PRODUCTION ANALYSIS OF HOUSEHOLD-LEVEL PAPER RECYCLING UNITS IN VIETNAM

By

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A thesis submitted in conformity with the requirements for the degree of Doctor of Philosophy, Faculty of Forestry, University of Toronto

ABSTRACT

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Doctor of Philosophy, 2005

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Three essays that incorporate social, environmental and economic factors into comprehensive production analyses of 63 paper-recycling units from Duong O craft village, Bac Ninh province, Vietnam are presented in this dissertation.

The first essay developed a reduced-form model of the household production function, in which social capital is treated as a production factor similar to other conventional factors such as physical capital, labor, and human capital, and household income and expenditure as dependent variables. The results show that social capital has a strong and positive contribution to household income, and the positive contribution of social capital on the general households' income is greater than that of the paper-recycling households. The results also indicate that trust and reciprocity play the most important roles out of four components of social capital in contributing to household income.

The second essay employed a parametric deterministic input distance function in computing the relative shadow prices of social capital with respect to physical capital and labor. The results indicate that social capital have positive effects on technical efficiency of the paper recycling mills and impacts of one unit of social capital on technical efficiency is much greater than that of one unit of physical capital, but less than that of one unit of labor. The results also show that the role of social capital in production process is different for different income groups and trust and number of memberships in associations play a key role in increasing technical efficiency.

The third essay presents the use of a two-stage procedure which combines deterministic linear programming with a stochastic parametric output distance function in which both environmental effects and the role of social capital were considered and encompassed within the production analysis. The results indicate that production efficiencies could potentially be improved by 28% and there is a potential for improving environmental quality through introducing pollution-prevention methods to paper-recycling production processes in Vietnam. Furthermore, the study suggests that it may be inappropriate to restrict the shadow prices of environmental outputs to be non-positive for the analysis of some production processes.

Acknowledgement

I am indebted to many people and organizations that helped me while preparing the thesis and during my time as a graduate student at the University of Toronto. I am especially grateful to my Supervisors, Prof. Shashi Kant and Prof. Virginia Maclaren, whose doors are always opened for their students, allowing me a convenient access to their advice at all times and whose support has been a constant source of encouragement to me throughout this study. I am indebted to Prof. Hy Luong Van for his profound knowledge in sociology that has stood me in good stead. I am grateful to other members of my supervisory committee, Prof. Rodney White and Prof. Sussana Laaksonen-Craig for their academic supports and encouragement.

I also would like to express my special thanks to Prof. William Hyde, the external appraiser/examiner, for his useful comments on an earlier draft of this thesis.

I wish to thank all households and the owners of the paper-recycling mills in Duong O village who gave me times, hospitality and who participated in interviews that made this thesis possible. My sincere appreciation is expressed to Mr. Nguyen Sy Thanh who was a great bridge connecting interviewees and me. I also thank Phong Khe commune people's committee for providing the necessary documents that made it easier for me to work with interviewees. I am also grateful to the staff of the Center for Environmental Science and Technology (CEST), who made the environmental data available for this thesis.

I would like to take this opportunity to thank the Forestry University of Vietnam for sanctioning my leave so that I can pursue my studies uninterruptedly. I also greatly appreciate financial support from the Canadian International Development Agency (CIDA).

A warm thank to all my friends in the University of Toronto and in Vietnam for their friendship and encouragement. My sincere thanks go to Mr. Dinesh Misra, a senior Ph.D. candidate in the Faculty of Forestry - University of Toronto, for sharing with me his research experiences and cooperating with me in the research uninterruptedly.

I am also thankful to many members of the Faculty of Forestry and the Department of Economics - University of Toronto for their valuable teaching and instructions during my studying at the University of Toronto, Canada.

Finally, I am grateful to my wife Hoai Thu, and children Chung and Thanh, for their sacrifice, encouragement and love that without those I could not have completed my work.

TABLE OF CONTENTS

CHAPTER	CONTENTS	Page Number
	ABSTRACT	ii
	ACKNOWLEDGEMENTS	iv
	TABLE OF CONTENTS	vi
	LIST OF TABLES	ix
	LIST OF FIGURES	xi
	LIST OF APPENDICES	xii
1.	**INTRODUCTION**	1
2.	**LITERATURE REVIEW**	5
2.1	Social capital as a production factor in the household production process	5
2.2	Efficiency concept and measurement	8
2.3	The distance function approach	10
2.3.1	Background	10
2.3.2	Nonparametric linear programming studies	12
2.3.3	Parametric studies	13
2.3.3.1	Deterministic linear programming studies	13
2.3.3.2	Econometric studies	15
3.	**CRAFT VILLAGES IN VIETNAM AND DATA COLLECTION**	18
3.1	Craft villages in Vietnam	18
3.1.1	Introduction	18
3.1.2	Types of craft villages in Vietnam	19
3.2	A brief history and development of Duong O village	20
3.3	Data collection	21
3.3.1	Data samples for the year 2002 and 2003	22

3.3.2 Production and social capital data 23

3.4 Key economic and demographic features of households Duong O village 34

4. THE CONTRIBUTION OF SOCIAL CAPITAL TO HOUSEHOLD WELFARE IN A PAPER-RECYCLING CRAFT VILLAGE IN VIETNAM 37

4.1 Introduction 37

4.2 Specification and estimation of econometric models 38

4.2.1 Outputs and inputs of the household production function 38

4.2.2 Functional form of the household production function and its estimation 38

4.3 Results of the econometric analysis 40

4.3.1 Household production functions with aggregated social capital 40

4.3.2 Household production functions with disaggregated social capital 43

4.3.3 Comparison of Output Elasticities with Respect to Social Capital and Other Factors 45

4.4 Policy implications and conclusions 49

5. SHADOW PRICES OF SOCIAL CAPITAL FOR HOUSEHOLD-LEVEL PAPER RECYCLING UNITS IN VIETNAM **53**

5.1 Introduction 53

5.2 Theoretical foundations of input distance function and relative shadow prices of social capital 55

5.3 Empirical estimation of the input distance function 58

5.4 Relative shadow prices of social capital 62

5.4.1 Relative shadow prices of aggregated social capital with respect to physical capital and labor 62

5.4.2 Relative shadow prices of disaggregated social capital with respect to physical capital and labor 64

5.4.3 Relative shadow prices of social capital for different income groups 67

5.5 Conclusion 69

6. SHADOW PRICES OF ENVIRONMENTAL OUTPUTS AND PRODUCTION EFFICIENCY OF HOUSEHOLD-LEVEL PAPER RECYCLING UNITS IN VIETNAM 72

6.1 Introduction 72

6.2 Theoretical concepts of output distance functions and shadow prices of outputs 75

6.3 Empirical estimation of the output distance function for the production process of household-level paper recycling units 78

6.3.1 Calculation of the parameters of a deterministic parametric output distance function using the linear programming method 79

6.3.2 Estimation of the parameters of a stochastic parametric output distance function using an econometric method 80

6.4 The estimated output distance functions and the production efficiency of the household-level paper recycling units 83

6.5 Shadow prices of environmental outputs of the household-level paper-recycling units 87

6.6 A comparative view of the shadow prices of environmental outputs: the household-level paper recycling units of Vietnam versus the large-scale paper production units from the developed world 92

6.7 Conclusion and policy implications 95

7. SUMMARY, RESULTS AND RECOMMMENDATIONS 98

8. REFERENCES 105

9. ANNEXURES 115

LIST OF TABLES

Table Number	DESCRIPTION	Page Number
3.1	Social capital variables selected for inclusion in the household production models	30
3.2	Descriptive statistics of the outputs and factors for the year 2002 of data collections	32
3.3	Descriptive statistics of the factors and outputs of household-level paper recycling units for 2003 of data collections	33
3.4	Selected characteristics of the paper-recycling households and the general households in Duong O village	34
4.1	Coefficients for the production function of the paper-recycling households with a social capital index	40
4.2	Coefficients for the production function of the general households with a social capital index	41
4.3	Coefficients for the production function of the paper-recycling households with disaggregated social capital	44
4.4	Coefficients for the production function of the general households with disaggregated social capital	45
4.5	Household income elasticities for paper-recycling households	46
4.6	Household income elasticities for general households	48
5.1	Distance function parameter estimates for the aggregated social capital model	60

5.2	Input distance function parameters for the disaggregated social capital model	60
5.3	Relative shadow prices of aggregated social capital with respect to physical capital and labor	62
5.4	Relative shadow prices of disaggregated social capital with respect to physical capital and labor	65
5.5	Relative shadow prices of social capital with respect to physical capital by income groups	67
6.1	Estimated parameters of the output distance function of the household-level paper recycling units	83
6.2	Output efficiencies for different categories of household-level paper recycling units	87
6.3	Shadow prices of environmental outputs of household-level paper recycling units	89
6.4	Descriptive statistics of shadow prices of BOD, COD, and SS for five categories of paper recycling production units	90
6.5	A comparative view of the shadow prices of environmental output	93

LIST OF FIGURES

Figure Number	DESCRIPTION	Page Number
5.1	The input distance function and the input set	56
6.1	Production possibility set in good output (Y_G) and environmental output (Y_E)	77

LIST OF APPENDICES

Annexure Number	DESCRIPTION	Page Number
3.1	Map showing the Duong O village, Bac Ninh province, Vietnam	115
3.2	Household questionnaire	116
3.3	Water indicators in paper mill wastewater of Duong O village, Vietnam (rainy season)	122
3.4	Production data of the general households in 2002	123
3.5	Production data of the household-level paper-recycling units in 2002	127
3.6	Production inputs of the household-level paper-recycling units in 2003	132
3.7	Gross income, total expenditure, and production outputs of the household-level paper-recycling units in 2003	137
3.8	Environmental outputs, measured by a concentration level, broken down by production process for the household-level paper-recycling units in 2003	140
3.9	Environmental outputs, measured by total amount discharged per year, broken down by production processes for the household-level paper-recycling units in 2003	141

CHAPTER 1

INTRODUCTION

Vietnam is a low-income country with more than 80% of its population living in rural areas (Haughton 2000). As a result, the history of Vietnamese national development is closely connected with the development of villages and craft villages that are typical of the social, economic, and cultural tradition of Vietnamese rural areas (Phuong 2001)[1]. The industrialization of rural areas in Vietnam combined with the development of craft villages has made significant contributions to economic development and to changes in the national economic structure. The most important contribution is their role in increasing local income while providing employment to residents of neighboring villages (Digregorio 1999). Observation of this important position has encouraged the Vietnam government's policy makers to reconsider craft villages as a rural development option. Furthermore, in its socio-economic development plan until 2010, the Vietnamese government confirms that craft villages act as a bridge, connecting agriculture and industry, rural areas and cities, and traditional and modern trends (Phuong 2001). Under the new conditions of the market economy, this recognition offers favorable conditions for both business expansion and social mobility, which has allowed many craft villages to develop and quickly expand into neighboring areas. These form clusters of industrial craft villages with a certain level of specialization and mechanization, significantly increasing local income, and creating employment opportunities for both local residents and those of neighboring villages.

In this general context, the craft villages in which waste paper is recycled have also gone through a period of rapid economic growth. Many of them have entered into a process that is transforming them from communities of handicraft producers to small

[1] Cook (1993) defines crafts as “artifacts produced through labor processes of low organic composition of capital (i.e., low proportion of capital to labor.)”. “Artisan labor is specialized and special, and depends upon non-mechanized technology. The relations of craft production are not restricted exclusively to family/household units or domestic groups; they may also be wage-based relations” (Cook, 1993: 78).

industrial clusters that apply more complex technology and production processes than those before. They have become an integral force in reducing a considerable portion of the solid waste stream destined to landfills through recycling, thereby reducing the financial pressure on the public environmental companies. They also alleviate the demand for pulpwood in paper production, as well as, create several socioeconomic benefits for those rural areas (Digregorio 1999). However, in Vietnam, paper recycling is dominated by small-scale household-level units. In addition to lacking of financial resources and advanced technical knowledge, these small-scale recycling units also face several constraints in controlling pollution. For example, management of environmental problems is particularly hindered by the lack of skill and knowledge about pollution problems within these small-scale production units and lack of access to environmentally-sound technologies that are compatible to the scale of enterprises. Furthermore, these small-scale units have limited space for the installation of treatment systems, and lack of financial resources prevents these units from the installation and operations of pollution control facilities. As a result, these recycling units cause serious water and land pollution for the localities through liquid effluents and solid waste from their production processes. Their impact on environment is even all the worse since they are situated within or in close proximity to residential areas. However, under pressure of employment and income, pollution issues have been neglected in the past, but now these issues have become a growing concern of the local people mainly due to adverse effects upon agricultural activities and human health (Digregorio 1999). Hence, it has become essential to include environmental effects in the economic analysis of paper-recycling units in Vietnam.

In addition, there is growing empirical evidence, from rural sector, suggesting that social capital, resources embedded in relationships among actors, can help households or small-scale household-level production units to overcome the deficiency of other capitals (Annen 2001; Fafchamp & Minten 2002) and it is one of the most necessary production factors for sustainable development (Grootaert 1999a; Grootaert 2001; Grootaert, Oh, & Swamy 2002; Grootaert & Narayan 2004). Therefore, the incorporation of social-capital as one of the factors of the production process of household-level recycling units is as essential as the incorporation of environmental outputs.

In recent years, a distance function approach has been used to incorporate environmental outputs into economic analysis of production units (e.g., Färe et all. 1993; Coggins & Swinton 1996; Hetemäki 1996; and Hailu & Veeman 2000). However, due to a lack of micro level data, most previous studies have generally concentrated on measuring the effects of undesired outputs using industry or country level aggregate data (Hetemäki 1996) and these studies have been limited to the large-scale production processes of capital-intensive technologies from developed countries. The concerns about environmental problems, including the contribution of industrial production processes and small-scale production units to environmental pollution, in developing countries are as serious as in developed countries, and should not be neglected.

Most important, there have been so far no studies incorporating social capital as a production factor into the framework of the distance function studies. This may cause bias in estimation results of the production analysis because of non-inclusion of known independent variables. In addition, most of the distance function studies, except Hetemäki (1996) and Reinhard (1999), constrain the shadow price of undesirable outputs to be negative (weak disposability), which may be a realistic approach for some technologies and countries where environmental regulations are strongly enforced and monitored but it may be inappropriate for countries that lacks of those conditions. Hence, the results and policy recommendations of the existing studies may not be appropriate to household-level recycling units of Vietnam which are constrained by different technical, economic, social, and environmental situations.

This research attempts to fill in the gap in both economics literature and empirical work by developing a theoretical framework for production analysis of a paper recycling craft village in Vietnam. The main feature of the production analysis, conducted in this research, can be grouped into three components. First, social capital was fully defined and its contributions to welfare of both general and paper-recycling households in a craft village in Vietnam were measured. Some policy implications to enrich different dimensions of social capital for different income groups in this craft village were proposed based on the results withdrawn from the research. Second, a parametric input distance function was used to derive the relative shadow prices of an aggregated and disaggregated non-conventional factor (social capital) to indicate its relative importance with respect to other production factors such as physical capital and labor. The information on relative shadow prices of social capital was not only used for some policy implications, but also served as a basis for technical efficiency analysis and for efficient resource allocation. Finally, a parametric output distance function, which includes environmental outputs (BOD, COD and SS), traditional output (finished paper), conventional factors (physical capital, materials, energy and labor) and non-conventional factor (social capital), is conceptualized, estimated, and the outcomes are used to estimate the efficiency of household-level paper recycling mill and absolute shadow prices of environmental outputs. The information on efficiency and absolute shadow prices is used for some policy implications for sustainable development of the village.

The thesis is organized in the following seven chapters: A brief review of the relevant literature is presented in Chapter 2. Chapter 3 describes the case study context and methodology. In the fourth chapter the concept of social capital as a factor of production function is established and the contribution of social capital to household welfare in Duong O paper-recycling craft village is evaluated. Chapter 5 develops a concept of relative shadow price of social capital and an input distance function is used to measure it. The stochastic and deterministic parametric output distance functions used in a comprehensive framework, taking both environmental pollution and social capital into consideration in its analysis of shadow prices of environmental outputs and the technical efficiency of paper recycling production, are the subject of sixth chapter and finally, the seventh chapter highlights the summary and conclusions, significance of the research and suggestions for future research[2].

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[2] Chapter 4 has been accepted for publication in Journal of Environment and Development 13(3): p. 1-29; Chapter 5 has been submitted to Ecological Economics; and Chapter 6 has been presented at the Southern Forest Economic Workers Annual Conference (**SOFEW**) organized from 14th to 16th March 2004 in St. Augustine Florida, USA and has been submitted to the Journal of Environmental Economics and Management.

CHAPTER 2

LITERATURE REVIEW

Even though firm and its production process has been one of the central concerns of the environmental economics literature since the subject area started to emerge as a separate branch of economic literature in the 1960s (Hetemäki 1996), the efficiency methodology was applied to environmental problems very recently. Pittman (1983) was the first who extended the multilateral productivity measurement technique of Caves, Christensen, & Diewert (1982a; 1982b) to include undesirable output and applied his model to the US paper industry (Yaisawarng & Klein 1994). Since Pittman's study, many studies (e.g., Färe, Grosskopf, Lovell, & Pasurka 1989; Färe, Grosskopf, Lovell, & Yaisawarng 1993; Nestor & Pasurka 1993; Yaisawarng & Klein 1994; Ball, Lovell, Nehring, & Somwaru 1994; Färe, Grosskopf, & Tyteca 1996; Hetemäki 1996; Reinhard 1999; and Hailu & Veeman 2000) have incorporated undesirable outputs into efficiency analysis. This thesis not only goes alongside with the previous work to incorporate undesirable outputs into the framework of efficiency and productivity analysis; but it is the first attempt to incorporate social capital as an individual input like other forms of capital such as physical capital, labor, and human capital into a framework of the efficiency measurement as well. Therefore, to cover literature on these research areas, the chapter has been divided into the following main parts:

1. Social capital as a production factor in the household production process,
2. Efficiency concept and measurement, and
3. Distance function approaches.

2.1 Social Capital as a Production Factor in The Household Production Process

In recent years, the concept of social capital has become increasingly popular and its definitions can be grouped into three categories depending on whether they focus mainly on the individual (micro) level, on the collective (macro) level, or on both levels of analysis. The micro-level perspective, offered by Bourdieu (1985), Burt (1992), Flap

(2002), and Lin (1999, 2001), focuses on the use of social capital as a resource facilitating action by an individual. However, this perspective has been criticized due to its focus on securing benefits for individuals who deliberately participate in groups for the purpose of creating this resource (Porters 1998). In the macro-level perspective, offered by Coleman (1988, 1990) and Putnam (1993, 1995), social capital is seen as a collective entity, from which all individual actors may benefit. Putnam (1993, p.167) defines social capital as "features of social organization, such as trust, norms, and networks, that can improve the efficiency of society by facilitating coordinated actions", while Coleman (1988: S98 and 1990, p.302) emphasizes the idea of a resource of social relations which "inheres in the structure of relations between actors and among actors". In contrast to the above two views, Adler & Kwon (2000, p.93) appear to take the middle ground in defining social capital as "a resource for individual and collective actors created by the configuration and content of the network of their more or less durable social relations".

The early phase of social capital characterization relied largely on abstract definitions, and was dominated by sociologists and political scientists. In 1995, Fukuyama incorporated social capital in an economic framework to explain economic development. After that, several studies explored the extent to which social capital contributes to economic success. The recognition of social capital as an input in a production function has contributed to a broader analysis of policy options for economic development.

Narayan & Pritchett (1999) used social capital as a production factor and found that, in rural Tanzania, the degree and characteristics of associational activity measured by membership in groups, the characteristics of these groups, and individuals' values and attitudes toward these groups, have a positive and a strong impact on household expenditure. Grootaert (1999), Grootaert et al. (2002), and Grootaert & Narayan (2004) replicated the main characteristics of the methodology used by Narayan & Pritchett (1999), and extended the analysis in several directions for Indonesia, Bolivia, and the Burkina Faso. They based their definition of social capital on households' memberships in local associations, which they measured using six variables: the density of association, the internal heterogeneity of association, frequency of meeting attendance, members' effective participation in the decision making of associations, payment of dues and the community orientation of associations. Combining these variables, they constructed a social capital index, which turned out to be positively and significantly related to household welfare - measured by expenditure per capita. They also studied the impact of different aspects of memberships on household welfare and found that the strongest effect on household welfare comes from the number of memberships and internal heterogeneity of the associations. Other studies by Maluccio, Haddad, & May (2000) in South Africa and Ruben & van Strien (2001) in Nicaragua also reveal that social capital has a positive effect on household income. However, all of these focused on farming activities alone. Other types of household production have yet to be investigated. Most restricted their analysis to associational activity as a measure of social capital, which does not capture the impact of other aspects of social capital on economic outcomes.

According to social capital theory, other influences on household income can include information sharing through social relations, trust, and reciprocity. Information sharing facilitates the flow of information, thereby reducing transaction costs, and avoiding the problems of opportunism and market failure due to imperfect information (Fafchamp & Minten 2002). High levels of trust, achieved through repeated interaction among economic actors, encourages co-operation and reduces transaction costs (Pargal, Huq, & Gilligan 2002), thereby saving resources and increasing the enforceability of contracts (Pretty & Ward 2001). Reciprocity fosters exchanges for mutual benefits (Maluccio et al. 2000). Thus, it contributes to the development of long-term obligations among actors, which are an important aspect of achieving positive outcomes (Pretty & Ward 2001).

For the purpose of my research, I defined social capital as *"resources embedded in relationships among households that facilitate productive capacity of households"*. I operationalized this definition by focusing on four different aspects of relationships: associational activity, information sharing (social relations), trust, and reciprocity at the individual and household levels. The emphasis in this case is on the actual or potential benefits that households accrue from their network of formal and informal ties with others (Burt 1992). Especially, in Vietnam social relations are extremely important since through these relations one may get financial or/and resources assistance to initiate his/her business or to continue maintaining his/her successes in business. For example, individuals or households use their personal contacts or through kinships to get credits, advice, information, solving problems, borrowing materials, and obtaining complementary resources for their production processes. Hence, similar to Loury (1977), Fukuyama (2001), and Glaeser, Laibson, & Sacerdote (2002), I conceptualize and measure social capital as a household good which is different from the conceptualization of social capital as a public good by Coleman (1990), Putnam (1993), and Dusgupta (2000)[3]. As a result, in the current study social capital is treated on a par with conventional production inputs - physical capital, human capital, and labor.

2.2 Efficiency Concept and Measurement

Efficiency can be broadly defined as the quality or degree to which a set of desirable effects is achieved (Färe, Grosskopf, & Lovell 1985). The efficiency of a producer is then measured using some index for comparing observed with desirable performance. This comparison may be made in terms of quantities (inputs and outputs) or values (cost, revenue, and profit). Efficiency can also be decomposed into a number of components such as technical and allocative efficiency.

Early efforts in the investigation of efficiency and its measurement were conducted by Koopmans (1951, 1957) and Debreu (1951); however, Farrell (1957) was the first one who developed a basic standard efficiency methodology. He considered that the efficiency of a firm consists of two main components: (i) technical efficiency, which involves the ability of a firm to obtain maximum possible output from a given set of inputs, and (ii) allocative efficiency, which reflects the ability of a firm to use the inputs in the optimal proportions to maximize its profits, given their respective prices. These two components are then combined to provide a measure of total economic efficiency (overall efficiency).

Most of the papers related to the measurement of productive efficiency have based their analysis either on parametric or on non-parametric methods. The choice of

[3] Although there is no contradiction between the two approaches, the treatment of social capital in production analysis differs. Social capital, conceptualized and measured as a public good, will be a shift factor in an aggregate production function and thus a component of total factor productivity (Dusgupta 2000), while social capital, conceptualized and measured as a private good, will be a production factor on par with other factors.

estimation method has been an issue of debate, with some researchers preferring the parametric approach (e.g. C. A. L. Lovell & Schmidt 1988; Berger 1993) and others preferring the non-parametric approach (e.g., Charnes, Cooper, & Rhoses 1978; Seiford & Thrall 1990).

Non-parametric methods are based on linear programming techniques (activity analysis) such as the Data Envelopment Analysis (DEA). The chief advantage of the non-parametric approach is that no explicit functional form needs to be imposed on the data; however, its main disadvantage is their deterministic nature. The DEA, for instance, does not distinguish between technical inefficiency and statistical noise effects. The parametric approach; on the other hand, starts with a postulated functional form for the production function or some dual representation of the technology (almost always using cost or profit function) that can handle the statistical noise. The main disadvantage of parametric approaches is that the functional form requirement may cause both specification and estimation problems.

The parametric approach is naturally subdivided into deterministic and stochastic (econometric) parametric models. Deterministic models envelope all the observations, identifying the distance between the observed production and the maximum production, defined by the frontier and the available technology, as technical inefficiency. On the other hand, stochastic approaches permit one to distinguish between technical efficiency and statistical noise.

Bjurek, Hjalmarsson, & Forsund (1990) observed that most of efficiency measurement was used for a single output and multiple inputs technology; however, when multiple inputs are used to produce multiple outputs, there must be a use of multi-output measures instead of single output measures for productive efficiency measurement. Several studies have applied the DEA in measuring technical efficiency for multi-output technology; however, as it is nonparametric, relying on comparison with extreme observations, it is sensitive to random error, and also does not provide estimates of the impacts of individual inputs on the level of outputs, or the relationship between the outputs themselves. In this case cost, revenue, and profit functions also enable us to deal easily with multi-outputs and multi-inputs; however, the use of these functions imposes a number of restrictive assumptions. For example, it requires behavioral assumptions such as profit maximization or cost minimization and information on prices of inputs and outputs. When price information is not available or alternatively when price information is available but cost, profit or revenue function representations are precluded because of violations of the required behavioral assumptions, the application of cost, profit or revenue functions for computing technical efficiency are not reliable. The distance function; however, requires no such conditions. I now discuss the distance function approach and its characteristics in some details.

2.3 The Distance Function Approach

2.3.1 Background

Input and output distance functions were introduced into economics by Shephard (1953) in a book named "cost and production function" that is widely known for the commonly used lemma named after him. Shephard (1970) continued to explore the properties and potential applications of input distance and output distance functions in his later work; however, it was not until recent years that applications involving distance functions have begun to appear in a large number (e.g., Färe et al. 1993; Yaisawarng & Klein 1994; Ball et al. 1994; Coggins & Swinton 1996; Hetemäki 1996). There are at least three important factors behind this increasing popularity. One is the introduction into the literature, by Caves et al. (1982a), of new input- and output-oriented Malmquist productivity indexes that are defined in term of input and output distance functions, respectively which are then extended by Pittman (1983) to include undesirable outputs in multilateral productivity measurement. The second is the work of Rolf Färe and his colleagues has been influential in popularizing the use of distance functions (e.g., Färe 1988; Färe et al. 1993; Färe & Grosskopf 1994; Färe & Primont 1995; Grosskopf, Hayes, Taylor, & Weber 1997). The third, but the most important one, is that it was motivated by a desire to calculate technical efficiency and/or shadow prices based on attractive characteristics of distance functions as presented in the following paragraph.

First, like production, cost, and profit function, distance function provides a complete representation of the production technology, showing "how inputs are turned to outputs." In contrast to production function, the distance function can model joint production of multiple outputs and join production technologies. Second, one importance advantage of distance function over cost, profit and revenue functions (which can also be readily used for model multiple output technology) is that no maintained behavioral hypothesis (cost minimum or profit/revenue maximization) is required. The distance function only identifies the boundary or frontier technology and measures the distance from a producer to the boundary of production possibilities. Therefore, distance functions are particularly useful for modeling the behavior of both publicly owned and highly regulated organizations that do not necessary follow conventional optimizing behavior. Third, the distance functions can be calculated with data on quantities of inputs and outputs alone; prices are not necessarily required. This fact is of particular importance in the present case since environmental outputs and social capital in this study are not traded in the market and the data on their prices are not observable. Furthermore, in developing economies like Vietnam, in many situations input and output markets are absent, and the existing markets are subject to many market imperfections. Therefore, information on prices is not a reliable measure.

