PERSPECTIVES

Sri Lanka Journal of
Economic Research
Volume 2 (1)
June 2014: 91-107
Sri Lanka Forum of
University Economists

VALUING ECOLOGICAL GOODS AND SERVICES: AN ANALYTICAL FRAMEWORK FOR POLICY MAKERS

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Abstract

Organic farming is a significant source of producing Ecosystem Goods and Services (EGSs). They are capable of producing many environmental benefits as well as health benefits. These benefits are utilized by consumers as well as the organic farmers. Recently with the growing concern over environmental and health issues and the fiscal burden of continuing fertilizer subsidy for paddy, the government of Sri Lanka encouraged paddy farmers to engage in organic farming. However, governments' efforts were not successful and they had to increase the chemical fertilizer subsidy again. This suggests that successful policy needs to be evidenced based and needs to move out of traditional and conventional frameworks. This paper argues that organic paddy farming policies needs to be conceptualized in the perspective of EGSs. Further understanding ways to look at it from demand as well as supply side is quite essential. This paper provides an analytical frame work for evidenced based policy making, looking at promoting organic paddy farming from a EGSs perspective.

***Key Words**: Ecosystem goods and services, Organic paddy farming, Opportunity cost of supply, Willingness to pay*

INTRODUCTION

Rice is the staple food of Sri Lanka. Ensuing the continuous production and establishing self-sufficiency in rice is a top priority of the government of Sri Lanka (Government of Sri Lanka, 2010). Therefore, even today, most agriculture policies in the country are thoroughly focused on increasing the output and productivity of farming systems. This was predominately done by providing input subsidies such as the fertilizer subsidy to increase the production. However with growing concerns over the environmental and social negative externalities, many argued the environmental, social and financial sustainability of chemical based paddy production. Recently strong suggestions emerged over promoting organic rice farming to address the mentioned negative externalities and heavy financial burdens.

Organic rice farming was not seen favourably as a potential way of increasing output/productivity (Somasiri, 2007). Over the years, farmers have either converted to or started organic rice farming in a very slow pace. (Rosairo, 2006). Generally, organic rice products are tagged with higher prices, hence they do not attract a broad consumer base in the country. Most organic products produced were consumed at the same farm households without even entering the market place. While there were organic markets established in the outskirts of cities it attracted a very limited number of consumers (Small Organic Farmers Association, 2013, Ceylon Today 2013). However, with a growing middle class, the country's rise to middle income status, increased health and environmental consciousness, concerns over budgetary and financial commitments towards the fertilizer subsidy and the government commitment towards sustainable agriculture; an interest has developed among policy makers, farmers as well as consumers on the possibilities of increasing the output and consumption of organic farming in Sri Lanka. Yet, looking at organic produce simply as another consumer good would not help much for its development. One possible and a promising way to argue whether organic rice in Sri Lanka has a potential future is to look at it from a perspective of Ecosystems Goods and Services (EGSs).

Organic rice farming is one of the significant ways of producing EGSs (Gerowitt et al, 2003)[17]. In addition to offering healthy products for human/animal consumption, organic farming systems are capable of providing EGS's such as clean water, clean air, good health, aesthetic/amenity benefits, bio-diversity and ecological conservation and soil improvements (EFTEC, 2005). Realizing some of these important attributes of organic rice farming, the government of Sri Lanka, through its 2013 budget imposed a fertilizer subsidy cut of 25% asking farmers to adopt more organic agriculture. However, it did not materialize as expected, hence the government increased the fertilizer subsidy again in the budget of 2014 imposing only a 10% fertilizer subsidy

[17] Ecosystem goods and services (EGS) are products and benefits arising to humans from healthy productive ecological systems (Millennium Ecosystem Assessment, 2005). Agriculture is both a provider and beneficiary of EGS (Mann and Wüstemann, 2008).

cut.[18] This shows the lack of information with the policy makers on the different profit and cost structures and demand and supply characteristics among organic and inorganic rice farmers of Sri Lanka. For example, opportunity cost supply will be a main deciding factor for a farmer to give up inorganic agriculture and convert to organic farming. At the same time a farmer would be conscious about the consumers' willingness to pay for (WTP) organic rice at a price premium. Therefore a successful policy intervention must carefully evaluate the profit structure between organic and inorganic farming, opportunity cost of supply in organic farming and the compensation level offered by the price premium or the WTP.

