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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:

$$\mathrm{P} = p_d + p_i + p_n$$

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:

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

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.

$$Q = aX^{\beta}W^{\alpha} \tag{2}$$

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:

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

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.

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

We can solve this equation for W

$$W= p\, a\beta X^{\beta-1}Z^{\alpha} \tag{5}$$

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):

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

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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PERSPECTIVES

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REFLECTIONS ON THE EVOLUTION OF MODERN FINANCIAL SCIENCE

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Abstract

Financial science or financial economics, as a sub-discipline in economics, has recorded a remarkable progress during the past fifty years. Finance deals with allocation of various assets and liabilities in the long run within uncertain conditions. Hence, the study of finance involves inquiring, explaining and predicting a diverse and growing number of financial instruments, institutions, and markets, as well as the relationship of their behavior to other economic variables. The study of finance has, therefore, become a study of human civilizations, progress, and even crises. This essay traces the key milestones of the evolution of financial science evaluating the path-breaking contributions to economic science made during a few decades. It attempts to highlight how the study of finance is useful in understanding and predicting human behavior as financial science has generated an extremely rich and rigorous body of theoretical, methodological and empirical knowledge which has increasingly become influential on the thought process of mainstream economics.

Key Words: *Financial economics, Financial instruments and Human behavior*

INTRODUCTION

Finance has often been an elusive and highly debated thing in the affairs of human economic activities. In early human societies, money was not in any significant way linked to the performance or progress of humankind. Before the emergence of fiat money, various metals and materials were used as money which played the roles of medium of exchange and store of value. In such contexts, progress of human societies was not influenced by money, but by human efforts. However, money, banking and finance, derived/related products of money, have been thought to significantly influence human economic activity since the emergence of fiat money in different civilizations. Finance is a form of manifestation of money in relation to human economic activity involving trading of financial instruments in the context of risk and uncertainty. It deals with allocation of various assets and liabilities in the long run within the uncertain conditions. Finance, therefore, in most ways, relates to how money is used for human economic activity in future time periods under risks and uncertainty. Defining and explaining finance, one of the Nobel Laureates in Economics, Robert Shiller states that "finance and insurance are about an uncertain future . . . It is about managing it, and sharing your risks, hedging your risks... Finance is not about beating the market, necessarily. It is about managing risks in such a way that we can be a productive society and we can achieve our goals" (Shiller 2014).

From the period of classical political economy to the aftermath of the Great Depression in 1920s, financial science was not known in any significant way in the economics literature though the function of money and its various manifestations have been treated in economic theory and policy. Early economics literature integrated money and banking into the mainstream theory and policy, but very little of finance. However, in the early economic literature, the role of financial capital has been exposited. Schumpeter's work on creative destruction and the dynamic evolutionary nature of capitalist system (Schumpeter 1934) highlights the role of finance in the process of socio-economic change. Initial efforts in financial science have focused more on analyzing and predicting the behavior of securities exchange markets. However, financial innovations resulting from the deepening and expansion of markets around the world gave space for the development of the financial science as a sub-discipline in economics. The focus on finance came to the forefront of the economic discourse beginning from the seminal work of Harry Markowitz who later won the Nobel Economics Prize for his contribution to the development of financial science.

This brief essay traces the key milestones of the evolution of modern financial science as a prominent sub-discipline in economics that has made vital contributions to the development of thought and empirical methods in economics. We will highlight the most significant contributions to the advancement of financial science during the past few decades. This brief essay is justified on the premise that most undergraduate and postgraduate study programmes in economics in Sri Lanka have paid a scant attention to

the advancement of financial science and its significant contributions to the development of mainstream economic theory and empirical methods. Though financial science has been developed by mainstream economics, the discipline has been left to the business or management schools in Sri Lanka. Economics degree programmes have rarely integrated financial science as an essential component of the skills and knowledge embodied in our graduates. It is also the case that much of the economic literature that we delivered to the undergraduate and postgraduate students through our programmes are highly dominated by theory and empirics developed in the context of certainty conditions, though theory and methods in financial science have made significant advancements in explaining markets and predicting the behavior of markets under risks and uncertainty. Teaching and promoting research in financial science in the undergraduate and postgraduate study programmes in economics would significantly enrich other sub-disciplines of economics. Financial science lends significant theoretical and methodological insights for the advancement of mainstream economics.