Finally, the duality between distance functions and cost, profit and revenue functions allows one to derive shadow prices for inputs and/or outputs. This is the most important characteristic of the distance function that makes it seem superior to other representations of the technology. For example, by the distance function I can estimate the “price” of pollution or “price” of social capital. In the case of environmental outputs, this ”price”, denoted as the shadow price of the ”bad” output, is measuring the revenue loss (or gain) due to an incremental decrease in the environmental outputs, while in the case of social capital which is considered as an input like other forms of capital (e.g., physical capital, human capital, and labor), this “price”, denoted as the shadow price of the “good” input, is measuring the revenue gain (or loss) due to a marginal increase in social capital.

The above advantages of distance function come at some cost. The main disadvantage of distance functions is that their empirical application is not as straightforward as that of production, cost and profit functions, especially the stochastic (econometric) estimation of distance function (Hetemäki 1996).

Like the measurement of productive efficiency by other approaches presented earlier, in the empirical applications of distance functions, non-parametric and parametric estimations are two main approaches found. In the next two sections the literature on them will be presented.

2.3.2 Nonparametric Linear Programming Studies

The nonparametric distance function approach for the computation of efficiency is similar to the DEA developed by Afriat (1972) among others which was widely used in operations research to measure efficiency. The major difference between them is that distance functions are firmly based on neoclassical production theory, whereas no such theory lies behind the DEA. As a result, in the DEA one does not define the production technology.

Banker, Charnes, & Cooper (1984) is the first ones who relate Shephard's distance function to the Charnes et al. (1978)'s efficiency measure (i.e., efficiency measured by the DEA approach) and establish an equivalence between the Charnes et al. (1978)'s measure and the reciprocal of Shepard's distance function under the assumption that the production possibility set satisfies four postulates such as convexity, weak disposability, constant returns to scale and minimum extrapolation. The following year, Färe et al. (1985) extensively exposed how distance function could be used to measure production efficiency. Färe, Grosskopf, & Lovell (1994) continued providing a number of numerical examples of different ways to apply nonparametric computation of distance functions in measuring efficiency and productivity change.

The main advantage of using nonparametric estimation is that neither a parametric functional form nor a distribution form for the error terms is imposed in the model; however, its advantage is the limited amount of information it provides and its deterministic nature. For example, the nonparametric frontier is piecewise linear and thus non-differentiable at the corners. As a result, one cannot calculate shadow prices at those points based on the nonparametric estimation. Furthermore, with the deterministic nature, non-parametric approach provides no random errors that make the inference about the consistency of the "estimates" difficult. Perhaps, these limitations of non-parametric linear programming approach for computation of distance functions constrain the number of research applying this technique in measuring efficiency and recently there have been attempts to establish statistical properties for frontier models based on a nonparametric linear programming approach. For example, Grosskopf (1996) briefly surveyed the statistical inference in nonparametric, deterministic, linear programming-based frontier models in which he shows that the DEA estimators are maximum likelihood and discusses the attempts to employ resampling methods to derive empirical distribution for hypothesis testing.

2.3.3 Parametric Studies

The parametric approach is naturally subdivided into deterministic and stochastic models. Deterministic models envelope all the observations, identifying the distance between the observed production and the maximum production, defined by the frontier and the available technology, as technical inefficiency. On the other hand, stochastic approaches permit one to distinguish between technical efficiency and statistical noise. The most commonly used method in the empirical estimation of distance functions has so far been deterministic linear programming method, and only few studies have used econometric methods (Hetemäki 1996).

2.3.3.1 Deterministic Parametric Linear Programming Studies

Most of the papers related to applying distance function approach to measure productive efficiency and/or shadow prices have based their analysis on the parametric deterministic technique because of their simplicity and flexibility. The method relies on minimization of the sum of the value of distance between the observed production and the maximum production, defined by the available technology and the unknown frontier that is being estimated. The principal advantages of this approach compared to nonparametric approach are the ability to characterize technology in a simple mathematical form and the ability to accommodate non-constant returns to scale. The parametric deterministic programming method does not require any distribution assumptions. It is relatively easy to use and allows for the computation of a large number of parameters, even with a small number of observations (Hetemäki 1996). The major weakness of this approach is that it does not allow for random disturbances and provides no statistical criteria for the consistency of results (C. A. L. Lovell & Schmidt 1988). Most of the studies under this category have utilized a translog linear programming model computed using method first proposed by Dennis J. Aigner & Chu (1968).

Färe et al. (1993) was the first one who applied a deterministic output distance function to derive shadow prices of undesirable outputs. Utilizing the data used by Pittman (1983), they provided an alternative method of calculating the shadow prices of outputs including undesirable outputs. The study exploited the duality between the output distance function and the revenue function to measure shadow prices rather than constructing them from abatement costs like previous studies. By specifying a translog function form for output distance function and imposing conditions for weak disposability of undesirable outputs, they estimated the output distance function and the estimated shadow prices of undesirable outputs which reflected the opportunity cost in terms of forgone revenue due to an incremental decrease in the environmental outputs. Furthermore, they found that shadow prices varied across the sample, which suggested that regulations in effect in 1976 in the US were not achieving an efficient allocation of resources.

Coggins & Swinton (1996) estimated shadow prices of SO_2 abatement for 14 coal-burning electric plants in Wisconsin. They used this shadow price information to compare to the actual prices paid for SO_2 permits. This comparison indicated that the estimated average shadow price was above the prices of allowance auction (e.g., their average shadow price of SO_2 emissions was $292.70 US per ton at 1992 dollar price while the average price for Phase I allowance on the EPA's 1993 allowance auction was only $156.60 US per ton). They concluded that this divergence derived from Wisconsin's stringent state SO_2 legislation. In a similar approach Swinton (1998) estimated the shadow price of SO_2 abatement using output distance function approach for Illinois, Minnesota and Wisconsin coal-burning electric plants. The results from this research indicated that the plants with the highest emissions rates were also the plants with the lowest marginal abatement costs. Their empirical results suggest that shadow prices provide a good approximation to the actual prices paid for SO_2 permits by electric utilities.

Hailu & Veeman (2000) employed a parametric input distance function in which both undesirable and desirable outputs were incorporated into the analysis of productivity and derivation of shadow prices. They also employed a translog function form for input distance function, imposing conditions for weak disposability. Their estimation of shadow prices of environmental outputs using aggregate time series data for the period 1959 to 1994 from Canadian pulp and paper industry indicated that the marginal cost to producers of pollution control has been rising. They also found that productivity improvement was stronger than conventional measures would have suggested.

2.3.3.2 Econometric Studies

The preceding section based on a deterministic parametric approach means that all the departure from the frontier in efficiency scores are due to inefficiencies of production system only; however, in reality it is very possible that a firm's performance may be affected by factors entirely outside its control (e.g., bad weather, variation in labor and machinery performance, input supply breakdown, and so on), as well as by factors under its control (inefficiency). This argument lies behind the stochastic model of D. J. Aigner, Lovell, & Schmidt (1977) and Meenusen & van den Broeck (1977). The model allows for technical inefficiency, and captures the effects of measurement error, other statistical noise, and random shock outside the firm's control. In principle, it is possible to separate the contribution of random shock from that of technical inefficiency. For this purpose, the error term is usually supposed to consist of two components: (i) a positive one-sided component to capture the effects of inefficiency; and (ii) a symmetric two-sided noise component to capture random shocks. Therefore, this model also called the "composed error" model.

One issue that arises in estimation of stochastic distance function is that one does not observe (have data on) the dependent variable. Furthermore, if one sets the distance function equal to its efficient value (frontier) (i.e., Do(or i) =1), the left-hand side of the distance function is invariant. Therefore, an intercept cannot be estimated, and OLS parameter estimates will be biased. Most importantly, if the distance function is expressed in logarithms, the left-hand side of the distance function will be zero for all observations (i.e., Do(or Di) = Ln(1) = 0).

So far there have been two major methods applied in the stochastic distance function studies to deal with the above problems. One is the method applied by C. A. K.

Lovell, Richardson, Travers, & Wood (1994), Grosskopf et al. (1997), Tim Coelli & Perelman (1999), and Tim Coelli & Perelman (2000). This method utilizes the property that the output distance function is homogenous of degree +1 in outputs; while the input distance function is homogenous of degree +1 in inputs. Therefore, for each observation in both left-hand side and right-hand side, output (input) variables were multiplied by a number ($\lambda = 1/U_m$); where (U_m) is one of the outputs (inputs) chosen. This division makes the left-hand side variant; however, it imposed some problems with estimation. After the transformation, the multiplicative (output or input) variable appears on both the left- and right-hand sides of the equations, which may result in endogeneity on the right-hand side. Furthermore, in theory the value of the output distance function should never exceed one (i.e., plants operate below or on the frontier); however, in the estimation of a stochastic distance function transformed above, for some plants the forecasted value of the output distance function can exceed the theoretically plausible value. To account for this problem, the studies mentioned earlier including C. A. K. Lovell et al. (1994), Grosskopf et al. (1997), Tim Coelli & Perelman (1999), and Tim Coelli & Perelman (2000) used a method named "corrected ordinary least squares" (COLS). This method involves two stages. In the first stage, ordinary least square (OLS) is used to obtain the consistent and unbiased estimates of slope parameters and a consistent but biased estimate of the intercept parameter for the transformation function. In the second stage, the most negative residual from the distance function estimated in the earlier stage was calculated and then added to the intercept term so that the corrected estimates of the output distance function never exceed the theoretically plausible value for any plant. In other words, this ensures that the estimated frontier bounds the data from above. Although the COLS technique is simple and provides standard errors of the estimates, thus allowing statistical inference, the computation of inefficiency in these approaches reverts the analysis back to the deterministic model. As a result, this technique does not make allowance for the effect of random shocks, which might also contribute (positively or negatively) to variation in output.

The second method for estimating the stochastic distance function is the one used by Hetemäki (1996) in which a two-stage approach was applied to estimate output distance function. In the first stage, Hetemäki used a deterministic nonparametric piecewise linear model to estimate the distance from each plant to the reference production frontier (i.e., distance function). In the second stage, the distance measures computed in the first stage are use as a dependent variable in a parametric stochastic distance function model. By using this approach, one can relax the assumption that all the plants are operating on the frontier and avoid an invariance of dependent variable. However, similar to the method mentioned above in the two-stage stochastic estimation of the distance function, using values of the dependent variable (output distance) from the linear programming method, which were estimated using the same independent variables, may result in endogeneity on the right-hand side. Thus, one should test for potential endogeneity bias using; e.g., the Hausman specifications test.

CHAPTER 3

CASE STUDY CONTEXT AND METHODOLOGY

3.1 Craft Villages in Vietnam

3.1.1 Introduction

The Red River delta of the north of Vietnam is a fertile agricultural region. Its primary crop, wet rice, provides for the needs of its people and provides them with a large portion of their income. Apart from agriculture, the Red River delta also supports a large number of craft villages. These villages, which has supplied common tools and goods used by rural people such as rakes, ploughs, ceramic, pottery, votive goods for the people's spiritual life; artistic goods for their cultural life and paper for their intellectual life for uncountable generations, have more recently undergone a rapid progress of renovation and industrialization.

Most of craft-making villages in rural areas of Vietnam started as “extra-occupation” for local people to produce goods during idle time to sell for cash supplementing a low income from agricultural activities. At the early this century, Gourou (1936) counted 108 craft villages within the Red River delta employing more than 250,000 people, roughly 7% of the adult population. During this period, in each craft village there were only a small number of the people who concentrated on their non-agricultural occupation year round. The majority engaged in “extra-occupation” during idle time between agricultural seasons. These small-scale household producers used relatively simple manual technology and non-toxic materials. As a result, their production activities had little effects on environment.

Since 1986, together with the process of economic reform and industrialization of the country, the craft villages in the Red River delta have also gone through a period of rapid growth. According to recent reports there are about 200 craft villages within the watershed of the Cau River, a river running through the six provinces of Bac Kan, Thai Nguyen, Vinh Phuc, Bac Giang, Bac Ninh and Hai Duong (Digregorio 1999). In these craft villages, households have been divided into three types of different production activities: agricultural only, both agricultural and "extra-occupation", and "extra-occupation" only. However, "extra-occupation" has been become the most important for local people since it provides main source of income for the households. Therefore, they are accelerating investment, purchasing machines to increase labor productivity and improving product quality. In this way, many craft villages have become small industrial centers. This development, on the one hand, has provided many employment opportunities and increase income for local people, but on the other hand, has raised a number of problems, especially problems related to environmental pollution and its impacts on the health of the community (Digregorio 1999).

3.1.2 Types of Craft Villages in Vietnam

There are many different names that have been given to the craft villages in Vietnam such as traditional craft villages (lang nghe truyen thong), handicraft villages (lang thu cong), and small industrial villages (lang tieu thu cong nghiep). According to Phuong (2001, p.13), "a craft village is a rural village that has one (or some) handicraft occupation(s) that operates independently and separately from the agricultural activities". It is generally accepted that a craft village is a rural village that has from 35-40% of households specializing in a certain occupation and they can live on the income from that occupation (Phuong 2001). Digregorio (1999) classified craft villages in Vietnam into six main categories based on a product group and a production process group as follows:

Handicraft villages are villages that produce goods for daily use, such as scissors, knives, baskets and mats familiar to many Vietnamese. Handicraft production is as it appears, largely the work of artisans working with simple hand and power tools. Handicraft industries are also generally cottage industries with each household carrying out as much of the production process as possible, considering its particular mix of labor and capital.

Art craft villages produce goods of cultural and decorative value. Some of these goods, like inlaid wooden furniture, are considered symbolic of attaining a social-cultural standard. Others such as stones wood and lacquer statuary have both artistic value and value as religious objects. Art craft villages have benefited from the opening of the market both in term of expanding customer bases and through the work of dealers and agents, improvements in product quality and design.

Services and trading villages are less obvious than other village industries and thus frequently overlooked. In a sense, all craft villages contain individuals who derive their incomes solely from services and trading. What separates service and trading villages from other craft villages is that they generally do not produce the goods that they sell, and in fact, may only sell their services. Therefore, service and trading villages consists of traders and retailers, on the one hand, and itinerant craft people and service providers, on the other hand.

Industrial villages produce intermediate and final goods in a form of production that incorporates both technical and organizational characteristics more similar to industrial production than handicraft production. Industrializing craft villages are in minority among craft villages in the Red River delta but they are extremely important indicators of the potential of craft villages as a form of production to successfully compete with vertically integrated producers in the market. Therefore, they are the main objects of this research.

Food processing villages process agricultural products, produce beer, raise and slaughter livestock, distill alcohol, or produce other agricultural products, such as essential oils. Some food processing villages, such as the starch processing villages in Duong Lieu, Cat Que and Minh Khai subdistrict of Ha Tay, province, resemble industrializing craft villages in the degree of horizontal integration present within the overall production process. Most, however, is more like the cottage industries common in handcraft villages.

Material supply and processing villages lay some where between handicraft and industrial villages in their production methods. Many produce common construction inputs such as quicklime and sand. Others play an important part in processing recycled materials for use as inputs in other industries. The common characteristic of these villages is that they take raw materials and process them into a form that can be used by other producers and service providers.

3.2 A Brief History and the Development of Duong O Village

Among many different types of craft villages in Vietnam, there are three main types of recycling craft villages: plastic-recycling, metal-recycling (foundry villages), and paper-recycling villages. My focus being on paper recycling, we selected for the current study site Duong O village, Bac Ninh province, situated about 32 kilometers northeast of the Vietnamese capital, Hanoi (please see Annexure 3.1 for a map of studying area). The development of Duong O village is not only significant for creating several socio-economic benefits for Hanoi, but also reducing a considerable portion of the solid waste stream destined to landfills through recycling waste paper, thereby reducing the financial pressure on environmental companies in Hanoi and in surrounding areas. According to statistics supplied by the People's Committee of Phong Khe commune (Personal communication, June 2002), Duong O village currently has a population of 3,950 with 700 households. Of many traditional paper-making craft villages that have existed in the north of Vietnam for centuries, Duong O has become the most industrialized village, while other villages have developed poorly. In the past, Duong O was known for its production of Do paper. Do paper is an off-white paper produced from the bark of the Do tree (Nepal paper plant). It is silky smooth and flexible, acid free, mold resistant and water resistant.

The production of traditional Do paper in the village, because of the shrinkage of the Do paper market, has almost stopped. During the past decade, the village has been transformed from a community of Do paper producers to a community of small industrial producers. From six paper mills with six paper production lines in 1992, Duong O village now possesses 71 paper mills with more than 100 paper production lines. By using mostly wastepaper as material input, Duong O village produces about 200 tons of finished paper per day and employs about 1,900 workers working directly in the paper factories. Different categories of paper produced by the village, such as toilet paper, tissues, votive paper, Kraft paper, and printing paper, are distributed throughout Vietnam. Duong O recycling village has created jobs for thousands of people in other localities as they participate in the process of trading wastepaper, collecting, sorting and cleaning wastepaper, and transporting wastepaper, materials or finished products.

3.3 Data Collection

3.3.1 Data Samples for the Year 2002 and 2003

I collected production data, including social capital, in Duong O village using a questionnaire survey conducted in two years.

In the year of 2002, the major objective for the first essay is to study the contribution of social capital to household welfare; therefore, I collected data from two types of households – general (non-paper manufacturer) and paper-recycling households. The first category consisted of a random sample of 15% (105 households) of the total households in the village. One of every six households on an alphabetical list was selected. In the case of refusals or a selected household being also a paper-recycling household, either the immediately preceding or succeeding household on the list replaced that household randomly. Only 13 households were replaced (2 general households refused to cooperate, and 11 households were moved to the second sample because they owned paper recycling factories). The second set of households comprised 67 household-owned paper-recycling factories (hereafter referred to as paper recycling households), representing 90% of the total paper recycling factories in the village. Eight households of 75 households having paper factories could not be reached for various reasons such as holidays, mourning, and refusals. I administered the survey using face-to-face interviews with the head of a household in the presence of other members of the family, from the beginning of June to the end of July 2002, and a complete data set for this survey was given in Annexure 3.4 and Annexure 3.5.

In the year of 2003, the focus of the study is on the paper-recycling units to study their production efficiency and to derive shadow prices of social capital and environmental outputs; therefore, I approached all seventy-one household-level paper-recycling units in the village to participate in my survey[4]. However, eight households could not be reached for various reasons such as holidays and refusals; thus, 63 household-level paper recycling units were interviewed in 2003. Data were also completed by means of face-to-face interviews with the head of a household in the presence of other members of the family, from the beginning of June to the end of July

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[4] Compared to the year 2002, four paper-recycling units were closed due to difficulties in their production.

2003, and the complete data set was given in Annexure 3.6. It should be noted that the data set collected in 2002 was used for analysis in Chapter 4; while the one collected in the year 2003 was used for all the analysis in Chapter 5 and Chapter 6.

3.3.2 Production and Social Capital Data

Data on one good output or desirable output (paper production) and the six inputs – capital, labor, energy, raw material (waste paper), other materials, and social capital were collected through a questionnaire; however, data on environmental outputs or undesirable outputs were collected by the Center for Environmental Science and Technology (CEST), Hanoi Technology Institute. The questions on good output, capital, labor, energy, waste paper, and other material were standard and direct. The type of social capital included in this analysis was household-specific social capital, which exists in the social relationships directly relating to the process of production and services. Details about production data and social capital data were discussed next.

Desirable production output: Generally, outputs and inputs are measured in physical terms; however, production-specific conditions may demand the measurement of output and/or inputs in value terms (Nerlove 1965). The paper recycling households produce different types of paper; and the general households produce many outputs that cannot be added together in term of physical units (e.g., "apples cannot be added to pears," Nerlove 1965, p.11). Moreover, it was impossible to measure the general household's outputs in terms of physical units because their major income was from provision of support services for recycling and paper production (Table 3.4). Hence, we measured household outputs in monetary terms.

Many authors have used expenditures as a proxy for production output, mainly because of difficulties in obtaining data on household income. Narayan & Pritchett (1999) claimed that even if it is possible to obtain income data, the presence of "saving and dissaving" means that using current expenditures to measure permanent income is better than using current income. A counterargument to this claim is that consumption, and hence expenditures, depends not only on income but on many other factors as well, such as habits, traditions, attitudes toward risk, and moral, socioeconomic, and political conditions that can vary by nation or community. Consequently, the substitutability of income and expenditures needs to be carefully tested when applied to different contexts. In recognition of this concern, we have used household income and household expenditure as production outputs in the current study. The total annual household income is the total income from different sources (i.e., agriculture, animal husbandry, paper production, services, pensions, and subsidies), whereas household expenditures include production expenses (e.g., agriculture, animal husbandry, paper production, and other services), living expenses (e.g., food, clothes, transportation, health care, education, electricity, telephone, and entertainments), and any other expenditure.

Undesirable production outputs: With technical advice and support from the Center for Environmental Science and Technology (CEST), Hanoi Technology Institute, I identified biological oxygen demand (BOD), chemical oxygen demand (COD), and total suspended solids (SS) as the three most important environmental outputs from recycling units.

Three undesirable outputs (BOD, COD, and SS) were also chosen by most previous studies on technical efficiency in paper production industry (e.g., Färe et al. 1993; Hetemäki 1996; Hailu & Veeman 2000; and Murty & Kumar 2002). Further, as presented in annexure 3.3, the average levels of pollutants in the wastewater of recycling units in Duong O village have been much higher than the Vietnamese government's industrial wastewater standards for many years, and this has become a concern of local people and researchers. For example, the levels of BOD, COD, and SS in wastewater in 2003 exceeded the standards by more than 10, 19.6, and 11 times, respectively. The levels of BOD and COD have also been increasing over time. For example, the level of BOD in 2003 was 5 times greater than that in 1998 and the level of COD in 2003 was twice the level in 1998[5]. However, the level of SS in the wastewater in 2003 was only half of that in 1998. The reduction in the level of SS might be because of two major reasons. First, the paper production lines installed in recent years may have better technology with respect to recovery of paper fibers, the main component of SS. Second, paper-recycling units might have used their experiences in recovery of paper fibers to increase their productivity. Further, in Vietnam there is a community of people living around Tan Mai pulp and paper

[5] Only 15 samples were used to measure the levels of environmental outputs in wastewater in 1998, while 63 samples were used in present study; therefore, there might be some inconsistence in this comparison.

mill, Dong Nai province, earns their living by recovering paper fiber emitted in the mill's wastewater, and then selling it to low-grade paper-makers in nearby Ho Chi Minh City (O'Rourke 2002); therefore, the paper-recycling units in Duong O might have leant the experiences from there to increase their production efficiency. The above presentations indicate that the inclusion of BOD, COD, and SS as undesirable outputs is necessary in the analysis of production efficiency in present study.

The CEST collected wastewater samples from each production unit and analyzed the samples. These samples were collected in August 2003 (rainy seasons) for 63 paper-recycling factories. The CEST identified the concentration of BOD, COD, and SS levels in the wastewater for each paper-recycling production unit. The complete data on the concentration of environmental outputs in wastewater are given in Annexure 3.7 and Annexure 3.8. In these two annexures, environmental outputs are shown for each household-level paper-recycling unit in Annexure 3.7, and the concentration levels of BOD, COD, and SS in wastewater broken down by production processes for the household-level paper-recycling units in 2003 was given in Annexure 3.8. These environmental outputs were used to calculate total amount of BOD, COD, and SS discharged into the canal of Duong O village per year which were used for the models of Chapter 5 and Chapter 6, and were shown in Annexure 3.9. In Duong O village the systems used for discharging wastewater from paper production and wastewater discharged from daily living are separate; therefore, it is easy to identify the amount of wastewater discharged from paper recycling process per day; however, it should be noted that there may be some bias in the data of environmental outputs because they were collected only at one time in the year 2003 and in rainy season. To have more reliable data on environmental outputs, the samples should be collected at least three different periods in the year.

The environmental data in Annexure 3.8 indicate that production of tissue and toilet paper has the lowest level of water pollution. For example, the concentration of BOD, COD, and SS levels in wastewater for this type of paper is much lower than the average levels. It is also interesting to note that production of Kraft paper has a very low level of SS in the wastewater; while production of votive paper has a low level of BOD in wastewater. The lower levels of environmental outputs in wastewater in producing Kraft paper, tissue and toilet paper, and votive paper mainly came from a use of modern paper production lines to produce these types of paper. For example, in the village the most modern production lines were used to produce tissue and toilet paper, votive paper and Kraft paper. This made the recovery of chemicals and input materials such as paper fibers, chlorine and pine resin much higher than that of production of other type of paper (e.g., wrapping and mixed paper). As a result, the concentration of environmental output in wastewater is much lower for producing these types of paper than that of wrapping and mixed paper and production efficiency for producing these types of paper might be higher than that of wrapping and mixed paper as well.

Physical capital: The measurement of physical capital, in terms of physical units, poses the same problem as in the case of measurement of output. The different types of machines, instruments, and tools cannot be added together in physical terms. Hence, the physical capital was also measured in term of monetary value, and it is the total value of the means of production for a household. The value of the paper production lines and workshops constitutes a main part of the physical capital of the households having paper-recycling units, whereas the value of transportation and agriculture equipment, farm animals, and so on are the main constituents for the general households.

It should be noted that as well-known, the construction of data for capital stock and user cost of capital poses fundamental difficulties. Normally, they are counted by a summation of purchases of capital goods and basic improvement costs, and then deducted by rented capital goods and depreciation costs over time; however, in the current study since the production scales are small, it is easy to estimate the capital stock at a point in time of the household interviews. This construction of data for physical capital is more accurate than that counted by the formula mentioned above because the paper owners know the values of their assets very well. Moreover, the production means used for paper production in the village were assembled by the workers and owners of paper-recycling units. They are simple technologies, developed by local people using crude trial and error methods; therefore, they vary from factory by factory. As a result, it is impossible to have a standard or a general formula to count depreciations for these types of production means.

Labor: In developing economies such as Vietnam, in many situations labor markets are absent, and the existing labor markets are subject to many market imperfections. Therefore, the labor inputs may not be reflected by the worker's wages. For example, workers might not be paid at their marginal product but on the basic of their relationships with the owners of paper-recycling mill (e.g., with the same labor, the mill owner's uncle might get higher payment compared to that of other workers). For the same reason, the opportunity cost of household members, providing labor inputs, cannot be measured. Hence, labor was measured in physical units.

Paper recycling households employ skilled workers and also rely on family labor. Hence, for these households, the total amount of labor is the numbers of outside workers plus the number of family members older than 8 years. Household members older than age 8 years are considered part of the labor force because at this age they contribute to the production process by sorting and cleaning wastepaper or making votive papers. Previous studies have also used the number of people older than age 8 years as an indication of the amount of family labor available for farm production (Ruben & van Strien 2001). Moreover, in Vietnam, children only go to school for a half-day; therefore, they can help their parents for the rest of the day. General households do not hire workers, so the total labor in these households consists of all family members older than 8 years.

Human capital: In the rural areas of Vietnam, the family is normally managed by a patriarchal system in which the head of the household decides nearly everything from production to expenditure on expensive items. Therefore, I measured the level of education of the head of the household as a proxy for the human capital of the household.

Social capital: The four components of social capital - associational activity, social relations (information sharing), trust, and norms of reciprocity - are measured by their proxies, as discussed next. I also created an additive index of social capital, similar to that used by Grootaert (1999), Grootaert & Narayan (1999), and Grootaert et al. (2002).

