag{4}$$

For any given level of consumption, the budget constraints (3) and (4) ensure there exist unique portfolios h_1 and h_2 such that

$$h_1 = \frac{k_E^1 + k_L^1 - al}{2A}$$

and

$$h_2 = (D^T D)^{-1} D^T \Big(\frac{k_E^2 + k_L^2}{2} - pz - \frac{al1^S}{2} \Big)$$

Substituting out of the portfolios h_1 and h_2, the period 0 budget constraint yields:

$$\begin{aligned} \max_{k_E^1, k_L^1, k_E^2, k_L^2, z, l} \; & W\Big(\omega - c(w, z; l) + r(L - l) - \frac{v_1}{2A}(k_E^1 + k_L^1 - al) \\ & - v_2^T (D^T D)^{-1} D^T \Big(\frac{k_E^2 + k_L^2}{2} - pz - \frac{al1^S}{2} \Big), k_E^1, k_L^1, k_E^2, k_L^2 \Big) \end{aligned} \tag{5}$$

Other things equal, the farmer is indifferent between consumption that is produced via the agricultural technology and consumption produced via the financial markets. Assuming strictly increasing preferences, at the margin, the farmer will price the consumption produced with the agricultural technology using the opportunity cost of assembling the same consumption via the financial markets. Hence, this implies separability between consumption and production decisions.

[10] As far as I am aware, in agricultural economics literature this argument is due to Chambers (2007) who applies it to agricultural insurance.

[11] The proof of this result is similar to the proof of Theorem 1 in Chambers and Voica (2016) and as such it is omitted.

Note in (5) that (1) z, l appear only in the first argument of this unconstrained maximization problem and that (2) although first and second-period state-contingent consumptions do appear in the first argument, the *optimal* choice of z, l does not depend on them since they appear as additive constants.

By Bellman's principle of optimality, (5) can be broken into two subproblems. The first one consists in choosing the optimal consumption,$k_E^1, k_L^1, k_E^2, k_L^2$, and the second problem consists in choosing the optimal output, z, and the optimal farmland, l. Because the second problem can be solved independent of the first, it follows that the optimal agricultural output, z, and optimal farmland, l, are chosen according to[12]

$$\Pi(p, w, r, v_1/A, v_2^T(D^TD)^{-1}D^T) = \max_{z,l}\Big\{v_2^T(D^TD)^{-1}D^Tpz \\ - c(w, z; l) - \Big[r - \frac{a}{2}\Big(\frac{v_1}{A} + v_2^T(D^TD)^{-1}D^T1^S\Big)\Big]l\Big\}$$

The state-contingent output level, z, is determined independent of consumption or farmer's preferences for risk.

Result 1. An interior solution to (1) satisfies [13]

$$\max_{k_E^1, k_L^1, k_E^2, k_L^2} W\Big(\omega + r(L - l) - \frac{v_1}{2A}(k_E^1 + k_L^1) - v_2^T(D^TD)^{-1}D^T\Big(\frac{k_E^2 + k_L^2}{2}\Big) \\ + \Pi(p, w, r, v_1/2A, v_2^T(D^TD)^{-1}D^T), k_E^1, k_L^1, k_E^2, k_L^2\Big)$$

where

$$\Pi(p, w, r, v_1/A, v_2^T(D^TD)^{-1}D^T) = \max_{z,l}\Big\{v_2^T(D^TD)^{-1}D^Tpz \\ - c(w, z; l) - \Big[r - \frac{a}{2}\Big(\frac{v_1}{A} + v_2^T(D^TD)^{-1}D^T1^S\Big)\Big]l\Big\}$$

[12] Chambers and Voica (2016) contains a detailed discussion of this result.

[13] This result extends Theorem 1 of Chambers and Voica (2016) to the present context. The strand of literature on which this result is based can be traced to Chambers and Quiggin (2009).