It is not that researchers have not looked at the potentials of organic rice farming in Sri Lanka (Siriwardane and Gunaratne, 2010, Ratnayake, 2010). The failure is that they did not look at it from an EGS point of view. Therefore, this review study is focused on providing an analytical framework for policy makers to look at the demand and supply of organic rice in Sri Lanka. The next section of this paper is focused on providing a broader background on the concept of EGS. It will also include several international studies that looked at formulating policies for agricultural produce and systems that produce EGS. Then this paper will provide an analytical frame work for policy makers. Finally, a comprehensive research plan for an evidence based policy decision on promoting organic paddy farming is provided as annexes.

Background to Ecosystem Goods and Services (EGS)

Why is Organic Agriculture Important? : Ecosystem Services from Agriculture Farming Systems

EGS are the benefits people derive from functioning ecosystems, ecological characteristics, functions, or processes that directly or indirectly contribute to human well-being (Costanza et al, 1997). Many ecosystems that generate EGSs hold the property of "multifunctionality" (Abler, 2004). Ecosystem processes and functions, while contributing to ecosystem services, however, are not synonymous with EGS as they exist regardless of whether or not humans benefit (Boyd and Banzhaf, 2007, Granek et al, 2010). Hence, EGS exist if they contribute to human well-being only and cannot be defined independently (de Groot, 2002).

Many ecosystem services are public goods. This means that multiple users can simultaneously benefit from using them and it is difficult to exclude people from benefiting from them. Being public goods, EGS are generally not traded in markets. We need to develop other methods to assess their value. There are a number of methods that can be used to estimate or measure benefits from ecosystems. Valuation can be expressed in several ways, including money, physical units, or indices. Economists have developed a number of valuation methods that typically use monetary units (Freeman,

[18] This information are published on the president's budget speeches for 2013 and 2014. http://www.treasury.gov.lk

2003) whereas ecologists and others have developed measures expressed in a variety of nonmonetary units such as biophysical trade-offs and qualitative analyses (Costanza et al, 2004).

The agriculture sector is increasingly gaining its reputation as a means of providing valuable outputs in addition to the traditional commodities that generate income (Randall, 2003). A number of studies that examined EGS produced from agricultural systems have appeared recently (Sandhu et al, 2010 and Power, 2010). Being an ecosystem that generates EGSs, the agricultural systems are also multifunctional (Abler, 2004). As mentioned before, they are capable of producing environmental, economic and social functions. These EGSs are produced not separately but as a system, hence it is a “joint production”. Many EGSs produced through agricultural systems are externalities For example, generating a health food is a direct positive externality while improving biodiversity is an indirect positive externality. Kallas et al (2006, 2007, 2008) highlight the point that in order to design operative public policies, multi-functionality of agricultural systems need to be carefully understood in terms of social demand for them. Kallas et al (2006) employed a contingent valuation method and an analytical hierarchy method for their analysis and found that there is a significant demand for different attributes of agricultural systems. They further identified that demand is heterogeneous but is based on the socio-economic characteristics of the individual person. Ecosystem services with agriculture can be categorized into four groups: provisioning, supporting, regulating and cultural services) as explained by (Reid et al 2005, Cullen et al, 2004, Sandhu et at, 2007, Zhang et al, 2007, UN 2008).

Provisioning goods and services: These are foods and services for direct human consumption. They range from food, forage, biofuels, and fuel woods to the conservation of species and agro-biodiversity (de Groot et al, 2002, Reid et al, 2005). These goods and services are produced in agricultural landscapes.

Supporting services: These services will help the production of other ecosystem goods and services. They will support the production of the grains, wool, fruits, and vegetables etc. Key supporting ecosystem services associated with agricultural systems are biological control of pests (natural enemies of insect pests control the pest populations), biological control of diseases and weeds (natural suppression by soil microbes of soil-borne diseases and weed seed removal by predators), pollination (for seed production), nutrient supply (availability of nutrients by soil microbial activity), carbon sequestration (storage of carbon in soils and vegetation), soil formation (soil turnover by earthworms) etc. The global economic value of these ecosystem services was estimated to be \$100, \$80, \$100, \$90, \$135 and \$25 billion annually, respectively (Pimentel et al, 1997).

Regulating services: Ecosystems regulate essential ecological processes that maintain temperature and precipitation (Costanza et al 1997, Daily, 1997).