I measured associational activity by the number of group and association memberships per capita in the household. To measure the remaining dimensions of social capital, I adapted some questions from the Social Capital Questionnaire (A. Krishna & Shrader 1999; and Grootaert, Narayan, Jones, & Woolcock 2003) recommended by the World Bank and developed some of my own that were more appropriate for the context of this particular case study. For example, four questions to measure reciprocity I developed by myself. Based on what M. S. Granovetter (1973) called 'weak ties', I developed questions to measure reciprocity in a viewpoint that the levels of reciprocity are higher for household who may get help or seek help from outsiders rather than that from relatives and friends since this removes the limits of the movement of households between social groups to obtain ideas, information, production experience, human resources and assistance for their production (Fukuyama 2001).

The complete set of social capital questions is given in Annexure 3.2. In the case of paper-recycling households, the social capital questions focus mostly on relationships that are specific to the process of paper recycling, whereas the general households' social capital questions focus on a more general form of household-level social capital, covering relationships embedded among households who earn their living by different activities (e.g., agriculture, animal husbandry, trade, and wastepaper services). For all social capital variables, the higher value of the variable indicates the greater level of social capital.

It should be noted that I asked exactly the same questions in my household survey in 2002 as in 2003, but had no difficulty in getting people to answer exactly the same questions for two years in a row because I had built a high level of trust between me (interviewer) and households (interviewees) in the village through many means of communication and from a long-term process. First, I communicated and gained trust and help from the president of Phong Khe commune people's committee and the head of Duong O village who continuously announced to all households in the village that I was a student, collecting data for a dissertation, and that my research might be useful for their village. Further, they urged all the owners of paper-recycling mill to help me in a viewpoint that I was a student in need of information like their children who were also collecting data for their thesis elsewhere (many owners of the paper-recycling mill had their children studying at the universities in Vietnam or abroad). Second, the head of Duong O village introduced me to Mr. Nguyen Sy Thanh, who was a former lecturer at the Agriculture University No. 1 in Vietnam. He became a great informant and assistant for me since households in the village respected him very much. Third, I also gained great trust from the households in the village since I helped some their children to learn English at night during my stay at the village for data collections. Finally, the experiences that I had learned about over more than 10 years of conducting research by using Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA) methods in many rural areas of Vietnam; perhaps, contributed somehow to the successes in the interviews I conducted by myself at Duong O paper-recycling village. The high level of trust between me and households (interviewees) in the village also made them provide me with a high credibility of information. Other features of social capital variables and the construction of social capital index are discussed in the next section.

I selected a single measure, except for social relations, for each dimension of social capital. I had only one measure for associational activity - the number of group and association memberships per capita in the household, and it was used as it is. The proxies for social relations consist of three variables, one of which is binary and two are on 5-point scales. I kept the binary variable as a dummy variable and selected one of the two remaining social relations variables by choosing the variable having the highest correlation with the dependent variables (i.e., income and expenditure)[6]. The four proxies for trust are all measured on 5-point scales; although the proxies for reciprocity[7] for paper-recycling households are measured on a ratio scale and those for general households are

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[6] Using the factor analysis method also gave the same result, since in the case of two variables, the variable that had stronger correlation with the dependent variable, would have higher loading.

[7] The lowest rating for social capital on the reciprocity variable occurs when households seek mutual help from relatives, while the highest is for households that look to others outside their village. The rational for this rating is that in traditional social groups with the presence of what Granovetter (1973) calls 'weak ties', their members are able to move between groups thereby become bearers of new idea and information. They also have more opportunities to pass on innovation and production experience and to exchange human and financial resources more easily (Fukuyama 2001).

on a 5-point scale[8]. I applied factor analysis to select one variable (question) from among the four variables used to measure each of the trust and reciprocity dimensions[9].

As suggested by Hjollund & Svendsen (in press), I chose the highest loading variable on each factor representing these dimensions. The selected variables for trust and reciprocity are shown in Table 3.1.

Table 3.1: Social capital variables selected for inclusion in the household production models

Social Capital Variables	Paper Recycling Households	General Households
ASSOCIATIONS	Number of memberships	Number of memberships
SOCIAL RELATIONS	It is helpful to join with other paper factories when making production decisions	It is helpful to join with others in the village to solve common issues
TRUST	Level of trust of wastepaper suppliers in the paper recycling household	Level of trust in other households in the village to help in difficult times
RECIPROCITY	Number of times the paper recycling household had helped a paper buyer in the past two years	The household has helped others with production capital

[8] The choice of scales, five point scale and a ratio scale, was based on the responses of people interviewed during the pre-testing phase of the data collection, and was used to improve the reliability of data. However, all these variables, measured on these two scales, are continuous variables, and they are treated accordingly in factor analysis and regression analysis.

[9] The suitability of factor analysis was checked by examining the strength of the relationship among variables using the Kaiser-Meyer-Olkin (KMO) test. The KMO values of trust variables for paper-recycling household and general household are 0.63 and 0.64, respectively, while the KMO values for reciprocity variables are 0.83 and 0.79 for paper-recycling household and general household, respectively. All these values are greater than the critical value of 0.6 suggested by Field (2000) for factor analysis.

Second, I created a single additive index of social capital, as suggested by A. Krishna & Uphoff (2002) and Hjollund & Svendsen (forthcoming 2004), for both categories of households using the similar methodology as used by Grootaert (1999), Grootaert & Narayan (1999), and Grootaert et al. (2002). The index was calculated using the arithmetic average of the four variables listed in Table 3.1. All the variables were first rescaled to a range from 0 to 100 and then the arithmetic average was counted.

The index of social capital was found not to be a reliable measure since there were weak correlations among variables. For example, the Cronbach's alphas for the index of social capital for general household and paper recycling household were only 0.29 and 0.22 respectively. Similarly, it was not appropriate to use a factor analysis method to aggregate an index of social capital since the strength of the relationship among variables was very weak. For example, the KMO values for the index of social capital for general household and paper-recycling household are 0.57 and 0.40 respectively. The low correlations are perhaps due to the fact that these variables measure different dimensions of social capital (e.g., number of memberships, trust, information sharing and reciprocity). Hence, it may be more useful to use an aggregate index when only one dimension of social capital is considered (e.g., the social capital index might be more reliable in the case studies by Grootaert (1999) and others in which the index was aggregated from different characteristics of association activity). However, we still used the social capital index in the analyses presented in this chapter because one of the objectives of this study was to make a comparison of the outcomes using measures of the four components of social capital and the index of social capital, as well as, a comparison between the current study and previous studies which have used the social capital index. Furthermore, it should be noted that all of the dimensions of social capital and the index of social capital for the year 2002 were measured on 5-point scales. This enabled us to make an equivalent comparison with most previous studies (e.g., Grootaert, 1999, Grootaert et al., 2002, and Grootaert and Narayan, 2004) in which 5-point scales were also used to measure social capital. However, when social capital was incorporated into a distance function approach to calculate production efficiency and to derive shadow prices, we rescaled it into a measurement scale ranging from 0 to 100% which were considered as continuous and differentiable variable for deriving its shadow prices. Summary statistics for all factors and outputs are given in Table 3.2 for the year 2002 of data collections and in Table 3.3 for the year 2003 of data collections.

Table 3.2 Descriptive statistics of the outputs and factors for the year 2002 of data collections

Variables	Paper recycling households		General households	
	Mean	Standard Deviation	Mean	Standard Deviation
Total annual income (1,000 VND)[1]	3,324,959	3,910,550	31,548	57,716
Ln (total income)	14.54	0.94	9.87	0.83
Total annual expenditures (1,000 VND)	2,977,546	3,559,531	22,326	52,496
Ln (expenditures)	14.42	0.94	9.48	0.77
Total value of physical capital (1,000 VND)	1,232,761	1,615,032	56,711	70,241
Ln (physical capital)	13.57	0.88	9.64	2.10
Number of laborers	22.57	18.52	-	-
Household size	4.73	1.48	4.02	1.47
Head of household years of	9.90	2.33	8.70	2.43

education				
Average number of memberships per capita	3.76	1.25	3.32	1.02
TRUST	3.84	0.83	4.43	0.50
SOCIAL RELATIONS	2.67	1.99	4.28	1.55
RECIPROCITY	3.36	4.78	1.15	0.77
Households received support or information from influential persons	0.22	0.42	0.07	0.25
Social capital index	2.24	0.71	3.15	0.56
Sample size		67		105

1. 1USD = 15,500 VND

Table 3.3: Descriptive statistics of the factors and outputs of household-level paper recycling units for 2003 of data collections

Factors of Outputs	Factors and Outputs[10]	Units	Mean	Standard Deviation
Finished paper	u_1	kg/year	983,810.00	1,158,400.00
Biological oxygen demand	u_2	kg/year	854.10	1,398.60
Chemical oxygen demand	u_3	kg/year	2,879.00	5,320.00
Total suspended solid	u_4	kg/year	1,399.40	2,083.90
Capital	x_1	Mil. VND	1,311.20	1,197.80
Labor	x_2	100 worker-hours/year	681.20	602.10

[10] The symbols given in this column (factors and outputs) are explained in Chapter 5, Section 5.3.

Waste paper	x_3	Mil. VND	2,345.40	2,486.60
Energy	x_4	Mil. VND	281.00	262.09
Other (e.g., chemicals)	x_5	Mil. VND	1,588.30	1,841.10
Trust	x_6	%	83.81	13.85
Reciprocity	x_7	%	19.78	19.17
Memberships	x_8	%	58.76	12.65
Social relations	x_9	%	20.36	18.88
Social capital index	x_6	%	45.71	10.04
Sample size			63	

3.4 Key Economic and Demographic Features of Households in Duong O Village

Data from survey 2002 shows some key summary statistics for the two categories of households in Table 3.4[11].

Table 3.4: Selected characteristics of the paper-recycling households and the general households in Duong O village[12]

Variables	Paper-recycling households		General households	
	Percent	Mean	Percent	Mean
Value of physical capital (1,000 VND)[1]		1,232,761		56,711
Number of people older than eight years		4.73		4.02
Education (no. of years)		9.9		8.7
- None	0.0		1.0	
- Primary	1.5		4.8	
- Secondary	58.2		73.3	

[11] For paper recycling households their income mainly comes from paper production activities while general households earn their living by different activities such as agriculture, animal husbandry, trade, and waste paper services.

- High school	35.8		18.1	
- Above	4.5		2.9	
Composition of gross household income (1,000 VND)		3,383,004		31,548
- Income from raising animals	0.2	5,750	6.0	3,905
- Income from agriculture	0.1	2,145	2.2	1,345
- Income from paper production	98.2	3,320,349		
- Income from paper-recycling services			54.1	25,974
- Income from wages (paper workers)			10.4	8,033
- Allowances (commune and village staffs)	0.1	2,760	1.1	2,798
- Other (transportation, small shops, etc.)	1.5	52,000	26.2	20,638
Annual per capita net income (1,000 VND)		83,451		4,752
Composition of household expenditure (1,000 VND)		2,977,546		22,327
- For production activities	98.1	2,920,050	43.4	9,690
- For daily living	1.9	57,496	56.6	12,637
Annual per capita living expenditure (1,000 VND)		11,891		2,754
Living expenditure as percentage of net income		14.3		58.0
Annual per capita saving (1,000VND)		71,517		1,995

1. 1USD = 15,500 VND

The average value of physical capital owned by paper-recycling households is nearly 23 times higher than that of the general households. Although most of the heads of households graduated from secondary school, the heads of paper-recycling households have a higher level of education. The main annual source of income of the paper-recycling and the general households is from the paper industry, which for the general households includes services such as buying, transporting, sorting, and selling wastepaper materials and finished paper. Besides producing some traditional paper, general households also provide labor (receiving wages) to the paper production enterprises. The paper-recycling households receive almost all of their income from paper production while the general households receive about one half of their income from paper-recycling services. The average net income per capita of the paper-recycling households is about 18 times higher than that of the general households. Daily living expenses for paper-recycling households constitute only 1.9% of total household expenditures; however, daily expenses for general households amount to more than one half of all expenditures. The per capita annual living expenditure of paper-recycling households is 4 times greater than that of the general households.

One finding of interest from these data is that the ratios of average annual-per-capita living expenditure to the average annual-per-capita net income for the paper-recycling and the general households are quite different. Paper-recycling households use only 14.3% of their net income for living expenses while general households use 58.0% of their net income. On average, paper-recycling households save 85.7% of their income, equivalent to 71,517,000 Vietnam dong (VND; U.S. $4,600) per year while general households only save 42% of their income, equivalent to 1,995,000 VND (U.S. $130) per year. This means that I should be careful when using expenditures as a proxy for income when comparing the two groups of households because they have different patterns of consumption and savings.

Paper recycling households tend to have greater amounts of physical capital, heads of household with higher education levels, higher net incomes per capita, and higher expenditures per capita than general households. The vast majority of income sources for both categories of households originate from paper production and activities relating to paper production. Therefore, the welfare of households in the village is highly susceptible to changes in the demand for recycled paper and the supply of used paper.

CHAPTER 4

THE CONTRIBUTION OF SOCIAL CAPITAL TO HOUSEHOLD WELFARE IN A PAPER-RECYCLING CRAFT VILLAGE IN VIETNAM

4.1 Introduction

The concept of social capital has become increasingly popular; however, there has been very little research on the connection between social capital and waste management. In addition, there are at least two other aspects that have not been addressed adequately in previous studies of social capital and economic development. First, most previous studies have used an aggregate measure of social capital, normally defined as the quantity and quality of membership in social groups. However, similar to other production factors – such as labor, physical capital, and human capital – social capital is made up of different types of social capital, and the contributions of different types to the production process may vary. In such circumstances, an aggregate measure of social capital conceals the effects of different components of social capital, and waste management policies based on an understanding of the outcome of an aggregate measure of social capital may prove to be misleading. Second, social capital may be different for different production processes such as production from household-level recycling units and production from other activities.

In this chapter, my focus is on the role of social capital in the production process of household-level paper-recycling units in Vietnam; however, I also address the two aspects mentioned above. First, I consider four components of social capital – associational activity, social relations (information sharing), trust, and norms of reciprocity – and examine the contributions of these components separately to the production process of household-level paper recycling units. Following the lead of previous studies, I also examined the contribution of a social capital index to household welfare. To address the contribution of social capital to different production processes, I examined the household production function of households that own paper-recycling microenterprises and the household production function of households who earn their living from agriculture, raising animals, and provision of support services for recycling and paper production. I also address the issue of income versus expenditure as a measure of the output of a household's production function by estimating separate, household production functions for income and expenditures.

4.2 Specification and Estimation of Econometric Models

4.2.1 Outputs and Inputs of the Household Production Function

With the definition of social capital, given earlier, I used the same form of the household production-function model used by Grootaert (1999), Grootaert & Narayan (2004), and Grootaert et al. (2002), in which social capital is treated as a private good input to the production process and on a par with other types of capital such as physical capital, human capital and labor[13]. I also considered the production function as continuous so that it can be approximated as a linear function (Griliches & Intriligator 1983). Hence, the basic form of the household production function can be expressed as:

$$Y = F(K, L, H, SC) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.1)$$

and

$$Y = F(K, L, H, SC_1, SC_2, SC_3, SC_4) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.2)$$

In these two equations, Y is production output, K is physical capital, L is labor, H is human capital, SC is social capital (expressed as a composite index), SC_1 is associational activity, SC_2 is information sharing, SC_3 is trust, and SC_4 is reciprocity.

4.2.2 Functional Form of the Household Production Function and Its Estimation

One of the main challenges in any production analysis is the choice of functional form of production function. Because of the absence of any previous study on household-level production analysis of paper-recycling units, I do not have a priori information about the appropriate functional form for production analysis in the current case. In the most

[13] This form of the production function is different from the production functions in which social capital is treated as a public good and a shift factor in the aggregate production function.

general terms, the choice for functional form is between the constant elasticity of substitution (CES) and the variable elasticity of substitution (VES) functions. Hence, first I estimated two production functions using Cobb-Douglas specification and the transcendental logarithmic specification. However, for both cases, neither the coefficients of most of the terms nor the F statistics were significant at 5% significance level. Next, following the lead from Griliches & Intriligator (1983), I estimated the simplest form of VES function given below:

$$Y_i = \alpha_0 + \alpha_1 K_i + \alpha_2 L_i + \alpha_3 H_i + \alpha_4 SC_i + u_i \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (4.3)$$

and

$$Y_i = \alpha_0 + \alpha_1 K_i + \alpha_2 L_i + \alpha_3 H_i + \alpha_4 SC_{1i} + \alpha_5 SC_{2i} + \alpha_6 SC_{3i} + \alpha_7 SC_{4i} + u_i \ \ldots \ (4.4)$$

During the estimation of these two functions (4.3 and 4.4), I found that there is no harmful multicollinearity[14]; however, heteroscedasticity was present. I addressed this problem by transforming the income, expenditure, and physical capital variables into their natural logarithms. As a result, the final functional form of the two production functions, which were estimated, is as given in Equation 4.5 and 4.6

$$Ln(Y_i) = \alpha_0 + \alpha_1 * Ln(K_i) + \alpha_2 L_i + \alpha_3 H_i + \alpha_4 SC_i + u_i \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (4.5)$$

and

$$Ln(Y_i) = \alpha_0 + \alpha_1 * Ln(K_i) + \alpha_2 L_i + \alpha_3 H_i + \alpha_4 SC_{1i} + \alpha_5 SC_{2i} + \alpha_6 SC_{3i} + \alpha_7 SC_{4i} + u_i \ldots \quad (4.6)$$

The production functions given in Equation 4.5 and 4.6 are simple additive nonhomogeneous production functions (details are available in Bairam (1998)). In terms of elasticity of output with respect to factors, they are a hybrid of constant and variable elasticity – elasticities of output with respect to physical capital is constant while the elasticities with respect to labor, human capital, and social capital are variable. The results of the estimated production functions are discussed next.

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[14] The variance inflation factor (VIF) for the income models of paper-recycling households and general households ranged from 1.11 to 3.21 and 1.05 to 1.10, respectively which means there was no harmful multicollinearity (Studenmund (1996) suggested that there is no harmful multicollinearity if the VIF is less than 5).

4.3 Results of the Econometric Analysis

4.3.1 Household Production Functions with Aggregated Social Capital

The results for two production functions, with income and expenditure as output, of the paper-recycling and general households, are given in Tables 4.1 and 4.2, respectively. The results indicate that both income and expenditure models explain roughly 76% of the variation in the production output of paper-recycling households and 40% of the variation for general households. The similar fit found with the income and expenditure models is not surprising in light of the fact that the correlation between the income and expenditure variables is high at 0.99 for paper recycling households and 0.98 for general households. These results suggest that my previous caution about using expenditure as a proxy for income may be unwarranted.

Table 4.1: Coefficients for the production function of the paper-recycling households with a social capital index

Dependent Variables	Coefficients with Income as an Output	Coefficients with Expenditure as an Output
Intercept	8.870**	8.275**
Ln (physical capital)	0.277*	0.310*
Employed labor	0.026**	0.026**
Household size	0.002	0.024
Human capital (education)	0.062*	0.055*
Social capital index	0.323**	0.335**
Households received support or information from influential persons	-0.119	-0.179
Number of observations	67	67
Adj. R-Square	0.757	0.767

*p <0.05 **p<0.01

Table 4.2: Coefficients for the production function of the general households with a social capital index

Dependent Variables	Coefficients with Income as an Output	Coefficients with Expenditure as an Output
Intercept	6.484**	6.471**
Ln (physical capital)	0.219**	0.193**
Household size	0.222**	0.206**
Human capital (education)	-0.003	-0.032
Social capital index	0.191*	0.213*
Households received support or information from influential persons	0.595**	0.550**
Households working as farmers	-0.649**	0.460*[15]
Households working as paper workers	-0.448**	-0.448**
Traditional paper producers		-0.330*
Number of observations	105	105
Adj. R-Square	0.416	0.390
*p <0.05 **p<0.01		

[15] The sign of this coefficient is different from that of the income model because farmer households have a larger number of people in the family compared to those of other types of household. Moreover, for the general households, the major component of expenditure was for living expenses. As a result, the expenditure had a tendency increase with households working as farmer since there were more people in the family, the expenses for living were also increasing, and so for expenditure.

The comparative analysis of household production functions for the two groups of households provides some interesting outcomes. First, the explanatory power of the paper-recycling household model is much better than that of the general household model. This result suggests that specific measures of social capital (i.e., measures of social capital for paper-recycling units) may provide much better model fits and estimates for income and expenditures than general social capital. Because I collected information on the general social capital variables from the paper-recycling households, I were able to check whether substituting general social capital for specific social capital affected the model fit for those households. The fit was found to be weaker, with adjusted R^2 of 0.64 and 0.66 for the income and expenditure models, respectively. Second, the coefficient of household size is not significant for paper-recycling households but is significant for general households. This is not difficult to explain. Because paper-recycling households have higher incomes, they can afford to place priority on ensuring that their children receive a good education rather than working in the family business. For the lower-income general households, where the work is less specialized - sorting wastepaper, some agricultural activities - children and all members of the family are more likely to be working. Furthermore, the coefficient of labor employed by paper-recycling households is significant, confirming that there are differences in the nature of productive labor by type of household. Third, the human capital variable is not significant for general households although it is positive for paper-recycling households. This might be because the more highly skilled and capital-intensive nature of the paper-recycling business requires higher education levels for households to be successful**.** Fourth, the coefficients of the social capital index are positive and statistically significant for both types of households, as expected. Fifth, if members of a general household have made personal contact with influential persons, their household income improves while this contact is not significant for paper recycling households[16]. Sixth, among general households, the two dummy variables for source of income, namely

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[16] There can be two potential reasons for the support and/or information from influential people that has more impact on general households than that of the paper recycling households. First, there is a great number of paper recycling households who got help from the influential people (e.g., 15 out of 67); therefore, there is a less variation of impacts on paper recycling household's income compared to that of general households (e.g., only 7 out of 105 got helps from influential people). Second, the general households have much lower income compared to that of paper recycling households; therefore, with the same small change in any production factor of the general household will have greater impacts on their income than that on the income of the paper recycling household.

households receiving income from farming and households receiving income as paper workers, are negative and significant. The magnitudes of these coefficients indicate that the farmer households have the lowest income while paper worker households are the second lowest in income. Next, I discuss the results with disaggregated social capital.

4.3.2 Household Production Functions with Disaggregated Social Capital

The results for the production function for the paper recycling households are given in Table 4.3. These results have two noticeable and interesting outcomes. First, the explanatory powers of income and expenditure models are almost identical to the explanatory powers of the two models with the social capital index. Second, contrary to previous studies by Grootaert (1999), Grootaert & Narayan (2004), and Grootaert et al. (2002), the membership variable representing associational activity (ASSOCIATIONS) is not statistically significant. There are two possible explanations for this finding. First, in Vietnam, people are often encouraged to participate in a numbers of organizations or associations involuntarily. This type of membership yields little or no benefit for its members, but costs them membership fees, their time, and energy. For example, during my interviews, some owners of the paper factories complained that every year they had to pay more then 500,000 VND for membership fees but got nothing from them. To check whether this explanation could be valid, I re-estimated the equations using two separate membership variables: the first consisted of the number of memberships in 10 voluntary organizations and the second consisted of memberships in 6 organizations, mostly mass organizations, that household members are expected to join. Neither variable was significant, and I concluded that the voluntary/involuntary nature of membership was not responsible for the lack of significance.

Table 4.3: Coefficients for the production function of the paper recycling households with disaggregated social capital

Dependent Variables	Coefficients with Income as an Output	Coefficients with Expenditure as an Output
Intercept	8.804**	8.126**

Ln (physical capital)	0.263*	0.304*
Employed labor	0.028**	0.027**
Household size	-0.015	0.016
Human capital (education)	0.058*	0.051*
ASSOCIATIONS	-0.024	0.002
TRUST	0.245**	0.203**
SOCIAL RELATIONS	0.050	0.055
RECIPROCITY	0.030*	0.032*
Households received support or information from influential persons	-0.196	-0.239
Number of observations	67	67
Adj. R-Square	0.763	0.769

*p <0.05 **p<0.01

A second possible reason for the lack of significance in the membership variable is that, as mentioned earlier, in the rural areas of Vietnam there is a strong patriarchal system in which the head of the household decides nearly everything. Consequently, what other members of the family gain from participation in associations is hard to apply to household production activities.

The results for the production functions for the general households are given in Table 4.4. The results are similar to the results for paper recycling households except that the explanatory powers of the income and expenditure models have improved greatly in comparison to the models with a social capital index.

Table 4.4: Coefficients for the production function of the general households with disaggregated social capital

Dependent Variables	Coefficients with Income as an Output	Coefficients with Expenditure as an Output
Intercept	5.628**	6.367**
Ln (physical capital)	0.215**	0.153**
Household size	0.189**	0.197**
Human capital (education)	-0.001	-0.035
ASSOCIATIONS	-0.030	0.018
TRUST	0.345**	0.228*
SOCIAL RELATIONS	-0.029	-0.023
RECIPROCITY	0.239**	0.265**
Households received support or information from influential persons	0.586**	0.620**
Households working as farmers	-0.572**	-0.465**
Households working as paper workers	-0.403**	-0.355**
Number of observations	105	105
Adj. R-Square	0.487	0.433

*p <0.05 **p<0.01

4.3.3 Comparison of Output (Household Income) Elasticities with Respect to Social Capital and Other Factors

In addition to the insights given by the above discussion of the coefficients of different variables and their significance, the relative responsiveness of production output with respect to different factors (point elasticities) will provide important information for household decision makers as well as policy makers[17]. The following discussion focuses on point elasticities for household income only. However, I provide a comparative view of point elasticities for the two treatments of social capital – aggregated and disaggregated.

The mean values and the range of household income point elasticities with respect to different factors for the paper-recycling households are given in Table 4.5. The elasticity of physical capital is a constant and is equal to 0.28; however, the elasticities of all other factors vary with their levels.

Table 4.5: Household income elasticities for paper-recycling households

Factors	Aggregated Social Capital		Disaggregated Social Capital	
	Factor coefficient	Factor elasticity *	Factor coefficient	Factor elasticity
Social capital index	0.323	0.72 (0.38, 1.29)	-	-
TRUST	-	-	0.245	0.94 (0.49, 1.22)
RECIPROCITY	-	-	0.030	0.10 (0.0, 0.6)
Number of laborers	0.026	0.59 (0.21, 2.60)	0.028	0.63 (0.22, 2.8)
Human capital (education)	0.062	0.61 (0.25, 0.99)	0.058	0.57 (0.23, 0.93)

** The numbers in brackets are the point elasticities at the minimum and maximum points*

[17] Since point elasticities are defined at a specific point, we have calculated point elasticities at mean values, minimum values, and maximum values.

In the case of the aggregated social capital model, the point elasticity of income with respect to social capital, at mean values, is 0.72. Although at this point, income is inelastic with respect to social capital, the magnitude of the income elasticity with respect to social capital is greater than that with respect to labor and human capital. This means that household income is relatively more responsive to social capital compared to that of labor and human capital. For example, an increase of 1% in the social capital index increases the income level of paper factories by 0.72%; however, a similar increase of labor or in the years of education for the heads of paper-recycling households only yields an increase of 0.59% and 0.61% in their income level, respectively. The aggregate data in Table 4.6 also indicate that household income is inelastic with respect to social capital, labor, and human capital at the minimum and mean values; however, it becomes elastic with respect to social capital and labor at the maximum points. For example, income elasticities at the maximum points with respect to social capital and labor are 1.29 and 2.60, respectively. This means that when paper-recycling households reach a certain level of production, their production becomes more responsive to these two factors, especially with households having a large number of workers. Income is not very responsive to human capital even at the maximum point.

