Lund University
Department of Economics
Master's Thesis
August 31st, 2012

An Analysis of Global Silk Trade

Linking Coordination to Technological Improvements and Exports

by

Fredrik Saïd Madsen

Supervisor: Joakim Gullstrand, Associate Professor.

Abstract

Many studies have over the years utilized gravity models derived from trade theories to investigate how various factors affect trade in agricultural goods. Although technological improvements could be considered in such models, few studies have considered this topic in depth, leaving a void to fill. To partly fill this void, this study has chosen the silk sector to analyze the impact of technological improvements – more specifically yield increases through the introduction of silkworm hybrids – on silk exports. This sector is particularly interesting as it is highly labor-intensive, generates a high-value added and requires little land area for cultivation, thereby having the potential to reduce poverty. Additionally, as the supply of silk from the main exporter China has decreased in recent years, there is a possibility for other countries to overtake China's earlier role. By dint of data and information collected from publications and over 30 research institutions, 26 silk exporting countries are qualitatively and quantitatively analyzed over the period 2000-2010. In the qualitative analysis, the study classifies countries' silk sectors according to their performance in research, and in grainage – i.e. silkworm egg provision – by drawing on arguments from two studies considering technological improvements in African cotton sectors. In the quantitative analysis, a gravity model is used. The study concludes that there is a significantly positive relationship between introduced silkworm hybrids and silk exports. Moreover, for a country to increase its silk exports, the country should aim to make funding available for research and grainage, and to foster collaboration between research institutions.

Keywords: *Trade, technological improvements, silk, silkworm hybrid, coordination, gravity model*.

Acknowledgements

I would firstly like to thank my supervisor Associate Professor Joakim Gullstrand who during the writing of this study provided very valuable feedback and comments. I would also like to extend my deepest gratitude to Professor Maria Aparecida Fernandez at UEM in Maringá, Brazil who invited me to two events – the 3rd Symposium of Applied Sericulture Sciences and the 1st Latin American Silk Congress (III SICAS / I ELASEDA) that took place during August 22nd to 24th in Maringá, Brazil – where I presented this study. Additionally, to all my key informants, I thank you very much for sharing vital data and information, enabling me to achieve the quality of the study for which I was aiming. Lastly, I would like to thank everybody else who in any way has contributed to the realization of my study.

Table of Contents

List of Charts, Tables and Figures

List of Abbreviations

AFD	-	Agence Française de Développement
APSSRDI	-	Andhra Pradesh State Sericulture Research and Development Institute
ASEAN	-	Association of Southeast Asian Nations
AUP	-	Agricultural University, Plovdiv
BACSA	-	Black, Caspian Seas and Central Asia Silk Association
Bratac	-	Fiação de Seda Bratac S/A
BSRI	-	Sericulture Research Institute, Bursa
BSRTI	-	Bangladesh Sericulture Research and Training Institute
CDTS	-	Centro de Desarrollo Tecnológica de la Sericultura
CENASE	-	Centro Nacional de Sericultura
Chul Thai	-	Chul Thai Silk Co.
CNS	-	Centre National de la Soie
COCAMAR	-	Cooperativa Agroindustrial e Controladas
CSB	-	Central Silk Board
CSRTI	-	Central Sericultural Research and Training Institute
DMMMSU	-	Don Mariano Marcos Memorial State University
DoIED	-	Directorate of Industrial Entomology Development
DoST-CAR	-	Department of Science and Technology, Cordillera Administrative Region
DSAJK	-	Directorate of Sericulture, Azad Jammu and Kashmir
DSF	-	Dainippon Silk Foundation
EU	-	European Union
FAO	-	Food and Agricultural Organization
FDKP	-	Forest Department, Khyber Pakhtunkhwa
FIDA	-	Fiber Industry Development Authority
GMM	-	Generalized Method of Moments
GSRI	-	Sericulture Research Institute, Gandja
GSTC	-	Gunma Sericultural Technology Center
ICA	-	Instituto Colombiano Agropecuario
ICIPE	-	International Center of Insect Physiology and Ecology
IFAD	-	International Fund for Agricultural Development
IILA	-	Instituto Italo-Latinoamericano
IV	-	Instrumental Variable
JICA	-	Japan International Cooperation Agency
Jim Thompson	-	Thai Silk Co. Ltd.
KARS	-	Komotini Agricultural Research Station
KOICA	-	Korea International Cooperation Agency
KOZABİRLİK	-	Union of Sericulture Cooperatives
KPSA	-	Kesatuan Pengusahaan Sutera Alam
KSSRDI	-	Karnataka State Sericulture Research and Development Institute
LAREC	-	Lam Dong Research Center on Agro-Forestry
MARC	-	Melkassa Agricultural Research Center
MoA	-	Ministry of Agriculture
NGO	-	Non-Governmental Organization
Nembri IT SRL	-	Nembri Industrie Tessili SRL
NIAS	-	National Institute of Agrobiological Sciences
NVSU	-	Nueva Vizcaya State University
PPUS	-	Pusat Pembibitan Ulat Sutera
PTRI	-	Philippine Textile Research Institute
QSDS	-	Queen Sirikit Department of Sericulture
RELASEDA	-	Red Latinoamericana de la Seda
RSU	-	Rizal State University
SES	-	Sericultural Experiment Station, Vratza
SFE	-	Service Fraternel d'Entraide
SIS	-	Société Industrielle de la Soie
SKUAST	-	Sher-e Kashmir University of Agricultural Sciences and Technology
SOA Mania	-	Soie Amoron'i Mania
SRDI	-	Sericulture Research and Development Institute
SREC	-	Sericulture Research and Extension Center
SRICAAS	-	Sericultural Research Institute, Chinese Academy of Agricultural Sciences
SRSC	-	Sheki Regional Scientific Center
SSBP	-	Sezione Specializzata per la Bachicoltura in Padova
TAAS	-	Tajik Academy of Agricultural Science
UEM	-	Universidade Estadual de Maringá
UNALM	-	Universidad Nacional Agraria la Molina
UNESP	-	Universidade Estadual Paulista, Jaboticabal
UNIDO	-	United Nations Industrial Development Organization
UNIOESTE	-	Universidade Estadual do Oeste do Paraná
UPDG	-	Unidade de Pesquisa e Desenvolvimento, Gália
UPLB	-	University of the Philippines at Los Baños
UQG	-	University of Queensland, Gatton
USAID	-	United States Agency for International Development
UTP	-	Universidad Tecnológica de Pereira
VIETSERI	-	Vietnam Sericulture Research Center

1. Introduction

Several trade theories have been utilized to analyze trade in agricultural goods. One of these trade theories is the Ricardo model of comparative advantage that for the first time appeared in a study by Mill (1844). Since then, several extensions of the Ricardo model have been presented in studies by inter alia Dornbusch et al (1977), Melitz (2003) and Eaton & Kortum (2006). Studies have used these theories – along with the Heckscher-Ohlin model and its extensions – to derive so-called gravity models that have allowed studies to quantitatively analyze how various factors affect trade in agricultural goods. Such studies have been conducted by for instance Dascal et al (2002), Lambert & McKoy (2009) and Canavari & Cantore (2010). The above-mentioned theories can also be utilized to derive gravity models that consider the impact of technological improvements on trade in agricultural goods. However, this topic has despite the vast literature on trade received limited attention, leaving a void to fill. One of the main aims of this study is therefore to partly fill this void by analyzing technological improvements in the context of global silk trade.

There are various reasons for why the silk sector has been chosen for this analysis. The silk sector is a highly labor-intensive sector, and in comparison to other agricultural goods, silk has a high value-added and requires little land area for its cultivation (Anitha, 2011; Ashfaq & Aslam, 2006). Due to these reasons, the silk sector has the potential of reducing poverty in developing countries. Moreover has the supply of silk from the main exporter China decreased in recent years (McNair, 2011). Since this situation enables other countries to fill the demand gap, increases in yields – i.e. in productivity – through technological improvements could potentially satisfy the existing silk demand without saturating the market.

Technological improvements in the silk sector involve the introduction of silkworm hybrids, mulberry varieties, and management technologies.[1] Since an analysis considering technological improvements in all of these areas would be too comprehensive, the analysis is

[1] Silkworms produce cocoons that later are processed into raw silk – the main material used for textiles – whereas the mulberry plant is the fodder base for silkworms in the production process. Moreover, through cross-breeding silkworm breeds, research institutions develop silkworm hybrids that are commercialized. Silk farmers can thereby make use of the newly commercialized silkworm hybrids by being provided disease-free silkworm hybrid eggs. Hence, the term silkworm breeds refers to the silkworms used in research while the term silkworm hybrids refer the silkworms utilized in silk farming. The more informed reader may know that silkworm breeds actually have been used directly in silk farming, but as to simplify the terminology, the study still uses the term silkworm hybrids for the silkworm breeds being used directly.

confined to the introduction of silkworm hybrids. Through delimitating the study in this manner, the study still considers one of the most important aspects of silk farming, because silkworm hybrids being characterized by low yields and low disease resistance can severely impede production (Khan et al, 2008; Kumar et al, 2011).

By analyzing 26 silk exporting countries, this study attempts to answer two research questions. Firstly, do technological improvements – in this case the introduction of silkworm hybrids – in a country's silk sector stimulate that country's silk exports? Secondly, provided that there are indications of an affirmative response to the first research question, what measures should a country take in order to increase its silk exports? So as to answer these questions, not only a quantitative analysis is required, but also a qualitative analysis that provides an understanding of why some countries have managed to ensure high yields whereas other countries have failed.

The study is organized as follows. Section 2 presents an overview of silk sector performance by drawing on arguments from two studies that have considered technological improvements in African cotton sectors. Section 3 presents the theoretical arguments underpinning the gravity model used in this study, and also briefly discusses how the introduction of a silkworm hybrid in a country should affect that country's silk exports. Section 4 presents the data, the variables and the methodology that are used for the quantitative analysis being conducted in Section 5. Section 6 concludes the study with main findings, limitations of the study, suggestions for future research, and policy implications.