Regulating services associated with agriculture regulate fluctuations in water provisions and temperature.

Cultural services: Cultural services contribute to the maintenance of human health and well-being by providing recreation, aesthetics and educational opportunities (Costanza et al, 1997, de Groot et al, 2002 , Reid et al 2005)

This study is focused on organic rice farming systems, with the use of traditional paddy varieties. Organic agriculture is defined as "a holistic production management system (whose) primary goal is to optimize the health and productivity of independent communities of soil, life, plants animals and people" (UNCTAD, 2006). Therefore it aims to utilize and maintain ecosystem services by improving the natural environment, increased water retention, reduced soil erosion and increased agro-biodiversity (UN, 2008). At present organic farming, including organic rice is practiced on over 31 million hectares of land with a global market estimated at more than US 26.8 billion which is increasing at a 20% a year (Willer and Yussefi, 2006). Organic rice farming is a major component of organic agriculture, especially in the Asian region. Rice is the staple food of Sri Lanka and around 37% of the cultivatable land is allocated for rice farming. Among that, close to 10% is employed for commercial organic rice farming.

Why is Organic Rice Farming Important to Sri Lanka?

There are some specific ecosystem services to a rice production system and those are: production of a toxic free produce, soil quality improvement, increasing the biodiversity and water quality improvement. However these benefits are interconnected. Enhance in the one aspect would have a ripple effect on the other factors and will ultimately boost the productivity of the farming environment. Most of the time benefits of EGSs are not limited to the onsite farm land. Rather they will be felt strongly in the downstream. For example, use of less pesticides will result in less run off of nitrates to water which will be beneficial to onsite farmers as well as downstream farmers (OFRF 2011).

Health benefits from organic rice come through organic produce. It is free of toxic materials since cultivation does not use chemicals such as pesticides, herbicides, insecticides and inorganic fertilizers. As a result, incidences of pesticide availability are extremely low in organic produce and this is common to organic rice also. Again these benefits are materialized by farmers only if they consume what they produce, otherwise it is a benefit to the consumers of organic rice. (Pompratansombt et al, 2011). On average organic farming reduces the chances of having pesticide residuals in the produce by 70% while having more inorganic practices are only capable of doing this at >30%. A mixed cultivation has the potential to bring this close to 50% (Baker et al, 2002).

Application of organic fertilizer increases the soil water holding capacity, improve the bonds between the root system and soil, improve the soil aeration and prevent soil erosion. Application of the chemical fertilizer and cultivation of improved commercial rice varieties have over the years degraded the soil quality, and most paddy lands could become barren (Colombo et al, 2003). On average, organic agriculture will cause about 25% less erosion then conventional agriculture under otherwise identical site conditions. The inorganic dominant farming is capable of producing only 5% less erosion while a mixed method would yield somewhere close to 15%. (Auerswald et al, 2003).

Biodiversity is protected by organic farming systems since it does not use any chemicals that could harm the fauna and flora of the paddy field environment. The organic farming systems are capable of preserving the soil micro and macro organisms in the field itself, which in turn improve the soil quality. Chemical free environment can boost the natural pollination process, which helps the spread of the local flora (Milon et al, 2006). A comprehensive analysis of 66 scientific studies shows that organically farmed areas have on average 30 percent more species and 50 percent more individuals than non-organic areas. Inorganic dominant farming is capable of increasing species percentages only close to 5% and a mixed method would have an increased of species diversity close to 15% (RIOA, 2011).

Rainfall and irrigation water normally wash chemicals and inorganic fertilizer away to the water streams. This damages the water quality, harms the water fauna and flora and also create health hazards such as kidney diseases for human. However, organic farming does not yield heavy metal and other chemicals that could drain in to nearby water streams, hence the possibility of controlling the water pollution is high (Weligamage, 2013). There are many aspects of water quality improvements by organic farming. Organic farming reduces the nutrient runoff and thereby reducing the nitrate-nitrogen levels in the water by 60%. Adapting more inorganic farming will reduce this level close only to 10% and a mixed method will result somewhere close to 30% (OFRF 2011).