For the disaggregated social capital model, the point elasticities of income with respect to different dimensions of social capital, at mean values, are quite varied. For instance, the income elasticity with respect to trust is close to unitary elastic (0.94), while the income elasticity with respect to reciprocity is quite inelastic (0.1). This can be explained by the differences in the development stages, in which each dimension of social capital plays different roles. In a market economy where there is strong competition among the suppliers in input and output markets, trust facilitates cooperation, and supports a long-term relationship among actors, reducing transaction costs for paper factories and increasing their income. However, reciprocity is not as important for paper-recycling households since most of them can meet the demands of physical capital and labor for their production.

Compared to other capitals, the magnitude of the mean point elasticity of income with respect to trust is much greater than that with respect to labor and human capital. This means that trust has more impact on the income of paper recycling households than labor and human capital. Most important, trust has a large range of elasticities (i.e., from 0.49 to 1.22) on which policy should be focused to enrich them to maximum levels.

The range of income elasticities with respect to social capital varies greatly. However, household income remains inelastic with respect to reciprocity across the full range of this factor, and thus income responsiveness with respect to this component of social capital is similar to human capital and physical capital. On the other hand, household income, at the higher end, becomes elastic with respect to trust, and this means that the responsiveness of household income with respect to this component is similar to labor. The wide range of income elasticities with respect to trust indicates that social capital may or may not contribute much to the increase of household income depending on how it is used and at what level it is being used. In other words, finding appropriate policy options for the enrichment and suitable utilization of social capital has an important role in the economic development of the village because with those policies, social capital can be an important contributor to increasing household income; otherwise, it can be useless or less useful.

The mean values and the range of household income point elasticities with respect to different factors for the general households are given in Table 4.6, and the main features of these results are discussed next.

Table 4.6: Household income elasticities for general households

Factors	Aggregated Social Capital		Disaggregated Social Capital	
	Factor coefficient	Factor elasticity	Factor coefficient	Factor elasticity
Social capital index	0.191	0.56 (0.33, 0.90)	-	-
Household received help from influential persons	0.595	0.04 (0.0, 0.595)	0.586	0.04 (0.0, 0.586)
TRUST	-	-	0.345	1.52 (1.38, 1.72)
RECIPROCITY	-	-	0.239	0.275 (0.239, 1.19)
Household size	0.222	0.89 (0.44, 2.0)	0.189	0.76 (0.38, 1.70)

First, in the case of the aggregated social capital model, income elasticity with respect to social capital, at mean values, is 0.56, which is smaller than that of income elasticity with respect to household size (0.89). Similar to the case of paper recycling households, household income with respect to labor (household size) is inelastic at the minimum and mean points; however, at the maximum points it is elastic with a value of 2.0.

Second, in the case of the disaggregated social capital model, trust plays the most important role in the increase of income for general households. Even at mean values, its impact on the income of household is nearly twice that of the labor (household size). This could be because personal trust among general households is very important for them because households rely on trust to obtain credit from others to compensate for any temporary shortage of physical and financial capital.

Third, although the income elasticity with respect to the reciprocity index has a large range, from 0.24 to 1.19, the magnitude of point elasticity at the mean point is still small, only 0.28. This means that policy makers should focus on enriching this component of social capital so as to improve household income[18].

Finally, the point elasticities of paper-recycling and general household models indicate that in the aggregated and disaggregated social capital models, social capital has a positive impact on household income, and the influence of trust on income is far greater than that of labor and human capital.

4.4 Policy Implications and Conclusions

This chapter has examined the contribution of social capital to the welfare of paper recycling households and general households in a typical craft village in Vietnam. In contrast to most previous studies at the micro-level that used group memberships to measure social capital, four dimensions of social capital: associational activity, social relations (information sharing), trust, and norms of reciprocity – were used in this chapter.

[18] The mean value of the reciprocity index is very low indicating an absence of what M. S. Granovetter (1973) called ‘weak ties’. This limits the movement of households between social groups to obtain ideas, information, production experience, human resources and assistance for their production.

This is the first study on these issues in Vietnam, and it is limited to only one craft village. Hence, the results of this chapter alone are insufficient as a basis for policy prescriptions. However, they offer some important insights that may be used, but carefully, for enhancing welfare in the craft villages of Vietnam.

First, similar to empirical results from other countries, social capital has a strong impact on the income of households. The effects of social capital on the income of households are far greater than those of human capital and labor. Hence, social capital should receive a high priority in policy interventions directed toward the development of craft villages. A study by Quinones & Seibel (2000) also indicates that social capital can be improved through policy interventions. For example, the removal of restrictive regulation of the formal financial system in Philippine banking system contributed to the formation of positive social capital that in turn created a space wherein micro-finance institutions serving the poor have sprouted, enhancing the capacity of poor households for cooperation and mutual support (Quinones & Seibel 2000).

Second, among the four dimensions of social capital, the strongest contributions are from trust and reciprocity. In contrast to previous research, the number of memberships does not have an impact on the income of either paper-recycling or general households. Hence, policy makers may like to focus their attention on trust, reciprocity, and evaluation of the forced memberships to many associations. Because trust was one of the most important aspects of social capital for paper-recycling household and general household, the Vietnamese government might use regulations and economic incentives to encourage the change in actors' behavior to enhance trust. In the case of paper recycling households, the government may increase the monitoring and enforcement of implementing agreements and contracts among producers and between producers and customers. In the case of general households, traditional and communal activities may be regularly organized to create confidence through providing occasions for trust and commitment. Similarly, reciprocity can be enhanced through a policy that maintains and encourages cooperation among households in the village (e.g., a policy to establish cooperative associations in which households can exchange labor and paper and borrow credit to satisfy urgent demand for their production) would create favorable conditions for capital mobilization and for the exchange of labor and production experiences. At the same time, through this cooperation, people may come to understand one another better, thus enhancing interpersonal trust and promoting even more cooperation. Together with this process, the state should improve the functions and activities of professional associations so that they can help households to strengthen their ties. Professional associations could also provide assistance with better market information and improved knowledge of efficient production processes.

Third, social capital effects differ by type of household. For example, although getting help from influential persons contributes to increases in the income of general households, it has no impact on the income of paper recycling households. My findings also suggest that the enrichment of social capital in the village will benefit the poorer general households more than the richer paper-recycling households. Hence, policy makers may like to develop different policy interventions for different categories of households. For example, in order to reduce poverty and increase equity among the people in the village, the attentions of policy should be put on a priority to encourage the cooperation and mutual helps among households. This can be done through establishing volunteer cooperative associations and credit rotation associations like the ones have been done in many other countries in which the members of associations can exchange labor, production inputs, and credit for one another in a long-term period.

Fourth, the study verified that there is relatively high trust among general households and that family ties remain at the center of social networks in Vietnam. These findings are consistent with the study by Dalton, Hac, Nghi, & Ong (2002), in which they attributed the high level of social trust in Vietnam to the country's political mobilization efforts in the past and suggested that the presence of strong family ties reflected the traditions of many other East Asian societies. Policy makers should make use of these features of rural communities in Vietnam.

Finally, the relevance of the outcomes of this study is not limited to policy makers. Some outcomes may be highly influential and useful for future research on social capital. First, social capital exists at the household level as well as at the community level, and social capital can be general in nature as well as specific related to a productive activity.

Second, associational activity is only one dimension of social capital, and the analysis of the contribution of associational activity to productive activities provides only a very small picture of the contribution of social capital to production process. Third, an aggregate index may not be an appropriate approach to measure the total social capital which includes all the dimensions of social capital. Fourth, the contributions of different dimensions of social capital may vary across the categories of households and production processes.

In conclusion, to improve the reliability of the outcomes of this study, and to suggest specific and definitive policy interventions for craft villages of Vietnam, similar studies should be repeated in other craft villages. It is expected that the similar results can be obtained from studies in other types of craft villages in Vietnam because they have developed under the same economic, political, cultural, and social conditions; however, the applications of policy proposed in this study to other villages should be conducted carefully since each craft village has its own historical and traditional characteristics; therefore, the levels of social capital existing among relationships within villages may vary greatly and the intervention to social capital as a policy option for enhancing welfare in the craft villages of Vietnam should be flexible for each village.

CHAPTER 5

SHADOW PRICES OF SOCIAL CAPITAL FOR HOUSEHOLD-LEVEL PAPER RECYCLING UNITS IN VIETNAM

5.1 Introduction

In recent years, social capital has emerged as one of the dominant concepts for explaining the outcomes of various social and economic phenomena, including economic production and economic development. Similar to other production factors – such as labor, physical capital, and human capital – social capital is comprised of different types of social capital, and the contributions of different types to the production process may vary. Serageldin & Grootaert (1997) showed that different types of social capital coexist in society and that the recognition of all types of social capital is necessary to produce the optimal results for economic outcomes. They suggest that there should be an integrating view on the definition and measurement of social capital because different types of social capital reflect different manifestations of the social capital present in a society and their complementarity will enhance the contribution of social capital to development. Similarly, Hean, Cowley, Forbes, Griffiths, & Maben (2003) emphasized a multidimensional concept of social capital and contend that single dimensions of social capital cannot fully capture the concept.

More recently, the role of social capital has been well recognized as a household production factor, on a par with the conventional production inputs such as physical capital, human capital, and labor. However, no attempt has been made to develop a mechanism to assign prices to social capital and to study its impact on production efficiency as being done to other production factors[19]. Furthermore, most previous studies (e.g., Narayan & Pritchett 1999; Grootaert 1999b; Grootaert & Narayan 2004; Grootaert et al. 2002; Ha, Kant, & Maclaren 2004a) have found that social capital's impacts on household output vary across income groups; thus, prices of social capital, including prices of different types of social capital, may also vary across income groups.

The purpose of this chapter is to investigate the above-mentioned aspects of social capital as a production factor. First, an input distance function approach will be used to calculate the relative shadow prices of social capital and identify the extent to which social capital contributes to the production efficiency of paper-recycling units in terms of value[20]. Second, in addition to evaluating the contribution of an aggregate social capital index to the production efficiency of paper-recycling mills, I will also examine the relative shadow prices and the contributions of four components of social capital – associational activity, social relations (information sharing), trust, and norms of reciprocity - to the production efficiency of household-level paper-recycling units in terms of value. Finally, the relative shadow prices and the contributions of the four components of social capital to production efficiency across five income levels will be assessed and compared.

The chapter is organized as follows: in Section 5.2 the theoretical foundations of the input distance function and relative shadow prices of social capital are set out. Section 5.3 contains an empirical estimation of the input distance function for the production process of paper-recycling units. In section 5.4 the relative shadow prices of social capital for household-level paper-recycling units are calculated and discussed. Concluding remarks are given in section 5.5.

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[19] Although some economists remain critical of the concept of social capital as an economic phenomenon, Solow (2000) points out that "those who write and talk about social capital are trying to get at something difficult, complicated and important: the way a society's institutions and shared attitudes interact with the way its economy works. It is a dirty job, but someone has to do it; and mainstream economics has puristically shied away from the task" (Solow, 2000, p.6).

[20] So far nobody has investigated the contribution of social capital to production efficiency, only to household income or expenditure.

5.2 Theoretical Foundations of the Input Distance Function and the Relative Shadow Prices of Social Capital

The theoretical background of distance functions is discussed by Färe & Primont (1995) and Kumbhakar & Lovell (2000). Suppose that the production technology of a paper recycling unit uses input set, L(u) representing a set of all (N×1) input vectors, $x = \Re_{+}^{N}$, to produce the output vector denoted by $u = \Re_{+}^{M}$. That is,

L(u) = { $x = \Re_{+}^{N}$: x can produce u}.

I assume that the technology satisfies the axioms listed in Färe & Primont (1995) such as convexity and strong disposability. The input distance function, $D_I(x, u)$, is then defined on the input set, L(u), as:

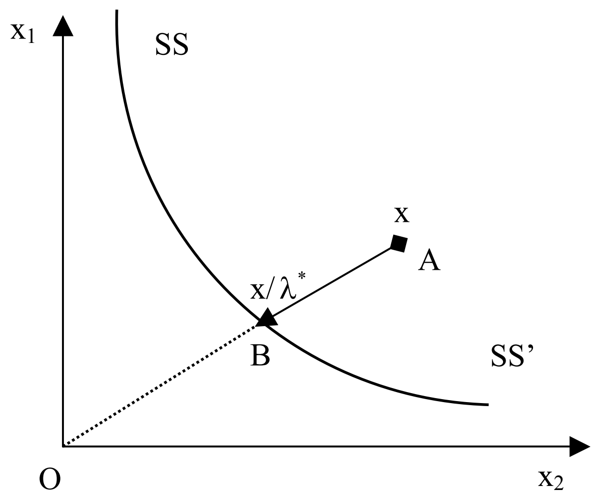
$$D_I(x,\ u) = Max\{\lambda : (x/\lambda) \in L(u)\}, \ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \ (5.1)$$

Where x and u are vectors of inputs and outputs, respectively, and λ is a positive scalar. Equation (5.1) gives the maximum amount by which a paper recycling unit's input vector can be radically contracted and still remain feasible for the output vector it produces. The value of the distance function is the maximum of $D_I(x, u)$ such that $x/\lambda \in L(u)$.

As noted in Kumbhakar & Lovell (2000), the input distance function is non-decreasing, homogeneous of degree one and concave in x, and non-increasing and quasi-concave in u. The value of the input distance function will be greater than or equal to one if the input vector, x, is an element of the feasible input set, L(u) . The input distance function has a value of unity if x is located on the inner boundary of the input set.

Figure 5.1 provides an illustration of an input distance function, where two inputs, x_1 and x_2, are used to produce output u. The isoquant, SS', is the inner boundary of the input set, reflecting the minimum input combinations that may be used to produce a given output vector. In the figure the scalar input x is feasible for output u, but u can be produced with smaller input (x/λ^*); therefore, $D_I(x,\ u) = \lambda^* = OA/OB > 1$.

Figure 5.1: The input distance function and the input set



There are many advantages in using the input distance function approach in the present case. First, unlike cost and profit functions; the use of input distance functions does not require information on output or input prices (Färe & Primont 1995), and I do not have price data for social capital and undesirable outputs. Second, in contrast to the cost and profit functions, using input distance functions does not need to maintain the behavioral assumptions of cost minimization or profit/revenue maximization (Kumbhakar & Lovell 2000). Third, a distance function only identifies the technology frontier and gives the distance to the frontier for each observation; as a result, the different measures of economic effects (for example, substitution) are not conditional on behavioral assumptions. Finally, the duality between the input distance function and the cost function allows us to retrieve the shadow prices of social capital (Färe & Primont 1995).

Assuming that the input distance and the cost functions are differentiable, application of Shepherd's dual lemma would lead to the following relationship:

$$\nabla_x D_I(x,u) = r^*(x,u) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5.2)$$

where r*(x, y) is the cost minimizing input price vector.

Assuming that the market price of x_n is equal to its shadow price (r_n^*) for all n $\neq$ n', the absolute shadow price of $x_{n'}$ is given by Equation (5.3):

$$r_{n'}^* = r_n^* \cdot \frac{\partial D_I(x,u)/\partial x_{n'}}{\partial D_I(x,u)/\partial x_n} \quad \text{...(5.3)}$$

where r_n^* and $r_{n'}^*$ are the shadow prices of inputs x_n and $x_{n'}$.

When input prices are not available and the optimal cost of production cannot be estimated accurately, then the following alternative formula can be derived to give a ratio of input shadow prices (Färe & Primont 1995, p. 56):

$$R_{nn'} = \frac{r_n^*}{r_{n'}^*} = \frac{\partial D_I(x,u)/\partial x_n}{\partial D_I(x,u)/\partial x_{n'}} \quad \text{...................................... (5.4)}$$

where r_n^* and $r_{n'}^*$ are the shadow prices of the inputs x_n and $x_{n'}$ respectively. This ratio is the relative shadow price of input n with respect to input n' and reflects the trade-off between different inputs in the actual mix of inputs.

Expression (5.4) is used to calculate the relative shadow prices of the four components of social capital and of aggregated social capital. Most interestingly, expression (5.4) can also be written as:

$$\partial D_I(x,u)/\partial x_n = \frac{r_n^*}{r_{n'}^*} \bullet \partial D_I(x,u)/\partial x_{n'} \text{..................................(5.5)}$$

Expression (5.5) says that the marginal input distance function with respect to input n is equal to ($r_n^* / r_{n'}^*$) times the marginal input distance function with respect to input n'. In other words, an increase in the value of the input distance function by one unit of input n is equal to ($r_n^* / r_{n'}^*$) times the value of the distance function increased by one unit of input n'. Therefore, I can derive the value of an increase in one unit of an input in terms of the increase in the other input at a given level of production efficiency. For example, if I measure social capital in percentages and physical capital in million Vietnamese dong

(VND), then an increase of one percent of social capital is equal to an increase of $(r_n^* / r_{n'}^*)$ times one million VND of physical capital to maintain a given level of production efficiency.

5.3 Empirical Estimation of the Input Distance Function

I used a parametric linear programming method, first suggested by Dennis J. Aigner & Chu (1968) and later used by Färe et al. (1993), Coggins & Swinton (1996), and Hailu & Veeman (2000), to estimate the input distance function parameters and a translog functional form for the input distance function, due to its comprehensive and flexible nature (Färe et al. 1993). In this form, the input distance function is expressed as:

$$\begin{aligned}\ln D_I(x^k,\ u^k) = \alpha_o &+ \sum_{n=1}^{n} \beta_n \ln x_{nk} + \sum_{m=1}^{m} \alpha_m \ln u_{mk} \\ &+ \frac{1}{2}\sum_{n=1}^{n}\sum_{n'=1}^{n} \beta_{nn'} (\ln x_{nk})(\ln x_{nk'}) \\ &+ \frac{1}{2}\sum_{m=1}^{m}\sum_{m'=1}^{m} \alpha_{mm'} (\ln u_{mk})(\ln u_{mk'}) \\ &+ \sum_{n=1}^{n}\sum_{m=1}^{m} \gamma_{nm} (\ln x_{nk})(\ln u_{mk})\end{aligned} \qquad (5.6)$$

where n and m indexes are the vectors of inputs and outputs, respectively. In the disaggregated social capital model, n includes capital (x_1), labor (x_2), waste paper (x_3), energy (x_4), other materials (x_5), trust (x_6), reciprocity (x_7), membership (x_8), and information sharing (x_9) while in the aggregated social capital model n includes capital (x_1), labor (x_2), waste paper (x_3), energy (x_4), other materials (x_5), and the social capital index (x_6). The output vector includes quantity of finished paper (u_1), a desirable output, and the undesirable outputs of biological oxygen demand (u_2), chemical oxygen demand (u_3), and total suspended solid (u_4). The subscript k denotes the rth firm (among 63 paper-recycling factories) in the sample. Values for the unknown parameters in Eq. (5.6) are obtained by using linear programming to minimize:

$$\text{Min} \sum_{k=1}^{63} [\ln D_I(x^k,\ u^k) - \ln 1] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5.7)$$

subject to

(i) $\ln D_I(x^k,\ u^k) \geq 0,$

(ii) $\partial \ln D_I(x^k,\ u^u) / \partial \ln x_n^k) \geq 0,$

(iii) $\partial \ln D_I(x^k,\ u^u) / \partial \ln u_m^k) \leq 0$ (m = 1)

(iv) $\partial \ln D_I(x^k,\ u^u) / \partial \ln u_m^k \geq 0$ (m = 2, 3, 4)

(v) $\sum_{n=1}^{n} \beta_n = 1; \qquad \sum_{n'}^{n} \beta_{nn'} = \sum_{n=1}^{n} \gamma_{nm} = 0;$

(vi) $\begin{array}{l} \alpha_{mm'} = \alpha_{m'm}, \quad m = 1, \ldots, M, \quad m' = 1, \ldots, M, \\ \beta_{nn'} = \beta_{n'n}, \quad n = 1, \ldots, N, \quad n' = 1, \ldots, N, \end{array}$

The first set of constraints labeled (i) restricts individual observations to be on or "above" the frontier. The second set labeled (ii) implies that the input distance function is non-decreasing in inputs; the third set in (iii) ensures that the input distant function is non-increasing in good outputs while (iv) ensures that the estimated input distance function is non-decreasing in the three environmental outputs. The constraints in (v) impose homogeneity of degree one in inputs. The final set of constraints in (vi) imposes symmetry.

The objective function (5.7) maximizes the sum of the deviations of individual observations from the frontier (i.e., saving as much input to produce a given output as possible). However, I am in fact minimizing because the input distance function takes values greater than or equal to one, and therefore its natural logarithms can take a value of greater than or equal to zero; in consequence, to maximize the sum of the absolute deviations of individual observations from the frontier, I have to minimize the deviations of distances expressed in the logs from zero.

The values of the parameters of the input distance function for the aggregated social capital model are given in Table 5.1 and for the disaggregated social capital model in Table 5.2.

Table 5.1: Distance function parameter estimates for the aggregated social capital model

Parameters	Estimated Coefficient	Parameters	Estimated Coefficient	Parameters	Estimated Coefficient	Parameters	Estimated Coefficient
α_0	1.76000	β_{24}	0.00200	γ_{42}	0.00400	α_{16}	-0.00100
β_1	-0.74400	β_{33}	-0.03500	γ_{43}	0.01400	α_{22}	-0.00900
β_2	0.12100	β_{34}	0.00900	γ_{44}	0.00400	α_{23}	0.00100
β_3	0.17300	β_{44}	-0.00700	γ_{51}	-0.00200	α_{24}	0.00200
β_4	0.08100	γ_{11}	-0.00005	γ_{52}	-0.00012	α_{25}	0.00200
α_1	0.00400	γ_{12}	0.00100	γ_{53}	0.00200	α_{26}	0.00500
α_2	0.18800	γ_{13}	-0.00100	γ_{54}	0.00063	α_{33}	0.01200
α_3	0.31000	γ_{14}	0.00033	γ_{61}	-0.04000	α_{34}	-0.00800
α_4	0.17100	γ_{21}	-0.02000	γ_{62}	0.01600	α_{35}	-0.00100
α_5	0.01700	γ_{22}	0.00600	γ_{63}	0.02100	α_{36}	-0.00500
α_6	0.31000	γ_{23}	0.01400	γ_{64}	0.00300	α_{44}	0.00036
β_{11}	0.12400	γ_{24}	-0.00010	α_{11}	-0.00071	α_{45}	0.00049
β_{12}	-0.02600	γ_{31}	-0.04800	α_{12}	-0.00083	α_{46}	0.00300
β_{13}	-0.02600	γ_{32}	0.02500	α_{13}	0.00059	α_{55}	-0.00085
β_{14}	-0.01000	γ_{33}	0.02300	α_{14}	0.00200	α_{56}	-0.00013
β_{22}	-0.01500	γ_{34}	-0.00092	α_{15}	-0.00013	α_{66}	-0.00200
β_{23}	0.00900	γ_{41}	-0.02100				

Table 5.2: Input distance function parameters for the disaggregated social capital model

Parameters	Value	Parameters	Value	Parameters	Value	Parameters	Value
α_0	2.37500	γ_{14}	0.00008	γ_{82}	0.01700	α_{35}	0.00099
β_1	-0.82500	γ_{21}	-0.01400	γ_{83}	0.02800	α_{36}	0.00200

β_2	0.13500	γ_{22}	0.00500	γ_{84}	0.00100	α_{37}	0.00007
β_3	0.28100	γ_{23}	0.01200	γ_{91}	-0.00003	α_{38}	-0.00200
β_4	0.07000	γ_{24}	-0.00300	γ_{92}	-0.00011	α_{39}	-0.00044
α_1	0.01300	γ_{31}	-0.03300	γ_{93}	0.00010	α_{44}	0.00400
α_2	0.11300	γ_{32}	0.01500	γ_{94}	0.00004	α_{45}	-0.00080
α_3	0.23200	γ_{33}	0.01600	α_{11}	-0.00100	α_{46}	-0.00200
α_4	0.14800	γ_{34}	0.00200	α_{12}	-0.00200	α_{47}	0.00008
α_5	0.00700	γ_{41}	-0.01700	α_{13}	0.00064	α_{48}	0.00500
α_6	0.08700	γ_{42}	0.00100	α_{14}	0.00200	α_{49}	0.00015
α_7	0.00200	γ_{43}	0.01200	α_{15}	-0.00028	α_{55}	-0.00200
α_8	0.40200	γ_{44}	0.00400	α_{16}	0.00100	α_{56}	-0.00200
α_9	-0.00300	γ_{51}	-0.00100	α_{17}	0.00000	α_{57}	0.00004
β_{11}	0.12400	γ_{52}	-0.00300	α_{18}	-0.00080	α_{58}	0.00200
β_{12}	-0.02200	γ_{53}	0.00400	α_{19}	0.00001	α_{59}	0.00023
β_{13}	-0.04000	γ_{54}	0.00100	α_{22}	-0.00700	α_{66}	0.05500
β_{14}	-0.01000	γ_{61}	-0.02200	α_{23}	0.00600	α_{67}	-0.00002
β_{22}	-0.00800	γ_{62}	0.01400	α_{24}	-0.00100	α_{68}	-0.06400
β_{23}	0.01500	γ_{63}	0.00900	α_{25}	0.00300	α_{69}	-0.00100
β_{24}	-0.00100	γ_{64}	-0.00087	α_{26}	0.01000	α_{77}	-0.00002
β_{33}	-0.02200	γ_{71}	-0.00007	α_{27}	-0.00029	α_{78}	0.00011
β_{34}	0.00900	γ_{72}	0.00025	α_{28}	-0.00900	α_{79}	0.00002
β_{44}	-0.00200	γ_{73}	-0.00022	α_{29}	0.00064	α_{88}	0.06900
γ_{11}	0.00017	γ_{74}	0.00004	α_{33}	0.00037	α_{89}	0.00035
γ_{12}	0.00055	γ_{81}	-0.04700	α_{34}	-0.00700	α_{99}	0.00004
γ_{13}	-0.00080						

5.4 Relative Shadow Prices of Social Capital

5.4.1. Relative Shadow Prices of Aggregated Social Capital with Respect to Physical Capital and Labor

Using the input distance function parameters in table 5.1, the relative shadow prices of aggregated social capital with respect to physical capital and labor, using expression (5.4) and expression (5.5), were calculated. The interpretation of the magnitude of the relative shadow prices of social capital depends on the measurement units of social capital, physical capital, and labor. In the current study, I measured social capital in percentages while physical capital and labor were measured in million Vietnamese Dong (Mil. VND) and 100-worker-hours, respectively (please refer to Table 3.3)[21]. Table 5.3 shows the relative shadow prices of aggregated social capital with respect to physical capital and labor.

Table 5.3: Relative shadow prices of aggregated social capital with respect to physical capital and labor

Parameters	With Respect to Physical Capital			With Respect to Employed Labor		
	Mean	Standard Deviation	Equivalent $US Value of Physical Capital[22]	Mean	Standard Deviation	Equivalent Worker-Hours of Labor
Relative shadow price of aggregated social capital	5.061	2.694	$324.436	0.855	0.312	85.511 hours

[21] Physical capital is measured in units of Mil. VND and labor is measured in units of 100-worker-hours because in monetary value they are the closest equivalent.

[22] The values of this column and the last column of the table are derived from expression (5.5) and the measurement units of physical capital and labor. For example, 324.436 is equal to the mean value (5.061) of relative shadow price of aggregate social capital multiplied by 1 Mil. VND and then divided by 15,600 (15,600 is the exchange rate of $US) for physical capital and 85.511 is equal to the mean value (0.855) of relative shadow price of aggregate social capital multiplied by 100 worker-hours for labor (where 1 Mil. VND and 100 worker-hours are the measurement units of physical capital and labor, respectively).