2. Silk Sector Performance: An Overview

To understand why some countries have been more successful than others in ensuring high yields through introducing silkworm hybrids – henceforth referred to as hybrids – it is useful to consider how well actors in each country have performed in grainage – i.e. silkworm hybrid egg provision to silk farmers – and research activities. Arguments considering performance in agricultural sectors are scarce, but two studies of African cotton sectors by Poulton et al (2004) and Tschirley et al (2009: 46-47, 106-107, 111) provide compelling arguments that also are practical for the purpose of this study. The main argument in these studies is that a sector should be characterized by a high degree of coordination in order to perform well. Adapting this argument to this study, a high degree of coordination in a country's silk sector is hypothesized to ensure high yields for that country's silk farmers. For the purpose of ensuring high yields, a country can choose to either import hybrids, or to develop and commercialize – hereinafter referred to as commercialize – higher-yielding hybrids through sufficient funding to research and grainage activities in the country. For the latter option, funding to these activities need to be specifically destined for maintaining facilities and for employing technical personnel with adequate expertise, enabling the commercialization of hybrids, as well as the provision of a sufficient amount of disease-free silkworm eggs to silk farmers, i.e. the grainage capacity is high due to adequate quality control of silkworm eggs. Countries not disposing of sufficient internal – i.e. national – funding have the possibility to request external funding from international donor organizations. Countries can additionally collaborate nationally or internationally – by so-called internal and external links respectively – facilitating a country's introduction of hybrids through economies of scale. Such collaboration takes place through organized meetings, coordinated research projects, and sharing of silkworm breeds through collaboration contracts. Silk farmers in a country can hence reap the benefits of the higher yields inherently characterizing an introduced hybrid. In contrast, when a country's silk sector is characterized by a low degree of coordination, funding for research and/or grainage activities is not sufficient, and internal and external links tend to be weak, forcing countries to either be stuck at low yields, or to import hybrids from abroad. In the latter case, yields are only expected to increase slightly as imported hybrids often are not well-adapted to the agro-ecological conditions in the importing country.

By dint of the above-mentioned arguments, Table 1 provides a qualitative classification of silk sector performance in 26 silk exporting countries during 2000-2010. On the

Table 1. Silk Sector Performance, 2000-2010

	Research Institutions	*Internal Links[a]*	*Sufficient Internal Research Funding*	*Commercialized Hybrids*	*Grainage Capacity*	*Imported Hybrids[b]*	*Enabling External Institutions[c]*	*External Links*	*Degree of Coordination*
East Asia									
China	SRICAAS, Others[d]	Yes	Yes	85	High	0	-	Yes	High
Japan	GSTC, DSF, NIAS	Yes	Yes	11	High	0	-	Yes	High
South Asia									
Bangladesh	BSRTI	-	No	11	Low	0	World Bank	No	Low
India	CSRTI, Others[e]	Yes	No	32	Low	0	JICA	Yes	Low
Nepal	DoIED	-	No	0	Low	0	JICA	No	Low
Pakistan	DSAJK, FDKP	Yes	No	14	Low	1	-	No	Low
Southeast Asia & Oceania									
Australia	UQG	-	No	2	Low	1	-	No	Low
Cambodia	CNS	-	No	0	Low	0	ASEAN, ADF, FAO	Yes	Low
Indonesia	PPUS, KPSA	No	No	5	Low	1	ASEAN	Yes	Low
Laos	SREC	-	No	0	Low	1	ASEAN, JICA, SFE, USAID	Yes	Low
Philippines	PTRI, SRDI, Others[f]	Yes	Yes	3	High	0	ASEAN, JICA, KOICA	Yes	High
Thailand	Chul Thai, Jim Thompson, QSDS	No	Yes	2	Low	0	ASEAN	Yes	Low
Vietnam	VIETSERI, LAREC	Yes	Yes	6	Low	0	ASEAN	Yes	Low
Europe									
Bulgaria	SES, AUP	Yes	Yes	3	High	0	BACSA, FAO	Yes	High
Greece	KARS	-	No	0	High	6	BACSA, FAO, EU	Yes	Low

(continued)

Table 1. (continued)

	Research Institutions	*Internal Links*[a]	*Sufficient Internal Research Funding*	*Commercialized Hybrids*	*Grainage Capacity*	*Imported Hybrids*[b]	*Enabling External Institutions*[c]	*External Links*	*Degree of Coordination*
Central & Western Asia									
Azerbaijan	GSRI, SRSC	No	Yes	15	High	0	BACSA, FAO	Yes	High
Kyrgyzstan	MoA	-	No	0	Low	0	-	No	Low
Tajikistan	TAAS	-	Yes	2	Low	0	BACSA, FAO	Yes	Low
Turkey	BSRI, KOZABİRLİK	-	Yes	0	High	0	BACSA, FAO	Yes	High
Latin America									
Brazil	Bratac, UEM, Others[g]	Yes	Yes	0	High	0	-	No	High
Colombia	CDTS, ICA, UTP	Yes	No	0	High	0	RELASEDA, IILA	Yes	High
Mexico	CENASE	-	No	0	High	0	JICA	No	Low
Paraguay	Seda y Fibras SRL	-	No	0	High	0	Nembri IT SRL	No	High
Peru	UNALM	-	No	6	High	0	RELASEDA, IILA, SSBP	Yes	High
Africa									
Ethiopia	MARC	-	No	0	Low	2	ICIPE, JICA, KOICA	Yes	Low
Madagascar	SIS, FAFIALA, SOA Mania	Yes	No	0	Low	3	ICIPE, UNIDO	Yes	Low

Sources: Abbasov (2006), Agroprod (2010), Anitha (2011), Asaoka (2011), Ashfaq & Aslam (2006), BACSA (2006), Boonchoo (2008), BSF (2012), Busch et al (2010), Chen (2002), CMU (2007), CITE (2009), CSB (2012), Dandin et al (2008), Dingle et al (2005), DSF (2012), Esim (2001), FAO (2009), Fenomanantsoa (2006), FIDA (2012), Gangopadhyay (2008), Grekov (2008), Grekov et al (2006), GP (2012), Hashmi (2011), Hussain et al (2011), JICA (2003), Karagözoğlu (2008), Karimov (2005), Karimov (2006), Kipriotis (2006), Kipriotis (2008), Lewis (2003), McNair (2011), Mey et al (2010), MoIC (2009), Munhoz (2010), Nguyen (2006), Nguyen & Eiligmann (2010), Nisar et al (2009), Nuraeni (2011), Petkov et al (2006), QSDS (2010), QSDS (2012), Ramanoelina et al (2008), Ramesha et al (2009), RUDEC (2011), Sohn & Kim (2011), Soto & Tamayo (2008), SRICAAS (2012), Tuckson et al (2004), Tzenov (2011), Tzenov & Kipriotis (2008), UTP (2012), Vieites et al (2010), Watanabe et al (2004), World Bank (1997), World Bank (2005), Yamamoto (2001).

Notes: This table has benefited greatly from data and information provided by the key informants, all of which are presented in Appendix 1. [a] "-" indicates the irrelevance of internal links. This irrelevance is either due to that there has only been one research institution conducting silkworm research, or due to that the mentioned research institutions never co-existed. [b] The imported hybrids here are those used on a big scale, and imported hybrids for field trials are thus excluded. [c] ASEAN, BACSA and RELASEDA are associations in which some of the countries in the table are members, whereas the other institutions are international donor organizations that have provided funding to countries through grants, donations, technical assistance, and/or silkworm breeds. "-" indicates that neither funding was received from abroad, nor that the country was member of any association. [d] SRICAAS has a high number of provincial institutes, and there are also universities involved in research, such as Southwest University, Zhejiang University and Suzhou University. There are moreover a few private research institutions, for instance Huasheng Group in Sichuan and Guangdong Silk Group. [e] APSSRDI, KSSRDI and SKUAST. [f] DoST-CAR and FIDA as well as state universities, e.g. DMMMSU (under which SRDI operates), UPLB, NVSU, and RSU. [g] Fujimura, COCAMAR, and the public institutions UPDG, UNESP and UNIOESTE.

basis of each country's performance, it is helpful to group the countries into three categories so as to understand why a high degree of coordination is important for ensuring high yields. The first category comprises Azerbaijan, Bulgaria, Turkey, Brazil, Japan and China, and all of these countries' silk sectors were characterized by a high degree of coordination, mainly due to sufficient internal funding for research and grainage activities. In Azerbaijan and Bulgaria, public institutions were responsible for these activities, and despite that the research institutions in Azerbaijan did not collaborate nationally, both countries commercialized high-yielding hybrids during 2000-2010. In China, more than 20 collaborating public and private research institutions have ensured high yields for its silk farmers, and the private companies involved in grainage have also displayed a high grainage capacity. Similarly can be argued about grainage and research in Japan, where research only was undertaken by public research institutions. The only countries displaying slight problems with grainage and research during the assessment period were Turkey and Brazil. In Turkey, the public research institution BSRI resigned its responsibility for research in 2004, and the cooperative KOZABİRLİK – which is a private institution that handled grainage during the entire assessment period – successfully overtook BSRI's earlier responsibility. Thus, although no hybrids were commercialized, KOZABİRLİK continued ensuring high yields for Turkish silk farmers since the hybrid already in use was characterized by high yields. In Brazil, there were three private institutions involved in grainage and research in the year 2000, namely the two companies Fujimura and Bratac, and the cooperative COCAMAR, all of which had so-called contract farmers that each institution independently served. When COCAMAR and Fujimura left the silk sector in 2008 and 2010 respectively, Bratac smoothly absorbed the Brazilian silk farmers not wanting to leave the silk sector. Also collaborating public institutions were involved in research in Brazil during the assessment period, but no hybrids were commercialized in the country. However, as the hybrids commercialized before the year 2000 were characterized by high yields, and due to that Bratac successfully managed to overtake the responsibility of COCAMAR's and Fujimura's silk farmers, high yields were ensured.

The countries in the first category have also to a high degree collaborated internationally – Brazil being the only exception – and such collaboration has not only taken place to a high degree with other countries, but also between these countries. Especially important was the association BACSA that countries in Europe, Central and Western Asia established in 2005 with funding from FAO. This association initially had nine member countries, but as the association was successful, six additional countries later joined BACSA. Under this association, four meetings have taken place, enabling the exchange of research experiences between the member countries and the signing of collaboration contracts that have allowed the exchange of silkworm breeds. In 2006, researchers from the member countries also carried out a coordinated research project in which the best 15 hybrids in Europe, Central and Western Asia were compared. The result was that the hybrids in Azerbaijan, Bulgaria and Turkey performed comparatively better than the other hybrids, and these countries were consequently selected as recommended silkworm egg exporters to the other member countries,[2] for instance to Greece.