An Analytical Framework

There are many ways to value the EGSs produced by different ecosystems. These approaches can be either representing stated preference methods or revealed preference methods concentrating both the consumer and the producer side of organic rice. Among stated preference methods, choice experiments have earned a significant reputation. Stated preference methods are used in hypothetical scenarios. In order to apply the stated preference method the context where the valuation is applied has to be hypothetical, but in the case of organic rice farming, it is a reality, products are available in the market place where consumers pay a price premium, hence it does not necessarily fit in to the application criteria of a stated preference method. This does not mean that employing stated preference methods are incorrect, it simply means that the stated method application can be simple since much information is available through the price signals. However, identification of different components of the price premium and what would consumers pay for improvements of those components is quite important to study in evidence-based policy formulation.

How Can We Look at This From a Supply Side Perspective?

Ideally, it is best to use a "production function approach" in valuing the EGSs produced by the organic rice farming systems in Sri Lanka. There are many revealed preference methods such as travel cost method, hedonic pricing method and replacement cost techniques. However, using EGSs as a productive approach requires plot level data on EGSs produced. For example, if using organic fertilizer improves the soil quality then ideally, the research needs to estimate the soil quality parameters for all the plots that it surveys. This is a tedious task which requires more budgets and time hence falls outside the scope of the research. Rather it is possible to compare the profits and cost of cultivation of organic and inorganic rice by estimating a production function. Further it is also possible to estimate the opportunity cost of supplying organic rice by estimating output supply and input demand functions. These approaches will allow policy makers to look at the production system of organic rice in a more detailed manner while capturing the economics of supplying the total EGSs from an organic rice farming system. Several studies in literature that have used similar kind of approach in valuing EGSs from different ecosystems are Barbier (2000), Subhrendu, (2004), Subhrendu and Mercer (1998), Subhrendu and Karmer (2001) and Subhrendu and Butry, (2001). A detailed theoretical and empirical framework for analysis is provided in the Annex 1 and Annex 2.

How Can We Look at This From a Demand Side Perspective?

Compared to non-organic produce, the organic produce which comes out of organic farming represents many EGS that have both use and non-use values (Sandhu et al, 2010). Organic produce attracts higher prices in the market place (Dettmann, 2008). Here the premium for organic produce over non-organic produce can be assumed as payments to EGS associated with organic produce.

$$P = P_o - P_N$$

Where P = Payment for EGS, P_O= price of organic produce and P_N= price of non-organic produce. Therefore, the higher price of organic produce represents the demand for the EGS that are associated with organic produce. Hence by estimating demand for organic produce relative to non-organic produce, it could be expected to capture consumers demand for EGS. Payments for EGS could be a result of two major attributes—source of value origin and trust. As far as source of value origin is concerned, payments could be originated from use values and non-use values placed by individual consumers upon organic produce. The use values that generated by organic farming may include both direct and indirect values. Direct values may be generated from perceptions about health benefits and absence of toxic materials etc. Indirect uses values may represent perceived eco-system services such as soil preservation, bio-diversity conservation, generating esthetic appeal and water pollution control. Payments could also be originated from consumers' expectations about non-use values. Two of such non-use values are existence values[19] and bequest values[20] . Hence, the payment to EGS (P) captured in price of organic produce can be disaggregated as follows:

$$P = p_d + p_i + p_n$$

Where, p_d = payments for direct use values (e.g. perceived health benefits), p_i = payments for indirect use values (e.g. perceived eco-system services) and p_n= payments for non-use values (e.g. existence value). Consumers could have variations in values placed upon a given organic produce based on their individual preferences over different sources of origin of value. In addition, consumers' demand (payments) for EGS could be expected to vary according to trust on the product source. Consumers build a trust towards organic produce that carry labeling and certifications (Dimitri and Greene, 2002). For instance consumers may be willing to pay more for certified product than non-certified product. Hence for the same organic produce:

$$P_{co} \geq P_{no}$$

where P_{co}= payments to produce from certified producer and P_{no}= payments to produce from non-certified producer. The above analysis of price of organic products as a carrier and indicator of demand for EGSs helps to provide useful insights with important policy implications. It suggests that demand for EGSs from consumers are influenced by two major attributes—source of value origin and trust.

CONCLUSIONS

It is important to think outside the conventional paradigm if organic rice farming is to be a success in Sri Lanka. Evidence-based policy making calls for looking at policy formulation from an innovative lens. Therefore, understanding and exploring organic paddy farming through the provision of Ecosystem Goods and Services is important. How much would farmers forgo in producing EGSs by organic paddy farming as oppose to inorganic farming with the available fertilizer subsidy is important to understand in order to provide necessary incentives for promotion of organic paddy farming. At the same time, it is important how much consumers would be willing to pay for the EGSs produced by organic paddy farming, which is visible through the prices for organic rice. A better evidence based policy needs to look at both of these aspects of demand and supply.