The results indicate that the relative shadow prices of aggregated social capital with respect to physical capital and labor are both positive, reflecting the fact that, like physical capital and labor, social capital makes a positive contribution to the mill's production efficiency. However, one unit (one percentage change) of aggregated social capital is much more productive than one unit (1 Mil. VND) of physical capital and less productive than one unit (100 worker-hours) of labor. For example, an increase of one unit (1 percentage) of aggregated social capital is equal to an increase of 5.061 units of physical capital while an increase of one unit of aggregated social capital is only equal to an increase of 0.855 units of labor. Thus, to maintain a given level of production efficiency, a percentage increase in social capital is equal to an increase of 5.061 Mil. VND or $324.436US in the value of physical capital or an increase of 85.511 worker-hours in labor.

Most interestingly, using the relative shadow prices of social capital with respect to physical capital and labor from equation 5.5, I can estimate the relative contribution of physical capital and labor to production efficiency. The results indicate that, at the margin, one unit of labor is 5.919 times more productive than one unit of physical capital[23]. Therefore, increasing the number of workers, rather than increasing physical capital will be a better option for increasing production efficiency. In fact, most of the owners of the paper-recycling mills that were surveyed thought that physical capital was much more productive and more important in improving their productivity than that of labor;

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[23] From expression (5.5), we have

$$\left(\frac{\partial D_I(x,u)/\partial SC}{\partial D_I(x,u)/\partial K} / \frac{\partial D_I(x,u)/\partial SC}{\partial D_I(x,u)/\partial L}\right) = \left(\frac{\partial D_I(x,u)/\partial L}{\partial D_I(x,u)/\partial K}\right) = 5.061/0.855 = 5.919.$$

therefore, they have tried to increase their physical capital while paying less attention to labor[24]. This result is consistent with the one withdrawn from Chapter 4 in which it indicates in the current stage of production process in Duong O the elasticities of output (income) with respect to physical capital was constant. This means the increase of physical capital has small impact on income or production efficiency of paper-recycling units.

5.4.2 Relative Shadow Prices of Disaggregated Social Capital with Respect to Physical Capital and Labor

The relative shadow prices of disaggregated social capital with respect to physical capital and labor are given in Table 5.4.

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24 In developing economies such as Vietnam, existing labor markets are subject to many market imperfections. For example, workers might not be paid at their marginal product but on the basis of their relationship with the owners of paper-recycling mills (e.g., for the same labor, the mill owner's uncle might get a higher payment compared to that of other workers). In the current study, workers were paid at an average rate of $1.28US per worker-hour, which is three times lower than the marginal physical product that they created for the owners of the paper-recycling mills (marginal physical product of a worker-hour is equal to $3.88US). Furthermore, Vietnam is a developing country, coming from a period with lacking of capital in general and physical capital in particularly; therefore, in every person's mind capital is the most important factor to initiate or maintain any business activity. While a high unemployment rate exists together with the labor market imperfections, paper-recycling producers can mobilize a number of laborers to satisfy their labor demand at any time; therefore, they usually consider labor not one of the important factors in their production. However, in my study it indicates that in this paper recycling village, physical capital is not a limitation factor any more (e.g., in Chapter 4 the elasticity of income with respect to physical capital is constant, while the elasticity of income with respect to labor is varied).

Table 5.4: Relative shadow prices of disaggregated social capital with respect to physical capital and labor

Parameters	With Respect to Physical Capital			With Respect to Employed Labor		
	Means [25]	Standard Deviation	Equivalent $US Value of Physical Capital[26]	Means	Standard Deviation	Equivalent Worker-Hours of Labor
Relative shadow price of trust	5.259	3.102	337.103	0.574	0.299	57.390
Relative shadow price of reciprocity	0.067	0.021	4.311	0.008	0.004	0.808
Relative shadow price of number of membership	5.693	4.048	364.936	0.592	0.410	59.184
Relative shadow price of information sharing	0.024	0.056	1.538	0.002	0.007	0.238

The results from Table 5.4 are interesting in several respects. First, like physical capital and labor, the mean values of the relative shadow prices of disaggregated social capital are all positive, reflecting a positive contribution to a mill's production efficiency. Second, the results indicate that trust and number of memberships are the most valuable

[25] The ratios of the mean values of social capital with respect to physical capital and labor should be constant across the four different dimensions of social capital; however, because these mean values were rounded up from 6 digits after the decimal, their values may be slightly different.

[26] The values of this column and the last one are based on expression (5.5) and calculated as explained in Table 5.4.

components out of the four components of disaggregated social capital[27]. For example, with a given level of production efficiency, an increase of one unit of trust and memberships is equal to an increase of 5.259 and 5.693 units of physical capital, respectively (i.e., equivalent to an increase in physical capital value of $337.103US and $364.936US, respectively) while an increase of the same amount in reciprocity and information sharing is only equal to an increase of 0.067 and 0.024 units of physical capital, respectively (i.e., equivalent to an increase in physical capital value of $4.311US and $1.538US, respectively). Third, similar to the case of aggregated social capital, one unit of any of the components of social capital is less productive than one unit of labor (100 person-hours). For example, at the margin, an increase of one unit of trust, reciprocity, membership, and information sharing is only equal to an increase of 57.39, 0.808, 59.184, and 0.238, respectively, in worker-hours of labor in order to maintain a given level of production efficiency. Finally, the relative shadow prices of aggregated social capital with respect to physical capital and labor are slightly smaller than those of trust or number of memberships in the disaggregated social capital model, but much greater than those of reciprocity or information sharing in the disaggregated social capital model. This means that the role of social capital varies across dimensions of social capital; therefore, using an aggregate index measure of social capital or one dimension of social

[27] In Ha et al. (2004a), the contribution of the number of memberships in social associations to household income in Duong O paper recycling village was evaluated as statistically insignificant; however, in the current study, the number of memberships is one of the most valuable components of social capital's contribution to production efficiency and it varies by income group. There are several possible reasons why the relationship between memberships and income is different in the two studies. First, Ha et al. (2004a) used a reduced production function form; while the current study uses a full translog production function. Second, the environmental outputs are included in the current model; whereas Ha et al. (2004a) did not include these outputs. Third, the current study uses a parametric deterministic programming method; whereas a stochastic parametric method was used in Ha et al. (2004a). Finally, the results are different not only because of the methodological differences in the models, but also because two different things are being measured and compared (the contributions of social capital to household income vs. its contribution to production efficiency). The implication of these contrasting results is that using more than one methodological approach may be best for truly understanding the contribution of social capital to household income.

capital may conceal the effects of different components of social capital and policy prescriptions based on the index may not be specific and therefore useful[28].

5.4.3 Relative Shadow Prices of Social Capital for Different Income Groups

Next, I examined the relative shadow prices of social capital for five income groups among the mill owners[29]. The relative shadow prices of both disaggregated and aggregated social capital with respect to physical capital and labor for these groups are given in Table 5.5.

Table 5.5: Relative shadow prices of social capital with respect to physical capital by income groups

Parameters	Relative Shadow Prices with Respect to Physical Capital by Different Income Groups					
	Under 1 billion	1-1.9 billion	2-3.9 billion	4-5.9 billion	6 billion or more	Means
Sample size	9	21	13	9	11	
Relative shadow price of trust	6.597	4.848	2.455	6.203	7.489	5.259
Relative shadow price of reciprocity	0.069	0.076	0.061	0.066	0.056	0.067
Relative shadow price of number of membership	8.795	5.996	4.560	5.142	4.368	5.693

[28] Ha et al. (2004a) found that the use of an aggregate index of social capital may not be a reliable measure in a case that there were weak correlations among variables and/or the variables measure different dimensions of social capital that have different characteristics.

[29] The gross annual income from paper production that occupies more than 98% of the gross annual income from all sources (agriculture, animal husbandry, paper production, services, pensions, and subsidies) was used for classifying five different income groups.

Relative shadow price of information sharing	0.013	0.002	0.030	0.017	0.074	0.024
Relative shadow price of social capital index	8.260	5.464	3.361	4.831	3.872	5.061

The results from table 5.5 show that the relative shadow prices of trust and number of membership with respect to physical capital for all five-income categories are much higher than one. This means that an increase in one unit of trust and number of memberships has a much greater effect on a mill's production efficiency than that of physical capital; therefore, in order to improve production efficiency, all income groups should focus on investing time and resources in memberships in associations and in social relations to increase trust.

A second point is that the relative shadow prices of number of memberships in associations and reciprocity with respect to physical capital are lowest for the highest income group. For example, the relative shadow price of the number of memberships with respect to physical capital for the highest income group is only a half of that of the lowest income group (e.g., 4.368 vs. 8.795) and the relative shadow price of reciprocity for the highest income group is only 81.16% of that for the lowest income group (e.g., 0.056 vs. 0.069). It is possible that the higher income groups normally have better knowledge and experiences in paper recycling production than those of the lower income groups; therefore, participating in social groups benefits members of the lower income group more than that of the higher income group since the lower income group can learn more from higher income members. Similarly, the lower relative shadow price of reciprocity for the highest income group is consistent with a previous study by Ha et al. (2004a), which found that the higher income groups in this paper recycling village needed less help from other lower income partners since they had enough resources for themselves to satisfy their production demands.

A third finding from Table 5.5 is that the relative shadow prices of trust and information sharing with respect to physical capital are highest for the highest income group. Specifically, the relative shadow prices of trust and information sharing for the highest income group are 7.489 and 0.074 respectively, which are much higher than those of other lower income groups and the mean values for all groups. This can be explained by two factors. First, the higher income group operates at a larger scale of production; therefore, the amount of goods and services exchanged per day for their production processes is much greater than those of the lower income groups. As a result, a small change in the level of trust and information sharing will have a greater effect on the transaction and production costs of the higher income group than for the lower income groups. This, in turn, has a stronger effect on the production efficiency of the paper recycling mills with higher income than that of the lower income mills. The other reason is that the higher income groups normally occupy more important positions in the paper recycling production and paper distribution networks; therefore, their ties encompass more influential individuals in the network. This gives them heightened access to more and better resources; therefore, a small change in trust and/or information sharing will have a greater impact on their paper production and distribution (Burt 1992).

Finally, the results also indicate that the relative shadow price of the social capital index with respect to physical capital is highest for the poorest group and declines as income increases. For example, the relative shadow price of the aggregate social capital of the lowest income group is 8.26, which is about twice that of the highest income group (3.872). This is consistent with previous studies by Grootaert (1999), Grootaert & Narayan (2004), Grootaert et al. (2002), and Ha et al. (2004a) which found that aggregated social capital has a stronger effect on lower income groups than higher income groups. This means that any policy change that improves an aggregated level of social capital will benefit the lower income groups more than the higher income groups.

5.5 Conclusion

This study is the first to employ a parametric deterministic input distance function for computing the relative shadow prices of social capital (or marginal returns of social capital) with respect to physical capital and labor. The major findings of the research are as follows.

First, I identified the magnitude of the impacts of social capital on paper recycling mills' production efficiency in terms of the value of physical capital and labor. The results indicate that social capital has a positive effect on the production efficiency of paper recycling mills, similar to that of physical capital and labor. However, the impact of one unit of social capital on production efficiency is much greater than that of one unit (i.e., 1 Mil. VND) of physical capital and less than that of one unit (i.e., 100 worker-hours) of labor. Therefore, there is scope for increasing production efficiency by promoting policy interventions that support new employment opportunities for local people and attempt to enrich social capital rather than increasing investment in physical capital.

Second, among the four dimensions of social capital, the strongest effects on production efficiency of paper recycling mills were found to come from trust and number of memberships in social associations. These results are consistent with most previous studies that indicated trust and number of memberships have the greatest effects on household well-being (Haddad & Maluccio 2003; Hjollund & Svendsen (in press)). Therefore, to improve production efficiency in the village by the means of social capital, the first priority should be to focus on increasing the level of trust and number of memberships in social associations. In order to increase levels of trust, the government may want to increase the level of monitoring and enforcement of implementing agreements and contracts among producers and between producers and customers. The accumulation of trust and number of membership in social associations also can be promoted through encouraging cooperation among the paper-recycling units and encouraging them to join the social groups.

Third, in line with Ha et al. (2004a), the current study also found that the impact of aggregated and disaggregated social capital on production efficiency differs by income of the household. For example, aggregated social capital has much greater effects on the production efficiency of the lowest income group than on the highest income group. Furthermore, trust and information sharing have stronger effects on the production efficiency of the highest income group than those of other groups, while number of memberships in social associations and reciprocity are most valuable for the lowest income groups. These findings are very important for policy since they imply that policy interventions to increase the levels of social capital in the village will benefit the lower income groups much more than higher income groups. Furthermore, policy makers and authorities may want to design different policy interventions for different income groups. For example, creating favorable conditions for the lower income groups to take part in the local social associations will allow these groups to benefit from the business experiences and technological information found in more efficient (higher income) production units; at the same time, participation in these groups will increase trust; therefore, this will benefit the higher income groups.

Finally, similar to previous empirical results (e.g., Narayan & Pritchett (1999); Grootaert;, 1999b(1999); Grootaert & Narayan (2004); Grootaert et al. (2002), and Ha et al. (2004a)), my findings suggest that the enrichment of social capital in the village will benefit the households with lower income more than those with higher income, since the relative shadow price of the aggregated social capital index has a stronger impact on the production efficiency of the lower income household groups than that of the higher income ones[30]. This finding is important in the sense that it determines whether policy interventions should focus on a change in social capital, or on other forms of capital. If the purpose of policy is to help the lower income groups, then an improvement of the levels of social capital is appropriate; whereas policies that increase other forms of capital will benefit the higher income groups more since they normally favor the rich.

[30] Ha et al. (2004a) examined the impacts of social capital on the income of different categories of household (e.g., paper-recycling households and general households) and discovered that the impacts of social capital on the income of general households (the poor) is greater than that of the paper-recycling households (the rich).

CHAPTER 6

SHADOW PRICES OF ENVIRONMENTAL OUTPUTS AND PRODUCTION EFFICIENCY OF HOUSEHOLD-LEVEL PAPER RECYCLING UNITS IN VIETNAM

6.1 Introduction

The concerns about environmental problems, including the contribution of industrial production processes to environmental pollution, in developing countries are as serious as in developed countries, and should not be neglected. However, many production activities in developing countries are quite different from those in developed countries; the main differences are in the terms of scale of operations, factors, and factor intensity (capital intensive versus labor intensive). In terms of scale, household-level production units are more common in developing countries than in developed countries. Similarly, in terms of factors, there is growing empirical evidence, at least from the rural sector of developing countries, that social capital can help households or small-scale household-level production units to overcome the deficiency of other types of capitals (Annen 2001, Fafchamp & Minten 2002). Many recent empirical studies, at the household-level, such as Narayan & Pritchett (1999), Grootaert (1999), Maluccio et al. (2000), Ruben & van Strien (2001), and Ha et al. (2004a), have used social capital as a production factor in the household production function and discovered that the contributions of social capital to household output (income) can even be greater than that of human capital and labor. Hence, the incorporation of social capital as one of the factors of the production process is as essential as the incorporation of environmental outputs. In terms of factor intensity, the production units in developing countries use more labor-intensive techniques; whereas firms in industrialized countries use more capital- intensive ones[31].

Furthermore, most of the distance function studies, except Hetemäki (1996) and Reinhard (1999), constrain the shadow price of undesirable outputs to be non-positive (weak disposability), which may be a realistic approach for some technologies and countries where environmental regulations are strongly enforced and monitored. However, the possibility of positive shadow prices of undesirable outputs[32], due to either "technological (biological) restrictions" (Reinhard 1999, p.61) and/or strong or free disposability due to absence and/or lack of enforcement of environmental regulations (i.e., free disposal of waste or lack of monitoring and enforcement of regulations) cannot be excluded, specifically in developing countries.

In this chapter, I extend and strengthen the production and efficiency analysis, in the presence of environmental outputs, to the household-level production processes in developing countries. Our specific case is of household-level paper recycling units in Vietnam. I address all four of the issues (in some sense limitations) mentioned above – scale, factor, factor-intensity, and the restriction on shadow prices. The scale of household-level paper recycling units is many times smaller than the scale in previous studies[33] and I use production unit level (micro-level) data; the production units are labor-

[31] For example, Färe et al. (1993) studied 30 pulp mills operating in Michigan and Wisconsin, USA. The average value of physical capital used for one ton of paper in these paper mills was 30.36 times greater than that of paper-recycling units in Vietnam (U.S. $2,352.42 per ton vs. U.S. $77.490 per ton at 2003 price); whereas the average worker-hour used for one ton of paper in the study by Färe et al. (1993) was 6.13 times less than that of paper recycling units in Vietnam (10.25 worker-hours per ton vs. 62.80 worker-hours per ton).

[32] Hetemäki (1996) also observed that there are no axioms behind the theoretical model that requires the imposition of a restriction of non-positive shadow prices of undesirable outputs. In his study, the bad output (FLOW) was non-regulated and its shadow price was also positive.

[33] For example, in the study by Färe et al. (1993) the average production output of the pulp mills was almost 100 times more than the production output of the paper-recycling units in our study (108,055.7 tons vs. 1,084.67 tons).

intensive; social capital is included as one of the production factors[34], and I do not impose any restrictions on shadow prices. In addition, the technologies used by these recycling units are local and primitive compared to the mature technologies of pulp and paper production units in developed countries, which have been the focus of previous studies. The Vietnamese household-level paper-recycling units also produce different types of paper – Kraft, votive, tissue, wrapping, and mixed paper. Hence, my analysis also provides a comparative view of shadow prices of environmental outputs for the production processes of different types of paper.

I use a parametric output distance function to examine the technical efficiency (output efficiency) of household-level paper-recycling units and to derive the shadow prices of three environmental outputs: biological oxygen demand (BOD), chemical oxygen demand (COD), and total suspended solids (SS). In contrast to previous studies, except Hetemäki (1996), I use a two-stage estimation procedure in estimating the distance function. The results are used to provide a comparative view of technical efficiency and shadow prices of environmental outputs for pulp and paper production for three cases: (i) household-level units in developing countries versus industrial units in developed countries, (ii) different sizes of household-level production units; and (iii) production units for different types of paper.

The paper is organized as follows. Section 6.2 briefly sets out the theoretical framework for output distance functions and shadow prices. Section 6.3 presents a methodology for empirical estimation of the output distance function. In Section 6.4 and 6.5 production efficiencies and shadow prices of household-level paper recycling units are

[34] In this chapter, the focus is on shadow prices of environmental outputs and production efficiency. Hence, social capital is included as a factor of production with the objective of avoiding misspecification, non-inclusion of known independent variables, and biased estimation results of the production process. However, due to space limitations, this chapter does not include a discussion of the relative shadow prices of social capital with respect to other factors. For a full analysis of social capital as a factor of production for paper-recycling units, see Ha, Kant, & Maclaren (2004b).

analyzed. Section 6.6 offers a static comparative view of the shadow prices of small scale versus large-scale production units. Concluding remarks are given in section 6.7.

6.2 Theoretical Concepts of Output Distance Functions and Shadow Prices of Outputs

The output distance function was first introduced by Shephard (1970), and developed further by Färe et al. (1993). Conceptually, an output distance function generalizes the notion of the conventional production function[35], and measures the differences in the outputs produced by production units under consideration and the outputs produced by the most efficient production unit. In other words, the output distance function gives the distance of an output vector from the boundary of the maximal output set, given the fixed input vector. Suppose that a production unit employs a vector of N inputs $x = \Re_+^N$ to produce a vector of M outputs $u = \Re_+^M$. The output distance function is defined as:

$$D_O(x,\ u) = Min\{\theta : (u/\theta) \in P(x)\} \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (6.1)$$

where P(x) is a set of output vectors that are technically feasible which employ the input vector x, and θ is a ratio with a range from zero to one. Larger values of D_0 indicate closer proximity to the production frontier and greater efficiency. The output distance function has the following properties (T. Coelli, Rao, & Battese 1998): (i) D_0 (x, 0) = 0 and $D_O(x,u) \le +\infty$; (ii) D_0 (x, u) is a lower-semi continuous function; (iii) D_0 (x, u) is non-decreasing in u and non-increasing in x; (iv) D_0 (x, u) is homogeneous of degree 1 in u; (v) $u \in P(x)$ if and only if $D_O(x,u) \le 1$; and (vi) D_0 (x, u) = 1 if u belongs to the “frontier” of the production possibility set.

The duality between the output distance function and the revenue function (Shephard 1970) allows the retrieval of the absolute and relative shadow prices of outputs

[35] See Färe & Primont (1995), and Kumbhakar & Lovell (2000) for a detailed discussion of distance functions.

(Färe et al. 1993). The relationship between the revenue function and the distance function can be expressed as:

$$R(x,u) = \max_{u}\{ru : D_O(x,u) \leq 1\} \text{ .... (6.2)}$$

and

$$D_O(x,u) = \max_{r}\{ru : R(x,u) \leq 1\} \text{ .... (6.3)}$$

where R(x, u) is a revenue function and r denotes output prices.

Assuming that the distance and the revenue functions are differentiable, Shepherd's dual lemma leads to the following relationship:

$$\nabla_u D_O(x,u) = r^*(x,u) \text{ .... (6.4)}$$

where r*(x, u) denotes the revenue maximizing output price vector.

The derivation of absolute shadow prices for environmental outputs using the distance function requires an assumption that the absolute shadow price of a marketable output is equal to its market price. Let m denote the marketable output and assume that the observed market price of m (r_m) equals its absolute shadow price (r_m^o). For all m′ ≠ m, absolute shadow prices are given by Equation (6.5) (Färe et al. 1993):

$$r_{m'} = r_m^o \cdot \frac{\partial D_o(x,u) / \partial u_{m'}}{\partial D_o(x,u) / \partial u_m} \text{ .... (6.5)}$$

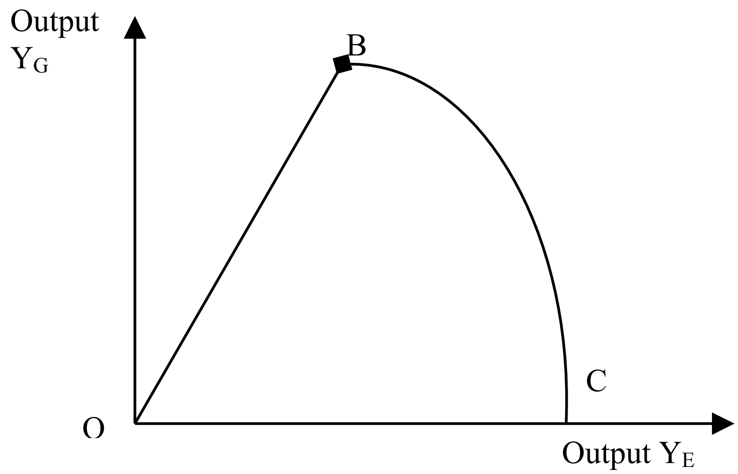
Relative shadow prices of output m′ with respect to output m can be expressed as:

$$R_{m'm} = \frac{\partial D_o(x,u) / \partial u_{m'}}{\partial D_o(x,u) / \partial u_m} \text{ .... (6.6)}$$

It is interesting that except for Hetemäki (1996) and Reinhard (1999), most of the studies on shadow prices of environmental outputs (including Färe et al. 1993; Coggins &

Swinton 1996; Swinton 1998; Hailu & Veeman 2000), constrain them to be non-positive or zero. However, as shown in Figure 6.1, such a restriction is not desirable.

Figure 6.1: Production possibility set in good output (Y_G) and environmental output (Y_E)



In the empirical studies, mentioned above, which impose negative shadow prices on environmental outputs, the focus is only on the trajectory OB that captures weak disposability (i.e., the regulations require abatement or cleanup of pollutants). On the trajectory BC in Figure 6.1, the relation between good and environmental output is characterized by positive shadow prices for the environmental output due to the "technological (biological) restrictions", and Reinhard (1999, p.61) focused only on this component (BC) of good and environmental outputs relationship. Similar to Hetemäki (1996), I focus on both the trajectories OB and BC that may result in positive or negative shadow prices of environmental outputs. Under strong or free disposability, (i.e., waste is freely disposed), production on the trajectory OB will have positive or zero shadow prices (e.g., a tax is not imposed on the environmental output). In the case of lack of enforcement of abatement regulations, production on trajectory OB may have a positive or negative shadow price depending on the "voluntary" compliance of the waste generator. For example, the shadow price will be negative if the abatement is implemented in compliance with the regulations since there is a resource-using for abatement, otherwise it will be positive or zero[36]. Production on the trajectory BC usually has a positive shadow price since the reduction of environmental outputs will result in increasing good outputs. For example, the paper mill trying to re-circulate wastewater in order to save materials (e.g., fibers) will result in both increasing output and reducing environmental products since this process recovers waste fibers. Therefore, more output can be produced with given inputs and at the same time it reduces total suspended solids (SS) (Hetemäki 1996).

6.3 Empirical Estimation of the Output Distance Function for the Production Process of Household-level Paper Recycling Units

The estimation of a distance function involves many choices – parametric versus non-parametric models, deterministic versus stochastic estimation, and the choice of a functional form. The most commonly used method in the empirical estimation of distance functions has so far been the deterministic linear programming method; only a few studies have used econometric methods (Kumbhakar & Lovell 2000). The deterministic linear programming approach does not require any distribution assumptions, is relatively easy to use and allows for the computation of a large number of parameters even with a small number of observations. The major weakness of the method is that the parameters are calculated rather than estimated (Dennis J. Aigner & Chu 1968). Therefore, it does not allow for disturbances and provides no statistical criteria for evaluating the consistency of the results. This may lead to distortions in assessment of economic performance since output can be affected by random shocks that are not under the control of a producer. Hence, I use a two-stage approach for estimation. In the first step, I calculate each production unit's distance to the reference production frontier using linear programming. In the second step, the distance measures computed in the first stage are used as a dependent

[36] In Vietnam, there is a lack of monitoring and enforcement of environmental regulations for household-level level production units because of the assumption that the waste generated by these small units is not significant compared to other larger firms. Furthermore, it is too expensive to monitor and enforce regulations at a large number of these small units. Thus, the shadow price of environmental outputs for each unit may vary greatly across the small production units and may be positive or negative depending on the "voluntary" compliance of the waste generator.

variable in the estimation of a parametric stochastic distance function. The two steps are described below.

6.3.1 Calculation of the Parameters of a Deterministic Parametric Output Distance Function Using the Linear Programming Method

Mathematical programming was first employed by Dennis J. Aigner & Chu (1968) to estimate production function parameters, and since then various authors such as Färe et al. (1993), Coggins & Swinton (1996), and Hailu & Veeman (2000) have used linear programming to estimate output and input distance functions. The translog functional form, due to its flexibility and general nature (Dennis J. Aigner & Chu 1968), is the most commonly used and appropriate functional form of distance functions. Hence, I use the translog functional form in my model.