Colombia, Peru, Paraguay and the Philippines constitute the second category, and as in the countries in the first category, the silk sectors in these four countries were also characterized by a high degree of coordination during 2000-2010. Still, a difference was that internal funding for grainage and/or research was limited, and sufficient funding was rather received from external sources. As countries in Europe, Central and Western Asia established the association BACSA, eight Latin American countries established a similar association in 2004 – namely RELASEDA – with financial support from the international donor organization IILA. This association was not only important in the way that it allowed the exchange of research experiences, but the association's funding to Colombia and Peru allowed these countries to overcome their respective coordination challenges in grainage and research. In Colombia, the collaborating institutions CDTS and ICA – which are private and public research institutions respectively – commercialized high-yielding hybrids already before the year 2000. CDTS was also responsible for grainage. Yet, in 2004, CDTS encountered economic difficulties and was subsequently liquidated. This liquidation also implied the termination of ICA's involvement in the Colombian silk sector. Nevertheless, Colombian silk farmers continued to be ensured high yields as the state university UTP with funding from RELASEDA was enabled to successfully overtake the responsibility of research and grainage. In Peru, RELASEDA's funding also proved to be important. Until 2006, Peruvian silk farmers made use of Colombian hybrids that had been imported since before the year 2000. Nonetheless, as the state university UNALM – the institution responsible for grainage and research – received funding from RELASEDA, UNALM managed to commercialize six hybrids. A few of these hybrids were popularized due to their high yields, and as the grainage capacity also was high due to funding from RELASEDA, as well as due to technical

[2] Also Ukrainian hybrids were recommended in this project, but as Ukraine not has exported any silk during 2000-2010, the country has been disregarded from the analysis.

assistance from the research institution SSBP in Italy, Peruvian silk farmers could enjoy high yields. Paraguay and the Philippines displayed resembling experiences during the assessment period. However, funding for grainage and research in the case of Paraguay was not received from RELASEDA. Instead, the company Seda y Fibras SRL – being responsible for research and grainage in the country – received sufficient funding from Nembri IT SRL, a company in Italy to which Seda y Fibras SRL is an affiliate. Although no hybrids were commercialized in Paraguay, Paraguayan silk farmers were ensured high yields since a high-yielding hybrid had been in use since before the year 2000. In the Philippines, collaborating public institutions were responsible for research and grainage, and although internal funding for research was sufficient – which enabled the commercialization of three high-yielding hybrids – high yields were ensured due to technical assistance in grainage from two international donor organizations, namely the agencies JICA and KOICA.

The third and last category comprises Thailand, Vietnam, Tajikistan, Greece, Mexico, Bangladesh, India, Nepal, Pakistan, Australia, Indonesia, Cambodia, Laos, Kyrgyzstan, Ethiopia and Madagascar. In these countries, public institutions were responsible for grainage and research; the exceptions being Thailand – where the two companies Jim Thompson and Chul Thai were involved along with the public research institution QSDS – Cambodia and Madagascar. Partly due to the limited internal funding in these countries, many of the countries had a lack of technical personnel with adequate expertise, resulting in low yields as well as that many of these countries have made use of imported hybrids. This situation has further been aggravated by the fact that external and internal links in some countries have been weak. Yet, efforts have been taken by QSDS in Thailand that organized two ASEAN Silk Conferences to promote the collaboration within the ASEAN member countries. Nonetheless, the results were limited as the first conference took place as late as 2009. Furthermore did many of these countries receive external funding through technical assistance, grants, donations and silkworm breeds from international donor organizations, including UNIDO, FAO, the agencies KOICA and JICA, the Kenyan research institution ICIPE, NGOs etc. Despite these efforts, problems remained. In Thailand, Vietnam and Tajikistan, grainage was the main problem as 80 % of the Thai silk farmers had to multiply the silkworm eggs themselves, while Vietnamese and Tajik silk farmers have had to import much more than half of the necessary silkworm eggs from China every year since before the year 2000. Greece and Mexico instead had difficulties commercializing high-yielding hybrids but did not exhibit any problems in grainage. The other countries in the third category – i.e.

Bangladesh, India, Nepal, Pakistan, Australia, Indonesia, Cambodia, Laos, Kyrgyzstan, Ethiopia and Madagascar – remained constrained by limited funding to both grainage and research activities for ensuring high yields during the entire assessment period with one exception. In Australia, the state university UQG successfully performed grainage and research activities until 2007, which was the year when UQG ceased to perform these activities. As Australian silk farmers thereby were left to multiply the silkworm eggs themselves, and since there consequently was no institution left to neither commercialize hybrids nor control the quality of silkworm eggs, high yields could not be ensured. The silk sectors in all countries in the third category were hence characterized by a low degree of coordination.

When summing up the experiences of all 26 countries, the importance of a high degree of coordination for ensuring high yields cannot be ignored. Silk farmers in the countries belonging to the first category have been ensured high yields mainly due to sufficient internal funding for research and grainage activities. Most of these countries have also to a high degree collaborated with each other and with other countries. Likewise were silk farmers in the countries constituting the second category ensured high yields, yet mainly due to sufficient external funding. Countries in the first two categories did thus dispose of sectors characterized by a high degree of coordination. In the third category, countries faced problems in either research, grainage or both, resulting in that silk farmers in these countries were stuck at low yields, even when importing higher-yielding hybrids from abroad. Some of these countries have moreover collaborated with each other and with other countries, but not to the same extent as countries in the first two categories. The countries in the third category did thus dispose of silk sectors characterized by a low degree of coordination. The evidence presented above hence provides strong indications of that a high degree of coordination is important for ensuring high yields in a country’s silk sector. In other words, a country that slightly increases its degree of coordination should also be able to slightly increase its yields through the introduction of higher-yielding hybrids. The question is whether higher yields also have positive implications for a country’s silk exports. The relationship between these two factors is therefore the subject of the following three sections of this study.

3. Theory: The Gravity Model and Technology

As emphasized in the introduction, several trade theories have been utilized to analyze trade in agricultural goods, and these trade theories have been used to derive gravity models for the purpose of analyzing the effect of various factors on trade. In the original gravity model, three factors are considered, namely the economic sizes of the exporting country and importing country – as their respective sizes are positively associated with bilateral trade – and the distance between these countries so as to consider transport costs being negatively associated with bilateral trade (Deardorff, 1995). In practice, the gravity model is also augmented with other factors that are thought to affect trade. Two of these factors are common languages and colonial links, and both of these factors imply lower costs of bilateral trade, in the earlier case because of facilitated communication, and in the latter case since historical trade patterns have a positive influence on trade patterns being observed today. Another factor typically considered are trade barriers – which can be modeled by actual tariff barriers or by memberships in free trade areas and customs unions, i.e. regional trade agreements – and this factor is included since lower trade barriers tend to increase bilateral trade.

In this study, all the above-mentioned factors are taken into consideration while also adding a so-called policy variable being constituted by the number of annually introduced hybrids. This policy variable is included in order to take into account technological improvements, and as argued in the preceding section, introduced hybrids should increase the yields of a silk exporting country. Yet, how do technological improvements generally affect trade? The Ricardo model of comparative advantage provides a basis to how technological improvements should affect trade with the following assumptions (Deardorff, 2007):

- There are two countries, each producing two goods in autarky, i.e. when there is no trade,
- Only one production factor is used, hence is the production possibility frontier linear,
- There are technological differences between countries and technologies are characterized by constant returns to scale,
- Countries will fully specialize in the production and exports of one good under free trade.

Under these assumptions, a technological improvement in one of the countries implies that its production possibility frontier shifts outwards. Assuming free trade, and that the technological improvement takes place in the sector in which a small country has its comparative advantage, the terms of trade – i.e. relative prices – remain unchanged, but the country is still allowed to export more of the good in which the country has its comparative advantage. Similar is the case for a big country, where the only difference is that the terms of trade improve, lowering the price of the exported good, further increasing exports due to a more attractive price. In both cases, the costs of production also decrease since more can be produced with the same amount of inputs. Adapting these arguments to the silk sector, a silk exporting country should be able to export more silk when a hybrid is introduced. Moreover, Dornbusch et al (1977) extended the Ricardo model of comparative advantage to consider a continuum of goods, i.e. the amount of goods produced in a country is infinite. In this context, a technological improvement could lead a country to cease importing a good and instead begin exporting that good. For this change to occur, a country must overcome a productivity threshold in the relevant import competing sector. Silk importing countries could hence become silk exporters if higher-yielding hybrids were to be introduced. Thus, by dint of these arguments and the arguments considering coordination in the preceding section, the relevant hypothesis for the quantitative analysis can be generated:

<u>Hypothesis:</u> *An introduced hybrid increases silk exports from a silk exporting country because a higher degree of coordination has ensured higher yields for silk farmers in that country.*

4. Data, Variables and Methodology

In order to test the hypothesis that introduced hybrids in a silk exporting country increases that country's silk exports, the study utilizes an unbalanced dataset of 928 observations covering 26 silk exporting countries over the period 2001-2010. The dependent variable in the analysis is silk exports, and bilateral raw silk trade data – measured as quantity exported in kilograms – was hence collected from UNCOMTRADE (2012). The initial dataset from this database contained 7765 observations, and there are four reasons for why the study has reduced this number. Firstly, the data contains both import and export data, and as this study focuses on exports, the import data was removed. Secondly, the initial dataset covered the period 1996-2011, and the years 1996-2000 as well as the year 2011 were removed to obtain a better fit between the assessment periods of the qualitative and the quantitative analyses.[3] Thirdly, a drawback of the data from UNCOMTRADE (2012) is that re-exports – i.e. that countries import silk to later export the imported silk – contaminate the export data, resulting in that some countries export more than they produce. There are even some countries that export silk that do not have their own silk farming. The study has therefore endeavored to combat this problem by excluding countries that merely re-export.[4] Fourthly, the study excluded some countries due to data unavailability.[5] Owing to the efforts to exclude the problematic observations, and due to that raw silk is the good mostly traded and used for the purpose of textile production, the remaining observations should provide rather fair estimates.