[19] Consumers might not be utilizing and direct or indirect benefits of organic farming yet they would like to know that it exists

[20] Even though consumers might not utilize any benefits now, they would prefer it to be available for future generations

Annex 1

Theoretical Idea

The organic rice production system is focused on the production process of an agricultural household. Here, the supply of EGSs that are associated with the organic rice farming systems are measured by differences in the profits and cost structures of organic and inorganic farmers and the opportunity cost of supplying organic rice compared to inorganic rice. In neoclassical economic theory, welfare is identified within a utility maximization framework; therefore, the theoretical model needs to capture cost of supplying EGSs, production process of organic rice, profits generated from organic rice production and the utility of the farming households. Agricultural households maximizes their utility, and this utility is a function of the agricultural commodity they produce (in this case it is the organic rice), and inputs they use to produce the agricultural commodity. However, this function is subjected to household characteristics. Furthermore, the utility of organic rice farming household is subjected to four constraints, and those are:

a. Input constraint: Sum of the “own” input supply and “own” input consumption cannot exceed the household input endowment which depends on the household characteristics.
b. Agricultural production function assumes that EGSs of organic rice farming system is a fixed input to the farming system itself and it helps to increase the farming environment better (through improved soil quality, improved water quality, increased biodiversity and pesticide free environment and a product). These EGSs are hard to measure at farm level, but they all create a favorable environment for farming, which inorganic farming systems does not create. There is no such thing as EGS to an inorganic farmer.
c. Household budget constraint establishes that all the expenditures are equal to the sum of the monetary equivalent of the household input endowment, agricultural profits, and the exogenous income (Strauss, 1986).
d. Market environment constraints: if a perfect market exists for a given output or an input, then they can be freely traded and the market constraint is not binding.

Based on this information it is possible to write a profit maximization problem,

For both organic and inorganic farmers;

Here, EGSs or the environment is not taken as an independent variable since this research would not be measuring it at plot levels:

Maximize, x, y, q, v, µ, ß

$$L = u(X, Y, H) + ß\,[p_v .\, T(H) + (p_q . Q - p_v . V) + E - p_v . Y - P_q . X] - þ\,[F(Q,V,Z)] + \mu_q\,[M_Q - Q + X] + \mu_v[M_V - V + T(H) - Y] \quad (1)$$

where, X= Agricultural commodity (Organic/inorganic rice), Y= production Inputs, H= Household characteristics, T= input endowment, V= Production inputs, Z= Biophysical and socioeconomic inputs, Q= outputs, E= exogenous income, P= price (P_v = Price of inputs, P_q= price of outputs) (Subhrendu and Karmer, 2001). Using the first equation, it is possible to see the differences in profits and costs of organic farmers and inorganic farmers, which is the first objective of this study. In order to achieve the second objective, the opportunity cost of supplying organic rice, this function needs to be transformed in to an output supply/input demand function.

Input Demand Function

Assume a production Cobb Douglas production function (flexible function form) for the moment. In this scenario only static conditions are looked at, dynamic conditions that include fixed inputs and risks are not considered. For explanatory purposes, variables inputs are also taken as two separate variable sets. One is representing fertilizers (organic/inorganic) and pesticides (inorganic/bio-pesticides) and other representing all the other variables inputs, for example, labour.

$$Q = aX^{\beta}W^{\alpha} \quad (2)$$

where, Q= Quantity of rice produced, X= Variable inputs other than fertilizers and pesticides, Z= Variable inputs: fertilizers and pesticides (for explanation purposes fertilizers and pesticides are taken together, but in analysis they will be separated). For an inorganic farmer these inputs are the organic fertilizers and the bio-pesticides.

We can substitute this production function in to the profit function as the first step in obtaining an input demand function:

$$\Pi = p\ (aX^{\beta}Z^{\alpha}) - W\ (X, Z) \quad (3)$$

Where, Π = Farm profits, W= Price of variable inputs and P= price of output.