Assuming $c(w, z; l)$ is differentiable, the first order conditions for determining the optimal output z require

$$\frac{\nabla_z c(w, z; l)}{p} D_j = v_{2j}, \; j = 1, \ldots, J \tag{6}$$

where $\nabla_z c(w, z; l)/p \in \mathbb{R}^S$ and its s-th entry equals $(\partial c(w, z; l)/\partial z_s)/p_s$, $D_j = (D_{1j}, D_{2j}, \ldots, D_{sj})^T$ is the payoffs vector of the j-th asset, D_{sj} is the payoff of asset j in state s, and v_{2j} is the price of the asset j in period 0. For the subjective probability measure, $\pi = (\pi_1, \ldots, \pi_s)$ (6) can be written in expectation form as

$$E\Big[\frac{\nabla_z c(w, z; l)}{p} \tilde{D}_j\Big] = v_{2j}, \; j = 1, \ldots, J \tag{7}$$

where expectation is take over the discrete subjective probability measure π and $\tilde{D}_j = D_j/\pi$.[14] Expressions (6) and (7) show that $\nabla_z c(w, z; l)/p \in \mathbb{R}^S$ can be interpreted as a stochastic discount factor that ensures that the discounted return on period 2 payouts for each asset equals its period 0 acquisition cost.

Similarly, the first order condition for using farm on land requires

$$\begin{aligned} \frac{\partial c(w, z; l)}{\partial l} + r &= a\frac{v_1}{2A}\Big[1 + \frac{A}{v_1} v_2 (D^T D)^{-1} D^T 1^S\Big] \\ &= a\frac{v_1}{2A}\Big[1 + \frac{A}{v_1} P 1^S\Big] \\ &= a\frac{v_1}{2A}\Big[1 + \frac{A}{v_1} E[\tilde{P} 1^S]\Big] \end{aligned} \tag{8}$$

where $P = v_2(D^T D)^{-1} D^T$, $\tilde{P} = P/\pi$. Expression (8) demonstrates how the acreage allocation decision depends upon the timing of the SFP payment.

If the subsidy is paid in the first period with certainty, the optimal amount of

[14] For the complete derivation please see the appendix.

farmland, l_a, is the implicit solution to

$$\frac{\partial c(w,z;l)}{\partial l} + r = a \tag{9}$$

For given z, the convexity of c in l ensures that l_a will be greater than the optimal amount farmed, $l_{a=0}$, in the absence of a subsidy determined as the implicit solution to

$$\frac{\partial c(w,z;l)}{\partial l} + r = 0 \tag{10}$$

The difference between the two optimal choices of farmland reflects the change in the opportunity cost of diverting land from the rental market to farming caused by the area payment.

Delaying the subsidy payment, however, weakens this effect because an area payment of a paid in period 2 is valued less by a farmer who intertemporally discounts consumption than an area payment of a paid in period 1. So long as farmers have positive intertemporal discount factors delaying the subsidy mitigates its distortionary effect on production.

This can be seen as follows. If the subsidy is paid in period 1 with certainty, its period 0 discounted value equals $av_1/2A$. If the subsidy is paid in period 2 with certainty, its period 0 discounted value is $aE[\tilde{P}1^S]/2$. Thus, so long as $v_1/A < E[\tilde{P}1^S]$, the delay decreases the distortionary impact of the subsidy. But this latter condition is always satisfied if farmers have positive intertemporal discount factors.

2 Estimation

Data limitations do not allow to discriminate between consumption activities that occur within a given agricultural production cycle. For empirical work, the three-period model was collapsed into a two period model. The formal justification that would permit this is to assume $A/v_1 = 1$. Then period 0 and period 1 are perfect substitutes in consumption and there is no discounting between period 0 and period 1. In short, the new first period includes the old first and second periods and the second period is previous third period. This also changes the cardinality of the state space Ω from $2S$ to S. Optimal output, z, and farmland, l, values are determined by solving the profit maximization problem:

$$\Pi(p, w, r, 1{,}P) = \max_{z,l} \Big\{ Ppz \\ - c(w, z; l) - \Big[r - \frac{a}{2}\Big(1 + P1^S\Big)\Big] l \Big\}$$

Hence, the new first order conditions for the profit maximization now require:

$$E\Big[\frac{\nabla_z c(w, z; l)}{p}\tilde{D}\Big] = v_2 \tag{11}$$

$$\frac{\partial c(w, z; l)}{\partial l} + r = \frac{a}{2}\Big[1 + E[\tilde{P}1^S]\Big] \tag{12}$$

If the theory is descriptive of farmer behavior, the system of equations (11) and (12) should permit estimation a parametric specification of $c\,(w, z, l)$ while allowing one to determine the effect of delaying subsidy payments on production and farmland. It proves convenient to rewrite them in terms financial returns.