The production process of household-level paper recycling units consists of six inputs - capital (x_1), labor (x_2), waste paper (x_3), energy (x_4), other materials (x_5), and social capital (x_6) – and four outputs - quantity of finished paper (u_1) and three environmental outputs (biological oxygen demand (u_2), chemical oxygen demand (u_3), and total suspended solid (u_4)). Hence, the translog output distance function of the household-level paper-recycling units can be expressed as:

$$\begin{aligned}\ln D_o(x^k,\ u^k) = {} & \alpha_o + \sum_{n=1}^{6}\beta_n \ln x_{nk} + \sum_{m=1}^{4}\alpha_m \ln u_{mk} \\ & + \frac{1}{2}\sum_{n=1}^{6}\sum_{n'=1}^{6}\beta_{nn'}(\ln x_{nk})(\ln x_{nk'}) \\ & + \frac{1}{2}\sum_{m=1}^{4}\sum_{m'=1}^{4}\alpha_{mm'}(\ln u_{mk})(\ln u_{mk'}) \\ & + \sum_{n=1}^{6}\sum_{m=1}^{4}\gamma_{nm}(\ln x_{nk})(\ln u_{mk})\end{aligned} \tag{6.7}$$

where, n indexes are the vector of six inputs, m indexes are the vector of four outputs, and k denotes a specific recycling unit (63 paper-recycling units). Values for the unknown parameters in Equation (6.7) are obtained by using linear programming to maximize:

$$\max \sum_{k=1}^{63} [\ln D_o(x^k,\ u^k) - \ln 1] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(6.8)}$$

subject to

(i) $\ln D_o(x^k,\ u^k) \leq 0,$

(ii) $\partial \ln D_o(x^k,\ u^u) / \partial \ln u_1^k) \geq 0$

(iii) $\partial \ln D_o(x^k,\ u^u) / \partial \ln x_n^k) \leq 0,$

(iv) $\sum_{m=1}^{4} \alpha_m = 1; \qquad \sum_{m'}^{4} \alpha_{mm'} = \sum_{m=1}^{4} \gamma_{nm} = 0;$

(v) $\begin{array}{l} \alpha_{mm'} = \alpha_{m'm}, \quad m = 1,2,3,4, \quad m' = 1,2,3,4, \\ \beta_{nn'} = \beta_{n'n}, \quad n = 1,2,3,4,5,6, \quad n' = 1,2,3,4,5,6, \end{array}$

The first set of constraints labeled (i) restricts individual observations to be less than or equal to one or “below” the production frontier. The second set labeled (ii) implies that the output distance function is non-decreasing in the quantity of finished paper produced (good output); while the third set in (iii) ensures that the output distant function is non-increasing in inputs. The constraints in (iv) impose homogeneity of degree one in outputs. The final set of constraints in (v) imposes symmetry.

The objective function (6.8) minimizes the sum of the deviations of individual observations from the frontier. However, I are in fact maximizing because the output distance function takes positive values smaller than or equal to one, and therefore its log can take a value of less than or equal to zero. In consequence, to minimize the sum of the absolute deviations of individual observations from the frontier, I have to maximize the deviations of distances, expressed in logs, from zero.

6.3.2 Estimation of the Parameters of a Stochastic Parametric Output Distance Function Using an Econometric Method

A generalized stochastic parametric distance function, as per D. J. Aigner et al. (1977) and Meenusen & van den Broeck (1977), can be expresses as given in equation (6.9) below[37]:

$$\begin{aligned}\ln D_o(x^k,\ u^k) = \alpha_o &+ \sum_{n=1}^{6} \beta_n \ln x_{nk} + \sum_{m=1}^{4} \alpha_m \ln u_{mk} \\ &+ \frac{1}{2}\sum_{n=1}^{6}\sum_{n'=1}^{6} \beta_{nn'} (\ln x_{nk})(\ln x_{nk'}) \\ &+ \frac{1}{2}\sum_{m=1}^{4}\sum_{m'=1}^{4} \alpha_{mm'} (\ln u_{mk})(\ln u_{mk'}) \\ &+ \sum_{n=1}^{6}\sum_{m=1}^{4} \gamma_{nm} (\ln x_{nk})(\ln u_{mk}) + \varepsilon^k\end{aligned} \tag{6.9}$$

The conditions of convexity in outputs and quasi-convexity in inputs of the output distance function were not imposed during the parameter estimation[38], but these conditions were tested after the model was estimated[39]. In order to maintain the homogeneity conditions (i.e., constraints (iv) in the linear programming estimation), I imposed those linear equality constraints on the parameters while using econometric method (O'Donnell & Coelli 2003).

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[37] In this specification, the error term (ε^k) is composed of two elements: a random error (v^k) and a one-sided, non-negative error (u^k). Generally, as per D. J. Aigner et al. (1977), Battese (1992); Forsund, Lovell, & Schmidt (1980); Hetemäki (1996); Kumbhakar & Lovell (2000), it is assumed that v^k is independently and identically distributed with mean zero and is independent of u^k. In order to separate the stochastic and inefficiency effects in the model, a distributional assumption is normally made for u^k. The (u^k) is non-negative, independently and identically distributed (Kumbhakar & Lovell 2000), and either a truncated normal (Stevenson (1980); D. J. Aigner et al. (1977)) or exponential distributional assumption (Meenusen & van den Broeck 1977) is typically imposed on (u^k).

[38] The curvature constraints are non-linear inequality constraints; thus, these conditions cannot be imposed using linear programming because they would turn the mathematical programming into a very large and highly non-linear problem. Similarly, it is almost impossible to impose non-linear restrictions using traditional econometric methods (see the discussion in Lau (1978). Furthermore, so far econometric software in public domain has not been able to impose non-linear inequality constraints for econometric models (O'Donnell & Coelli 2003).

[39] The estimated stochastic output distance function satisfied convexity in outputs for all observations and monotonicity in inputs at the mean for all inputs. It also satisfied the necessary conditions for quasi-convexity in inputs for all observations.

The complete translog model (9) could not be estimated due to the small number of observations. Hence, Ramsey's regression specification test (RESET) was used to choose from the alternate functional forms. The results from the test indicate that the restricted translog stochastic form with all the first-order terms in both inputs and outputs and cross product output and input-output terms, given below as equation 6.10, is an appropriate form.

$$\begin{aligned}\ln D_o(x^k,\ u^k) = \alpha_o + \sum_{n=1}^{6}\beta_n \ln x_{nk} + \sum_{m=1}^{4}\alpha_m \ln(u_{mk}) \\ + \frac{1}{2}\sum_{m=1}^{4}\sum_{m'=1}^{4}\alpha_{mm'}(\ln u_{mk})(\ln u_{mk'}) \qquad \ldots\ldots\ldots\ldots\ldots\ldots..\ (6.10) \\ + \sum_{n=1}^{6}\sum_{m=1}^{4}\gamma_{nm}(\ln x_{nk})(\ln u_{mk}) + \varepsilon^k\end{aligned}$$

In the two-stage stochastic estimation of the distance function, using values of the dependent variable (output distance) from the parametric linear programming method, which were estimated using the same independent variables, may result in endogeneity on the right-hand side. Hence, the Hausman specifications test was used to test for potential endogeneity bias. The test indicated that at the 1% significant level, OLS coefficients are consistent[40]. Next, two diagnostic tests were used to test for normality and homoskedasticity. The results of the Jarque-Bera Normality Test indicated that there was no non-normality in the error term distribution at the 5% level of significance (Chi-Square (2 DF) = 0.2982; p-value of JB statistics = 0.861). Similarly, as per the results of the White test, the assumption of homoskedasticity could not be rejected at the 5% level of significance. This implies the estimators would be efficient.

I tested the robustness of the parameter estimates with the bootstrap method, using SHAZAM 9.0 with 1,000 bootstrap trials.

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[40] We used cross product terms as instrumental variables for the output vector in the two-stage least squares estimation. The value of test statistic is m = 13.7. The critical chi-square with 1% significant level with 10 degrees of freedoms is 21.7.

6.4 The Estimated Output Distance Functions and the Production Efficiency of the Household-level Paper Recycling Units

The parameter estimates for the output distance function of paper recycling units are given in Table 6.1. For most of the parameters, the difference between the values of coefficients estimated by OLS and by bootstrap is only to the fifth decimal place (the average difference among the parameters is 0.0096 percent). Hence, I conclude that the OLS parameter estimates are robust.

Table 6.1: Estimated parameters of the output distance function of the household-level paper recycling units

	OLS coefficients and their standard errors		Bootstrap coefficients and their standard errors		Differences between OLS and bootstrap coefficients	
Parameters	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated Value	Percents
α_0	-4.68240*	2.48100	-4.68200	3.75E-07	-0.00040	0.0001
α_1	0.88146**	0.37750	0.88139	5.61E-08	0.00007	0.0001
α_2	0.69977	0.46890	0.69984	7.19E-08	-0.00007	-0.0001
α_3	-1.21290**	0.52840	-1.21300	8.09E-08	0.00010	-0.0001
α_4	0.63172**	0.22340	0.63180	3.34E-08	-0.00008	-0.0001
β_1	-0.22872	0.27480	-0.22872	4.11E-08	0.00000	0.0000
β_2	0.33663	0.38630	0.33651	5.97E-08	0.00012	0.0004
β_3	-0.17575	0.27560	-0.17562	4.02E-08	-0.00013	0.0007
β_4	-0.95866**	0.41680	-0.95875	6.26E-08	0.00009	-0.0001
β_5	-0.00787	0.16180	-0.00786	2.42E-08	-0.00001	0.0013
β_6	1.94390**	0.55440	1.94370	8.38E-08	0.00020	0.0001
α_{11}	0.09162**	0.04122	0.09163	6E-09	-0.00001	-0.0001

α_{12}	-0.09609**	0.03238	-0.09609	4.84E-09	0.00000	0.0000
α_{13}	0.01156	0.04696	0.01156	7.23E-09	0.00000	0.0000
α_{14}	-0.00710	0.01429	-0.00710	2.17E-09	0.00000	0.0000
α_{22}	0.44183***	0.04240	0.44183	6.6E-09	0.00000	0.0000
α_{23}	-0.39830***	0.03590	-0.39830	5.36E-09	0.00000	0.0000
α_{24}	0.05256**	0.01486	0.05256	2.26E-09	0.00000	0.0000
α_{33}	0.46722***	0.03890	0.46722	5.81E-09	0.00000	0.0000
α_{34}	-0.08048***	0.01604	-0.08048	2.51E-09	0.00000	0.0000
α_{44}	0.03502**	0.00970	0.03502	1.43E-09	0.00000	0.0000
γ_{11}	0.01918	0.04178	0.01917	6.25E-09	0.00001	0.0005
γ_{12}	0.04714	0.04010	0.04713	5.95E-09	0.00001	0.0002
γ_{13}	0.00259	0.05073	0.00261	7.51E-09	-0.00002	-0.0077
γ_{14}	-0.06891**	0.01902	-0.06892	2.81E-09	0.00001	-0.0001
γ_{21}	-0.03628	0.05816	-0.03627	9.04E-09	-0.00001	0.0003
γ_{22}	0.20386**	0.06179	0.20385	9.17E-09	0.00001	0.0000
γ_{23}	-0.11694*	0.06856	-0.11694	1.03E-08	0.00000	0.0000
γ_{24}	-0.05064**	0.02231	-0.05064	3.35E-09	0.00000	0.0000
γ_{31}	-0.13297**	0.04100	-0.13299	5.97E-09	0.00002	-0.0002
γ_{32}	-0.26996***	0.04555	-0.26996	6.73E-09	0.00000	0.0000
γ_{33}	0.27671***	0.04832	0.27672	7.06E-09	-0.00001	0.0000
γ_{34}	0.12622***	0.01792	0.12622	2.76E-09	0.00000	0.0000
γ_{41}	0.12875*	0.06350	0.12877	9.53E-09	-0.00002	-0.0002
γ_{42}	0.04999**	0.05561	0.05001	8.33E-09	-0.00002	-0.0004
γ_{43}	-0.14145*	0.07034	-0.14150	1.05E-08	0.00005	-0.0004
γ_{44}	-0.03729	0.02584	-0.03728	3.88E-09	-0.00001	0.0003
γ_{51}	-0.00740	0.02572	-0.00740	3.85E-09	0.00000	0.0000

γ_{52}	-0.00961	0.02493	-0.00961	3.65E-09	0.00000	0.0000
γ_{53}	0.01245	0.03373	0.01245	4.9E-09	0.00000	0.0000
γ_{54}	0.00456	0.00861	0.00456	1.31E-09	0.00000	0.0000
γ_{61}	-0.40098***	0.08325	-0.40097	1.27E-08	-0.00001	0.0000
γ_{62}	0.21892**	0.08113	0.21891	1.22E-08	0.00001	0.0000
γ_{63}	0.09018	0.10160	0.09017	1.55E-08	0.00001	0.0001
γ_{64}	0.09188**	0.02604	0.09189	3.71E-09	-0.00001	-0.0001

*p <0.05 **p<0.01

The OLS parameter estimates were used to compute the value of the output distance function or technical efficiency, for each recycling unit. The average, minimum, and maximum values of technical efficiency for five categories of recycling units are given in Table 6.2. The results from Table 6.2 indicate a significant variation of output efficiency among 63 mills; for example, the minimum efficiency is 0.37 while the highest is one. On average, efficiency is 0.72 with a standard deviation of 0.17. Therefore, on average the output efficiency of paper-recycling units can be improved by 28%, while the efficiency of the most inefficient production unit can be improved by 63%. It is interesting that the average output efficiency of paper-recycling units in Vietnam is much lower than the efficiency of pulp and paper units in the USA and Canada. For example, the average output efficiency for 30 pulp and paper mills operating in Michigan and Wisconsin (USA) was 0.92 in 1976 (Färe et al. 1993) and the average output efficiency for the Canadian pulp and paper industry from 1959 to 1994 was 0.99 (Hailu & Veeman 2000).

Althoug the production efficiency is a relative measure between producers, comparing observed with desirable performance, the lower average output efficiency of paper-recycling units in Vietnam can be attributed to at least three factors. First, paper-recycling units in Vietnam use simple technologies, developed by local people using crude trial and error methods; therefore, there is a great variation of techical efficiency among factories (e.g., the highest one is one while the lowest is only 0.37) that causes a lower average of technical efficiency. Second, the paper-recycling units in Vietnam use wastepaper as a raw material, hence its efficiency depends upon the recovery rate; whereas the paper factories studied by Färe et al. (1993) and Hailu & Veeman (2000) use wood pulp as a raw material which may contribute to higher efficiency. Finally, the higher efficiciency of paper production in the USA and Canada may be due to the high fixed cost component of those Canandian and US mills that may cause them to run so close to capacity and to technical efficiency.

The results also indicate that on an average the votive paper production units are the most efficient (mean efficiency of 0.86) whereas wrapping paper production units are the least efficient (mean efficiency of 0.60)[41]. The Kraft paper production units are second in terms of average efficiency, next to votive paper units, while the average efficiency of tissue paper units (0.68) and mixed paper units (0.66) is quite similar.

Three interesting features can be identified in the efficiency analysis of production units of different categories of paper. First, the lowest efficiency of votive paper production units is higher or very close to the average efficiency of all other categories of paper production units except Kraft paper. Second, the maximum efficiency is the lowest for wrapping paper units. Third, the range of variation of efficiency is the smallest for wrapping paper units (0.49 to 0.81) and the largest for the mixed paper units (0.37 to 0.93). Votive paper is a specialty product, and normally priced higher than Kraft, wrapping, and mixed paper[42]. Hence, the high price of votive paper may be one of the motivating factors for households to look for better technologies as a way to improve output efficiency. Similarly, low prices for wrapping paper may be one of the factors for

[41] Although the t test of differences between these 2 means is statistically significant at 5%, an analysis of variance (ANOVA) to test for significant differences across all of the means is not significant at 5%.

[42] Taiwan is the main market for selling votive paper; however, low quality votive paper is normally sold in the domestic market of Vietnam.

lower efficiency in wrapping paper production units. However, without detailed analysis of the technologies being used by different production units, it is not possible to draw definite conclusions about causes of variations in efficiencies across different types of papers. There is clearly a need for future research in this area. In general, all of the production units that are running inefficiently may benefit from the exchange of technological information with more efficient production units.

Table 6.2: Output efficiencies for different categories of household-level paper recycling units

	Categories of Paper Recycling Units					
	Kraft paper	Tissue & toilet	Votive paper	Wrapping paper	Mixed paper[43]	All units
Sample size	14	21	10	4	14	63
Average efficiency	0.77	0.68	0.86	0.60	0.66	0.72
Minimum efficiency	0.48	0.47	0.67	0.49	0.37	0.37
Maximum efficiency	0.96	0.98	1.00	0.81	0.93	1.00

6.5 Shadow Prices of Environmental Outputs of the Household-level Paper-recycling Units

The estimated parameters of the stochastic translog distance function (Equation 6.10) were used to estimate shadow prices of finished paper and three environmental outputs. The average absolute shadow prices of finished paper and the three environmental outputs (BOD, COD, and SS) are given in Table 6.3.

[43] These paper mills produce paper used for both writing and wrapping.

The results indicate that the average shadow prices of all three environmental outputs are positive, reflecting the fact that at the margin the desirable output (paper) and revenue will increase as a result of reducing the environmental outputs. The average shadow prices for BOD, COD, and SS per ton are 8,974,000 Vietnamese Dong (VND) (U.S. $575), 22,300,000 VND (U.S. $1,429), and 52,335,000 VND (U.S. $3,354), respectively. Hence, the reduction of BOD by one ton increases revenues by 8,974,000 VND (U.S. $575), equivalent to 2.04 tons of paper. Similarly, the reduction of one ton of COD and SS will increase the value of output by an amount equivalent to 5.08 and 11.92 tons of paper, respectively. These positive shadow prices are in accordance with previous studies on the link between wastewater recycling and production efficiency[44]. Kneese & Bower (1968) found that in the American pulp and paper industry, the amount of BOD per ton of paper product was reduced by about 5 to 10 percent when chemicals were recovered for reuse. They also remarked that the reduction of wastewater from pulp and paper mills is to some degree the result of the plant's objective to improve productivity. It should also be noted that the high positive shadow prices indicate that it becomes more difficult to improve the efficiency of paper recycling units in this craft village by the means of re-circulation of wastewater since shadow prices of environmental output are counted at the margin (i.e., it becomes harder to recover one more unit of environment output). More importantly, the average shadow prices are positive for all three environmental outputs, meaning that it is possible to apply pollution-prevention methods (re-circulation) to divert environmental outputs (pollutants) to good outputs for all environmental outputs from paper recycling in this village.

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[44] Nassar (2003) found that an internal wastewater treatment cycle of a paper factory reduced fresh water use by about 90%, reduced fiber loss by 80-90%, and increased board production by 13%.

Table 6.3: Shadow prices of environmental outputs of household-level paper recycling units

Parameters	Units	Mean Value	Minimum Value	Maximum Value
Price of finished paper (r_Q)	1,000 VND[45]/ton	4,390	2,449	6,804
Shadow price of BOD (r_{BOD})	1,000 VND/ton	8,974	-231,123	936,215
Shadow price of COD (r_{COD})	1,000 VND/ton	22,300	-531,393	1,316,688
Shadow price of SS (r_{SS})	1,000 VND/ton	52,335	-1,202,746	1,114,023

A significant variation in the shadow prices of pollutants across the production units is also noticeable. This variation is attributed to two factors. First, as presented in Figure 6.1, in the case of lack of enforcement of environmental regulations, the shadow prices of environmental outputs may be positive or negative depending on the waste generator's level of "voluntary" compliance with regulations (e.g., the shadow price will be negative if pollution abatement is implemented in compliance with the regulations since there is a resource-using for abatement, otherwise it will be positive). Second, the variation may be due to the variations in the technological procedures that produce different types of paper product and the advanced techniques used for certain paper production lines (e.g., some paper recycling mills may have better techniques for recovering chemicals for internal use while others may not recover chemicals at all).

Next, I calculated the shadow prices of the three environmental outputs for five categories of paper production units and these are given in Table 6.4.

[45] 1US dollar = 15,600VND

Table 6.4: Descriptive statistics of shadow prices of BOD, COD, and SS for five categories of paper recycling production units

Criteria	Production processes					
	Units	Kraft Paper	Tissue & toilet paper	Votive paper	Wrapping paper	Mixed paper
Sample size	Mill	14	21	10	4	14
Absolute average prices of finished paper	1,000 VND/ton	2,892	5,311	4,329	4,230	3,571
Average Shadow price of BOD	1,000 VND/ton	55,493	19,511	-27,654	-43,510	-12,194
Minimum		-42,556	-23,180	-231,123	-101,695	-101,777
Maximum		936,215	327,140	75,312	-10,092	33,392
Average Shadow price of COD	1,000 VND/ton	18,088	4,883	123,023	46,641	-26,257
Minimum		4,685	-61,871	-128,031	10,114	-531,393
Maximum		39,883	147,182	1,316,688	128,593	48,613
Average Shadow price of SS	1,000 VND/ton	16,849	127,614	142,755	-346,590	24,290
Minimum		-304,578	-134,327	30,092	-1,202,746	-753,326
Maximum		352,187	1,114,023	270,141	20,321	264,961

The disaggregated results show considerable variation in the shadow prices within each category of paper production. Similarly, there are sizeable differences in the shadow prices of different environmental outputs across the five categories. For example, for Kraft paper, the shadow price of BOD is more than three times greater than the shadow prices for COD and SS, while in the tissue and toilet paper category, the shadow price of BOD is almost four times greater than that of COD, but it is 6.5 times less than that of the shadow price of SS. This may indicate that the production processes of different paper categories are using different types of waste paper as well as different chemicals and different proportions of chemicals. Therefore, they generate different proportions of environmental outputs. Furthermore, the magnitude of the shadow prices reflects the cost of recycling wastewater to improve productivity and reduce water pollution. For example, in the Kraft paper category the shadow price of BOD indicates that it is three times more costly to reduce one ton of BOD than one ton of COD and SS. Similar inferences can be drawn about the cost comparisons across the five categories of production units. For example, on average, reducing one ton of BOD and COD for Kraft paper is 2.84 and 3.70 times more costly than for the tissue and toilet paper units, whereas to reduce one ton of SS for Kraft paper is 7.57 times cheaper than for tissue and toilet paper. These results indicate that abatement solutions have to be specific to environmental outputs (e.g., BOD, COD, and SS) and to the production process (e.g., Kraft paper, tissue and toilet paper, and so on).

Another interesting result is that the mean shadow prices of all three environmental outputs are positive for the Kraft paper, and tissue and toilet paper production processes. This means that for these two categories of paper production, on average there was no trade-off of revenue for the reduction of environmental outputs; reducing environmental outputs actually enhanced the revenues for the recycling units (e.g., positive shadow prices reflect the improvement of revenue as a result of wastewater reduction). It is possible that the factories producing Kraft paper, and tissue and toilet paper have had been using better recovery technologies and/or production lines. They may also have adapted their production processes to use equipment more efficiently in order to recover chemicals and materials. As a result, these paper mills may have greater capacity to reuse fiber, materials and chemicals through recirculation of wastewater than other types of paper mills. Another possible explanation is that these paper-recycling units might not be spending resources for cleanup of pollution since there was an absence of enforcement in pollution regulations in the village. In both of these cases, the end result is a positive shadow price for environmental outputs.

The disaggregated results also indicate that the shadow price of BOD is negative for votive paper, wrapping paper and mixed paper. The negative shadow price of BOD for these categories of paper indicates that lower BOD is achieved only through diverting resources from the production of pulp to the pollution abatement process (e.g., by building wastewater treatment facilities). Hence, either these categories of production units spent resources for pollution abatement, according to the requirements of environmental regulations, or the technologies of these categories of production units are not capable of recovering chemicals, which are sources of BOD, from wastewater. The shadow prices of COD and SS have different signs for these three types of paper. For example, the shadow prices of COD are positive for votive paper and wrapping paper and negative for mixed paper. This means that recycling can increase revenue and reduce levels of COD in wastewater for votive and wrapping paper units, but for mixed paper units some resources must be forgone to reduce the level of COD in wastewater.

6.6 A Comparative View of the Shadow Prices of Environmental Outputs: the Household-level Paper Recycling Units of Vietnam versus the Large-scale Paper Production Units from the Developed World

It is interesting to compare the present results to those obtained by Färe et al. (1993), Hetemäki (1996), and Hailu & Veeman (2000). Table 6.5 summarizes the shadow prices from those studies and the current study.

Table 6.5: A comparative view of the shadow prices of environmental outputs[46]

Criteria	Unit	Färe et al. (1993)	Hailu & Veeman (2000)	Hetemäki (1996)	Current study
Price of good output	$US/ton	1,553.72	492,28	950.84	281.23
Shadow price of BOD	$US/ton	-3,376.7	-103.45	-128.95	575.16
Shadow price of COD	$US/ton	N/A[47]	N/A	N/A	1,429.72
Shadow price of SS	$US/ton	0	-243.17	151.23	3,354.77
Average annual paper production by a single production unit	Tons	108,056	20,526,139	224,900	1,084.67

The price of paper in the Färe et al. (1993) study (which used an output distance function) of the pulp and paper industry in the U.S. is 5.5 times more expensive than that of the current study (U.S. $1,553.72 vs. U.S. $281.23 per ton); however, it is much more expensive for the pulp and paper industry in U.S. to reduce the level of BOD in wastewater. For example, it costs the U.S. mills 3,376.7 US dollars to reduce one ton of BOD while the value of output for paper-recycling mills in Vietnam will increase by

[46] The prices of outputs in this table were counted at 2003 US dollar prices. We used exchange rates and the Consumer Price Index (CPI) Conversion Factors 1800 to Estimated 2014 by Robert Sahr, Oregon State University, to convert all the prices to US dollars of 2003.

[47] The sign N/A indicates that the data for that price is not available in that specific study.

575.16 US dollars if the mills reduce BOD by the same amount. Similarly, a study by Hailu & Veeman (2000) using an input distance function reported the average shadow prices of BOD and SS for Canadian pulp paper industry, in the period from 1959 to 1994, to be -103.45US dollars and -243.17US dollars per ton, respectively. Both of these studies used a linear programming method and imposed restrictions on the shadow prices of environmental outputs to be negative or zero. A study by Hetemäki (1996) of Finish pulp plants, based on an output distance function without restrictions on the shadow prices, reported a shadow price of 151.23 U.S. dollars and -128.95 U.S. dollars for SS and BOD, respectively. In my study, the average shadow prices for all three outputs BOD, COD, and SS were positive, and the magnitude of all three shadow prices was much bigger than the magnitude of the respective shadow prices in the previous studies, except the magnitude of the shadow price of BOD in Färe et al. (1993). For example, the magnitude of the shadow price of SS is more than twenty times bigger than the shadow price of SS in Hetemäki (1996). In addition, the shadow prices of all three environmental outputs, in my case, are higher than the prices of main (paper) output while in Hetemäki (1996) and Hailu & Veeman (2000) the shadow prices of environmental outputs were generally lower than the prices of main output in absolute values.

In short, there are some substantial differences in the shadow prices of environmental outputs from paper production units in Vietnam and the developed world. Some of the reasons for these differences may be the same as the reasons discussed in Section 5 for differences in technical efficiency – scale of operation, primitive technology, and the nature of the raw material used for paper production. For example, in terms of output, the average annual output by production units studied in the U.S. and Canada is from 100 (Färe et al. 1993) to 19,000 (Hailu & Veeman 2000) times greater than that in the current study. The differences in production scale may affect the level and effectiveness of handling environmental outputs. For example, in India, the DESIRE project ("demonstration in small industries for reducing waste") sponsored by UNIDO and conducted by the National Productivity Council from 1993 to 1994, demonstrated the potential of waste minimization in small-scale industry. Several small-scale pulp and paper producers, pesticide manufacturers, and textile processors adopted low-cost waste minimization technologies and achieved remarkable environment improvements (Chandak 1994).

The primitive nature of local technology may be the cause of high fiber content in wastewater which may be the main reason for the very high shadow prices of SS. Similarly, the use of waste paper as a raw material, compared to pulp wood in production units of studies in developed countries, may be contributing to the release of large quantities of BOD and COD in the waste water, and the reuse of this wastewater in the production process will reduce the fresh demand of chemicals and input meterials (e.g., chlorines and pine resin) and fresh water.

In addition to these three factors, differences in environmental standards and their enforcement and monitoring will also be one of the main factors contributing to differences in shadow prices of environmental outputs. In fact, it appears that the combined effect of technological factors (scale, technology, and raw material) and institutional factors (lower standards of environmental regulations and weak enforcement and monitoring) is resuslting in the very high positive shadow prices of environmental outputs in the production process of paper recycling units in Vietnam.