RAPID DEVELOPMENT OF MODERN FINANCIAL SCIENCE SINCE 1950S

The process of financial innovations has resulted in creating various financial products and markets. According to the Investopedia, finance is defined as "advances over time in the financial instruments and payment systems used in the lending and borrowing of funds. These changes - which include innovations in technology, risk transfer and credit and equity generation- have increased available credit for borrowers and given banks new and less costly ways to raise equity capital." It can also be defined as the act of creating and then popularizing new financial instruments as well as new financial technologies, institutions and markets. It includes institutional, product and process innovation. Institutional innovations relate to the creation of new types of financial firms. Financial innovations have led to developing various financial instruments that include debt, equity and foreign exchange instruments. Long term debt securities include bonds, loans, bond futures, bond options, interest rate swaps, interest rate caps and floors, interest rate options, and exotic derivatives. Short term debt instruments include bills, commercial papers, certificate of deposits, interest rate futures, and forward rate agreements. Equity instruments include stocks, stock options, equity futures, and exotic derivatives. Foreign exchange instruments include spot foreign exchange, currency futures, foreign exchange options, outright onwards, foreign exchange swaps, and currency swaps. Development of these various financial instruments that resulted in creating new institutions and markets compelled economists to undertake rigorous research about them. The emergence of financial instruments, institutions and markets paved the way for generating a significant body of new knowledge in the area of finance creating the distinct discipline known now as financial economics or financial science.

In the 1950s, much of the research in financial science focused on analyzing and forecasting the behavior of stock markets, and how to deal with risks in stock markets.

The conventional wisdom in finance was that once one attains competency in investment decisions in stock markets, risk management and mitigation, by way of diversification, is undesirable. Therefore, one has to buy one or two, or at most three or four securities in order to maximize profits. It was thought that competent investors would never be satisfied beating the averages by a few small percentage points. In the paper entitled, *The Battle for Investment Survival*, Gerald M. Loeb (1935) analyzed securities one-by-one focusing on picking winners. It was emphasized to concentrate holdings to maximize returns. Broad diversification of securities was considered undesirable during this period. Financial science at the initial stage was, therefore, more of practical analysis of capital markets to assist investors rather than a rigorous academic discipline.

In mid 1950s, attention of researchers of capital markets moved towards bundling of various securities for diversification of risks. These bundles of securities, termed portfolios, were viewed in light of risks and returns. Harry Markowitz (1952, 1959), who won Nobel Prize in Economics in 1990 for his work on portfolio selection, emphasized that diversification of assets held by an investor tends to reduce risks by analyzing the portfolio risk versus security risk. Assets were evaluated by their effects on portfolio. Then, an optimal portfolio can be constructed to maximize return for a given level of risks measured by standard deviation. Harry Markowitz's pioneering work immensely contributed to the development of modern financial science.

James Tobin, who also won the Nobel Prize for his work, advanced Markowitz's seminal work much further by developing ideas related to the role of stocks mainly in his Separation Theorem in which he articulated that investors must form portfolio of risky assets and temper risk by lending and borrowing. His work shifted the focus from stock selection to portfolio structure. Tobin drew heavily from Keynes's work on liquidity preference in developing his own work (Tobin 1958).

Merton Miller (1986, 1991) and Franco Modigliani (1944) expanded the scope of finance research through their work on investments and capital structure. Among other things, their work is known as Modigliani-Miller Theorem (M&M Theorem). The theorem relates corporate finance to returns. They found that a firm's value is unrelated to its dividend policy. Dividend policy is an unreliable guide for stock selection. The work of M&M led to the emergence of another sub-discipline in economics, currently occupied in management/business schools, known as corporate finance. Their analysis lends much to the fact that how firm level actions and decisions affect the risks and returns of assets or portfolios of assets.

William Sharpe, who also won the Nobel Prize in Economics, focused, in his seminal work on analyzing the single factor asset pricing risk and return modeling. He developed the capital asset pricing model through which he explains the link between different types of assets, risks and returns. He defined risk as volatility relative to market. A stock's cost of capital (the investor's expected return) is proportional to the

stock's risk relative to the entire stock universe. This is a theoretical model for evaluating the risk and expected return of securities and portfolios (Sharpe 1963, 1964, 1970, 1987). Sharpe has been a pioneer in developing financial science.

Paul Samuelson (1965), who won the Nobel Prize in Economics in 1970, counts, among his numerous contributions to economics an examination of the behavior of securities prices. He emphasized that market prices are the best estimates of value. Price changes follow random patterns. According to Samuelson, future stock prices are unpredictable. The Concise Encyclopedia of Economics states that "in finance theory, which he [Samuelson] took up at age fifty, Samuelson did some of the initial work that showed that properly anticipated futures prices should fluctuate randomly. Samuelson also did path breaking work in capital theory..." These contributions made a significant contribution to the latter theoretical developments in financial science. The work of Robert Merton and William Sharpe has also significantly been influenced by the Samuelson's work.