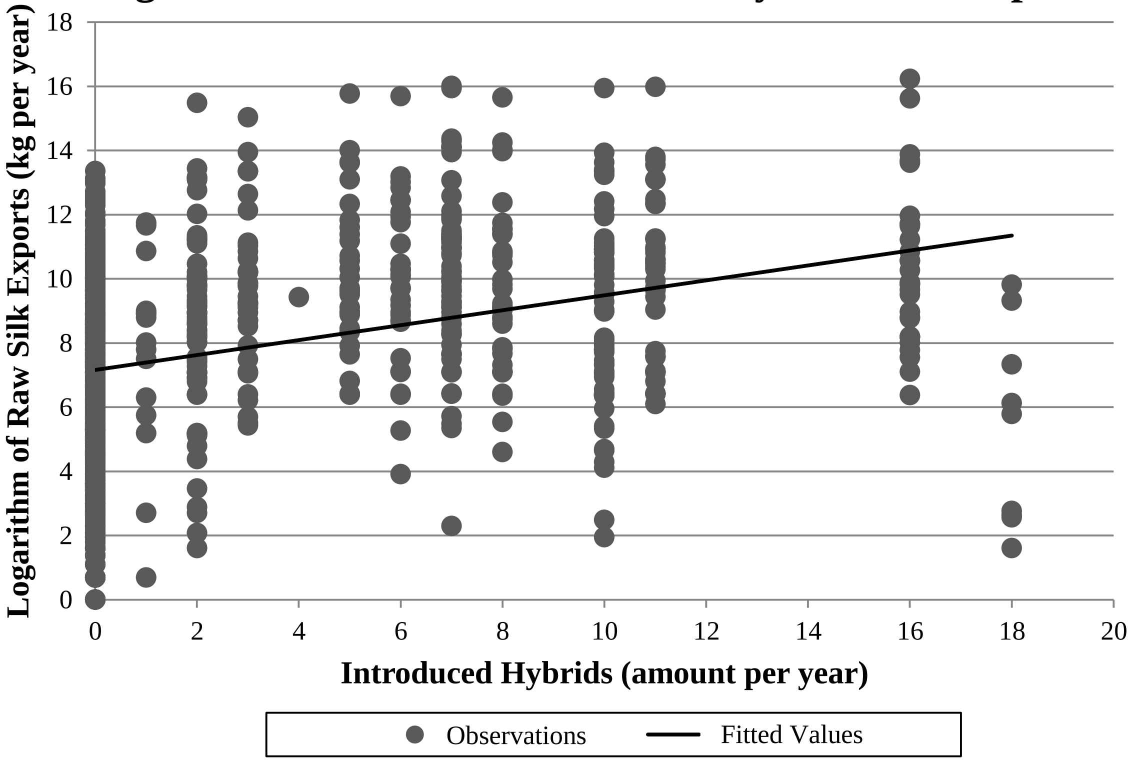
The independent variable of interest in this study is the number of annually introduced hybrids – i.e. both commercialized and imported hybrids – and this data was collected from publications (Agroprod, 2010; CSB, 2012; DSF, 2012; GP, 2012; QSDS, 2012; SRICAAS, 2012), and from direct correspondences with over 30 research institutions involved in the silk sector, including companies, research institutes and relevant ministries. As with the export data, there is also a drawback with this measure. Although the number of introduced hybrids

[3] The year 2000 was included in Table 1, but as severe multicollinearity and identification problems emerged when including this year in the quantitative analysis, the year was removed to avoid biased parameter estimates.
[4] Some of the excluded countries were engaged in silk farming before the year 2000. France has not had commercial silk farming since the end of the 1960s, Malaysia not since the 1980s, and South Korea and Sri Lanka not since the beginning of the 1990s. Similarly is the case in Poland that left silk farming in the 1980s, but the country continued performing research activities (Pieprzyk-Kokocha & Burczyk, 2006: 87). Czech Republic also had research activities during the assessment period, but no commercial silk farming. Two countries – Singapore and Hong Kong – were also excluded since these countries only are trading hubs. Lastly, Switzerland – which began silk farming on a commercial scale in 2009 – was excluded because the own production of silk yet had not been exported.
[5] Examples are Italy, Romania, Turkmenistan, and Uzbekistan.

shows a yield increase, the measure says nothing about how high is the yield increase. Nonetheless, the measure is still very good owing to two reasons. Firstly, the study only makes use of hybrids being introduced for silk farming purposes as the study excludes hybrids destined for inter alia the food, medicine and cosmetics industries. Secondly, it is not rational for a country to make use of a low-yielding hybrid when a higher-yielding hybrid is readily available, implying that the introduction of each hybrid de facto records a yield increase.

The correlation between annually introduced hybrids and raw silk exports is depicted in Figure 1, and as observed, there is already a priori a positive relationship between these two variables. More specifically, the value of the correlation coefficient is 0.3318. To the right of the figure where 18 hybrids have been introduced, there are outliers as some observations are far below the fitted values. There is only one country that in a single year has introduced 18 hybrids, and that is India. As shown in Table 1 in Section 2, this country had limited funding for both research and grainage activities during the assessment period, possibly giving rise to the outliers since yields thereby were low despite the high number of introduced hybrids. Yet, as already stated, there still appears to be a positive relationship between introduced hybrids and raw silk exports. Furthermore, as a check for robustness, the imported hybrids are excluded, and only the commercialized hybrids are thereby considered.

Figure 1. Correlation: Introduced Hybrids and Exports



Other independent variables are control variables, and there are 15 of these included, the first six being derived from the gravity model from the preceding section. The first two variables are the economic sizes of the exporting country and the importing country, and as these variables should affect trade positively, the study makes use of data on gross domestic product based on purchasing-power-parity in current international dollars from IMF (2012). The third variable models for trade barriers by using data from WTO (2012) on whether the exporting and importing countries – i.e. the country pairs – are part of the same free trade area or customs union, because being part of same regional trade agreement should positively affect trade. The fourth variable is the distance between countries – which is negatively associated with trade – and the study models the distance as the kilometers between the exporting and importing countries' capitals by dint of data from CEPII (2012). The study further makes use of data from CEPII (2012) for common languages and colonial links, being the fifth and sixth variables respectively, both of which should have a positive impact on trade. The last nine variables are not derived from the gravity model per se, but take into account so-called year effects. Such effects include unobserved factors that affect all countries each year. Not modeling for unobserved factors could result in that the effect from these factors instead becomes attributed to other variables in the model, giving rise to biased estimates. As the number of T = 10, and year effects are modeled with dummy variables, the study makes use of nine dummy variables to consider year effects. The study further presents the correlation matrix and the descriptive statistics of these year effects and all the other variables in Table 3 and Table 4 respectively in Appendix 2. The attentive reader may – by observing Table 3 – notice that the possibility of multicollinearity is excluded as all correlation coefficients are rather low.

The study utilizes the above-mentioned variables in the following semilog-linear panel data model:

$$
\begin{aligned}
lnexpq_{it} = \alpha + \beta_1 inth_{it} + \beta_2 lngdp_{it} + \beta_3 lngdppartner_{it} + \beta_4 lndist_{i\bullet} + \beta_5 ftacudum_{it} \\
+ \beta_6 comlangdum_{i\bullet} + \beta_7 colonydum_{i\bullet} + \beta_8' yeardummies_{\bullet t} + \varepsilon_{it}
\end{aligned}
$$

Where $lnexpq_{it}$ = the logarithm of raw silk exports, α = the intercept, β = the associated parameters, $inth_{it}$ = the number of annually introduced hybrids, $lngdp_{it}$ = the logarithm of gross domestic product for the exporting country, $lngdppartner_{it}$ = the logarithm of gross domestic product for the importing country, $lndist_{i\bullet}$ = the logarithm of the distance between the countries' capitals, $ftacudum_{it}$ = a dummy variable for regional trade agreements, $comlangdum_{i\bullet}$ = a dummy variable for common languages, $colonydum_{i\bullet}$ = a dummy variable for colonial links, $yeardummies_{\bullet t}$ = a vector of nine year dummy variables, and ε_{it} = the error term. Some of the variables do not have the sub-index *it* but rather the sub-index $i\bullet$, and in the case of the latter sub-index, the variables are time-invariant and therefore only vary over country pairs. In the case of the sub-index $\bullet t$, the variables only vary over time but not across country pairs. Moreover, provided the dummy variables' construction, the benchmark for all regressions is a country pair in the year 2001 not being part of the same regional trade agreement, not having common languages, and not having any colonial links.

5. Regression Analysis

Table 2 shows the estimation output from the panel data model employed in this study, and before generating the estimates in this table, tests were performed to choose adequate model specifications. In the case of Model 1 and Model 2, the study chose to employ the fixed effects estimator. It is often recommended to use this estimator when a study analyzes countries, but this study also tests the fixed effects estimator against random effects and pooled ordinary least squares – two other specifications commonly used in panel data – thereby not solely relying on recommendations. The fixed effects estimator was firstly tested against pooled ordinary least squares by dint of a Chow test, where a rejection of the null hypothesis of this test implies that fixed effects is preferred and vice versa. The F-statistic was 10.30 and the associated p-value 0.0000, implying a rejection of the null hypothesis. The study also tested the fixed effects estimator against the random effects estimator with a Hausman test, where rejecting the null hypothesis favors the usage of the fixed effects estimator and vice versa. The χ^2-statistic was 32.66 and the associated p-value 0.0019. Relying on the results of these tests, the fixed effects estimator is preferred, and the study therefore chose this estimator in Model 1 and Model 2.

The study furthermore conducted diagnostic tests for normality, autocorrelation, and heteroskedasticity before estimating Model 1 and Model 2. The Jarque-Bera test for normality was rejected, but as the sample size is rather big, inferences should still be useful. This test is thus disregarded hereinafter in the text. The Wooldridge and Breusch-Pagan tests were conducted for first-order autocorrelation and heteroskedasticity respectively. The null hypotheses of the Wooldridge and Breusch-Pagan tests were both rejected, implying that there is first-order autocorrelation, and heteroskedasticity in Model 1 and Model 2. As these problems cause inefficient estimates, the study uses jackknife standard errors in Model 2, and Driscoll-Kraay standard errors in Model 1. In the case of Driscoll-Kraay standard errors, these can be used when cross-sectional dependence is prevalent in a panel data model, a problem which causes inefficiency. In cases where T – i.e. the number of time periods – is small in a dataset, which also is the case in this study where T = 10, cross-sectional independence is often assumed. Nonetheless, as the dataset is strongly unbalanced – rendering the usage of Pesaran's test of cross-sectional dependence difficult – as well as due to that cross-sectional dependence could be prevalent, the study makes use of Driscoll-Kraay standard errors together with jackknife standards errors.