6.7 Conclusion and Policy Implications

In this study, the output distance function (technical efficiency) and shadow prices of bad outputs or marginal costs of pollution abatement for 63 paper-recycling mills in Vietnam were estimated using a two-stage procedure which combined deterministic linear programming with a stochastic parametric output distance function. This research attempted to fill a gap in both the economics literature and empirical work by developing a theoretical framework for production analysis of a paper recycling craft village in Vietnam. The main feature of the framework is that it provides a more complete picture of efficiency analysis by taking both environmental pollution and social capital into consideration in its analysis of the technical efficiency of paper recycling production. The results from this study might be used for designing pollutant-specific policies to help the paper-recycling mills to meet the prescribed environmental standards of the Vietnamese government while increasing their productivity in paper production.

First, the results indicate that there is a large variation in the technical efficiency of the paper-recycling units, and many production units are using highly inefficient technologies. On average, there is scope for improving technical efficiency by 28%, which is very high compared to potential improvements in technical efficiency for production units in the developed world. Hence, the owners of production units and policy makers should give special attention to the potential for technological improvements in these production units.

Second, the variation in technical efficiency across paper-based categories of production units and within each category of production unit should be examined when devising technological improvement for inefficient production units. For example, in each category of production unit, except wrapping paper units, there are production units where the technical efficiency is greater than 90%. Hence, exchange of information among and between production units' owners and local officials may be beneficial for the inefficient units.

Third, the current study found that the average shadow prices of all three environmental outputs are positive, meaning that at the margin the desirable output (paper) and production efficiency will increase as a result of reducing the environmental outputs. This may be a result of the recovery of chemicals and input materials such as paper fibers, chlorine and pine resin and reuse of fresh water in the production process. In this case, policies should focus on increasing investment credits from the state to help the owners of paper-recycling units to improve paper production lines and production technologies so as to reduce pollutants (e.g., BOD, COD and SS) by pollution-prevention methods (re-circulation of wastewater).

Fourth, the positive shadow prices of undesirable outputs may also be a result of the weak monitoring and enforcement of environmental regulations. Hence, policy makers should assess appropriate policy interventions for encouraging paper-recycling production units to meet environmental regulations as required.

Fifth, there is great variability in the magnitude and the sign of the shadow prices of the environmental outputs across the five categories of production units. Hence, the choice of a particular method for reducing pollution (such as pollution-prevention methods vs. end-of-pipe methods) should be based on the specific conditions of each paper-recycling unit and the types of product it produces. For example, an application of pollution-prevention techniques may be appropriate for Kraft paper units since most of their shadow prices are positive; whereas this method may not be appropriate for the mixed paper units because most of their shadow prices are negative. Similarly, Kraft paper units are just next to votive paper units in terms of technical efficiency and the average shadow prices for all three environmental outputs are positive, reflecting a significant potential for improving environmental quality and technical efficiency at the same time. On the other hand, wrapping paper units are not only the least efficient but also have average shadow prices of BOD and SS that are negative, meaning that it will be difficult to improve environmental quality. Hence, promotion of Kraft paper units and closure of wrapping paper units may be the best policy option.

Finally, the results of this study confirmed my initial contention that the shadow prices of undesirable outputs may be positive or negative depending upon the technology of the production process and the status of environmental regulations. Hence, a priori restrictions on the signs of shadow prices of environmental outputs may provide biased results and should be avoided in future studies.

Acknowledgements:

I are grateful to Shawna Grosskopf, Tim Coelli, and Rolf Färe for useful advice and for providing us with materials for testing curvature conditions of the functions. Thanks are also due to the participants of the Southern Forest Economic Workers Annual Conference (**SOFEW**) organized from 14th to 16th March 2004 in St. Augustine Florida, USA where this chapter was presented and received valuable comments. Financial support from the Canadian International Development Agency (CIDA) is also greatly appreciated.

CHAPTER 7

SUMMARY, RESULTS AND RECOMMMENDATIONS

7.1 Summary of the Essays

The essays of the present study contribute to the empirical and theoretical methodology for identifying the contribution of social capital to economic outcome, computing distance functions and deriving shadow prices of social capital and environmental outputs. These contributions are of the following.

First, in Essay I (reported in Chapter 4), the contribution of several dimensions of social capital to household income has been first examined. All the previous studies have used an aggregate measure of social capital, normally defined as the quantity and quality of membership in social groups. However, similar to other production factors – such as labor, physical capital, and human capital – social capital is made up of different types of social capital, and the contributions of different types to the production process may vary. In such circumstances, a single dimensional measure or an aggregate index measure of social capital conceals the effects of different components of social capital, and policies based on an understanding of the outcome of a single dimensional measure or an aggregate measure of social capital may prove to be misleading. Furthermore, in the current study, the impacts of social capital on household income have extended to other types of household production. Most previous studies focused on households who do farming activities alone; however, in the present study particular emphasize has been put on the contribution of social capital to household paper-recycling units. In addition to focusing on the impact of social capital on income of households that own paper-recycling microenterprises, I also examined and made a comparison with the other households who earn their living from agriculture, raising animals, and provision of support services for recycling and paper production. Finally, it is the first time that separate household production functions for income and expenditures has been analyzed and compared in the present study. Most previous studies have applied the model that expenditures were used for independent variable, mainly because of difficulties in obtaining data on household income.

Essay II presented in Chapter 5 concerned with estimating relative shadow prices of social capital (or marginal returns of social capital) for 63 paper-recycling units in Vietnam. The essay contributes to the literature by applying a parametric deterministic input distance function to investigate the contribution of social capital to production efficiency and compute the shadow prices of social capital for the first time. In recent years, social capital has emerged as one of the dominant concepts for explaining the outcomes of various social and economic phenomena and several recognized the role of social capital as a household production factor, on a par with the conventional production inputs such as physical capital, human capital, and labor; however, no attempt has been made to develop a mechanism to assign prices to social capital. Like environmental outputs, the basic problem with counting prices of social capital is that social capital is not traded in the market, and hence prices of social capital are not available from market information. As a result, in the present study a deterministic input distance function has been used to compute the contribution of social capital to production efficiency and derive the relative shadow price of social capital. Furthermore, most previous studies have found that social capital's impacts on household output vary across income groups; thus, in the current study the relative shadow prices of social capital, including prices of different types of social capital, have been calculating for different income groups as well.

In Essay III (reported in Chapter 6), a new and comprehensive framework for estimating shadow prices of environmental outputs and production efficiency of 63 paper-recycling units is proposed and applied. First, the essay contributes to the literature by extending the existing stochastic frontier literature in incorporating social capital as an input on a par with other forms of capital in stochastic models for the first time. Second, in the current study a two-stage estimation procedure, parametric linear programming and stochastic estimation, was used for estimating output distance function. The basic problem with distance functions, as concerns econometric estimation, is that one does not have data on the dependent variable. Further, if one sets the distance function equal to its efficient (frontier) value, the left-hand side of the distance function is invariant, an intercept cannot be estimated, and ordinary least squares (OLS) parameter estimate will be biased; therefore, different methods have been applied to overcome this obstacle. The most common way of overcoming this problem is to set the left-hand side equal to one and transform the equation to an estimable form (e.g., a division of both sides of equation by the value of one of the outputs based on the property that distance function is a homogeneous degree +1). Hetemäki (1996) applied another method in which a two-stage procedure, a nonparametric linear programming method and stochastic method, was used for estimating the output distance function. Similar to Hetemäki (1996), in the present study I used a two-stage procedure but in the first stage a parametric linear programming method was used instead of the nonparametric linear programming one used by Hetemäki (1996). In this stage, the distance from each observation to the production frontier is computed using a parametric linear programming method, and in the second stage, these values are used as the dependent variable in the stochastic model. As a result, the dependent variable is based on actual distance scores and estimation can be implemented by using an OLS method. Finally, similar to Hetemäki (1996) and Reinhard (1999), in the current study no constraints on the shadow price of undesirable outputs are imposed. The negative constraints on the shadow price of undesirable outputs (weak disposability) may be a realistic approach for some technologies and countries where environmental regulations are strongly enforced and monitored. However, these constraints may not be realistic for technologies where there is an absence and/or lack of enforcement of environmental regulations (i.e., free disposal of waste or lack of monitoring and enforcement of regulations), specifically in developing countries.

7.2 Studying Results of the Essays

The results of the essays fall basically into two categories: those related to social capital, and the others related to efficiency and shadow prices of environmental outputs.

7.2.1 Studying Results on Social Capital

The results from the two studies on social capital are briefly summarized and compared below.

First, similar to empirical results from other countries, the results from these studies indicate that social capital in a craft village in Vietnam has a strong impact on the income of households and production efficiency of paper-recycling units; therefore, policy interventions to enrich social capital in this paper recycling village are necessary for the village development. One may be doubtful on the issue of being able to change social capital through policy intervention; however, there has been growing evidence indicating that the intervention by government may improve social capital. For example, a study by Quinones & Seibel (2000) indicates that the removal of restrictive regulation of the formal financial system in Philippine banking system contributed to the formation of positive social capital that in turn created a space wherein micro-finance institutions serving the poor have sprouted, enhancing the capacity of poor households for cooperation and mutual support.

Second, the results from the research also indicate that the computed impacts of social capital on the income of household and the production efficiency are sensitive to the methodology used. Future research; thus, should carefully considered studying contexts of which one may choose between an aggregated index of social capital and disaggregated social capital for the research. For example, it may be appropriate to use an aggregate index of social capital in the case that only one category or dimension of social capital is considered such as the ones studied by Grootaert (1999); Grootaert (2001); Grootaert et al. (2002); Grootaert & Narayan (2004).

Third, the present study indicates that using more than one methodological approach may be best for evaluating contribution of social capital to economic outcome. For example, the contribution of the number of memberships in social associations to household income in Duong O paper recycling village was evaluated as statistically insignificant; however, it is one of the most valuable components of social capital's contribution to production efficiency.

Fourth, the results indicate that the impact of both aggregated and disaggregated social capital on economic outcome differs by the income levels of the household. For example, aggregated social capital has much greater effects on the production efficiency of the lowest income group than on the highest income group. Most interesting, both two ways of approach indicate that trust is usually most important for higher income groups; whereas reciprocity is normally most valuable for the lowest income groups. These findings are very important for policy since they imply that in general policy interventions to increase the levels of social capital in the village will benefit the lower income groups much more than higher income, but policy makers and authorities may also be able to design different policy interventions to social capital for different income groups.

Finally, the studies suggest that the enrichment of social capital in the village will benefit the households with lower income more than those with higher income. This finding is important in the sense that it determines whether policy interventions should focus on a change in social capital, or on other forms of capital. If the purpose of policy is to help the lower income groups, then an improvement of the levels of social capital is appropriate; whereas policies that increase other forms of capital may benefit the higher income groups more since they normally favor the rich.

7.2.1 Studying Results on Production Efficiency and Shadow Prices

The results from the study on shadow prices of environmental output and production efficiency of paper recycling units are as follows.

First, the results indicate that there is a large variation in the technical efficiency of the paper-recycling units, and many production units are using highly inefficient technologies. As a result, there is a great potential for improving technical efficiency for paper-recycling units in this paper recycling village that policy makers should take into account. Second, there is a variation in technical efficiency across paper-based categories of production units and within each category of production unit. Hence, exchange of information among and between production units'owners and local officials may be beneficial for the inefficient units.

Third, the results indicate that the average shadow prices of all three environmental outputs are positive, meaning that at the margin the desirable output (paper) and production efficiency will increase as a result of reducing the environmental outputs. This may be a result of the recovery of chemicals and input materials such as paper fibers, chlorine and pine resin and reuse of fresh water in the production process or may also be a result of the weak monitoring and enforcement of environmental regulations. Hence, policy makers should assess appropriate policy interventions according to practical situations of paper-recycling production units.

Fourth, there is great variability in the magnitude and the sign of the shadow prices of the environmental outputs across the five categories of production units. Hence, the choice of a particular method for reducing pollution (such as pollution-prevention methods vs. end-of-pipe methods) should be based on the specific conditions of each paper-recycling unit and the types of product it produces. For example, an application of pollution-prevention techniques may be appropriate for Kraft paper units since most of their shadow prices are positive; whereas this method may not be appropriate for the mixed paper units because most of their shadow prices are negative. Similarly, Kraft paper units are just next to votive paper units in terms of technical efficiency and the average shadow prices for all three environmental outputs are positive, reflecting a significant potential for improving environmental quality and technical efficiency at the same time. On the other hand, wrapping paper units are not only the least efficient but also have average shadow prices of BOD and SS that are negative, meaning that it will be difficult to improve environmental quality. Hence, promotion of Kraft paper units and closure of wrapping paper units may be the best policy option.

Finally, the results of this study confirmed that the shadow prices of undesirable outputs may be positive or negative depending upon the technology of the production process and the status of environmental regulations. Hence, a priori restrictions on the signs of shadow prices of environmental outputs may provide biased results and should be avoided in future studies.

7.3 Recommendations for Further Research

There are at least three aspects in which the current research can be extended. The first relates to a scale of the study. The present study has been limited to only one craft village. Hence, the results of these studies alone are insufficient as a solid basis for policy prescriptions in other villages. As a result, similar studies should be repeated in other craft villages in Vietnam. The results of the research can be generalized when there are at least three similar studies in three other recycling villages for three successive years. These studies should use the same system of questions as used in this study, but adapted some parts to be suitable with types of products that those village produce.

Second, in this study the number of memberships was the major focus for measuring associational activity; however, a study of other characteristics of associational activity such as the internal heterogeneity of association, frequency of meeting attendance, and members' effective participation in the decision making of associations such as the ones studied by Grootaert (1999); Grootaert (2001); Grootaert et al. (2002); Grootaert & Narayan (2004) may give more reliable results for measuring associational activity; therefore, future research should investigate the role of associational activity in more detail, using not just number of memberships, but quality of participation in those associations as well.

Finally, in this study it was limited to employ a parametric deterministic input distance function for computing the relative shadow prices of social capital; however, future research on the shadow prices of social capital should be extended to a stochastic deterministic parametric method. This extension enables one to compare the role of social capital in contribution to the household income and production efficiency with the same line; therefore, the comparison results will be more reliable.

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Annexure 3.1

Map showing the Duong O village, Bac Ninh province, Vietnam

Study area, 32 kilometers
northeast of Hanoi capital

Annexure 3.2

Household Questionnaire

I. General Information

1. Name of interviewee……………………..…………Sex: ……Male …… ….Female …

2. Total number of family members………………persons

3. Details on family members (including interviewee) by age, sex, relationship, married status, education, occupation.

No	Names of all individuals in household	Age Years	Sex Male...... 1 Female…2	Relationship to household head	Married status Not Married…1 Married………2 Divorce………3 Widow………..4 Never married…5	Education level (Specify what grade each has completed)	Occupation	
							Main	Secondary
1	Yourself							
2								
3								
4								
5								
6								
7								

II. Household's Assets and Household's Income and Expenditure

1. Please give the following details regarding current assets of your family

ASSETS	UNIT	NUMBER	VALUE
1. Land			
- For homestead	m^2		
- For production	m^2		
- For agriculture production and fish raising	m^2		
- Trades	m^2		
- Other *(specify)*	m^2		
2. Agriculture			
- Machineries	unit		
- Buffaloes and Oxen	head		
- Other *(specify)*			
3. Production means			
- Workshops	m^2		
- Warehouse	m^2		
- Machineries for paper processing	unit		
- Transportation means	unit		
- Electricity generators	unit		
- Other *(specify)*			

2. Please specify the gross annual income for the year 2002 from different sources:

SOURCES	UNIT	NUMBER	PRICE	INCOME
1. Income from livestock and fish raising				
- Buffaloes				
- Pigs				
- Chickens				
- Fish				
- Other *(specify)*				

2. Income from agriculture cultivations				
- Paddy				
- Peanut				
- Potato				
- Vegetables				
- Fruit trees				
-				
- Other *(specify)*				
3. Income from production				
-				
-				
-				
4. Income from pension or subsidy				
5. Other income *(specify)*				

3. Please estimate for us how much your household spends on these items last year:

EXPENDITURE ITEMS	UNIT	NUMBER	PRICE	EXPENDITURES
1. Expenditures for livestock and fish raising				
- Buffaloes				
- Pigs				
- Chickens				
- Fish				
- Other *(specify)*				
2. Expenditures for agriculture cultivations				
- Seeds				
- Fertilizers				
- Insecticides				
- Plowing				
- Irrigation				
- Other *(specify)*				

3. Expenditures for production				
- Waste materials	ton			
- Coal	ton			
- Electricity	Kw			
- Workers	person			
- Taxes				
- Interests				
- Other *(specify)*				
4. Expenditures for household living				
- Food				
- Clothes				
- Transportation				
- Healthcare				
- Education				
- Electricity, water, telephone				
- Entertainments (including drinking, books, movies, renting video tapes).				
- Community-oriented expenditures (wedding parties, gifts to other households, etc).				
- Other *(specify)*				

III. Social Capital Questions

Criteria	Households who have paper recycling units	General households
Associational activity	*1.* Are you or someone in your household a member of any of the following groups, organizations or associations? *Checklist of 16 organizations*	1. Are you or someone in your household a member of any of the following groups, organizations or associations? *Checklist of 16 organizations*
Social relations (information sharing)	1. In the last two years, have you contacted an influential person to ask for information or help for paper production? *1. No 2. Yes* 2. If you need information to make a decision in paper production, do you know where to find that information? *1. No, never 2. No, almost never 3. Sometimes 4. Yes, most of the time 5. Yes, always* 3. Do you find it helpful to join with owners of other paper factories to make a decision relating to paper production such as decisions on prices, hiring workers, or investment? *1. No, never 2. No, almost never 3.Sometimes 4. Yes, most of the time 5. Yes, always*	1. In the last two years, have you contacted an influential person to ask for information or help? *1. No 2. Yes* 2. If you need information to make a decision in your production, do you know where to find that information? *1. No, never 2. No, almost never 3. Sometimes 4. Yes, most of the time 5. Yes, always* *3.* Do you think that by joining with others in the village to solve common issues you have acquired new skills or learned something valuable? *1. No, never 2. No 3. Neutral 4. Yes 5. Yes, definitely*
Trust	*1.* What level of trust do you feel that wastepaper suppliers have in you? *1. No trust 2. Low trust 3. Moderate trust 4. High trust 5. Absolute trust* *2.* What is your level of trust in your wastepaper suppliers*?* *1. No trust 2. Low trust 3.Moderate trust 4. High trust 5. Absolute trust* 3. What is your level of trust in the people working for you? *1. No trust 2. Low trust 3. Moderate trust 4. High trust 5.*	*1.* What level of trust do you have in your neighbors to help you when you face difficult times? *1. No trust 2. Low trust 3. Moderate trust 4. High trust 5. Absolute trust* 2. If you lose something such as a pig or a chicken, would someone in the village help look for it or return it to you? *1. No, never 2. No, almost never 3. Sometimes 4. Yes, most of the time 5. Yes, always* *3.* Do people in this village generally trust one another in matters of

	Absolute trust 4. What is your level of trust in other paper producers? *1. No trust 2. Low trust 3. Moderate trust 4. High trust 5. Absolute trust*	lending and borrowing? *1. No, never 2. No, almost never 3. Sometimes 4. Yes, most of the time 5. Yes, always* *4.* Are people in this village basically honest and can be trusted? *1. No, nobody 2. No, hardly anybody 3.Some people; 4. Yes, most people 5. Yes, everyone*
Reciprocity (mutual help)	*1.* How many times have you borrowed wastepaper from other paper factories in the last two years? *Number of times* ____ *2.* How many times have you given credit to paper buyers in the last two years? *Number of times* ____ 3. How many times have other paper factories lent you their laborers or given credit to you in the last two years? *Number of times* ____ 4. How many times have paper buyers given you loans in the last two years? *Number of times* ____	*1.* Who do you most often ask for or may ask for a loan? *1. Relatives; 2. Friends; 3. Neighbor; 4. Others in your village; 5. Others from outside your village.* 2. Who most often provides or may provide you with advice on production activities? *1. Relatives; 2. Friends; 3. Neighbor; 4. Others in your village; 5. Others from outside your village.* 3. Who most often asks you or may ask you for a loan? *1. Relatives; 2. Friends; 3. Neighbor; 4. Others in your village; 5. Others from outside your villages*. 4. To whom do you most often provide or may provide with advice on production experiences? *1. Relatives; 2. Friends; 3. Neighbor; 4. Others in your village; 5. Others from outside your villages.*

Annexure 3.3

Water indicators in paper mill wastewater of Duong O village, Vietnam (rainy season)

Parameters	Units	Year 1998	Year 2003	Industrial wastewater Discharge standard (TCVN 5945-1995)
Biological oxygen demand	mg/l	102	536.4	50
Chemical oxygen demand	mg/l	970	1,964.5	100
Total suspended solid	mg/l	2,648	1,119.6	100

Annexure 3.4

Production data of the general households in 2002

Households	Gross Income (1,000 VND)	Total Expenditure (1,000 VND)	Traditional Inputs			Social Capital Inputs[48]											
			Physical Capital (1,000 VND)	Edu. (years)	HH Size	Total Membership	Social Relations			Trust				Reciprocity			
							Q. 1[49]	Q. 2	Q. 3	Q. 1	Q. 2	Q. 3	Q. 4	Q. 1	Q. 2	Q. 3	Q. 4
Household 1	18,400	12,200	3,000	12	2	10	-	5	1	5	5	4	4	1	1	1	1
Household 2	16,400	12,960	-	8	5	18	1	4	5	5	5	5	4	5	1	1	1
Household 3	12,000	8,400	300	12	4	10	-	3	1	4	4	4	4	1	1	1	1
Household 4	30,600	24,000	3,000	9	5	13	-	2	5	5	5	5	4	5	2	5	3
Household 5	38,000	35,600	3,000	9	5	16	-	4	5	5	4	4	4	2	2	2	2
Household 6	18,000	18,000	-	9	5	19	-	4	5	5	4	4	5	1	1	1	1
Household 7	15,200	14,600	-	6	6	9	-	4	1	4	4	4	4	1	1	1	1
Household 8	36,000	14,400	-	9	6	15	-	4	5	4	4	4	5	3	1	5	4
Household 9	25,200	22,050	250,000	9	4	18	-	4	5	5	5	2	4	1	1	1	2
Household 10	18,000	12,000	-	9	2	8	-	4	1	4	4	4	4	1	1	1	1
Household 11	330,000	325,000	250,000	9	6	27	-	5	5	5	5	5	5	4	1	5	2
Household 12	27,480	12,000	-	16	5	15	-	4	5	5	4	4	5	1	1	5	1
Household 13	5,400	4,500	500	6	3	8	-	4	5	4	4	4	4	1	1	1	1
Household 14	22,680	12,000	-	9	4	11	-	4	1	4	4	4	4	1	1	1	1

[48] Social capital inputs were measured by the Household Questionnaire, Part III, in Annexure 3.2.

[49] This stands for questions No. 1 in the by the Household Questionnaire, Part III, in Annexure 3.2., and other columns are similar.

Household 15	19,552	18,950	-	6	6	14	-	4	5	4	5	4	4	1	1	1	1
Household 16	150,000	82,000	12,000	7	5	20	-	2	5	5	5	4	4	3	1	1	1
Household 17	60,000	26,000	20,000	11	4	14	1	4	5	5	4	5	4	4	2	5	2
Household 18	6,840	4,200	-	9	2	8	-	4	5	4	4	4	4	1	1	1	1
Household 19	8,200	4,600	-	9	3	17	-	4	5	4	5	3	4	1	1	1	1
Household 20	15,200	12,153	90,000	10	6	21	-	4	5	5	5	5	5	3	3	5	3
Household 21	15,600	12,000	-	12	5	22	-	4	1	4	4	5	4	1	1	1	1
Household 22	9,480	9,100	-	6	3	9	-	4	5	4	5	4	4	1	1	1	1
Household 23	31,600	18,194	-	9	4	17	-	4	5	4	4	4	4	2	2	2	3
Household 24	24,000	13,080	1,200	9	3	8	-	4	5	4	4	4	4	1	1	1	1
Household 25	66,100	33,400	20,000	9	3	18	-	4	5	5	5	4	4	1	1	1	1
Household 26	29,200	19,600	-	9	6	16	-	4	5	5	4	4	4	1	1	1	1
Household 27	4,500	4,000	-	9	4	17	-	4	5	4	4	2	2	1	1	1	1
Household 28	11,400	2,000	-	16	4	12	-	5	1	5	4	4	4	2	1	1	2
Household 29	17,300	8,700	-	9	5	16	-	4	5	4	4	3	4	1	1	1	1
Household 30	12,800	6,000	-	6	4	13	-	3	1	4	5	3	4	1	1	1	1
Household 31	23,000	21,350	1,000	9	9	18	-	4	5	4	4	3	5	1	1	1	1
Household 32	22,400	18,500	-	8	4	10	-	4	5	5	4	4	4	1	1	1	1
Household 33	13,200	19,880	500	9	4	18	-	4	5	5	4	4	4	4	3	5	3
Household 34	14,120	18,820	350	9	5	6	-	4	1	4	4	4	4	1	1	1	1
Household 35	193,200	150,000	40,000	9	4	17	-	4	1	5	4	3	4	1	1	1	1
Household 36	6,000	4,800	-	12	2	9	-	4	5	5	5	4	5	1	1	1	1
Household 37	24,892	12,600	-	12	4	11	-	4	5	4	4	5	5	1	1	1	1
Household 38	10,800	7,200	-	6	3	7	-	4	5	4	5	5	4	1	1	1	1
Household 39	12,000	8,400	-	9	5	13	-	4	1	4	4	5	4	1	1	1	1
Household 40	13,200	12,000	-	9	4	13	-	4	1	4	4	5	4	1	1	1	1
Household 41	42,400	28,800	100,000	9	4	10	-	4	5	5	5	4	4	1	1	1	1
Household 42	13,120	12,200	-	7	7	30	-	4	1	4	5	5	5	1	1	1	1
Household 43	23,000	16,400	-	7	4	11	-	4	5	4	4	4	4	1	1	1	1
Household 44	52,000	19,000	-	8	5	6	-	4	5	4	4	3	4	1	1	1	1
Household 45	42,400	13,050	-	9	6	11	-	4	5	5	5	5	4	5	3	5	2

Household 46	14,000	9,390	-	9	5	15	-	5	5	5	5	4	4	1	1	2	1
Household 47	24,000	18,000	200,000	9	4	18	-	5	1	4	4	4	4	1	3	5	4
Household 48	21,200	9,850	1,000	9	3	8	-	4	5	4	4	4	4	1	1	1	1
Household 49	20,400	12,000	-	9	5	16	-	4	5	4	4	5	4	2	3	2	1
Household 50	20,320	15,105	15,000	12	5	11	-	4	5	4	4	3	4	1	1	1	1
Household 51	11,400	11,040	-	10	3	12	-	4	5	5	5	4	4	1	1	1	1
Household 52	7,200	4,800	750	7	2	11	-	3	5	4	4	4	4	1	1	1	1
Household 53	52,200	24,240	20,000	9	4	8	-	5	5	5	4	4	5	1	1	1	1
Household 54	17,400	12,240	-	6	4	8	-	4	1	5	4	5	4	1	1	1	1
Household 55	9,600	9,600	-	9	3	8	-	5	5	5	5	5	4	1	1	1	1
Household 56	66,000	24,000	100,000	9	3	10	1	4	5	5	4	5	5	1	1	1	1
Household 57	48,800	24,600	-	5	3	10	1	4	5	5	4	5	5	1	1	1	1
Household 58	4,800	4,800	-	5	2	8	-	4	5	4	4	4	5	1	1	1	1
Household 59	25,200	10,980	-	5	6	19	-	5	5	5	5	5	5	1	1	1	1
Household 60	15,600	8,020	-	9	5	14	-	5	1	5	4	5	5	1	1	1	1
Household 61	8,400	8,400	-	9	2	3	-	4	1	4	4	4	5	1	1	1	1
Household 62	14,400	12,000	-	10	2	11	-	4	5	4	5	4	5	1	1	1	1
Household 63	22,600	12,300	-	6	6	22	-	4	5	5	5	4	5	5	4	5	4
Household 64	29,200	26,050	-	7	7	22	-	4	5	5	4	5	5	1	1	1	1
Household 65	30,000	24,300	135,000	12	2	10	-	5	5	5	4	5	5	1	1	1	1
Household 66	44,400	29,300	-	11	5	21	-	4	5	5	4	4	5	5	4	5	5
Household 67	16,400	10,400	-	12	3	9	1	4	5	4	4	4	4	1	1	1	1
Household 68	22,600	14,800	-	11	4	18	-	5	5	4	5	5	5	1	1	1	1
Household 69	17,992	12,240	-	12	5	20	-	4	5	4	5	4	4	1	1	1	1
Household 70	10,080	6,800	-	6	3	10	-	4	1	4	4	5	4	1	1	1	1
Household 71	19,800	12,480	-	7	7	19	-	3	1	4	4	4	4	1	1	1	1
Household 72	463,600	425,200	100,000	4	4	10	1	4	5	5	4	5	5	1	1	1	1
Household 73	25,200	15,600	-	8	7	23	-	4	5	4	5	4	4	1	1	1	1
Household 74	30,800	13,230	-	9	5	20	-	3	5	4	4	4	4	1	1	1	1
Household 75	14,400	13,390	-	9	4	11	-	5	5	4	5	4	4	1	1	1	1
Household 76	17,200	13,050	-	11	5	15	-	4	5	4	5	4	4	1	1	1	1