Letting $R_j = \tilde{D}_j / v_{2j}$, $R_j \in \mathbb{R}^S$ for all j expression (11) becomes:

$$E\Big[\frac{\nabla_z c(w, z; l)}{\tilde{p}} R_j\Big] - 1 = 0. \tag{13}$$

If R_1 is assumed to be the return on the riskless (that is, 1\$ today returns $1 + i$\$ tomorrow), $R_1 = 1 + i$, and (13) becomes

$$E\Big[\frac{\nabla_z c(w, z; l)}{\tilde{p}}\Big] = \frac{1}{1 + i} \tag{14}$$

Using this result in equation (12) gives

$$\frac{\partial c(w,z;l)}{\partial l} + r = \frac{a}{2}\Big[1 + \frac{1}{1+i}\Big] \tag{15}$$

Or in expectation format, equation (12) becomes

$$E\Big[\Big(\frac{\partial c(w,z;l)}{\partial l} + r\Big)\frac{2(1+i)}{a(2+i)}\Big] - 1 = 0 \tag{16}$$

The econometric strategy is to use the generalized method of moments (GMM) to estimate a parametric representation of these equilibrium relationships (Hansen and Singleton (1982), Cochrane (2001), Chambers (2007), Pope, LaFrance, and Just (2011)). The analysis focuses on Romanian wheat production. This crop has an important share of the agricultural farmland area in Romania and is planted in the fall. As such, it is a good candidate for testing the timing effect. The cost function $c(w,z;l)$ for producing wheat is assumed to take the general form:

$$\begin{aligned} c_t(w_t, z_{t+1}; l_t) = \tau(w_t) + \phi(w_t)\Big[\alpha_z E_t(z_{t+1} - z_t) + \frac{\beta_z}{2} E_t[(z_{t+1} - z_t)^2] + \\ + \eta_z E_t(z_{t+1} - z_t) l + \gamma_z E_t[(z_{t+1} - z_t)(y_{t+1} - y_t)] + \alpha_l l_t + \frac{\beta_l}{2} l_t^2\Big] \end{aligned} \tag{17}$$

where z now represents wheat output and y is an output index corresponding to all crops output. While simple, this cost structure is sufficiently flexible to capture the effects of mean and dispersion shifts in z on the production cost $c(w,z;l)$, the effect of the covariance between z and other crops on the cost, as well as, the interaction between land and output.

The parameters α_z measure the change in the cost due to a change in the mean output by the farmer, β_z measure the effect on the cost of a change in the output dispersion as captured by the second moment, γ_z measures the change in the cost due to a change in the covariance between z and y, while η_z measures the interaction between land and the output. The land parameters α_l and β_l measure the effect on the cost of a change in the amount of land used. Given the subsidy a is paid per unit of land l, α_l and β_l can also be interpreted as measuring the effects of a change in the amount of subsidy a over the marginal cost of producing output z. Because the timing of the subsidy payments influence the subsidy amount received, when discounted to the first period, a change in α_l and β_l measure the effect of the payments timing on the coupling between subsidy and production decisions.