Table 2. Gravity Model Estimation Output

Independent Variable	*Commercialized and Imported Hybrids* Model 1. Fixed Effects (Driscoll-Kraay)	Model 2. Fixed Effects (Jackknife)	Model 3. Hausman-Taylor IV (Jackknife)	*Commercialized Hybrids (Robustness)* Model 4. Fixed Effects (Driscoll-Kraay)	Model 5. Fixed Effects (Jackknife)	Model 6. Hausman-Taylor IV (Jackknife)
inth	0.0404 (0.0210)*	0.0404 (0.0187)**	0.0437 (0.0188)**	0.0409 (0.0208)*	0.0409 (0.0188)**	0.0442 (0.0188)**
lngdp	0.3379 (0.0209)	0.3379 (0.9760)	1.0971 (0.9178)	-0.3367 (0.7494)	-0.3367 (0.9760)	1.0969 (0.9166)
lngdppartner	0.7244 (0.7506)	0.7244 (1.0987)	1.0815 (0.5093)**	0.7258 (0.5567)	0.7258 (1.0987)	1.0819 (0.5083)**
lndist	-	-	-5.1125 (2.0341)**	-	-	-5.1168 (2.0309)**
ftacudum	-3.0526 (0.0519)***	-3.0526 (0.2684)***	-3.0419 (13.9395)	-3.0516 (0.0158)***	-3.0516 (0.2684)***	-3.0404 (13.9241)
comlangdum	-	-	-0.5743 (0.7338)	-	-	-0.5720 (0.7340)
colonydum	-	-	-4.7168 (2.8879)	-	-	-4.2703 (2.8879)
year2002	0.0379 (0.0700)	0.0379 (0.2743)	-0.0605 (0.2861)	0.0379 (0.0699)	0.0379 (0.2743)	-0.0604 (0.2861)
year2003	-0.1362 (0.1724)	-0.1362 (0.3065)	-0.3826 (0.3240)	-0.1358 (0.1722)	-0.1358 (0.3065)	0.3819 (0.3238)
year2004	-0.3993 (0.2232)	-0.3993 (0.3754)	-0.8004 (0.3947)**	-0.3993 (0.2229)	-0.3993 (0.3755)	-0.7999 (0.3944)**
year2005	-0.1323 (0.4376)	-0.1323 (0.5355)	-0.7469 (0.5440)	-0.1353 (0.4361)	-0.1353 (0.5355)	-0.7493 (0.5433)
year2006	-0.5490 (0.3531)	-0.5490 (0.6969)	-1.3688 (0.7149)*	-0.5493 (0.3524)	-0.5493 (0.6969)	-1.3681 (0.7140)*
year2007	-0.5204 (0.5100)	-0.5204 (0.7928)	-1.5558 (0.8413)*	-0.5222 (0.5087)	-0.5222 (0.7928)	-1.5563 (0.8401)*
year2008	-0.3710 (0.5428)	-0.3710 (0.8466)	-1.5524 (0.9348)*	-0.3730 (0.5414)	-0.3730 (0.8466)	-1.5531 (0.9336)*
year2009	-0.5388 (0.5928)	-0.5388 (0.9039)	-1.7885 (0.9804)*	-0.5401 (0.5915)	-0.5401 (0.9039)	-1.7882 (0.9790)*
year2010	-0.3119 (0.5928)	-0.3119 (1.0230)	-1.7612 (1.1268)	-0.3129 (0.5964)	-0.3129 (1.0229)	-1.7605 (1.1251)
α	6.2612 (5.1436)	6.2612 (8.1874)	37.6385 (20.0650)*	6.2434 (0.4361)	6.2434 (8.1870)	37.6736 (20.0453)*
N	928	928	928	928	928	928
Country Pairs	269	269	269	269	269	269
R^2 (within)	0.0325	0.0325	-	0.0327	0.0327	-
R^2 (between)	0.0037	0.0037	-	0.0037	0.0037	-
R^2 (overall)	0.0001	0.0001	-	0.0001	0.0001	-
SIC	3180.952	3180.952	-	3180.841	3180.841	-
Wooldridge[a]	12.974 (0.0005)	12.974 (0.0005)	12.974 (0.0005)	12.982 (0.0005)	12.982 (0.0005)	12.982 (0.0005)
Breusch-Pagan[b]	206.294 (0.0000)	206.294 (0.0000)	256.406 (0.0000)	205.459 (0.0000)	205.459 (0.0000)	751.68 (0.0000)
Jarque-Bera[b]	298.353 (0.0000)	298.353 (0.0000)	274.635 (0.0000)	298.731 (0.0000)	298.731 (0.0000)	274.941 (0.0000)
Kleibergen-Paap[b]	-	-	24.174 (0.0072)	-	-	24.174 (0.0072)
Sargan-Hansen[bc]	-	-	6.894 (0.6482)	-	-	6.889 (0.6486)

*Notes: The dependent variable in these regressions is lnexpq. ***, **, * represent significant results on 1 %, 5 % and 10 % significance levels respectively (two-tailed tests). Numbers within parentheses in the upper part of the table are the standard errors, while numbers within parentheses in the lower part of the table are the p-values. The test statistics shown in the lower part of the table are before relevant adjustments. [a] F-statistics are given in these tests. [b] χ^2-statistics are given in these tests. [c] The version of this test being used here is robust against heteroskedasticity.*

After relevant adjustments, the estimation results in Model 1 and Model 2 in the table can finally be interpreted. In both models, *inth* – being the independent variable of interest – is positively associated with *lnexpq*, in Model 1 on a significance level of 10 %, and in Model 2 on a significance level of 5 %. Interpreting the magnitude in both models, an introduced hybrid in a country should generally increase that country's silk exports by 4.04 %. Yet, a rather peculiar result in these two models is that the control variable for regional trade agreements – i.e. *ftacudum* – was strongly and negatively associated with silk exports. As the fixed effect estimator cannot estimate the importance of time-invariant variables, the reason for the peculiar result most likely stems from that *ftacudum* hardly varies over time. Similarly can be argued about *lndist*, *colonydum*, and *comlangdum* since these three variables are time-invariant, and these three variables have therefore been excluded from the estimation. However, the time-invariance of the control variables do not cause any considerable problems in interpreting the parameter value on *inth*, so another estimator cannot be chosen on this basis. Nevertheless, when recalling the included countries in Table 1 in Section 2, some countries did not introduce any hybrids during the assessment period, implying that the variable of interest is time-invariant for some countries.

So as to consider the above-mentioned issue with *inth*, the random effects estimator could be used. Still, the employment of this estimator requires that the variables are not correlated with individual specific heterogeneity, i.e. the intercept α. As the Hausman test earlier rejected the use of the random effects model in favor of the fixed effects estimator, some of the variables are most likely correlated with individual specific heterogeneity. This correlation would cause inconsistent estimates when utilizing the random effects estimator since some variables by these means are endogenous. To get around this problem, the study makes use of another estimator in Model 3, namely the Hausman-Taylor IV estimator. As this estimator makes use of instrumental variables, the Kleibergen-Paap and Sargan-Hansen tests for underidentification and overidentification respectively should be conducted in order make sure that the parameter values have been identified. These tests are conducted by firstly choosing excluded instruments – i.e. the variables which the researcher believes to be endogenous – to later test whether the included instruments – i.e. the exogenous variables being constituted by the other variables in the model – are valid. Rejecting the Kleibergen-Paap test and not rejecting the Sargan-Hansen test bodes well because the parameter values have in this case been identified. Adequate adjustments have in other words been made to correct for the endogeneity caused by the correlation between the variables and individual specific heterogeneity. Not rejecting the Kleibergen-Paap test and/or rejecting the Sargan-Hansen test implies that the included instruments are questionable, in turn meaning that adequate adjustments for endogeneity not have been made, and that the parameter estimates thereby should be interpreted with caution.

In the Hausman-Taylor IV estimation employed in Model 3, the study chose *inth*, *lndist*, *ftacudum* and *year2007* as the best excluded instruments by dint of subsequent testing for underidentification and overidentification. As observed in the table, the Kleibergen-Paap test is rejected whereas the Sargan-Hansen test is not rejected. The parameter values – most importantly the parameter value for *inth* – are thereby identified as the estimator adequately adjusts for the endogeneity problem referred to above. The study further tested for autocorrelation and heteroskedasticity by utilizing the Wooldridge and Breusch-Pagan tests respectively. Since these tests were rejected, the study employed jackknife standard errors to increase the efficiency of the results.

Interpreting the results in Model 3 after using jackknife standard errors provides the result that *inth* is positively associated with *lnexpq* on a significance level of 5 %. More specifically does an introduced hybrid in a country generally increase that country's silk exports by 4.37 %. The magnitude of the increase in the Hausman-Taylor IV estimation is thus slightly higher than in the earlier two models, probably because more countries were considered in the estimation.

The study also employs a robustness check by excluding the imported hybrids from the data to only consider countries' commercialized hybrids. By using the same methodology utilized in Model 1 and Model 2, testing between the fixed effects, random effects and pooled ordinary least squares estimators were also undertaken in Model 4 and Model 5 in order to determine which of these estimators is appropriate. When testing the fixed effects estimator against pooled ordinary least squares, the F-statistic in the Chow test was 10.30 and the associated p-value 0.0000, a result being in favor of the fixed effects estimator as the null hypothesis was rejected. Likewise was the case when testing the fixed effects estimator against the random effects estimator, where the χ^2-statistic in the Hausman test was 32.49 and its associated p-value 0.0020. Also the result from this test hence pointed to that the fixed effects estimator is preferred since the null hypothesis was rejected. Furthermore did the study conduct diagnostic tests for autocorrelation and heteroskedasticity. The null hypothesis was rejected in these two tests. By also taking into account potential cross-sectional dependence in accordance to above-mentioned arguments, Driscoll-Kraay standard errors were used together with jackknife standard errors in Model 4 and Model 5 respectively. After using these standard errors, *inth* was positively associated with *lnexpq*, in Model 4 on a significance level of 10 %, and in Model 5 on a significance level of 5 %. The magnitude was equal in both models, rendering the general interpretation that when a country commercializes a hybrid, the country's silk exports increase by 4.09 %.

In the Hausman-Taylor IV estimation in Model 6, the same methodology as in Model 3 was used. As earlier, the best excluded instruments after subsequent testing for overidentification and underidentification proved to be *inth*, *lndist*, *ftacudum* and *year2007* since the Kleibergen-Paap test was rejected whereas the Sargan-Hansen test was not rejected. The study also chose to make use of jackknife standard errors in Model 6 owing to that the Breusch-Pagan and Wooldridge tests for heteroskedasticity and first-order autocorrelation respectively were rejected. The variables *inth* and *lnexpq* were positively associated with each other on a significance level of 5 %, where the parameter value was 0.0442. A commercialized hybrid in a country does thereby generally increase that country's silk exports by 4.42 % according to the results in Model 6.