Household 77	54,000	24,000	-	7	5	12	-	4	5	5	5	5	5	4	2	5	2
Household 78	48,400	30,900	-	11	5	12	-	4	5	4	4	4	4	1	1	1	1
Household 79	9,740	9,600	-	9	2	6	-	4	5	4	4	4	4	1	1	1	1
Household 80	43,000	24,500	80,000	8	3	9	-	4	5	4	4	4	4	1	1	1	1
Household 81	14,400	12,000	20,000	7	3	11	-	4	5	4	4	4	4	1	1	1	1
Household 82	14,000	8,800	-	6	4	11	-	4	5	4	4	4	4	1	1	1	1
Household 83	12,000	6,000	160,000	9	2	10	-	4	5	4	4	4	4	1	1	1	1
Household 84	6,000	6,000	-	9	2	9	-	4	5	4	4	4	4	1	1	1	1
Household 85	20,800	12,000	-	9	2	11	-	4	5	5	4	5	5	1	1	1	1
Household 86	16,000	12,300	13,000	12	3	12	-	4	5	4	4	4	4	1	1	1	1
Household 87	12,200	6,000	-	6	2	9	-	4	5	4	4	5	4	1	1	1	1
Household 88	10,800	8,400	-	7	2	5	-	4	5	5	4	5	5	2	1	1	1
Household 89	13,600	8,400	-	7	2	7	-	4	5	5	4	5	3	1	1	1	1
Household 90	8,400	6,000	-	6	2	9	-	4	5	5	5	5	5	1	1	1	1
Household 91	5,200	6,720	7,000	-	2	8	-	5	5	5	5	4	5	1	2	1	1
Household 92	23,400	20,500	22,000	9	6	19	-	5	5	4	4	4	4	1	1	1	1
Household 93	54,000	12,000	70,000	9	2	7	-	4	5	5	4	4	5	1	1	1	1
Household 94	9,400	7,200	-	9	4	12	-	4	5	4	5	4	4	1	1	1	1
Household 95	16,000	9,600	123,000	8	3	8	-	4	5	4	5	4	4	1	1	1	1
Household 96	37,000	12,000	62,000	9	5	16	-	4	5	5	5	5	4	1	1	1	1
Household 97	10,000	7,920	-	6	5	16	-	4	5	4	5	4	4	1	1	1	1
Household 98	5,300	3,750	-	8	3	5	-	4	5	5	5	5	5	1	1	1	1
Household 99	3,000	8,760	-	3	3	14	-	4	5	4	4	5	4	1	1	1	1
Household 100	25,100	9,550	-	9	3	11	-	4	5	4	4	4	5	1	2	5	2
Household 101	24,800	12,120	60,000	9	4	7	-	5	5	5	5	5	5	2	3	5	4
Household 102	6,200	12,000	-	12	5	11	-	4	5	4	4	5	4	1	1	1	1
Household 103	15,600	12,000	-	9	5	10	-	4	5	4	4	4	4	1	1	1	1
Household 104	36,000	12,000	58,000	9	4	9	-	5	5	5	5	4	5	1	1	1	1
Household 105	12,200	10,400	-	16	2	5	1	4	5	4	4	4	4	1	1	1	1

Annexure 3.5

Production data of the household-level paper-recycling units in 2002

Production Units	Gross Income (1,000 VND)	Total Expenditure (1,000 VND)	Traditional Inputs				Social Capital											
			Physical Capital (1,000 VND)	Edu. (years)	Workers (persons)	HH Size	Total Membership	Social Relations			Trust				Reciprocity			
								Q. 1	Q. 2	Q. 3	Q. 1	Q. 2	Q. 3	Q. 4	Q. 1	Q. 2	Q. 3	Q. 4
Unit 1	666,800	637,200	300,000	9	10	4	13	-	5	4	3	2	2	3	-	-	-	-
Unit 2	400,800	379,800	400,000	9	10	5	17	-	1	4	3	2	3	3	-	-	-	-
Unit 3	21,700,000	19,319,000	2,700,000	9	100	7	26	1	5	4	3	2	3	3	4	4	3	4
Unit 4	648,000	540,400	600,000	12	10	4	14	-	1	4	3	3	3	2	-	-	-	1
Unit 5	2,700,000	2,198,000	760,000	12	15	5	13	-	1	4	4	3	2	4	-	-	-	-
Unit 6	399,200	411,150	770,000	8	10	5	20	-	1	4	3	2	3	2	2	3	1	3
Unit 7	2,400,000	1,741,800	650,000	9	15	4	12	-	5	4	4	4	4	4	1	-	1	1
Unit 8	1,260,000	1,153,200	370,000	16	10	7	20	-	1	4	4	3	4	3	-	-	-	1
Unit 9	2,520,000	2,529,000	1,200,000	7	20	6	18	-	5	4	3	3	3	2	-	-	-	-
Unit 10	1,083,200	906,200	1,000,000	7	12	5	16	-	1	4	4	3	3	3	-	-	-	1

Unit 11	990,000	720,000	500,000	7	12	6	17	1	1	4	4	3	4	3	-	-	-	1
Unit 12	6,003,200	4,848,240	3,000,000	12	40	6	20	-	1	4	4	4	4	4	-	2	1	3
Unit 13	720,000	725,200	700,000	6	12	4	19	-	1	4	4	2	4	4	-	-	-	2
Unit 14	1,320,000	933,200	250,000	12	8	2	7	-	1	4	4	4	2	4	-	2	-	2
Unit 15	4,329,200	3,172,200	1,200,000	16	20	5	15	-	1	5	4	4	4	4	2	2	1	1
Unit 16	1,804,000	1,622,600	450,000	9	20	5	22	-	1	4	4	4	3	4	1	1	-	1
Unit 17	480,000	483,000	250,000	9	10	5	18	-	1	4	3	4	4	4	1	-	-	-
Unit 18	840,000	750,000	400,000	4	13	6	19	-	1	4	4	3	2	4	-	-	-	1
Unit 19	1,080,000	1,028,000	500,000	12	11	4	13	-	5	4	3	3	4	4	-	5	-	3
Unit 20	2,161,000	2,121,400	1,250,000	12	18	5	25	-	5	5	4	4	3	3	-	1	1	2
Unit 21	7,440,000	7,093,600	3,600,000	16	42	5	21	1	5	4	3	5	3	3	6	20	12	4
Unit 22	6,360,000	6,612,800	2,950,000	12	30	4	13	-	5	5	4	3	4	3	2	2	2	1
Unit 23	4,068,000	2,950,000	650,000	9	15	2	9	1	5	5	4	2	4	2	10	20	12	5
Unit 24	5,040,000	4,764,000	2,130,000	12	45	5	21	1	5	5	4	4	2	4	4	5	2	1
Unit 25	1,736,400	1,709,800	850,000	12	20	5	16	1	5	5	4	3	4	2	5	10	8	5
Unit 26	913,600	905,380	700,000	6	8	7	20	-	1	4	4	2	4	4	2	2	2	-
Unit 27	820,600	806,840	300,000	9	10	5	21	-	5	4	4	3	2	3	8	10	8	5

Unit 28	12,600,000	10,246,000	4,000,000	11	60	3	13	1	5	4	3	5	3	4	-	10	5	8
Unit 29	900,000	833,800	250,000	9	15	3	11	-	1	4	3	5	3	3	-	-	-	1
Unit 30	901,000	839,100	600,000	10	12	2	13	-	1	4	2	3	2	3	7	10	8	1
Unit 31	6,003,400	5,052,600	1,950,000	12	50	4	15	-	1	5	4	4	4	4	-	2	3	2
Unit 32	960,000	816,000	400,000	9	10	4	14	-	1	5	4	4	4	3	-	-	2	1
Unit 33	2,523,600	2,466,480	490,000	9	18	7	16	-	1	3	2	1	5	1	10	20	15	5
Unit 34	2,160,000	1,913,400	550,000	7	18	3	12	-	1	5	5	4	5	3	2	10	8	5
Unit 35	13,500,000	12,061,150	1,700,000	7	33	7	21	-	5	5	5	4	5	4	5	2	2	1
Unit 36	11,520,000	11,264,000	1,100,000	12	30	4	15	-	5	5	4	4	5	4	-	-	-	1
Unit 37	969,400	973,350	350,000	9	10	6	19	-	1	5	3	3	3	2	-	-	-	1
Unit 38	10,800,000	9,144,000	3,500,000	9	40	5	16	1	5	4	4	2	5	4	5	10	2	5
Unit 39	12,960,000	12,932,000	11,200,000	6	100	6	23	1	1	4	4	4	4	4	2	2	2	2
Unit 40	2,667,400	2,367,900	1,280,000	9	20	4	10	-	5	4	3	4	5	3	-	-	-	1
Unit 41	676,000	482,600	200,000	10	12	4	17	-	1	4	4	4	4	4	2	2	2	2
Unit 42	2,640,000	2,346,000	500,000	9	20	2	9	-	1	4	4	4	5	3	1	1	2	-
Unit 43	3,600,000	3,213,600	1,800,000	12	26	4	18	-	5	5	5	4	4	3	8	10	6	6
Unit 44	2,523,200	1,630,050	450,000	12	15	2	12	1	1	5	5	4	5	5	2	2	2	2

Unit 45	1,251,200	1,022,200	700,000	9	20	7	27	-	5	4	3	4	5	3	2	2	2	1
Unit 46	6,120,000	5,416,000	2,800,000	12	40	5	18	1	5	5	5	4	5	5	4	5	4	5
Unit 47	1,560,000	1,464,800	350,000	9	10	5	17	-	1	4	2	2	2	2	2	2	2	1
Unit 48	1,860,000	1,635,000	880,000	9	15	2	7	-	1	4	4	3	4	2	2	2	2	1
Unit 49	1,080,000	847,200	250,000	9	17	3	15	-	1	5	4	3	4	3	-	-	-	-
Unit 50	720,000	722,000	550,000	9	10	5	17	-	1	3	2	2	2	3	2	1	2	1
Unit 51	768,000	604,000	600,000	8	14	6	15	-	1	4	4	4	4	4	-	-	1	1
Unit 52	1,625,000	1,561,000	330,000	7	16	5	19	-	5	5	4	4	4	4	10	10	8	5
Unit 53	7,459,000	7,380,900	4,000,000	12	60	5	21	-	5	4	4	2	3	4	5	6	4	1
Unit 54	1,805,300	1,754,900	420,000	9	12	7	21	-	1	5	4	4	4	4	2	2	2	1
Unit 55	4,563,200	3,862,000	4,200,000	10	50	5	13	1	5	5	5	3	4	4	2	2	2	1
Unit 56	2,400,000	2,143,800	750,000	11	22	5	18	-	1	4	5	2	4	2	2	2	3	1
Unit 57	2,702,760	2,502,000	850,000	11	24	5	15	1	5	5	5	4	4	2	2	2	2	1
Unit 58	1,326,000	1,290,800	260,000	9	10	6	16	1	1	5	4	2	4	2	5	5	4	5
Unit 59	5,403,200	5,286,000	1,700,000	12	30	2	23	-	1	4	5	2	2	2	-	-	-	1
Unit 60	1,620,000	1,104,900	600,000	10	15	2	8	-	5	3	5	4	4	3	2	2	2	1
Unit 61	2,700,000	2,470,800	845,000	9	18	8	30	-	5	5	4	4	4	3	2	2	2	1

Unit 62	2,628,000	2,447,200	1,170,000	12	20	6	14	-	1	4	5	4	5	4	2	2	2	1
Unit 63	2,000,000	1,862,000	1,000,000	9	20	5	23	1	5	4	5	4	4	3	2	2	2	1
Unit 64	1,980,000	1,472,400	260,000	12	12	6	15	-	1	4	5	4	4	2	2	2	2	2
Unit 65	1,100,000	964,000	650,000	9	12	6	20	-	5	5	4	3	4	3	.	-	-	1
Unit 66	1,660,800	1,447,000	330,000	12	18	4	16	-	1	5	4	4	4	2	2	2	-	1
Unit 67	651,800	590,650	350,000	9	12	4	18	-	1	5	2	3	4	2	2	2	-	1

Annexure 3.6

Production inputs of the household-level paper-recycling units in 2003

Production Units	Traditional Inputs					Social Capital Inputs											
	Physical Capital (1,000 VND)	Labor (100 worker-hours)	Waste paper (1,000 VND)	Energy (1,000 VND)	Others (1,000 VND)	Total Membership	Social Relations			Trust				Reciprocity			
							Q. 1	Q. 2	Q. 3	Q. 1	Q. 2	Q. 3	Q. 4	Q. 1	Q. 2	Q. 3	Q. 4
Unit 1	350,000	317	600	89	600	13	-	4	4	4	4	3	3	-	-	3	-
Unit 2	400,000	346	220	66	600	16	-	4	2	4	4	4	4	2	2	2	-
Unit 3	3,870,000	4,320	10,620	1,214	6,000	26	1	4	5	4	4	3	3	-	5	3	2
Unit 4	600,000	317	880	154	240	14	-	5	1	3	3	3	2	-	2	3	-
Unit 5	1,900,000	1,152	3,888	298	3,600	13	-	4	1	4	4	4	3	-	2	4	-
Unit 6	1,070,000	288	1,065	89	360	21	1	4	1	4	3	3	3	-	3	3	2
Unit 7	900,000	432	1,296	111	600	14	-	4	5	4	4	4	3	1	1	3	2
Unit 8	370,000	288	583	100	1,200	18	-	4	1	3	4	4	3	-	-	4	-
Unit 9	1,400,000	490	2,700	297	480	19	-	4	4	3	3	3	3	-	-	2	-
Unit 10	1,000,000	346	605	110	960	16	-	1	1	4	4	4	3	2	-	4	-

Unit 11	500,000	346	540	112	120	17	1	4	1	4	4	4	4	-	-	2	-
Unit 12	3,000,000	720	2,160	441	1,200	21	-	4	1	5	4	4	4	-	3	3	3
Unit 13	700,000	432	605	111	960	19	-	4	1	4	4	4	2	1	2	3	-
Unit 14	400,000	346	2,304	111	960	15	1	4	2	4	4	4	3	-	3	2	1
Unit 15	1,400,000	576	2,700	200	1,800	15	-	4	4	4	4	4	4	-	3	2	5
Unit 16	450,000	432	667	132	480	21	-	4	1	4	4	4	3	-	2	3	2
Unit 17	**Closed**																
Unit 18	400,000	403	720	133	600	19	-	4	2	4	4	4	3	-	-	3	3
Unit 19	500,000	288	403	111	1,440	13	1	5	5	5	4	4	3	-	6	2	3
Unit 20	1,400,000	576	2,448	331	1,800	25	-	5	4	4	5	5	3	-	2	10	3
Unit 21	3,620,000	432	2,160	333	1,200	29	1	4	4	4	3	4	3	-	10	2	-
Unit 22	3,700,000	1,440	5,760	885	12,000	13	-	5	4	5	4	4	3	-	3	2	-
Unit 23	700,000	432	1,800	226	2,160	9	1	4	2	4	4	4	3	-	20	3	-
Unit 24	2,280,000	1,152	3,240	552	3,600	23	1	5	5	5	5	4	4	-	5	3	2
Unit 25	1,700,000	1,152	3,360	441	1,200	16	1	5	4	5	4	4	3	-	8	3	3
Unit 26	700,000	288	540	100	720	20	-	4	1	4	3	4	3	-	3	-	-

Unit 27	700,000	317	1,080	122	1,800	21	-	4	1	5	4	4	4	-	10	2	2
Unit 28	4,070,000	1,728	7,920	660	2,160	13	1	4	5	4	4	3	3	-	10	2	3
Unit 29	270,000	461	583	89	600	11	-	4	1	3	3	3	3	-	-	3	-
Unit 30	600,000	317	312	122	120	13	-	5	1	4	2	5	3	2	10	4	-
Unit 31	2,450,000	1,584	4,400	665	2,400	15	1	5	5	5	4	4	3	-	7	3	3
Unit 32	**Closed**																
Unit 33	490,000	547	1,540	155	840	16	-	3	1	3	3	3	2	-	15	5	3
Unit 34	550,000	346	1,470	133	1,800	14	-	5	1	5	5	5	3	2	8	5	5
Unit 35	1,700,000	864	3,600	331	1,440	21	-	5	4	5	5	4	4	5	3	3	3
Unit 36	1,200,000	778	9,200	440	1,200	15	-	5	4	4	4	4	4	-	1	3	-
Unit 37	400,000	259	576	144	2,160	19	-	5	1	4	4	3	2	-	-	2	1
Unit 38	4,620,000	1,008	7,500	551	2,400	16	1	5	5	3	4	3	2	-	9	5	3
Unit 39	3,700,000	1,584	7,603	1,099	7,200	23	1	4	1	4	4	4	3	-	3	-	-
Unit 40	1,280,000	576	1,512	144	840	10	-	4	1	4	3	4	3	-	-	2	2
Unit 41	200,000	346	403	66	360	17	-	4	1	4	4	4	4	10	3	3	1
Unit 42	550,000	576	1,100	111	3,600	9	-	4	1	5	4	5	3	-	2	1	2

Unit 43	1,900,000	979	3,300	330	960	18	-	5	5	5	5	4	4	-	10	3	3
Unit 44	450,000	374	1,400	133	1,200	12	1	5	1	4	5	5	4	-	3	5	2
Unit 45	700,000	547	540	133	600	29	-	4	5	4	3	4	3	-	4	5	3
Unit 46	2,800,000	1,210	3,672	727	2,000	17	1	5	5	5	5	5	4	-	7	2	2
Unit 47	350,000	317	900	111	600	17	-	4	1	4	2	3	2	-	3	2	2
Unit 48	1,030,000	576	1,100	243	1,440	7	-	4	1	4	4	5	3	-	2	2	2
Unit 49	**Closed**																
Unit 50	550,000	432	464	111	600	17	-	4	1	4	4	4	3	2	2	3	2
Unit 51	650,000	518	864	111	540	15	-	4	1	4	4	4	3	-	-	2	2
Unit 52	480,000	432	1,512	144	1,200	19	-	5	4	4	4	4	3	-	8	-	1
Unit 53	4,000,000	1,440	10,750	879	3,600	21	-	4	5	2	4	3	1	2	5	6	2
Unit 54	500,000	346	1,080	111	1,200	21	-	5	1	4	4	4	3	2	3	3	2
Unit 55	4,200,000	1,152	3,240	661	1,920	13	1	5	5	5	5	4	4	-	2	3	-
Unit 56	750,000	634	1,080	89	360	18	-	4	1	4	5	4	3	-	3	3	3
Unit 57	850,000	1,152	2,204	332	1,200	16	1	5	5	3	4	3	3	2	3	3	2
Unit 58	260,000	288	731	111	600	18	1	5	4	5	4	4	4	3	6	4	3

Unit 59	1,700,000	864	2,602	440	600	23	-	4	2	5	4	5	3	-	1	2	-
Unit 60	650,000	317	1,008	111	480	11	-	3	1	4	4	4	3	-	2	5	-
Unit 61	845,000	518	2,720	439	960	31	-	5	5	5	4	4	3	4	3	4	2
Unit 62	1,170,000	432	2,880	441	1,200	15	1	5	4	5	5	5	4	-	2	5	2
Unit 63	1,200,000	576	2,600	144	960	25	1	4	5	5	5	4	4	-	3	3	-
Unit 64	**Closed**																
Unit 65	700,000	346	650	111	2,000	20	-	5	1	5	5	4	3	-	5	6	3
Unit 66	380,000	518	900	100	1,080	16	-	5	2	5	4	4	3	-	3	3	1
Unit 67	400,000	346	900	111	960	17	-	5	1	5	2	4	3	-	3	2	1

Annexure 3.7

Gross income, total expenditure, and production outputs of the household-level paper-recycling units in 2003

Production Units	Total Income (1,000 VND)	Total Expenditure (1,000 VND)	Paper (Ton)	BOD (mg/l)	COD (mg/l)	SS (mg/l)
Unit 1	665,700	932,400	120	1,300	3,394	1,192
Unit 2	550,800	486,400	84	250	884	1,196
Unit 3	20,640,000	14,400,000	5,700	1,000	5,401	1,064
Unit 4	1,800,000	1,278,400	360	600	1,052	674
Unit 5	6,120,000	5,220,000	1,560	900	4,350	6,460
Unit 6	1,562,000	1,404,600	240	250	1,243	402
Unit 7	1,800,000	1,728,000	360	540	1,338	44
Unit 8	720,000	1,016,400	180	150	1,004	1,782
Unit 9	3,888,000	3,444,000	1,440	550	932	36
Unit 10	1,083,200	1,003,200	180	310	1,320	100
Unit 11	900,000	900,000	180	300	1,458	2,028
Unit 12	4,322,000	3,372,000	1,200	300	1,267	476
Unit 13	1,080,000	1,003,200	180	100	382	39
Unit 14	3,120,000	2,810,400	480	120	717	498
Unit 15	4,320,000	3,780,000	1,440	1,400	2,725	756
Unit 16	1,203,300	1,027,960	240	110	621	26
Unit 17	**Closed**					

Unit 18	1,440,000	1,124,400	240	300	2,868	476
Unit 19	912,000	885,600	240	400	1,697	1,658
Unit 20	3,841,000	3,720,000	1,200	500	1,745	676
Unit 21	3,600,000	3,250,000	1,200	650	3,466	934
Unit 22	9,600,000	9,120,000	2,400	140	574	760
Unit 23	3,900,000	2,938,000	600	120	645	812
Unit 24	5,400,000	5,376,000	1,800	1,650	4,063	1,016
Unit 25	6,384,000	4,800,000	1,680	768	2,199	135
Unit 26	1,093,600	926,400	180	800	1,568	705
Unit 27	1,801,000	1,614,000	360	250	1,004	66
Unit 28	11,400,000	9,612,000	3,000	2,600	9,942	2,228
Unit 29	990,000	905,400	180	280	1,386	84
Unit 30	901,000	644,400	216	210	1,410	704
Unit 31	8,103,200	6,570,000	1,800	450	1,840	512
Unit 32	**Closed**					
Unit 33	2,343,600	2,101,600	360	440	2,151	158
Unit 34	2,160,000	1,985,400	360	70	478	794
Unit 35	5,040,000	4,560,000	1,440	600	3,920	134
Unit 36	13,500,000	10,436,000	3,000	740	1,960	4,056
Unit 37	1,446,400	1,208,400	240	250	837	1,330
Unit 38	11,760,000	9,240,000	4,200	1,200	5,354	3,588
Unit 39	17,820,000	10,795,200	3,960	600	2,533	228
Unit 40	2,960,400	1,982,400	420	180	1,960	2,586

Unit 41	601,000	739,000	120	800	1,568	712
Unit 42	1,800,000	1,762,400	360	410	980	1,450
Unit 43	5,400,000	4,456,000	1,800	820	2,271	324
Unit 44	2,642,000	1,898,000	480	300	2,318	82
Unit 45	1,173,200	1,156,000	180	500	2,772	2,768
Unit 46	6,660,000	5,514,000	1,800	1,200	2,435	548
Unit 47	1,320,000	1,274,400	240	140	574	2,116
Unit 48	2,530,000	1,868,000	360	420	1,200	1,400
Unit 49	**Closed**					
Unit 50	936,000	844,800	144	900	5,497	1,984
Unit 51	1,080,000	1,278,000	360	1,350	4,015	2,700
Unit 52	2,160,000	2,056,800	360	180	1,769	3,274
Unit 53	16,203,000	13,390,000	3,600	950	350	1,325
Unit 54	1,654,000	1,560,000	300	650	1,052	674
Unit 55	5,403,000	4,902,000	1,800	650	2,008	700
Unit 56	1,260,000	1,394,400	360	330	1,099	1,594
Unit 57	2,882,760	3,176,000	480	90	645	902
Unit 58	1,260,000	1,093,400	360	290	1,171	122
Unit 59	3,962,000	3,802,400	1,140	100	765	1,570
Unit 60	1,800,000	1,394,400	240	240	2,199	672
Unit 61	4,752,000	3,752,000	1,440	800	2,199	944
Unit 62	4,800,000	4,722,000	1,200	400	2,151	708
Unit 63	4,320,000	3,106,400	1,080	170	789	1,792

Unit 64	**Closed**					
Unit 65	1,400,000	1,136,400	216	315	1,760	657
Unit 66	1,954,800	1,322,400	300	260	249	671
Unit 67	1,443,700	1,290,000	240	150	239	430

Annexure 3.8

Environmental outputs, measured by a concentration level, broken down by production process for the household-level paper-recycling units in 2003

Criteria	Production Process						
	Units	Kraft Paper	Tissue & toilet paper	Votive paper	Wrapping paper	Mixed paper	Average
Sample size	Mill	14	21	10	4	14	
Average BOD level	mg/l	900.71	286.74	452.00	527.50	375.40	536.40
Minimum		300	70	140	170	100	
Maximum		2,600	1,350	1,350	900	1,200	
Average COD level	mg/l	3,064.40	808.55	1,557.50	2,599.00	1,567.50	1,964.50
Minimum		932	239	574	789	249	
Maximum		9,942	4,015	4,015	5,497	5,401	
Average SS level	mg/l	1,120.10	840.46	1,378.70	1,647.00	1,590.90	1,119.60
Minimum		36	26	122	44	66	
Maximum		4,056	2,700	2,700	2,768	6,460	

Annexure 3.9

Environmental outputs, measured by total amount discharged per year, broken down by production process for the household-level paper-recycling units in 2003

Criteria	Production Process						
	Units	Kraft Paper	Tissue & toilet paper	Votive paper	Wrapping paper	Mixed paper	Average
Sample size	Mill	14	21	10	4	14	
Average BOD level	kg/year	1,592.80	171.63	228.84	241.88	1,760.70	854.10
Minimum		450.00	45.00	67.50	90.00	113.40	
Maximum		3,900.00	487.50	540.00	486.00	7,125.00	
Average COD level	kg/year	5,591.80	753.43	755.47	939.44	5,425.50	2,879.00
Minimum		1,570.50	143.40	344.40	498.96	186.75	
Maximum		14,913.00	1,720.80	1,084.00	1,204.20	38,482.00	
Average SS level	kg/year	1,917.40	568.63	678.15	828.54	2,805.90	1,399.40
Minimum		90.72	15.60	109.80	39.60	59.40	
Maximum		9,126.00	1,900.70	1,269.60	2,419.20	9,540.00	