Information efficiency is vital to the success of the capital markets as decisions have to be taken based on all available information. This particular aspect of the financial markets was seriously addressed by Eugene F. Fama (1965, 1972, 1976), who also won the Nobel Prize in Economics for his work on finance, in his seminal work on efficient market hypothesis. Fama's work has significantly been influenced by the contribution of Samuelson. He conducted extensive research on stock price patterns. Fama distinguished between three types of efficiencies, namely, weak form efficiency, semi-strong form efficiency, and strong form efficiency, under three different sets of information available to the investors. He extended earlier work on unpredictability of stock prices and finds that prices quickly incorporate information. He argued that if investors use past information to make predictions, markets are only weak form efficient. If investors do have access to past and current public information, markets become semi-strong form efficient. When investors use all available information markets become strong form efficient meaning that no single individual is able to make a different prediction about the future behavior of stock prices from what the average investor is able to foresee. He developed "Efficient Markets Hypothesis," which asserts that prices reflect values and information accurately and quickly. It is difficult, if not impossible, to capture returns in excess of market returns without taking greater than market levels of risk. Investors cannot identify superior stocks using fundamental information. In practice, however, there is no perfect information situation in any market meaning that future securities prices can be predicted by using various past and current information available (Vidanage and Dayaratna-Banda 2012 and 2013).

In the late 1960s, researchers also began inquiring into the performance of managers and how that tended to determine the risks and returns. Michael Jensen (1965) and A.G. Becker Corporation (1968) have conducted in depth research into the nexus between financial market performance and manager performance. First Jensen studied mutual

funds and A.G Corporation institutional plans indicating that active managers under-perform indexes. Becker Corporation gives rise to consulting industry with creation of "Green Book" performance tables comparing results to benchmarks. First studies showing investment professionals fail to outperform market indexes. Jensen specifically analyzed the role of fund managers in managing mutual funds.

In early 1970s, Chicago University researchers began to inquire into the derivative pricing models, especially focusing on option pricing. These researchers include Fisher Black and Myron Scholes of University of Chicago and Robert Merton of Harvard University, who also won the Nobel Prize in Economics in 1997. The development of the Option Pricing Model allows new ways to segment, quantify and manage risk. It spurs the development of a market for alternative investments. Their work was mainly focused on highly risky derivative securities. Option pricing under risk and uncertainty open various new theoretical avenues for researchers to inquire into human behavior under conditions of uncertainty and risks (Black 1975, 1976, 1986, 1987; Black and Scholes 1973, 1974; Merton 1973).

The link between random prices and practical investing was inquired into by John McQuown and Rex Sinquefield (1963). This led to the birth of index funds and Wells Fargo Bank which have developed the first passive S&P 500 Index funds. Years later, Sinquefield chaired Dimensional and McQuown sat on its Board. Dimensional further develops passive and structured investment strategies. A major plan first committed to indexing of prices began in 1975. New York Telephone Company invests $ 40 million in an S&P 500 Index fund. The first major plan to index helped launch the era of indexed investing. "Fund spokesmen are quick to point out you cannot buy the market averages, and it is time the public could" (Burton G. Malkiel 1973). In order to facilitate this process, database of securities prices were developed. In 1977 Roger Ibbotson & Rex Sinquefield in an article entitled "Stocks, Bonds, Bills and Inflation", an extensive returns database for multiple asset classes was first developed which would become one of the most widely used investment databases. This is the first extensive, empirical basis for making asset allocation decisions changes the way investors build portfolios.

The effect of the size on risks and returns was also examined by Rolf Banz (1981). He analyzed New York Stock Exchange stocks from 1926 to 1975 and found that, in the long term, smallest companies had largest expected returns. Small companies behave differently from large companies and deserve stronger than market representation. International size effects were incorporated since 1986. This led to structured investing versus indexing. Dimensional Fund Advisors Inc. created a structured product in an undiscovered asset class. Dimensional product returns become the index used in Ibbotson Associates' database. Structured investing is innovative. It is based on a rational risk dimension, and does not slavishly follow indexes or investing conventions.

Eugene Fama and Kenneth French (1992) developed the multi-factor asset pricing model to explain the value effects. They improved on the single factor asset pricing model (CAPM) developed earlier by William Sharpe. They identified market, size and value factors in determining returns for securities. Fama and French further developed the three-factor asset pricing model, an invaluable asset allocation and portfolio analysis tool. They revolutionized the way we construct and analyzed portfolios by identifying independent sources of risk and return. They also introduced the first concentrated, empirical value strategies, which led to similar findings internationally.

Financial science over the last fifty years has brought us to a powerful understanding of the risks that are worth taking and the risks that are not. Three equity factors market included: stocks which have higher expected returns than fixed income, size which means that small company stocks have higher expected returns than large company stocks, price which means that lower-priced "value stocks" have higher expected returns than higher-priced "growth stocks".