Given this representation of the production cost function,

$$\frac{\nabla_z c_t(w_t, z_{t+1}; l_t)}{p_{t+1}} = \frac{\phi(w_t)}{p_{t+1}}\Big[\alpha_z + \beta_z(z_{t+1} - z_t) + \gamma_z(y_{t+1} - y_t) + \eta_z l_t)\Big] \tag{18}$$

and

$$\frac{\partial c_t(w_t, z_{t+1}, y_{t+1}; l_t)}{\partial l_t} = \phi(w_t)\Big[\alpha_l + \beta_l l_t + \eta_z E(z_{t+1} - z_t)\Big] \tag{19}$$

Using suitable instruments ensures that the number of moment conditions is at least as large as the number of parameters to be estimated and helps identify those parameters. If conditional on information available at time t (13) and (16) hold as identities, then for any set of instruments Z_t predetermined at time t, the law of iterated expectations requires

$$g(d_t, \theta) = E\left[Z_t^T\Big(\frac{\nabla_z c(w_t, z_{t+1}, l_t; \theta)}{\tilde{p}_{t+1}} R_{jt+1} - 1\Big)\right] = 0 \tag{20}$$

where $d_t = (w_t, z_{t+1}, l, p_{t+1}, R_{t+1})$, $\theta = (\alpha_z, \beta_z, \gamma_z, \alpha_l, \beta_l)$ is the vector of parameters to be estimated, and

$$h(d_t, \theta) = E\left[Z_t^T\left(a\Big(1 + \frac{1}{1+i}\Big) - \frac{\partial c(w, z_{t+1}, l; \theta)}{\partial l} - r\right)\right] = 0 \tag{21}$$

The GMM procedure estimates θ as the solution to the minimization problem

$$J_T(\theta) = [g(d_t, \theta), h(d_t, \theta)]' W[g(d_t, \theta), h(d_t, \theta)] \tag{22}$$

where W is a positive definite weighting matrix.

2.1 Data and Empirical Strategy

The data for this paper come from the Romanian EU Farm Accountancy Data Network (FADN). These data are part of a short unbalanced panel which covers the period 2007 to 2010, and includes data on agricultural production, prices, land use, subsidy amount, labor, farm financial assets. The number of farmers sampled in this survey has increased yearly from approximately 1,000 farmers in 2007 to around 6,000 in 2010. In order to create a balanced panel, the data were aggregated to the county level. To account for differences between micro and aggregate levels, I use county level fixed effects. Pope, LaFrance, and Just (2011) provide a detailed explanation of the potential gains and losses from data aggregation.

A second issue is the lack of description regarding the sequence of decisions. The approach used here is to assume that the first period stochastic discount factor equals 1. Hence, periods one and two are perfect substitutes in consumption. While restrictive, this assumption allows testing for the timing effects on subsidy.

The data used in the estimation of the equations above are as follows. $\phi(w_t)$ corresponds to an index of agricultural input prices for Romania obtained from the Eurostat. Output and output prices for period are available from the FADN. For the first year, z_t is taken as the national county average. The instruments used are the unemployment rates, lagged observed output prices and the county fixed effects. The financial assets used are Romanian Stock Exchange return and the national interest rates obtained from the Romanian National Bank.

Table 1: Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
Subsidy (RON/ha)	267.51	162.65	137.26	2133.93
Input Price Index	132.23	7.34	121.90	141.30
Wheat Price (RON/tone)	649.66	229.70	271.33	1267.00
Wheat Production (tones)	256.00	338.07	0.21	1539.62
Land Rent (RON/ha)	8891.64	34004.37	456.75	332462.60
Area (ha)	233.47	270.38	2.86	1736.10
Interest Rate - national	1.09	0.02	1.07	1.12
Romanian Stock Exchange Return	0.99	0.41	0.55	1.53
Unemployment	6.60	0.57	5.80	7.30

2.2 Empirical Results and Discussion

Table 2: Estimated Pricing Kernel and Subsidy Delay Effect for County Level with Fixed Effects and Panel Newey-West Standard errors

	Arbitrage Wheat		
Parameter	α_z	β_z	γ_z
Estimate	14289.31	-770.99	1484.86
t	2.40	-5.82	2.27
	Timing Effect		
	α_l	β_l	η_z
Estimate	-67.19	0.35	-0.08
t	-67.1958		-0.43
TJt	66.01		
p-value	0.91		
Observation	164		

Table 2 summarizes the results of the GMM estimation. The estimated value of the J statistics suggests that this cost function specification reasonably approximates the underlying data.