Summarizing the results from Model 1-6 yields the interpretation that the introduction of a higher-yielding hybrid increases a country's silk exports by a little more than 4 %. Recalling the discussion on coordination in Section 2 indeed renders this result important as a country increasing its degree of coordination thereby can increase its silk exports. The results also appear to be robust to minor modifications in the variable of interest, by these means providing more substance to the results. Moreover, although the study conducted the estimations in Model 4-6 merely for the purpose of robustness, it is interesting to note that the magnitude of the silk export increase was bigger when the imported hybrids were excluded. This result may stem from that imported hybrids often are not well-adapted to the agro-ecological conditions in the importing country but still record a yield increase. Yet, the difference is very small, but the result may indicate that it is preferable for a country to commercialize hybrids rather than importing these from abroad. Nonetheless, on the basis of the quantitative analysis being conducted in this section, it is recommended for a country to introduce higher-yielding hybrids so as to increase its silk exports.

6. Conclusion

This study began by providing an overview of silk sector performance by drawing on arguments from two earlier studies that were conducted in African cotton sectors. The main finding in this part of the study was that a high degree of coordination in a country is important for ensuring high yields for that country's silk farmers. This statement implies that a country that slightly increases its degree of coordination also should be able to slightly increase the yields for its silk farmers through the introduction of higher-yielding hybrids. The study thereafter analyzed the relationship between introduced hybrids and silk exports where the main finding was that there is a significantly positive relationship between these two factors. Interpreting this result causally, a country should be able to increase its silk exports by a little more than 4 % when introducing a higher-yielding hybrid.

Although these results are promising, there are limitations of this study that deserve to be highlighted. Firstly, as stated in Section 3, the export data being used is contaminated by re-exports, a problem which the study attempts to deal with by excluding countries that merely re-export. Nevertheless, problems may still persist. Secondly, the analysis in Section 5 dealt with endogeneity caused by the correlation between the variables and individual specific heterogeneity, rendering the estimates more consistent. This procedure does, however, not rule out the inconsistency originating from the type of endogeneity being caused by omitted variable problems, i.e. by the correlation between the variables and the error term. Thirdly, although the sample size is rather big, the study excluded some countries from the analysis due to data unavailability. As the estimation results might be biased due to these three limitations, all of these three areas deserve future research. Such research could in the first case be conducted by transforming the data so as to in some way not consider countries' re-exports, in the second case through the usage of alternative estimators – for instance GMM or other IV estimators – and in the third case by collecting data from more countries.

There are also other areas in which future research could focus. This study has merely considered the introduction of hybrids and has thereby disregarded the introduction of mulberry varieties and management technologies. These factors could in future research be considered along with other factors – for instance input credits – as all of these factors also could be argued to influence production – and thereby also exports – positively. Future research could furthermore focus on resembling factors in other agricultural sectors. Findings as those found in this study may therefore prove to be generalizable to other aspects of the silk sector as well as to other agricultural sectors.

To return to the findings of this study, there are indications of a positive relationship between introduced hybrids and silk exports, providing an affirmative response to the first research question. Provided that these indications point to a true positive relationship, there are important policy implications, which also answer the second research question of this study. A country should, in short, aim to increase its degree of coordination in order to increase its silk exports, because an increase in the degree of coordination ensures higher yields for a country's silk farmers through the introduction of higher-yielding hybrids. This conclusion is especially important for countries being characterized by a low degree of coordination as these countries have the biggest potential to increase their silk exports. Additionally, by dint of the argument derived from the study conducted by Dornbusch et al (1977), silk importing countries could become silk exporters if higher-yielding hybrids were to be introduced. A higher degree of coordination in a silk importing country could thereby lead that country to begin exporting silk. In other words, the findings in this study might be generalizable to all silk producing countries.

There are various ways in which a country may go about to achieve an increase in its degree of coordination, enabling that country to increase its silk exports. A country could endeavor to make internal funding available for research and grainage activities, thereby ensuring that the country's silk farmers can reap the benefits of the higher yields inherently characterizing a commercialized hybrid. If the country for some reason does not dispose of sufficient internal funding, the country could seek to attract and request external funding from international donor organizations. A country could furthermore try to benefit from economies of scale by using internal and external links, allowing for collaboration through the exchange of research experiences and silkworm breeds, and through coordinated research projects. Where the institutional foundation for such collaboration on the international level already exists – i.e. the associations ASEAN, BACSA and RELASEDA – collaboration could be intensified, and countries having the possibility to join these associations could also do so. An alternative would be to create a new institutional foundation – e.g. a new association – where countries could collaborate. By collaborating, countries may not even have to commercialize hybrids, but a country could instead import hybrids that have been properly tested so as to ensure that the imported hybrids are well-adapted to the agro-ecological conditions in the importing country, thereby ensuring high yields.

Yet, there is one last issue that has to be considered before following the above-mentioned recommendations. Despite that this study emphasizes what measures a country should take in order to increase its silk exports, the study does not consider whether it is viable for a country to actually engage in silk farming at all. Some countries may never become silk exporters due to for instance adverse agro-ecological conditions. However, as this issue is rather contextual, the study leaves this topic open for future research.

References

Abbasov, B. (2006), *Follow-Up Activities of Tashkent Workshop and National Strategy for Sericulture Revival and Development in Azerbaijan*, Proceedings of the 2nd Executive Meeting of Black, Caspian seas and Central Asia Silk Association, Bursa. pp. 377-402.

Agroprod (2010), *National Register of Varieties and Hybrids of Plants Approved for Use*, Ministry of Agriculture, Republic of Kyrgyzstan. [http://www.agroprod.kg/themes%5Csp-3%5Cimages%5CMapKR_Oblasti%5CGosreestr20101.pdf, accessed 2012-08-03] (in Russian)

Anitha, R. (2011), *Indian Silk Industry in the Global Scenario*, International Journal of Multidisciplinary Management Studies, Vol. 1. No. 3. pp. 100-110.

Asaoka, K. (2011), *Present Situation of Sericulture in Japan*, Proceedings from the 22nd Congress of the International Sericultural Commission “Silk for the Better Life”, Chiang Mai. pp. 243-244.

Ashfaq, M. & M. Aslam (2006), *Renewal of Sericulture Industry*, Middle-East Journal of Scientific Research, Vol. 1. No. 1. pp. 58-59.

BACSA (2006), *Comparative Studies of Silkworm Hybrids Performance for Sericultural Enterprise Development in Black, Caspian Seas and Central Asia Region*, Mini Regional Project, Black Caspian Seas and Central Asia Silk Association.

Boonchoo, S. (2008), *Distinctive Signs for Collective Use: Non-Agricultural Products*, International Forum on Distinctive Signs for Collective Use. pp. 1-11.

BSF (2012), *About BSF*, Bangladesh Silk Foundation. [http://www.silkfoundation.com/about.htm, accessed 2012-07-25]

Busch, A. P. B., M. C. D. O. Freitas & M. Mazzarotto (2010), *Perfil da Sericicultura no Estado do Paraná: Safra 2009-2010*, Relatório Takii, Secretaria da Agricultura e Abastecimento, Estado do Paraná. (in Portuguese)

Canavari, M. & N. Cantore (2010), *Equivalence of Organic Standards as a Signal of Affinity: A Gravity Model of Italian Agricultural Trade*, Journal of International Food and Agribusiness Marketing, Vol. 22. No. 3-4. pp. 314-327.

CEPII (2012), *GeoDist*, Centre d’Études Prospectives et d’Informations Internationales. [http://www.cepii.fr/anglaisgraph/bdd/distances.htm, accessed 2012-06-24]

Chen, Y. (2002), *Conservation Status of Silkworm Germplasm in China*, Papers Contributed to the Expert Consultation on Promotion of Global Exchange of Sericulture Germplasm Satellite Session of 19th International Sericultural Commission Congress, Bangkok. [http://www.fao.org/docrep/005/AD108E/ad108e01.htm#bm01, accessed 2012-06-08]

CMU (2007), *Value Chain Analysis for Thai Home Textiles Silk Sub-Sector*, The Case of Thai Home Textiles: Building Export Competence of a SME Dominated Value Chain, EU-Thailand Small Projects Facility, Chiang Mai University.

CITE (2009), *Étude Nationale de la Filière Soie: Analamanga – Ambalavao – Amoron’i Mania – Vakinankatra – Itasy, Rapport Final*, Cofinancé par le Programme IFAC, Mis en Œuvre par le GRET et le CITE. (in French)

CSB (2012), *CSB’s R&D Achievements*, Central Silk Board, Ministry of Textiles, Government of India. [http://www.csb.gov.in/assets/Uploads/rti-files/item-17-b6.pdf, accessed 2012-08-07]

Dandin, S. B., B. S. Angadi & H. K. Basavaraja (2008), *Impact of Foundation Cross Male Component on Cross Breed Egg Production in South India*, Proceedings of the 21st International Sericultural Congress, Athens. pp. 100-106.

Dascal, D., K. Mattas & V. Tzouvelekas (2002), *An Analysis of EU Wine Trade: A Gravity Model Approach*, International Advances in Economic Research, Vol. 8. No. 2. pp. 135-147.

Deardorff, A. V. (1995), *Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?*, Research Seminar in International Economics, Discussion Paper No. 382, University of Michigan.

Deardorff, A. V. (2007), *The Ricardian Model*, Princeton Encyclopedia of the World Economy.

Dingle, J. G., E. Hassan, M. Gupta, D. George, L. Anota & H. Begum (2005), *Silk Production in Australia*, Rural Industries Research and Development Corporation, Australian Government.

Dornbusch, R., S. Fischer & P. A. Samuelson (1977), *Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods*, American Economic Review, Vol. 67. No. 5. pp. 823-839.

DSF (2012), *Breeds*, Dainippon Silk Foundation.