Profit maximizing uses of inputs occur where the first derivation of this equation is equal to zero.

$$d\pi/dx = p(a\beta X^{\beta-1}Z^{\alpha})-W \quad (4)$$

We can solve this equation for W

$$W= p\ a\beta X^{\beta-1}Z^{\alpha} \quad (5)$$

This is the inverse input demand function. In this equation, the right hand side gives the marginal value product of the variable input X. it shows the farmers' willingness to pay for the variable input X. Similarly it is possible to calculate the farmers' willingness to pay for variable input Z (either inorganic fertilizers and pesticides or organic fertilizers and bio-pesticides).

It is also possible to solve the equation for X or Z. Then it becomes the standard (non-inverse) input demand function.

$$X = [\{pa\beta Z^{\alpha}\} / W]^{(1/1-\beta)} \quad (6)$$

This does not include the physical quantities of output and it is the profit maximizing variable input to be used by the farmer.

Output Supply Function

Output supply function is obtained by substituting the equation (6) back in to the equation (2). Then,

$$Q = a\,[p\alpha\beta Z^{\alpha}]^{(1/1-\beta)} * Z^{\alpha} \quad (7)$$

The output supply function is the similar version of the marginal cost function that describes the same supply relationship.

Profit Function

Using profit maximizing input demand function and output supply function it is possible to construct the profit function for an organic/inorganic farmer. Consider the equation (3) again and substitute equation (5) and (6) to that.

$$\Pi = p[a[pa\beta Z^{\alpha}/Z]^{(1/1-\beta)} Z^{\alpha}] - W(pa\beta Z^{\alpha}/W)^{(1/1-\beta)} \quad (8)$$

With Shepherd’s Lemma it is possible to go back to the input demand and output supply function from the above profit function which is the analogous to the Hotelling’s Lemma associated with the cost function.

(Vincent, 2008)

Annex 2

An Empirical Model

The empirical model is centered on a profit function. The function form of the profit function will be specifically catered to the production technology of the organic/inorganic rice. However it can be a functional form such as a normalized quadratic, a second order flexible approximation of the profit function or the Cobb-Douglas profit function. Thompson (1998) talks about 14 different flexible functional forms and this research will explore all the possibilities and will select the best functional form of the profit function to carry out the empirical estimations to establish the relationship between the EGSs and the household organic rice production. An agricultural household maximises its profits subject to a production function. (Subhrendu and Karmer, 2001).

π = TR (Total Revenue) – TC (Total cost)

TR = P (Y)

where, P is the price of output and Y is the agricultural produce in this case it is the organic/inorganic rice.

TC = P. Q

where, P is the price of the input and Q is the amount of particular input.

This is where there is a single output with a single input, but in reality there are multiple outputs with multiple inputs. For this research there is only a single output, which is the organic/inorganic rice but there will be multiple inputs, hence the production function of the organic rice producing household will take the most general form of (without considering any particular production form):

Q = F (Z, H, B)

where, Q = quantity of organic rice production, Z = the fixed inputs, H = Socio economic and demographic characteristics and B = farm land specific characteristics (Biophysical characteristics of the farming environment)

For example a Cobb-Douglas profit function will take the form of (Subhrendu and Mercer, 1998):

$$\text{In } \pi = \alpha_y \text{ In } P_y + \alpha_x \text{ In } P_x + \alpha_{fx} \text{ In } Z_{fx} + \alpha_{hc} \text{ In } H_{hc} + \alpha_{bc} \text{ In } B_{bc} + \varepsilon \qquad (9)$$

where,

Π = Farm household profits , P_y = output prices, P_x = Input prices, Z_{fx} = Fixed inputs, H_{hc} = Socio economic and demographic characteristics and B_{bc} = farm land specific characteristics (Biophysical characteristics of the farming environment)

Maximization of the profit function with respect to the production function (production technology), will enable to derive a factor demand function for respective factors of production. Substituting them in the production function will allow deriving output supply functions or input demand function. Basically these equations are derived by taking the first derivatives of the profit function with respect to the price (applying Hotelling's Lemma). Therefore, there are cross-equation restrictions on all coefficients. Therefore on the EGS-price interactions terms in the profit equation are equal to the coefficients on the EGS term in the output supply or input demand equation. The estimation of these functions could be done individually and also as a system of equations. The proper method to employ will be selected based on the characteristics of data (Subhrendu and Karmer, 2001, Vincent, 2008).

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