Everything about expected returns in the equity markets can be summarized in three dimensions. The first is that stocks are riskier than bonds and have greater expected returns. Relative performance among stocks is largely driven by the two other dimensions: small/large and value/growth. Many economists believe small cap and value stocks outperform because the market rationally discounts their prices to reflect underlying risk. The lower prices give investors greater upside as compensation for bearing this risk. Applied core equity dimensional portfolio construction methodology weights securities by size and value characteristics instead of market capitalization. Total market strategies launched to provide efficient, diversified risk factor exposure while limiting turnover and transaction costs. Core equity portfolios move beyond traditional, component-based asset allocation via vast diversification and cost-efficient market coverage. Theory and policy in other sub-disciplines of economics are yet to incorporate analysis of human economic behavior under risks and uncertainty even though some advancement has taken place in recent times in macroeconomics.

The central premise that financial science as a subject holds in economics is more evident from the number of Nobel Memorial Prizes in Economics awarded to those who have been doing research on finance or on finance-related fields. Since the introduction of Nobel Memorial Prize in Economics in 1969, nearly thirty Nobel laureates have emerged from the area of finance or finance-related fields in economics (Table 1). Research on finance has contributed a great deal to the advancement of econometrics as quantitative methods widely applied in economic research. Most research developments in macroeconomics and microeconomics have also been highly influenced by the recent development of knowledge in financial science. The 2014 Nobel Prize in Economics was awarded to Jean Tirole whose theoretical and empirical work in microeconomics focusing on market power and regulating to tame big firms has heavily relied on financial markets and institutions for his analysis.

Table 1: Nobel Memorial Prize in Economics for Finance and Finance Related Research

	Year	Laureate	Nobel Citation	Field
1	1970	Paul Samuelson	"for the scientific work through which he has developed static and dynamic economic theory and actively contributed to raising the level of analysis in economic science"	Finance in microeconomics
2	1981	James Tobin	“for his analysis of financial markets and their relations to expenditure decisions, employment, production and prices”	Finance in macroeconomics
3	1985	Franco Modigliani	“for his pioneering analyses of saving and of financial economics”	Finance in macroeconomics
4	1990	Harry Markowitz Merton Miller William Sharpe	“for their pioneering work in the theory of financial economics”	Financial economics
5	1996	James Mirrlees William Vickrey	“for their fundamental contributions to the economic theory of incentives under asymmetric information”	Financial Economics
6	1997	Robert Merton Myron Scholes	“for a new method to determine the value of derivatives.”	Financial Economics
7	1999	Robert Mundell	“for his analysis of monetary and fiscal policy under different exchange rate regimes and his analysis of optimum currency areas”	Finance in international macroeconomics
8	2000	Daniel McFadden	“for his development of theory and methods for analyzing discrete choice”	Banking and Finance
9	2001	George Akerlof Michael Spence Joseph E. Stiglitz	“for their analyses of markets with asymmetric information”	Banking and finance
10	2003	Robert F. Engle	“for methods of analyzing	Finance in

			economic time series with time-varying volatility (ARCH)"	econometrics
11		Clive Granger	"for methods of analyzing economic time series with common trends (cointegration)"	Finance in econometrics
12	2010	Peter A. Diamond Dale T. Mortensen Christopher Pissarides	"for their analysis of markets with search frictions"	Finance in microeconomics and macroeconomics
13	2013	Eugene F Fama Lars Peter Hansen Robert J. Shiller	"for their empirical analysis of asset prices."	Financial economics

CONCLUDING REMARKS

The study of money, banking and finance has played varying roles, though pivotal, in shaping the theory and practice of modern economics. From the periphery of economic thought in early years of modern economics, the study of money, banking and finance has increasingly occupied a central premise in economic thought. Advancement of financial science as a distinct discipline has provided significant insights into the development of other sub-disciplines of economics. It has served as a platform for building economic theory in various sub-disciplines, staggering advancements in empirical methods in economics. Financial science has also increasingly become a vital policy tool in modern societies. Financial science is occupying a central place in mainstream economic theory and policy. Some have even suggested theoretically that finance literacy can be considered a capital serving as a vital input in production suggesting that human progress tends to depend also on, among other things, whether people are literate about finance or not. The study of finance has also gone beyond economics and has increasingly influenced the thought process of other disciplines in human sciences. However, financial science has not been given its central premise in economics study programmes and research in Sri Lanka. It is vital that we attempt to mainstream financial science in economics to provide a new leaf of valuable life to economics for analyzing human economic behavior under risks and uncertainty.

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