[http://www.silk.or.jp/silk_breed.html, accessed 2012-08-07] (in Japanese)
Eaton, J. & S. Kortum (2006), *Innovation, Diffusion, and Trade*, National Bureau of Economic Research, Working Paper No. 12385.
Esim, S. (2001), *See How They Grow: Business Development Services for Women's Business Growth*, International Center for Research on Women.
FAO (2009), *FAO Provides Much Needed Boost to Cambodian Silk Sector*, Food and Agriculture Organization of the United Nations, Phnom Penh. [http://www.un.org.kh/index.php?option=com_content&view=article&id=180:fao-provides-much-needed-boost-to-cambodian-silk-sector&catid=43:latest-press-releases&Itemid=76, accessed 2012-07-01]
Fenomanantsoa, R. (2006), *Silk Handicrafts Cottage Industries and Silk Enterprises Development in Madagascar*, Proceedings of the 2nd Executive Meeting of Black, Caspian seas and Central Asia Silk Association, Bursa. pp. 155-174.
FIDA (2012), *Silk – History*, Fiber Industry Development Authority, Department of Agriculture, Republic of the Philippines. [http://fida.da.gov.ph/Templates/silk_history.htm, accessed 2012-07-25]
Gangopadhyay, D. (2008), *Sericulture Industry in India – A Review*, S&T for Rural India and Inclusive Growth. [http://www.nistads.res.in/indiasnt2008/t6rural/t6rur16.htm, accessed 2012-06-09]
Grekov, D. (2008), *Recent Sericulture Status in Bulgaria and Trends for Development*, Proceedings of the 4th Black, Caspian Seas and Central Asia Silk Association Meeting, Athens. pp. 41-43.
Grekov, D., P. I. Tzenov, S. Beshkov & N. I. Petkov (2006), *Follow-Up Activities of Tashkent Workshop and National Strategy for Sericulture Revival and Development in Bulgaria, with Emphasis on Status and/or Prospects of Silk Handcraft Cottage Industries Development*, Proceedings of the 2nd Executive Meeting of Black, Caspian Seas and Central Asia Silk Association, Bursa. pp. 403-426.
GP (2012), *Silkworm Varieties*, Gunma Prefecture. [http://www.pref.gunma.jp/07/p14710006.html, accessed 2012-08-07] (in Japanese)
Hashmi, F. Z. (2011), *Development of Sericulture Activities in Punjab*, Evaluation Report on Project, Directorate General Monitoring & Evaluation, Planning & Development Department, Government of the Punjab.
Hussain, M., Sh. A. Khan, M. Naeem & M. F. Nasir (2011), *Effect of Rearing Temperature and Humidity on Fecundity and Fertility of Silkworm, Bombyx Mori L. (Lepidoptera: Bombycidae)*, Pakistan Journal of Zoology, Vol. 45. No. 5. pp. 979-985.
IMF (2012), *World Economic Outlook Database*, International Monetary Fund. [http://www.imf.org/external/pubs/ft/weo/2012/01/weodata/weoselgr.aspx, accessed 2012-06-17]
JICA (2003), *Newsletter*, Japan International Cooperation Agency, Vol. 31.
Karagözoğlu, A. (2008), *Sericulture in Turkey*, Proceedings of the 4th Black, Caspian Seas and Central Asia Silk Association Meeting, Athens. pp. 49-62.
Karimov, M. A. (2005), *National Plan for Sericulture Revival and Development in Tajikistan*, 1st International Workshop on Revival and Promotion of Sericultural Industries and Small Enterprise Development in the Black, Caspian Seas and Central Asia Region, Tashkent. [http://www.bacsa-silk.org/en/tajikistan-national-sericulture-development-plan/, accessed 2012-06-14]
Karimov, M. A. (2006), *Follow-Up Activities of Tashkent Workshop and National Strategy for Sericulture Revival and Development in Tajikistan*, Proceedings of the 2nd Executive Meeting of Black, Caspian Seas and Central Asia Silk Association, Bursa. pp. 479-490.
Khan, Sh. A., M. Hussain, Gh. Sabir, M. M. U. Rehman & M. S. Anwar Ch. (2008), *Evaluation of Genetic Potential of Pure Lines of Silkworm for Breeding and Silk Production*, Proceedings of the 21st International Sericultural Congress, Athens. pp. 51-56.
Kipriotis, E. A. (2006), *Follow-Up Activities of Tashkent Workshop and National Strategy for Sericulture Revival and Development in Greece*, Proceedings of the 2nd Executive Meeting of Black, Caspian Seas and Central Asia Silk Association, Bursa. pp. 451-466.
Kipriotis, E. A. (2008), *Sericulture in Greece of 2008: Problems – Aspects – Prospects*, Proceedings of the 4th Black, Caspian Seas and Central Asia Silk Association Meeting, Athens. pp. 44-45.
Lambert, D. & Sh. McKoy (2009), *Trade Creation and Diversion Effects of Preferential Trade Associations on Agricultural and Food Trade*, Journal of Agricultural Economics, Vol. 60. No. 1. pp. 17-39.
Lewis, David (2003), *NGOs, Organizational Culture, and Institutional Instability*, The Annals of the American Academy, AAPSS.

McNair, P. (2011), *Reviving Sericulture in Indonesia*, Sericulture for Multi-Products – New Prospects for Development, Proceedings of the 5th Black, Caspian Seas and Central Asia Silk Association International Conference, Bucharest. pp. 31-44.
Melitz, M. J. (2003), *The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity*, Econometrica, Vol. 71. No. 6. pp. 1695-1725.
Mey, K., V. Srey & L. Valenti (2010), *Practical Manual for Preparing Agricultural Projects*, Ministry of Agriculture and Fisheries & Food and Agriculture Organization of the United Nations.
MoIC (2009), *Sustainable Silk and Handicraft Production*, Ministry of Industry and Commerce, Lao PDR.
Munhoz, R. E. F. (2010), *Variabilidade Genética de Raças e Híbridos Simples de Bombyx Mori L. do Banco de Germoplasma da Universidade Estadual de Maringá*, Universidade Estadual de Maringá, Maringá. (in Portuguese)
Nguyen, T. T. (2006), *Value Chain Analysis for Sericulture Sub-Sector in Quang Binh Province, Report*, Sustainable Management of Natural Resources in Central Vietnam (SMNR-CV).
Nguyen, T. T. & A. Eiligmann (2010), *Value Chain Study for Sericulture in Phu Tho, Hoa Binh, Thanh Hoa and Nghe An, Viet Nam*, Crafting out of Poverty, Joint Programme on Green Production and Trade to Increase Income and Employment Opportunities for the Rural Poor.
Nisar, A. G., K. S. Afifa, M. F. Baqual, R. K. Sharma, K. A. Dar & I. L. Khan (2012), *Indian Sericulture Industry with Particular Reference to Jammu & Kashmir*, International Journal of Advanced Biological Research, Vol. 2. No. 2. pp. 194-202.
Nuraeni, S. (2011), *Perbandingan Karakteristik dan Kualitas Ulat Sutera (Bombyx Mori L.) Dari Bibit Hibrid China Import dan Perum Perhutani*, Program Studi Ilmu Hama dan Penyakit Tumbuhan Jur. Budidaya Pertanian, Faperta Unhalu. (in Indonesian)
Petkov, N. I., P. I. Tzenov, Z. M. Petkov, Y. S. Natcheva & Y. B. Vasileva (2006), *Silkworm, Bombyx Mori L. Germplasm Resources in Bulgaria*, PublishScieSet – Eco, Sofia.
Pieprzyk-Kokocha, D. & H. Burczyk (2006), *Breeding and Rearing Mulberry Silkworm (Bombyx Mori L.) at the Institute of Natural Fibers*, in R. Kozłowski, G. E. Zaikov & F. Pudel (eds.)(2006), *Renewable Resources and Plant Biotechnology*, Nova Science Publishers. pp. 87-92.
Poulton, C., P. Gibbon, B. Hanyani-Mlambo, J. Kydd, W. Maro, M. N. Larsen, A. Osório, D. L. Tschirley & B. Zulu (2004), *Competition and Coordination in Liberalized African Cotton Market Systems*, World Development, Vol. 32. No. 3. pp. 519-536.
QSDS (2010), *ASEAN Sericulture Conference 2010 and ASEAN Silk Fabric and Fashion Design Contest 2010*, Organized by the Queen Sirikit Department of Sericulture. [http://www.qsds.go.th/qthaisilk/upload_page/SET_The%20Whole%20event%20general.pdf, accessed 2012-08-07]
QSDS (2012), *Species Certified by the Department*, Queen Sirikit Department of Sericulture. [http://www.qsds.go.th/qthaisilk_center/inside.php?com_option=page&aid=306&sub=305&site=tak, accessed 2012-08-05] (in Thai)
Ramanoelina, P., J. Rasoarahona, R. N. Rabearamisa & J. Razafiarajiaona (2008), *Situation Analysis of Agricultural Research and Training in the SADC Region (Madagascar)*, Implementation and Coordination of Agricultural Research and Training (ICART) in the SADC Region, FANR Directorate, SADC Secretariat.
Ramesha, C., S. V. Seshagiri & C. G. P. Rao (2009), *Evaluation and Identification of Superior Polyvoltine Crossbreeds of Mulberry Silkworm*, Bombyx Mori L., Journal of Entomology, Vol. 6. No. 4. pp. 188-197.
RUDEC (2011), *Vietnam: Green Production and Trade to Increase Income and Employment Opportunities for the Rural Poor*, Support Proposals for Material Growers, Rural Development Center, Institute of Policy and Strategy for Agriculture and Rural Development.
Sohn, K. & H. Kim (2011), *A Draft Strategic Development Plan for Sericulture Sector in Cambodia 2011-2017*, Food and Agriculture Organization of the United Nations.
Soto, C. A. M. & C. A. M. Tamayo (2008), *Aprovechamento Integral de la Crisalida de Gusano de Seda (Bombyx Mori Linn) Híbrido Pilamo 1*, Facultad de Tecnología, Universidad Tecnológica de Pereira. (in Spanish)
SRICAAS (2012), *National Sericulture Technology System*, Sericulture Research Institute, Chinese Academy of Agricultural Sciences. [http://www.cnsilkworm.com/so_yc/index.asp, accessed 2012-08-10] (in Chinese)

Tuckson, M., T. Tijayamorn & T. Phetmany (2004), *The Future of the LEAPSS Project: An Evaluation of the Lao Economic Acceleration Program for the Silk Sector (LEAPSS) in Xieng Khouang and Hua Phan*, Recommendations for Enhancing Sustainability of Project Interventions, USAID Report.

Tschirley, D. L., C. Poulton & P. Labaste (2009), *Organization and Performance of Cotton Sectors in Africa,* Agriculture and Rural Development, World Bank, Washington.

Tzenov, P. I. (2011), *Black, Caspian Seas and Central Asia Silk Association (BACSA) Activities for Revival and Development of Sericulture in Europe and Central Asia*, Sericulture for Multi-Products – New Prospects for Development, Proceedings of the 5th Black, Caspian Seas and Central Asia Silk Association International Conference, Bucharest. pp. 13-18.

Tzenov, P. I. & E. A. Kipriotis (2008), *Product Diversification: An Alternative for Sericulture Development in the Black, Caspian Seas and Central Asia Region Countries*, Proceedings of the 21st International Sericultural Congress, Athens. pp. 232-239.