The estimated value of α_z is positive and significant. The positive sign suggests that keeping other moments constant, the cost of producing wheat increases as the expected value of the crop increases. The estimated value of β_z is negative suggesting that allowing the variance of wheat to increase would decrease cost suggesting that production of wheat is inherently risky in the sense of (Chambers and Quiggin, 2000). Keeping other moments constant, decreasing variability as measured by second moment of the crop distribution, raises costs. Hence, eliminating production risk is costly. The estimate of γ_z is also positive suggesting that the cost of producing wheat increases as the covariance between wheat production and other crop production increases. Keeping other moments constant, increasing y will determined a reduction in the optimal level of z, hence z and y are substitutes in production. The estimate of η_z is negative and insignificant.

The estimated land coefficients, α_l and β_l, imply that the cost of producing wheat is indeed convex in land farmed and will be decreasing in the amount of land farmed over an appropriate interval of the data. Convexity is particularly important because it implies that, holding z constant, land use will be increasing in the SFP subsidy.

To illustrate, suppose that the estimated cost function is realistic for the representative Romanian farmer. If there is no delay in the subsidy payments the optimal choice of land, $l_{a=r,ND}$, satisfies

$$\phi(w_t)(-67.19 + 0.35 l_{a=r,ND} - 0.08 E(z_{t+1} - z_t)) = a - r \tag{23}$$

which can be compared to the optimal amount of land in the absence of any area subsidy, $l_{a=0}$, which solves

$$\phi(w_t)(-67.19 + 0.35 l_{a=0} - 0.08 E(z_{t+1} - z_t)) = -r. \tag{24}$$

Convexity ensures that the amount of land will depend upon both the magnitude and timing of the subsidy payments, because in the presence of delays the optimal amount of land, $l_{a=r,D}$ is

$$\phi(w_t)(-67.19 + 0.35 l_{a=r,D} - 0.08 E(z_{t+1} - z_t)) = a\frac{1}{1+i} - r \tag{25}$$

from where it is clear that $l_{a=0} < l_{a=r,D} < l_{a=r,ND}$, hence the coupling effect between production and subsidy decreases with the delay in the payments of the subsidy.

The estimated elasticity of land with respect to land rent, calculated at sample means, in the absence of a subsidy is -0.823, which compares with an estimated elasticity of land with respect to the land rent when the subsidy is paid on time is -0.798. The mean of the subsidy is approximately 3% of the average rental rate of land. Thus, holding z constant, one would expect that a subsidy paid on time would result in a 2.5% increase in land utilization by the representative farmer. Delaying the payment of the subsidy, given existing interest rates, by one period is equivalent to reducing the subsidy by approximately 10% which translates into about a .25% change in land utilization by the farmer.

The estimated yield effects associated with the SFP subsidy are legibly small. The estimated elasticity of expected output with respect to the land rent is insignificantly different of the elasticity of expected output in the presence of the subsidy. Hence the change in the expected output due to the subsidy delay is negligible and insignificant.

3 Conclusions

This paper contributes to the debate surrounding agricultural policy support for farmers and the potential distortionary effects of area payments. It shows how the timing of subsidy payments decreases the intensity of the distortionary effect associated with subsidies. Measured at current levels, the area based SFP causes the representative Romania wheat farmer to increase acreage by approximately 2.5%. Delaying the subsidy has negligible yield effects but reduces acreage by approximately .25%.

Following Chambers and Voica (2016), the paper also shows that the production distortion associated with area payments is independent of the farmer's risk preferences. In the presence of off-farm opportunities, which are exogenous to the government intervention, separation between farmers consumption and production decisions occurs. However, area payments can affect production via land allocation. I show that the timing of subsidy payments can weaken the link between area payments and production decisions. The theoretical predictions are supported by the empirical analysis. The results of the paper provide an alternative explanation to why previous empirical studies have found little evidence of coupling between area payments and agriculture production.

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4 Appendix I

The optimal stochastic agricultural output z can be determined as a solution to the profit maximization problem

$$\Pi(p, w, r, v_1/A, v_2^T(D^TD)^{-1}D^T) = \max_{z,l} \Big\{ v_2^T(D^TD)^{-1}D^T pz - c(w, z; l) - \Big[r - \frac{s}{2}\Big(\frac{v_1}{A} + v_2^T(D^TD)^{-1}D^T 1^S\Big)\Big] l \Big\}$$

Assuming the profit function is differentiable, the first order conditions for the output z are

$$(z_s) : \frac{\partial c(w, z; l)}{\partial z_s} = v_2^T(D^TD)^{-1}D_s^T p_s, \; \forall s \in S$$

from where

$$(z_s) : \frac{\partial c(w, z; l)}{\partial z_s}\frac{1}{p_s} = v_2^T(D^TD)^{-1}D_s^T, \; \forall s \in S$$

or in vector notation

$$\frac{\nabla_z c(w, z; l)}{p} = v_2^T(D^TD)^{-1}D^T, \; \forall s \in S$$

post multiply by D to obtain

$$\frac{\nabla_z c(w, z; l)}{p} D = v_2$$

which must hold for any asset j

$$\frac{\nabla_z c(w, z; l)}{p} D_j = v_{2j}, \; j = 1, \dots, J$$

multiply and divide every states s by its associate probability π_s

$$\frac{\nabla_z c(w, z; l)}{p}\frac{\pi_s}{\pi_s} D_j = v_{2j}, \; j = 1, \dots, J$$

given the expectation form

$$E\Big[\frac{\nabla_z c(w, z; l)}{p}\tilde{D}_j\Big] = v_{2j}, \; j = 1, \dots, J$$

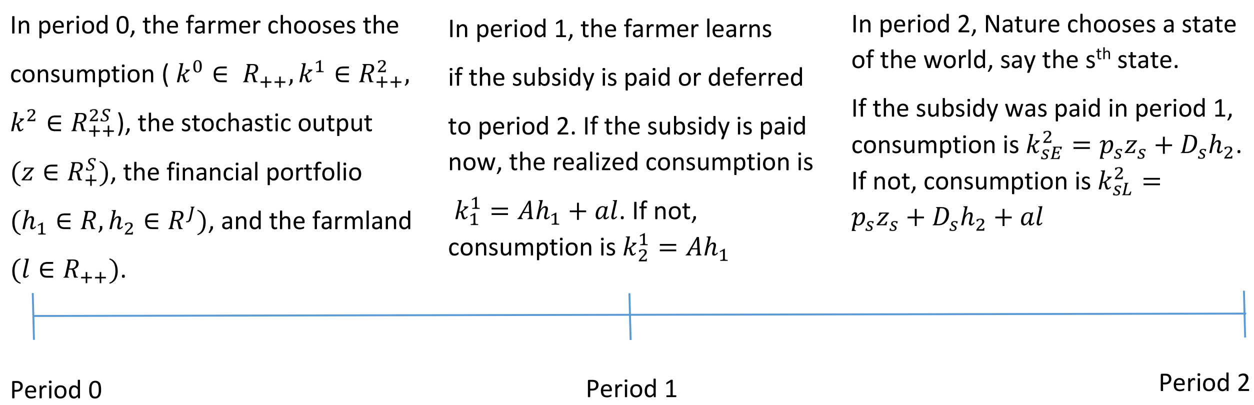

Figure 1: Decisions Timeline

Government \ Nature	1	2	…	S
Late Payments (third period)	$p_1 z_1 + \sum_{j=1}^{J} D_{1j} h_{2j} + sl$	$p_2 z_2 + \sum_{j=1}^{J} D_{2j} h_{2j} + sl$	…	$p_s z_s + \sum_{j=1}^{J} D_{sj} h_{2j} + sl$
Early Payments (second period)	$p_1 z_1 + \sum_{j=1}^{J} D_{1j} h_{2j}$	$p_2 z_2 + \sum_{j=1}^{J} D_{2j} h_{2j}$	…	$p_s z_s + \sum_{j=1}^{J} D_{sj} h_{2j}$

Figure 2: Subsidy Payments