UNCOMTRADE (2012), *Raw Silk (Not Thrown)*, United Nations Commodity Trade Statistics Database. [http://comtrade.un.org/db/mr/daCommoditiesResults.aspx?&px=H1&cc=5002, accessed 2012-07-04].

UTP (2012), *Reseña Histórica*, Universidad Tecnológica de Pereira. [http://www.utp.edu.co/granjaelpilamo/resena-historica.pdf, accessed 2012-06-14] (in Spanish)

Vieites, C. M., C. P. Basso & H. Zunini (2010), *Aporte a la Comprensión de la Situación de la Sericicultura en la Argentina y en Latinoamérica*, Instituto Nacional de Tecnología Industrial & Facultad de Agronomia en la Universidad de Buenos Aires. (in Spanish)

Watanabe, J. K., R. Yamaoka & S. A. Barini (2004), *Cadeia Produtiva da Seda: Diagnóstico e Demandas Atuais*, IAPAR, Londrina. (in Portuguese)

World Bank (1997), *World Bank Supports Reform of Bangladesh Silk Production*, World Bank. [http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/0,,contentMDK:20012462~menuPK:64282138~pagePK:41367~piPK:279616~theSitePK:40941,00.html, accessed 2012-07-31]

World Bank (2005), *Thailand Northeast Development Project*, Poverty Reduction and Economic Management Sector Unit, East Asia and Pacific Region, World Bank.

WTO (2012), *Participation in Regional Trade Agreements,* World Trade Organization. [http://www.wto.org/english/tratop_e/region_e/rta_participation_map_e.htm?country_selected=none&sense=b, accessed 2012-06-15]

Yamamoto, T. (2001), *The Use and Production of Silkworm Breeds*, National Institute of Agrobiological Sciences. [http://www.nias.affrc.go.jp/silkwave/hiroba/FYI/kaisetu/yamamoto.htm, accessed 2012-08-05] (in Japanese)

Appendix 1. List of Key Informants

2012-04-10 Mr. A. J. Porto, PhD Researcher – UPDG, Brazil.
2012-04-10 Mr. K. Sohn, Former Technical Officer – FAO, South Korea.
2012-04-19 Mr. J. Berdu, Partner – Bisa Overseas, Brazil.
2012-04-19 Mr. H. Homidy, International Silk Expert – IFAD, Italy.
2012-04-20 Mr. F. Sehnal, Head – Institute of Entomology Biology Centre, Czech Republic.
2012-04-20 Mr. P. I. Tzenov, Director – SES, Bulgaria.
2012-04-24 Mrs. K. Seng, Director – CNS, Cambodia.
2012-04-26 Mr. U. Ramseier, President – Swiss Silk, Switzerland.
2012-05-03 Mrs. M. A. Fernandez, PhD Researcher – UEM, Brazil.
2012-05-09 Mr. C. Fresquet, Secretary General – International Sericultural Commission, France.
2012-05-15 Mrs. S. Nuraeni, PhD Researcher – Hasanuddin University, Indonesia.
2012-05-15 Mr. E. Hassan, Associate Professor – UQG, Australia.
2012-05-15 Mr. Y. Banno, Associate Professor – Kyushu University, Japan.
2012-05-18 Ms. D. N. A. Hayati, Assistant Director – Ministry of Agriculture, Malaysia.
2012-05-24 Mr. A. D. Diga, Researcher – FIDA, Philippines.
2012-05-29 Mr. A. H. Miah, Director – BSRTI, Bangladesh.
2012-06-02 Mr. E. Haque, Member (Extension & Motivation) – BSRTI, Bangladesh.
2012-06-08 Mr. F. O. Bayeng Jr., Sericulture Coordinator – DoST-CAR, Philippines.
2012-06-19 Mr. E. A. Fernandez, Associate Professor – UTP, Colombia.
2012-06-20 Mrs. N. B. Mangalindan, Science Research Specialist – PTRI, Philippines.
2012-06-21 Mrs. V. R. Ocampo, Entomologist – UPLB, Philippines.
2012-06-26 Mr. Ch. Ho, Community Development Officer – Khmer Silk Villages, Cambodia.
2012-06-27 Mr. C. Gülseren, Silk Reeling Unit Manager – KOZABİRLİK, Turkey.
2012-06-27 Mr. S. Boulavong, Chief of Extension – Sericulture Research and Extension Center, Laos.
2012-06-27 Ms. S. Pandey, Government Officer – DoIED, Nepal.
2012-06-29 Mr. H. N. P. Wijayagunasekara, Senior Lecturer – University of Peradeniya, Sri Lanka.
2012-06-29 Mr. Z. Alizade, Director – SRSC, Azerbaijan.
2012-06-29 Mrs. E. K. Nguku, Sericulture Research Consultant – ICIPE, Kenya.
2012-07-02 Mr. K. Shifa O., Researcher – MARC, Ethiopia.
2012-07-03 Mr. M. Kiuchi, Director of the Entomological Science Division – NIAS, Japan.
2012-07-06 Mr. M. Ashfaq, Dean of the Faculty of Agriculture – University of Faisalabad, Pakistan.
2012-07-10 Mr. A. M. Tupes, Biologist – UNALM, Peru.
2012-07-10 Mr. E. Seitz, Partner – Osh Silk, Kyrgyzstan.
2012-07-11 Mr. R. F. Endo, Director – CENASE, Mexico.
2012-07-13 Mr. E. A. Kipriotis, Director – KARS, Greece.
2012-07-15 Mr. L. Blaser, Partner – Lao Swiss Silk, Laos.
2012-07-17 Mrs. R. E. F. Munhoz, PhD Researcher – UEM, Brazil.
2012-07-21 Mr. P. Rohde, Silk Expert – Research Institute of Natural Filaments, Uzbekistan.
2012-07-22 Mr. X. Shen, Researcher – SRICAAS, China.
2012-07-23 Mr. L. Q. Tú, Director – VIETSERI, Vietnam.
2012-07-25 Mr. J. R. Rasoanaivo, Director of Animal Resources – Ministry of Breeding, Madagascar.
2012-07-27 Mr. A. Nembri, Director – Seda y Fibras SRL, Paraguay.
2012-08-03 Mr. K. Kim, Investigator – National Academy of Agricultural Science, South Korea.
2012-08-03 Mr. J. Cunvong, CEO – Chul Thai, Thailand.
2012-08-04 Mrs. S. Trisunan, Head of Silkworm Research – Chul Thai, Thailand.
2012-08-07 Mr. S. Supasavasdebhandu, Deputy Managing Director – Jim Thompson, Thailand.
2012-08-08 Mr. B. P. Sapitula, President – DMMMSU, Philippines.
2012-08-14 Mr. M. Hussain, Deputy Director – University of Gujrat, Pakistan.
2012-08-14 Mr. Sh. A. Khan, Senior Research Officer – Lahore Sericulture Research Laboratory, Pakistan.
2012-08-14 Mr. M. Afzal, Director – Punjab Forestry Research Institute, Pakistan.
2012-08-28 Mr. S. Salimjanov, Head of the Experiment Station – TAAS, Tajikistan.
2012-08-29 Mr. R. O. Casero, Science Research Specialist – PTRI, Philippines.

Appendix 2. Correlation Matrix and Descriptive Statistics

Table 3. Correlation Matrix

	lnexpq	*inth*	*lngdp*	*lngdppartner*	*lndist*	*ftacudum*	*comlangdum*	*colonydum*	*year2002*	*year2003*	*year2004*	*year2005*	*year2006*	*year2007*	*year2008*	*year2009*
inth	0.3318															
lngdp	0.2723	0.4840														
lngdppartner	0.0293	-0.1255	-0.0746													
lndist	-0.0900	-0.0030	0.2037	0.2766												
ftacudum	-0.0511	-0.1814	-0.3849	-0.1763	-0.5213											
comlangdum	-0.0844	0.0181	0.1118	0.0215	0.0500	-0.0662										
colonydum	-0.0673	-0.0722	0.0259	0.0326	-0.1119	-0.0449	0.1417									
year2002	0.0240	0.0008	-0.0852	-0.0341	-0.0254	0.0163	-0.0320	0.0405								
year2003	0.0125	-0.0297	-0.0316	0.0138	0.0173	0.0037	-0.0195	-0.0263	-0.0888							
year2004	0.0221	-0.1134	-0.0420	-0.0331	-0.0456	0.0414	-0.0092	0.0132	-0.0964	-0.1137						
year2005	0.0435	0.3211	-0.0100	-0.0235	-0.0063	0.0025	-0.0092	-0.0321	-0.0964	-0.1137	-0.1235					
year2006	-0.0642	-0.1642	0.0002	0.0283	-0.0107	-0.0056	0.0083	0.0162	-0.0938	-0.1106	-0.1201	-0.1201				
year2007	-0.0187	0.0830	0.0621	0.0092	0.0361	-0.0160	-0.0244	-0.0054	-0.0921	-0.1087	-0.1180	-0.1180	-0.1147			
year2008	-0.0144	0.0468	0.0655	0.0414	0.0127	-0.0170	-0.0255	-0.0059	-0.0927	-0.1093	-0.1187	-0.1187	-0.1154	-0.1134		
yaer2009	0.0245	-0.0685	0.0789	0.0187	-0.0122	0.0059	0.0095	-0.0009	-0.0977	-0.1034	-0.1123	-0.1123	-0.1092	-0.1073	-0.1079	
year2010	-0.0127	-0.0179	0.0813	0.0338	-0.0093	-0.0172	0.0030	0.0020	-0.0849	-0.1001	-0.1087	-0.1087	-0.1057	-0.1038	-0.1044	-0.0988

Table 4. Descriptive Statistics

	Mean	*Standard Deviation*	Min	Max
lnexpq	7.9246	3.1811	0	16.2327
inth	3.2166	4.5932	0	18
lngdp	7.2735	1.7499	1.8271	9.2231
lngdppartner	6.2371	1.6504	0.1398	9.5837
lndist	8.5453	0.7905	5.1245	9.8152
ftacudum	0.0765	0.2656	0	1
comlangdum	0.0959	0.2946	0	1
colonydum	0.0237	0.1522	0	1
year2002	0.0700	0.2553	0	1
year2003	0.0948	0.2931	0	1
year2004	0.1099	0.3130	0	1
year2005	0.1099	0.3130	0	1
year2006	0.1045	0.3061	0	1
year2007	0.1013	0.3019	0	1
year2008	0.1024	0.3032	0	1
year2009	0.0927	0.2901	0	1
year2010	0.0873	0.2824	0	1